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## Changes in soft drinks purchased by British households associated with the UK soft drinks industry levy: controlled interrupted time series analysis

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# Changes in soft drinks purchased by British households associated with the UK soft drinks industry levy: controlled interrupted time series analysis

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## Abstract

**Objective** To determine changes in household purchases of drinks one year after implementation of the UK soft drinks industry levy (SDIL).

**Design** Controlled interrupted time series analysis.

**Participants** Households reporting their purchasing to a market research company (average weekly n=22,091), March 2014-March 2019.

**Intervention** A two tiered tax levied on manufacturers of soft drinks, announced in March 2016 and implemented in April 2018. Drinks with  $\geq 8$ g sugar/100mL (high tier) are taxed at £0.24/L, drinks with  $\geq 5$  to  $< 8$ g sugar/100mL (low tier) are taxed at £0.18/L.

**Main outcome measures** Absolute and relative differences in the volume of, and amount of sugar in, soft drinks categories, all soft drinks combined, alcohol, and confectionery purchased per household per week one year after implementation.

**Results** In March 2019, compared with the counterfactual, purchased volume of high tier drinks decreased by 140.8mL (95% confidence interval 104.3-177.3mL) per household per week, equivalent to 37.8% (47.6-28.0%), and sugar purchased in these drinks decreased by 16.2g (13.5-18.8g), or 42.6% (35.6-49.6%). Purchases of low tier drinks decreased by 170.5mL (154.5-186.5mL) or 85.8% (77.8-93.9%), with an 11.5g (9.1-13.9g) reduction in sugar in these drinks, equivalent to 87.8% (69.2-106.4%). When all soft drinks were combined irrespective of levy tier or eligibility, the volume of drinks purchased increased by 188.8mL (30.7-346.9mL) per household per week, or 2.6% (0.4-4.7%), but sugar decreased by 8.0g (2.4-13.6g), or 2.7% (0.8-4.5%). Purchases of confectionery and alcoholic drinks did not increase.

**Conclusions** Compared with trends before the SDIL was announced, one year after implementation, the volume of soft drinks purchased increased by 189mL, or 2.6% per household per week. The amount of sugar in those drinks was 8g, or 2.7%, lower per household per week. The SDIL might benefit both public health and industry.

**Trial registration** ISRCTN18042742.

## Strengths and limitations

- we used a large, nationally representative dataset, included a control category, and explored changes in two potential substitute categories (alcohol and confectionery)
- we only included purchases brought into homes
- we did not assess changes in other categories beyond soft drinks, alcohol, and confectionery
- the estimate of effect size in interrupted time series analyses is based on a modelled counterfactual that might be inaccurate
- attribution of effects in interrupted time series analyses is vulnerable to time varying confounding including co-interventions

## Introduction

High consumption of sugar sweetened beverages (SSBs) is associated with increased risk of dental caries, obesity, type 2 diabetes, and cardiovascular disease.<sup>1-3</sup> The World Health Organization recommends the use of SSB taxes to reduce consumption.<sup>4</sup> A systematic review of studies published to June 2018 suggests that SSB taxes lead to decreases in the sales, purchasing and consumption of taxed drinks.<sup>5</sup> More recent findings support this conclusion.<sup>6-10</sup> Although price is one important mediator of these changes,<sup>11-16</sup> other potential mechanisms include reformulation of products to reduce sugar concentration, smaller portion sizes, and increases in the perception of SSBs being harmful to health associated with them being grouped with other taxed products such as alcohol and tobacco.<sup>17</sup> Furthermore, any public health benefits of reduced SSB consumption associated with SSB taxes might be negated by increased consumption of substitutes such as confectionery and alcohol.<sup>18-20</sup>

The UK soft drinks industry levy (SDIL) was one of the first taxes on SSBs explicitly designed to incentivise manufacturers of SSBs to reduce sugar content.<sup>21 22</sup> This is reflected in three design features. Firstly, the SDIL is levied on manufacturers, importers, and bottlers rather than on consumers. Secondly, the levy includes two tiers: £0.24/L for drinks containing  $\geq 8$  g total sugar per 100 mL, and £0.18/L for drinks containing  $\geq 5$  g and  $< 8$  g total sugar per 100 mL. Thirdly, the SDIL was intentionally announced in 2016, two years before implementation in 2018, to allow manufacturers time to adjust. The SDIL also provides exemptions (see box 1).<sup>23</sup>

### Box 1 Glossary of terms

*Soft drinks industry levy (SDIL)*—a tiered tax on manufacturers of sugar sweetened beverages

*Levy exempt drinks*—drinks exempt from the SDIL irrespective of sugar content; that is, drinks containing  $> 75\%$  milk, drinks containing  $> 1.2\%$  alcohol, and drinks sold as alcohol replacements, drinks sold as powders, 100% fruit juices, and drinks sold by manufacturers selling less than one million litres of drinks not exempt for other reasons each year

*High tier drinks*—drinks that are not levy exempt and contain  $\geq 8$  g of sugar per 100 mL

*Low tier drinks*—drinks that are not levy exempt and contain  $\geq 5$  g to  $< 8$  g of sugar per 100 mL

*No levy drinks*—drinks that are not levy exempt but contain  $< 5$  g of sugar per 100 mL; we subdivided this category into drinks containing  $> 0$  g to  $< 5$  g of sugar per 100 mL, drinks containing 0 g of sugar per 100 mL, and bottled water

*Levy liable drinks*—drinks that are not levy exempt drinks; that is, the sum of high tier drinks, low tier drinks, and no levy drinks

*Soft drinks*—any drink not containing alcohol

*Confectionery*—products in the sugar confectionery and chocolate confectionery categories

*Toiletries*—products in the shampoo, hair conditioner, and liquid soap categories

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3 Two before and after analyses have shown reductions of around 30% in sales weighted  
4 sugar concentration of levy eligible drinks in the UK from before the announcement of the  
5 SDIL on 16 March 2016 to after implementation on 6 April 2018.<sup>24 25</sup> However, background  
6 trends in purchases of sugary drinks are not stable, with decreases reported over several  
7 years.<sup>26</sup> This makes it difficult to attribute before and after decreases in sugary drinks  
8 purchases to the SDIL. An interrupted time series analysis found that the announcement and  
9 implementation of the SDIL were together associated with a 34 percentage point reduction in  
10 the proportion of levy liable drinks with >5 g total sugar per 100 mL, indicating substantial  
11 reformulation of the market.<sup>16</sup> Changes in prices across the UK soft drink market were also  
12 reported, although it was difficult to discern clear patterns in these, with some levied  
13 categories increasing and others decreasing in price. In a controlled interrupted time series  
14 analysis including data up to the point of SDIL implementation, we found that the SDIL  
15 announcement was associated with changes in both the volume of, and sugar purchased in,  
16 drinks in many categories.<sup>27</sup> Overall we found no change in total volume of purchases of all  
17 soft drinks combined, but a small increase in sugar purchased from soft drinks of 5.3g per  
18 household per week, or 1.7%.

19 We determined whether household purchases of drinks and confectionery had changed  
20 one year after implementation of the SDIL.

## 21 **Methods**

22 Here we extend our previous analyses<sup>27</sup> to study changes in the volume of, and amount of  
23 sugar in, household purchases of drinks in each levy tier, exempt drinks categories (including  
24 alcoholic drinks), and confectionery from two years before the announcement of the SDIL to  
25 one year after its implementation (March 2014 to March 2019). As before, we used controlled  
26 interrupted time series methods, with toiletries included as a control category.<sup>27</sup> We compared  
27 observed changes associated with the announcement and implementation of the SDIL to the  
28 counterfactual scenarios in which the announcement and implementation did not take place.  
29 Including a full two years of data before the announcement enables us to estimate pre-  
30 intervention trends and project these forward as counterfactual scenarios. The protocol is  
31 published elsewhere<sup>28</sup> and the study was registered. This study is reported in accordance with  
32 the strengthening the reporting of observational studies in epidemiology (STROBE) guideline  
33 (see supplementary material A).



## Data source

We used data from a panel of households reporting their purchasing on a weekly basis to a market research company (Kantar Worldpanel; KWP). Participating households are asked to record all food and drink purchases brought into the home (including those ordered online and delivered) through barcodes scanners and manual report. Purchasing information is uploaded weekly, where it is linked to nutritional data collected by KWP field workers on a rolling basis. Households record their personal characteristics and receive gift vouchers worth about £100 (\$122; €112) annually—equivalent to 0.3% of median UK annual household income after tax in 2019 (£29 600).<sup>29</sup>

KWP samples households from across Great Britain (GB) using proprietary methods, aiming to achieve a sample that is demographically representative of GB households. It excludes households that record fewer than six purchases weekly along with those whose adjusted weekly spend is lower than an undisclosed minimum. KWP applies proprietary weights to purchases to adjust for these exclusions and maintain the representativeness of the panel. We used these weights throughout.

The main data cleaning that occurred before analysis involved assigning products and product groups in the KWP dataset to SDIL relevant groups. This was done based on KWP assigned product groups, product names, and nutritional content. In previous work we found some evidence of error, but not bias, in the sugar concentration reported by KWP compared with information provided on manufacturers' websites.<sup>27</sup>

### Product categories: drinks, confectionery, and toiletries

Purchased drinks that were levy liable were divided into high tier, low tier, or no levy based on sugar content (see box 1 for definitions). No levy drinks were additionally disaggregated, as described in box 1.

As the SDIL might have led to substitution to other drinks categories, we also examined purchasing of levy exempt drinks in several categories: milk based drinks (comprising milk, milk alternatives such as soya drinks, and yoghurt based juices and drinks), alcoholic drinks (comprising both alcoholic and alcohol replacement drinks), no added sugar fruit juices, and drinks sold as powder (eg, tea, coffee, hot chocolate). Other exempt categories (infant formulas and drinks sold for medical purposes) were excluded.

We also hypothesised that the SDIL might lead to substitution from sugary drinks to other high sugar categories. To investigate this, we used sugar and chocolate confectionery purchases (referred to as confectionery).



### Control group

To control for background trends in household purchases we used purchases of shampoo, hair conditioner, and liquid soap (ie, toiletries). Toiletries meet the proposed criteria for a controlled interrupted time series: they are robust to seasonality and may have similar purchase volumes by households regardless of socioeconomic position or other potential confounders.<sup>30</sup>

### Outcome measures

Most evaluations of SSB taxes focus on volume of drinks purchased. However, the SDIL's focus on reformulation makes the sugar purchased in drinks of additional public health interest. Thus, the outcome measures of interest were mean volume purchased per household per week in each of the drink categories and grams per household per week of confectionery; and mean sugar purchased per household per week from each of the drink categories and confectionery. Data were aggregated at the weekly level and analysed as a time series.

### Overall analysis strategy

Previous evidence indicates that reformulation occurred after the announcement of the SDIL and price changes after implementation.<sup>16</sup> As such, we hypothesised the SDIL might act as two linked interventions: the announcement on 16 March 2016 and implementation on 6 April 2018.<sup>17</sup> Thus, our analysis strategy involved three separate comparisons that isolate the announcement and implementation of the SDIL and then examine the combined effect (fig 1). In the first analysis we isolated the announcement of the SDIL. Here we compared anticipatory effects on purchasing two years after the announcement to the counterfactual estimated from purchasing in the two years before the announcement. This replicates and updates our previous analysis<sup>27</sup> as we anticipate that the stabilising effect of including additional post-announcement data likely reduces error. In the second analysis, we isolated the implementation of the SDIL. Here we compared purchasing one year after implementation to the counterfactual estimated from purchasing in the four years before implementation. In the third analysis we considered both the announcement and the implementation and we compared purchasing one year after implementation (ie three years after announcement) to the counterfactual estimated from purchasing in the two years before the announcement.

Throughout, we used the proprietary weights provided by KWP.

### **Primary analysis: category specific analyses**

For each of the three analyses we developed separate controlled interrupted time series models for volume and sugar purchased from each levy liable and levy exempt drinks category and confectionery (fig 1). Supplementary material B provides the full model specification.

We present absolute and relative differences between observed purchasing and counterfactual scenarios in the final week of each observation period, with standard errors used to calculate 95% confidence intervals for the relative difference obtained using the delta method.<sup>31</sup>

### **Secondary analysis: all soft drinks categories combined, irrespective of levy eligibility**

Levy exempt drinks include drinks that might contain comparable amounts of sugar to levy liable products. To examine the extent to which the SDIL impacted on the purchased volume of, and amount of sugar in, soft drinks, regardless of SDIL liability, we carried out controlled interrupted time series analysis, combining purchases of all soft drinks irrespective of sugar content (ie, high tier, low tier, no levy, milk and milk based drinks, no added sugar fruit juice, and drinks sold as powders), levy liable drinks irrespective of sugar content (ie, high tier, low tier, and no levy drinks), and according to sugar content based on levy tiers irrespective of levy eligibility (ie, all soft drinks with  $\geq 8$  g of sugar per 100 mL, all soft drinks with  $\geq 5$  g to  $< 8$  g of sugar per 100 mL, and all soft drinks with  $< 5$  g of sugar per 100 mL).

### **Sensitivity analysis: excluding small manufacturers**

The SDIL exempts drinks from manufacturers and producers who sell less than one million litres of levy liable drinks annually. As we were unable to obtain a list of exempt manufacturers, our main analyses include all manufacturers. We conducted sensitivity analyses to examine the effect of excluding manufacturers who we estimated to be small. The total purchase volume was summed by manufacturer by year across the five years in the KWP dataset, and a mean purchase volume per year for each manufacturer was calculated. In the first sensitivity analysis, we excluded manufacturers with a mean of less than one million litres purchased per year. Acknowledging KWP data excludes purchases not brought home, we repeated these analyses excluding manufacturers with mean annual purchased volumes of  $< 0.5$  million litres in KWP. We were unable to access accurate estimates of the proportion of all drinks purchases brought home. This value reflects an arbitrary, but we think conservative, estimate of the minimum proportion of drinks brought home.

### **Sensitivity analysis: interrupted time series without a control category**

Toiletries were chosen as a control condition a priori to account for background trends in household purchases. It is, however, possible that a more appropriate control exists. As we only have access to data on purchasing of the categories described here (confectionery, drinks, toiletries), we were not able to examine alternative potential control categories. To examine the effect of the decision to use toiletries as the control category, we performed an additional sensitivity analysis with no control condition.

### **Changes to protocol**

We made several changes to the published protocol.<sup>28</sup> KWP provided additional data that allowed us to increase the precision of our estimates. Specifically, we were able to increase the pre-announcement study period from 104 to 107 weeks and reduce the unit of analysis from purchases every four weeks to purchases every week. We originally intended to include purchases not brought home. We excluded these purchases, however, as these data were not available before mid-2015, meaning that robust pre-announcement trends could not be estimated. Although we originally intended to combine all no levy drinks, we present these disaggregated into those with >0 g and <5 g of sugar per 100 mL, 0 g of sugar per 100 mL, and bottled water, as trends for these different categories are noticeably different. Our original intention to explore potential disparities across socioeconomic groups will be pursued in future work.

### **Patient and public involvement**

The steering group for the wider SDIL evaluation includes two lay members and meets twice a year. Patients and the public were not involved in developing the research question, the outcome measures, the design, or the conduct of the work reported here. The steering group has regularly contributed ideas for routes to dissemination.

### **Results**

About 31 million purchases of drinks, confectionery, and toiletries from March 2014 to March 2019 were included from a mean of 22 091 households each week. The characteristics of included households remained consistent over the study period, and after weighting they largely reflected households in 2014-19 in the UK (see supplementary table 1).

Table 1 summarises households' weekly purchased volumes of, and amounts of sugar in, drinks and other categories over the study period. Substantial reductions in volume of, and sugar in, purchases of SDIL liable drinks were observed in the high and low tiers over time.

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3 These reductions were accompanied by a smaller increase in volume of no levy drinks  
4 purchased, but proportionally much greater increases in sugar purchased in these drinks.  
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### 7 **Primary analysis: category specific results**

8 Results of the controlled interrupted time series analyses of purchased volume of, and  
9 sugar in, levy liable drinks and confectionery are shown in figure 2 (volume) and figure 3  
10 (sugar). Absolute and relative changes are summarised in tables 2 and 3. Supplementary  
11 tables 2a and b show level and trend changes from these models. Supplementary figures 1a  
12 and b show similar figures and data for subcategories of no levy drinks and exempt  
13 categories.  
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### 19 **High tier drinks**

20 The trend in purchased volume of, and sugar in, high tier drinks continued downwards  
21 throughout the study period. The announcement of the SDIL was associated with an increase  
22 in purchased volume of (34.7ml (95% confidence intervals 8.1 to 61.4ml, or 7.3% (1.7 to  
23 12.9%)), and sugar in (5.5g (3.8 to 7.2), or 10.8% (7.4 to 14.1%)), these drinks. In contrast,  
24 the implementation of the SDIL was associated with a reduction in purchased volume of, and  
25 sugar in, these drinks. The volume of high tier drinks purchased was 171.6 mL (135.1 to  
26 208.1mL) per household per week, or 42.5% (33.5% to 51.6%), lower in March 2019  
27 compared with the counterfactual estimated from pre-implementation trends. The reductions  
28 associated with implementation outweighed the increases associated with announcement,  
29 such that the intervention as a whole was associated with a decrease in purchased volume of  
30 140.8ml (104.3 to 177.3ml) per household per week or 37.8% (28.0 to 47.6%) and sugar of  
31 16.2 g (13.5 to 18.8g) per household per week or 42.6% (35.6% to 49.6%) from these drinks.  
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### 43 **Low tier drinks**

44 Purchased volume of, and sugar in, low tier drinks gradually increased before the  
45 announcement of SDIL. The announcement was associated with a reversal of this trend.  
46 There were reductions in purchased volume of, and sugar in, low tier drinks associated with  
47 announcement, implementation and the whole intervention. Compared with the  
48 counterfactual estimated from pre-announcement trends, in March 2019 the volume of  
49 purchased low tier drinks per household per week decreased by 170.5 mL (154.5 to 186.5  
50 mL), or 85.8% (77.8 to 93.9%); and sugar purchased in these drinks decreased by 11.5 g (9.1  
51 to 13.9g) per household per week, or 87.8% (69.2 to 106.4%).  
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### **No levy drinks**

Before the announcement of the SDIL there was a gradual upward trend in volume of purchased no levy drinks but a gradual downward trend in purchased sugar. Announcement, implementation and the whole intervention were associated with increases in volume of no levy drinks purchased as well as sugar purchased from those drinks. Overall, purchased volume of no levy drinks in March 2019 was 685.5 mL (599.8 to 771.1mL) higher, equivalent to 40.2% (35.2% to 45.2%) increase compared with the counterfactual of pre-announcement trends. Equivalent figures for sugar purchased from no levy drinks were a 19.2g (16.7 to 21.6g) per household per week, equivalent to 242.8% (211.9 to 273.7%), increase.

Changes in purchased volume of subcategories within the no levy drinks group were not uniform and the overall increase in both volume and sugar purchased in this category was driven by low and no sugar drinks, rather than bottled water. The implementation, but not the announcement, of the SDIL were associated with significant decreases in bottled water purchased which led to an overall decrease in volume of bottled water purchased as a result of the whole intervention of 130.5ml (88.8 to 174.1ml) per household per week, or 15.7% (10.4 to 20.9%). In contrast, the implementation and the announcement of the SDIL were associated with increases in volume of purchased drinks with no sugar and with >0 to <5 g total sugar per 100 mL, and increases of sugar in drinks with >0 to <5g sugar per 100ml.

### **Levy exempt drinks and confectionery**

Overall, the combined announcement and implementation of the SDIL were associated with decreases in purchased volume of alcoholic and milk and milk-based drinks, but no change in sugar purchased from levy exempt categories or from confectionery. Compared with the counterfactual of pre-announcement trends, in March 2019 volume of alcoholic drinks purchased decreased by 103.1ml (53.0 to 153.3ml) per household per week, equivalent to a 5.8% (3.0 to 8.6%) reduction; and volume of milk and milk based drinks purchased decreased by 132.8ml (51.7 to 213.9ml), equivalent to a 3.6% (1.4 to 5.7%) reduction.

### **Secondary analysis: all soft drinks categories combined**

Supplementary table 3a and supplementary figure 2 summarise the results of the controlled interrupted time series analyses of the associated effects of the SDIL on purchased volume of, and sugar from, all soft drinks categories combined, irrespective of levy eligibility. Supplementary table 3b summarises absolute and relative changes in volume of, and sugar in, all soft drinks and confectionery purchased.

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3 Overall, compared with the counterfactual estimated from pre-announcement trends, a  
4 small increase was observed in volume of all soft drinks purchased in March 2019 of 188.8ml  
5 (30.7 to 346.9ml) per household per week, equivalent to a 2.6% (0.4 to 4.7%) increase. A  
6  
7 reduction was, however, found in sugar purchased in all soft drinks (including exempt drinks)  
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9 combined of 8.0g per household per week (2.4 to 13.6g), equivalent to 2.7% (0.8 to 4.5%).  
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### 12 **Sensitivity analyses**

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14 Excluding manufacturers of levy liable products with less than one million and less than  
15 500 000 litres of purchased drinks annually in our dataset was associated with small changes  
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17 in the magnitude of estimated coefficients, but with no change in the direction or statistical  
18  
19 significance of any findings (supplementary tables 4a to b).  
20

21 In general, removing the control category led to minor changes in effect estimates but  
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23 wider confidence intervals (see supplementary material G).  
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### 25 **Discussion**

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27 Taking account of pre-existing pre-announcement trends, this study found that one year  
28  
29 after implementation of the SDIL, sugar purchased from soft drinks that were taken home  
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31 decreased by 8.0 g per household per week (or 2.7%), whilst volume increased by 188.8 mL  
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33 per household per week (or 2.6%). Assuming a mean UK household size of 2.4 people,<sup>32</sup> this  
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35 is equivalent to a reduction in sugar from SSBs of 3.3 g per person per week and an increase  
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37 in volume of 79 mL per person per week, or equivalent to the replacement of 66 mL of a  
38  
39 drink with 5 g sugar per 100 mL per person per week with 145 mL of a sugar-free alternative.  
40  
41 A modelling study conducted before implementation of the SDIL found that if the levy  
42  
43 achieved reformulation it could be expected to lead to a decrease in sugar consumption from  
44  
45 SSBs (from all sources, not just for consumption at home) of 7-38 g per person per week and  
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47 that this would be associated with a reduction in the number of obese individuals in the UK  
48  
49 of 0.2-0.9% and a reduction in incidence cases of type 2 diabetes of -2.0 to 31.1 per 1000  
50  
51 person years.<sup>34</sup> The reduction in sugar from SSBs we report one year after implementation of  
52  
53 the SDIL is around half of these lower effect estimates.

### 54 **Strengths and weaknesses of this study**

55  
56 In this study we used a large, nationally representative dataset, included a control  
57  
58 category, and explored changes in two potential substitute categories (alcohol and  
59  
60 confectionery).

We only included purchases brought into homes. Although KWP also collects data on  
other purchases, this smaller panel was established in mid-2015 and so was unsuitable for our



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2  
3 analyses because robust pre-announcement trends could not be estimated. KWP data are  
4 collected at the household level and do not take account of waste or differential sharing  
5 within households. Nevertheless, the data provide a reasonable estimate of consumption.<sup>33</sup>  
6  
7 We did not assess changes in other categories beyond soft drinks, alcohol, and confectionery.  
8  
9

10 The estimate of effect size in interrupted time series analyses is based on a modelled  
11 counterfactual that might be inaccurate. For example, the strong downward trend in higher  
12 tier drinks before the announcement of SDIL might not have continued. Attribution of effects  
13 in interrupted time series analyses is vulnerable to time varying confounding including co-  
14 interventions. The SDIL is part of a wider sugar reduction strategy, although this has been  
15 found to have achieved minimal changes beyond those attributable to the SDIL.<sup>24</sup>  
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18 The personal characteristics of the panel remained similar over the study period, and  
19 proprietary weightings were used to account for non-consumers and to adjust for variations in  
20 panel composition. Households participating in KWP are slightly more likely to be from  
21 lower social grades and to have no qualifications compared with UK households generally.  
22 This might reflect the relative value placed on the small rewards for participation by different  
23 households and could limit the generalisability of our findings. If households from lower  
24 socioeconomic backgrounds are more likely to change purchasing as a result of the SDIL,  
25 then we could have marginally overestimated the effect of the SDIL. However, while we  
26 previously found that the price of soft drinks in the UK did change after implementation of  
27 the SDIL, no clear pattern was found, with the price of some groups of drinks increasing and  
28 others decreasing.<sup>16</sup> We previously found no systematic differences between the sugar  
29 content of drinks reported in KWP data and contemporaneous values listed on supermarket  
30 websites.<sup>27</sup>  
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#### 44 **Comparison with other work**

45 Our finding that the SDIL was associated with a reduction in purchased sugar from all  
46 soft drinks is consistent with previous analyses that focused on the SDIL.<sup>24 25</sup> Although our  
47 estimate of the reduction in sugar consumption from all soft drinks associated with the levy  
48 (2.7%) is less than that estimated by others (29%)<sup>24</sup> this previous estimate did not take  
49 account of pre-existing trends which we have demonstrated were on a steep downward  
50 trajectory for high tier drinks.  
51

52 We found that the reduction in purchased sugar from all soft drinks alongside a 2.6%  
53 increase in volume of all soft drinks purchased. This is consistent with previously reported  
54 reductions in the sugar concentration of drinks associated with the SDIL.<sup>16</sup> However, the  
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3 estimated effect size is below the range of reformulation scenarios modelled before  
4 implementation (ie, a reduction of 17 to 90 g of sugar per household per week).<sup>34</sup> This  
5 difference may be, at least partly, attributable to our focus on drinks taken home versus the  
6 modelling study's focus on all drinks.  
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10 Evaluations of other SSB taxes have revealed a consistent trend of reductions in  
11 purchasing of taxed drinks and no change in purchasing of untaxed drinks.<sup>5</sup> We found similar  
12 with both volume of, and sugar in, high and low tier drinks decreasing overall. However,  
13 these reductions in volume of taxed drinks were more than offset by increases in volume of  
14 no levy drinks purchased. Despite some increases in sugar purchased in no levy drinks, these  
15 did not offset decreases in sugar purchased from high and low tier drinks. The SDIL is  
16 relatively unique in being explicitly designed to encourage reformulation and there is  
17 evidence that substantial reformulation occurred.<sup>16</sup> We are not able to determine from our  
18 findings whether the changes we report are due to changes in consumer preference,  
19 formulation, or both.  
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### 28 **Meaning of the study and implications for policymakers**

29 Our main findings are that the SDIL was associated with a reduction in purchased sugar  
30 from all soft drinks with evidence of an increase in the total volume of soft drinks purchased.  
31 Given the reformulation associated with the SDIL already documented,<sup>16</sup> it is probable that  
32 the changes we report were driven by reductions in the sugar concentration of available  
33 drinks, alongside consumers switching to and, indeed increasing consumption of, lower sugar  
34 alternatives. Despite the overall reduction we found in sugar purchased in soft drinks, the  
35 average amount of sugar purchased in drinks in the no levy group paradoxically increased  
36 after implementation of the SDIL, with many drinks that previously had sugar concentrations  
37 above the levy threshold now having them just below the threshold. This seems to reflect  
38 manufacturers reformulating to target thresholds. Lowering the threshold sugar concentration  
39 at which drinks become eligible for the SDIL even further could potentially lead to greater  
40 overall reductions in sugar concentrations and sugar purchased in soft drinks, as could  
41 extension of the SDIL to milk based drinks and other currently exempt categories that  
42 sometimes contain high levels of sugar.  
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53 Nevertheless, the overall reduction in sugar with an increase in volume we report here  
54 might represent a valuable benefit for public health with potential associated benefit to the  
55 food industry. The SDIL has also been found to have had no long term negative effects on the  
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3 share value or turnover of UK soft drinks companies,<sup>35 36</sup> suggesting that, contrary to industry  
4 predictions, public health can gain without negatively affecting the soft drinks sector.

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6 We note a marked pre-implementation decline in purchasing of high levy tier drinks. It is  
7 possible that this was, at least in part, driven by concern from industry about a possible SSB  
8 tax, leading to some pre-announcement reformulation; alongside growing consumer  
9 awareness of, and concerns about, the health impacts of SSBs.<sup>37</sup> Although it is uncertain if  
10 this trend would have continued in the absence of the SDIL, it is likely to be beneficial for  
11 health.

12  
13 Reassuringly, we did not observe any increase in purchasing of potentially harmful  
14 substitutes (ie, alcohol and confectionery) associated with the SDIL, which could have  
15 partially or wholly offset any public health gains from the SDIL. However, we did not study  
16 the SDIL's effect on purchases of other food groups or on overall diet.

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18 In contrast with previous findings from Mexico and Barbados,<sup>6 38</sup> we did not observe an  
19 increase in purchased bottled water associated with the SDIL. Indeed purchases of bottled  
20 water decreased significantly during the study period (by 130.5 mL per household per week,  
21 or 15.7%). Although we cannot rule out an effect of the SDIL on bottled water purchases, we  
22 cannot think of a plausible pathway through which it achieved reductions in purchased  
23 bottled water. Instead, this reduction might be due to coincident increases in concern about  
24 single use plastic that have been attributed, in the UK, to the broadcast of the nature  
25 documentary series *Blue Planet 2* in October-December 2017.<sup>39</sup> It is not clear if a similar  
26 “Blue Planet effect” has occurred in other countries. Unlike for many other soft drinks, a like-  
27 for-like substitution is available for bottled water in countries such as the UK—that is, filling  
28 reusable water bottles with tap water. Several UK retailers have reported substantial growth  
29 in sales of reusable water bottles since 2018.<sup>40</sup> Given that tap water is freely available, it is  
30 difficult to study changes in its consumption directly.

### 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 **Unanswered questions and future research**

48 Future work should seek to understand the longer term effects of the SDIL on purchasing  
49 and consumption of soft drinks as well as total diet, and health outcomes. Differential effects  
50 of the SDIL on all these outcomes across population groups (eg, by socioeconomic position  
51 and in households with vs without children) should also be explored to determine whether the  
52 SDIL contributes to narrowing inequalities in health. The changes in purchasing we report  
53 here could be used as an input to health impact modelling to estimate the effect of changes on  
54 population prevalence of obesity, diabetes, and other chronic conditions. It is likely that the  
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3 reformulation that has occurred in response to the SDIL<sup>16</sup> reflects substantial increases in the  
4 use of artificial sweeteners in the UK soft drinks market. Given public mistrust of artificial  
5 sweeteners,<sup>37</sup> the effect of the SDIL on consumption of these should also be explored.  
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### 9 **Conclusion**

10 One year after implementation of the SDIL, purchased sugar in soft drinks decreased by  
11 around 8 g per household per week (or 2.7%) with an increase in the volume of purchased  
12 soft drinks of 189 mL per household per week (or 2.6%). This tiered tax aiming to stimulate  
13 industry to remove sugar from soft drinks might represent a benefit for public health (by  
14 reducing sugar purchased from soft drinks without substitution to confectionery and alcohol)  
15 and also to the soft drinks industry (by total volume of soft drinks purchased).  
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## Figure legends

**Fig 1** Schematic of overall analysis strategy. Solid lines=observed data; dashed lines=counterfactual estimated from previous observed data

**Fig 2** Observed and modelled volume (mls) of drinks liable to the Soft Drinks Industry Levy (SDIL), and weight of confectionery (g) purchased per household per week, March 2014 to March 2019 (weighted). Points are observed data for drinks/ confectionery; black lines (with shadows) show modelled data (and 95% confidence intervals); red lines indicate the counterfactuals had the announcement (red solid line) and implementation (red dashed line) not happened; the first dashed vertical line indicates the announcement of SDIL; the second dashed vertical line indicates the implementation of SDIL; the Y axis varies in scale between panels to maximise the resolution of figures; modelled purchases include averaged effects for seasonality and the impact of December and January (Christmas period), and, for confectionery, Easter; the control category of toiletries is shown in Fig 3

**Fig 3** Observed and modelled amount of sugar (g) in drinks liable to the Soft Drinks Industry Levy and confectionery purchased per household per week, March 2014 to March 2019 (weighted). Points are observed data for drinks/ confectionery and toiletries; black lines (with shadows) show modelled data (and 95% confidence intervals); red lines indicate the counterfactuals had the announcement (red solid line) and implementation (red dashed line) not happened; the first dashed vertical line indicates the announcement of SDIL; the second dashed vertical line indicates the implementation of SDIL; the Y axis varies in scale between panels to maximise the resolution of figures; modelled purchases include averaged effects for seasonality and the impact of December and January (Christmas period), and, for confectionery, Easter

## Contributors

MW, SC, MR, RS, HR, JA, PS, OM, AB, and TLP conceived the study and defined the analytical strategy. NR, JA, OM, TLP, and SS performed statistical analyses and provided preliminary interpretation of findings. NR, JA, OM, and TLP drafted the manuscript. All authors critically interpreted the results, revised the manuscript, provided relevant intellectual input, and read and approved the final manuscript. NR and JA had primary responsibility for the final content. JA will act as guarantor. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

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## Competing interests

All authors have completed the ICMJE uniform disclosure form at [www.icmje.org/coi\\_disclosure.pdf](http://www.icmje.org/coi_disclosure.pdf) (available on request from the corresponding author) and declare: MW was director of the National Institute for Health Research Public Health Research Funding programme when this work was conducted, and OM was on secondment at the UK Department of Health and Social Care when this work was conducted and previously worked with Public Health England; no support from any organisation for the submitted work other than that described above; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years; and no other relationships or activities that could appear to have influenced the submitted work.

## Ethical approval

Not required for secondary data analysis of anonymised data.

## Data sharing

The statistical code for the analyses are available from <https://github.com/MRC-Epid/SDILEvaluation>. Kantar Worldpanel data are not publicly available but can be purchased from Kantar Worldpanel (<http://www.kantarworldpanel.com>). The authors are not legally permitted to share the data used for this study but interested parties can contact Kantar WorldPanel representative Sean Cannon ([Sean.Cannon@kantar.com](mailto:Sean.Cannon@kantar.com)) to inquire about accessing this proprietary data.

The lead author affirms 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 planned (and, if relevant, registered) have been explained.

### **Dissemination to participants and related patient and public communities**

This work was presented at the 2020 annual scientific meeting of the Society of Social Medicine. We will issue a press release on this work and engage with media outlets as relevant. We will summarise our findings in a Twitter thread. A lay summary of this paper will be prepared in advance of publication and shared on the Medical Research Council Epidemiology Unit and Centre for Diet and Activity Research websites. We will share this summary with our networks of public health practitioners and policymakers through our social media accounts and regular e-newsletter. A lay summary of the findings of the wider project of which this is part will be made available on the National Institute for Health Research website.

For peer review only

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**Table 1** Mean volume of, and amount of sugar in, purchased drinks and confectionery per household per week in relation to the UK soft drinks industry levy, March 2014 to March 2019 (weighted)

	Mean (SD) volume (mL) per household/week			Mean (SD) amount of sugar (g) per household/week		
	Pre-announcement: Mar 2014-Mar 2016	Post-announcement: Mar 2016-Mar 2018	Post-implementation: Apr 2018-Mar 2019	Pre-announcement: Mar 2014-Mar 2016	Post-announcement: Mar 2016-Mar 2018	Post-implementation: Apr 2018-Mar 2019
<b>All drinks</b>	7595 (295)	7547 (466)	7826 (540)	364 (17)	337(24)	307(19)
<b>Levy liable drinks (sugar/100 mL)</b>						
High tier (≥8 g)	880 (128)	680 (136)	363 (76)	98(14)	76(15)	40(9)
Low tier (≥5 g to <8 g)	155 (32)	147 (37)	75 (32)	10(2)	10(2)	5(2)
No levy (<5 g):	1811 (169)	1876 (216)	2448 (321)	12(2)	12(3)	25(5)
>0 g to <5 g	785 (78)	989 (139)	768 (92)	12(2)	12(3)	25(5)
0 g	1027 (104)	1108 (132)	1459 (190)	0 (0)	0 (0)	0 (0)
Bottled water	591(72)	714(90)	786 (138)	0 (0)	0 (0)	0 (0)
<b>Levy exempt drinks</b>						
Alcoholic drinks	1874 (380)	1872 (456)	1948 (467)	.	.	.
Milk and milk based drinks:	3546 (137)	3540 (155)	3542 (148)	172 (7)	172(8)	170(7)
Fruit juices with no added sugar	516.6(29)	502(44)	520(47)	51(3)	49(4)	50(5)
Drinks sold as powders (g)	95(12)	88(11)	90(11)	21(3)	19(3)	18(3)
Confectionery (g)	308 (91)	303 (92)	318 (100)	173 (51)	170 (52)	178 (57)
Toiletries	123 (8)	120 (8)	121 (9)	.	.	.

Sugar from alcoholic drinks is not included here as many alcoholic drinks contain sugar but the product label does not provide the amount.

**Table 2** Absolute and relative change in volume of drinks (mL) and confectionery (g) purchased per household per week in relation to the UK soft drinks industry Levy, March 2014 to March 2019 (weighted)

	Analysis 1: pre-post announcement (Mar 2014-Mar 2018)		Analysis 2: pre-post implementation (Mar 2016-Mar 2019)		Analysis 3: pre-post announcement and implementation (Mar 2014-Mar 2019)	
	Absolute change (mL or g)	Relative change (%)	Absolute change (mL or g)	Relative change (%)	Absolute change (mL or g)	Relative change (%)
<b>All drinks</b>	<b>11.8 (-103.7, 127.3)</b>	0.16 (-1.42, 1.74)	<b>187.8 (29.7, 345.9)</b>	<b>2.56 (0.40, 4.71)</b>	<b>188.8 (30.7, 346.9)</b>	<b>2.6 (0.4, 4.7)</b>
<b>Levy liable drinks (sugar/100 mL)</b>						
High tier (≥8 g)	<b>34.7 (8.06, 61.4)</b>	<b>7.27 (1.69, 12.9)</b>	<b>-171.6 (-208.1,-135.1)</b>	<b>-42.5 (-51.6, -33.5)</b>	<b>-140.8 (-177.3, -104.3)</b>	<b>-37.8 (-47.6, -28.0)</b>
Low tier (≥5 g to <8 g)*	<b>-65.7 (-77.5, -53.8)</b>	<b>-37.1 (-43.7, -30.4)</b>	<b>-71.8 (-87.8, -55.8)</b>	<b>-71.8 (-87.8, -55.8)</b>	<b>-170.5 (-186.5, -154.5)</b>	<b>-85.8 (-93.9, -77.8)</b>
No levy (<5 g):	<b>181.0 (118.4, 243.5)</b>	<b>11.1 (7.26, 14.9)</b>	<b>395.0 (309.4, 480.7)</b>	<b>19.8 (15.5, 24.1)</b>	<b>685.5 (599.8, 771.1)</b>	<b>40.2 (35.2, 45.2)</b>
>0 g to <5 g	<b>103.8 (75.2, 132.5)</b>	<b>16.7 (12.1, 21.3)</b>	<b>202.0 (162.7, 241.2)</b>	<b>25.0 (20.1, 29.9)</b>	<b>374.6 (335.4, 413.9)</b>	<b>59.0 (52.8, 65.1)</b>
0 g	<b>87.8 (41.1, 134.5)</b>	<b>8.66 (4.05, 13.3)</b>	<b>178.9 (115.6, 242.3)</b>	<b>14.7 (9.52, 20.0)</b>	<b>316.1 (252.7, 379.4)</b>	<b>29.4 (23.5, 35.3)</b>
Bottled water	30.3 (-62.0, 1.4)	4.24 (-8.7, 0.2)	<b>82.1 (-125.7, -38.4)</b>	<b>-10.5 (-16.1, -4.9)</b>	<b>-130.5 (-174.1, -88.8)</b>	<b>-15.7 (-20.9, -10.4)</b>
<b>Levy exempt drinks</b>						
Alcoholic drinks	-16.5 (-48.5, 15.4)	0.95 (-2.79, 0.89)	<b>-84.9 (-135.1, -34.7)</b>	<b>-4.81 (-7.66, -1.97)</b>	<b>-103.1 (-153.3, -53.0)</b>	<b>-5.8 (-8.60, -2.97)</b>
Milk and milk based drinks	<b>-185.5 (-249.7, -121.4)</b>	<b>-4.9 (-6.60, -3.20)</b>	<b>145.5 (64.4, 226.6)</b>	<b>4.21 (1.86, 6.56)</b>	<b>-132.8 (-213.9, -51.7)</b>	<b>-3.56 (-5.73, -1.38)</b>
No added sugar fruit juices	6.8 (-6.9, 20.5)	1.4 (-1.4, 4.3)	-6.2 (-24.8, 12.5)	-1.26 (-6.1, 2.5)	8.7 (-9.9, 27.3)	1.82 (-2.1, 5.7)
Drinks sold as powders (g)	<b>-6.9 (-10.0, -3.8)</b>	<b>-6.8 (-9.9, -3.8)</b>	<b>9.6 (5.3, 13.9)</b>	<b>11.2 (6.2, 16.2)</b>	0.9 (-3.3, 5.2)	1.0 (-3.5, 5.5)
Confectionery (g)	-10.1 (-53.9, 33.8)	-2.4 (-13.1, 8.2)	39.8 (-19.0, 98.6)	11.6 (-5.5, 28.8)	35.3 (94.1, -23.5)	10.2 (-6.8, 27.1)

Bold indicates significant difference at 95% confidence interval level

**Table 3** Absolute and relative change in sugar in drinks and confectionery (g) purchased per household (95% CI) per week in relation to the UK SDIL, March 2014- March 2019 (weighted)

	Analysis 1: pre-post announcement (Mar 2014-Mar 2018)		Analysis 2: pre-post implementation (Mar 2016-Mar 2019)		Analysis 3: pre-post announcement and implementation (Mar 2014-Mar 2019)	
	Absolute change (g)	Relative change (%)	Absolute change (g)	Relative change (%)	Absolute change (g)	Relative change (%)
<b>All drinks</b>	<b>4.6 (0.5, 8.6)</b>	<b>1.4 (0.2, 2.7)</b>	<b>-12.9 (-18.5, -7.4)</b>	<b>-4.3 (-6.1, -2.4)</b>	<b>-8.0 (-13.6, -2.4)</b>	<b>-2.7 (-4.5, -0.8)</b>
<b>Levy liable drinks (sugar/100 mL)</b>						
High tier (≥8 g)	5.5 (3.8, 7.2)	10.8 (7.4, 14.1)	-21.2 (-23.8, -18.5)	-49.3 (-55.4, -43.1)	-16.2 (-18.8, -13.5)	-42.6 (-49.6, -35.6)
Low tier (≥5 g to <8 g)	-4.3 (-6.1, -2.6)	-37.5 (-52.5, -22.5)	-5.0 (-7.4, -2.6)	-75.8 (-112.7, -38.9)	-11.5 (-13.9, -9.1)	-87.8 (-106.4, -69.2)
No levy (<5 g)†	5.7 (3.9, 7.4)	72.6 (50.3, 94.9)	9.7 (7.3, 12.1)	56.0 (41.9, 70.0)	19.2 (16.7, 21.6)	242.8 (211.9, 273.7)
>0 g to <5 g sugar per 100 mL†	5.7 (3.9, 7.4)	72.6 (50.3, 94.9)	9.7 (7.3, 12.1)	56.0 (41.9, 70.0)	19.2 (16.7, 21.6)	242.8 (211.9, 273.7)
<b>Levy exempt drinks</b>						
Milk and milk based drinks	-3.9 (-6.5, -1.3)	-2.2 (-3.6, -0.7)	4.1 (0.5, 7.7)	2.4 (0.3, 4.6)	-3.1 (-6.7, 0.5)	-1.8 (-3.8, 0.3)
No added sugar fruit juices	2.6 (0.3, 4.8)	5.7 (0.7, 10.7)	-1.7 (-4.8, 1.5)	-3.5 (-10.0, 3.0)	2.6 (-0.5, 5.7)	5.9 (-1.2, 13.1)
Drinks sold as powders (g)	0.3 (-1.6, 2.2)	1.6 (-7.5, 10.6)	-0.04 (-2.7, 2.6)	-0.2 (-13.9, 13.5)	1.1 (-1.6, 3.7)	5.7 (-8.8, 20.2)
Confectionery (g)	-6.6 (-32.0, 18.9)	-2.8 (-13.8, 8.14)	22.1 (-12.0, 56.1)	11.4 (-6.2, 29.1)	18.4 (-15.7, 52.4)	9.3 (-8.0, 26.7)

The counterfactual for low tier drinks crossed 0 mL shortly before the end of the study period thus predicting negative purchases; therefore the non-counterfactual estimate at the end of the study period was compared with the final week during which the counterfactual was a positive number.

\*Significant difference at 95% confidence interval level.

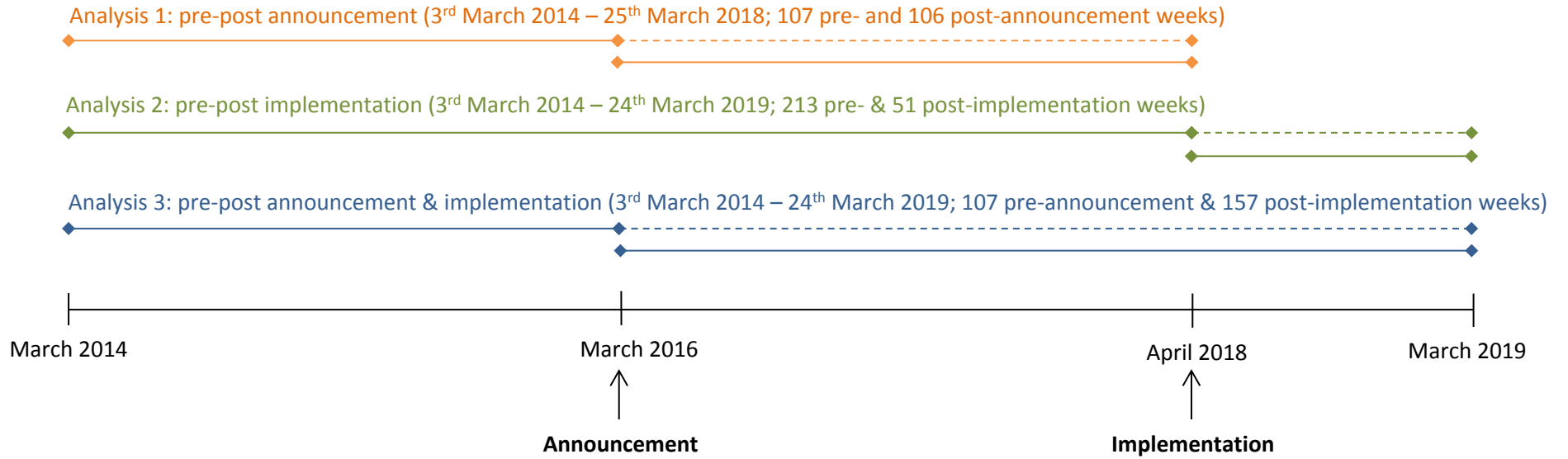
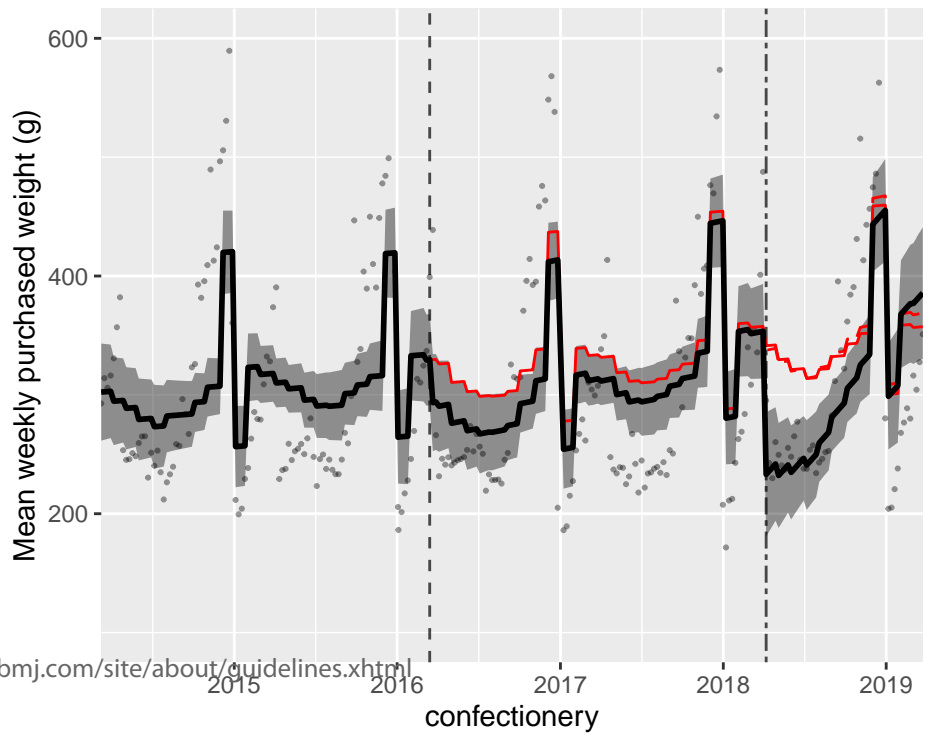
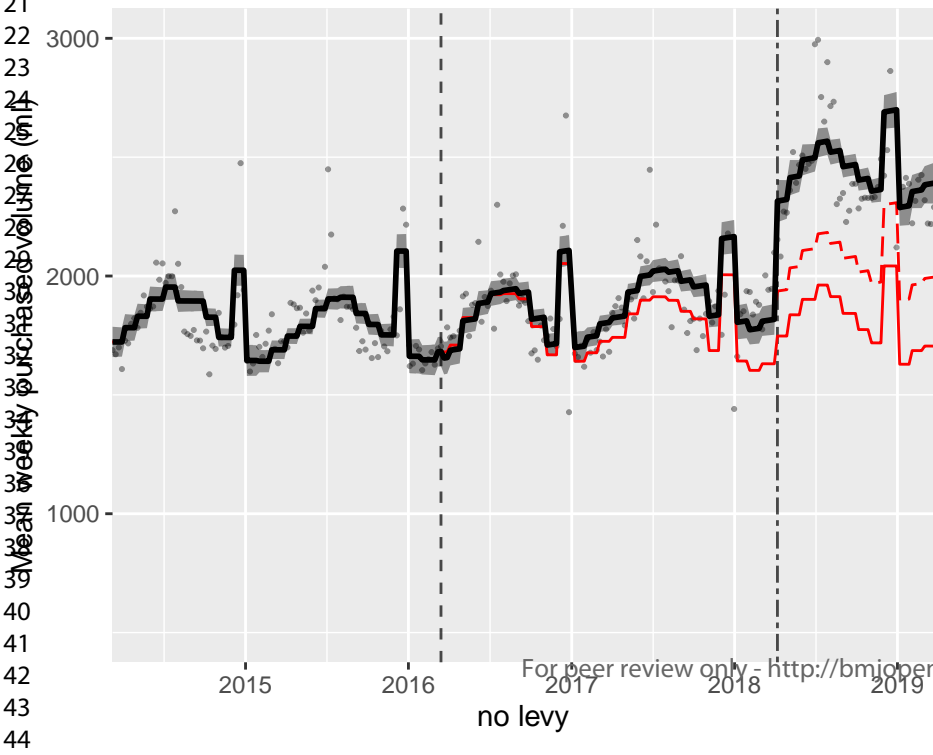
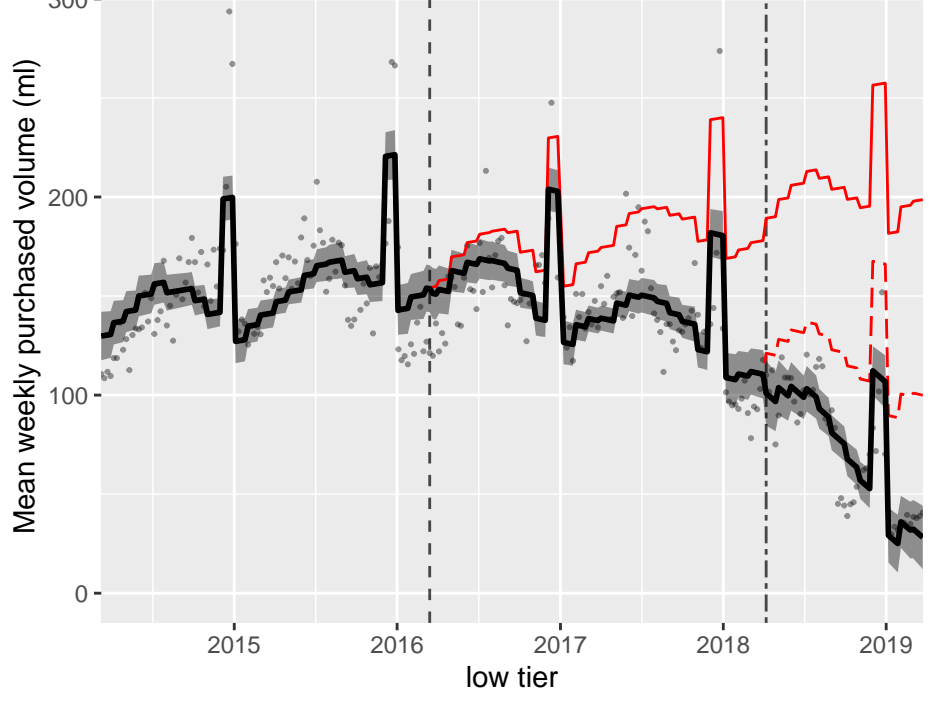
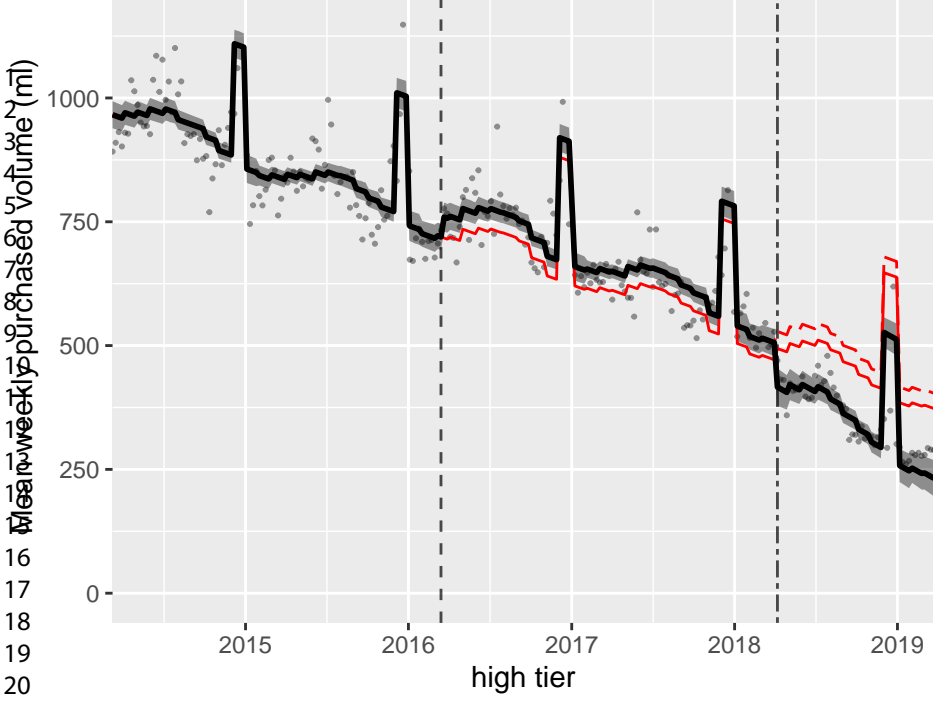


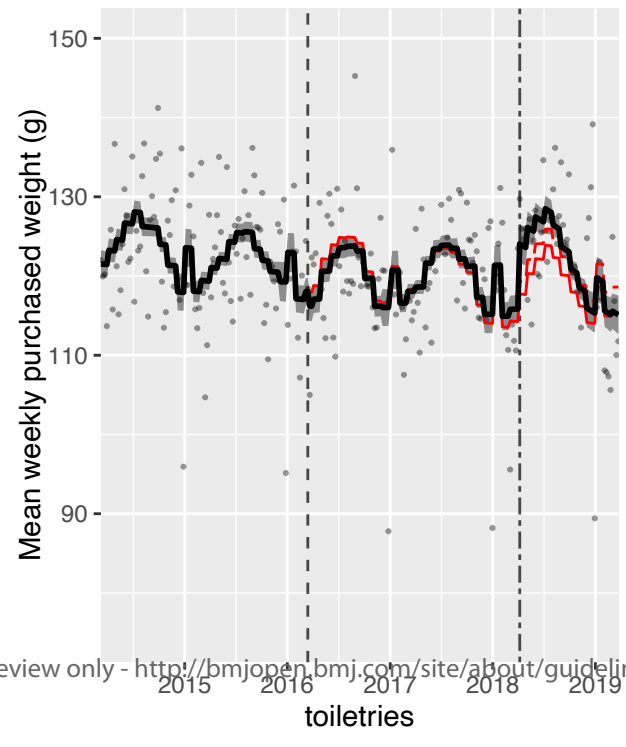
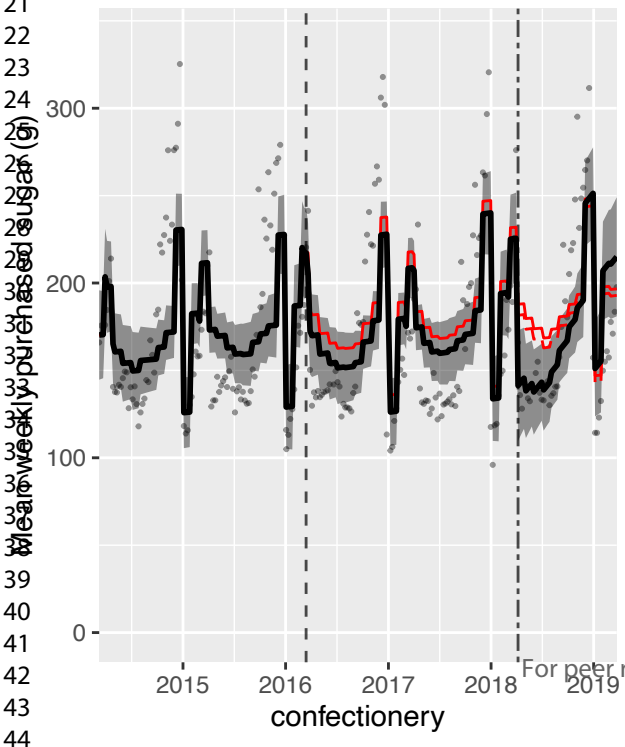
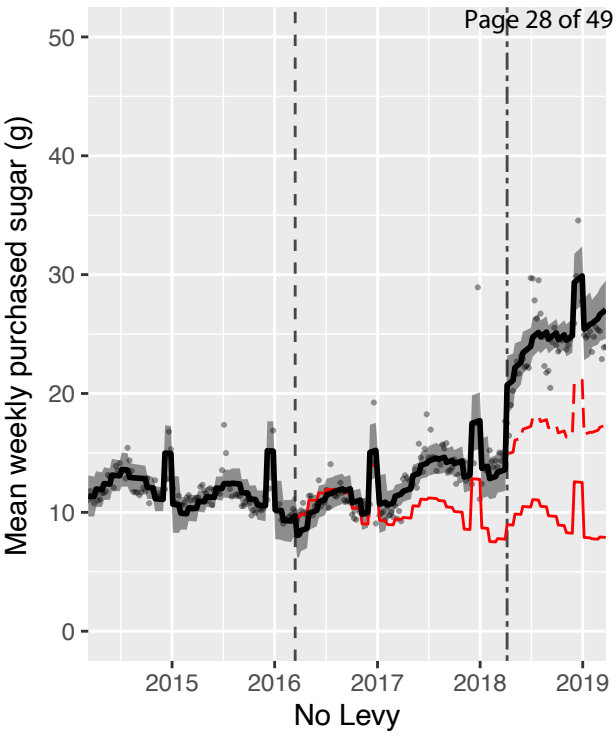
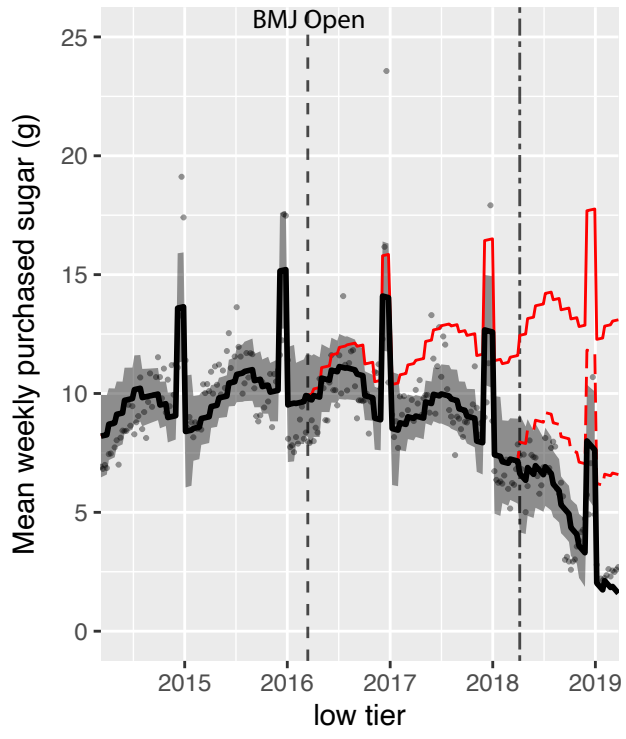
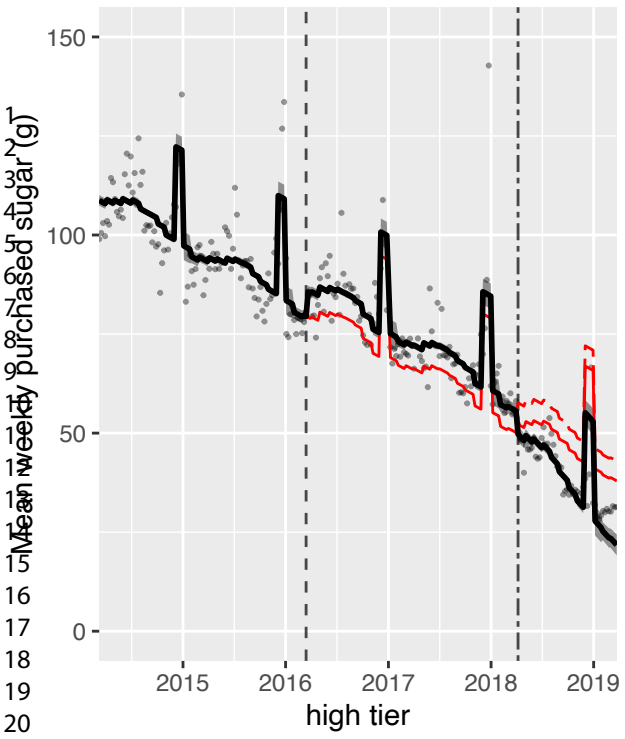
Figure 1: Schematic of overall analysis strategy

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## Supplementary material A

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Section and Paragraph No
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	Title.
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	Abstract: main outcome measures; results; conclusions.
<b>Introduction</b>			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	Introduction: paragraphs 1-3.
Objectives	3	State specific objectives, including any prespecified hypotheses	Introduction: paragraph 3-4.
<b>Methods</b>			
Study design	4	Present key elements of study design early in the paper	Methods: paragraph 1.
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Methods: data source; overall analysis strategy; Figure 1.
Participants	6	(a) <i>Cohort study</i> —Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up <i>Case-control study</i> —Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls <i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants	Methods: data source, product categories – drinks, confectionery and toiletries; control group; outcome measures.
		(b) <i>Cohort study</i> —For matched studies, give matching criteria and number of exposed and unexposed <i>Case-control study</i> —For matched studies, give matching criteria and the number of controls per case	NA.
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect	Outcome measures; overall analysis strategy; primary analysis: category specific analyses; secondary analysis: all soft drinks categories combined, irrespective of levy

		modifiers. Give diagnostic criteria, if applicable	eligibility; sensitivity analysis: excluding small manufacturers; sensitivity analysis: ITS without a control category; supplementary material B.
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Data source; overall analysis strategy; primary analysis: category specific analyses; secondary analysis: all soft drinks categories combined, irrespective of levy eligibility; sensitivity analysis: excluding small manufacturers; sensitivity analysis: ITS without a control category; supplementary material B.
Bias	9	Describe any efforts to address potential sources of bias	Product categories: drinks confectionery and toiletries; control group; sensitivity analysis: excluding small manufacturers; sensitivity analysis: ITS without a control category.
Study size	10	Explain how the study size was arrived at	Data source.
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Overall analysis strategy; primary analysis: category specific analyses; secondary analysis: all soft drinks categories combined, irrespective of levy eligibility; Box 1.
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	Control group; sensitivity analysis: ITS without a control category; Supplementary material A.
		(b) Describe any methods used to examine subgroups and interactions	Overall analysis strategy; primary analysis: category specific analyses; secondary analysis: all soft drinks categories combined, irrespective of levy eligibility.
		(c) Explain how missing data were addressed	Methods: data source
		(d) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed <i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed <i>Cross-sectional study</i> —If applicable, describe analytical methods taking account of sampling strategy	Methods: data source.
<b>Results</b>			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Results: paragraph 1.
		(b) Give reasons for non-participation at each stage	Data source.
		(c) Consider use of a flow diagram	-
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical,	Results: paragraph 1; Supplementary material C.

		social) and information on exposures and potential confounders	
		(b) Indicate number of participants with missing data for each variable of interest	Results: paragraph 1.
		(c) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)	NA.
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time	NA.
		<i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure	NA.
		<i>Cross-sectional study</i> —Report numbers of outcome events or summary measures	Results: paragraph 2; Table 1.
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Primary analysis: category specific results; high tier drinks; low tier drinks; no levy drinks; levy exempt drinks and confectionery; Figures 2-3; Tables 2-3; supplementary material D.
		(b) Report category boundaries when continuous variables were categorized	Introduction - paragraph 3; product categories: drinks, confectionery and toiletries; Box 1.
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	Tables 2-3.
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Sensitivity analysis: excluding small manufacturers; sensitivity analysis: no control category; supplementary tables 4a-b; supplementary material G.
<b>Discussion</b>			
Key results	18	Summarise key results with reference to study objectives	Summary of main findings.
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	Key strengths and limitations.
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Interpretation of findings - paragraphs 1-3.
Generalisability	21	Discuss the generalisability (external validity) of the study results	Interpretation of findings - paragraphs 4.
<b>Other information</b>			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Funding.

\*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

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3 **Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological  
4 background and published examples of transparent reporting. The STROBE checklist is best used in conjunction  
5 with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals  
6 of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information  
7 on the STROBE Initiative is available at [www.strobe-statement.org](http://www.strobe-statement.org).  
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### Supplementary material B

The model specification is given by:

$$Y_t = \beta_0 + \beta_1 T + \beta_2 A_t + \beta_3 A_t T + \beta_4 A_t Z + \beta_5 A_t TZ + \beta_6 I_t + \beta_7 I_t T + \beta_8 I_t Z + \beta_9 I_t TZ + e_t$$

$Y$	<i>Average volume of (or purchased sugar in) drink or confectionery per household per week at week <math>t</math> (<math>t=1, \dots, 264</math>)</i>
$T$	<i>Weeks since the start of the study; <math>1, \dots, 264</math></i>
$A_t$	<i>0 if <math>t</math> prior to announcement, 1 if <math>t</math> on or after announcement</i>
$I_t$	<i>0 if <math>t</math> prior to implementation, 1 if <math>t</math> on or after implementation</i>
$Z$	<i>Control category (toiletries) = 0, drink or confectionery category = 1</i>
$e_t$	<i><math>N(0, \sigma^2)</math> representing the residual variance of the model</i>

Dummy indicator variables determined to be statistically significant ( $p < 0.05$ ) were included for the intervention group as appropriate representing: interaction terms restart at 0 at the point of the interventions; the increase in purchases seen throughout December in the weeks before Christmas; the fall in purchases in the weeks immediately after Christmas; and the increase in confectionery purchases seen at Easter, for toiletries these were set to 0. To adjust for temperature-related trends in drink consumption the average UK monthly temperature was included in the intervention group with the average study period temperature used for toiletries.<sup>5</sup> Quadratic functions of announcement trends were included where they improved model fit - assessed using likelihood ratio tests. Stationary was examined using augmented Dickey-Fuller tests.<sup>41</sup> Autocorrelation between preceding time points was examined using autocorrelation and partial-autocorrelation plots. An appropriate autocorrelation structure was determined and then compared to alternative models using likelihood ratio tests. Visual inspection of the data suggested no additional benefit would be gained from including polynomial terms.

## Supplementary material C

Supplementary Table 1: Demographic characteristics of Kantar Worldpanel take-home panel households from March 2014 – March 2018 (weighted)

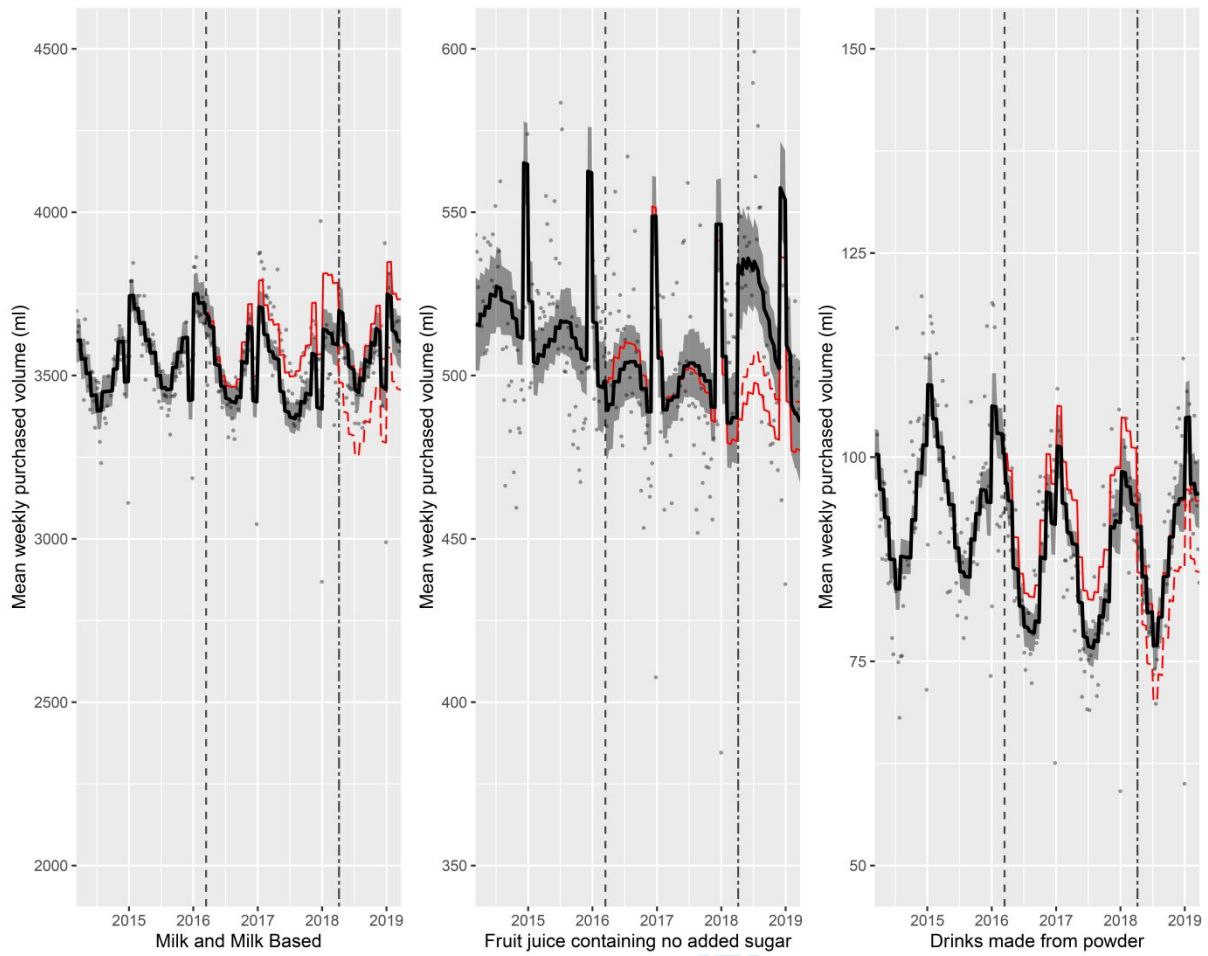
	Level	Kantar Worldpanel (%)	UK population (%)
Children in household <sup>1</sup>	No	65.3	71.5
	Yes	34.6	28.5
Social grade of chief income earner <sup>2</sup>	AB: Higher and intermediate managerial	19.3	27
	C1: Junior managerial	34.1	28
	C2: Skilled manual workers	16.4	20
	D: Semi and unskilled-manual workers	12.4	15
	E: lowest grade workers	7.9	10
Total household income (£ per annum) <sup>3</sup>	0-9,999	6.4	..
	10,000-19,999	18.9	..
	20,000-29,999	17.2	..
	30,000-39,999	13.1	....
	40,000-49,999	9.0	..
	50,000-59,999	5.5	..
	60,000-69,999	2.9	..
	70,000+	4.1	..
	Refused to answer	14.4	..
	Mean (£)	..	35,697
Median (£)	..	28,947	
Highest qualification of chief income earner <sup>4</sup>	Higher than School leaving qualifications taken at ~18 years (e.g. A-Levels)	38.3	43.8
	School leaving qualifications taken at ~18 years (e.g. A-Levels)	12.3	22.4
	School leaving qualifications taken at ~16 years (e.g. GCSE)	20.6	18.7
	Other (including no qualifications and unknown)	16.2	15.1

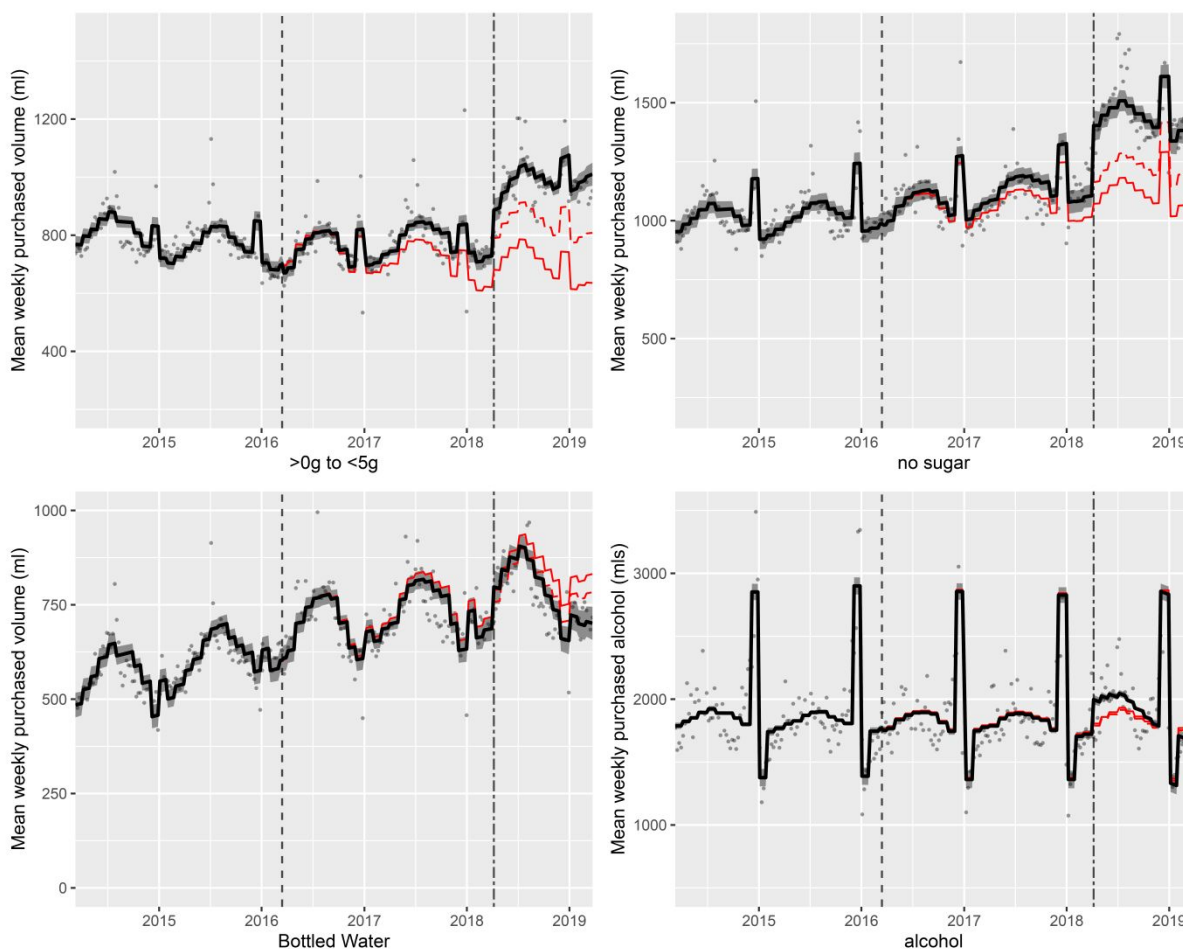
<sup>1</sup>Average of households with dependent children from 2014-2018; <sup>2</sup>UK population figures from 2016; <sup>3</sup>No directly comparable figures available from ONS, mean and medians are averaged over 2014-2019; <sup>4</sup>UK population figures from 2014



Supplementary material D

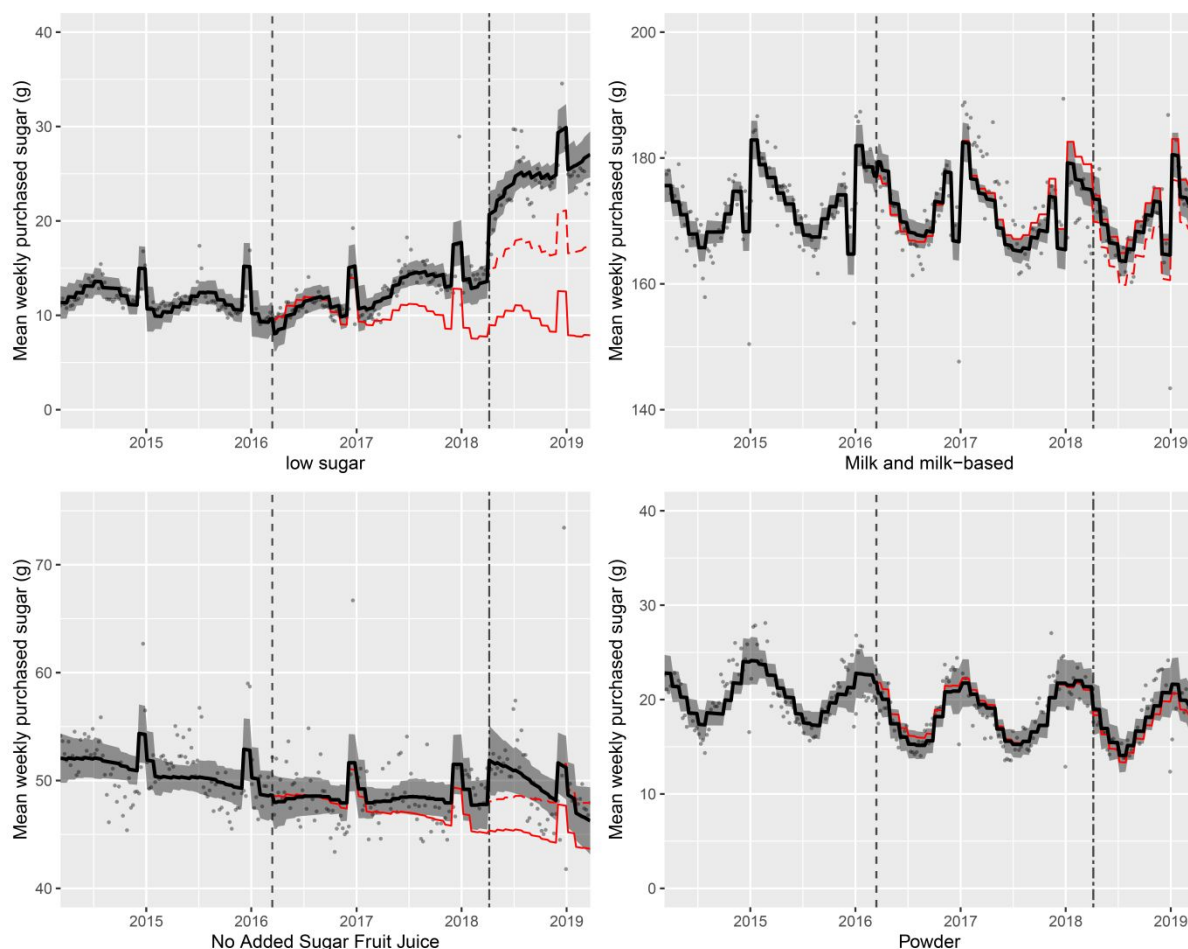
Supplementary Figure 1a. Observed and modelled volume (ml) of drinks exempt from the Soft Drinks Industry Levy purchased per household per week, March 2014- March 2019 (weighted)





Notes. Points are observed data, black lines (with shadows) are modelled data (and 95% confidence intervals); red lines indicate counterfactuals had the announcement (red solid line) and implementation (red dashed line) not happened; the first dashed vertical line indicates the point of announcement; the second dashed vertical line indicates the point of implementation; The Y-axis varies in scale between panels to maximise the resolution of figures; modelled purchases include averaged effects for seasonality and the impact of December and January (Christmas period). The control category of toiletries is shown in Figure 3.

Supplementary Figure 1b. Observed and modelled amount of sugar in drinks exempt from the Soft Drinks Industry Levy purchased per household per week, March 2014- March 2019 (weighted)



Notes. Points are observed data, black lines (with shadows) are modelled data (and 95% confidence intervals); red lines indicate counterfactuals had the announcement (red solid line) and implementation (red dashed line) not happened; the first dashed vertical line indicates the point of announcement; the second dashed vertical line indicates the point of implementation; The Y-axis varies in scale between panels to maximise the resolution of figures; modelled purchases include averaged effects for seasonality and the impact of December and January (Christmas period). The control category of toiletries is shown in Figure 3.

Supplementary Table 2a: Modelled level and trend changes in volume of drinks (ml) and confectionery (g) purchased per household per week (95% CI) in relation to the UK SDIL, March 2014 - March 2019 (weighted)

	Analysis 1: pre-post announcement (March 2014 – March 2018)		Analysis 2: pre-post implementation (March 2016 – March 2019)		Analysis 3: pre-post announcement & implementation (March 2014 – March 2019)	
	Level Change	Trend Change	Level Change	Trend Change	Level Change	Trend Change
<i>Levy liable drinks</i>						
High tier (≥8g sugar per 100ml)	44.0 (-7.7, 95.7)	-0.1 (-0.9, 0.7)	<b>-117.2 (-183.3, -51.1)</b>	1.0 (-0.9, 2.9)	-73.2 (-157.1, 10.7)	0.9 (-1.2, 3.0)
Low tier (≥5g - <8g sugar per 100ml)	-0.11 (-22.4, 22.1)	<b>-0.6 (-1.0, -0.3)</b>	-26.3 (-53.6, 1.04)	-0.81 (-1.6, 0.01)	-26.4 (-61.7, 8.8)	<b>-1.5 (-2.4, -0.6)</b>
No levy (<5g sugar per 100ml)	-28.2 (-149.4, 92.9)	<b>2.0 (0.04, 3.9)</b>	<b>372.0 (217.6, 526.4)</b>	<b>0.52 (-3.9, 4.9)</b>	<b>343.8 (147.5, 540.0)</b>	2.5 (-2.3, 7.3)
>0g to <5g sugar per 100ml	-27.1 (-82.6, 28.5)	<b>1.3 (0.4, 2.2)</b>	<b>88.1 (17.0, 159.3)</b>	<b>2.31 (0.3, 4.3)</b>	61.0 (-29.2, 151.4)	<b>3.6 (1.4, 5.8)</b>
0g sugar per 100ml	-7.37 (-93.9, 79.2)	0.9 (-0.6, 2.4)	<b>231.0 (125.2, 336.8)</b>	-0.99 (-4.3, 2.3)	<b>223.6 (87.0, 360.3)</b>	-0.08 (-3.7, 3.5)
Bottled water	6.86 (-53.4, 67.2)	-0.4 (-1.4, 0.6)	36.6 (-38.8, 112.0)	-2.24 (-4.5, 0.005)	43.5 (-53.1, 140.0)	<b>-2.6 (-5.1, -0.2)</b>
<i>Levy exempt drinks</i>						
Alcoholic drinks	-10.8 (-48.6, 27.0)	-0.07 (-0.5, 0.3)	<b>208.0 (137.9, 278.1)</b>	<b>-5.7 (-7.8, -3.6)</b>	<b>197.2 (117.6, 276.8)</b>	<b>-5.8 (-7.9, -3.7)</b>
Milk and milk based drinks <sup>1</sup>	-6.61 (-105.8, 92.6)	-1.7 (-4.0, 0.5)	<b>210.7 (98.7, 322.7)</b>	-1.2 (-5.3, 2.9)	<b>204.1 (54.4, 353.7)</b>	-2.9 (-7.6, 1.8)
No added sugar fruit juices	-8.72 (-34.3, 16.9)	0.1 (-0.3, 0.6)	30.5 (-0.9, 61.9)	-0.7 (-1.6, 0.3)	21.78 (-18.8, 62.3)	-0.5 (-1.6, 0.5)
Drinks sold as powders (g)	-1.79 (-7.8, 4.18)	-0.06 (-0.2, 0.03)	0.10 (-7.7, 7.9)	<b>0.3 (0.04, 0.5)</b>	-1.69 (-11.6, 8.17)	0.2 (-0.04, 0.4)
Confectionery (g)	-17.0 (-88.0, 54.0)	0.07 (-1.3, 1.5)	-77.9 (-163.9, 8.19)	2.4 (-0.6, 5.4)	<b>-98.9 (-206.4, -16.7)</b>	2.5 (-0.8, 5.8)

Notes. Bold indicates a significant difference at the 95% confidence interval level. <sup>1</sup>Milk comprises drinks in the following categories: semi-skimmed; specific low fat % milk (e.g. 1% fat milk); whole milk; buttermilk; modified milk; other milk; other non-cows milk; rice drink; soya milk. Skimmed milk is excluded from all analysis in this paper due to missing data.

Supplementary Table 2b: Modelled level and trend changes in sugar in drinks (ml) and confectionery (g) purchased per household per week (95% CI) in relation to the UK SDIL, March 2014 - March 2019 (weighted)

	Analysis 1: pre-post announcement (March 2014 – March 2018)		Analysis 2: pre-post implementation (March 2016 – March 2019)		Analysis 3: pre-post announcement & implementation (March 2014 – March 2019)	
	Level Change	Trend Change	Level Change	Trend Change	Level Change	Trend Change
<i>Levy liable drinks</i>						
High tier (≥8g sugar per 100ml)	<b>8.9 (6.8, 10.9)</b>	<b>-0.05 (-0.08, -0.03)</b>	<b>-11.5 (-15.3, -7.7)</b>	<b>-0.1 (-0.2, -0.02)</b>	-2.6 (-6.9, 1.6)	<b>-0.2 (-0.3, -0.07)</b>
Low tier (≥5g - <8g sugar per 100ml)	1.7 (-1.6, 5.1)	<b>-0.07 (-0.1, -0.02)</b>	<b>-6.2 (-10.6, -1.8)</b>	0.09 (-0.03, 0.2)	-4.5 (-10.0, 1.1)	0.02 (-0.1, 0.2)
No levy (<5g sugar per 100ml)	0.2 (-3.1, 3.5)	0.04 (-0.01, 0.09)	0.8 (-3.6, 5.3)	<b>0.2 (0.1, 0.4)</b>	1.0 (-4.5, 6.6)	<b>0.3 (0.2, 0.4)</b>
>0g to <5g sugar per 100ml	0.2 (-3.1, 3.5)	0.04 (-0.01, 0.09)	0.8 (-3.6, 5.3)	<b>0.2 (0.1, 0.4)</b>	1.0 (-4.5, 6.6)	<b>0.3 (0.2, 0.4)</b>
<i>Levy exempt drinks</i>						
Milk and milk based drinks <sup>1</sup>	4.1 (-0.1, 9.1)	<b>-0.09 (-0.2, -0.01)</b>	-2.0 (-8.6, 4.6)	<b>0.2 (0.01, 0.4)</b>	2.1 (-6.2, 10.4)	0.1 (-0.09, 0.3)
No added sugar fruit juices	1.0 (-3.4, 5.4)	0.001 (-0.06, 0.06)	-1.6 (-7.3, 4.1)	0.07 (-0.09, 0.2)	-0.6 (-7.8, 6.6)	0.07 (-0.1, 0.2)
Drinks sold as powders (g)	0.6 (-3.3, 4.5)	-0.02 (-0.08, 0.04)	-5.1 (-0.004, 10.2)	<b>0.2 (0.03, 0.3)</b>	-4.5 (-10.9, 1.9)	<b>0.2 (0.001, 0.3)</b>
Confectionery (g)	-8.6 (-49.7, 32.6)	0.03 (-0.8, 0.9)	-49.4 (-99.2, 0.4)	1.5 (-0.2, 3.2)	<b>-58.0 (-122.6, -6.7)</b>	1.6 (-0.4, 3.5)

Notes. Bold indicates a significant difference at the 95% confidence interval level. <sup>1</sup>Milk comprises drinks in the following categories: semi-skimmed; specific low fat % milk (e.g. 1% fat milk); whole milk; buttermilk; modified milk; other milk; other non-cows milk; rice drink; soya milk. Skimmed milk is excluded from all analysis in this paper due to missing data.

## Supplementary material E

Secondary analysis: all drinks categories combined irrespective of levy eligibility

Supplementary Table 3a: Level and trend changes in volume of, and sugar in, all drinks (ml) and confectionery (g) purchased per household per week (95% CI) in relation to the UK SDIL, March 2014 - March 2019 (weighted)

	Analysis 1: pre-post announcement (March 2014 – March 2018)		Analysis 2: pre-post implementation (March 2016 – March 2019)		Analysis 3: pre-post announcement & implementation (March 2014 – March 2019)	
	Level Change	Trend Change	Level Change	Trend Change	Level Change	Trend Change
<i>All drinks - volume</i>						
Higher tier (≥8g sugar per 100ml)	22.8 (-37.5, 83.1)	0.5 (-0.5, 1.5)	-76.8 (-154.0, 0.4)	-2.2 (-4.4, 0.01)	-54.0 (-152.0, 44.0)	-1.7 (-4.1, 0.7)
Lower tier (≥5g - <8g sugar per 100ml)	19.0 (-52.2, 90.2)	<b>-3.2 (-5.9, -0.5)</b>	27.9 (-47.8, 103.6)	-4.4 (-8.9, 0.02)	46.9 (-57.0, 150.8)	<b>-7.6 (-12.9, -2.4)</b>
Drinks containing <5g sugar per 100ml)	-152.1 (-348.3, 44.1)	2.6 (-0.7, 5.8)	<b>435.7 (187.7, 683.7)</b>	1.1 (-6.0, 8.3)	283.6 (-32.6, 599.8)	3.7 (-4.2, 11.5)
Levy liable drinks combined	15.2 (-72.9, 103.3)	0.6 (-0.8, 2.0)	-39.7 (-152.7, 73.4)	0.01 (-3.2, 3.2)	-24.5 (-167.8, 118.9)	0.6 (-2.9, 4.1)
All drinks excluding milk <sup>1</sup>	12.9 (-205.3, 231.0)	1.0 (-2.6, 4.5)	<b>347.6 (70.1, 625.0)</b>	-5.2 (-13.1, 2.7)	<b>360.5 (7.47, 713.4)</b>	-4.2 (-12.9, 4.5)
All drinks combined	33.9 (-189.0, 256.7)	-0.2 (-3.8, 3.4)	<b>453.0 (170.1, 735.9)</b>	-5.1 (-13.2, 3.0)	<b>486.9 (126.7, 847.0)</b>	-5.4 (-14.2, 3.5)
<i>All drinks – sugar</i>						
Higher tier (≥8g sugar per 100ml)	4.1 (-2.6, 10.8)	0.04 (-0.07, 1.1)	<b>-13.4 (-22.2, -4.7)</b>	-0.1 (-0.4, 0.1)	-9.3 (-20.3, 1.7)	-0.08 (-0.3, 0.2)
Lower tier (≥5g - <8g sugar per 100ml)	<b>11.0 (5.6, 16.3)</b>	<b>-0.2 (-0.3, -0.1)</b>	-2.7 (-9.67, 4.3)	-0.01 (-0.2, 0.2)	8.3 (-0.5, 17.1)	<b>-0.2 (-0.4, -0.01)</b>
Drinks containing <5g sugar per 100ml)	-6.3 (-12.2, -0.4)	<b>1.0 (0.9, 1.0)</b>	-0.7 (-8.30, 7.0)	<b>0.4 (0.2, 0.6)</b>	-7.0 (-16.6, 2.7)	<b>1.4 (1.1, 1.6)</b>
Levy liable drinks combined	5.0 (-1.8, 11.8)	-0.003 (-0.1, 0.1)	<b>-13.1 (-22.0, -4.2)</b>	0.02 (-0.2, 0.3)	-8.1 (-19.3, 3.1)	0.02 (-0.3, 0.3)
All drinks excluding milk <sup>1</sup>	3.1 (-4.6, 10.8)	0.04 (-0.08, 0.2)	-9.3 (-19.2, 0.7)	-0.09 (-0.4, 0.2)	-6.2 (-18.8, 6.4)	-0.05 (-0.4, 0.3)
All drinks combined	5.3 (-2.6, 13.2)	-0.02 (-0.1, 0.1)	-5.7 (-15.9, 4.5)	-0.08 (-0.4, 0.2)	-0.4 (-13.2, 12.5)	-0.1 (-0.4, 0.2)

Notes. Bold indicates a significant difference at the 95% confidence interval level. The levy liable drinks category is a combination of high tier, low tier and no levy drinks. <sup>1</sup>Milk comprises drinks in the following categories: semi-skimmed; specific low fat % milk (e.g. 1% fat milk); whole milk; buttermilk; modified milk; other milk; other non-cows milk; rice drink; soya milk. Skimmed milk is excluded from all analysis in this paper due to missing data.

Supplementary Table 3b: Absolute and relative change in volume of, and sugar in, all drinks and confectionery (g) purchased per household (95% CI) per week in relation to the UK SDIL, March 2014- March 2019 (weighted)

	Analysis 1: pre-post announcement (March 2014 – March 2018)		Analysis 2: pre-post implementation (March 2016 – March 2019)		Analysis 3: pre-post announcement & implementation (March 2014 – March 2019)	
	Absolute change (ml or g)	Relative change (%)	Absolute change (ml or g)	Relative change (%)	Absolute change (ml or g)	Relative change (%)
<i>All drinks - volume</i>						
High tier (≥8g sugar per 100ml)	<b>76.6 (45.6, 107.7)</b>	<b>7.5 (4.5, 10.6)</b>	<b>-190.9 (-233.5, -148.3)</b>	<b>-19.4 (-23.7, -15.1)</b>	<b>-85.6 (-128.2, -43.0)</b>	<b>-9.8 (-14.6, -4.9)</b>
Low tier (≥5g - <8g sugar per 100ml)	316.7 (-241.7, -391.7)	<b>-28.0 (-21.3, -34.6)</b>	<b>-205.2 (-295.9, -114.5)</b>	<b>-26.2 (-37.8, -14.6)</b>	<b>-693.6 (-784.3, -602.9)</b>	<b>-54.5 (-61.7, -47.4)</b>
Drinks containing <5g sugar per 100ml)	<b>114.3 (12.4, 216.2)</b>	<b>2.2 (0.2, 4.1)</b>	<b>506.7 (367.3, 646.1)</b>	<b>9.0 (6.5, 11.4)</b>	<b>760.2 (620.8, 899.6)</b>	<b>14.1 (11.5, 16.6)</b>
Levy liable drinks combined	<b>76.5 (31.1, 121.8)</b>	<b>6.0 (2.5, 9.6)</b>	-42.7 (-104.9, 19.6)	-3.3(-8.1, 1.5)	<b>66.3 (4.1, 128.6)</b>	<b>5.6 (0.3, 10.8)</b>
All drinks excluding milk <sup>1</sup>	<b>116.1 (3.3, 229.0)</b>	<b>3.3 (0.09, 6.4)</b>	79.6 (-74.8, 234.1)	2.1 (-2.0, 6.1)	<b>250.1 (95.7, 404.5)</b>	<b>6.8 (2.6, 11.0)</b>
All drinks combined	11.8 (-103.7, 127.3)	0.2 (-1.4, 1.7)	<b>187.8 (29.7, 345.9)</b>	<b>2.6 (0.4, 4.7)</b>	<b>188.8 (30.7, 346.9)</b>	<b>2.6 (0.4, 4.7)</b>
<i>All drinks – sugar</i>						
High tier (≥8g sugar per 100ml)	<b>9.3 (5.9, 12.8)</b>	<b>7.6 (4.8, 10.4)</b>	<b>-22.9 (-27.8, -18.1)</b>	<b>-19.4 (-23.4, -15.3)</b>	<b>-9.99 (-14.8, -5.18)</b>	<b>-9.5 (-14.0, -4.9)</b>
Low tier (≥5g - <8g sugar per 100ml)	<b>-9.7 (-12.5, -6.9)</b>	<b>-18.6 (-23.9, -13.3)</b>	<b>-7.2 (-11.0, -3.4)</b>	<b>-19.4 (-29.7, -9.1)</b>	<b>-26.7 (-30.5, -22.9)</b>	<b>-47.1 (-53.9, -40.4)</b>
Drinks containing <5g sugar per 100ml)	<b>5.1 (2.1, 8.1)</b>	<b>3.6 (1.5, 5.8)</b>	<b>16.7 (12.5, 20.9)</b>	<b>11.2 (8.4, 14.0)</b>	<b>28.6 (24.4, 32.8)</b>	<b>20.9 (17.9, 23.9)</b>
Levy liable drinks combined	<b>6.1 (2.6, 9.6)</b>	<b>8.6 (3.6, 13.5)</b>	<b>-15.5 (-20.4, -10.7)</b>	<b>-22.7 (-29.8, -15.6)</b>	<b>-8.0 (-12.9, -3.2)</b>	<b>-13.2 (-21.1, -5.2)</b>
All drinks excluding milk <sup>1</sup>	<b>8.9 (5.0, 12.8)</b>	<b>6.5 (3.6, 9.4)</b>	<b>-17.2 (-22.7, -11.8)</b>	<b>-12.7 (-16.7, -8.67)</b>	<b>-4.5 (-10.0, 1.0)</b>	<b>-3.7 (-8.1, 0.8)</b>
All drinks combined	<b>4.6 (0.5, 8.6)</b>	<b>1.4 (0.2, 2.7)</b>	<b>-12.9 (-18.5, -7.4)</b>	<b>-4.3 (-6.1, -2.4)</b>	<b>-8.0 (-13.6, -2.4)</b>	<b>-2.7 (-4.5, -0.8)</b>

Notes. Bold indicates a significant difference at the 95% confidence interval level. The levy liable drinks category is a combination of high tier, low tier and no levy drinks. <sup>1</sup>Milk comprises drinks in the following categories: semi-skimmed; specific low fat % milk (e.g. 1% fat milk); whole milk; buttermilk; modified milk; other milk; other non-cows milk; rice drink; soya milk. Skimmed milk is excluded from all analysis in this paper due to missing data.



**Supplementary material F**

Sensitivity analysis: excluding small manufacturers

Supplementary table 4a: Modelled level and trend changes in volume of, and sugar in, drinks (ml) purchased per household per week (95% CI) in relation to the UK SDIL, March 2014 - March 2019; excluding small manufacturers (weighted)

	Analysis 1: pre-post announcement (March 2014 – March 2018)		Analysis 2: pre-post implementation (March 2016 – March 2019)		Analysis 3: pre-post announcement & implementation (March 2014 – March 2019)	
	Level Change	Trend Change	Level Change	Trend Change	Level Change	Trend Change
<i>Volume</i>						
<i>High levy tier (≥8g sugar per 100ml)</i>						
All Manufacturers	44.0 (-7.7, 95.7)	-0.1 (-0.9, 0.7)	<b>-117.2 (-183.3, -51.1)</b>	1.0 (-0.9, 2.9)	-73.2 (-157.1, 10.7)	0.9 (-1.2, 3.0)
Excluding Manufacturers with <1M Litres	41.5 (-9.7, 92.7)	-0.09 (-0.9, 0.7)	<b>-111.9 (-177.3, -46.6)</b>	-1.1 (-2.9, 0.8)	-70.8 (-153.4, 12.6)	-1.2 (-3.2, 0.9)
Excluding Manufacturers with <0.5M Litres	41.5 (-9.7, 92.7)	-0.09 (-0.9, 0.7)	<b>-111.9 (-177.3, -46.6)</b>	-1.1 (-2.9, 0.8)	-70.8 (-153.4, 12.6)	-1.2 (-3.2, 0.9)
<i>Low levy tier (≥5g - &lt;8g sugar per 100ml)</i>						
All Manufacturers	-0.1 (-22.4, 22.1)	<b>-0.6 (-1.0, -0.3)</b>	-26.3 (-53.6, 1.0)	-0.8 (-1.6, 0.01)	-26.4 (-61.7, 8.8)	<b>-1.5 (-2.4, -0.6)</b>
Excluding Manufacturers with <1M Litres	-2.1 (-24.0, 19.9)	<b>-0.7 (-1.0, -0.3)</b>	-20.9 (-47.5, 5.7)	<b>-0.9 (-1.8, -0.1)</b>	-23.0 (-57.5, 11.6)	<b>-1.6 (-2.5, -0.7)</b>
Excluding Manufacturers with <0.5M Litres	-2.1 (-24.0, 19.6)	<b>-0.7 (-1.0, -0.3)</b>	-20.7 (-47.3, 5.9)	<b>-0.9 (-1.8, -0.1)</b>	-22.9 (-57.2, 11.5)	<b>-1.6 (-2.5, -0.7)</b>
<i>Sugar</i>						
<i>High tier (≥8g sugar per 100ml)</i>						
All Manufacturers	<b>8.9 (6.8, 10.9)</b>	<b>-0.05 (-0.08, -0.03)</b>	<b>-11.5 (-15.3, -7.7)</b>	<b>-0.1 (-0.2, -0.02)</b>	-2.6 (-6.9, 1.6)	<b>-0.2 (-0.3, -0.07)</b>
Excluding Manufacturers with <1M Litres	4.5 (-1.3, 10.2)	-0.03 (-0.1, 0.06)	<b>-13.5 (-20.8, -6.1)</b>	-0.07 (-0.3, 0.1)	-9.0 (-18.3, 0.4)	-0.1 (-0.3, 0.1)
Excluding Manufacturers with <0.5M Litres	4.5 (-1.3, 10.2)	-0.03 (-0.1, 0.06)	<b>-13.5 (-20.8, -6.1)</b>	-0.07 (-0.3, 0.1)	-9.0 (-18.3, 0.4)	-0.1 (-0.3, 0.1)
<i>Low tier (≥5g - &lt;8g sugar per 100ml)</i>						
All Manufacturers	1.7 (-1.6, 5.1)	<b>-0.07 (-0.1, -0.02)</b>	<b>-6.2 (-10.6, -1.8)</b>	0.09 (-0.03, 0.2)	-4.5 (-10.0, 1.1)	0.02 (-0.1, 0.2)
Excluding Manufacturers with <1M Litres	-0.4 (-2.1, 1.3)	<b>-0.07 (-0.1, -0.04)</b>	<b>-2.5 (-4.6, -0.4)</b>	0.002 (-0.06, 0.06)	<b>-3.0 (-5.7, -0.2)</b>	-0.007 (-0.1, 0.0001)
Excluding Manufacturers with <0.5M Litres	-0.5 (-2.1, 1.2)	<b>-0.07 (-0.1, -0.04)</b>	<b>-2.5 (-4.7, -0.4)</b>	0.003 (-0.06, 0.06)	<b>-3.0 (-5.7, -0.2)</b>	-0.007 (-0.1, 0.0001)

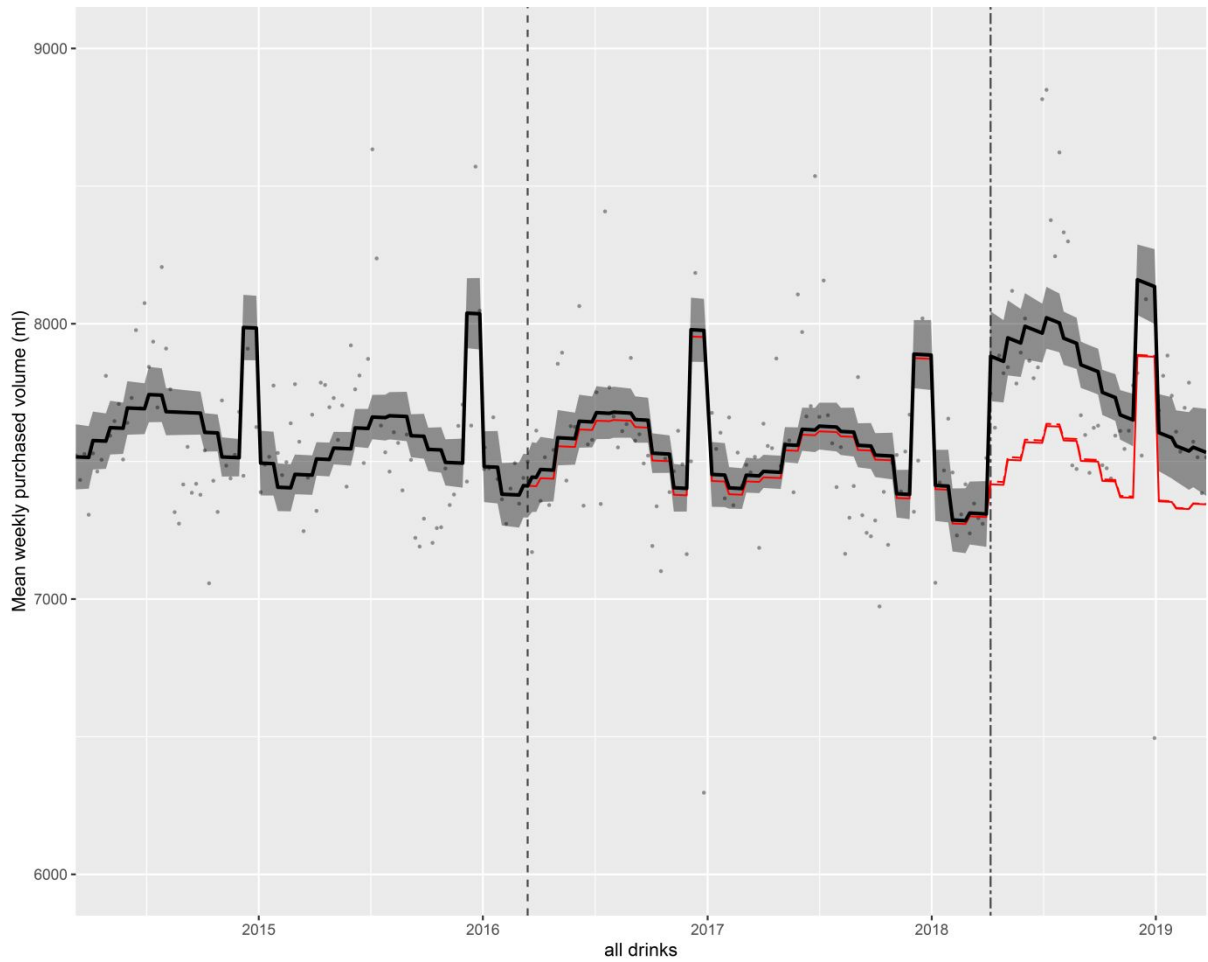
Notes. Bold indicates a significant difference at the 95% confidence interval level.

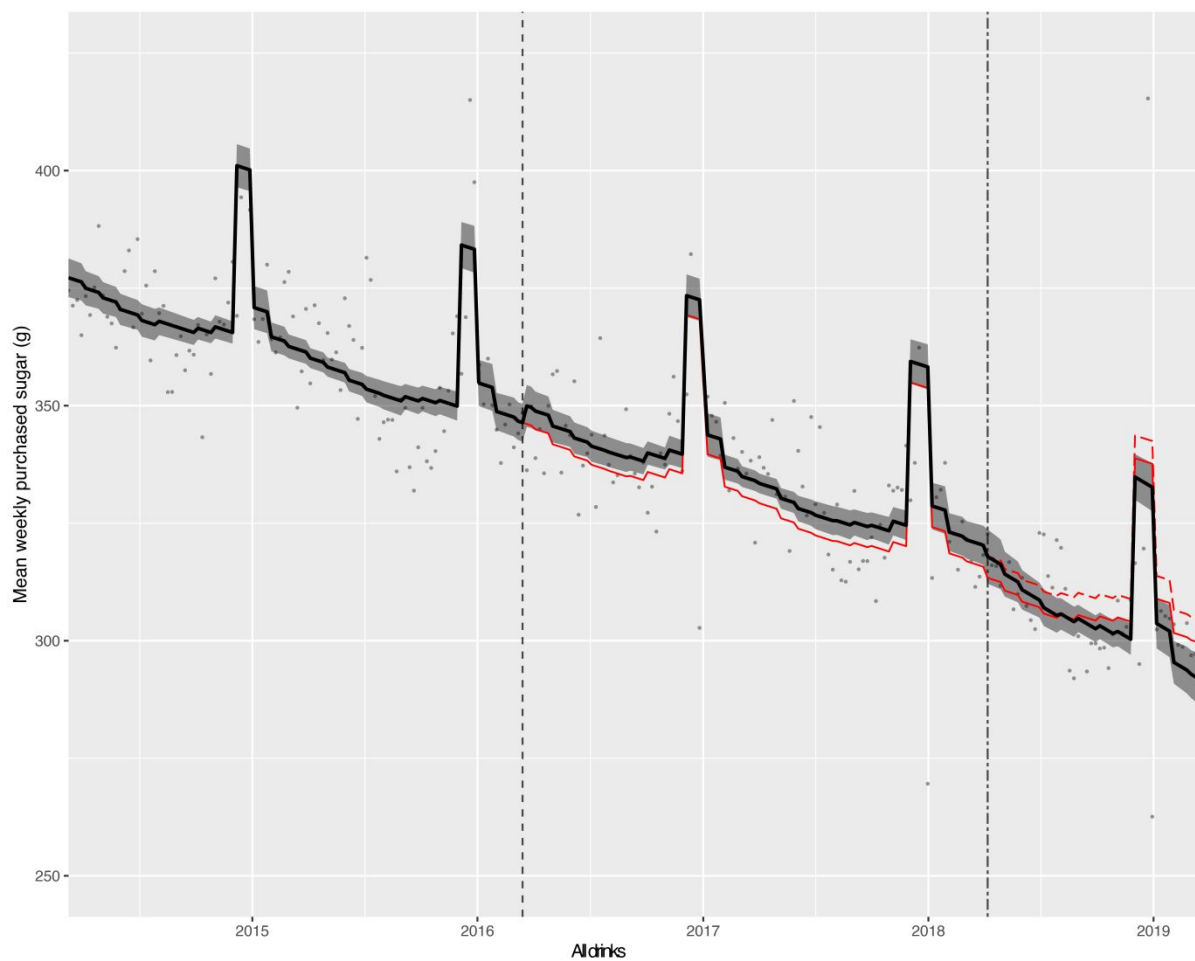
Supplementary Table 4b: Modelled absolute and relative change in volume of, and sugar in, all drinks (ml) purchased per household (95% CI) per week in relation to the UK SDIL, March 2014- March 2019; excluding small manufacturers (weighted)

	Analysis 1: pre-post announcement (March 2014 – March 2018)		Analysis 2: pre-post implementation (March 2016 – March 2019)		Analysis 3: pre-post announcement & implementation (March 2014 – March 2019)	
	Absolute change (ml)	Relative change (%)	Absolute change (ml)	Relative change (%)	Absolute change (ml)	Relative change (%)
<i>Volume</i>						
<i>High tier (≥8g sugar per 100ml)</i>						
All Manufacturers	<b>34.7 (8.1, 61.4)</b>	<b>7.3 (1.7, 12.9)</b>	<b>-171.6 (-208.1, -135.1)</b>	<b>-42.5 (-51.6, -33.5)</b>	<b>-140.8 (-177.3, -104.3)</b>	<b>-37.8 (-47.6, -28.0)</b>
Excluding Manufacturers with <1M Litres	<b>35.3 (8.9, 61.6)</b>	<b>7.5 (1.9, 13.1)</b>	<b>-168.1 (-204.2, -131.9)</b>	<b>-42.6 (-51.7, -33.4)</b>	<b>-136.2 (-172.3, -100.1)</b>	<b>-37.6 (-47.5, -27.6)</b>
Excluding Manufacturers with <0.5M Litres	<b>35.3 (8.9, 61.6)</b>	<b>7.5 (1.9, 13.1)</b>	<b>-168.1 (-204.2, -131.9)</b>	<b>-42.6 (-51.7, -33.4)</b>	<b>-136.2 (-172.3, -100.1)</b>	<b>-37.6 (-47.5, -27.6)</b>
<i>Low tier (≥5g - &lt;8g sugar per 100ml)</i>						
All Manufacturers	<b>-65.7 (-77.5, -53.8)</b>	<b>-37.1 (-43.7, -30.4)</b>	<b>-71.8 (-87.8, -55.8)</b>	<b>-71.8 (-87.8, -55.8)</b>	<b>-170.5 (-186.5, -154.5)</b>	<b>-85.8 (-93.9, -77.8)</b>
Excluding Manufacturers with <1M Litres	<b>-66.4 (-78.2, -54.6)</b>	<b>-37.6 (-44.3, -30.9)</b>	<b>-71.2 (-87.1, -55.3)</b>	<b>-72.5 (-88.7, -56.3)</b>	<b>-171.1 (-187.0, -155.2)</b>	<b>-86.4 (-94.4, -78.4)</b>
Excluding Manufacturers with <0.5M Litres	<b>-66.5 (-78.2, -54.7)</b>	<b>-37.6 (-44.2, -31.0)</b>	<b>-71.3 (-87.1, -55.5)</b>	<b>-72.4 (-88.5, -56.3)</b>	<b>-171.2 (-187.1, -155.4)</b>	<b>-86.3 (-94.3, -78.3)</b>
<i>Sugar</i>						
<i>High tier (≥8g sugar per 100ml)</i>						
All Manufacturers	<b>5.5 (3.8, 7.3)</b>	<b>10.8 (7.4, 14.1)</b>	<b>-21.2 (-23.8, -18.5)</b>	<b>-49.3 (-55.4, -43.1)</b>	<b>-16.2 (-18.8, -13.5)</b>	<b>-42.6 (-49.6, -35.6)</b>
Excluding Manufacturers with <1M Litres	<b>4.7 (1.7, 7.7)</b>	<b>9.3 (3.4, 15.1)</b>	<b>-19.3 (-23.4, -15.2)</b>	<b>-44.3 (-53.6, -35.0)</b>	<b>-14.6 (-18.7, -10.6)</b>	<b>-37.6 (-48.1, -27.1)</b>
Excluding Manufacturers with <0.5M Litres	<b>4.7 (1.7, 7.7)</b>	<b>9.3 (3.4, 15.1)</b>	<b>-19.3 (-23.4, -15.2)</b>	<b>-44.3 (-53.6, -35.0)</b>	<b>-14.6 (-18.7, -10.6)</b>	<b>-37.6 (-48.1, -27.1)</b>
<i>Low tier (≥5g - &lt;8g sugar per 100ml)</i>						
All Manufacturers	<b>-4.3 (-6.1, -2.6)</b>	<b>-37.5 (-52.5, -22.5)</b>	<b>-5.0 (-7.4, -2.6)</b>	<b>-75.8 (-112.7, -38.9)</b>	<b>-11.5 (-13.9, -9.07)</b>	<b>-87.8 (-106.4, -69.2)</b>
Excluding Manufacturers with <1M Litres	<b>-4.7 (-5.5, -3.8)</b>	<b>-39.1 (-46.5, -31.7)</b>	<b>-4.8 (-6.0, -3.6)</b>	<b>-73.0 (-91.3, -54.7)</b>	<b>-11.8 (-13.0, -10.6)</b>	<b>-86.9 (-95.8, -78.1)</b>
Excluding Manufacturers with <0.5M Litres	<b>-4.7 (-5.6, -3.8)</b>	<b>-39.1 (-46.5, -31.8)</b>	<b>-4.8 (-6.0, -3.6)</b>	<b>-72.9 (-91.1, -54.6)</b>	<b>-11.8 (-13.0, -10.6)</b>	<b>-86.9 (-95.7, -78.0)</b>

Notes. Bold indicates a significant difference at the 95% confidence interval level.

Supplementary Figure 2. Observed and modelled volume (ml) and amount of sugar (g) in all drinks combined purchased per household per week, March 2014- March 2019 (weighted)





Notes. Points are observed data, black lines (with shadows) are modelled data (with 95% confidence intervals); red lines indicate the counterfactuals had the announcement (red solid line) and implementation (red dashed line) not happened; the first dashed vertical line indicates the point of announcement; the second dashed vertical line indicates the point of implementation; The Y-axis varies in scale between panels to maximise the resolution of figures; modelled purchases include averaged effects for seasonality and the impact of December and January (the Christmas period). The control category of toiletries is shown in Fig 3.

**Supplementary material G**

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6 Removing the control category led to wider confidence intervals in a small number of cases such that  
7 absolute and relative changes in volume were not significantly different from the pre-  
8 implementation counterfactuals for no levy drinks and the pre-announcement and post  
9 implementation counterfactual for drinks containing 0g of sugar per 100ml. Significantly lower  
10 volumes of purchased volumes of powdered drinks were seen following the announcement in the  
11 controlled analysis unlike in the uncontrolled analysis. In the uncontrolled analysis absolute and  
12 relative differences in the amount of sugar in milk based drinks were significantly different from the  
13 pre-implementation counterfactual but not significantly different when examining the impact of the  
14 SDIL overall. Additionally the amount of sugar in confectionery was not significantly different from  
15 the pre-announcement counterfactual in the uncontrolled ITS analysis unlike in the controlled  
16 analysis.  
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Supplementary Table 5a: Level and trend changes in volume of drinks (ml) and confectionery (g) purchased per household per week (95% CI) in relation to the UK SDIL, March 2014 - March 2019 without toiletries as a control condition (weighted)

	Analysis 1: pre-post announcement (March 2014 – March 2018)		Analysis 2: pre-post implementation (March 2016 – March 2019)		Analysis 3: pre-post announcement & implementation (March 2014 – March 2019)	
	Level Change	Trend Change	Level Change	Trend Change	Level Change	Trend Change
<i>Levy liable drinks</i>						
High tier (≥8g sugar per 100ml)	42.3 (-9.4, 94.0)	-0.07 (-0.9, 0.8)	<b>-111.2 (-177.1, -45.3)</b>	-1.2 (-3.0, 0.7)	-68.9 (-152.7, 14.9)	-1.3 (-3.3, 0.8)
Low tier (≥5g - <8g sugar per 100ml)	-2.2 (-24.1, 19.8)	<b>-0.6 (-1.0, -0.2)</b>	-18.9 (-45.8, 8.0)	-1.0 (1.9, -0.2)	-21.1 (-55.75, 13.6)	<b>-1.7 (-2.6, -0.7)</b>
No levy (<5g sugar per 100ml)	-29.8 (-150.9, 91.3)	<b>2.0 (0.08, 4.0)</b>	<b>378.1 (223.7, 532.5)</b>	<b>0.3 (0.5, 2.0)</b>	<b>348.3 (152.0, 544.6)</b>	2.4 (-2.4, 7.2)
>0g to <5g sugar per 100ml	-27.9 (-78.3, 22.5)	<b>1.3 (0.5, 2.0)</b>	<b>98.0 (32.7, 163.3)</b>	<b>2.1 (0.3, 3.9)</b>	70.1 (-12.4, 152.6)	<b>3.4 (1.4, 5.4)</b>
0g sugar per 100ml	-2.0 (-75.5, 71.5)	0.8 (-0.4, 2.0)	<b>278.9 (185.6, 372.2)</b>	-1.7 (-4.4, 1.0)	<b>276.9 (158.2, 395.7)</b>	-0.9 (-3.9, 2.0)
Bottled water	9.9 (-49.1, 68.9)	-0.4 (-1.4, 0.6)	53.5 (-20.8, 127.8)	-2.6 (-4.7, 0.4)	63.4 (-31.5, 158.2)	<b>-2.9 (-5.3, -0.6)</b>
<i>Levy exempt drinks</i>						
Alcoholic drinks	-13.3 (-51.0, 24.4)	-0.03 (-0.4, 0.4)	<b>212.7 (142.5, 282.9)</b>	<b>-5.8 (-7.9, -3.8)</b>	<b>199.4 (119.8, 279.1)</b>	<b>-5.9 (-8.0, -3.8)</b>
Milk and milk based drinks <sup>1</sup>	26.0 (-35.7, 87.7)	<b>-1.1 (-2.0, -0.09)</b>	75.7 (-4.5, 155.9)	0.6 (-1.6, 2.8)	<b>101.7 (0.52, 202.9)</b>	-0.5 (-2.9, 2.0)
No added sugar fruit juices	-9.9 (-35.0, 15.2)	0.2 (-0.3, 0.6)	<b>40.9 (10.1, 71.7)</b>	-0.9 (-1.9, 0.02)	31.0 (-8.73, 70.7)	-0.8 (-1.8, 0.3)
Drinks sold as powders (g)	-3.4 (-9.01, 2.20)	-0.03 (-0.1, 0.06)	5.66 (-1.6, 12.9)	0.07 (-0.1, 0.3)	2.25 (-6.90, 11.4)	0.04 (-0.2, 0.3)
Confectionery (g)	-20.5 (-90.8, 49.8)	0.7 (-1.3, 1.5)	-70.6 (-155.8, 14.6)	<b>2.2 (0.7, 3.7)</b>	-91.1 (-201.5, 19.3)	2.3 (-2.2, 6.8)

Notes. Bold indicates a significant difference at the 95% confidence interval level. <sup>1</sup>Milk comprises drinks in the following categories: semi-skimmed; specific low fat % milk (e.g. 1% fat milk); whole milk; buttermilk; modified milk; other milk; other non-cows milk; rice drink; soya milk. Skimmed milk is excluded from all analysis in this paper due to missing data.

Supplementary Table 5b: Level and trend changes in sugar in drinks (ml) and confectionery (g) purchased per household per week (95% CI) in relation to the UK SDIL, March 2014 - March 2019 without toiletries as a control condition (weighted)

	Analysis 1: pre-post announcement (March 2014 – March 2018)		Analysis 2: pre-post implementation (March 2016 – March 2019)		Analysis 3: pre-post announcement & implementation (March 2014 – March 2019)	
	Level Change	Trend Change	Level Change	Trend Change	Level Change	Trend Change
<i>Levy liable drinks</i>						
High tier (≥8g sugar per 100ml)	4.8 (-1.0, 10.6)	-0.008 (-0.1, 0.09)	<b>-12.1 (-19.5, -4.8)</b>	-0.2 (-0.4, 0.06)	-7.3 (-16.6, 2.0)	-0.2 (-0.4, 0.07)
Low tier (≥5g - <8g sugar per 100ml)	-0.2 (-1.7, 1.2)	<b>-0.4 (-0.5, -0.4)</b>	-1.2 (-2.9, 0.6)	<b>-0.07 (-0.1, -0.01)</b>	-1.4 (-3.7, 0.9)	<b>-0.5 (-0.6, -0.5)</b>
No levy (<5g sugar per 100ml)	1.7 (-0.2, 3.3)	<b>0.07 (0.04, 0.1)</b>	<b>5.2 (3.2, 7.2)</b>	<b>0.08 (0.02, 0.1)</b>	<b>6.9 (4.4, 9.5)</b>	<b>0.2 (0.09, 0.2)</b>
>0g to <5g sugar per 100ml	1.7 (-0.2, 3.3)	<b>0.07 (0.04, 0.1)</b>	<b>5.2 (3.2, 7.2)</b>	<b>0.08 (0.02, 0.1)</b>	<b>6.9 (4.4, 9.5)</b>	<b>0.2 (0.09, 0.2)</b>
<i>Levy exempt drinks</i>						
Milk and milk based drinks <sup>1</sup>	2.4 (-0.6, 5.3)	<b>-0.06 (-0.1, -0.02)</b>	3.7 (-0.1, 7.5)	0.01 (-0.10, 0.1)	<b>6.1 (1.3, 10.9)</b>	-0.05 (-0.2, 0.06)
No added sugar fruit juices	-1.1 (-3.5, 1.4)	0.03 (-0.03, 0.07)	<b>3.3 (0.3, 6.3)</b>	<b>-0.10 (-0.2, -0.01)</b>	2.3 (-1.6, 6.1)	-0.07 (-0.2, 0.03)
Drinks sold as powders (g)	-1.0 (-3.1, 1.1)	0.01 (-0.02, 0.05)	0.4 (-2.2, 3.0)	-0.01 (-0.1, 0.07)	-0.6 (-3.9, 2.7)	0.001 (-0.09, 0.09)
Confectionery (g)	-11.7 (-51.5, 28.1)	0.05 (-0.8, 0.9)	-42.6 (-90.8, 5.6)	1.3 (-0.4, 3.0)	-54.3 (-116.8, 8.2)	1.3 (-0.5, 3.2)

Notes. Bold indicates a significant difference at the 95% confidence interval level. <sup>1</sup>Milk comprises drinks in the following categories: semi-skimmed; specific low fat % milk (e.g. 1% fat milk); whole milk; buttermilk; modified milk; other milk; other non-cows milk; rice drink; soya milk. Skimmed milk is excluded from all analysis in this paper due to missing data.



Supplementary Table 5c: Absolute and relative changes in volume of drinks (ml) and confectionery (g) purchased per household per week (95% CI) in relation to the UK SDIL, March 2014 - March 2019 without toiletries as a control condition (weighted)

	Analysis 1: pre-post announcement (March 2014 – March 2018)		Analysis 2: pre-post implementation (March 2016 – March 2019)		Analysis 3: pre-post announcement & implementation (March 2014 – March 2019)	
	Absolute change (ml or g)	Relative change (%)	Absolute change (ml or g)	Relative change (%)	Absolute change (ml or g)	Relative change (%)
<i>Levy liable drinks</i>						
High tier (≥8g sugar per 100ml)	34.4 (-4.5, 73.3)	7.3 (-1.0, 15.6)	<b>-171.6 (-223.1, -120.0)</b>	<b>-42.5 (-55.3, -29.7)</b>	<b>-140.9 (-192.5, -89.4)</b>	<b>-37.8 (-51.6, -24.0)</b>
Low tier (≥5g - <8g sugar per 100ml)	<b>-68.3 (-85.7, -50.9)</b>	<b>-38.2 (-47.9, -28.4)</b>	<b>-71.4 (-94.1, -48.7)</b>	<b>-71.5 (-94.2, -48.8)</b>	<b>-171.3 (-193.9, -148.6)</b>	<b>-85.8 (-97.1, -74.4)</b>
No levy (<5g sugar per 100ml)	<b>187.1 (95.7, 278.5)</b>	<b>11.5 (5.9, 17.1)</b>	<b>395.0 (273.9, 516.0)</b>	<b>19.8 (13.7, 25.9)</b>	<b>685.5 (564.4, 806.5)</b>	<b>40.2 (33.1, 47.3)</b>
>0g to <5g sugar per 100ml	<b>106.4 (68.7, 144.2)</b>	<b>17.2 (11.1, 23.3)</b>	<b>205.9 (155.5, 256.3)</b>	<b>25.6 (19.3, 31.8)</b>	<b>374.6 (326.0, 426.8)</b>	<b>59.3 (51.4, 67.2)</b>
0g sugar per 100ml	<b>80.7 (25.1, 136.4)</b>	<b>8.0 (2.5, 13.5)</b>	<b>191.9 (118.2, 265.5)</b>	<b>16.1 (9.9, 22.3)</b>	<b>312.0 (238.4, 385.6)</b>	<b>29.1 (22.3, 36.0)</b>
Bottled water	<b>-31.3 (-76.3, 13.7)</b>	<b>-4.4 (-10.6, 1.91)</b>	<b>-76.9 (-136.6, -17.2)</b>	<b>-9.89 (-17.6, -2.2)</b>	<b>-127.8 (-187.6, -68.1)</b>	<b>-15.4 (-22.6, -8.2)</b>
<i>Levy exempt drinks</i>						
Alcoholic drinks	-16.6 (-62.2, 28.9)	1.0 (-3.6, 1.7)	<b>-84.9 (-155.8, -14.0)</b>	<b>-4.81 (-8.8, -0.8)</b>	<b>-103.1 (-174.0, -32.2)</b>	<b>-5.8 (-9.8, -1.8)</b>
Milk and milk based drinks <sup>1</sup>	<b>-85.9 (-39.6, 132.2)</b>	<b>-2.3 (-3.6, -1.1)</b>	<b>106.4 (44.5, 168.3)</b>	<b>3.03 (1.3, 4.8)</b>	-32.8 (-94.6, 29.1)	-0.9 (-2.6, 0.8)
No added sugar fruit juices	5.9 (-13.9, 25.8)	1.2 (-2.9, 5.4)	-6.56 (-32.7, 19.6)	-1.33 (-6.6, 4.0)	6.95 (-19.2, 33.1)	1.5 (-4.0, 6.9)
Drinks sold as powders (g)	<b>-6.8 (-11.0, -2.57)</b>	<b>-6.8 (-10.9, -2.6)</b>	<b>9.3 (3.7, 14.9)</b>	<b>10.8 (4.3, 17.4)</b>	0.89 (-4.7, 6.5)	1.0 (-5.0, 6.9)
Confectionery (g)	-9.5 (-72.7, 53.7)	-2.3 (-17.7, 13.0)	40.6 (-42.1, 123.2)	11.9 (-12.3, 36.0)	36.3 (-46.4, 118.9)	10.5 (-13.4, 34.3)

Notes. Bold indicates a significant difference at the 95% confidence interval level. <sup>1</sup>Milk comprises drinks in the following categories: semi-skimmed; specific low fat % milk (e.g. 1% fat milk); whole milk; buttermilk; modified milk; other milk; other non-cows milk; rice drink; soya milk. Skimmed milk is excluded from all analysis in this paper due to missing data.

Supplementary Table 5d: Absolute and relative changes in sugar in drinks (ml) and confectionery (g) purchased per household per week (95% CI) in relation to the UK SDIL, March 2014 - March 2019 without toiletries as a control condition (weighted)

	Analysis 1: pre-post announcement (March 2014 – March 2018)		Analysis 2: pre-post implementation (March 2016 – March 2019)		Analysis 3: pre-post announcement & implementation (March 2014 – March 2019)	
	Level Change	Trend Change	Level Change	Trend Change	Level Change	Trend Change
<i>Levy liable drinks</i>						
High tier (≥8g sugar per 100ml)	3.9 (-0.4, 8.3)	7.6 (-0.78, 15.9)	<b>-19.6 (-25.3, -13.8)</b>	<b>-43.8 (-56.6, -30.9)</b>	<b>-16.1 (-21.8, -10.3)</b>	<b>-39.0 (-52.9, -25.0)</b>
Low tier (≥5g - <8g sugar per 100ml)	<b>-4.9 (-6.1, -3.8)</b>	<b>-40.3 (-49.6, -30.9)</b>	<b>-4.7 (-6.2, -3.2)</b>	<b>-70.9 (-93.3, -48.4)</b>	<b>-11.9 (-13.4, -10.4)</b>	<b>-86.0 (-96.8, -75.2)</b>
No levy (<5g sugar per 100ml)	<b>6.1 (4.9, 7.3)</b>	<b>77.7 (62.6, 92.8)</b>	<b>9.3 (7.8, 10.9)</b>	<b>52.5 (43.6, 61.4)</b>	<b>19.2 (17.6, 20.8)</b>	<b>240.9 (221.0, 260.8)</b>
>0g to <5g sugar per 100ml						
<i>Levy exempt drinks</i>						
Milk and milk based drinks <sup>1</sup>	<b>-4.2 (-6.4, -2.0)</b>	<b>-2.3 (-3.6, -1.1)</b>	<b>4.1 (1.1, 7.0)</b>	<b>2.4 (0.7, 4.2)</b>	<b>-3.2 (-6.5, -0.3)</b>	<b>-1.8 (-3.5, -0.1)</b>
No added sugar fruit juices	<b>2.6 (0.7, 4.6)</b>	<b>5.9 (1.5, 10.2)</b>	-1.8 (-4.3, 0.8)	-3.7 (-9.1, 1.6)	<b>2.6 (0.04, 5.2)</b>	<b>5.9 (0.08, 11.8)</b>
Drinks sold as powders (g)	0.4 (-1.2, 2.1)	2.1 (-5.9, 10.0)	-0.3 (-2.4, 1.9)	-1.3 (-12.5, 10.0)	0.9 (-1.3, 3.0)	4.7 (-7.2, 16.7)
Confectionery (g)	-5.9 (-42.0, 30.1)	-2.6 (-18.1, 13.0)	23.4 (-24.0, 70.7)	12.1 (-12.4, 36.7)	20.2 (-27.1, 67.6)	10.3 (-13.9, 34.5)

Notes.<sup>1</sup>Trend<sup>2</sup>, Bold indicates a significant difference at the 95% confidence interval level. <sup>1</sup>Milk comprises drinks in the following categories: semi-skimmed; specific low fat % milk (e.g. 1% fat milk); whole milk; buttermilk; modified milk; other milk; other non-cows milk; rice drink; soya milk. Skimmed milk is excluded from all analysis in this paper due to missing data.

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## Changes in soft drinks purchased by British households associated with the UK soft drinks industry levy: a controlled interrupted time series analysis

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# Changes in soft drinks purchased by British households associated with the UK soft drinks industry levy: a controlled interrupted time series analysis

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## Abstract

**Objective** To determine changes in household purchases of drinks one year after implementation of UK soft drinks industry levy (SDIL).

**Design** Controlled interrupted time series.

**Participants** Households reporting their purchasing to market research company (average weekly n=22,091), March 2014 to March 2019.

**Intervention** A two tiered tax levied on soft drinks manufacturers, announced in March 2016 and implemented in April 2018. Drinks with  $\geq 8$ g sugar/100mL (high tier) are taxed at £0.24/L, drinks with  $\geq 5$  to  $< 8$ g sugar/100mL (low tier) are taxed at £0.18/L.

**Main outcome measures** Absolute and relative differences in the volume of, and amount of sugar in, soft drinks categories, all soft drinks combined, alcohol, and confectionery purchased per household per week one year after implementation.

**Results** In March 2019, compared with the counterfactual, purchased volume of high tier drinks decreased by 140.8mL (95% confidence interval 104.3-177.3mL) per household per week, equivalent to 37.8% (47.6-28.0%), and sugar purchased in these drinks decreased by 16.2g (13.5-18.8g), or 42.6% (35.6-49.6%). Purchases of low tier drinks decreased by 170.5mL (154.5-186.5mL) or 85.8% (77.8-93.9%), with an 11.5g (9.1-13.9g) reduction in sugar in these drinks, equivalent to 87.8% (69.2-106.4%). When all soft drinks were combined irrespective of levy tier or eligibility, the volume of drinks purchased increased by 188.8mL (30.7-346.9mL) per household per week, or 2.6% (0.4-4.7%), but sugar decreased by 8.0g (2.4-13.6g), or 2.7% (0.8-4.5%). Purchases of confectionery and alcoholic drinks did not increase.

**Conclusions** Compared with trends before the SDIL was announced, one year after implementation, volume of soft drinks purchased increased by 189mL, or 2.6% per household per week. The amount of sugar in those drinks was 8g, or 2.7%, lower per household per week. The SDIL might benefit both public health and industry. Further studies should determine whether and how apparently small effect sizes translate into health outcomes.

**Study registration** ISRCTN18042742.

## Strengths and limitations of this study

- We used a large, nationally representative dataset, included a control category, and explored changes in two potential substitute categories (alcohol and confectionery).
- We only included purchases brought into homes.
- We did not assess changes in other categories beyond soft drinks, alcohol, and confectionery.
- The estimate of effect size in interrupted time series analyses is based on a modelled counterfactual that might be inaccurate.
- Attribution of effects in interrupted time series analyses is vulnerable to time varying confounding such as co-interventions.

## Introduction

High consumption of sugar sweetened beverages (SSBs) is associated with increased risk of dental caries, obesity, type 2 diabetes, and cardiovascular disease.[1-3] The World Health Organization recommends the use of SSB taxes to reduce consumption.[4] A systematic review of studies published to June 2018 suggests that SSB taxes lead to decreases in the sales, purchasing and consumption of taxed drinks.[5] More recent findings support this conclusion.[6-10] Although price is one important mediator of these changes,[11-16] other potential mechanisms include reformulation of products to reduce sugar concentration, smaller portion sizes, and increases in the perception of SSBs being harmful to health associated with them being grouped with other taxed products such as alcohol and tobacco.[17] Furthermore, any public health benefits of reduced SSB consumption associated with SSB taxes might be negated by increased consumption of substitutes such as confectionery and alcohol.[18-20]

The UK soft drinks industry levy (SDIL) was one of the first taxes on SSBs explicitly designed to incentivise manufacturers of SSBs to reduce sugar content.[21 22] This is reflected in three design features. Firstly, the SDIL is levied on manufacturers, importers, and bottlers rather than on consumers. Secondly, the levy includes two tiers: £0.24/L for drinks containing  $\geq 8$  g total sugar per 100 mL, and £0.18/L for drinks containing  $\geq 5$  g and  $< 8$  g total sugar per 100 mL. Thirdly, the SDIL was intentionally announced in 2016, two years before implementation in 2018, to allow manufacturers time to adjust. The SDIL also provides exemptions (see Box 1).[23]

### Box 1. Glossary of terms

*Soft drinks industry levy (SDIL)*—a tiered tax on manufacturers of sugar sweetened beverages

*Levy exempt drinks*—drinks exempt from the SDIL irrespective of sugar content; that is, drinks containing  $> 75\%$  milk, drinks containing  $> 1.2\%$  alcohol, and drinks sold as alcohol replacements, drinks sold as powders, 100% fruit juices, and drinks sold by manufacturers selling less than one million litres of drinks not exempt for other reasons each year

*High tier drinks*—drinks that are not levy exempt and contain  $\geq 8$  g of sugar per 100 mL

*Low tier drinks*—drinks that are not levy exempt and contain  $\geq 5$  g to  $< 8$  g of sugar per 100 mL

*No levy drinks*—drinks that are not levy exempt but contain  $< 5$  g of sugar per 100 mL; we subdivided this category into drinks containing  $> 0$  g to  $< 5$  g of sugar per 100 mL, drinks containing 0 g of sugar per 100 mL, and bottled water

*Levy liable drinks*—drinks that are not levy exempt drinks; that is, the sum of high tier drinks, low tier drinks, and no levy drinks

*Soft drinks*—any drink not containing alcohol

*Confectionery*—products in the sugar confectionery and chocolate confectionery categories



### *Toiletries*—products in the shampoo, hair conditioner, and liquid soap categories

Two before and after analyses have shown reductions of around 30% in sales weighted sugar concentration of levy eligible drinks in the UK from before the announcement of the SDIL on 16 March 2016 to after implementation on 6 April 2018.[24 25] However, background trends in purchases of sugary drinks are not stable, with decreases reported over several years.[26] This makes it difficult to attribute before and after decreases in sugary drinks purchases to the SDIL. An interrupted time series analysis found that the announcement and implementation of the SDIL were together associated with a 34 percentage point reduction in the proportion of levy liable drinks with >5 g total sugar per 100 mL, indicating substantial reformulation of the market.[15] Changes in prices across the UK soft drink market were also reported, although it was difficult to discern clear patterns in these, with some levied categories increasing and others decreasing in price. In a controlled interrupted time series analysis including data up to the point of SDIL implementation, we found that the SDIL announcement was associated with changes in both the volume of, and sugar purchased in, drinks in many categories.[27] Overall we found no change in total volume of purchases of all soft drinks combined, but a small increase in sugar purchased from soft drinks of 5.3g per household per week, or 1.7%.

In this paper our aim was to determine whether household purchases of drinks and confectionery had changed one year after implementation of the SDIL.

## **Methods**

Here we extend our previous analyses[27] to study changes in the volume of, and amount of sugar in, household purchases of drinks in each levy tier, exempt drinks categories (including alcoholic drinks), and confectionery from two years before the announcement of the SDIL to one year after its implementation (March 2014 to March 2019). As before, we used controlled interrupted time series methods, with toiletries included as a control category.[27] We compared observed changes associated with the announcement and implementation of the SDIL to the counterfactual scenarios in which the announcement and implementation did not take place. Including a full two years of data before the announcement enables us to estimate pre-intervention trends and project these forward as counterfactual scenarios. The protocol is published elsewhere[28] and the study was registered. This study is reported in accordance with the strengthening the reporting of observational studies in epidemiology (STROBE) guideline (see Supplementary material A).

### Data source

We used data from a panel of households reporting their purchasing on a weekly basis to a market research company (Kantar Worldpanel; KWP). Participating households are asked to record all food and drink purchases brought into the home (including those ordered online and delivered) through barcodes scanners and manual report. Purchasing information is uploaded weekly, where it is linked to nutritional data collected by KWP field workers on a rolling basis. Households record their personal characteristics and receive gift vouchers worth about £100 (\$122; €112) annually—equivalent to 0.3% of median UK annual household income after tax in 2019 (£29 600).[29]

KWP samples households from across Great Britain (GB) using proprietary methods, aiming to achieve a sample that is demographically representative of GB households. It excludes households that record fewer than six purchases weekly along with those whose adjusted weekly spend is lower than an undisclosed minimum. KWP applies proprietary weights to purchases to adjust for these exclusions and maintain the representativeness of the panel. We used these weights throughout.

The main data cleaning that occurred before analysis involved assigning products and product groups in the KWP dataset to SDIL relevant groups. This was done based on KWP assigned product groups, product names, and nutritional content. In previous work we found some evidence of error, but not bias, in the sugar concentration reported by KWP compared with information provided on manufacturers' websites.[27]

### Product categories: drinks, confectionery, and toiletries

Purchased drinks that were levy liable were divided into high tier, low tier, or no levy based on sugar content (see box 1 for definitions). No levy drinks were additionally disaggregated, as described in box 1.

As the SDIL might have led to substitution to other drinks categories, we also examined purchasing of levy exempt drinks in several categories: milk based drinks (comprising milk, milk alternatives such as soya drinks, and yoghurt based juices and drinks), alcoholic drinks (comprising both alcoholic and alcohol replacement drinks), no added sugar fruit juices, and drinks sold as powder (eg, tea, coffee, hot chocolate). Other exempt categories (infant formulas and drinks sold for medical purposes) were excluded.

We also hypothesised that the SDIL might lead to substitution from sugary drinks to other high sugar categories. To investigate this, we used sugar and chocolate confectionery purchases (referred to as confectionery).

### **Control group**

To control for background trends in household purchases we used purchases of shampoo, hair conditioner, and liquid soap (ie, toiletries). Toiletries meet the proposed criteria for a controlled interrupted time series: they are robust to seasonality and may have similar purchase volumes by households regardless of socioeconomic position or other potential confounders.[30]

### **Outcome measures**

Most evaluations of SSB taxes focus on volume of drinks purchased. However, the SDIL's focus on reformulation makes the sugar purchased in drinks of additional public health interest. Thus, the outcome measures of interest were mean volume purchased per household per week in each of the drink categories and grams per household per week of confectionery; and mean sugar purchased per household per week from each of the drink categories and confectionery. Data were aggregated at the weekly level and analysed as a time series.

### **Overall analysis strategy**

Previous evidence indicates that reformulation occurred after the announcement of the SDIL and price changes after implementation.[15] As such, we hypothesised the SDIL might act as two linked interventions: the announcement on 16 March 2016 and implementation on 6 April 2018.[17] Thus, our analysis strategy involved three separate comparisons that isolate the announcement and implementation of the SDIL and then examine the combined effect (Figure 1). In the first analysis we isolated the announcement of the SDIL. Here we compared anticipatory effects on purchasing two years after the announcement to the counterfactual estimated from purchasing in the two years before the announcement. This replicates and updates our previous analysis[27] as we anticipate that the stabilising effect of including additional post-announcement data likely reduces error. In the second analysis, we isolated the implementation of the SDIL. Here we compared purchasing one year after implementation to the counterfactual estimated from purchasing in the four years before implementation. In the third analysis we considered both the announcement and the implementation and we compared purchasing one year after implementation (ie three years after announcement) to the counterfactual estimated from purchasing in the two years before the announcement.

Throughout, we used the proprietary weights provided by KWP.

### **Primary analysis: category specific analyses**

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3 For each of the three analyses we developed separate controlled interrupted time series  
4 models for volume and sugar purchased from each levy liable and levy exempt drinks  
5 category and confectionery (Figure 1). Supplementary material B provides the full model  
6 specification.  
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10 We present absolute and relative differences between observed purchasing and  
11 counterfactual scenarios in the final week of each observation period, with standard errors  
12 used to calculate 95% confidence intervals for the relative difference obtained using the delta  
13 method.[31]  
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### 17 **Secondary analysis: all soft drinks categories combined, irrespective of levy eligibility**

18 Levy exempt drinks include drinks that might contain comparable amounts of sugar to levy  
19 liable products. To examine the extent to which the SDIL impacted on the purchased volume  
20 of, and amount of sugar in, soft drinks, regardless of SDIL liability, we carried out controlled  
21 interrupted time series analysis, combining purchases of all soft drinks irrespective of sugar  
22 content (ie, high tier, low tier, no levy, milk and milk based drinks, no added sugar fruit juice,  
23 and drinks sold as powders), levy liable drinks irrespective of sugar content (ie, high tier, low  
24 tier, and no levy drinks), and according to sugar content based on levy tiers irrespective of  
25 levy eligibility (ie, all soft drinks with  $\geq 8$  g of sugar per 100 mL, all soft drinks with  $\geq 5$  g to  
26  $< 8$  g of sugar per 100 mL, and all soft drinks with  $< 5$  g of sugar per 100 mL).  
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### 35 **Sensitivity analysis: excluding small manufacturers**

36 The SDIL exempts drinks from manufacturers and producers who sell less than one million  
37 litres of levy liable drinks annually. As we were unable to obtain a list of exempt  
38 manufacturers, our main analyses include all manufacturers. We conducted sensitivity  
39 analyses to examine the effect of excluding manufacturers who we estimated to be small. The  
40 total purchase volume was summed by manufacturer by year across the five years in the  
41 KWP dataset, and a mean purchase volume per year for each manufacturer was calculated. In  
42 the first sensitivity analysis, we excluded manufacturers with a mean of less than one million  
43 litres purchased per year. Acknowledging KWP data excludes purchases not brought home,  
44 we repeated these analyses excluding manufacturers with mean annual purchased volumes of  
45  $< 0.5$  million litres in KWP. We were unable to access accurate estimates of the proportion of  
46 all drinks purchases brought home. This value reflects an arbitrary, but we think conservative,  
47 estimate of the minimum proportion of drinks brought home.  
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### 58 **Sensitivity analysis: interrupted time series without a control category**

Toiletries were chosen as a control condition a priori to account for background trends in household purchases. It is, however, possible that a more appropriate control exists. As we only have access to data on purchasing of the categories described here (confectionery, drinks, toiletries), we were not able to examine alternative potential control categories. To examine the effect of the decision to use toiletries as the control category, we performed an additional sensitivity analysis with no control condition.

### **Changes to the protocol**

We made several changes to the published protocol.[28] KWP provided additional data that allowed us to increase the precision of our estimates. Specifically, we were able to increase the pre-announcement study period from 104 to 107 weeks and reduce the unit of analysis from purchases every four weeks to purchases every week. We originally intended to include purchases not brought home. We excluded these purchases, however, as these data were not available before mid-2015, meaning that robust pre-announcement trends could not be estimated. Although we originally intended to combine all no levy drinks, we present these disaggregated into those with >0 g and <5 g of sugar per 100 mL, 0 g of sugar per 100 mL, and bottled water, as trends for these different categories are noticeably different. Our original intention to explore potential disparities across socioeconomic groups will be pursued in future work.

### **Patient and public involvement**

The steering group for the wider SDIL evaluation includes two lay members and meets twice a year. Patients and the public were not involved in developing the research question, the outcome measures, the design, or the conduct of the work reported here. The steering group has regularly contributed ideas for routes to dissemination.

### **Correction of Pell et al (2021)**

This paper is a corrected version of Pell et al (2021),[32], now retracted, which was originally published in the *BMJ*. The analysis presented in the original Pell et al (2021) paper included an incorrect weighting variable. This variable was incorrectly calculated as the inverse of what it should have been. The variable was also redundant to the analysis as it replicated a component of a second weighting variable also included (the “proprietary weights provided by KWP” mentioned above). The current corrected version replicates the original analysis without this redundant and incorrectly calculated weighting variable. The second, correct, weighting variable (the “proprietary weights provided by KWP” mentioned above) remains included. The authors identified the error themselves and alerted the journal and readers.[33]

## Results

About 31 million purchases of drinks, confectionery, and toiletries from March 2014 to March 2019 were included from a mean of 22 091 households each week. The characteristics of included households remained consistent over the study period, and after weighting they largely reflected households in 2014-19 in the UK (see Supplementary table 1).

Table 1 summarises households' weekly purchased volumes of, and amounts of sugar in, drinks and other categories over the study period. Substantial reductions in volume of, and sugar in, purchases of SDIL liable drinks were observed in the high and low tiers over time. These reductions were accompanied by a smaller increase in volume of no levy drinks purchased, but proportionally much greater increases in sugar purchased in these drinks.

### Primary analysis: category specific results

Results of the controlled interrupted time series analyses of purchased volume of, and sugar in, levy liable drinks and confectionery are shown in Figure 2 (volume) and Figure 3 (sugar). Absolute and relative changes are summarised in Tables 2 and 3. Supplementary tables 2a and b show level and trend changes from these models. Supplementary figures 1a and b show similar figures and data for subcategories of no levy drinks and exempt categories.

### High tier drinks

The trend in purchased volume of, and sugar in, high tier drinks continued downwards throughout the study period. The announcement of the SDIL was associated with an increase in purchased volume of (34.7ml (95% confidence intervals 8.1 to 61.4ml, or 7.3% (1.7 to 12.9%)), and sugar in (5.5g (3.8 to 7.2), or 10.8% (7.4 to 14.1%)), these drinks. In contrast, the implementation of the SDIL was associated with a reduction in purchased volume of, and sugar in, these drinks. The volume of high tier drinks purchased was 171.6 mL (135.1 to 208.1mL) per household per week, or 42.5% (33.5% to 51.6%), lower in March 2019 compared with the counterfactual estimated from pre-implementation trends. The reductions associated with implementation outweighed the increases associated with announcement, such that the intervention as a whole was associated with a decrease in purchased volume of 140.8ml (104.3 to 177.3ml) per household per week or 37.8% (28.0 to 47.6%) and sugar of 16.2 g (13.5 to 18.8g) per household per week or 42.6% (35.6% to 49.6%) from these drinks.

### Low tier drinks

Purchased volume of, and sugar in, low tier drinks gradually increased before the announcement of SDIL. The announcement was associated with a reversal of this trend.



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3 There were reductions in purchased volume of, and sugar in, low tier drinks associated with  
4 announcement, implementation and the whole intervention. Compared with the  
5 counterfactual estimated from pre-announcement trends, in March 2019 the volume of  
6 purchased low tier drinks per household per week decreased by 170.5 mL (154.5 to 186.5  
7 mL), or 85.8% (77.8 to 93.9%); and sugar purchased in these drinks decreased by 11.5 g (9.1  
8 to 13.9g) per household per week, or 87.8% (69.2 to 106.4%).  
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### 14 **No levy drinks**

15 Before the announcement of the SDIL there was a gradual upward trend in volume of  
16 purchased no levy drinks but a gradual downward trend in purchased sugar. Announcement,  
17 implementation and the whole intervention were associated with increases in volume of no  
18 levy drinks purchased as well as sugar purchased from those drinks. Overall, purchased  
19 volume of no levy drinks in March 2019 was 685.5 mL (599.8 to 771.1mL) higher,  
20 equivalent to 40.2% (35.2% to 45.2%) increase compared with the counterfactual of pre-  
21 announcement trends. Equivalent figures for sugar purchased from no levy drinks were a  
22 19.2g (16.7 to 21.6g) per household per week, equivalent to 242.8% (211.9 to 273.7%),  
23 increase.  
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31 Changes in purchased volume of subcategories within the no levy drinks group were not  
32 uniform and the overall increase in both volume and sugar purchased in this category was  
33 driven by low and no sugar drinks, rather than bottled water. The implementation, but not the  
34 announcement, of the SDIL were associated with significant decreases in bottled water  
35 purchased which led to an overall decrease in volume of bottled water purchased as a result  
36 of the whole intervention of 130.5ml (88.8 to 174.1ml) per household per week, or 15.7%  
37 (10.4 to 20.9%). In contrast, the implementation and the announcement of the SDIL were  
38 associated with increases in volume of purchased drinks with no sugar and with >0 to <5 g  
39 total sugar per 100 mL, and increases of sugar in drinks with >0 to <5g sugar per 100ml.  
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### 48 **Levy exempt drinks and confectionery**

49 Overall, the combined announcement and implementation of the SDIL were associated with  
50 decreases in purchased volume of alcoholic and milk and milk-based drinks, but no change in  
51 sugar purchased from levy exempt categories or from confectionery. Compared with the  
52 counterfactual of pre-announcement trends, in March 2019 volume of alcoholic drinks  
53 purchased decreased by 103.1ml (53.0 to 153.3ml) per household per week, equivalent to a  
54 5.8% (3.0 to 8.6%) reduction; and volume of milk and milk based drinks purchased decreased  
55 by 132.8ml (51.7 to 213.9ml), equivalent to a 3.6% (1.4 to 5.7%) reduction.  
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### Secondary analysis: all soft drinks categories combined

Supplementary table 3a and Supplementary figure 2 summarise the results of the controlled interrupted time series analyses of the associated effects of the SDIL on purchased volume of, and sugar from, all soft drinks categories combined, irrespective of levy eligibility.

Supplementary table 3b summarises absolute and relative changes in volume of, and sugar in, all soft drinks and confectionery purchased.

Overall, compared with the counterfactual estimated from pre-announcement trends, a small increase was observed in volume of all soft drinks purchased in March 2019 of 188.8ml (30.7 to 346.9ml) per household per week, equivalent to a 2.6% (0.4 to 4.7%) increase. A reduction was, however, found in sugar purchased in all soft drinks (including exempt drinks) combined of 8.0g per household per week (2.4 to 13.6g), equivalent to 2.7% (0.8 to 4.5%).

### Sensitivity analyses

Excluding manufacturers of levy liable products with less than one million and less than 500 000 litres of purchased drinks annually in our dataset was associated with small changes in the magnitude of estimated coefficients, but with no change in the direction or statistical significance of any findings (Supplementary tables 4a to b).

In general, removing the control category led to minor changes in effect estimates but wider confidence intervals (see Supplementary material G).

### Discussion

Taking account of pre-existing pre-announcement trends, this study found that one year after implementation of the SDIL, sugar purchased from soft drinks that were taken home decreased by 8.0 g per household per week (or 2.7%), whilst volume increased by 188.8 mL per household per week (or 2.6%). Assuming a mean UK household size of 2.4 people,[34] this is equivalent to a reduction in sugar from SSBs of 3.3 g per person per week and an increase in volume of 79 mL per person per week, or equivalent to the replacement of 66 mL of a drink with 5 g sugar per 100 mL per person per week with 145 mL of a sugar-free alternative. A modelling study conducted before implementation of the SDIL found that if the levy achieved reformulation it could be expected to lead to a decrease in sugar consumption from SSBs (from all sources, not just for consumption at home) of 7-38 g per person per week and that this would be associated with a reduction in the number of obese individuals in the UK of 0.2-0.9% and a reduction in incidence cases of type 2 diabetes of -2.0 to 31.1 per 1000 person years.[35] The reduction in sugar from SSBs we report one year after implementation of the SDIL is around half of these lower effect estimates.

### Strengths and weaknesses of this study

In this study we used a large, nationally representative dataset, included a control category, and explored changes in two potential substitute categories (alcohol and confectionery).

We only included purchases brought into homes. Although KWP also collects data on other purchases, this smaller panel was established in mid-2015 and so was unsuitable for our analyses because robust pre-announcement trends could not be estimated. KWP data are collected at the household level and do not take account of waste or differential sharing within households. Nevertheless, the data provide a reasonable estimate of consumption.[36] We did not assess changes in other categories beyond soft drinks, alcohol, and confectionery.

The estimate of effect size in interrupted time series analyses is based on a modelled counterfactual that might be inaccurate. For example, the strong downward trend in higher tier drinks before the announcement of SDIL might not have continued. Attribution of effects in interrupted time series analyses is vulnerable to time varying confounding including co-interventions. The SDIL is part of a wider sugar reduction strategy, although this has been found to have achieved minimal changes beyond those attributable to the SDIL.[25]

The personal characteristics of the panel remained similar over the study period, and proprietary weightings were used to account for non-consumers and to adjust for variations in panel composition. Households participating in KWP are slightly more likely to be from lower social grades and to have no qualifications compared with UK households generally. This might reflect the relative value placed on the small rewards for participation by different households and could limit the generalisability of our findings. If households from lower socioeconomic backgrounds are more likely to change purchasing as a result of the SDIL, then we could have marginally overestimated the effect of the SDIL. However, while we previously found that the price of soft drinks in the UK did change after implementation of the SDIL, no clear pattern was found, with the price of some groups of drinks increasing and others decreasing.[15] We previously found no systematic differences between the sugar content of drinks reported in KWP data and contemporaneous values listed on supermarket websites.[27]

### Comparison with other work

Our finding that the SDIL was associated with a reduction in purchased sugar from all soft drinks is consistent with previous analyses that focused on the SDIL.[24 25] Although our estimate of the reduction in sugar consumption from all soft drinks associated with the levy (2.7%) is less than that estimated by others (29%)[25] this previous estimate did not take

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3 account of pre-existing trends which we have demonstrated were on a steep downward  
4 trajectory for high tier drinks.  
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6 We found that the reduction in purchased sugar from all soft drinks alongside a 2.6%  
7 increase in volume of all soft drinks purchased. This is consistent with previously reported  
8 reductions in the sugar concentration of drinks associated with the SDIL.[15] However, the  
9 estimated effect size is below the range of reformulation scenarios modelled before  
10 implementation (ie, a reduction of 17 to 90 g of sugar per household per week).[35] This  
11 difference may be, at least partly, attributable to our focus on drinks taken home versus the  
12 modelling study's focus on all drinks. Furthermore, the modelling was based on pre-  
13 implementation best and worst case scenarios of changes in formulation, price and SSB  
14 market share whilst our analysis was based on observed data.  
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22 Evaluations of other SSB taxes have revealed a consistent trend of reductions in  
23 purchasing of taxed drinks and no change in purchasing of untaxed drinks.[5] We found  
24 similar with both volume of, and sugar in, high and low tier drinks decreasing overall.  
25 However, these reductions in volume of taxed drinks were more than offset by increases in  
26 volume of no levy drinks purchased. Despite some increases in sugar purchased in no levy  
27 drinks, these did not offset decreases in sugar purchased from high and low tier drinks. The  
28 SDIL is relatively unique in being explicitly designed to encourage reformulation and there is  
29 evidence that substantial reformulation occurred.[15] We are not able to determine from our  
30 findings whether the changes we report are due to changes in consumer preference,  
31 formulation, or both.  
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#### 40 **Meaning of the study and implications for policymakers**

41 Our main findings are that the SDIL was associated with a reduction in purchased sugar from  
42 all soft drinks with evidence of an increase in the total volume of soft drinks purchased.  
43 Given the reformulation associated with the SDIL already documented,[15] it is probable that  
44 the changes we report were driven by reductions in the sugar concentration of available  
45 drinks, alongside consumers switching to and, indeed increasing consumption of, lower sugar  
46 alternatives. Despite the overall reduction we found in sugar purchased in soft drinks, the  
47 average amount of sugar purchased in drinks in the no levy group paradoxically increased  
48 after implementation of the SDIL, with many drinks that previously had sugar concentrations  
49 above the levy threshold now having them just below the threshold. This seems to reflect  
50 manufacturers reformulating to target thresholds. Lowering the threshold sugar concentration  
51 at which drinks become eligible for the SDIL even further could potentially lead to greater  
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3 overall reductions in sugar concentrations and sugar purchased in soft drinks, as could  
4 extension of the SDIL to milk based drinks and other currently exempt categories that  
5 sometimes contain high levels of sugar.  
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8 Nevertheless, the overall reduction in sugar with an increase in volume we report here  
9 might represent a valuable benefit for public health with potential associated benefit to the  
10 food industry. The SDIL has also been found to have had no long term negative effects on the  
11 share value or turnover of UK soft drinks companies,[37 38] suggesting that, contrary to  
12 industry predictions, public health can gain without negatively affecting the soft drinks  
13 sector.  
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19 We note a marked pre-implementation decline in purchasing of high levy tier drinks. It is  
20 possible that this was, at least in part, driven by concern from industry about a possible SSB  
21 tax, leading to some pre-announcement reformulation; alongside growing consumer  
22 awareness of, and concerns about, the health impacts of SSBs.[39] Although it is uncertain if  
23 this trend would have continued in the absence of the SDIL, it is likely to be beneficial for  
24 health.  
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29 Reassuringly, we did not observe any increase in purchasing of potentially harmful  
30 substitutes (ie, alcohol and confectionery) associated with the SDIL, which could have  
31 partially or wholly offset any public health gains from the SDIL. However, we did not study  
32 the SDIL's effect on purchases of other food groups or on overall diet.  
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36 In contrast with previous findings from Mexico and Barbados,[6 40] we did not observe  
37 an increase in purchased bottled water associated with the SDIL. Indeed purchases of bottled  
38 water decreased significantly during the study period (by 130.5 mL per household per week,  
39 or 15.7%). Although we cannot rule out an effect of the SDIL on bottled water purchases, we  
40 cannot think of a plausible pathway through which it achieved reductions in purchased  
41 bottled water. Instead, this reduction might be due to coincident increases in concern about  
42 single use plastic that have been attributed, in the UK, to the broadcast of the nature  
43 documentary series *Blue Planet 2* in October-December 2017.[41] It is not clear if a similar  
44 “Blue Planet effect” has occurred in other countries. Unlike for many other soft drinks, a like-  
45 for-like substitution is available for bottled water in countries such as the UK—that is, filling  
46 reusable water bottles with tap water. Several UK retailers have reported substantial growth  
47 in sales of reusable water bottles since 2018.[42] Given that tap water is freely available, it is  
48 difficult to study changes in its consumption directly.  
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## 59 **Unanswered questions and future research**

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3 Future work should seek to understand the longer term effects of the SDIL on purchasing and  
4 consumption of soft drinks as well as total diet, and health outcomes. Differential effects of  
5 the SDIL on all these outcomes across population groups (eg, by socioeconomic position and  
6 in households with vs without children) should also be explored to determine whether the  
7 SDIL contributes to narrowing inequalities in health. The changes in purchasing we report  
8 here could be used as an input to health impact modelling to estimate the effect of changes on  
9 population prevalence of obesity, diabetes, and other chronic conditions to determine how  
10 apparently small changes in consumption at the household level translate into health benefits.  
11 It is likely that the reformulation that has occurred in response to the SDIL[15] reflects  
12 substantial increases in the use of artificial sweeteners in the UK soft drinks market. Given  
13 public mistrust of artificial sweeteners[39] and the recent advice from WHO that artificial  
14 sweeteners should not be used to reduce the risk of non-communicable diseases,[43] the  
15 effect of the SDIL on consumption of these should also be explored.

### 26 **Conclusion**

27 One year after implementation of the SDIL, purchased sugar in soft drinks decreased by  
28 around 8 g per household per week (or 2.7%) with an increase in the volume of purchased  
29 soft drinks of 189 mL per household per week (or 2.6%). This tiered tax aiming to stimulate  
30 industry to remove sugar from soft drinks might represent a benefit for public health (by  
31 reducing sugar purchased from soft drinks without substitution to confectionery and alcohol)  
32 and also to the soft drinks industry (by total volume of soft drinks purchased). Further studies  
33 are required to determine whether and how these apparently small effect sizes translate into  
34 health outcomes.  
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## Contributors

DP, MW, SC, MR, RS, HR, JA, PS, OM, AB, and TLP conceived the study and defined the analytical strategy. DP, NR, JA, OM, TLP, and SS performed statistical analyses and provided preliminary interpretation of findings. DP, NR, JA, OM, and TLP drafted the manuscript. All authors critically interpreted the results, revised the manuscript, provided relevant intellectual input, and read and approved the final manuscript. NR and JA had primary responsibility for the final content. JA will act as guarantor. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

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## Competing interests

All authors have completed the ICMJE uniform disclosure form at [www.icmje.org/coi\\_disclosure.pdf](http://www.icmje.org/coi_disclosure.pdf) (available on request from the corresponding author) and declare: MW was director of the National Institute for Health Research Public Health Research Funding programme when this work was conducted, and OM was on secondment at the UK Department of Health and Social Care when this work was conducted and previously worked with Public Health England; no support from any organisation for the submitted work other than that described above; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years; and no other relationships or activities that could appear to have influenced the submitted work.

## Ethical approval

Not required for secondary data analysis of anonymised data.

## Data availability statement

The statistical code for the analyses are available from <https://github.com/MRC-Epid/SDILEvaluation>. Kantar Worldpanel data are not publicly available but can be purchased from Kantar Worldpanel (<http://www.kantarworldpanel.com>). The authors are not legally permitted to share the data used for this study but interested parties can contact Kantar WorldPanel representative Sean Cannon ([Sean.Cannon@kantar.com](mailto:Sean.Cannon@kantar.com)) to inquire about accessing this proprietary data.

The lead author affirms 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;

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3 and that any discrepancies from the study as planned (and, if relevant, registered) have been  
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For peer review only



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## Figure legends

**Figure 1.** Schematic of overall analysis strategy. Solid lines=observed data; dashed lines=counterfactual estimated from previous observed data.

**Figure 2.** Observed and modelled volume (mls) of drinks liable to the Soft Drinks Industry Levy (SDIL), and weight of confectionery (g) purchased per household per week, March 2014 to March 2019 (weighted). Points are observed data for drinks/ confectionery; black lines (with shadows) show modelled data (and 95% confidence intervals); red lines indicate the counterfactuals had the announcement (red solid line) and implementation (red dashed line) not happened; the first dashed vertical line indicates the announcement of SDIL; the second dashed vertical line indicates the implementation of SDIL; the Y axis varies in scale between panels to maximise the resolution of figures; modelled purchases include averaged effects for seasonality and the impact of December and January (Christmas period), and, for confectionery, Easter; the control category of toiletries is shown in Figure 3.

**Figure 3.** Observed and modelled amount of sugar (g) in drinks liable to the Soft Drinks Industry Levy and confectionery purchased per household per week, March 2014 to March 2019 (weighted). Points are observed data for drinks/ confectionery and toiletries; black lines (with shadows) show modelled data (and 95% confidence intervals); red lines indicate the counterfactuals had the announcement (red solid line) and implementation (red dashed line) not happened; the first dashed vertical line indicates the announcement of SDIL; the second dashed vertical line indicates the implementation of SDIL; the Y axis varies in scale between panels to maximise the resolution of figures; modelled purchases include averaged effects for seasonality and the impact of December and January (Christmas period), and, for confectionery, Easter.

**Table 1.** Mean volume of, and amount of sugar in, purchased drinks and confectionery per household per week in relation to the UK soft drinks industry levy, March 2014 to March 2019 (weighted)

	Mean (SD) volume (mL) per household/week			Mean (SD) amount of sugar (g) per household/week		
	Pre- announcement: Mar 2014-Mar 2016	Post- announcement: Mar 2016-Mar 2018	Post- implementation: Apr 2018-Mar 2019	Pre- announcement: Mar 2014-Mar 2016	Post- announcement: Mar 2016-Mar 2018	Post- implementation: Apr 2018-Mar 2019
<b>All drinks</b>	7595 (295)	7547 (466)	7826 (540)	364 (17)	337(24)	307(19)
<b>Levy liable drinks (sugar/100 mL)</b>						
High tier ( $\geq 8$ g)	880 (128)	680 (136)	363 (76)	98(14)	76(15)	40(9)
Low tier ( $\geq 5$ g to $< 8$ g)	155 (32)	147 (37)	75 (32)	10(2)	10(2)	5(2)
No levy ( $< 5$ g):	1811 (169)	1876 (216)	2448 (321)	12(2)	12(3)	25(5)
$> 0$ g to $< 5$ g	785 (78)	989 (139)	768 (92)	12(2)	12(3)	25(5)
0 g	1027 (104)	1108 (132)	1459 (190)	0 (0)	0 (0)	0 (0)
Bottled water	591(72)	714(90)	786 (138)	0 (0)	0 (0)	0 (0)
<b>Levy exempt drinks</b>						
Alcoholic drinks	1874 (380)	1872 (456)	1948 (467)	.	.	.
Milk and milk based drinks:	3546 (137)	3540 (155)	3542 (148)	172 (7)	172(8)	170(7)
Fruit juices with no added sugar	516.6(29)	502(44)	520(47)	51(3)	49(4)	50(5)
Drinks sold as powders (g)	95(12)	88(11)	90(11)	21(3)	19(3)	18(3)
Confectionery (g)	308 (91)	303 (92)	318 (100)	173 (51)	170 (52)	178 (57)
Toiletries	123 (8)	120 (8)	121 (9)	.	.	.

Sugar from alcoholic drinks is not included here as many alcoholic drinks contain sugar but the product label does not provide the amount.



**Table 2.** Absolute and relative change in volume of drinks (mL) and confectionery (g) purchased per household per week in relation to the UK soft drinks industry Levy, March 2014 to March 2019 (weighted)

	Analysis 1: pre-post announcement (Mar 2014-Mar 2018)		Analysis 2: pre-post implementation (Mar 2016-Mar 2019)		Analysis 3: pre-post announcement and implementation (Mar 2014-Mar 2019)	
	Absolute change (mL or g)	Relative change (%)	Absolute change (mL or g)	Relative change (%)	Absolute change (mL or g)	Relative change (%)
<b>All drinks</b>	<b>11.8 (-103.7, 127.3)</b>	0.16 (-1.42, 1.74)	<b>187.8 (29.7, 345.9)</b>	2.56 (0.40, 4.71)	<b>188.8 (30.7, 346.9)</b>	2.6 (0.4, 4.7)
<b>Levy liable drinks (sugar/100 mL)</b>						
High tier (≥8 g)	<b>34.7 (8.06, 61.4)</b>	<b>7.27 (1.69, 12.9)</b>	-171.6 (-208.1,-135.1)	-42.5 (-51.6, -33.5)	-140.8 (-177.3, -104.3)	-37.8 (-47.6, -28.0)
Low tier (≥5 g to <8 g)*	<b>-65.7 (-77.5, -53.8)</b>	<b>-37.1 (-43.7, -30.4)</b>	-71.8 (-87.8, -55.8)	-71.8 (-87.8, -55.8)	-170.5 (-186.5, -154.5)	-85.8 (-93.9, -77.8)
No levy (<5 g):	<b>181.0 (118.4, 243.5)</b>	<b>11.1 (7.26, 14.9)</b>	<b>395.0 (309.4, 480.7)</b>	<b>19.8 (15.5, 24.1)</b>	<b>685.5 (599.8, 771.1)</b>	<b>40.2 (35.2, 45.2)</b>
>0 g to <5 g	<b>103.8 (75.2, 132.5)</b>	<b>16.7 (12.1, 21.3)</b>	<b>202.0 (162.7, 241.2)</b>	<b>25.0 (20.1, 29.9)</b>	<b>374.6 (335.4, 413.9)</b>	<b>59.0 (52.8, 65.1)</b>
0 g	<b>87.8 (41.1, 134.5)</b>	<b>8.66 (4.05, 13.3)</b>	<b>178.9 (115.6, 242.3)</b>	<b>14.7 (9.52, 20.0)</b>	<b>316.1 (252.7, 379.4)</b>	<b>29.4 (23.5, 35.3)</b>
Bottled water	30.3 (-62.0, 1.4)	4.24 (-8.7, 0.2)	<b>82.1 (-125.7, -38.4)</b>	-10.5 (-16.1, -4.9)	-130.5 (-174.1, -88.8)	-15.7 (-20.9, -10.4)
<b>Levy exempt drinks</b>						
Alcoholic drinks	-16.5 (-48.5, 15.4)	0.95 (-2.79, 0.89)	<b>-84.9 (-135.1, -34.7)</b>	-4.81 (-7.66, -1.97)	-103.1 (-153.3, -53.0)	-5.8 (-8.60, -2.97)
Milk and milk based drinks	<b>-185.5 (-249.7, -121.4)</b>	<b>-4.9 (-6.60, -3.20)</b>	<b>145.5 (64.4, 226.6)</b>	<b>4.21 (1.86, 6.56)</b>	-132.8 (-213.9, -51.7)	-3.56 (-5.73, -1.38)
No added sugar fruit juices	6.8 (-6.9, 20.5)	1.4 (-1.4, 4.3)	-6.2 (-24.8, 12.5)	-1.26 (-6.1, 2.5)	8.7 (-9.9, 27.3)	1.82 (-2.1, 5.7)
Drinks sold as powders (g)	<b>-6.9 (-10.0, -3.8)</b>	<b>-6.8 (-9.9, -3.8)</b>	<b>9.6 (5.3, 13.9)</b>	<b>11.2 (6.2, 16.2)</b>	0.9 (-3.3, 5.2)	1.0 (-3.5, 5.5)
Confectionery (g)	-10.1 (-53.9, 33.8)	-2.4 (-13.1, 8.2)	39.8 (-19.0, 98.6)	11.6 (-5.5, 28.8)	35.3 (94.1, -23.5)	10.2 (-6.8, 27.1)

**Bold** indicates significant difference at 95% confidence interval level.



**Table 3.** Absolute and relative change in sugar in drinks and confectionery (g) purchased per household (95% CI) per week in relation to the UK SDIL, March 2014- March 2019 (weighted)

	Analysis 1: pre-post announcement (Mar 2014-Mar 2018)		Analysis 2: pre-post implementation (Mar 2016-Mar 2019)		Analysis 3: pre-post announcement and implementation (Mar 2014-Mar 2019)	
	Absolute change (g)	Relative change (%)	Absolute change (g)	Relative change (%)	Absolute change (g)	Relative change (%)
<b>All drinks</b>	<b>4.6 (0.5, 8.6)</b>	<b>1.4 (0.2, 2.7)</b>	<b>-12.9 (-18.5, -7.4)</b>	<b>-4.3 (-6.1, -2.4)</b>	<b>-8.0 (-13.6, -2.4)</b>	<b>-2.7 (-4.5, -0.8)</b>
<b>Levy liable drinks (sugar/100 mL)</b>						
High tier ( $\geq 8$ g)	<b>5.5 (3.8, 7.2)</b>	<b>10.8 (7.4, 14.1)</b>	<b>-21.2 (-23.8, -18.5)</b>	<b>-49.3 (-55.4, -43.1)</b>	<b>-16.2 (-18.8, -13.5)</b>	<b>-42.6 (-49.6, -35.6)</b>
Low tier ( $\geq 5$ g to $< 8$ g)	<b>-4.3 (-6.1, -2.6)</b>	<b>-37.5 (-52.5, -22.5)</b>	<b>-5.0 (-7.4, -2.6)</b>	<b>-75.8 (-112.7, -38.9)</b>	<b>-11.5 (-13.9, -9.1)</b>	<b>-87.8 (-106.4, -69.2)</b>
No levy ( $< 5$ g) <sup>†</sup>	<b>5.7 (3.9, 7.4)</b>	<b>72.6 (50.3, 94.9)</b>	<b>9.7 (7.3, 12.1)</b>	<b>56.0 (41.9, 70.0)</b>	<b>19.2 (16.7, 21.6)</b>	<b>242.8 (211.9, 273.7)</b>
$> 0$ g to $< 5$ g sugar per 100 mL <sup>†</sup>	<b>5.7 (3.9, 7.4)</b>	<b>72.6 (50.3, 94.9)</b>	<b>9.7 (7.3, 12.1)</b>	<b>56.0 (41.9, 70.0)</b>	<b>19.2 (16.7, 21.6)</b>	<b>242.8 (211.9, 273.7)</b>
<b>Levy exempt drinks</b>						
Milk and milk based drinks	<b>-3.9 (-6.5, -1.3)</b>	<b>-2.2 (-3.6, -0.7)</b>	<b>4.1 (0.5, 7.7)</b>	<b>2.4 (0.3, 4.6)</b>	-3.1 (-6.7, 0.5)	-1.8 (-3.8, 0.3)
No added sugar fruit juices	<b>2.6 (0.3, 4.8)</b>	<b>5.7 (0.7, 10.7)</b>	-1.7 (-4.8, 1.5)	-3.5 (-10.0, 3.0)	2.6 (-0.5, 5.7)	5.9 (-1.2, 13.1)
Drinks sold as powders (g)	0.3 (-1.6, 2.2)	1.6 (-7.5, 10.6)	-0.04 (-2.7, 2.6)	-0.2 (-13.9, 13.5)	1.1 (-1.6, 3.7)	5.7 (-8.8, 20.2)
Confectionery (g)	-6.6 (-32.0, 18.9)	-2.8 (-13.8, 8.14)	22.1 (-12.0, 56.1)	11.4 (-6.2, 29.1)	18.4 (-15.7, 52.4)	9.3 (-8.0, 26.7)

The counterfactual for low tier drinks crossed 0 mL shortly before the end of the study period thus predicting negative purchases; therefore, the non-counterfactual estimate at the end of the study period was compared with the final week during which the counterfactual was a positive number.

\*Significant difference at 95% confidence interval level.

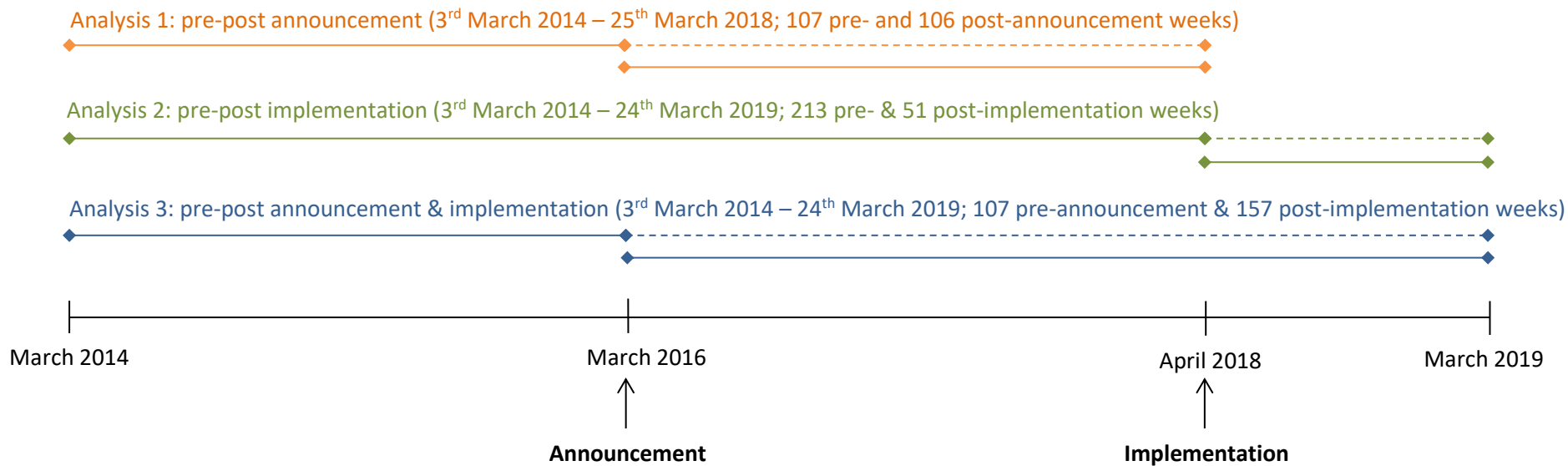
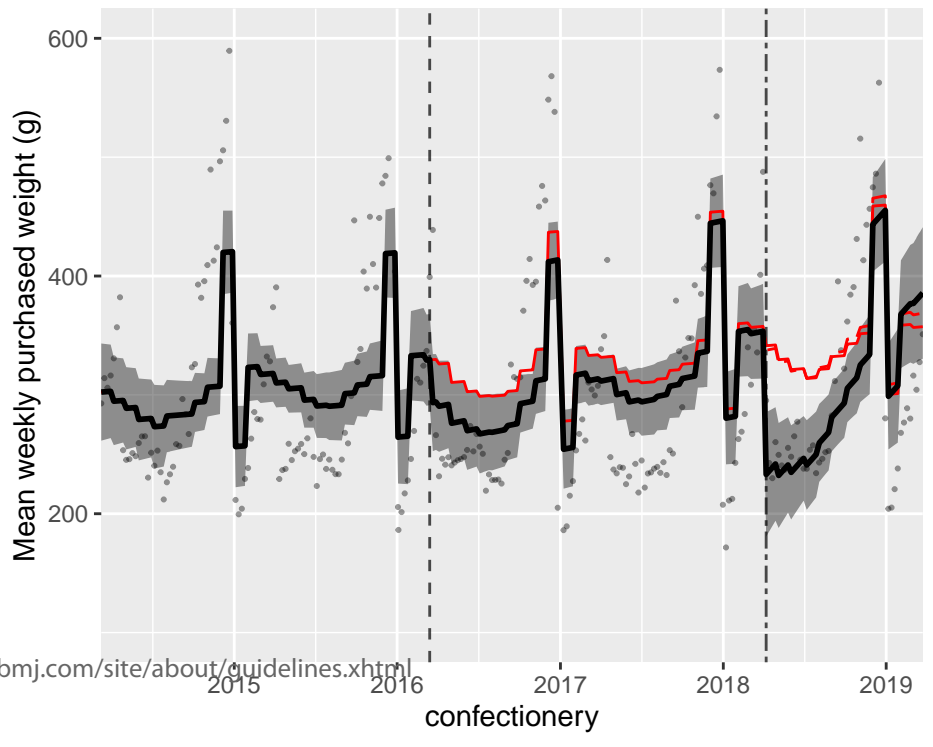
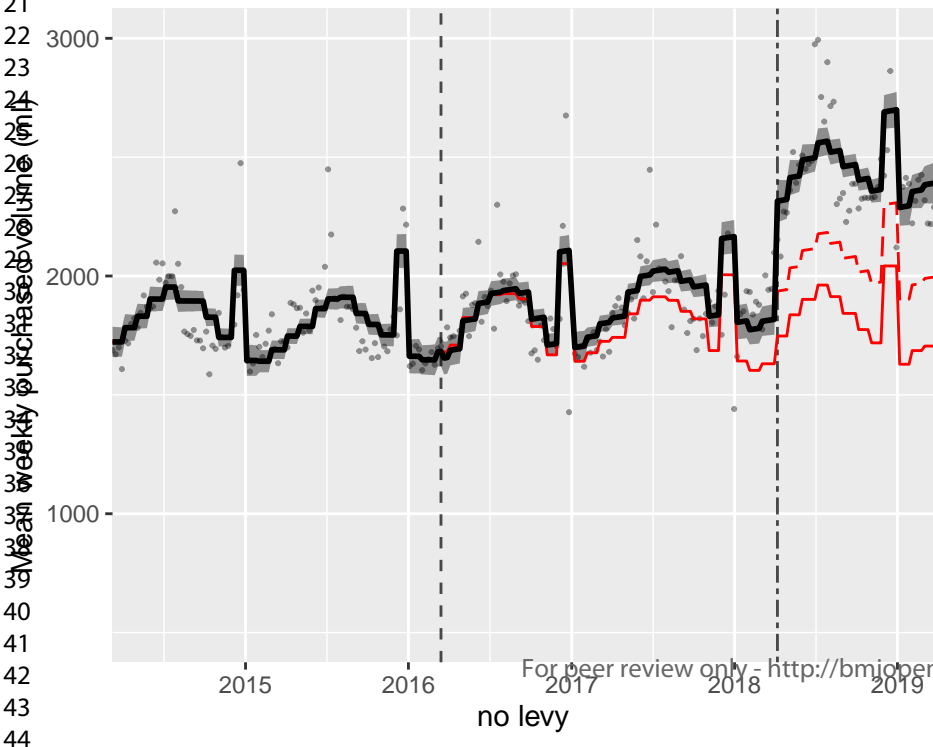
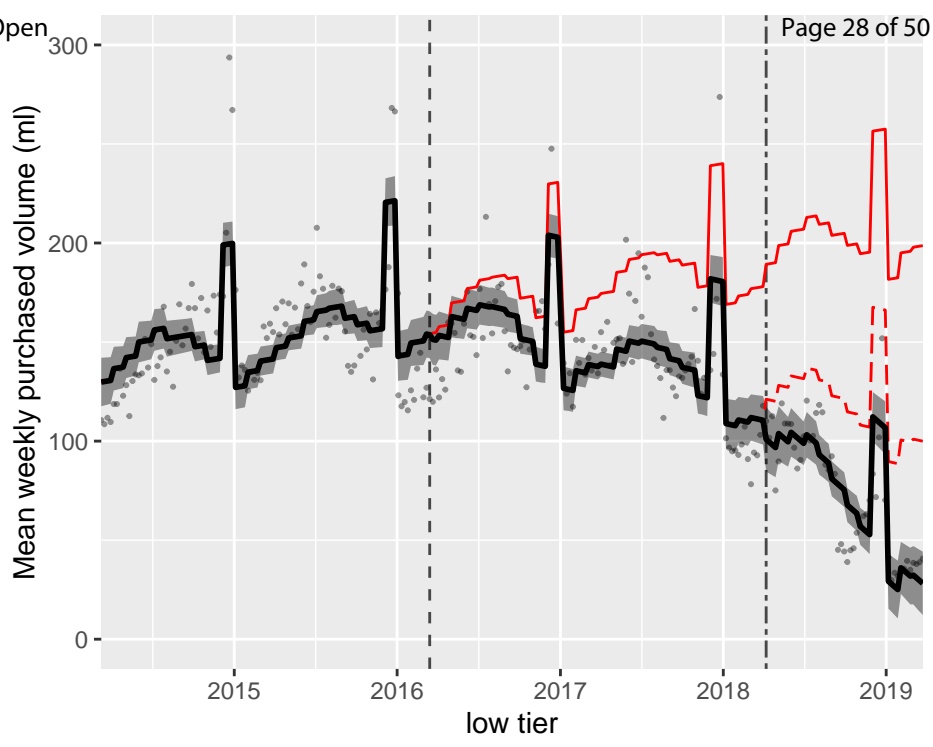
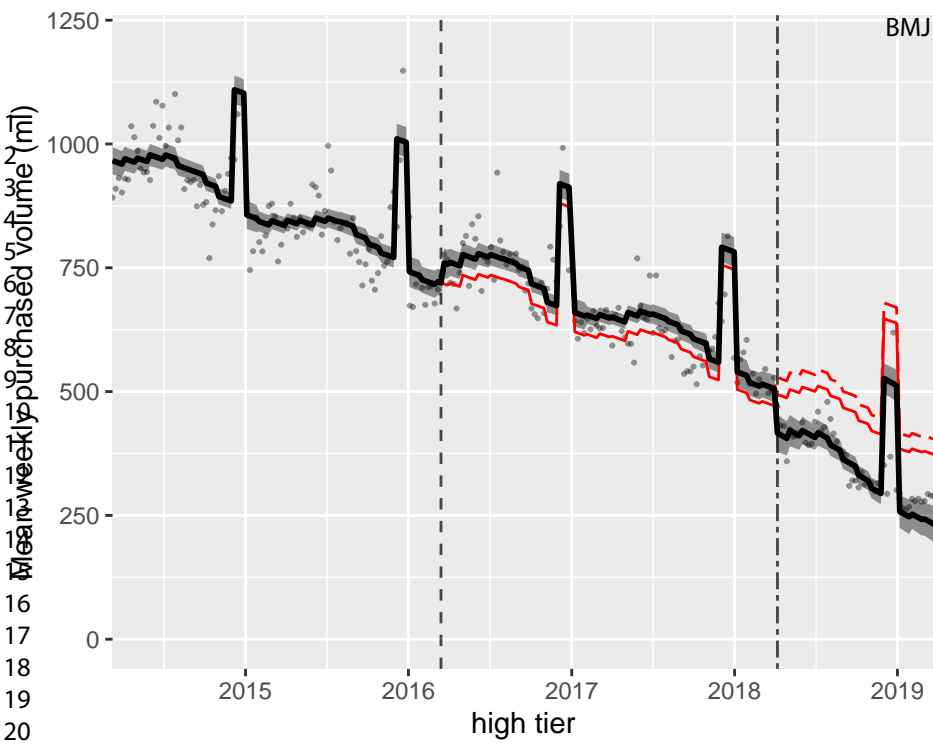
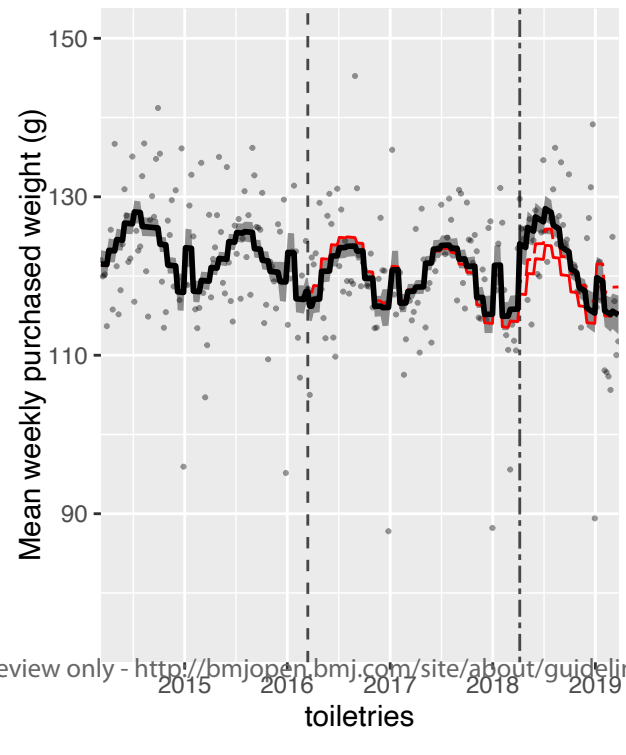
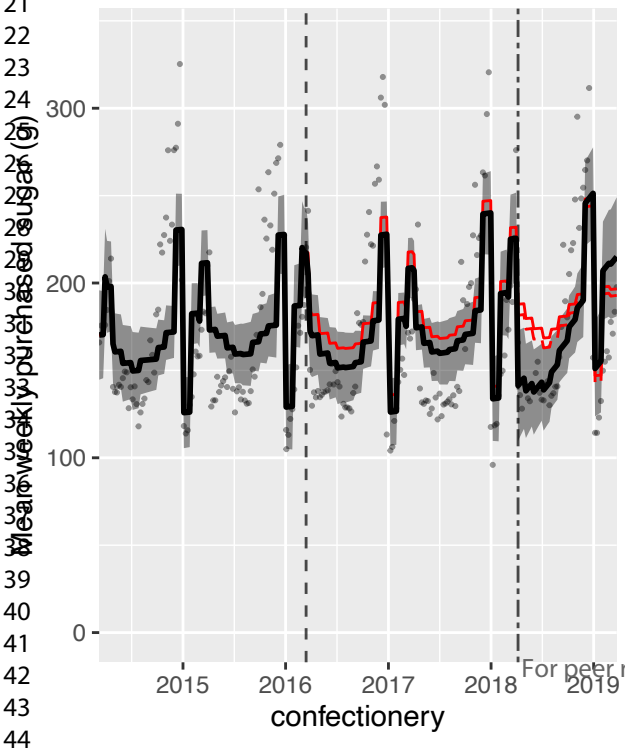
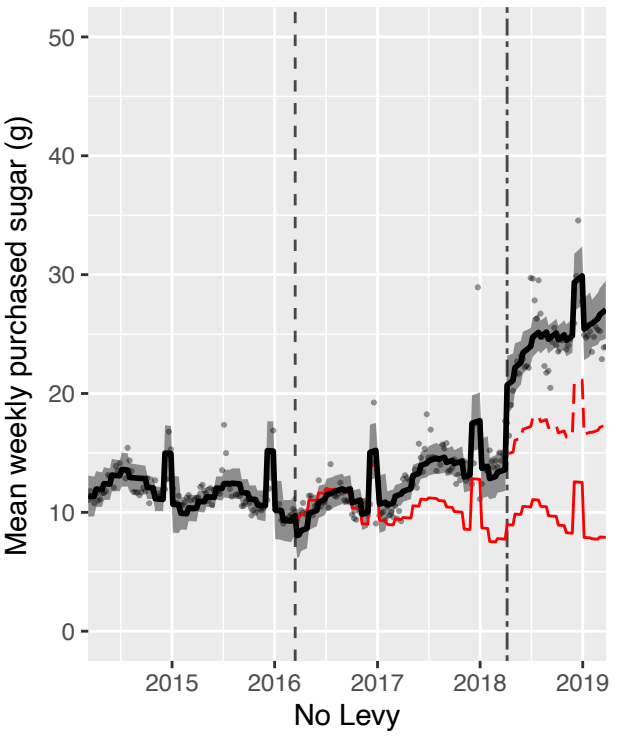
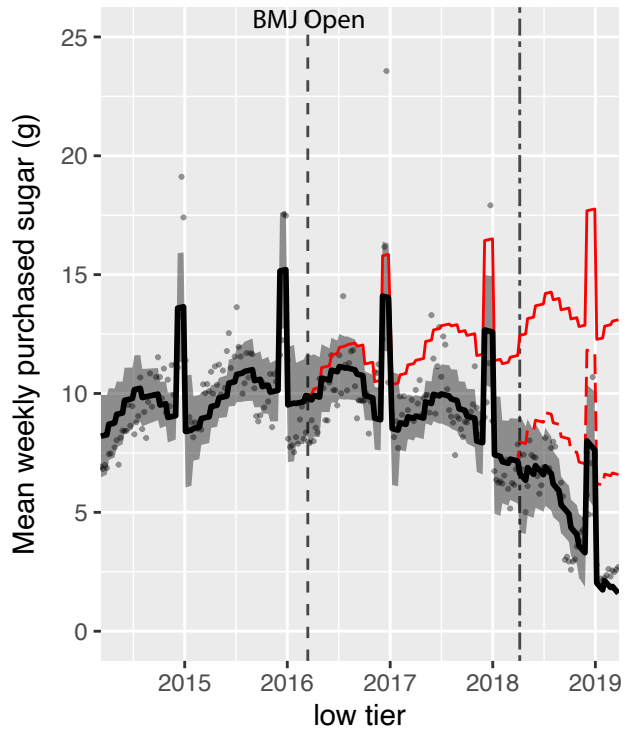
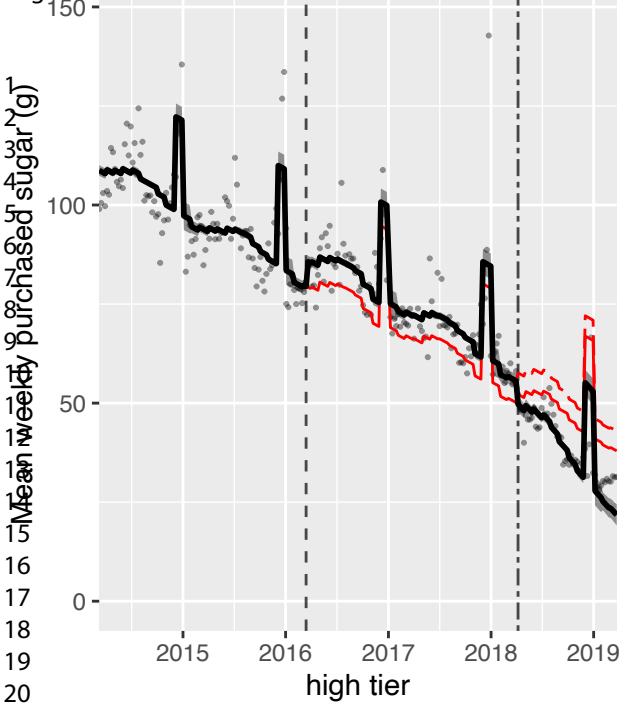


Figure 1: Schematic of overall analysis strategy

view only





## Supplementary material A

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Section and Paragraph No
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	Title.
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	Abstract: main outcome measures; results; conclusions.
<b>Introduction</b>			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	Introduction: paragraphs 1-3.
Objectives	3	State specific objectives, including any prespecified hypotheses	Introduction: paragraph 3-4.
<b>Methods</b>			
Study design	4	Present key elements of study design early in the paper	Methods: paragraph 1.
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Methods: data source; overall analysis strategy; Figure 1.
Participants	6	(a) <i>Cohort study</i> —Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up <i>Case-control study</i> —Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls <i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants	Methods: data source, product categories – drinks, confectionery and toiletries; control group; outcome measures.
		(b) <i>Cohort study</i> —For matched studies, give matching criteria and number of exposed and unexposed <i>Case-control study</i> —For matched studies, give matching criteria and the number of controls per case	NA.
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect	Outcome measures; overall analysis strategy; primary analysis: category specific analyses; secondary analysis: all soft drinks categories combined, irrespective of levy

		modifiers. Give diagnostic criteria, if applicable	eligibility; sensitivity analysis: excluding small manufacturers; sensitivity analysis: ITS without a control category; supplementary material B.
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Data source; overall analysis strategy; primary analysis: category specific analyses; secondary analysis: all soft drinks categories combined, irrespective of levy eligibility; sensitivity analysis: excluding small manufacturers; sensitivity analysis: ITS without a control category; supplementary material B.
Bias	9	Describe any efforts to address potential sources of bias	Product categories: drinks confectionery and toiletries; control group; sensitivity analysis: excluding small manufacturers; sensitivity analysis: ITS without a control category.
Study size	10	Explain how the study size was arrived at	Data source.
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Overall analysis strategy; primary analysis: category specific analyses; secondary analysis: all soft drinks categories combined, irrespective of levy eligibility; Box 1.
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	Control group; sensitivity analysis: ITS without a control category; Supplementary material A.
		(b) Describe any methods used to examine subgroups and interactions	Overall analysis strategy; primary analysis: category specific analyses; secondary analysis: all soft drinks categories combined, irrespective of levy eligibility.
		(c) Explain how missing data were addressed	Methods: data source
		(d) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed <i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed <i>Cross-sectional study</i> —If applicable, describe analytical methods taking account of sampling strategy	Methods: data source.
<b>Results</b>			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Results: paragraph 1.
		(b) Give reasons for non-participation at each stage	Data source.
		(c) Consider use of a flow diagram	-
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical,	Results: paragraph 1; Supplementary material C.

		social) and information on exposures and potential confounders	
		(b) Indicate number of participants with missing data for each variable of interest	Results: paragraph 1.
		(c) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)	NA.
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time	NA.
		<i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure	NA.
		<i>Cross-sectional study</i> —Report numbers of outcome events or summary measures	Results: paragraph 2; Table 1.
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Primary analysis: category specific results; high tier drinks; low tier drinks; no levy drinks; levy exempt drinks and confectionery; Figures 2-3; Tables 2-3; supplementary material D.
		(b) Report category boundaries when continuous variables were categorized	Introduction - paragraph 3; product categories: drinks, confectionery and toiletries; Box 1.
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	Tables 2-3.
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Sensitivity analysis: excluding small manufacturers; sensitivity analysis: no control category; supplementary tables 4a-b; supplementary material G.
<b>Discussion</b>			
Key results	18	Summarise key results with reference to study objectives	Summary of main findings.
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	Key strengths and limitations.
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Interpretation of findings - paragraphs 1-3.
Generalisability	21	Discuss the generalisability (external validity) of the study results	Interpretation of findings - paragraphs 4.
<b>Other information</b>			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Funding.

\*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.



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**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at [www.strobe-statement.org](http://www.strobe-statement.org).

For peer review only

### Supplementary material B

The model specification is given by:

$$Y_t = \beta_0 + \beta_1 T + \beta_2 A_t + \beta_3 A_t T + \beta_4 A_t Z + \beta_5 A_t T Z + \beta_6 I_t + \beta_7 I_t T + \beta_8 I_t Z + \beta_9 I_t T Z + e_t$$

$Y$	<i>Average volume of (or purchased sugar in) drink or confectionery per household per week at week <math>t</math> (<math>t=1, \dots, 264</math>)</i>
$T$	<i>Weeks since the start of the study; <math>1, \dots, 264</math></i>
$A_t$	<i>0 if <math>t</math> prior to announcement, 1 if <math>t</math> on or after announcement</i>
$I_t$	<i>0 if <math>t</math> prior to implementation, 1 if <math>t</math> on or after implementation</i>
$Z$	<i>Control category (toiletries) = 0, drink or confectionery category = 1</i>
$e_t$	<i><math>N(0, \sigma^2)</math> representing the residual variance of the model</i>

Dummy indicator variables determined to be statistically significant ( $p < 0.05$ ) were included for the intervention group as appropriate representing: interaction terms restart at 0 at the point of the interventions; the increase in purchases seen throughout December in the weeks before Christmas; the fall in purchases in the weeks immediately after Christmas; and the increase in confectionery purchases seen at Easter, for toiletries these were set to 0. To adjust for temperature-related trends in drink consumption the average UK monthly temperature was included in the intervention group with the average study period temperature used for toiletries.<sup>5</sup> Quadratic functions of announcement trends were included where they improved model fit - assessed using likelihood ratio tests. Stationary was examined using augmented Dickey-Fuller tests.<sup>41</sup> Autocorrelation between preceding time points was examined using autocorrelation and partial-autocorrelation plots. An appropriate autocorrelation structure was determined and then compared to alternative models using likelihood ratio tests. Visual inspection of the data suggested no additional benefit would be gained from including polynomial terms.

Supplementary material C

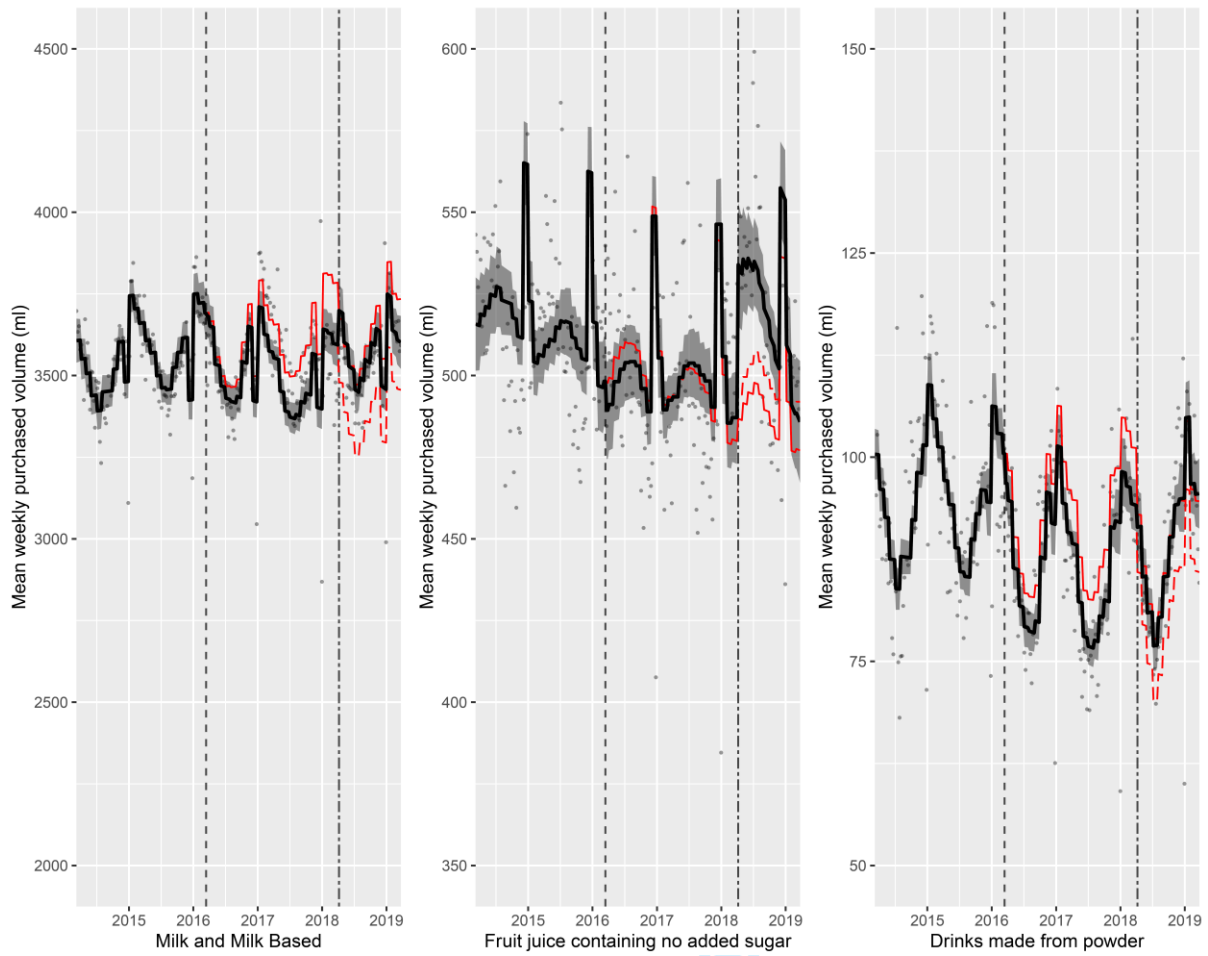
Supplementary Table 1: Demographic characteristics of Kantar Worldpanel take-home panel households from March 2014 – March 2018 (weighted)

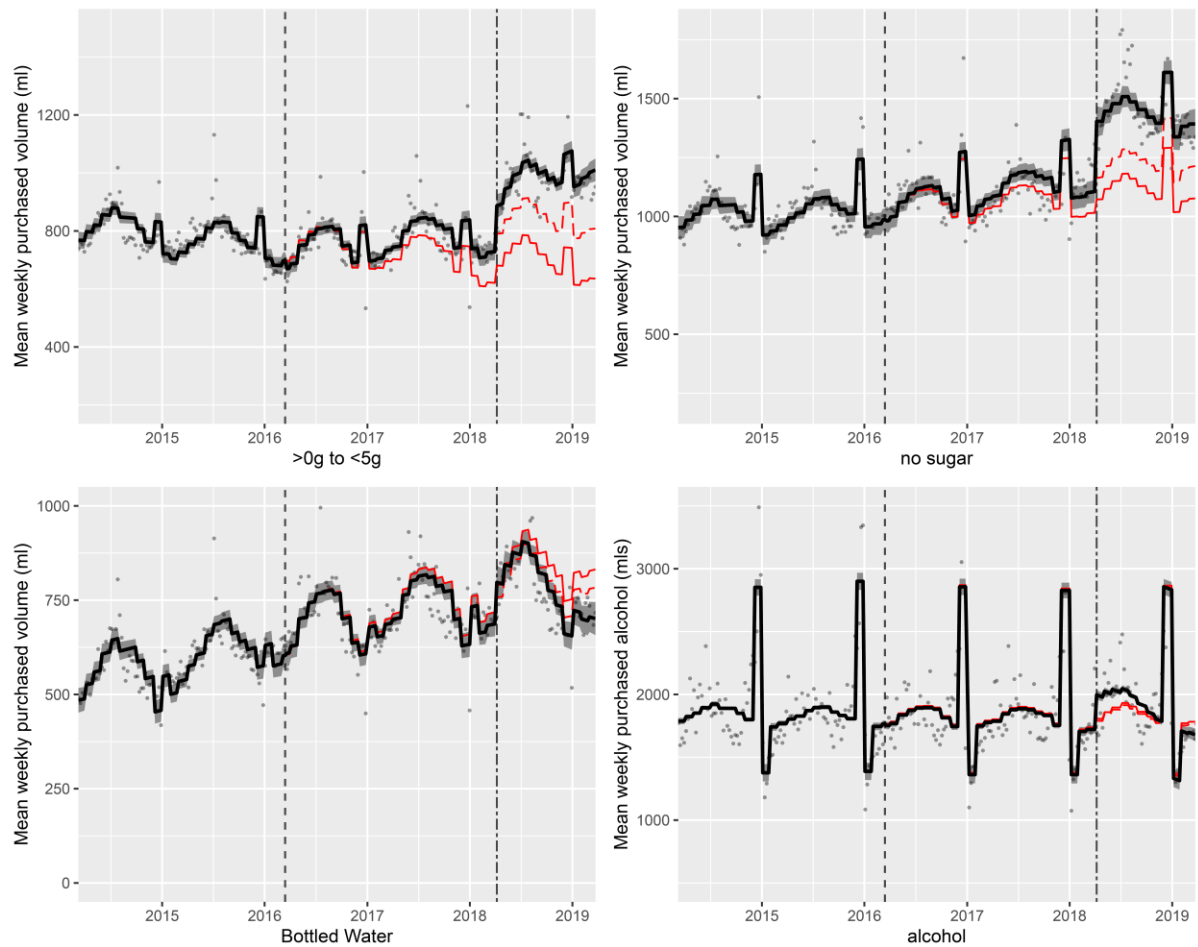
	Level	Kantar Worldpanel (%)	UK population (%)
Children in household <sup>1</sup>	No	65.3	71.5
	Yes	34.6	28.5
Social grade of chief income earner <sup>2</sup>	AB: Higher and intermediate managerial	19.3	27
	C1: Junior managerial	34.1	28
	C2: Skilled manual workers	16.4	20
	D: Semi and unskilled-manual workers	12.4	15
	E: lowest grade workers	7.9	10
Total household income (£ per annum) <sup>3</sup>	0-9,999	6.4	..
	10,000-19,999	18.9	..
	20,000-29,999	17.2	..
	30,000-39,999	13.1	....
	40,000-49,999	9.0	..
	50,000-59,999	5.5	..
	60,000-69,999	2.9	..
	70,000+	4.1	..
	Refused to answer	14.4	..
	Mean (£)	..	35,697
Median (£)	..	28,947	
Highest qualification of chief income earner <sup>4</sup>	Higher than School leaving qualifications taken at ~18 years (e.g. A-Levels)	38.3	43.8
	School leaving qualifications taken at ~18 years (e.g. A-Levels)	12.3	22.4
	School leaving qualifications taken at ~16 years (e.g. GCSE)	20.6	18.7
	Other (including no qualifications and unknown)	16.2	15.1

<sup>1</sup>Average of households with dependent children from 2014-2018; <sup>2</sup>UK population figures from 2016; <sup>3</sup>No directly comparable figures available from ONS, mean and medians are averaged over 2014-2019; <sup>4</sup>UK population figures from 2014

Supplementary material D

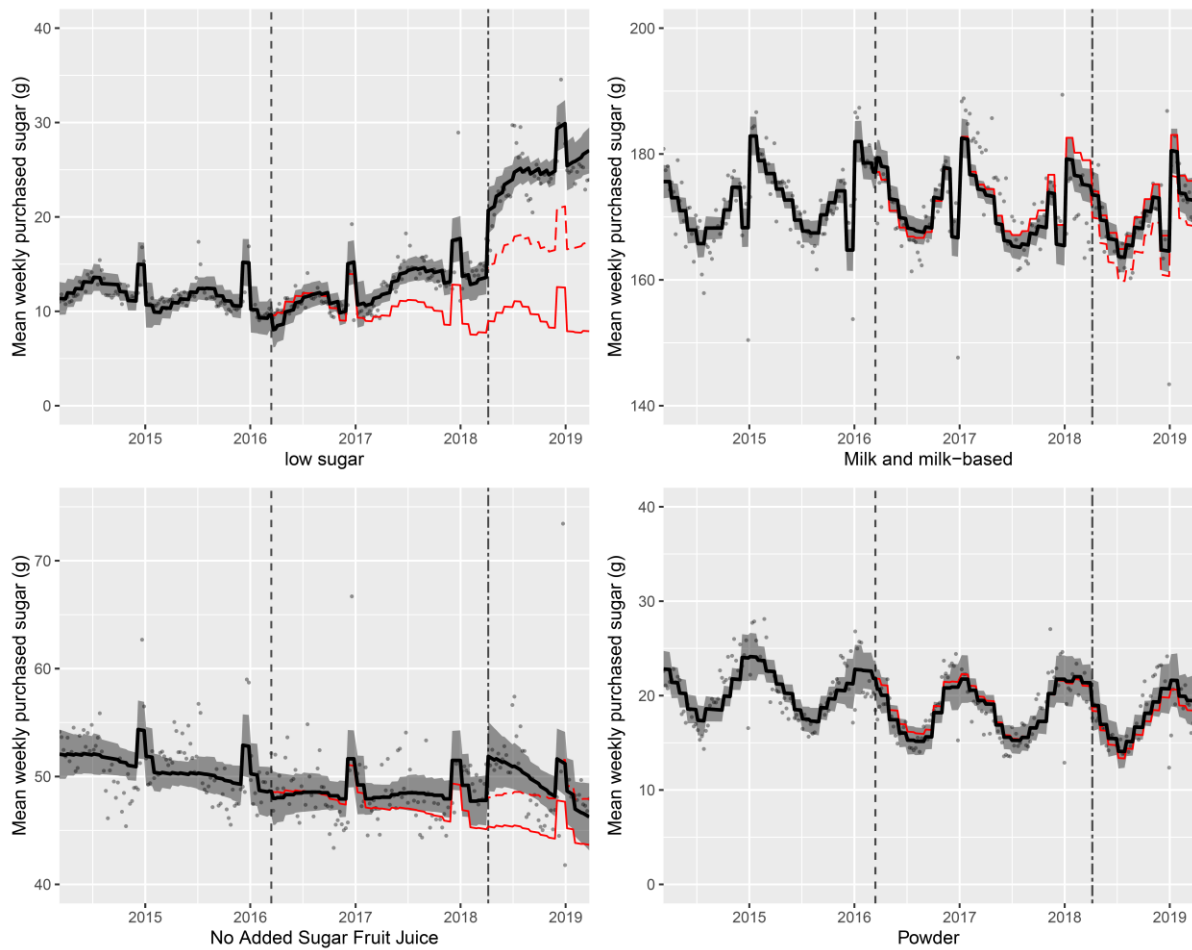
Supplementary Figure 1a. Observed and modelled volume (ml) of drinks exempt from the Soft Drinks Industry Levy purchased per household per week, March 2014- March 2019 (weighted)





Notes. Points are observed data, black lines (with shadows) are modelled data (and 95% confidence intervals); red lines indicate counterfactuals had the announcement (red solid line) and implementation (red dashed line) not happened; the first dashed vertical line indicates the point of announcement; the second dashed vertical line indicates the point of implementation; The Y-axis varies in scale between panels to maximise the resolution of figures; modelled purchases include averaged effects for seasonality and the impact of December and January (Christmas period). The control category of toiletries is shown in Figure 3.

Supplementary Figure 1b. Observed and modelled amount of sugar in drinks exempt from the Soft Drinks Industry Levy purchased per household per week, March 2014- March 2019 (weighted)



Notes. Points are observed data, black lines (with shadows) are modelled data (and 95% confidence intervals); red lines indicate counterfactuals had the announcement (red solid line) and implementation (red dashed line) not happened; the first dashed vertical line indicates the point of announcement; the second dashed vertical line indicates the point of implementation; The Y-axis varies in scale between panels to maximise the resolution of figures; modelled purchases include averaged effects for seasonality and the impact of December and January (Christmas period). The control category of toiletries is shown in Figure 3.

Supplementary Table 2a: Modelled level and trend changes in volume of drinks (ml) and confectionery (g) purchased per household per week (95% CI) in relation to the UK SDIL, March 2014 - March 2019 (weighted)

	Analysis 1: pre-post announcement (March 2014 – March 2018)		Analysis 2: pre-post implementation (March 2016 – March 2019)		Analysis 3: pre-post announcement & implementation (March 2014 – March 2019)	
	Level Change	Trend Change	Level Change	Trend Change	Level Change	Trend Change
<i>Levy liable drinks</i>						
High tier (≥8g sugar per 100ml)	44.0 (-7.7, 95.7)	-0.1 (-0.9, 0.7)	<b>-117.2 (-183.3, -51.1)</b>	1.0 (-0.9, 2.9)	-73.2 (-157.1, 10.7)	0.9 (-1.2, 3.0)
Low tier (≥5g - <8g sugar per 100ml)	-0.11 (-22.4, 22.1)	<b>-0.6 (-1.0, -0.3)</b>	-26.3 (-53.6, 1.04)	-0.81 (-1.6, 0.01)	-26.4 (-61.7, 8.8)	<b>-1.5 (-2.4, -0.6)</b>
No levy (<5g sugar per 100ml)	-28.2 (-149.4, 92.9)	<b>2.0 (0.04, 3.9)</b>	<b>372.0 (217.6, 526.4)</b>	<b>0.52 (-3.9, 4.9)</b>	<b>343.8 (147.5, 540.0)</b>	2.5 (-2.3, 7.3)
>0g to <5g sugar per 100ml	-27.1 (-82.6, 28.5)	<b>1.3 (0.4, 2.2)</b>	<b>88.1 (17.0, 159.3)</b>	<b>2.31 (0.3, 4.3)</b>	61.0 (-29.2, 151.4)	<b>3.6 (1.4, 5.8)</b>
0g sugar per 100ml	-7.37 (-93.9, 79.2)	0.9 (-0.6, 2.4)	<b>231.0 (125.2, 336.8)</b>	-0.99 (-4.3, 2.3)	<b>223.6 (87.0, 360.3)</b>	-0.08 (-3.7, 3.5)
Bottled water	6.86 (-53.4, 67.2)	-0.4 (-1.4, 0.6)	36.6 (-38.8, 112.0)	-2.24 (-4.5, 0.005)	43.5 (-53.1, 140.0)	<b>-2.6 (-5.1, -0.2)</b>
<i>Levy exempt drinks</i>						
Alcoholic drinks	-10.8 (-48.6, 27.0)	-0.07 (-0.5, 0.3)	<b>208.0 (137.9, 278.1)</b>	<b>-5.7 (-7.8, -3.6)</b>	<b>197.2 (117.6, 276.8)</b>	<b>-5.8 (-7.9, -3.7)</b>
Milk and milk based drinks <sup>1</sup>	-6.61 (-105.8, 92.6)	-1.7 (-4.0, 0.5)	<b>210.7 (98.7, 322.7)</b>	-1.2 (-5.3, 2.9)	<b>204.1 (54.4, 353.7)</b>	-2.9 (-7.6, 1.8)
No added sugar fruit juices	-8.72 (-34.3, 16.9)	0.1 (-0.3, 0.6)	30.5 (-0.9, 61.9)	-0.7 (-1.6, 0.3)	21.78 (-18.8, 62.3)	-0.5 (-1.6, 0.5)
Drinks sold as powders (g)	-1.79 (-7.8, 4.18)	-0.06 (-0.2, 0.03)	0.10 (-7.7, 7.9)	<b>0.3 (0.04, 0.5)</b>	-1.69 (-11.6, 8.17)	0.2 (-0.04, 0.4)
Confectionery (g)	-17.0 (-88.0, 54.0)	0.07 (-1.3, 1.5)	-77.9 (-163.9, 8.19)	2.4 (-0.6, 5.4)	<b>-98.9 (-206.4, -16.7)</b>	2.5 (-0.8, 5.8)

Notes. Bold indicates a significant difference at the 95% confidence interval level. <sup>1</sup>Milk comprises drinks in the following categories: semi-skimmed; specific low fat % milk (e.g. 1% fat milk); whole milk; buttermilk; modified milk; other milk; other non-cows milk; rice drink; soya milk. Skimmed milk is excluded from all analysis in this paper due to missing data.



Supplementary Table 2b: Modelled level and trend changes in sugar in drinks (ml) and confectionery (g) purchased per household per week (95% CI) in relation to the UK SDIL, March 2014 - March 2019 (weighted)

	Analysis 1: pre-post announcement (March 2014 – March 2018)		Analysis 2: pre-post implementation (March 2016 – March 2019)		Analysis 3: pre-post announcement & implementation (March 2014 – March 2019)	
	Level Change	Trend Change	Level Change	Trend Change	Level Change	Trend Change
<i>Levy liable drinks</i>						
High tier (≥8g sugar per 100ml)	<b>8.9 (6.8, 10.9)</b>	<b>-0.05 (-0.08, -0.03)</b>	<b>-11.5 (-15.3, -7.7)</b>	<b>-0.1 (-0.2, -0.02)</b>	-2.6 (-6.9, 1.6)	<b>-0.2 (-0.3, -0.07)</b>
Low tier (≥5g - <8g sugar per 100ml)	1.7 (-1.6, 5.1)	<b>-0.07 (-0.1, -0.02)</b>	<b>-6.2 (-10.6, -1.8)</b>	0.09 (-0.03, 0.2)	-4.5 (-10.0, 1.1)	0.02 (-0.1, 0.2)
No levy (<5g sugar per 100ml)	0.2 (-3.1, 3.5)	0.04 (-0.01, 0.09)	0.8 (-3.6, 5.3)	<b>0.2 (0.1, 0.4)</b>	1.0 (-4.5, 6.6)	<b>0.3 (0.2, 0.4)</b>
>0g to <5g sugar per 100ml	0.2 (-3.1, 3.5)	0.04 (-0.01, 0.09)	0.8 (-3.6, 5.3)	<b>0.2 (0.1, 0.4)</b>	1.0 (-4.5, 6.6)	<b>0.3 (0.2, 0.4)</b>
<i>Levy exempt drinks</i>						
Milk and milk based drinks <sup>1</sup>	4.1 (-0.1, 9.1)	<b>-0.09 (-0.2, -0.01)</b>	-2.0 (-8.6, 4.6)	<b>0.2 (0.01, 0.4)</b>	2.1 (-6.2, 10.4)	0.1 (-0.09, 0.3)
No added sugar fruit juices	1.0 (-3.4, 5.4)	0.001 (-0.06, 0.06)	-1.6 (-7.3, 4.1)	0.07 (-0.09, 0.2)	-0.6 (-7.8, 6.6)	0.07 (-0.1, 0.2)
Drinks sold as powders (g)	0.6 (-3.3, 4.5)	-0.02 (-0.08, 0.04)	-5.1 (-0.004, 10.2)	<b>0.2 (0.03, 0.3)</b>	-4.5 (-10.9, 1.9)	<b>0.2 (0.001, 0.3)</b>
Confectionery (g)	-8.6 (-49.7, 32.6)	0.03 (-0.8, 0.9)	-49.4 (-99.2, 0.4)	1.5 (-0.2, 3.2)	<b>-58.0 (-122.6, -6.7)</b>	1.6 (-0.4, 3.5)

Notes. Bold indicates a significant difference at the 95% confidence interval level. <sup>1</sup>Milk comprises drinks in the following categories: semi-skimmed; specific low fat % milk (e.g. 1% fat milk); whole milk; buttermilk; modified milk; other milk; other non-cows milk; rice drink; soya milk. Skimmed milk is excluded from all analysis in this paper due to missing data.

**Supplementary material E**

Secondary analysis: all drinks categories combined irrespective of levy eligibility

Supplementary Table 3a: Level and trend changes in volume of, and sugar in, all drinks (ml) and confectionery (g) purchased per household per week (95% CI) in relation to the UK SDIL, March 2014 - March 2019 (weighted)

	Analysis 1: pre-post announcement (March 2014 – March 2018)		Analysis 2: pre-post implementation (March 2016 – March 2019)		Analysis 3: pre-post announcement & implementation (March 2014 – March 2019)	
	Level Change	Trend Change	Level Change	Trend Change	Level Change	Trend Change
<i>All drinks - volume</i>						
Higher tier (≥8g sugar per 100ml)	22.8 (-37.5, 83.1)	0.5 (-0.5, 1.5)	-76.8 (-154.0, 0.4)	-2.2 (-4.4, 0.01)	-54.0 (-152.0, 44.0)	-1.7 (-4.1, 0.7)
Lower tier (≥5g - <8g sugar per 100ml)	19.0 (-52.2, 90.2)	<b>-3.2 (-5.9, -0.5)</b>	27.9 (-47.8, 103.6)	-4.4 (-8.9, 0.02)	46.9 (-57.0, 150.8)	<b>-7.6 (-12.9, -2.4)</b>
Drinks containing <5g sugar per 100ml)	-152.1 (-348.3, 44.1)	2.6 (-0.7, 5.8)	<b>435.7 (187.7, 683.7)</b>	1.1 (-6.0, 8.3)	283.6 (-32.6, 599.8)	3.7 (-4.2, 11.5)
Levy liable drinks combined	15.2 (-72.9, 103.3)	0.6 (-0.8, 2.0)	-39.7 (-152.7, 73.4)	0.01 (-3.2, 3.2)	-24.5 (-167.8, 118.9)	0.6 (-2.9, 4.1)
All drinks excluding milk <sup>1</sup>	12.9 (-205.3, 231.0)	1.0 (-2.6, 4.5)	<b>347.6 (70.1, 625.0)</b>	-5.2 (-13.1, 2.7)	<b>360.5 (7.47, 713.4)</b>	-4.2 (-12.9, 4.5)
All drinks combined	33.9 (-189.0, 256.7)	-0.2 (-3.8, 3.4)	<b>453.0 (170.1, 735.9)</b>	-5.1 (-13.2, 3.0)	<b>486.9 (126.7, 847.0)</b>	-5.4 (-14.2, 3.5)
<i>All drinks – sugar</i>						
Higher tier (≥8g sugar per 100ml)	4.1 (-2.6, 10.8)	0.04 (-0.07, 1.1)	<b>-13.4 (-22.2, -4.7)</b>	-0.1 (-0.4, 0.1)	-9.3 (-20.3, 1.7)	-0.08 (-0.3, 0.2)
Lower tier (≥5g - <8g sugar per 100ml)	<b>11.0 (5.6, 16.3)</b>	<b>-0.2 (-0.3, -0.1)</b>	-2.7 (-9.67, 4.3)	-0.01 (-0.2, 0.2)	8.3 (-0.5, 17.1)	<b>-0.2 (-0.4, -0.01)</b>
Drinks containing <5g sugar per 100ml)	-6.3 (-12.2, -0.4)	<b>1.0 (0.9, 1.0)</b>	-0.7 (-8.30, 7.0)	<b>0.4 (0.2, 0.6)</b>	-7.0 (-16.6, 2.7)	<b>1.4 (1.1, 1.6)</b>
Levy liable drinks combined	5.0 (-1.8, 11.8)	-0.003 (-0.1, 0.1)	<b>-13.1 (-22.0, -4.2)</b>	0.02 (-0.2, 0.3)	-8.1 (-19.3, 3.1)	0.02 (-0.3, 0.3)
All drinks excluding milk <sup>1</sup>	3.1 (-4.6, 10.8)	0.04 (-0.08, 0.2)	-9.3 (-19.2, 0.7)	-0.09 (-0.4, 0.2)	-6.2 (-18.8, 6.4)	-0.05 (-0.4, 0.3)
All drinks combined	5.3 (-2.6, 13.2)	-0.02 (-0.1, 0.1)	-5.7 (-15.9, 4.5)	-0.08 (-0.4, 0.2)	-0.4 (-13.2, 12.5)	-0.1 (-0.4, 0.2)

Notes. Bold indicates a significant difference at the 95% confidence interval level. The levy liable drinks category is a combination of high tier, low tier and no levy drinks. <sup>1</sup>Milk comprises drinks in the following categories: semi-skimmed; specific low fat % milk (e.g. 1% fat milk); whole milk; buttermilk; modified milk; other milk; other non-cows milk; rice drink; soya milk. Skimmed milk is excluded from all analysis in this paper due to missing data.

Supplementary Table 3b: Absolute and relative change in volume of, and sugar in, all drinks and confectionery (g) purchased per household (95% CI) per week in relation to the UK SDIL, March 2014- March 2019 (weighted)

	Analysis 1: pre-post announcement (March 2014 – March 2018)		Analysis 2: pre-post implementation (March 2016 – March 2019)		Analysis 3: pre-post announcement & implementation (March 2014 – March 2019)	
	Absolute change (ml or g)	Relative change (%)	Absolute change (ml or g)	Relative change (%)	Absolute change (ml or g)	Relative change (%)
<i>All drinks - volume</i>						
High tier (≥8g sugar per 100ml)	<b>76.6 (45.6, 107.7)</b>	<b>7.5 (4.5, 10.6)</b>	<b>-190.9 (-233.5, -148.3)</b>	<b>-19.4 (-23.7, -15.1)</b>	<b>-85.6 (-128.2, -43.0)</b>	<b>-9.8 (-14.6, -4.9)</b>
Low tier (≥5g - <8g sugar per 100ml)	316.7 (-241.7, -391.7)	<b>-28.0 (-21.3, -34.6)</b>	<b>-205.2 (-295.9, -114.5)</b>	<b>-26.2 (-37.8, -14.6)</b>	<b>-693.6 (-784.3, -602.9)</b>	<b>-54.5 (-61.7, -47.4)</b>
Drinks containing <5g sugar per 100ml)	<b>114.3 (12.4, 216.2)</b>	<b>2.2 (0.2, 4.1)</b>	<b>506.7 (367.3, 646.1)</b>	<b>9.0 (6.5, 11.4)</b>	<b>760.2 (620.8, 899.6)</b>	<b>14.1 (11.5, 16.6)</b>
Levy liable drinks combined	<b>76.5 (31.1, 121.8)</b>	<b>6.0 (2.5, 9.6)</b>	-42.7 (-104.9, 19.6)	-3.3(-8.1, 1.5)	<b>66.3 (4.1, 128.6)</b>	<b>5.6 (0.3, 10.8)</b>
All drinks excluding milk <sup>1</sup>	<b>116.1 (3.3, 229.0)</b>	<b>3.3 (0.09, 6.4)</b>	79.6 (-74.8, 234.1)	2.1 (-2.0, 6.1)	<b>250.1 (95.7, 404.5)</b>	<b>6.8 (2.6, 11.0)</b>
All drinks combined	11.8 (-103.7, 127.3)	0.2 (-1.4, 1.7)	<b>187.8 (29.7, 345.9)</b>	<b>2.6 (0.4, 4.7)</b>	<b>188.8 (30.7, 346.9)</b>	<b>2.6 (0.4, 4.7)</b>
<i>All drinks – sugar</i>						
High tier (≥8g sugar per 100ml)	<b>9.3 (5.9, 12.8)</b>	<b>7.6 (4.8, 10.4)</b>	<b>-22.9 (-27.8, -18.1)</b>	<b>-19.4 (-23.4, -15.3)</b>	<b>-9.99 (-14.8, -5.18)</b>	<b>-9.5 (-14.0, -4.9)</b>
Low tier (≥5g - <8g sugar per 100ml)	<b>-9.7 (-12.5, -6.9)</b>	<b>-18.6 (-23.9, -13.3)</b>	<b>-7.2 (-11.0, -3.4)</b>	<b>-19.4 (-29.7, -9.1)</b>	<b>-26.7 (-30.5, -22.9)</b>	<b>-47.1 (-53.9, -40.4)</b>
Drinks containing <5g sugar per 100ml)	<b>5.1 (2.1, 8.1)</b>	<b>3.6 (1.5, 5.8)</b>	<b>16.7 (12.5, 20.9)</b>	<b>11.2 (8.4, 14.0)</b>	<b>28.6 (24.4, 32.8)</b>	<b>20.9 (17.9, 23.9)</b>
Levy liable drinks combined	<b>6.1 (2.6, 9.6)</b>	<b>8.6 (3.6, 13.5)</b>	<b>-15.5 (-20.4, -10.7)</b>	<b>-22.7 (-29.8, -15.6)</b>	<b>-8.0 (-12.9, -3.2)</b>	<b>-13.2 (-21.1, -5.2)</b>
All drinks excluding milk <sup>1</sup>	<b>8.9 (5.0, 12.8)</b>	<b>6.5 (3.6, 9.4)</b>	<b>-17.2 (-22.7, -11.8)</b>	<b>-12.7 (-16.7, -8.67)</b>	<b>-4.5 (-10.0, 1.0)</b>	<b>-3.7 (-8.1, 0.8)</b>
All drinks combined	<b>4.6 (0.5, 8.6)</b>	<b>1.4 (0.2, 2.7)</b>	<b>-12.9 (-18.5, -7.4)</b>	<b>-4.3 (-6.1, -2.4)</b>	<b>-8.0 (-13.6, -2.4)</b>	<b>-2.7 (-4.5, -0.8)</b>

Notes. Bold indicates a significant difference at the 95% confidence interval level. The levy liable drinks category is a combination of high tier, low tier and no levy drinks. <sup>1</sup>Milk comprises drinks in the following categories: semi-skimmed; specific low fat % milk (e.g. 1% fat milk); whole milk; buttermilk; modified milk; other milk; other non-cows milk; rice drink; soya milk. Skimmed milk is excluded from all analysis in this paper due to missing data.

**Supplementary material F**

Sensitivity analysis: excluding small manufacturers

Supplementary table 4a: Modelled level and trend changes in volume of, and sugar in, drinks (ml) purchased per household per week (95% CI) in relation to the UK SDIL, March 2014 - March 2019; excluding small manufacturers (weighted)

	Analysis 1: pre-post announcement (March 2014 – March 2018)		Analysis 2: pre-post implementation (March 2016 – March 2019)		Analysis 3: pre-post announcement & implementation (March 2014 – March 2019)	
	Level Change	Trend Change	Level Change	Trend Change	Level Change	Trend Change
<i>Volume</i>						
<i>High levy tier (≥8g sugar per 100ml)</i>						
All Manufacturers	44.0 (-7.7, 95.7)	-0.1 (-0.9, 0.7)	<b>-117.2 (-183.3, -51.1)</b>	1.0 (-0.9, 2.9)	-73.2 (-157.1, 10.7)	0.9 (-1.2, 3.0)
Excluding Manufacturers with <1M Litres	41.5 (-9.7, 92.7)	-0.09 (-0.9, 0.7)	<b>-111.9 (-177.3, -46.6)</b>	-1.1 (-2.9, 0.8)	-70.8 (-153.4, 12.6)	-1.2 (-3.2, 0.9)
Excluding Manufacturers with <0.5M Litres	41.5 (-9.7, 92.7)	-0.09 (-0.9, 0.7)	<b>-111.9 (-177.3, -46.6)</b>	-1.1 (-2.9, 0.8)	-70.8 (-153.4, 12.6)	-1.2 (-3.2, 0.9)
<i>Low levy tier (≥5g - &lt;8g sugar per 100ml)</i>						
All Manufacturers	-0.1 (-22.4, 22.1)	<b>-0.6 (-1.0, -0.3)</b>	-26.3 (-53.6, 1.0)	-0.8 (-1.6, 0.01)	-26.4 (-61.7, 8.8)	<b>-1.5 (-2.4, -0.6)</b>
Excluding Manufacturers with <1M Litres	-2.1 (-24.0, 19.9)	<b>-0.7 (-1.0, -0.3)</b>	-20.9 (-47.5, 5.7)	<b>-0.9 (-1.8, -0.1)</b>	-23.0 (-57.5, 11.6)	<b>-1.6 (-2.5, -0.7)</b>
Excluding Manufacturers with <0.5M Litres	-2.1 (-24.0, 19.6)	<b>-0.7 (-1.0, -0.3)</b>	-20.7 (-47.3, 5.9)	<b>-0.9 (-1.8, -0.1)</b>	-22.9 (-57.2, 11.5)	<b>-1.6 (-2.5, -0.7)</b>
<i>Sugar</i>						
<i>High tier (≥8g sugar per 100ml)</i>						
All Manufacturers	<b>8.9 (6.8, 10.9)</b>	<b>-0.05 (-0.08, -0.03)</b>	<b>-11.5 (-15.3, -7.7)</b>	<b>-0.1 (-0.2, -0.02)</b>	-2.6 (-6.9, 1.6)	<b>-0.2 (-0.3, -0.07)</b>
Excluding Manufacturers with <1M Litres	4.5 (-1.3, 10.2)	-0.03 (-0.1, 0.06)	<b>-13.5 (-20.8, -6.1)</b>	-0.07 (-0.3, 0.1)	-9.0 (-18.3, 0.4)	-0.1 (-0.3, 0.1)
Excluding Manufacturers with <0.5M Litres	4.5 (-1.3, 10.2)	-0.03 (-0.1, 0.06)	<b>-13.5 (-20.8, -6.1)</b>	-0.07 (-0.3, 0.1)	-9.0 (-18.3, 0.4)	-0.1 (-0.3, 0.1)
<i>Low tier (≥5g - &lt;8g sugar per 100ml)</i>						
All Manufacturers	1.7 (-1.6, 5.1)	<b>-0.07 (-0.1, -0.02)</b>	<b>-6.2 (-10.6, -1.8)</b>	0.09 (-0.03, 0.2)	-4.5 (-10.0, 1.1)	0.02 (-0.1, 0.2)
Excluding Manufacturers with <1M Litres	-0.4 (-2.1, 1.3)	<b>-0.07 (-0.1, -0.04)</b>	<b>-2.5 (-4.6, -0.4)</b>	0.002 (-0.06, 0.06)	<b>-3.0 (-5.7, -0.2)</b>	-0.007 (-0.1, 0.0001)
Excluding Manufacturers with <0.5M Litres	-0.5 (-2.1, 1.2)	<b>-0.07 (-0.1, -0.04)</b>	<b>-2.5 (-4.7, -0.4)</b>	0.003 (-0.06, 0.06)	<b>-3.0 (-5.7, -0.2)</b>	-0.007 (-0.1, 0.0001)

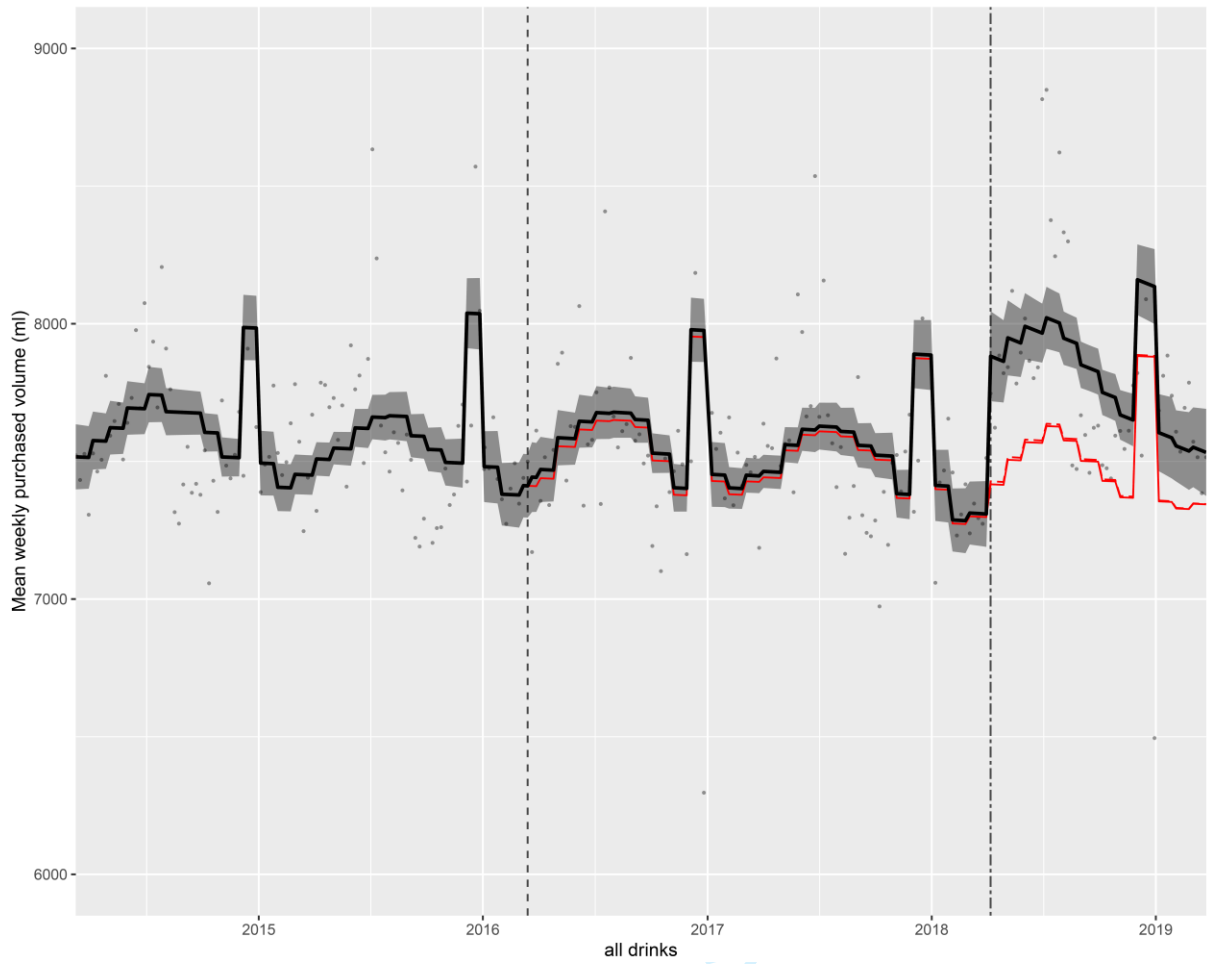
Notes. Bold indicates a significant difference at the 95% confidence interval level.

Supplementary Table 4b: Modelled absolute and relative change in volume of, and sugar in, all drinks (ml) purchased per household (95% CI) per week in relation to the UK SDIL, March 2014- March 2019; excluding small manufacturers (weighted)

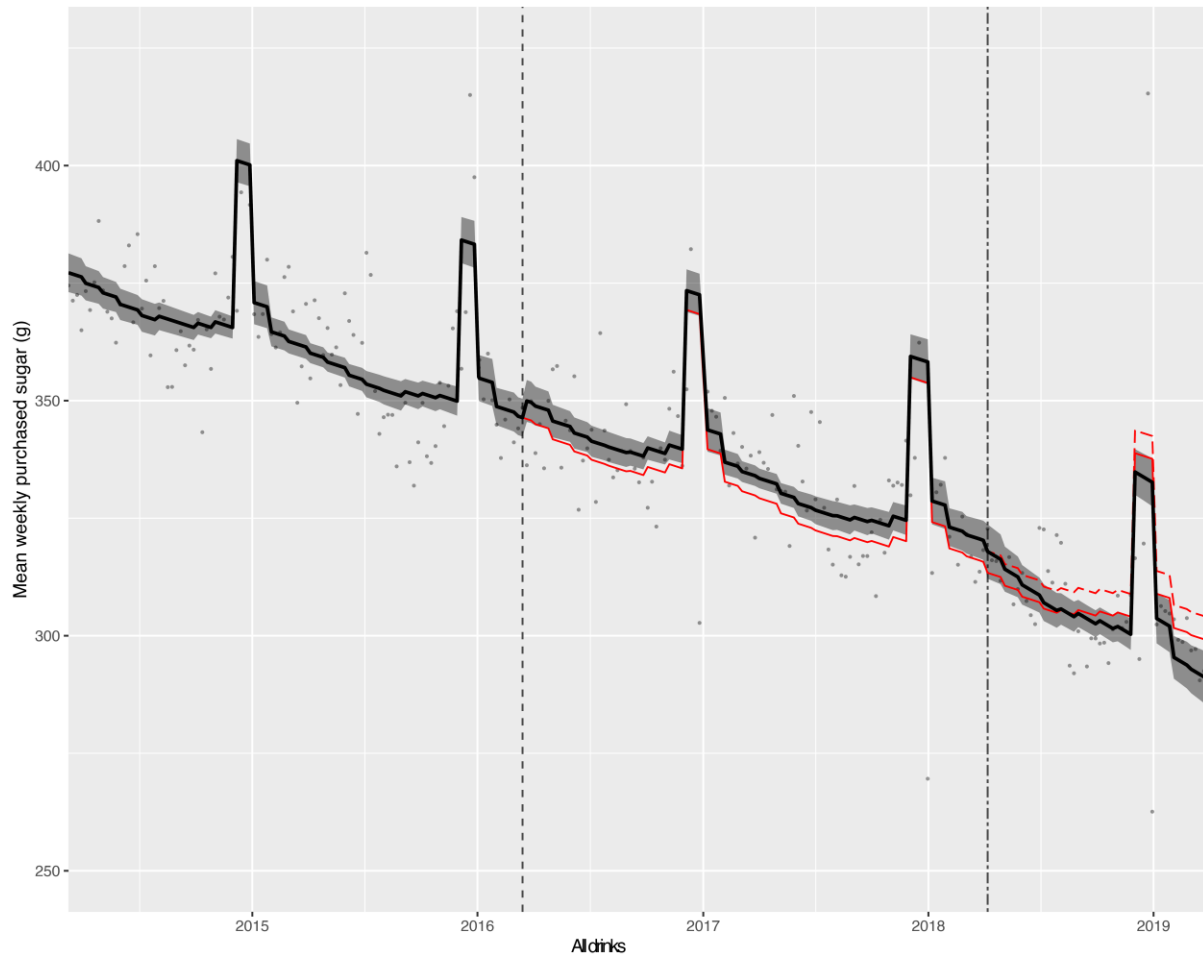
	Analysis 1: pre-post announcement (March 2014 – March 2018)		Analysis 2: pre-post implementation (March 2016 – March 2019)		Analysis 3: pre-post announcement & implementation (March 2014 – March 2019)	
	Absolute change (ml)	Relative change (%)	Absolute change (ml)	Relative change (%)	Absolute change (ml)	Relative change (%)
<i>Volume</i>						
<i>High tier (≥8g sugar per 100ml)</i>						
All Manufacturers	<b>34.7 (8.1, 61.4)</b>	<b>7.3 (1.7, 12.9)</b>	<b>-171.6 (-208.1, -135.1)</b>	<b>-42.5 (-51.6, -33.5)</b>	<b>-140.8 (-177.3, -104.3)</b>	<b>-37.8 (-47.6, -28.0)</b>
Excluding Manufacturers with <1M Litres	<b>35.3 (8.9, 61.6)</b>	<b>7.5 (1.9, 13.1)</b>	<b>-168.1 (-204.2, -131.9)</b>	<b>-42.6 (-51.7, -33.4)</b>	<b>-136.2 (-172.3, -100.1)</b>	<b>-37.6 (-47.5, -27.6)</b>
Excluding Manufacturers with <0.5M Litres	<b>35.3 (8.9, 61.6)</b>	<b>7.5 (1.9, 13.1)</b>	<b>-168.1 (-204.2, -131.9)</b>	<b>-42.6 (-51.7, -33.4)</b>	<b>-136.2 (-172.3, -100.1)</b>	<b>-37.6 (-47.5, -27.6)</b>
<i>Low tier (≥5g - &lt;8g sugar per 100ml)</i>						
All Manufacturers	<b>-65.7 (-77.5, -53.8)</b>	<b>-37.1 (-43.7, -30.4)</b>	<b>-71.8 (-87.8, -55.8)</b>	<b>-71.8 (-87.8, -55.8)</b>	<b>-170.5 (-186.5, -154.5)</b>	<b>-85.8 (-93.9, -77.8)</b>
Excluding Manufacturers with <1M Litres	<b>-66.4 (-78.2, -54.6)</b>	<b>-37.6 (-44.3, -30.9)</b>	<b>-71.2 (-87.1, -55.3)</b>	<b>-72.5 (-88.7, -56.3)</b>	<b>-171.1 (-187.0, -155.2)</b>	<b>-86.4 (-94.4, -78.4)</b>
Excluding Manufacturers with <0.5M Litres	<b>-66.5 (-78.2, -54.7)</b>	<b>-37.6 (-44.2, -31.0)</b>	<b>-71.3 (-87.1, -55.5)</b>	<b>-72.4 (-88.5, -56.3)</b>	<b>-171.2 (-187.1, -155.4)</b>	<b>-86.3 (-94.3, -78.3)</b>
<i>Sugar</i>						
<i>High tier (≥8g sugar per 100ml)</i>						
All Manufacturers	<b>5.5 (3.8, 7.3)</b>	<b>10.8 (7.4, 14.1)</b>	<b>-21.2 (-23.8, -18.5)</b>	<b>-49.3 (-55.4, -43.1)</b>	<b>-16.2 (-18.8, -13.5)</b>	<b>-42.6 (-49.6, -35.6)</b>
Excluding Manufacturers with <1M Litres	<b>4.7 (1.7, 7.7)</b>	<b>9.3 (3.4, 15.1)</b>	<b>-19.3 (-23.4, -15.2)</b>	<b>-44.3 (-53.6, -35.0)</b>	<b>-14.6 (-18.7, -10.6)</b>	<b>-37.6 (-48.1, -27.1)</b>
Excluding Manufacturers with <0.5M Litres	<b>4.7 (1.7, 7.7)</b>	<b>9.3 (3.4, 15.1)</b>	<b>-19.3 (-23.4, -15.2)</b>	<b>-44.3 (-53.6, -35.0)</b>	<b>-14.6 (-18.7, -10.6)</b>	<b>-37.6 (-48.1, -27.1)</b>
<i>Low tier (≥5g - &lt;8g sugar per 100ml)</i>						
All Manufacturers	<b>-4.3 (-6.1, -2.6)</b>	<b>-37.5 (-52.5, -22.5)</b>	<b>-5.0 (-7.4, -2.6)</b>	<b>-75.8 (-112.7, -38.9)</b>	<b>-11.5 (-13.9, -9.07)</b>	<b>-87.8 (-106.4, -69.2)</b>
Excluding Manufacturers with <1M Litres	<b>-4.7 (-5.5, -3.8)</b>	<b>-39.1 (-46.5, -31.7)</b>	<b>-4.8 (-6.0, -3.6)</b>	<b>-73.0 (-91.3, -54.7)</b>	<b>-11.8 (-13.0, -10.6)</b>	<b>-86.9 (-95.8, -78.1)</b>
Excluding Manufacturers with <0.5M Litres	<b>-4.7 (-5.6, -3.8)</b>	<b>-39.1 (-46.5, -31.8)</b>	<b>-4.8 (-6.0, -3.6)</b>	<b>-72.9 (-91.1, -54.6)</b>	<b>-11.8 (-13.0, -10.6)</b>	<b>-86.9 (-95.7, -78.0)</b>

Notes. Bold indicates a significant difference at the 95% confidence interval level.

Supplementary Figure 2. Observed and modelled volume (ml) and amount of sugar (g) in all drinks combined purchased per household per week, March 2014- March 2019 (weighted)



view only



Notes. Points are observed data, black lines (with shadows) are modelled data (with 95% confidence intervals); red lines indicate the counterfactuals had the announcement (red solid line) and implementation (red dashed line) not happened; the first dashed vertical line indicates the point of announcement; the second dashed vertical line indicates the point of implementation; The Y-axis varies in scale between panels to maximise the resolution of figures; modelled purchases include averaged effects for seasonality and the impact of December and January (the Christmas period). The control category of toiletries is shown in Fig 3.



**Supplementary material G**

Removing the control category led to wider confidence intervals in a small number of cases such that absolute and relative changes in volume were not significantly different from the pre-implementation counterfactuals for no levy drinks and the pre-announcement and post implementation counterfactual for drinks containing 0g of sugar per 100ml. Significantly lower volumes of purchased volumes of powdered drinks were seen following the announcement in the controlled analysis unlike in the uncontrolled analysis. In the uncontrolled analysis absolute and relative differences in the amount of sugar in milk based drinks were significantly different from the pre-implementation counterfactual but not significantly different when examining the impact of the SDIL overall. Additionally the amount of sugar in confectionery was not significantly different from the pre-announcement counterfactual in the uncontrolled ITS analysis unlike in the controlled analysis.

Supplementary Table 5a: Level and trend changes in volume of drinks (ml) and confectionery (g) purchased per household per week (95% CI) in relation to the UK SDIL, March 2014 - March 2019 without toiletries as a control condition (weighted)

	Analysis 1: pre-post announcement (March 2014 – March 2018)		Analysis 2: pre-post implementation (March 2016 – March 2019)		Analysis 3: pre-post announcement & implementation (March 2014 – March 2019)	
	Level Change	Trend Change	Level Change	Trend Change	Level Change	Trend Change
<i>Levy liable drinks</i>						
High tier (≥8g sugar per 100ml)	42.3 (-9.4, 94.0)	-0.07 (-0.9, 0.8)	<b>-111.2 (-177.1, -45.3)</b>	-1.2 (-3.0, 0.7)	-68.9 (-152.7, 14.9)	-1.3 (-3.3, 0.8)
Low tier (≥5g - <8g sugar per 100ml)	-2.2 (-24.1, 19.8)	<b>-0.6 (-1.0, -0.2)</b>	-18.9 (-45.8, 8.0)	-1.0 (1.9, -0.2)	-21.1 (-55.75, 13.6)	<b>-1.7 (-2.6, -0.7)</b>
No levy (<5g sugar per 100ml)	-29.8 (-150.9, 91.3)	<b>2.0 (0.08, 4.0)</b>	<b>378.1 (223.7, 532.5)</b>	<b>0.3 (0.5, 2.0)</b>	<b>348.3 (152.0, 544.6)</b>	2.4 (-2.4, 7.2)
>0g to <5g sugar per 100ml	-27.9 (-78.3, 22.5)	<b>1.3 (0.5, 2.0)</b>	<b>98.0 (32.7, 163.3)</b>	<b>2.1 (0.3, 3.9)</b>	70.1 (-12.4, 152.6)	<b>3.4 (1.4, 5.4)</b>
0g sugar per 100ml	-2.0 (-75.5, 71.5)	0.8 (-0.4, 2.0)	<b>278.9 (185.6, 372.2)</b>	-1.7 (-4.4, 1.0)	<b>276.9 (158.2, 395.7)</b>	-0.9 (-3.9, 2.0)
Bottled water	9.9 (-49.1, 68.9)	-0.4 (-1.4, 0.6)	53.5 (-20.8, 127.8)	-2.6 (-4.7, 0.4)	63.4 (-31.5, 158.2)	<b>-2.9 (-5.3, -0.6)</b>
<i>Levy exempt drinks</i>						
Alcoholic drinks	-13.3 (-51.0, 24.4)	-0.03 (-0.4, 0.4)	<b>212.7 (142.5, 282.9)</b>	<b>-5.8 (-7.9, -3.8)</b>	<b>199.4 (119.8, 279.1)</b>	<b>-5.9 (-8.0, -3.8)</b>
Milk and milk based drinks <sup>1</sup>	26.0 (-35.7, 87.7)	<b>-1.1 (-2.0, -0.09)</b>	75.7 (-4.5, 155.9)	0.6 (-1.6, 2.8)	<b>101.7 (0.52, 202.9)</b>	-0.5 (-2.9, 2.0)
No added sugar fruit juices	-9.9 (-35.0, 15.2)	0.2 (-0.3, 0.6)	<b>40.9 (10.1, 71.7)</b>	-0.9 (-1.9, 0.02)	31.0 (-8.73, 70.7)	-0.8 (-1.8, 0.3)
Drinks sold as powders (g)	-3.4 (-9.01, 2.20)	-0.03 (-0.1, 0.06)	5.66 (-1.6, 12.9)	0.07 (-0.1, 0.3)	2.25 (-6.90, 11.4)	0.04 (-0.2, 0.3)
Confectionery (g)	-20.5 (-90.8, 49.8)	0.7 (-1.3, 1.5)	-70.6 (-155.8, 14.6)	<b>2.2 (0.7, 3.7)</b>	-91.1 (-201.5, 19.3)	2.3 (-2.2, 6.8)

Notes. Bold indicates a significant difference at the 95% confidence interval level. <sup>1</sup>Milk comprises drinks in the following categories: semi-skimmed; specific low fat % milk (e.g. 1% fat milk); whole milk; buttermilk; modified milk; other milk; other non-cows milk; rice drink; soya milk. Skimmed milk is excluded from all analysis in this paper due to missing data.

Supplementary Table 5b: Level and trend changes in sugar in drinks (ml) and confectionery (g) purchased per household per week (95% CI) in relation to the UK SDIL, March 2014 - March 2019 without toiletries as a control condition (weighted)

	Analysis 1: pre-post announcement (March 2014 – March 2018)		Analysis 2: pre-post implementation (March 2016 – March 2019)		Analysis 3: pre-post announcement & implementation (March 2014 – March 2019)	
	Level Change	Trend Change	Level Change	Trend Change	Level Change	Trend Change
<i>Levy liable drinks</i>						
High tier (≥8g sugar per 100ml)	4.8 (-1.0, 10.6)	-0.008 (-0.1, 0.09)	<b>-12.1 (-19.5, -4.8)</b>	-0.2 (-0.4, 0.06)	-7.3 (-16.6, 2.0)	-0.2 (-0.4, 0.07)
Low tier (≥5g - <8g sugar per 100ml)	-0.2 (-1.7, 1.2)	<b>-0.4 (-0.5, -0.4)</b>	-1.2 (-2.9, 0.6)	<b>-0.07 (-0.1, -0.01)</b>	-1.4 (-3.7, 0.9)	<b>-0.5 (-0.6, -0.5)</b>
No levy (<5g sugar per 100ml)	1.7 (-0.2, 3.3)	<b>0.07 (0.04, 0.1)</b>	<b>5.2 (3.2, 7.2)</b>	<b>0.08 (0.02, 0.1)</b>	<b>6.9 (4.4, 9.5)</b>	<b>0.2 (0.09, 0.2)</b>
>0g to <5g sugar per 100ml	1.7 (-0.2, 3.3)	<b>0.07 (0.04, 0.1)</b>	<b>5.2 (3.2, 7.2)</b>	<b>0.08 (0.02, 0.1)</b>	<b>6.9 (4.4, 9.5)</b>	<b>0.2 (0.09, 0.2)</b>
<i>Levy exempt drinks</i>						
Milk and milk based drinks <sup>1</sup>	2.4 (-0.6, 5.3)	<b>-0.06 (-0.1, -0.02)</b>	3.7 (-0.1, 7.5)	0.01 (-0.10, 0.1)	<b>6.1 (1.3, 10.9)</b>	-0.05 (-0.2, 0.06)
No added sugar fruit juices	-1.1 (-3.5, 1.4)	0.03 (-0.03, 0.07)	<b>3.3 (0.3, 6.3)</b>	<b>-0.10 (-0.2, -0.01)</b>	2.3 (-1.6, 6.1)	-0.07 (-0.2, 0.03)
Drinks sold as powders (g)	-1.0 (-3.1, 1.1)	0.01 (-0.02, 0.05)	0.4 (-2.2, 3.0)	-0.01 (-0.1, 0.07)	-0.6 (-3.9, 2.7)	0.001 (-0.09, 0.09)
Confectionery (g)	-11.7 (-51.5, 28.1)	0.05 (-0.8, 0.9)	-42.6 (-90.8, 5.6)	1.3 (-0.4, 3.0)	-54.3 (-116.8, 8.2)	1.3 (-0.5, 3.2)

Notes. Bold indicates a significant difference at the 95% confidence interval level. <sup>1</sup>Milk comprises drinks in the following categories: semi-skimmed; specific low fat % milk (e.g. 1% fat milk); whole milk; buttermilk; modified milk; other milk; other non-cows milk; rice drink; soya milk. Skimmed milk is excluded from all analysis in this paper due to missing data.

Supplementary Table 5c: Absolute and relative changes in volume of drinks (ml) and confectionery (g) purchased per household per week (95% CI) in relation to the UK SDIL, March 2014 - March 2019 without toiletries as a control condition (weighted)

	Analysis 1: pre-post announcement (March 2014 – March 2018)		Analysis 2: pre-post implementation (March 2016 – March 2019)		Analysis 3: pre-post announcement & implementation (March 2014 – March 2019)	
	Absolute change (ml or g)	Relative change (%)	Absolute change (ml or g)	Relative change (%)	Absolute change (ml or g)	Relative change (%)
<i>Levy liable drinks</i>						
High tier (≥8g sugar per 100ml)	34.4 (-4.5, 73.3)	7.3 (-1.0, 15.6)	<b>-171.6 (-223.1, -120.0)</b>	<b>-42.5 (-55.3, -29.7)</b>	<b>-140.9 (-192.5, -89.4)</b>	<b>-37.8 (-51.6, -24.0)</b>
Low tier (≥5g - <8g sugar per 100ml)	<b>-68.3 (-85.7, -50.9)</b>	<b>-38.2 (-47.9, -28.4)</b>	<b>-71.4 (-94.1, -48.7)</b>	<b>-71.5 (-94.2, -48.8)</b>	<b>-171.3 (-193.9, -148.6)</b>	<b>-85.8 (-97.1, -74.4)</b>
No levy (<5g sugar per 100ml)	<b>187.1 (95.7, 278.5)</b>	<b>11.5 (5.9, 17.1)</b>	<b>395.0 (273.9, 516.0)</b>	<b>19.8 (13.7, 25.9)</b>	<b>685.5 (564.4, 806.5)</b>	<b>40.2 (33.1, 47.3)</b>
>0g to <5g sugar per 100ml	<b>106.4 (68.7, 144.2)</b>	<b>17.2 (11.1, 23.3)</b>	<b>205.9 (155.5, 256.3)</b>	<b>25.6 (19.3, 31.8)</b>	<b>374.6 (326.0, 426.8)</b>	<b>59.3 (51.4, 67.2)</b>
0g sugar per 100ml	<b>80.7 (25.1, 136.4)</b>	<b>8.0 (2.5, 13.5)</b>	<b>191.9 (118.2, 265.5)</b>	<b>16.1 (9.9, 22.3)</b>	<b>312.0 (238.4, 385.6)</b>	<b>29.1 (22.3, 36.0)</b>
Bottled water	<b>-31.3 (-76.3, 13.7)</b>	<b>-4.4 (-10.6, 1.91)</b>	<b>-76.9 (-136.6, -17.2)</b>	<b>-9.89 (-17.6, -2.2)</b>	<b>-127.8 (-187.6, -68.1)</b>	<b>-15.4 (-22.6, -8.2)</b>
<i>Levy exempt drinks</i>						
Alcoholic drinks	-16.6 (-62.2, 28.9)	1.0 (-3.6, 1.7)	<b>-84.9 (-155.8, -14.0)</b>	<b>-4.81 (-8.8, -0.8)</b>	<b>-103.1 (-174.0, -32.2)</b>	<b>-5.8 (-9.8, -1.8)</b>
Milk and milk based drinks <sup>1</sup>	<b>-85.9 (-39.6, 132.2)</b>	<b>-2.3 (-3.6, -1.1)</b>	<b>106.4 (44.5, 168.3)</b>	<b>3.03 (1.3, 4.8)</b>	-32.8 (-94.6, 29.1)	-0.9 (-2.6, 0.8)
No added sugar fruit juices	5.9 (-13.9, 25.8)	1.2 (-2.9, 5.4)	-6.56 (-32.7, 19.6)	-1.33 (-6.6, 4.0)	6.95 (-19.2, 33.1)	1.5 (-4.0, 6.9)
Drinks sold as powders (g)	<b>-6.8 (-11.0, -2.57)</b>	<b>-6.8 (-10.9, -2.6)</b>	<b>9.3 (3.7, 14.9)</b>	<b>10.8 (4.3, 17.4)</b>	0.89 (-4.7, 6.5)	1.0 (-5.0, 6.9)
Confectionery (g)	-9.5 (-72.7, 53.7)	-2.3 (-17.7, 13.0)	40.6 (-42.1, 123.2)	11.9 (-12.3, 36.0)	36.3 (-46.4, 118.9)	10.5 (-13.4, 34.3)

Notes. Bold indicates a significant difference at the 95% confidence interval level. <sup>1</sup>Milk comprises drinks in the following categories: semi-skimmed; specific low fat % milk (e.g. 1% fat milk); whole milk; buttermilk; modified milk; other milk; other non-cows milk; rice drink; soya milk. Skimmed milk is excluded from all analysis in this paper due to missing data.

Supplementary Table 5d: Absolute and relative changes in sugar in drinks (ml) and confectionery (g) purchased per household per week (95% CI) in relation to the UK SDIL, March 2014 - March 2019 without toiletries as a control condition (weighted)

	Analysis 1: pre-post announcement (March 2014 – March 2018)		Analysis 2: pre-post implementation (March 2016 – March 2019)		Analysis 3: pre-post announcement & implementation (March 2014 – March 2019)	
	Level Change	Trend Change	Level Change	Trend Change	Level Change	Trend Change
<i>Levy liable drinks</i>						
High tier (≥8g sugar per 100ml)	3.9 (-0.4, 8.3)	7.6 (-0.78, 15.9)	<b>-19.6 (-25.3, -13.8)</b>	<b>-43.8 (-56.6, -30.9)</b>	<b>-16.1 (-21.8, -10.3)</b>	<b>-39.0 (-52.9, -25.0)</b>
Low tier (≥5g - <8g sugar per 100ml)	<b>-4.9 (-6.1, -3.8)</b>	<b>-40.3 (-49.6, -30.9)</b>	<b>-4.7 (-6.2, -3.2)</b>	<b>-70.9 (-93.3, -48.4)</b>	<b>-11.9 (-13.4, -10.4)</b>	<b>-86.0 (-96.8, -75.2)</b>
No levy (<5g sugar per 100ml)	<b>6.1 (4.9, 7.3)</b>	<b>77.7 (62.6, 92.8)</b>	<b>9.3 (7.8, 10.9)</b>	<b>52.5 (43.6, 61.4)</b>	<b>19.2 (17.6, 20.8)</b>	<b>240.9 (221.0, 260.8)</b>
>0g to <5g sugar per 100ml						
<i>Levy exempt drinks</i>						
Milk and milk based drinks <sup>1</sup>	<b>-4.2 (-6.4, -2.0)</b>	<b>-2.3 (-3.6, -1.1)</b>	<b>4.1 (1.1, 7.0)</b>	<b>2.4 (0.7, 4.2)</b>	<b>-3.2 (-6.5, -0.3)</b>	<b>-1.8 (-3.5, -0.1)</b>
No added sugar fruit juices	<b>2.6 (0.7, 4.6)</b>	<b>5.9 (1.5, 10.2)</b>	-1.8 (-4.3, 0.8)	-3.7 (-9.1, 1.6)	<b>2.6 (0.04, 5.2)</b>	<b>5.9 (0.08, 11.8)</b>
Drinks sold as powders (g)	0.4 (-1.2, 2.1)	2.1 (-5.9, 10.0)	-0.3 (-2.4, 1.9)	-1.3 (-12.5, 10.0)	0.9 (-1.3, 3.0)	4.7 (-7.2, 16.7)
Confectionery (g)	-5.9 (-42.0, 30.1)	-2.6 (-18.1, 13.0)	23.4 (-24.0, 70.7)	12.1 (-12.4, 36.7)	20.2 (-27.1, 67.6)	10.3 (-13.9, 34.5)

Notes.<sup>†</sup>Trend<sup>2</sup>, Bold indicates a significant difference at the 95% confidence interval level. <sup>1</sup>Milk comprises drinks in the following categories: semi-skimmed; specific low fat % milk (e.g. 1% fat milk); whole milk; buttermilk; modified milk; other milk; other non-cows milk; rice drink; soya milk. Skimmed milk is excluded from all analysis in this paper due to missing data.

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# Changes in soft drinks purchased by British households associated with the UK soft drinks industry levy: a controlled interrupted time series analysis

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## Abstract

**Objective** To determine changes in household purchases of drinks one year after implementation of UK soft drinks industry levy (SDIL).

**Design** Controlled interrupted time series.

**Participants** Households reporting their purchasing to a market research company (average weekly n=22,091), March 2014 to March 2019.

**Intervention** A two tiered tax levied on soft drinks manufacturers, announced in March 2016 and implemented in April 2018. Drinks with  $\geq 8$ g sugar/100mL (high tier) are taxed at £0.24/L, drinks with  $\geq 5$  to  $< 8$ g sugar/100mL (low tier) are taxed at £0.18/L.

**Main outcome measures** Absolute and relative differences in the volume of, and amount of sugar in, soft drinks categories, all soft drinks combined, alcohol, and confectionery purchased per household per week one year after implementation.

**Results** In March 2019, compared with the counterfactual, purchased volume of high tier drinks decreased by 140.8mL (95% confidence interval 104.3-177.3mL) per household per week, equivalent to 37.8% (28.0%-47.6%), and sugar purchased in these drinks decreased by 16.2g (13.5-18.8g), or 42.6% (35.6-49.6%). Purchases of low tier drinks decreased by 170.5mL (154.5-186.5mL) or 85.8% (77.8-93.9%), with an 11.5g (9.1-13.9g) reduction in sugar in these drinks, equivalent to 87.8% (69.2-106.4%). When all soft drinks were combined irrespective of levy tier or eligibility, the volume of drinks purchased increased by 188.8mL (30.7-346.9mL) per household per week, or 2.6% (0.4-4.7%), but sugar decreased by 8.0g (2.4-13.6g), or 2.7% (0.8-4.5%). Purchases of confectionery and alcoholic drinks did not increase.

**Conclusions** Compared with trends before the SDIL was announced, one year after implementation, volume of all soft drinks purchased combined increased by 189mL, or 2.6% per household per week. The amount of sugar in those drinks was 8g, or 2.7%, lower per household per week. Further studies should determine whether and how apparently small effect sizes translate into health outcomes.

**Study registration** ISRCTN18042742.

## Strengths and limitations of this study

- We used a large, nationally representative dataset, included a control category, and explored changes in two potential substitute categories (alcohol and confectionery).
- We only included purchases brought into homes.
- We did not assess changes in other categories beyond soft drinks, alcohol, and confectionery.
- The estimate of effect size in interrupted time series analyses is based on a modelled counterfactual that might be inaccurate.
- Attribution of effects in interrupted time series analyses is vulnerable to time varying confounding such as co-interventions.

## INTRODUCTION

High consumption of sugar sweetened beverages (SSBs) is associated with increased risk of dental caries, obesity, type 2 diabetes, and cardiovascular disease.[1-3] The World Health Organization recommends the use of SSB taxes to reduce consumption.[4] A systematic review of studies published to June 2018 suggests that SSB taxes lead to decreases in the sales, purchasing and consumption of taxed drinks.[5] More recent findings support this conclusion.[6-10] Although price is one important mediator of these changes,[11-16] other potential mechanisms include reformulation of products to reduce sugar concentration, smaller portion sizes, and increases in the perception of SSBs being harmful to health associated with them being grouped with other taxed products such as alcohol and tobacco.[17] Furthermore, any public health benefits of reduced SSB consumption associated with SSB taxes might be negated by increased consumption of substitutes such as confectionery and alcohol.[18-20]

The UK soft drinks industry levy (SDIL) was one of the first taxes on SSBs explicitly designed to incentivise manufacturers of SSBs to reduce sugar content.[21 22] This is reflected in three design features. Firstly, the SDIL is levied on manufacturers, importers, and bottlers rather than on consumers. Secondly, the levy includes two tiers: £0.24/L for drinks containing  $\geq 8$  g total sugar per 100 mL, and £0.18/L for drinks containing  $\geq 5$  g and  $< 8$  g total sugar per 100 mL. Thirdly, the SDIL was intentionally announced in 2016, two years before implementation in 2018, to allow manufacturers time to adjust. The SDIL also provides exemptions (Box 1).[23]

### Box 1. Glossary of terms

*Soft drinks industry levy (SDIL)*—a tiered tax on manufacturers of sugar sweetened beverages

*Levy exempt drinks*—drinks exempt from the SDIL irrespective of sugar content; that is, drinks containing  $> 75\%$  milk, drinks containing  $> 1.2\%$  alcohol, and drinks sold as alcohol replacements, drinks sold as powders, 100% fruit juices, and drinks sold by manufacturers selling less than one million litres of drinks not exempt for other reasons each year

*High tier drinks*—drinks that are not levy exempt and contain  $\geq 8$  g of sugar per 100 mL

*Low tier drinks*—drinks that are not levy exempt and contain  $\geq 5$  g to  $< 8$  g of sugar per 100 mL

*No levy drinks*—drinks that are not levy exempt but contain  $< 5$  g of sugar per 100 mL; we subdivided this category into drinks containing  $> 0$  g to  $< 5$  g of sugar per 100 mL, drinks containing 0 g of sugar per 100 mL. Bottled water was considered separately.

*Levy liable drinks*—drinks that are not levy exempt drinks; that is, the sum of high tier drinks, low tier drinks, and no levy drinks

*Soft drinks*—any drink not containing alcohol

*Confectionery*—products in the sugar confectionery and chocolate confectionery categories

### *Toiletries*—products in the shampoo, hair conditioner, and liquid soap categories

Two before and after analyses have shown reductions of around 30% in sales weighted sugar concentration of levy eligible drinks in the UK from before the announcement of the SDIL on 16 March 2016 to after implementation on 6 April 2018.[24 25] However, background trends in purchases of sugary drinks are not stable, with decreases reported over several years.[26] This makes it difficult to attribute before and after decreases in sugary drinks purchases to the SDIL. An interrupted time series analysis found that the announcement and implementation of the SDIL were together associated with a 34 percentage point reduction in the proportion of levy liable drinks with >5 g total sugar per 100 mL, indicating substantial reformulation of the market.[15] Changes in prices across the UK soft drink market were also reported, although it was difficult to discern clear patterns in these, with some levied categories increasing and others decreasing in price. In a controlled interrupted time series analysis including data up to the point of SDIL implementation, we found that the SDIL announcement was associated with changes in both the volume of, and sugar purchased in, drinks in many categories.[27] Overall we found no change in total volume of purchases of all soft drinks combined, but a small increase in sugar purchased from soft drinks of 5.3g per household per week, or 1.7%.

In this paper, our aim was to determine whether household purchases of drinks and confectionery had changed one year after implementation of the SDIL.

## **METHODS**

Here we extend our previous analyses[27] to study changes in the volume of, and amount of sugar in, household purchases of drinks in each levy tier, exempt drinks categories (including alcoholic drinks), and confectionery from two years before the announcement of the SDIL to one year after its implementation (March 2014 to March 2019). As before, we used controlled interrupted time series methods, with toiletries included as a control category.[27] We compared observed changes associated with the announcement and implementation of the SDIL to the counterfactual scenarios in which the announcement and implementation did not take place. Including a full two years of data before the announcement enables us to estimate pre-intervention trends and project these forward as counterfactual scenarios. The protocol is published elsewhere[28] and the study was registered. This study is reported in accordance with the strengthening the reporting of observational studies in epidemiology (STROBE) guideline (see Supplementary material A).

## Data source

We used data from a panel of households reporting their purchasing on a weekly basis to a market research company (Kantar Worldpanel; KWP). Participating households are asked to record all food and drink purchases brought into the home (including those ordered online and delivered) through barcodes scanners and manual report. Purchasing information is uploaded weekly, where it is linked to nutritional data collected by KWP field workers on a rolling basis. Households record their personal characteristics and receive gift vouchers worth about £100 (\$122; €112) annually—equivalent to 0.3% of median UK annual household income after tax in 2019 (£29 600).[29]

KWP samples households from across Great Britain (GB) using proprietary methods, aiming to achieve a sample that is demographically representative of GB households. Data excludes households that record fewer than six purchases weekly along with those whose adjusted weekly spend is lower than an undisclosed minimum. KWP applies proprietary weights to purchases to adjust for these exclusions and maintain the representativeness of the panel. We used these weights throughout.

The main data cleaning that occurred before analysis involved assigning products and product groups in the KWP dataset to SDIL relevant groups. This was done based on KWP assigned product groups, product names, and nutritional content. In previous work we found some evidence of error, but not bias, in the sugar concentration reported by KWP compared with information provided on manufacturers' websites.[27]

### **Product categories: drinks, confectionery, and toiletries**

Purchased drinks that were levy liable were divided into high tier, low tier, or no levy based on sugar content (see box 1 for definitions). No levy drinks were additionally disaggregated, as described in box 1.

As the SDIL might have led to substitution to other drinks categories, we also examined purchasing of levy exempt drinks in several categories: milk based drinks (comprising milk, milk alternatives such as soya drinks, and yoghurt based juices and drinks), alcoholic drinks (comprising both alcoholic and alcohol replacement drinks), no added sugar fruit juices, and drinks sold as powder (eg, tea, coffee, hot chocolate). Other exempt categories (infant formulas and drinks sold for medical purposes) were excluded.

We also hypothesised that the SDIL might lead to substitution from sugary drinks to other high sugar categories. To investigate this, we used sugar and chocolate confectionery purchases (referred to as confectionery).

### **Control group**

To control for background trends in household purchases we used purchases of shampoo, hair conditioner, and liquid soap (ie, toiletries). Toiletries meet the proposed criteria for a controlled interrupted time series: they are robust to seasonality and may have similar purchase volumes by households regardless of socioeconomic position or other potential confounders.[30]

### **Outcome measures**

Most evaluations of SSB taxes focus on volume of drinks purchased. However, the SDIL's focus on reformulation makes the sugar purchased in drinks of additional public health interest. Thus, the outcome measures of interest were mean volume purchased per household per week in each of the drink categories and grams per household per week of confectionery; and mean sugar purchased per household per week from each of the drink categories and confectionery. Data were aggregated at the weekly level and analysed as a time series.

### **Overall analysis strategy**

Previous evidence indicates that reformulation occurred after the announcement of the SDIL and price changes after implementation.[15] As such, we hypothesised the SDIL might act as two linked interventions: the announcement on 16 March 2016 and implementation on 6 April 2018.[17] Thus, our analysis strategy involved three separate comparisons that isolate the announcement and implementation of the SDIL and then examine the combined effect (Figure 1). In the first analysis, we isolated the announcement of the SDIL. Here we compared anticipatory effects on purchasing two years after the announcement to the counterfactual estimated from purchasing in the two years before the announcement. This replicates and updates our previous analysis[27] as we anticipate that the stabilising effect of including additional post-announcement data likely reduces error. In the second analysis, we isolated the implementation of the SDIL. Here we compared purchasing one year after implementation to the counterfactual estimated from purchasing in the four years before implementation. In the third analysis, we considered both the announcement and the implementation and we compared purchasing one year after implementation (ie three years after announcement) to the counterfactual estimated from purchasing in the two years before the announcement.

Throughout, we used the proprietary weights provided by KWP.

### **Primary analysis: category specific analyses**



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3 For each of the three analyses we developed separate controlled interrupted time series  
4 models for volume and sugar purchased from each levy liable and levy exempt drinks  
5 category and confectionery (Figure 1). Supplementary material B provides the full model  
6 specification.  
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10 We present absolute and relative differences between observed purchasing and  
11 counterfactual scenarios in the final week of each observation period, with standard errors  
12 used to calculate 95% confidence intervals for the relative difference obtained using the delta  
13 method.[31]  
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### 17 **Secondary analysis: all soft drinks categories combined, irrespective of levy eligibility**

18 Levy exempt drinks include drinks that might contain comparable amounts of sugar to levy  
19 liable products. To examine the extent to which the SDIL impacted on the purchased volume  
20 of, and amount of sugar in, soft drinks, regardless of SDIL liability, we carried out controlled  
21 interrupted time series analysis, combining purchases of all soft drinks irrespective of sugar  
22 content (ie, high tier, low tier, no levy, milk and milk based drinks, no added sugar fruit juice,  
23 and drinks sold as powders), levy liable drinks irrespective of sugar content (ie, high tier, low  
24 tier, and no levy drinks), and according to sugar content based on levy tiers irrespective of  
25 levy eligibility (ie, all soft drinks with  $\geq 8$  g of sugar per 100 mL, all soft drinks with  $\geq 5$  g to  
26  $< 8$  g of sugar per 100 mL, and all soft drinks with  $< 5$  g of sugar per 100 mL).  
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### 35 **Sensitivity analysis: excluding small manufacturers**

36 The SDIL exempts drinks from manufacturers and producers who sell less than one million  
37 litres of levy liable drinks annually. As we were unable to obtain a list of exempt  
38 manufacturers, our main analyses include all manufacturers. We conducted sensitivity  
39 analyses to examine the effect of excluding manufacturers who we estimated to be small. The  
40 total purchase volume was summed by manufacturer by year across the five years in the  
41 KWP dataset, and a mean purchase volume per year for each manufacturer was calculated. In  
42 the first sensitivity analysis, we excluded manufacturers with a mean of less than one million  
43 litres purchased per year. Acknowledging KWP data excludes purchases not brought home,  
44 we repeated these analyses excluding manufacturers with mean annual purchased volumes of  
45  $< 0.5$  million litres in KWP. We were unable to access accurate estimates of the proportion of  
46 all drinks purchases brought home. This value reflects an arbitrary, but we think conservative,  
47 estimate of the minimum proportion of drinks brought home.  
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### 58 **Sensitivity analysis: interrupted time series without a control category**



Toiletries were chosen as a control condition a priori to account for background trends in household purchases. It is, however, possible that a more appropriate control exists. As we only have access to data on purchasing of the categories described here (confectionery, drinks, toiletries), we were not able to examine alternative potential control categories. To examine the effect of the decision to use toiletries as the control category, we performed an additional sensitivity analysis with no control condition.

### **Changes to the protocol**

We made several changes to the published protocol.[28] KWP provided additional data that allowed us to increase the precision of our estimates. Specifically, we were able to increase the pre-announcement study period from 104 to 107 weeks and reduce the unit of analysis from purchases every four weeks to purchases every week. We originally intended to include purchases not brought home. We excluded these purchases, however, as these data were not available before mid-2015, meaning that robust pre-announcement trends could not be estimated. Although we originally intended to combine all no levy drinks, we present these disaggregated into those with  $>0$  g and  $<5$  g of sugar per 100 mL and 0 g of sugar per 100 mL, as well as bottled water, as trends for these different categories are noticeably different. Our original intention to explore potential disparities across socioeconomic groups will be pursued in future work.

### **Patient and public involvement**

The steering group for the wider SDIL evaluation includes two lay members and meets twice a year. Patients and the public were not involved in developing the research question, the outcome measures, the design, or the conduct of the work reported here. The steering group has regularly contributed ideas for routes to dissemination.

### **Correction of Pell et al (2021)**

This paper is a corrected version of Pell et al (2021),[32], now retracted, which was originally published in the *BMJ*. The analysis presented in the original Pell et al (2021) paper included an incorrect weighting variable. This variable was incorrectly calculated as the inverse of what it should have been. The variable was also redundant to the analysis as it replicated a component of a second weighting variable also included (the “proprietary weights provided by KWP” mentioned above). The current corrected version replicates the original analysis without this redundant and incorrectly calculated weighting variable. The second, correct, weighting variable (the “proprietary weights provided by KWP” mentioned above) remains included. The authors identified the error themselves and alerted the journal and readers.[33]

## RESULTS

About 31 million purchases of drinks, confectionery, and toiletries from March 2014 to March 2019 were included from a mean of 22 091 households each week. The characteristics of included households remained consistent over the study period, and after weighting they largely reflected households in 2014-19 in the UK (see Supplementary table 1 in Supplementary material C).

Table 1 summarises households' weekly purchased volumes of, and amounts of sugar in, drinks and other categories over the study period. Substantial reductions in volume of, and sugar in, purchases of SDIL liable drinks were observed in the high and low tiers over time. These reductions were accompanied by a smaller increase in volume of no levy drinks purchased, but proportionally much greater increases in sugar purchased in these drinks.

### Primary analysis: category specific results

Results of the controlled interrupted time series analyses of purchased volume of, and sugar in, levy liable drinks and confectionery are shown in Figure 2 (volume) and Figure 3 (sugar). Absolute and relative changes are summarised in Tables 2 and 3. Supplementary tables 2a and b in Supplementary material D show level and trend changes from these models. Supplementary figures 1a and b in Supplementary material D show similar figures and data for subcategories of no levy drinks, bottled water and exempt categories.

### High tier drinks

The trend in purchased volume of, and sugar in, high tier drinks continued downwards throughout the study period. The announcement of the SDIL was associated with an increase in purchased volume of (34.7ml (95% confidence intervals 8.1 to 61.4ml, or 7.3% (1.7 to 12.9%)), and sugar in (5.5g (3.8 to 7.2), or 10.8% (7.4 to 14.1%)), these drinks. In contrast, the implementation of the SDIL was associated with a reduction in purchased volume of, and sugar in, these drinks. The volume of high tier drinks purchased was 171.6 mL (135.1 to 208.1mL) per household per week, or 42.5% (33.5% to 51.6%), lower in March 2019 compared with the counterfactual estimated from pre-implementation trends. The reductions associated with implementation outweighed the increases associated with announcement, such that the intervention as a whole was associated with a decrease in purchased volume of 140.8ml (104.3 to 177.3ml) per household per week or 37.8% (28.0 to 47.6%) and sugar of 16.2 g (13.5 to 18.8g) per household per week or 42.6% (35.6% to 49.6%) from these drinks.

### Low tier drinks

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3 Purchased volume of, and sugar in, low tier drinks gradually increased before the  
4 announcement of SDIL. The announcement was associated with a reversal of this trend.  
5  
6 There were reductions in purchased volume of, and sugar in, low tier drinks associated with  
7 announcement, implementation and the whole intervention. Compared with the  
8  
9 counterfactual estimated from pre-announcement trends, in March 2019 the volume of  
10  
11 purchased low tier drinks per household per week decreased by 170.5 mL (154.5 to 186.5  
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13 mL), or 85.8% (77.8 to 93.9%); and sugar purchased in these drinks decreased by 11.5 g (9.1  
14  
15 to 13.9g) per household per week, or 87.8% (69.2 to 106.4%).  
16

### 17 **No levy drinks**

18  
19 Before the announcement of the SDIL there was a gradual upward trend in volume of  
20  
21 purchased no levy drinks but a gradual downward trend in purchased sugar. Announcement,  
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23 implementation and the whole intervention were associated with increases in volume of no  
24  
25 levy drinks purchased as well as sugar purchased from those drinks. Overall, purchased  
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27 volume of no levy drinks in March 2019 was 685.5 mL (599.8 to 771.1mL) higher,  
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29 equivalent to 40.2% (35.2% to 45.2%) increase compared with the counterfactual of pre-  
30  
31 announcement trends. Equivalent figures for sugar purchased from no levy drinks were a  
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33 19.2g (16.7 to 21.6g) per household per week, equivalent to 242.8% (211.9 to 273.7%),  
34  
35 increase.

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37 The implementation and the announcement of the SDIL were associated with increases in  
38  
39 volume of purchased drinks with no sugar and with >0 to <5 g total sugar per 100 mL, and  
40  
41 increases of sugar in drinks with >0 to <5g sugar per 100ml.

### 42 **Bottled water**

43  
44 The implementation, but not the announcement, of the SDIL were associated with significant  
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46 decreases in bottled water purchased which led to an overall decrease in volume of bottled  
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48 water purchased as a result of the whole intervention of 130.5ml (88.8 to 174.1ml) per  
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50 household per week, or 15.7% (10.4 to 20.9%).

### 51 **Levy exempt drinks and confectionery**

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53 Overall, the combined announcement and implementation of the SDIL were associated with  
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55 decreases in purchased volume of alcoholic and milk and milk-based drinks, but no change in  
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57 sugar purchased from levy exempt categories or from confectionery. Compared with the  
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59 counterfactual of pre-announcement trends, in March 2019 volume of alcoholic drinks  
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61 purchased decreased by 103.1ml (53.0 to 153.3ml) per household per week, equivalent to a

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3 5.8% (3.0 to 8.6%) reduction; and volume of milk and milk based drinks purchased decreased  
4 by 132.8ml (51.7 to 213.9ml), equivalent to a 3.6% (1.4 to 5.7%) reduction.  
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### 7 **Secondary analysis: all soft drinks categories combined**

8 Supplementary table 3a in Supplementary material E and Supplementary figure 2a and 2b in  
9 Supplementary material F summarise the results of the controlled interrupted time series  
10 analyses of the associated effects of the SDIL on purchased volume of, and sugar from, all  
11 soft drinks categories combined, irrespective of levy eligibility. Supplementary table 3b in  
12 Supplementary material E summarises absolute and relative changes in volume of, and sugar  
13 in, all soft drinks and confectionery purchased. Summary figures are also provided in Table 2  
14 and Table 3.  
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20 Overall, compared with the counterfactual estimated from pre-announcement trends, a  
21 small increase was observed in volume of all soft drinks purchased in March 2019 of 188.8ml  
22 (30.7 to 346.9ml) per household per week, equivalent to a 2.6% (0.4 to 4.7%) increase. A  
23 reduction was, however, found in sugar purchased in all soft drinks (including exempt drinks)  
24 combined of 8.0g per household per week (2.4 to 13.6g), equivalent to 2.7% (0.8 to 4.5%).  
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### 30 **Sensitivity analyses**

31 Excluding manufacturers of levy liable products with less than one million and less than  
32 500 000 litres of purchased drinks annually in our dataset was associated with small changes  
33 in the magnitude of estimated coefficients, but with no change in the direction or statistical  
34 significance of absolute or relative changes in volume of, or sugar in, drinks (Supplementary  
35 tables 4a to b in Supplementary material F).  
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40 In general, removing the control category led to minor changes in effect estimates but  
41 wider confidence intervals (see Supplementary tables 5a to d in Supplementary material G).  
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## 45 **DISCUSSION**

46 Taking account of pre-existing pre-announcement trends, this study found that one year after  
47 implementation of the SDIL, sugar purchased from all soft drinks combined that were taken  
48 home decreased by 8.0 g per household per week (or 2.7%), whilst volume increased by  
49 188.8 mL per household per week (or 2.6%). Assuming a mean UK household size of 2.4  
50 people,[34] this is equivalent to a reduction in sugar from SSBs of 3.3 g per person per week  
51 and an increase in volume of 79 mL per person per week, or equivalent to the replacement of  
52 66 mL of a drink with 5 g sugar per 100 mL per person per week with 145 mL of a sugar-free  
53 alternative. A modelling study conducted before implementation of the SDIL found that if the  
54 levy achieved reformulation it could be expected to lead to a decrease in sugar consumption  
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3 from SSBs (from all sources, not just for consumption at home) of 7-38 g per person per  
4 week and that this would be associated with a reduction in the number of obese individuals in  
5 the UK of 0.2-0.9% and a reduction in incidence cases of type 2 diabetes of -2.0 to 31.1 per  
6 1000 person years.[35] The reduction in sugar from SSBs we report one year after  
7 implementation of the SDIL is around half of these lower effect estimates.  
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### 12 **Strengths and weaknesses of this study**

14 In this study we used a large, nationally representative dataset, included a control category,  
15 and explored changes in two potential substitute categories (alcohol and confectionery).  
16

17 We only included purchases brought into homes. Although KWP also collects data on  
18 other purchases, this smaller panel was established in mid-2015 and so was unsuitable for our  
19 analyses because robust pre-announcement trends could not be estimated. KWP data are  
20 collected at the household level and do not take account of waste or differential sharing  
21 within households. Nevertheless, the data provide a reasonable estimate of consumption.[36]  
22 We did not assess changes in other categories beyond soft drinks, alcohol, and confectionery.  
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28 The estimate of effect size in interrupted time series analyses is based on a modelled  
29 counterfactual that might be inaccurate. For example, the strong downward trend in higher  
30 tier drinks before the announcement of SDIL might not have continued. Attribution of effects  
31 in interrupted time series analyses is vulnerable to time varying confounding including co-  
32 interventions. The SDIL is part of a wider sugar reduction strategy, although this has been  
33 found to have achieved minimal changes beyond those attributable to the SDIL.[25]  
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38 The personal characteristics of the panel remained similar over the study period, and  
39 proprietary weightings were used to account for non-consumers and to adjust for variations in  
40 panel composition. Households participating in KWP are slightly more likely to be from  
41 lower social grades and to have no qualifications compared with UK households generally.  
42 This might reflect the relative value placed on the small rewards for participation by different  
43 households and could limit the generalisability of our findings. If households from lower  
44 socioeconomic backgrounds are more likely to change purchasing as a result of the SDIL,  
45 then we could have marginally overestimated the effect of the SDIL. However, while we  
46 previously found that the price of soft drinks in the UK did change after implementation of  
47 the SDIL, no clear pattern was found, with the price of some groups of drinks increasing and  
48 others decreasing.[15] We previously found no systematic differences between the sugar  
49 content of drinks reported in KWP data and contemporaneous values listed on supermarket  
50 websites.[27]  
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### **Comparison with other work**

Our finding that the SDIL was associated with a reduction in purchased sugar from all soft drinks combined is consistent with previous analyses that focused on the SDIL.[24 25] Although our estimate of the reduction in sugar consumption from all soft drinks combined associated with the levy (2.7%) is less than that estimated by others (29%)[25] this previous estimate did not take account of pre-existing trends which we have demonstrated were on a steep downward trajectory for high tier drinks.

We found that the reduction in purchased sugar from all soft drinks combined alongside a 2.6% increase in volume of all soft drinks purchased. This is consistent with previously reported reductions in the sugar concentration of drinks associated with the SDIL.[15] However, the estimated effect size is below the range of reformulation scenarios modelled before implementation (ie, a reduction of 17 to 90 g of sugar per household per week).[35] This difference may be, at least partly, attributable to our focus on drinks taken home versus the modelling study's focus on all drinks. Furthermore, the modelling was based on pre-implementation best and worst case scenarios of changes in formulation, price and SSB market share whilst our analysis was based on observed data.

Evaluations of other SSB taxes have revealed a consistent trend of reductions in purchasing of taxed drinks and no change in purchasing of untaxed drinks.[5] We found similar with both volume of, and sugar in, high and low tier drinks decreasing overall. However, these reductions in volume of taxed drinks were more than offset by increases in volume of no levy drinks purchased. Despite some increases in sugar purchased in no levy drinks, these did not offset decreases in sugar purchased from high and low tier drinks. The SDIL is relatively unique in being explicitly designed to encourage reformulation and there is evidence that substantial reformulation occurred.[15] We are not able to determine from our findings whether the changes we report are due to changes in consumer preference, formulation, or both.

### **Meaning of the study and implications for policymakers**

Our main findings are that the SDIL was associated with a reduction in purchased sugar from all soft drinks combined with evidence of an increase in the total volume of all soft drinks purchased. Given the reformulation associated with the SDIL already documented,[15] it is probable that the changes we report were driven by reductions in the sugar concentration of available drinks, alongside consumers switching to and, indeed increasing consumption of, lower sugar alternatives. Despite the overall reduction we found in sugar purchased in soft drinks, the average amount of sugar purchased in drinks in the no levy group paradoxically



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3 increased after implementation of the SDIL, with many drinks that previously had sugar  
4 concentrations above the levy threshold now having them just below the threshold. This  
5 seems to reflect manufacturers reformulating to target thresholds. Lowering the threshold  
6 sugar concentration at which drinks become eligible for the SDIL even further could  
7 potentially lead to greater overall reductions in sugar concentrations and sugar purchased in  
8 soft drinks, as could extension of the SDIL to milk based drinks and other currently exempt  
9 categories that sometimes contain high levels of sugar.

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15 The SDIL has also been found to have had no long term negative effects on the share  
16 value or turnover of UK soft drinks companies,[37 38] suggesting that, contrary to industry  
17 predictions, public health can gain without negatively affecting the soft drinks sector.

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21 We note a marked pre-implementation decline in purchasing of high levy tier drinks. It is  
22 possible that this was, at least in part, driven by concern from industry about a possible SSB  
23 tax, leading to some pre-announcement reformulation; alongside growing consumer  
24 awareness of, and concerns about, the health impacts of SSBs.[39] Although it is uncertain if  
25 this trend would have continued in the absence of the SDIL, it is likely to be beneficial for  
26 health.

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31 Reassuringly, we did not observe any increase in purchasing of potentially harmful  
32 substitutes (ie, alcohol and confectionery) associated with the SDIL, which could have  
33 partially or wholly offset any public health gains from the SDIL. However, we did not study  
34 the SDIL's effect on purchases of other food groups or on overall diet.

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38 In contrast with previous findings from Mexico and Barbados,[6 40] we did not observe  
39 an increase in purchased bottled water associated with the SDIL. Indeed purchases of bottled  
40 water decreased significantly during the study period (by 130.5 mL per household per week,  
41 or 15.7%). Although we cannot rule out an effect of the SDIL on bottled water purchases, we  
42 cannot think of a plausible pathway through which it achieved reductions in purchased  
43 bottled water. Instead, this reduction might be due to coincident increases in concern about  
44 single use plastic that have been attributed, in the UK, to the broadcast of the nature  
45 documentary series *Blue Planet 2* in October-December 2017.[41] It is not clear if a similar  
46 “Blue Planet effect” has occurred in other countries. Unlike for many other soft drinks, a like-  
47 for-like substitution is available for bottled water in countries such as the UK—that is, filling  
48 reusable water bottles with tap water. Several UK retailers have reported substantial growth  
49 in sales of reusable water bottles since 2018.[42] Given that tap water is freely available, it is  
50 difficult to study changes in its consumption directly.



### Unanswered questions and future research

Future work should seek to understand the longer term effects of the SDIL on purchasing and consumption of soft drinks as well as total diet, and health outcomes. Differential effects of the SDIL on all these outcomes across population groups (eg, by socioeconomic position and in households with vs without children) should also be explored to determine whether the SDIL contributes to narrowing inequalities in health. The changes in purchasing we report here could be used as an input to health impact modelling to estimate the effect of changes on population prevalence of obesity, diabetes, and other chronic conditions to determine how apparently small changes in consumption at the household level translate into health benefits. It is likely that the reformulation that has occurred in response to the SDIL[15] reflects substantial increases in the use of artificial sweeteners in the UK soft drinks market. Given public mistrust of artificial sweeteners[39] and the recent advice from WHO that artificial sweeteners should not be used to reduce the risk of non-communicable diseases,[43] the effect of the SDIL on consumption of these should also be explored.

### CONCLUSION

One year after implementation of the SDIL, purchased sugar in all soft drinks combined decreased by around 8 g per household per week (or 2.7%) with an increase in the volume of purchased soft drinks of 189 mL per household per week (or 2.6%). Further studies are required to determine whether and how these apparently small effect sizes translate into health outcomes.

## Contributors

DP, MW, SC, MR, RS, HR, JA, PS, OM, AB, RDS and TLP conceived the study and defined the analytical strategy. DP, NR, JA, OM, TLP, and SJS performed statistical analyses. DP, NR, JA, OM, TLP, CJ and SJS provided preliminary interpretation of findings. DP, NR, JA, OM, and TLP drafted the manuscript. All authors critically interpreted the results, revised the manuscript, provided relevant intellectual input, and read and approved the final manuscript. NR and JA had primary responsibility for the final content. JA will act as guarantor. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

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## Competing interests

All authors have completed the ICMJE uniform disclosure form at [www.icmje.org/coi\\_disclosure.pdf](http://www.icmje.org/coi_disclosure.pdf) (available on request from the corresponding author) and declare: MW was director of the National Institute for Health Research Public Health Research Funding programme when this work was conducted, and OM was on secondment at the UK Department of Health and Social Care when this work was conducted and previously worked with Public Health England; no support from any organisation for the submitted work other than that described above; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years; and no other relationships or activities that could appear to have influenced the submitted work.

## Ethical approval

Not required for secondary data analysis of anonymised data.

## Data availability statement

The statistical code for the analyses are available from <https://github.com/MRC-Epid/SDILEvaluation>. Kantar Worldpanel data are not publicly available but can be purchased from Kantar Worldpanel (<http://www.kantarworldpanel.com>). The authors are not legally permitted to share the data used for this study but interested parties can contact Kantar WorldPanel representative Sean Cannon ([Sean.Cannon@kantar.com](mailto:Sean.Cannon@kantar.com)) to inquire about accessing this proprietary data.

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## Figure legends

**Figure 1.** Schematic of overall analysis strategy. Solid lines=observed data; dashed lines=counterfactual estimated from previous observed data.

**Figure 2.** Observed and modelled volume (mLs) of drinks liable to the Soft Drinks Industry Levy (SDIL), and weight of confectionery (g) purchased per household per week, March 2014 to March 2019 (weighted). Points are observed data for drinks/ confectionery; black lines (with shadows) show modelled data (and 95% confidence intervals); red lines indicate the counterfactuals had the announcement (red solid line) and implementation (red dashed line) not happened; the first dashed vertical line indicates the announcement of SDIL; the second dashed vertical line indicates the implementation of SDIL; the Y axis varies in scale between panels to maximise the resolution of figures; modelled purchases include averaged effects for seasonality and the impact of December and January (Christmas period), and, for confectionery, Easter; the control category of toiletries is shown in Figure 3.

**Figure 3.** Observed and modelled amount of sugar (g) in drinks liable to the Soft Drinks Industry Levy and confectionery purchased per household per week, March 2014 to March 2019 (weighted). Points are observed data for drinks/ confectionery and toiletries; black lines (with shadows) show modelled data (and 95% confidence intervals); red lines indicate the counterfactuals had the announcement (red solid line) and implementation (red dashed line) not happened; the first dashed vertical line indicates the announcement of SDIL; the second dashed vertical line indicates the implementation of SDIL; the Y axis varies in scale between panels to maximise the resolution of figures; modelled purchases include averaged effects for seasonality and the impact of December and January (Christmas period), and, for confectionery, Easter.

**Table 1.** Mean volume of, and amount of sugar in, purchased drinks and confectionery per household per week in relation to the UK soft drinks industry levy, March 2014 to March 2019 (weighted)

	Mean (SD) volume (mL) per household/week			Mean (SD) amount of sugar (g) per household/week		
	Pre-announcement: Mar 2014-Mar 2016	Post-announcement: Mar 2016-Mar 2018	Post- implementation: Apr 2018-Mar 2019	Pre-announcement: Mar 2014-Mar 2016	Post- announcement: Mar 2016-Mar 2018	Post- implementation: Apr 2018-Mar 2019
<b>Levy liable drinks (sugar/100 mL)</b>						
High tier ( $\geq 8$ g)	880 (128)	680 (136)	363 (76)	98(14)	76(15)	40(9)
Low tier ( $\geq 5$ g to $< 8$ g)	155 (32)	147 (37)	75 (32)	10(2)	10(2)	5(2)
No levy ( $< 5$ g)	1811 (169)	1876 (216)	2448 (321)	12(2)	12(3)	25(5)
$> 0$ g to $< 5$ g	785 (78)	768 (92)	989 (139)	12(2)	12(3)	25(5)
0 g	1027 (104)	1108 (132)	1459 (190)	0 (0)	0 (0)	0 (0)
Bottled water	591 (72)	714 (90)	786 (138)	0 (0)	0 (0)	0 (0)
<b>Levy exempt drinks</b>						
Alcoholic drinks*	1874 (380)	1872 (456)	1948 (467)	.	.	.
Milk and milk based drinks**	3546 (137)	3540 (155)	3542 (148)	172 (7)	172(8)	170(7)
Fruit juices with no added sugar	516 (29)	502 (44)	520 (47)	51(3)	49(4)	50(5)
Drinks sold as powders (g)	95 (12)	88 (11)	90 (11)	21(3)	19(3)	18(3)
<b>Other categories</b>						
Confectionery (g)	308 (91)	303 (92)	318 (100)	173 (51)	170 (52)	178 (57)
Toiletries	123 (8)	120 (8)	121 (9)	.	.	.
<b>All soft drinks combined (ie excluding alcohol)</b>	7595 (295)	7547 (466)	7826 (540)	364 (17)	337(24)	307(19)

\*Sugar from alcoholic drinks is not included here as many alcoholic drinks contain sugar but the product label does not provide the amount.

\*\*Milk comprises drinks in the following categories: semi-skimmed; specific low fat % milk (e.g. 1% fat milk); whole milk; buttermilk; modified milk; other milk; other non-cows milk; rice drink; soya milk. Skimmed milk is excluded from all analysis in this paper due to missing data.

**Table 2.** Absolute and relative change in volume of drinks (mL) and confectionery (g) purchased per household per week in relation to the UK soft drinks industry Levy, March 2014 to March 2019 (weighted)

	Analysis 1: pre-post announcement (Mar 2014-Mar 2018)		Analysis 2: pre-post implementation (Mar 2016-Mar 2019)		Analysis 3: pre-post announcement and implementation (Mar 2014-Mar 2019)	
	Absolute change (mL or g)	Relative change (%)	Absolute change (mL or g)	Relative change (%)	Absolute change (mL or g)	Relative change (%)
<b>Levy liable drinks (sugar/100 mL)</b>						
High tier (≥8 g)	<b>34.7 (8.06, 61.4)</b>	<b>7.27 (1.69, 12.9)</b>	-171.6 (-208.1,-135.1)	-42.5 (-51.6, -33.5)	-140.8 (-177.3, -104.3)	-37.8 (-47.6, -28.0)
Low tier (≥5 g to <8 g)	<b>-65.7 (-77.5, -53.8)</b>	<b>-37.1 (-43.7, -30.4)</b>	-71.8 (-87.8, -55.8)	-71.8 (-87.8, -55.8)	-170.5 (-186.5, -154.5)	-85.8 (-93.9, -77.8)
No levy (<5 g):	<b>181.0 (118.4, 243.5)</b>	<b>11.1 (7.26, 14.9)</b>	395.0 (309.4, 480.7)	19.8 (15.5, 24.1)	685.5 (599.8, 771.1)	40.2 (35.2, 45.2)
>0 g to <5 g	<b>103.8 (75.2, 132.5)</b>	<b>16.7 (12.1, 21.3)</b>	202.0 (162.7, 241.2)	25.0 (20.1, 29.9)	374.6 (335.4, 413.9)	59.0 (52.8, 65.1)
0 g	<b>87.8 (41.1, 134.5)</b>	<b>8.66 (4.05, 13.3)</b>	178.9 (115.6, 242.3)	14.7 (9.52, 20.0)	316.1 (252.7, 379.4)	29.4 (23.5, 35.3)
Bottled water	30.3 (-62.0, 1.4)	4.24 (-8.7, 0.2)	82.1 (-125.7, -38.4)	-10.5 (-16.1, -4.9)	-130.5 (-174.1, -88.8)	-15.7 (-20.9, -10.4)
<b>Levy exempt drinks</b>						
Alcoholic drinks	-16.5 (-48.5, 15.4)	0.95 (-2.79, 0.89)	<b>-84.9 (-135.1, -34.7)</b>	<b>-4.81 (-7.66, -1.97)</b>	<b>-103.1 (-153.3, -53.0)</b>	<b>-5.8 (-8.60, -2.97)</b>
Milk and milk based drinks*	<b>-185.5 (-249.7, -121.4)</b>	<b>-4.9 (-6.60, -3.20)</b>	<b>145.5 (64.4, 226.6)</b>	<b>4.21 (1.86, 6.56)</b>	<b>-132.8 (-213.9, -51.7)</b>	<b>-3.56 (-5.73, -1.38)</b>
No added sugar fruit juices	6.8 (-6.9, 20.5)	1.4 (-1.4, 4.3)	-6.2 (-24.8, 12.5)	-1.26 (-6.1, 2.5)	8.7 (-9.9, 27.3)	1.82 (-2.1, 5.7)
Drinks sold as powders (g)	<b>-6.9 (-10.0, -3.8)</b>	<b>-6.8 (-9.9, -3.8)</b>	<b>9.6 (5.3, 13.9)</b>	<b>11.2 (6.2, 16.2)</b>	0.9 (-3.3, 5.2)	1.0 (-3.5, 5.5)
<b>Other categories</b>						
Confectionery (g)	-10.1 (-53.9, 33.8)	-2.4 (-13.1, 8.2)	39.8 (-19.0, 98.6)	11.6 (-5.5, 28.8)	35.3 (94.1, -23.5)	10.2 (-6.8, 27.1)
<b>All soft drinks combined (ie excluding alcohol)</b>	<b>11.8 (-103.7, 127.3)</b>	<b>0.16 (-1.42, 1.74)</b>	<b>187.8 (29.7, 345.9)</b>	<b>2.56 (0.40, 4.71)</b>	<b>188.8 (30.7, 346.9)</b>	<b>2.6 (0.4, 4.7)</b>

**Bold** indicates significant difference at 95% confidence interval level.

\*Milk comprises drinks in the following categories: semi-skimmed; specific low fat % milk (e.g. 1% fat milk); whole milk; buttermilk; modified milk; other milk; other non-cows milk; rice drink; soya milk. Skimmed milk is excluded from all analysis in this paper due to missing data.

**Table 3.** Absolute and relative change in sugar in drinks and confectionery (g) purchased per household (95% CI) per week in relation to the UK SDIL, March 2014- March 2019 (weighted)

	Analysis 1: pre-post announcement (Mar 2014-Mar 2018)		Analysis 2: pre-post implementation (Mar 2016-Mar 2019)		Analysis 3: pre-post announcement and implementation (Mar 2014-Mar 2019)	
	Absolute change (g)	Relative change (%)	Absolute change (g)	Relative change (%)	Absolute change (g)	Relative change (%)
<b>All drinks</b>						
<b>Levy liable drinks (sugar/100 mL)</b>						
High tier (≥8 g)	5.5 (3.8, 7.2)	10.8 (7.4, 14.1)	-21.2 (-23.8, -18.5)	-49.3 (-55.4, -43.1)	-16.2 (-18.8, -13.5)	-42.6 (-49.6, -35.6)
Low tier (≥5 g to <8 g)*	-4.3 (-6.1, -2.6)	-37.5 (-52.5, -22.5)	-5.0 (-7.4, -2.6)	-75.8 (-112.7, -38.9)	-11.5 (-13.9, -9.1)	-87.8 (-106.4, -69.2)
No levy (<5 g)**	5.7 (3.9, 7.4)	72.6 (50.3, 94.9)	9.7 (7.3, 12.1)	56.0 (41.9, 70.0)	19.2 (16.7, 21.6)	242.8 (211.9, 273.7)
>0 g to <5 g	5.7 (3.9, 7.4)	72.6 (50.3, 94.9)	9.7 (7.3, 12.1)	56.0 (41.9, 70.0)	19.2 (16.7, 21.6)	242.8 (211.9, 273.7)
<b>Levy exempt drinks</b>						
Milk and milk based drinks†	-3.9 (-6.5, -1.3)	-2.2 (-3.6, -0.7)	4.1 (0.5, 7.7)	2.4 (0.3, 4.6)	-3.1 (-6.7, 0.5)	-1.8 (-3.8, 0.3)
No added sugar fruit juices	2.6 (0.3, 4.8)	5.7 (0.7, 10.7)	-1.7 (-4.8, 1.5)	-3.5 (-10.0, 3.0)	2.6 (-0.5, 5.7)	5.9 (-1.2, 13.1)
Drinks sold as powders	0.3 (-1.6, 2.2)	1.6 (-7.5, 10.6)	-0.04 (-2.7, 2.6)	-0.2 (-13.9, 13.5)	1.1 (-1.6, 3.7)	5.7 (-8.8, 20.2)
<b>Other categories</b>						
Confectionery	-6.6 (-32.0, 18.9)	-2.8 (-13.8, 8.14)	22.1 (-12.0, 56.1)	11.4 (-6.2, 29.1)	18.4 (-15.7, 52.4)	9.3 (-8.0, 26.7)
<b>All soft drinks combined (ie excluding alcohol)</b>	<b>4.6 (0.5, 8.6)</b>	<b>1.4 (0.2, 2.7)</b>	<b>-12.9 (-18.5, -7.4)</b>	<b>-4.3 (-6.1, -2.4)</b>	<b>-8.0 (-13.6, -2.4)</b>	<b>-2.7 (-4.5, -0.8)</b>

**Bold** indicates significant difference at 95% confidence interval level.

\*The counterfactual for low tier drinks crossed 0 mL shortly before the end of the study period thus predicting negative purchases; therefore, the non-counterfactual estimate at the end of the study period was compared with the final week during which the counterfactual was a positive number.

\*\*We do not report change in sugar purchased from drinks with 0g sugar/100ml or bottled water as these contain no sugar; the figures for the combined No levy line and the >0g to <5g of sugar/100ml line are the same as the only drinks in the No levy category containing sugar are those with >0g to <5g

† Milk comprises drinks in the following categories: semi-skimmed; specific low fat % milk (e.g. 1% fat milk); whole milk; buttermilk; modified milk; other milk; other non-cows milk; rice drink; soya milk. Skimmed milk is excluded from all analysis in this paper due to missing data.

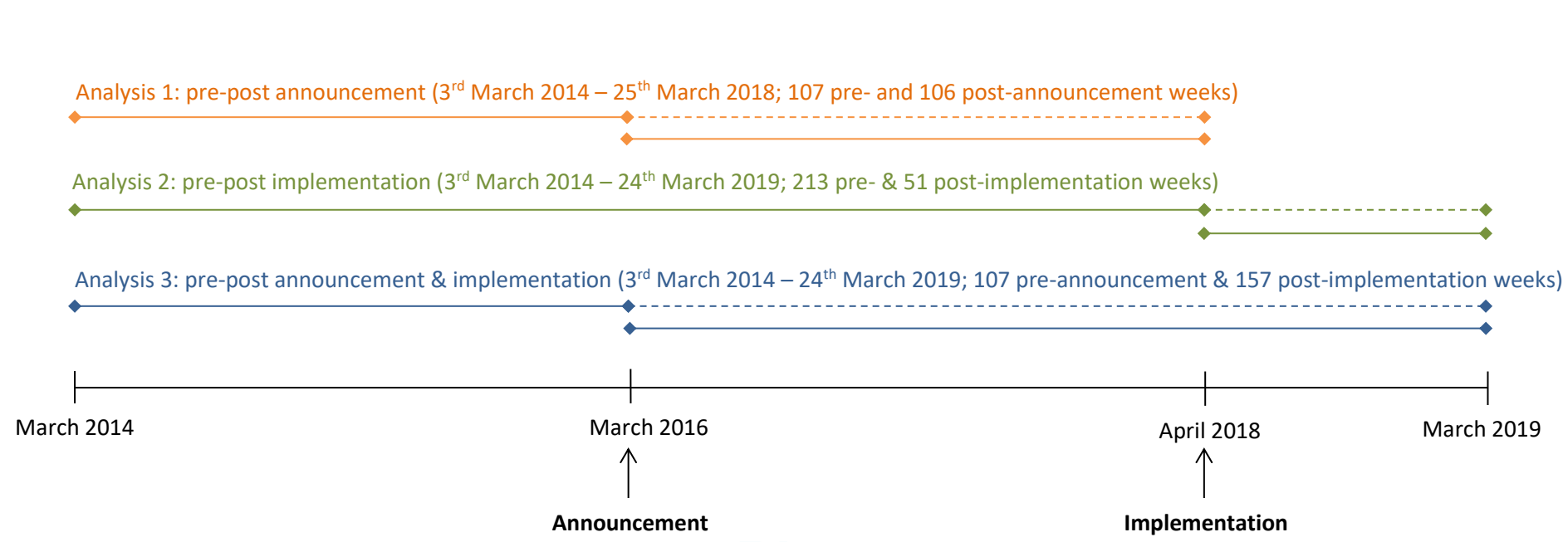
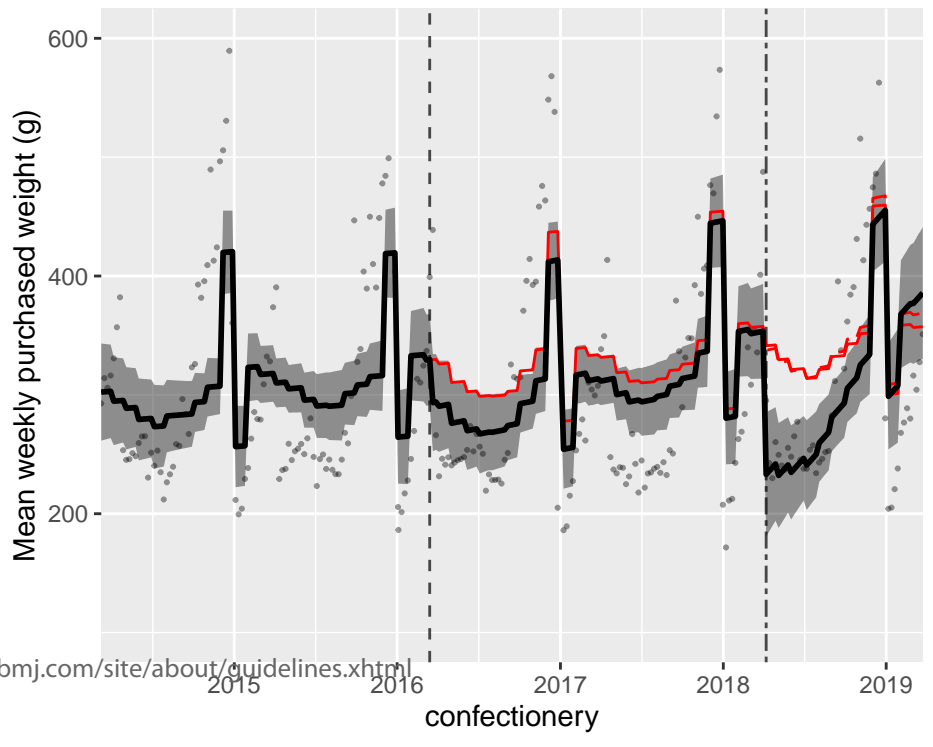
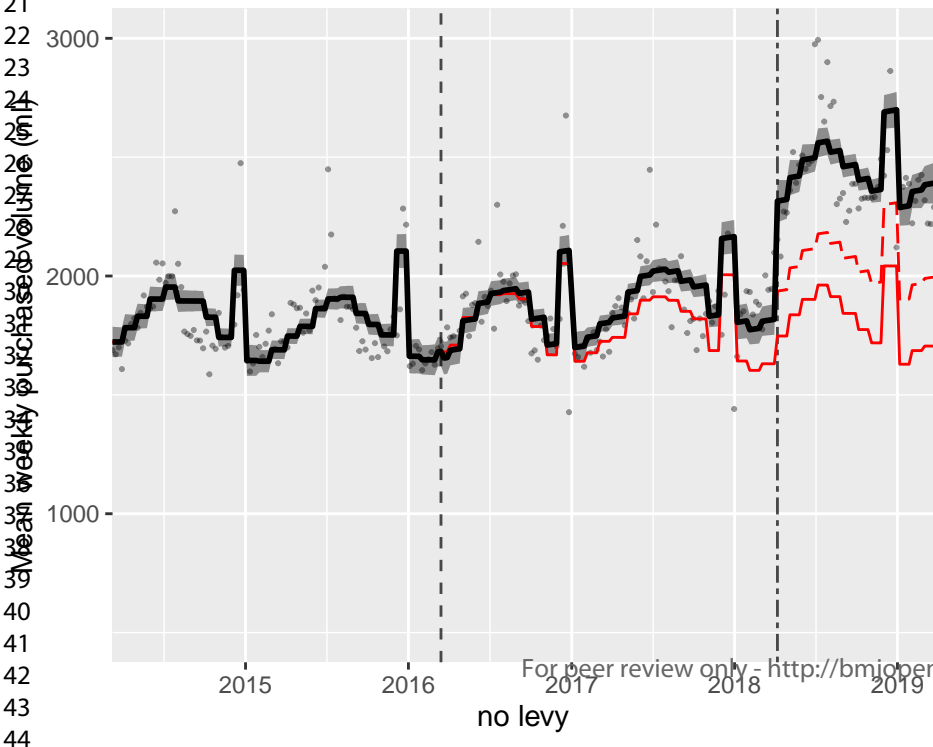
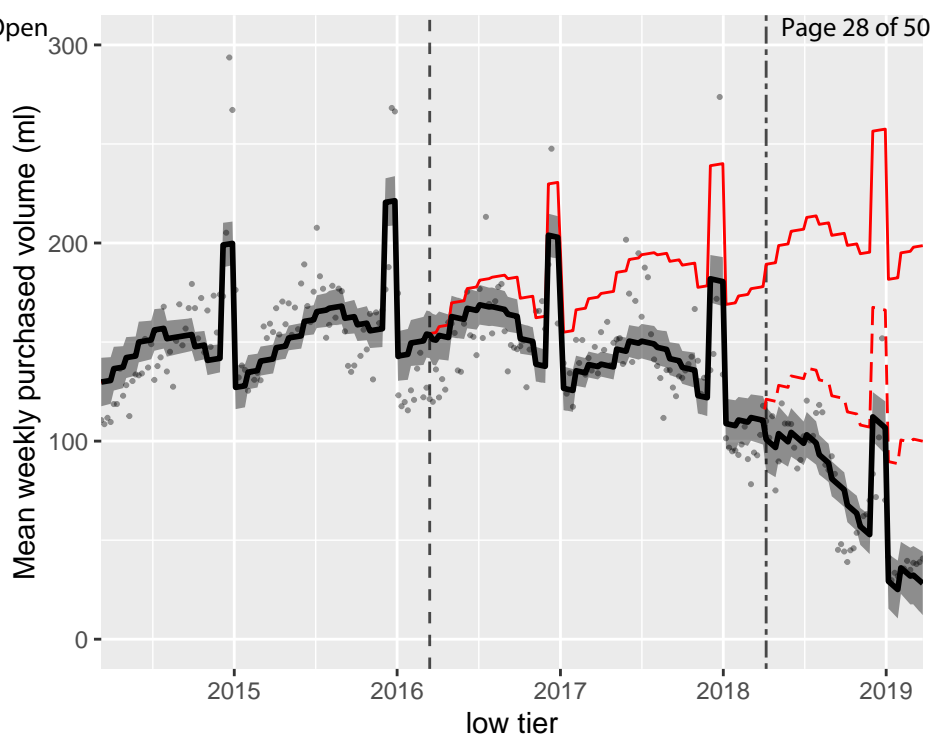
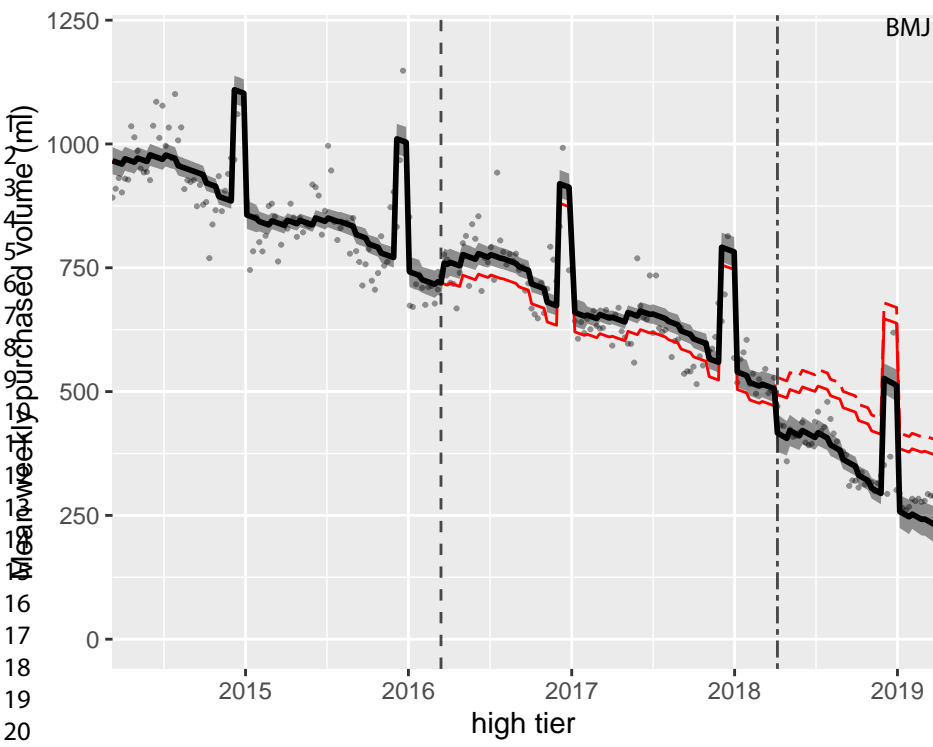
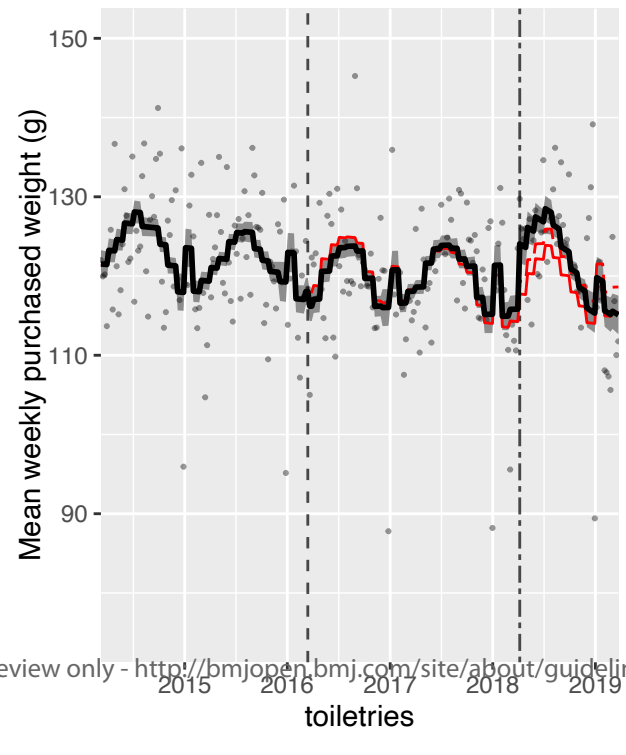
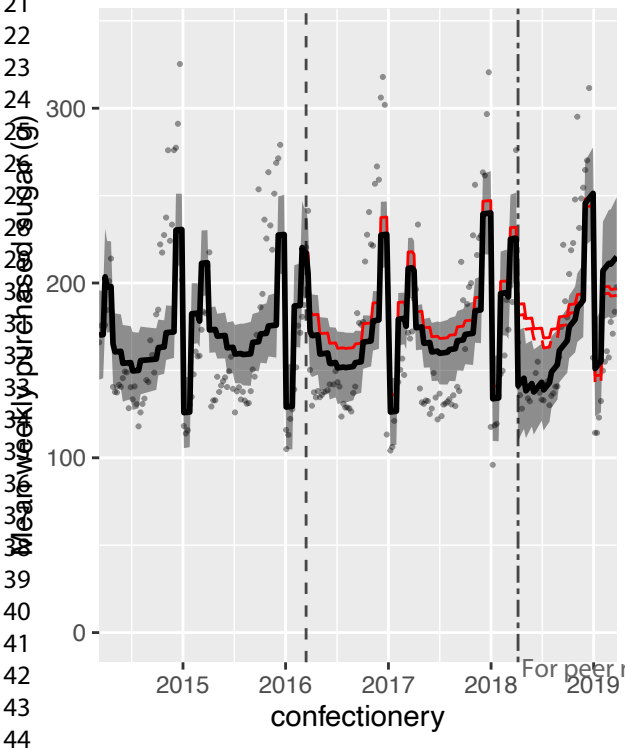
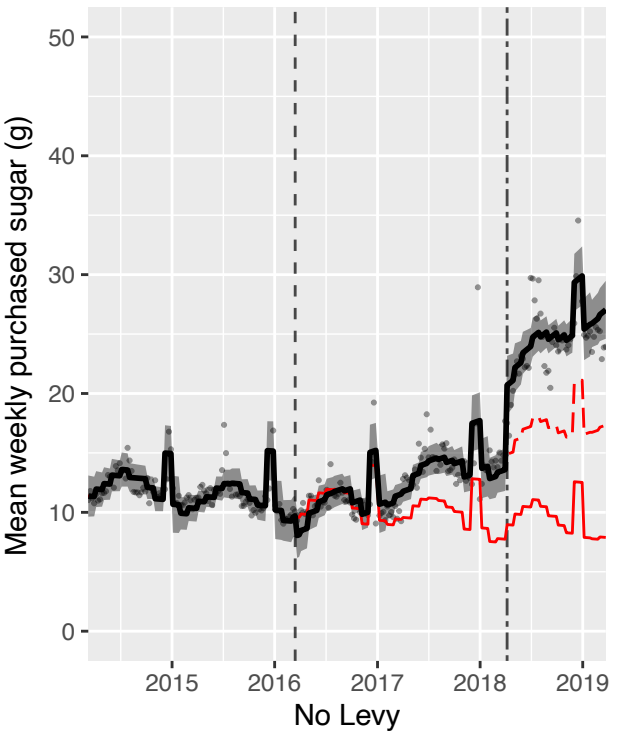
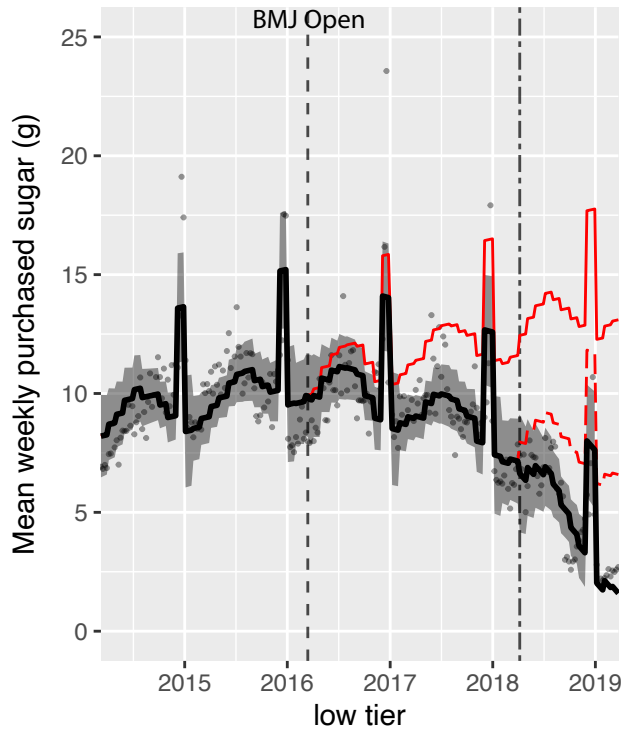
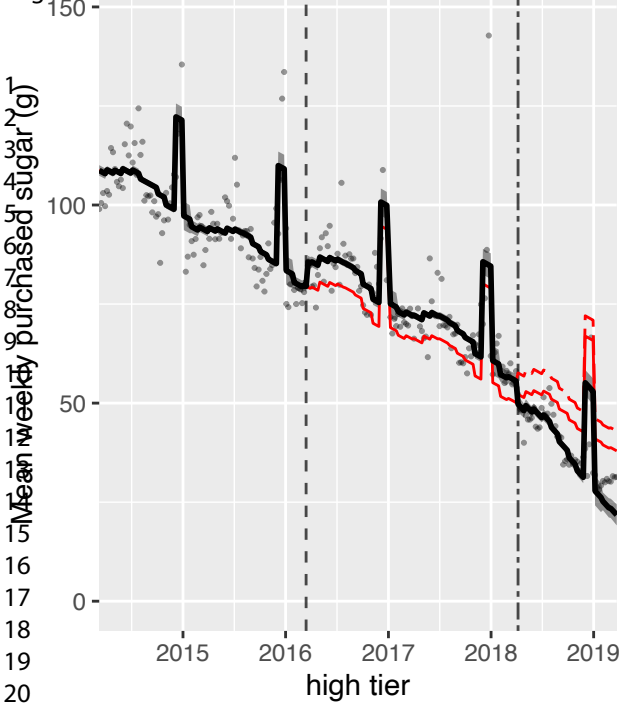


Figure 1: Schematic of overall analysis strategy

view only







## Supplementary material A

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Section and Paragraph No
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	Title.
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	Abstract: main outcome measures; results; conclusions.
<b>Introduction</b>			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	Introduction: paragraphs 1-3.
Objectives	3	State specific objectives, including any prespecified hypotheses	Introduction: paragraph 3-4.
<b>Methods</b>			
Study design	4	Present key elements of study design early in the paper	Methods: paragraph 1.
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Methods: data source; overall analysis strategy; Figure 1.
Participants	6	(a) <i>Cohort study</i> —Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up <i>Case-control study</i> —Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls <i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants	Methods: data source, product categories – drinks, confectionery and toiletries; control group; outcome measures.
		(b) <i>Cohort study</i> —For matched studies, give matching criteria and number of exposed and unexposed <i>Case-control study</i> —For matched studies, give matching criteria and the number of controls per case	NA.
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect	Outcome measures; overall analysis strategy; primary analysis: category specific analyses; secondary analysis: all soft drinks categories combined, irrespective of levy

		modifiers. Give diagnostic criteria, if applicable	eligibility; sensitivity analysis: excluding small manufacturers; sensitivity analysis: ITS without a control category; supplementary material B.
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Data source; overall analysis strategy; primary analysis: category specific analyses; secondary analysis: all soft drinks categories combined, irrespective of levy eligibility; sensitivity analysis: excluding small manufacturers; sensitivity analysis: ITS without a control category; supplementary material B.
Bias	9	Describe any efforts to address potential sources of bias	Product categories: drinks confectionery and toiletries; control group; sensitivity analysis: excluding small manufacturers; sensitivity analysis: ITS without a control category.
Study size	10	Explain how the study size was arrived at	Data source.
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Overall analysis strategy; primary analysis: category specific analyses; secondary analysis: all soft drinks categories combined, irrespective of levy eligibility; Box 1.
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	Control group; sensitivity analysis: ITS without a control category; Supplementary material A.
		(b) Describe any methods used to examine subgroups and interactions	Overall analysis strategy; primary analysis: category specific analyses; secondary analysis: all soft drinks categories combined, irrespective of levy eligibility.
		(c) Explain how missing data were addressed	Methods: data source
		(d) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed <i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed <i>Cross-sectional study</i> —If applicable, describe analytical methods taking account of sampling strategy	Methods: data source.
<b>Results</b>			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Results: paragraph 1.
		(b) Give reasons for non-participation at each stage	Data source.
		(c) Consider use of a flow diagram	-
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical,	Results: paragraph 1; Supplementary material C.

		social) and information on exposures and potential confounders	
		(b) Indicate number of participants with missing data for each variable of interest	Results: paragraph 1.
		(c) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)	NA.
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time	NA.
		<i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure	NA.
		<i>Cross-sectional study</i> —Report numbers of outcome events or summary measures	Results: paragraph 2; Table 1.
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Primary analysis: category specific results; high tier drinks; low tier drinks; no levy drinks; levy exempt drinks and confectionery; Figures 2-3; Tables 2-3; supplementary material D.
		(b) Report category boundaries when continuous variables were categorized	Introduction - paragraph 3; product categories: drinks, confectionery and toiletries; Box 1.
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	Tables 2-3.
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Sensitivity analysis: excluding small manufacturers; sensitivity analysis: no control category; supplementary tables 4a-b; supplementary material G.
<b>Discussion</b>			
Key results	18	Summarise key results with reference to study objectives	Summary of main findings.
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	Key strengths and limitations.
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Interpretation of findings - paragraphs 1-3.
Generalisability	21	Discuss the generalisability (external validity) of the study results	Interpretation of findings - paragraphs 4.
<b>Other information</b>			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Funding.

\*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

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3 **Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological  
4 background and published examples of transparent reporting. The STROBE checklist is best used in conjunction  
5 with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals  
6 of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information  
7 on the STROBE Initiative is available at [www.strobe-statement.org](http://www.strobe-statement.org).  
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### Supplementary material B

The model specification is given by:

$$Y_t = \beta_0 + \beta_1 T + \beta_2 A_t + \beta_3 A_t T + \beta_4 A_t Z + \beta_5 A_t T Z + \beta_6 I_t + \beta_7 I_t T + \beta_8 I_t Z + \beta_9 I_t T Z + e_t$$

$Y$	<i>Average volume of (or purchased sugar in) drink or confectionery per household per week at week <math>t</math> (<math>t=1, \dots, 264</math>)</i>
$T$	<i>Weeks since the start of the study; <math>1, \dots, 264</math></i>
$A_t$	<i>0 if <math>t</math> prior to announcement, 1 if <math>t</math> on or after announcement</i>
$I_t$	<i>0 if <math>t</math> prior to implementation, 1 if <math>t</math> on or after implementation</i>
$Z$	<i>Control category (toiletries) = 0, drink or confectionery category = 1</i>
$e_t$	<i><math>N(0, \sigma^2)</math> representing the residual variance of the model</i>

Dummy indicator variables determined to be statistically significant ( $p < 0.05$ ) were included for the intervention group as appropriate representing: interaction terms restart at 0 at the point of the interventions; the increase in purchases seen throughout December in the weeks before Christmas; the fall in purchases in the weeks immediately after Christmas; and the increase in confectionery purchases seen at Easter, for toiletries these were set to 0. To adjust for temperature-related trends in drink consumption the average UK monthly temperature was included in the intervention group with the average study period temperature used for toiletries.<sup>5</sup> Quadratic functions of announcement trends were included where they improved model fit - assessed using likelihood ratio tests. Stationary was examined using augmented Dickey-Fuller tests.<sup>41</sup> Autocorrelation between preceding time points was examined using autocorrelation and partial-autocorrelation plots. An appropriate autocorrelation structure was determined and then compared to alternative models using likelihood ratio tests. Visual inspection of the data suggested no additional benefit would be gained from including polynomial terms.

Supplementary material C

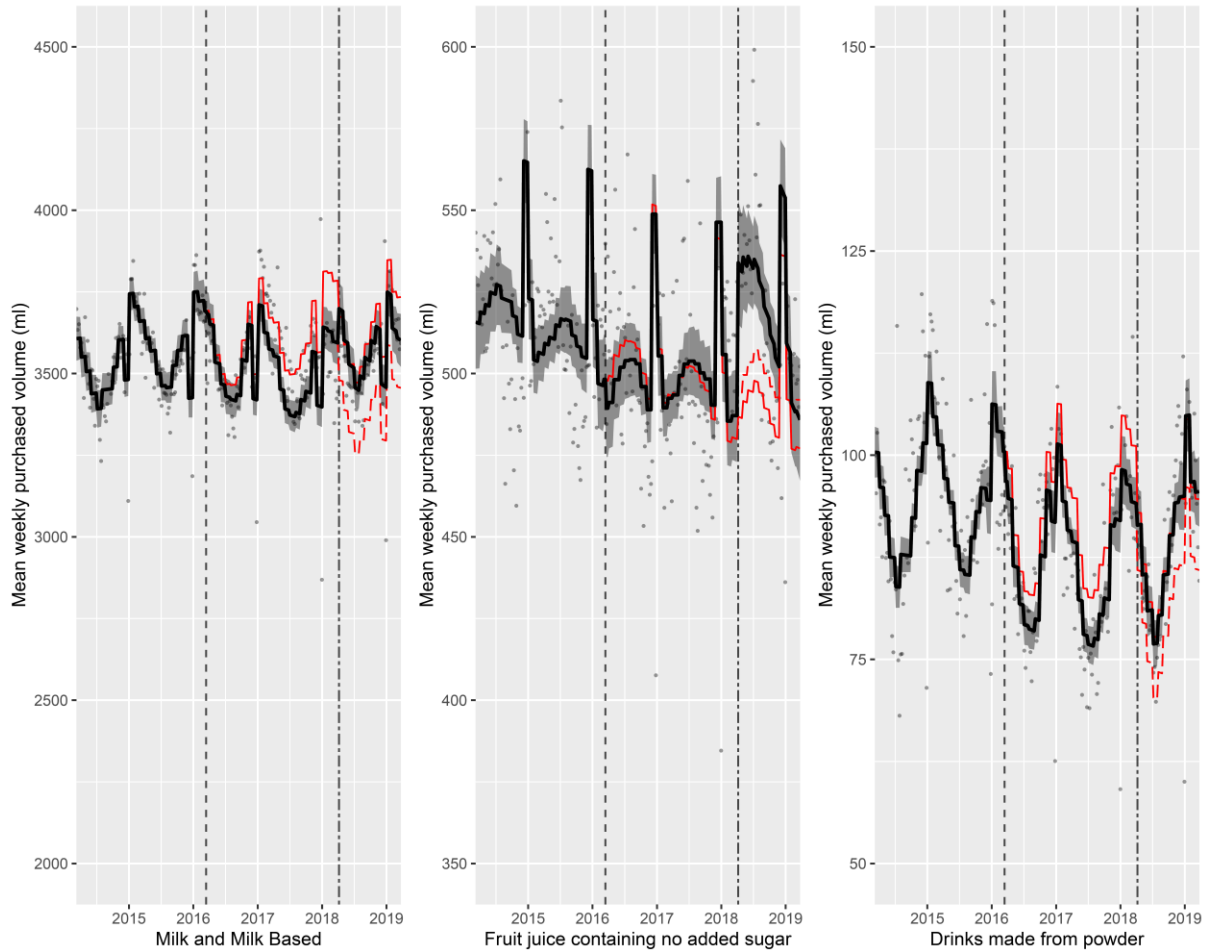
Supplementary Table 1: Demographic characteristics of Kantar Worldpanel take-home panel households from March 2014 – March 2018 (weighted)

	Level	Kantar Worldpanel (%)	UK population (%)
Children in household <sup>1</sup>	No	65.3	71.5
	Yes	34.6	28.5
Social grade of chief income earner <sup>2</sup>	AB: Higher and intermediate managerial	19.3	27
	C1: Junior managerial	34.1	28
	C2: Skilled manual workers	16.4	20
	D: Semi and unskilled-manual workers	12.4	15
	E: lowest grade workers	7.9	10
Total household income (£ per annum) <sup>3</sup>	0-9,999	6.4	..
	10,000-19,999	18.9	..
	20,000-29,999	17.2	..
	30,000-39,999	13.1	....
	40,000-49,999	9.0	..
	50,000-59,999	5.5	..
	60,000-69,999	2.9	..
	70,000+	4.1	..
	Refused to answer	14.4	..
	Mean (£)	..	35,697
Median (£)	..	28,947	
Highest qualification of chief income earner <sup>4</sup>	Higher than School leaving qualifications taken at ~18 years (e.g. A-Levels)	38.3	43.8
	School leaving qualifications taken at ~18 years (e.g. A-Levels)	12.3	22.4
	School leaving qualifications taken at ~16 years (e.g. GCSE)	20.6	18.7
	Other (including no qualifications and unknown)	16.2	15.1

<sup>1</sup>Average of households with dependent children from 2014-2018; <sup>2</sup>UK population figures from 2016; <sup>3</sup>No directly comparable figures available from ONS, mean and medians are averaged over 2014-2019; <sup>4</sup>UK population figures from 2014

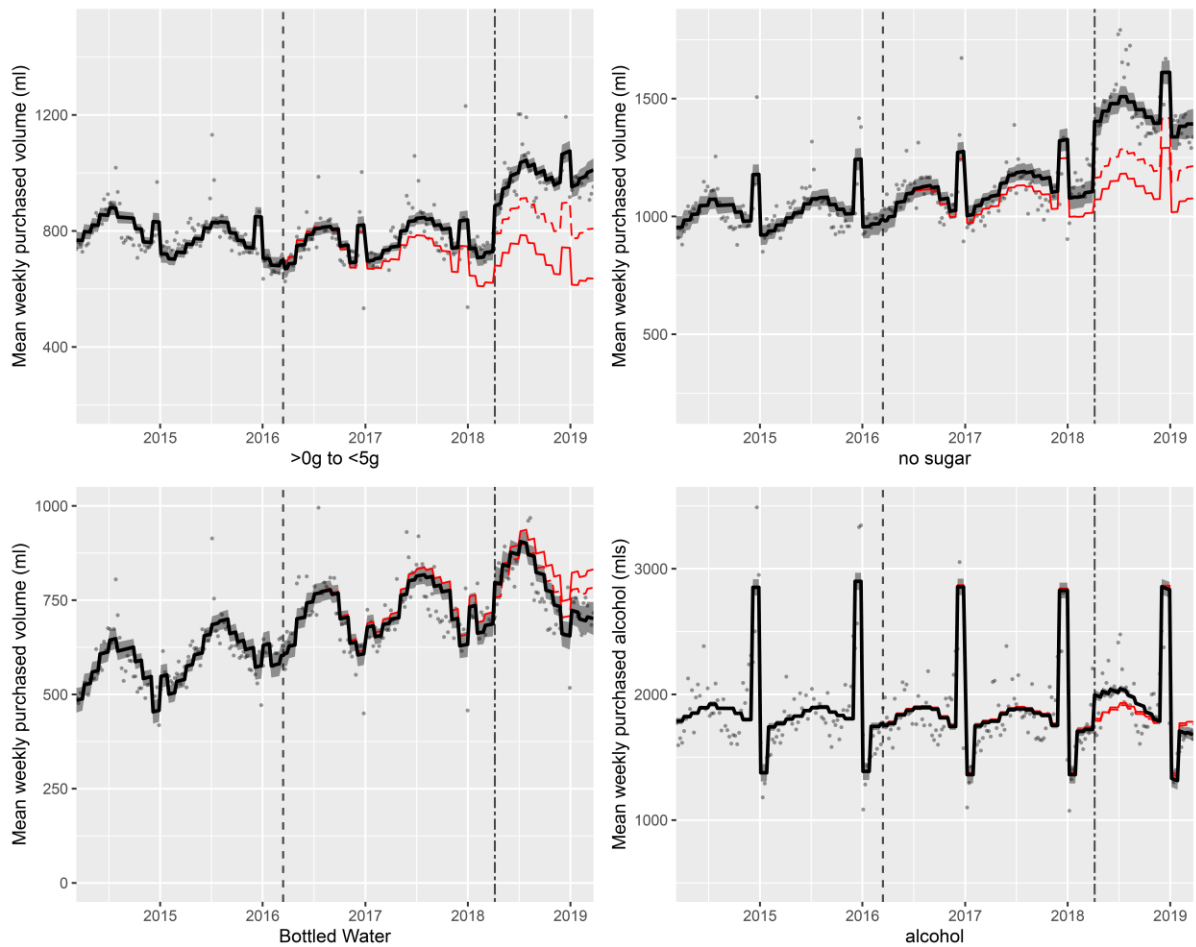
**Supplementary material D**

Supplementary Figure 1a. Observed and modelled volume (ml) of drinks exempt from the Soft Drinks Industry Levy, subcategories of low levy drinks and bottled water purchased per household per week, March 2014- March 2019 (weighted)



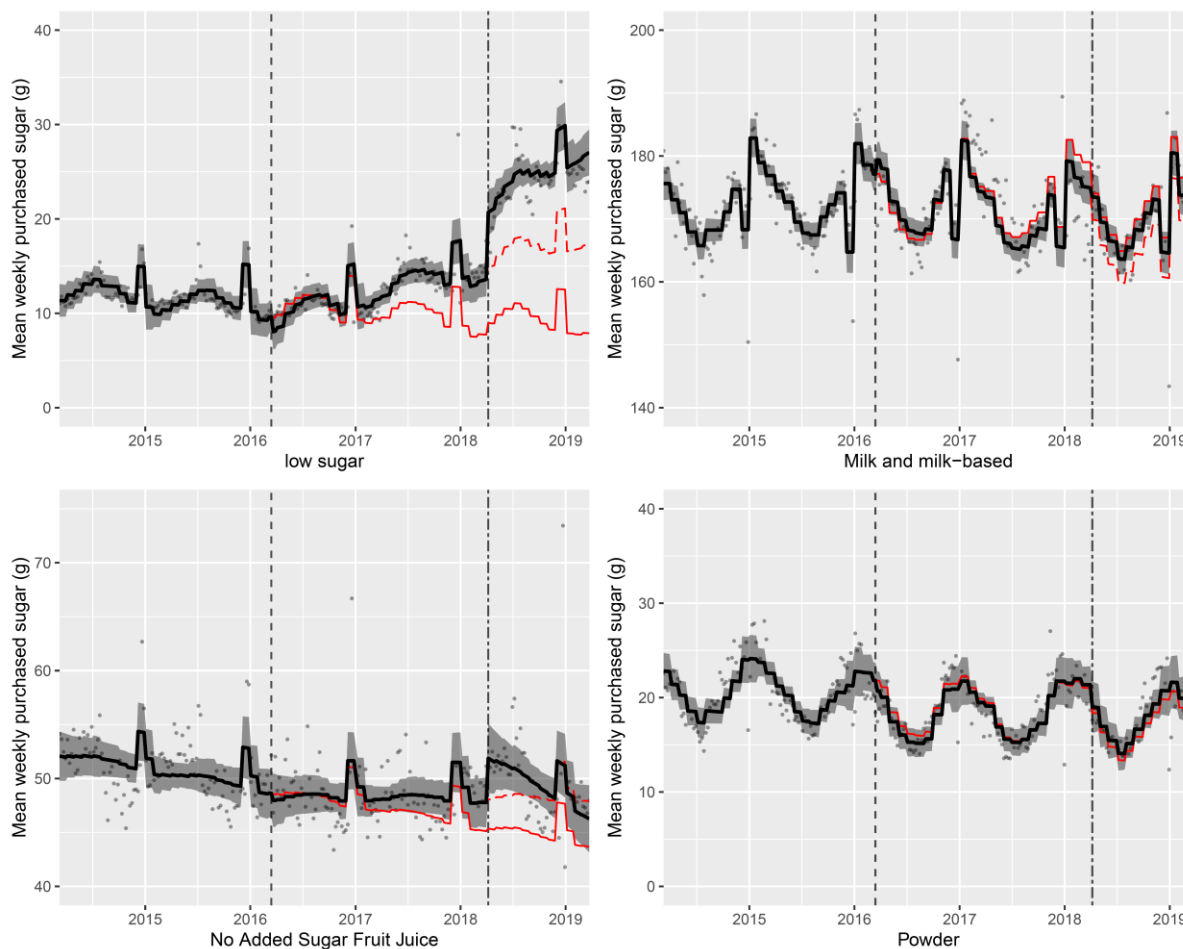
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Notes. Points are observed data, black lines (with shadows) are modelled data (and 95% confidence intervals); red lines indicate counterfactuals had the announcement (red solid line) and implementation (red dashed line) not happened; the first dashed vertical line indicates the point of announcement; the second dashed vertical line indicates the point of implementation; The Y-axis varies in scale between panels to maximise the resolution of figures; modelled purchases include averaged effects for seasonality and the impact of December and January (Christmas period). The control category of toiletries is shown in Figure 3.

Supplementary Figure 1b. Observed and modelled amount of sugar in no levy drinks containing sugar (low sugar) and drinks exempt from the Soft Drinks Industry Levy purchased per household per week, March 2014- March 2019 (weighted)



Notes. Points are observed data, black lines (with shadows) are modelled data (and 95% confidence intervals); red lines indicate counterfactuals had the announcement (red solid line) and implementation (red dashed line) not happened; the first dashed vertical line indicates the point of announcement; the second dashed vertical line indicates the point of implementation; The Y-axis varies in scale between panels to maximise the resolution of figures; modelled purchases include averaged effects for seasonality and the impact of December and January (Christmas period). The control category of toiletries is shown in Figure 3.

Supplementary Table 2a: Modelled level and trend changes in volume of drinks (ml) and confectionery (g) purchased per household per week (95% CI) in relation to the UK SDIL, March 2014 - March 2019 (weighted)

	Analysis 1: pre-post announcement (March 2014 – March 2018)		Analysis 2: pre-post implementation (March 2016 – March 2019)		Analysis 3: pre-post announcement & implementation (March 2014 – March 2019)	
	Level Change	Trend Change	Level Change	Trend Change	Level Change	Trend Change
<i>Levy liable drinks</i>						
High tier (≥8g sugar per 100ml)	44.0 (-7.7, 95.7)	-0.1 (-0.9, 0.7)	<b>-117.2 (-183.3, -51.1)</b>	1.0 (-0.9, 2.9)	-73.2 (-157.1, 10.7)	0.9 (-1.2, 3.0)
Low tier (≥5g - <8g sugar per 100ml)	-0.11 (-22.4, 22.1)	<b>-0.6 (-1.0, -0.3)</b>	-26.3 (-53.6, 1.04)	-0.81 (-1.6, 0.01)	-26.4 (-61.7, 8.8)	<b>-1.5 (-2.4, -0.6)</b>
No levy (<5g sugar per 100ml)	-28.2 (-149.4, 92.9)	<b>2.0 (0.04, 3.9)</b>	<b>372.0 (217.6, 526.4)</b>	<b>0.52 (-3.9, 4.9)</b>	<b>343.8 (147.5, 540.0)</b>	2.5 (-2.3, 7.3)
>0g to <5g sugar per 100ml	-27.1 (-82.6, 28.5)	<b>1.3 (0.4, 2.2)</b>	<b>88.1 (17.0, 159.3)</b>	<b>2.31 (0.3, 4.3)</b>	61.0 (-29.2, 151.4)	<b>3.6 (1.4, 5.8)</b>
0g sugar per 100ml	-7.37 (-93.9, 79.2)	0.9 (-0.6, 2.4)	<b>231.0 (125.2, 336.8)</b>	-0.99 (-4.3, 2.3)	<b>223.6 (87.0, 360.3)</b>	-0.08 (-3.7, 3.5)
Bottled water	6.86 (-53.4, 67.2)	-0.4 (-1.4, 0.6)	36.6 (-38.8, 112.0)	-2.24 (-4.5, 0.005)	43.5 (-53.1, 140.0)	<b>-2.6 (-5.1, -0.2)</b>
<i>Levy exempt drinks</i>						
Alcoholic drinks	-10.8 (-48.6, 27.0)	-0.07 (-0.5, 0.3)	<b>208.0 (137.9, 278.1)</b>	<b>-5.7 (-7.8, -3.6)</b>	<b>197.2 (117.6, 276.8)</b>	<b>-5.8 (-7.9, -3.7)</b>
Milk and milk based drinks*	-6.61 (-105.8, 92.6)	-1.7 (-4.0, 0.5)	<b>210.7 (98.7, 322.7)</b>	-1.2 (-5.3, 2.9)	<b>204.1 (54.4, 353.7)</b>	-2.9 (-7.6, 1.8)
No added sugar fruit juices	-8.72 (-34.3, 16.9)	0.1 (-0.3, 0.6)	30.5 (-0.9, 61.9)	-0.7 (-1.6, 0.3)	21.78 (-18.8, 62.3)	-0.5 (-1.6, 0.5)
Drinks sold as powders (g)	-1.79 (-7.8, 4.18)	-0.06 (-0.2, 0.03)	0.10 (-7.7, 7.9)	<b>0.3 (0.04, 0.5)</b>	-1.69 (-11.6, 8.17)	0.2 (-0.04, 0.4)
<i>Other categories</i>						
Confectionery (g)	-17.0 (-88.0, 54.0)	0.07 (-1.3, 1.5)	-77.9 (-163.9, 8.19)	2.4 (-0.6, 5.4)	<b>-98.9 (-206.4, -16.7)</b>	2.5 (-0.8, 5.8)

**Bold** indicates a significant difference at the 95% confidence interval level.

\*Milk comprises drinks in the following categories: semi-skimmed; specific low fat % milk (e.g. 1% fat milk); whole milk; buttermilk; modified milk; other milk; other non-cows milk; rice drink; soya milk. Skimmed milk is excluded from all analysis in this paper due to missing data.

Supplementary Table 2b: Modelled level and trend changes in sugar in drinks and confectionery (g) purchased per household per week (95% CI) in relation to the UK SDIL, March 2014 - March 2019 (weighted)

	Analysis 1: pre-post announcement (March 2014 – March 2018)		Analysis 2: pre-post implementation (March 2016 – March 2019)		Analysis 3: pre-post announcement & implementation (March 2014 – March 2019)	
	Level Change	Trend Change	Level Change	Trend Change	Level Change	Trend Change
<i>Levy liable drinks</i>						
High tier (≥8g sugar per 100ml)	<b>8.9 (6.8, 10.9)</b>	<b>-0.05 (-0.08, -0.03)</b>	<b>-11.5 (-15.3, -7.7)</b>	<b>-0.1 (-0.2, -0.02)</b>	-2.6 (-6.9, 1.6)	<b>-0.2 (-0.3, -0.07)</b>
Low tier (≥5g - <8g sugar per 100ml)	1.7 (-1.6, 5.1)	<b>-0.07 (-0.1, -0.02)</b>	<b>-6.2 (-10.6, -1.8)</b>	0.09 (-0.03, 0.2)	-4.5 (-10.0, 1.1)	0.02 (-0.1, 0.2)
No levy (<5g sugar per 100ml)	0.2 (-3.1, 3.5)	0.04 (-0.01, 0.09)	0.8 (-3.6, 5.3)	<b>0.2 (0.1, 0.4)</b>	1.0 (-4.5, 6.6)	<b>0.3 (0.2, 0.4)</b>
>0g to <5g sugar per 100ml	0.2 (-3.1, 3.5)	0.04 (-0.01, 0.09)	0.8 (-3.6, 5.3)	<b>0.2 (0.1, 0.4)</b>	1.0 (-4.5, 6.6)	<b>0.3 (0.2, 0.4)</b>
<i>Levy exempt drinks</i>						
Milk and milk based drinks*	4.1 (-0.1, 9.1)	<b>-0.09 (-0.2, -0.01)</b>	-2.0 (-8.6, 4.6)	<b>0.2 (0.01, 0.4)</b>	2.1 (-6.2, 10.4)	0.1 (-0.09, 0.3)
No added sugar fruit juices	1.0 (-3.4, 5.4)	0.001 (-0.06, 0.06)	-1.6 (-7.3, 4.1)	0.07 (-0.09, 0.2)	-0.6 (-7.8, 6.6)	0.07 (-0.1, 0.2)
Drinks sold as powders (g)	0.6 (-3.3, 4.5)	-0.02 (-0.08, 0.04)	-5.1 (-0.004, 10.2)	<b>0.2 (0.03, 0.3)</b>	-4.5 (-10.9, 1.9)	<b>0.2 (0.001, 0.3)</b>
<i>Other categories</i>						
Confectionery (g)	-8.6 (-49.7, 32.6)	0.03 (-0.8, 0.9)	-49.4 (-99.2, 0.4)	1.5 (-0.2, 3.2)	<b>-58.0 (-122.6, -6.7)</b>	1.6 (-0.4, 3.5)

**Bold** indicates a significant difference at the 95% confidence interval level.

\*Milk comprises drinks in the following categories: semi-skimmed; specific low fat % milk (e.g. 1% fat milk); whole milk; buttermilk; modified milk; other milk; other non-cows milk; rice drink; soya milk. Skimmed milk is excluded from all analysis in this paper due to missing data.

Supplementary material E

Secondary analysis: all drinks categories combined irrespective of levy eligibility

Supplementary Table 3a: Level and trend changes in volume of, and sugar in, all soft drinks (ml) and confectionery (g) purchased per household per week (95% CI) in relation to the UK SDIL, March 2014 - March 2019 (weighted)

	Analysis 1: pre-post announcement (March 2014 – March 2018)		Analysis 2: pre-post implementation (March 2016 – March 2019)		Analysis 3: pre-post announcement & implementation (March 2014 – March 2019)	
	Level Change	Trend Change	Level Change	Trend Change	Level Change	Trend Change
<i>All soft drinks - volume</i>						
Higher tier (≥8g sugar per 100ml)	22.8 (-37.5, 83.1)	0.5 (-0.5, 1.5)	-76.8 (-154.0, 0.4)	-2.2 (-4.4, 0.01)	-54.0 (-152.0, 44.0)	-1.7 (-4.1, 0.7)
Lower tier (≥5g - <8g sugar per 100ml)	19.0 (-52.2, 90.2)	<b>-3.2 (-5.9, -0.5)</b>	27.9 (-47.8, 103.6)	-4.4 (-8.9, 0.02)	46.9 (-57.0, 150.8)	<b>-7.6 (-12.9, -2.4)</b>
Drinks containing <5g sugar per 100ml)	-152.1 (-348.3, 44.1)	2.6 (-0.7, 5.8)	<b>435.7 (187.7, 683.7)</b>	1.1 (-6.0, 8.3)	283.6 (-32.6, 599.8)	3.7 (-4.2, 11.5)
Levy liable drinks combined	15.2 (-72.9, 103.3)	0.6 (-0.8, 2.0)	-39.7 (-152.7, 73.4)	0.01 (-3.2, 3.2)	-24.5 (-167.8, 118.9)	0.6 (-2.9, 4.1)
All soft drinks excluding milk*	12.9 (-205.3, 231.0)	1.0 (-2.6, 4.5)	<b>347.6 (70.1, 625.0)</b>	-5.2 (-13.1, 2.7)	<b>360.5 (7.47, 713.4)</b>	-4.2(-12.9, 4.5)
All soft drinks combined	33.9 (-189.0, 256.7)	-0.2 (-3.8, 3.4)	<b>453.0 (170.1, 735.9)</b>	-5.1 (-13.2, 3.0)	<b>486.9 (126.7, 847.0)</b>	-5.4 (-14.2, 3.5)
<i>All soft drinks – sugar</i>						
Higher tier (≥8g sugar per 100ml)	4.1 (-2.6, 10.8)	0.04 (-0.07, 1.1)	<b>-13.4 (-22.2, -4.7)</b>	-0.1 (-0.4, 0.1)	-9.3 (-20.3, 1.7)	-0.08 (-0.3, 0.2)
Lower tier (≥5g - <8g sugar per 100ml)	<b>11.0 (5.6, 16.3)</b>	<b>-0.2 (-0.3, -0.1)</b>	-2.7 (-9.67, 4.3)	-0.01 (-0.2, 0.2)	8.3 (-0.5, 17.1)	<b>-0.2 (-0.4, -0.01)</b>
Drinks containing <5g sugar per 100ml)	-6.3 (-12.2, -0.4)	<b>1.0 (0.9, 1.0)</b>	-0.7 (-8.30, 7.0)	<b>0.4 (0.2, 0.6)</b>	-7.0 (-16.6, 2.7)	<b>1.4 (1.1, 1.6)</b>
Levy liable drinks combined	5.0 (-1.8, 11.8)	-0.003 (-0.1, 0.1)	<b>-13.1 (-22.0, -4.2)</b>	0.02 (-0.2, 0.3)	-8.1(-19.3, 3.1)	0.02 (-0.3, 0.3)
All soft drinks excluding milk*	3.1 (-4.6, 10.8)	0.04 (-0.08, 0.2)	-9.3 (-19.2, 0.7)	-0.09 (-0.4, 0.2)	-6.2 (-18.8, 6.4)	-0.05 (-0.4, 0.3)
All soft drinks combined	5.3 (-2.6, 13.2)	-0.02 (-0.1, 0.1)	-5.7 (-15.9, 4.5)	-0.08 (-0.4, 0.2)	-0.4 (-13.2, 12.5)	-0.1 (-0.4, 0.2)

**Bold** indicates a significant difference at the 95% confidence interval level. The levy liable drinks category is a combination of high tier, low tier and no levy drinks.

\*Milk comprises drinks in the following categories: semi-skimmed; specific low fat % milk (e.g. 1% fat milk); whole milk; buttermilk; modified milk; other milk; other non-cows milk; rice drink; soya milk. Skimmed milk is excluded from all analysis in this paper due to missing data.

Supplementary Table 3b: Absolute and relative change in volume of, and sugar in, all soft drinks and confectionery (g) purchased per household (95% CI) per week in relation to the UK SDIL, March 2014- March 2019 (weighted)

	Analysis 1: pre-post announcement (March 2014 – March 2018)		Analysis 2: pre-post implementation (March 2016 – March 2019)		Analysis 3: pre-post announcement & implementation (March 2014 – March 2019)	
	Absolute change (ml or g)	Relative change (%)	Absolute change (ml or g)	Relative change (%)	Absolute change (ml or g)	Relative change (%)
<i>All soft drinks - volume</i>						
High tier (≥8g sugar per 100ml)	<b>76.6 (45.6, 107.7)</b>	<b>7.5 (4.5, 10.6)</b>	<b>-190.9 (-233.5, -148.3)</b>	<b>-19.4 (-23.7, -15.1)</b>	<b>-85.6 (-128.2, -43.0)</b>	<b>-9.8 (-14.6, -4.9)</b>
Low tier (≥5g - <8g sugar per 100ml)	316.7 (-241.7, -391.7)	<b>-28.0 (-21.3, -34.6)</b>	<b>-205.2 (-295.9, -114.5)</b>	<b>-26.2 (-37.8, -14.6)</b>	<b>-693.6 (-784.3, -602.9)</b>	<b>-54.5 (-61.7, -47.4)</b>
Drinks containing <5g sugar per 100ml	<b>114.3 (12.4, 216.2)</b>	<b>2.2 (0.2, 4.1)</b>	<b>506.7 (367.3, 646.1)</b>	<b>9.0 (6.5, 11.4)</b>	<b>760.2 (620.8, 899.6)</b>	<b>14.1 (11.5, 16.6)</b>
Levy liable drinks combined	<b>76.5 (31.1, 121.8)</b>	<b>6.0 (2.5, 9.6)</b>	-42.7 (-104.9, 19.6)	-3.3(-8.1, 1.5)	<b>66.3 (4.1, 128.6)</b>	<b>5.6 (0.3, 10.8)</b>
All soft drinks excluding milk*	<b>116.1 (3.3, 229.0)</b>	<b>3.3 (0.09, 6.4)</b>	79.6 (-74.8, 234.1)	2.1 (-2.0, 6.1)	<b>250.1 (95.7, 404.5)</b>	<b>6.8 (2.6, 11.0)</b>
All soft drinks combined	11.8 (-103.7, 127.3)	0.2 (-1.4, 1.7)	<b>187.8 (29.7, 345.9)</b>	<b>2.6 (0.4, 4.7)</b>	<b>188.8 (30.7, 346.9)</b>	<b>2.6 (0.4, 4.7)</b>
<i>All soft drinks – sugar</i>						
High tier (≥8g sugar per 100ml)	<b>9.3 (5.9, 12.8)</b>	<b>7.6 (4.8, 10.4)</b>	<b>-22.9 (-27.8, -18.1)</b>	<b>-19.4 (-23.4, -15.3)</b>	<b>-9.99 (-14.8, -5.18)</b>	<b>-9.5 (-14.0, -4.9)</b>
Low tier (≥5g - <8g sugar per 100ml)	<b>-9.7 (-12.5, -6.9)</b>	<b>-18.6 (-23.9, -13.3)</b>	<b>-7.2 (-11.0, -3.4)</b>	<b>-19.4 (-29.7, -9.1)</b>	<b>-26.7 (-30.5, -22.9)</b>	<b>-47.1 (-53.9, -40.4)</b>
Drinks containing <5g sugar per 100ml	<b>5.1 (2.1, 8.1)</b>	<b>3.6 (1.5, 5.8)</b>	<b>16.7 (12.5, 20.9)</b>	<b>11.2 (8.4, 14.0)</b>	<b>28.6 (24.4, 32.8)</b>	<b>20.9 (17.9, 23.9)</b>
Levy liable drinks combined	<b>6.1 (2.6, 9.6)</b>	<b>8.6 (3.6, 13.5)</b>	<b>-15.5 (-20.4, -10.7)</b>	<b>-22.7 (-29.8, -15.6)</b>	<b>-8.0 (-12.9, -3.2)</b>	<b>-13.2 (-21.1, -5.2)</b>
All soft drinks excluding milk*	<b>8.9 (5.0, 12.8)</b>	<b>6.5 (3.6, 9.4)</b>	<b>-17.2 (-22.7, -11.8)</b>	<b>-12.7 (-16.7, -8.67)</b>	<b>-4.5 (-10.0, 1.0)</b>	<b>-3.7 (-8.1, 0.8)</b>
All soft drinks combined	<b>4.6 (0.5, 8.6)</b>	<b>1.4 (0.2, 2.7)</b>	<b>-12.9 (-18.5, -7.4)</b>	<b>-4.3 (-6.1, -2.4)</b>	<b>-8.0 (-13.6, -2.4)</b>	<b>-2.7 (-4.5, -0.8)</b>

**Bold** indicates a significant difference at the 95% confidence interval level. The levy liable drinks category is a combination of high tier, low tier and no levy drinks.

\*Milk comprises drinks in the following categories: semi-skimmed; specific low fat % milk (e.g. 1% fat milk); whole milk; buttermilk; modified milk; other milk; other non-cows milk; rice drink; soya milk. Skimmed milk is excluded from all analysis in this paper due to missing data.

## Supplementary material F

Sensitivity analysis: excluding small manufacturers

Supplementary table 4a: Modelled level and trend changes in volume of, and sugar in, drinks (ml) purchased per household per week (95% CI) in relation to the UK SDIL, March 2014 - March 2019; excluding small manufacturers (weighted)

	Analysis 1: pre-post announcement (March 2014 – March 2018)		Analysis 2: pre-post implementation (March 2016 – March 2019)		Analysis 3: pre-post announcement & implementation (March 2014 – March 2019)	
	Level Change	Trend Change	Level Change	Trend Change	Level Change	Trend Change
<i>Volume</i>						
<i>High levy tier (≥8g sugar per 100ml)</i>						
All Manufacturers	44.0 (-7.7, 95.7)	-0.1 (-0.9, 0.7)	<b>-117.2 (-183.3, -51.1)</b>	1.0 (-0.9, 2.9)	-73.2 (-157.1, 10.7)	0.9 (-1.2, 3.0)
Excluding Manufacturers with <1M Litres	41.5 (-9.7, 92.7)	-0.09 (-0.9, 0.7)	<b>-111.9 (-177.3, -46.6)</b>	-1.1 (-2.9, 0.8)	-70.8 (-153.4, 12.6)	-1.2 (-3.2, 0.9)
Excluding Manufacturers with <0.5M Litres	41.5 (-9.7, 92.7)	-0.09 (-0.9, 0.7)	<b>-111.9 (-177.3, -46.6)</b>	-1.1 (-2.9, 0.8)	-70.8 (-153.4, 12.6)	-1.2 (-3.2, 0.9)
<i>Low levy tier (≥5g - &lt;8g sugar per 100ml)</i>						
All Manufacturers	-0.1 (-22.4, 22.1)	<b>-0.6 (-1.0, -0.3)</b>	-26.3 (-53.6, 1.0)	-0.8 (-1.6, 0.01)	-26.4 (-61.7, 8.8)	<b>-1.5 (-2.4, -0.6)</b>
Excluding Manufacturers with <1M Litres	-2.1 (-24.0, 19.9)	<b>-0.7 (-1.0, -0.3)</b>	-20.9 (-47.5, 5.7)	<b>-0.9 (-1.8, -0.1)</b>	-23.0 (-57.5, 11.6)	<b>-1.6 (-2.5, -0.7)</b>
Excluding Manufacturers with <0.5M Litres	-2.1 (-24.0, 19.6)	<b>-0.7 (-1.0, -0.3)</b>	-20.7 (-47.3, 5.9)	<b>-0.9 (-1.8, -0.1)</b>	-22.9 (-57.2, 11.5)	<b>-1.6 (-2.5, -0.7)</b>
<i>Sugar</i>						
<i>High tier (≥8g sugar per 100ml)</i>						
All Manufacturers	<b>8.9 (6.8, 10.9)</b>	<b>-0.05 (-0.08, -0.03)</b>	<b>-11.5 (-15.3, -7.7)</b>	<b>-0.1 (-0.2, -0.02)</b>	-2.6 (-6.9, 1.6)	<b>-0.2 (-0.3, -0.07)</b>
Excluding Manufacturers with <1M Litres	4.5 (-1.3, 10.2)	-0.03 (-0.1, 0.06)	<b>-13.5 (-20.8, -6.1)</b>	-0.07 (-0.3, 0.1)	-9.0 (-18.3, 0.4)	-0.1 (-0.3, 0.1)
Excluding Manufacturers with <0.5M Litres	4.5 (-1.3, 10.2)	-0.03 (-0.1, 0.06)	<b>-13.5 (-20.8, -6.1)</b>	-0.07 (-0.3, 0.1)	-9.0 (-18.3, 0.4)	-0.1 (-0.3, 0.1)
<i>Low tier (≥5g - &lt;8g sugar per 100ml)</i>						
All Manufacturers	1.7 (-1.6, 5.1)	<b>-0.07 (-0.1, -0.02)</b>	<b>-6.2 (-10.6, -1.8)</b>	0.09 (-0.03, 0.2)	-4.5 (-10.0, 1.1)	0.02 (-0.1, 0.2)
Excluding Manufacturers with <1M Litres	-0.4 (-2.1, 1.3)	<b>-0.07 (-0.1, -0.04)</b>	<b>-2.5 (-4.6, -0.4)</b>	0.002 (-0.06, 0.06)	<b>-3.0 (-5.7, -0.2)</b>	-0.007 (-0.1, 0.0001)
Excluding Manufacturers with <0.5M Litres	-0.5 (-2.1, 1.2)	<b>-0.07 (-0.1, -0.04)</b>	<b>-2.5 (-4.7, -0.4)</b>	0.003 (-0.06, 0.06)	<b>-3.0 (-5.7, -0.2)</b>	-0.007 (-0.1, 0.0001)

**Bold** indicates a significant difference at the 95% confidence interval level.

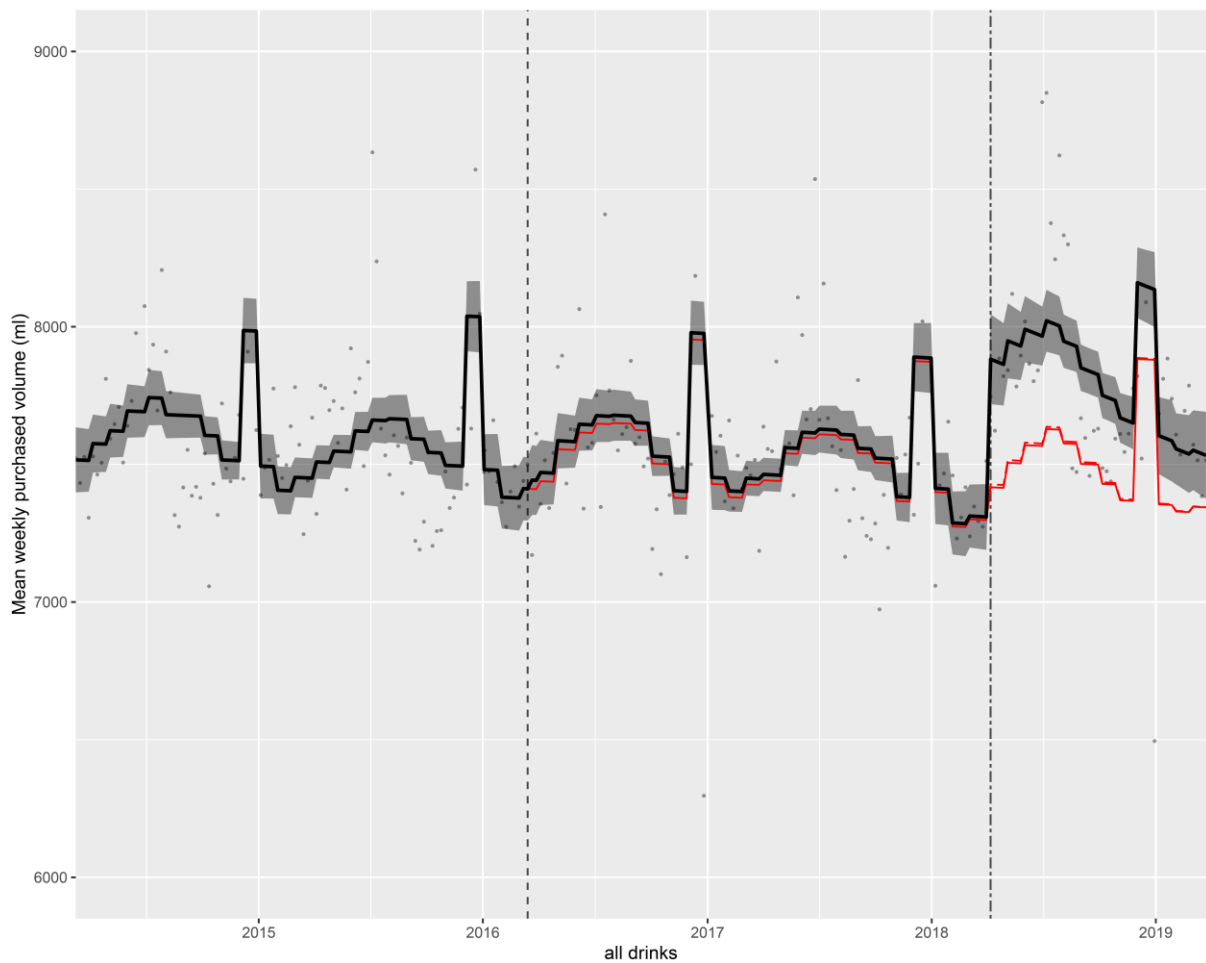


Supplementary Table 4b: Modelled absolute and relative change in volume of, and sugar in, all drinks (ml) purchased per household (95% CI) per week in relation to the UK SDIL, March 2014- March 2019; excluding small manufacturers (weighted)

	Analysis 1: pre-post announcement (March 2014 – March 2018)		Analysis 2: pre-post implementation (March 2016 – March 2019)		Analysis 3: pre-post announcement & implementation (March 2014 – March 2019)	
	Absolute change (ml)	Relative change (%)	Absolute change (ml)	Relative change (%)	Absolute change (ml)	Relative change (%)
<i>Volume</i>						
<i>High tier (≥8g sugar per 100ml)</i>						
All Manufacturers	<b>34.7 (8.1, 61.4)</b>	<b>7.3 (1.7, 12.9)</b>	<b>-171.6 (-208.1, -135.1)</b>	<b>-42.5 (-51.6, -33.5)</b>	<b>-140.8 (-177.3, -104.3)</b>	<b>-37.8 (-47.6, -28.0)</b>
Excluding Manufacturers with <1M Litres	<b>35.3 (8.9, 61.6)</b>	<b>7.5 (1.9, 13.1)</b>	<b>-168.1 (-204.2, -131.9)</b>	<b>-42.6 (-51.7, -33.4)</b>	<b>-136.2 (-172.3, -100.1)</b>	<b>-37.6 (-47.5, -27.6)</b>
Excluding Manufacturers with <0.5M Litres	<b>35.3 (8.9, 61.6)</b>	<b>7.5 (1.9, 13.1)</b>	<b>-168.1 (-204.2, -131.9)</b>	<b>-42.6 (-51.7, -33.4)</b>	<b>-136.2 (-172.3, -100.1)</b>	<b>-37.6 (-47.5, -27.6)</b>
<i>Low tier (≥5g - &lt;8g sugar per 100ml)</i>						
All Manufacturers	<b>-65.7 (-77.5, -53.8)</b>	<b>-37.1 (-43.7, -30.4)</b>	<b>-71.8 (-87.8, -55.8)</b>	<b>-71.8 (-87.8, -55.8)</b>	<b>-170.5 (-186.5, -154.5)</b>	<b>-85.8 (-93.9, -77.8)</b>
Excluding Manufacturers with <1M Litres	<b>-66.4 (-78.2, -54.6)</b>	<b>-37.6 (-44.3, -30.9)</b>	<b>-71.2 (-87.1, -55.3)</b>	<b>-72.5 (-88.7, -56.3)</b>	<b>-171.1 (-187.0, -155.2)</b>	<b>-86.4 (-94.4, -78.4)</b>
Excluding Manufacturers with <0.5M Litres	<b>-66.5 (-78.2, -54.7)</b>	<b>-37.6 (-44.2, -31.0)</b>	<b>-71.3 (-87.1, -55.5)</b>	<b>-72.4 (-88.5, -56.3)</b>	<b>-171.2 (-187.1, -155.4)</b>	<b>-86.3 (-94.3, -78.3)</b>
<i>Sugar</i>						
<i>High tier (≥8g sugar per 100ml)</i>						
All Manufacturers	<b>5.5 (3.8, 7.3)</b>	<b>10.8 (7.4, 14.1)</b>	<b>-21.2 (-23.8, -18.5)</b>	<b>-49.3 (-55.4, -43.1)</b>	<b>-16.2 (-18.8, -13.5)</b>	<b>-42.6 (-49.6, -35.6)</b>
Excluding Manufacturers with <1M Litres	<b>4.7 (1.7, 7.7)</b>	<b>9.3 (3.4, 15.1)</b>	<b>-19.3 (-23.4, -15.2)</b>	<b>-44.3 (-53.6, -35.0)</b>	<b>-14.6 (-18.7, -10.6)</b>	<b>-37.6 (-48.1, -27.1)</b>
Excluding Manufacturers with <0.5M Litres	<b>4.7 (1.7, 7.7)</b>	<b>9.3 (3.4, 15.1)</b>	<b>-19.3 (-23.4, -15.2)</b>	<b>-44.3 (-53.6, -35.0)</b>	<b>-14.6 (-18.7, -10.6)</b>	<b>-37.6 (-48.1, -27.1)</b>
<i>Low tier (≥5g - &lt;8g sugar per 100ml)</i>						
All Manufacturers	<b>-4.3 (-6.1, -2.6)</b>	<b>-37.5 (-52.5, -22.5)</b>	<b>-5.0 (-7.4, -2.6)</b>	<b>-75.8 (-112.7, -38.9)</b>	<b>-11.5 (-13.9, -9.07)</b>	<b>-87.8 (-106.4, -69.2)</b>
Excluding Manufacturers with <1M Litres	<b>-4.7 (-5.5, -3.8)</b>	<b>-39.1 (-46.5, -31.7)</b>	<b>-4.8 (-6.0, -3.6)</b>	<b>-73.0 (-91.3, -54.7)</b>	<b>-11.8 (-13.0, -10.6)</b>	<b>-86.9 (-95.8, -78.1)</b>
Excluding Manufacturers with <0.5M Litres	<b>-4.7 (-5.6, -3.8)</b>	<b>-39.1 (-46.5, -31.8)</b>	<b>-4.8 (-6.0, -3.6)</b>	<b>-72.9 (-91.1, -54.6)</b>	<b>-11.8 (-13.0, -10.6)</b>	<b>-86.9 (-95.7, -78.0)</b>

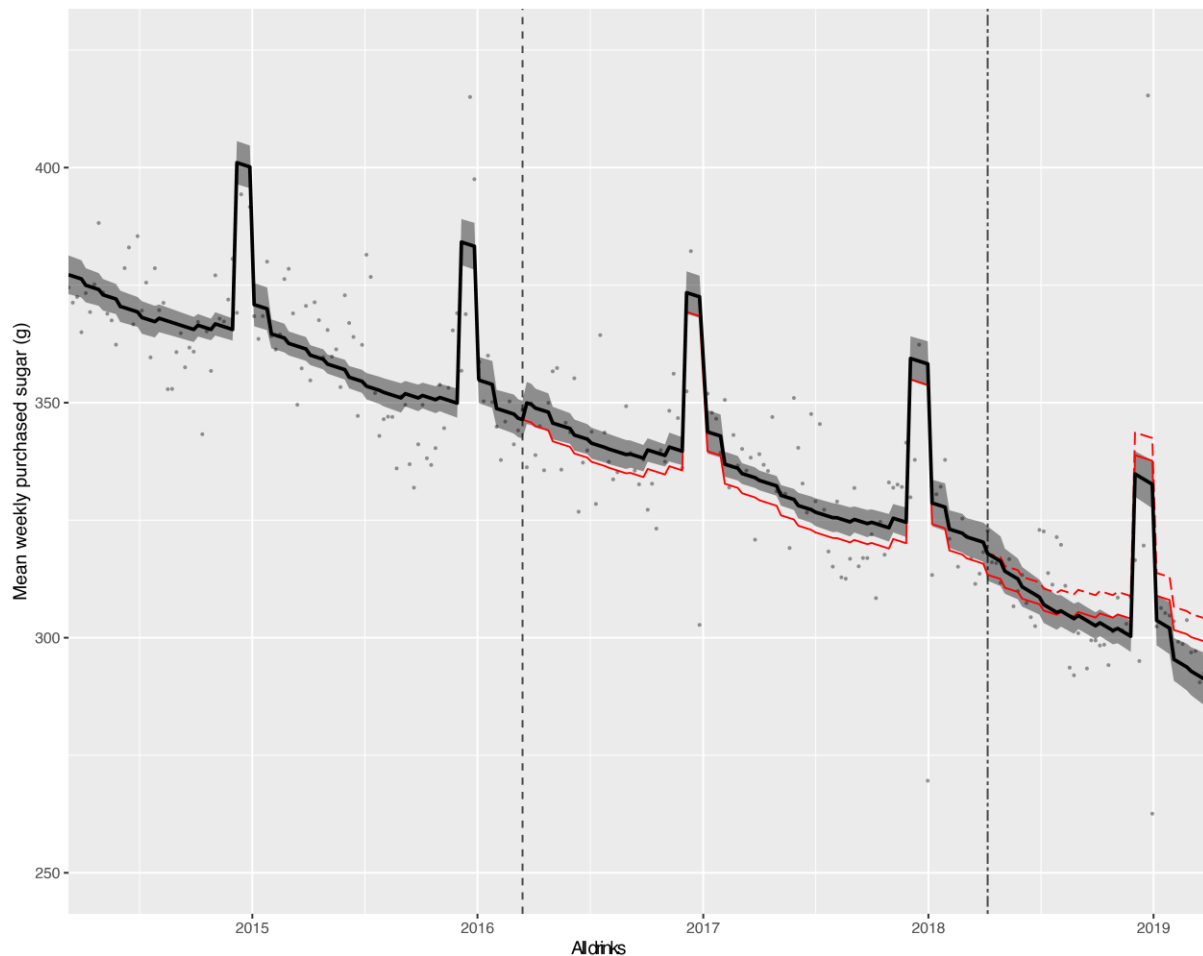
**Bold** indicates a significant difference at the 95% confidence interval level.

Supplementary Figure 2a. Observed and modelled volume (ml) in all soft drinks combined purchased per household per week, March 2014- March 2019 (weighted)



Notes. Points are observed data, black lines (with shadows) are modelled data (with 95% confidence intervals); red lines indicate the counterfactuals had the announcement (red solid line) and implementation (red dashed line) not happened; the first dashed vertical line indicates the point of announcement; the second dashed vertical line indicates the point of implementation; modelled purchases include averaged effects for seasonality and the impact of December and January (the Christmas period). The control category of toiletries is shown in Fig 3.

Supplementary Figure 2b. Observed and modelled amount of sugar (g) in all soft drinks combined purchased per household per week, March 2014- March 2019 (weighted)



Notes. Points are observed data, black lines (with shadows) are modelled data (with 95% confidence intervals); red lines indicate the counterfactuals had the announcement (red solid line) and implementation (red dashed line) not happened; the first dashed vertical line indicates the point of announcement; the second dashed vertical line indicates the point of implementation; modelled purchases include averaged effects for seasonality and the impact of December and January (the Christmas period). The control category of toiletries is shown in Fig 3.

**Supplementary material G**

Removing the control category led to wider confidence intervals in a small number of cases such that absolute and relative changes in volume were not significantly different from the pre-implementation counterfactuals for no levy drinks and the pre-announcement and post implementation counterfactual for drinks containing 0g of sugar per 100ml. Significantly lower volumes of purchased volumes of powdered drinks were seen following the announcement in the controlled analysis unlike in the uncontrolled analysis. In the uncontrolled analysis absolute and relative differences in the amount of sugar in milk based drinks were significantly different from the pre-implementation counterfactual but not significantly different when examining the impact of the SDIL overall. Additionally the amount of sugar in confectionery was not significantly different from the pre-announcement counterfactual in the uncontrolled ITS analysis unlike in the controlled analysis.

Supplementary Table 5a: Level and trend changes in volume of drinks (ml) and confectionery (g) purchased per household per week (95% CI) in relation to the UK SDIL, March 2014 - March 2019 without toiletries as a control condition (weighted)

	Analysis 1: pre-post announcement (March 2014 – March 2018)		Analysis 2: pre-post implementation (March 2016 – March 2019)		Analysis 3: pre-post announcement & implementation (March 2014 – March 2019)	
	Level Change	Trend Change	Level Change	Trend Change	Level Change	Trend Change
<i>Levy liable drinks</i>						
High tier (≥8g sugar per 100ml)	42.3 (-9.4, 94.0)	-0.07 (-0.9, 0.8)	<b>-111.2 (-177.1, -45.3)</b>	-1.2 (-3.0, 0.7)	-68.9 (-152.7, 14.9)	-1.3 (-3.3, 0.8)
Low tier (≥5g - <8g sugar per 100ml)	-2.2 (-24.1, 19.8)	<b>-0.6 (-1.0, -0.2)</b>	-18.9 (-45.8, 8.0)	-1.0 (1.9, -0.2)	-21.1 (-55.75, 13.6)	<b>-1.7 (-2.6, -0.7)</b>
No levy (<5g sugar per 100ml)	-29.8 (-150.9, 91.3)	<b>2.0 (0.08, 4.0)</b>	<b>378.1 (223.7, 532.5)</b>	<b>0.3 (0.5, 2.0)</b>	<b>348.3 (152.0, 544.6)</b>	2.4 (-2.4, 7.2)
>0g to <5g sugar per 100ml	-27.9 (-78.3, 22.5)	<b>1.3 (0.5, 2.0)</b>	<b>98.0 (32.7, 163.3)</b>	<b>2.1 (0.3, 3.9)</b>	70.1 (-12.4, 152.6)	<b>3.4 (1.4, 5.4)</b>
0g sugar per 100ml	-2.0 (-75.5, 71.5)	0.8 (-0.4, 2.0)	<b>278.9 (185.6, 372.2)</b>	-1.7 (-4.4, 1.0)	<b>276.9 (158.2, 395.7)</b>	-0.9 (-3.9, 2.0)
Bottled water	9.9 (-49.1, 68.9)	-0.4 (-1.4, 0.6)	53.5 (-20.8, 127.8)	-2.6 (-4.7, 0.4)	63.4 (-31.5, 158.2)	<b>-2.9 (-5.3, -0.6)</b>
<i>Levy exempt drinks</i>						
Alcoholic drinks	-13.3 (-51.0, 24.4)	-0.03 (-0.4, 0.4)	<b>212.7 (142.5, 282.9)</b>	<b>-5.8 (-7.9, -3.8)</b>	<b>199.4 (119.8, 279.1)</b>	<b>-5.9 (-8.0, -3.8)</b>
Milk and milk based drinks*	26.0 (-35.7, 87.7)	<b>-1.1 (-2.0, -0.09)</b>	75.7 (-4.5, 155.9)	0.6 (-1.6, 2.8)	<b>101.7 (0.52, 202.9)</b>	-0.5 (-2.9, 2.0)
No added sugar fruit juices	-9.9 (-35.0, 15.2)	0.2 (-0.3, 0.6)	<b>40.9 (10.1, 71.7)</b>	-0.9 (-1.9, 0.02)	31.0 (-8.73, 70.7)	-0.8 (-1.8, 0.3)
Drinks sold as powders (g)	-3.4 (-9.01, 2.20)	-0.03 (-0.1, 0.06)	5.66 (-1.6, 12.9)	0.07 (-0.1, 0.3)	2.25 (-6.90, 11.4)	0.04 (-0.2, 0.3)
<i>Other categories</i>						
Confectionery (g)	-20.5 (-90.8, 49.8)	0.7 (-1.3, 1.5)	-70.6 (-155.8, 14.6)	<b>2.2 (0.7, 3.7)</b>	-91.1 (-201.5, 19.3)	2.3 (-2.2, 6.8)

**Bold** indicates a significant difference at the 95% confidence interval level.

\*Milk comprises drinks in the following categories: semi-skimmed; specific low fat % milk (e.g. 1% fat milk); whole milk; buttermilk; modified milk; other milk; other non-cows milk; rice drink; soya milk. Skimmed milk is excluded from all analysis in this paper due to missing data.

Supplementary Table 5b: Level and trend changes in sugar in drinks and confectionery (g) purchased per household per week (95% CI) in relation to the UK SDIL, March 2014 - March 2019 without toiletries as a control condition (weighted)

	Analysis 1: pre-post announcement (March 2014 – March 2018)		Analysis 2: pre-post implementation (March 2016 – March 2019)		Analysis 3: pre-post announcement & implementation (March 2014 – March 2019)	
	Level Change	Trend Change	Level Change	Trend Change	Level Change	Trend Change
<i>Levy liable drinks</i>						
High tier (≥8g sugar per 100ml)	4.8 (-1.0, 10.6)	-0.008 (-0.1, 0.09)	<b>-12.1 (-19.5, -4.8)</b>	-0.2 (-0.4, 0.06)	-7.3 (-16.6, 2.0)	-0.2 (-0.4, 0.07)
Low tier (≥5g - <8g sugar per 100ml)	-0.2 (-1.7, 1.2)	<b>-0.4 (-0.5, -0.4)</b>	-1.2 (-2.9, 0.6)	<b>-0.07 (-0.1, -0.01)</b>	-1.4 (-3.7, 0.9)	<b>-0.5 (-0.6, -0.5)</b>
No levy (<5g sugar per 100ml)	1.7 (-0.2, 3.3)	<b>0.07 (0.04, 0.1)</b>	<b>5.2 (3.2, 7.2)</b>	<b>0.08 (0.02, 0.1)</b>	<b>6.9 (4.4, 9.5)</b>	<b>0.2 (0.09, 0.2)</b>
>0g to <5g sugar per 100ml	1.7 (-0.2, 3.3)	<b>0.07 (0.04, 0.1)</b>	<b>5.2 (3.2, 7.2)</b>	<b>0.08 (0.02, 0.1)</b>	<b>6.9 (4.4, 9.5)</b>	<b>0.2 (0.09, 0.2)</b>
<i>Levy exempt drinks</i>						
Milk and milk based drinks*	2.4 (-0.6, 5.3)	<b>-0.06 (-0.1, -0.02)</b>	3.7 (-0.1, 7.5)	0.01 (-0.10, 0.1)	<b>6.1 (1.3, 10.9)</b>	-0.05 (-0.2, 0.06)
No added sugar fruit juices	-1.1 (-3.5, 1.4)	0.03 (-0.03, 0.07)	<b>3.3 (0.3, 6.3)</b>	<b>-0.10 (-0.2, -0.01)</b>	2.3 (-1.6, 6.1)	-0.07 (-0.2, 0.03)
Drinks sold as powders	-1.0 (-3.1, 1.1)	0.01 (-0.02, 0.05)	0.4 (-2.2, 3.0)	-0.01 (-0.1, 0.07)	-0.6 (-3.9, 2.7)	0.001 (-0.09, 0.09)
<i>Other categories</i>						
Confectionery	-11.7 (-51.5, 28.1)	0.05 (-0.8, 0.9)	-42.6 (-90.8, 5.6)	1.3 (-0.4, 3.0)	-54.3 (-116.8, 8.2)	1.3 (-0.5, 3.2)

**Bold** indicates a significant difference at the 95% confidence interval level.

\*Milk comprises drinks in the following categories: semi-skimmed; specific low fat % milk (e.g. 1% fat milk); whole milk; buttermilk; modified milk; other milk; other non-cows milk; rice drink; soya milk. Skimmed milk is excluded from all analysis in this paper due to missing data.

Supplementary Table 5c: Absolute and relative changes in volume of drinks (ml) and confectionery (g) purchased per household per week (95% CI) in relation to the UK SDIL, March 2014 - March 2019 without toiletries as a control condition (weighted)

	Analysis 1: pre-post announcement (March 2014 – March 2018)		Analysis 2: pre-post implementation (March 2016 – March 2019)		Analysis 3: pre-post announcement & implementation (March 2014 – March 2019)	
	Absolute change (ml or g)	Relative change (%)	Absolute change (ml or g)	Relative change (%)	Absolute change (ml or g)	Relative change (%)
<i>Levy liable drinks</i>						
High tier (≥8g sugar per 100ml)	34.4 (-4.5, 73.3)	7.3 (-1.0, 15.6)	<b>-171.6 (-223.1, -120.0)</b>	<b>-42.5 (-55.3, -29.7)</b>	<b>-140.9 (-192.5, -89.4)</b>	<b>-37.8 (-51.6, -24.0)</b>
Low tier (≥5g - <8g sugar per 100ml)	<b>-68.3 (-85.7, -50.9)</b>	<b>-38.2 (-47.9, -28.4)</b>	<b>-71.4 (-94.1, -48.7)</b>	<b>-71.5 (-94.2, -48.8)</b>	<b>-171.3 (-193.9, -148.6)</b>	<b>-85.8 (-97.1, -74.4)</b>
No levy (<5g sugar per 100ml)	<b>187.1 (95.7, 278.5)</b>	<b>11.5 (5.9, 17.1)</b>	<b>395.0 (273.9, 516.0)</b>	<b>19.8 (13.7, 25.9)</b>	<b>685.5 (564.4, 806.5)</b>	<b>40.2 (33.1, 47.3)</b>
>0g to <5g sugar per 100ml	<b>106.4 (68.7, 144.2)</b>	<b>17.2 (11.1, 23.3)</b>	<b>205.9 (155.5, 256.3)</b>	<b>25.6 (19.3, 31.8)</b>	<b>374.6 (326.0, 426.8)</b>	<b>59.3 (51.4, 67.2)</b>
0g sugar per 100ml	<b>80.7 (25.1, 136.4)</b>	<b>8.0 (2.5, 13.5)</b>	<b>191.9 (118.2, 265.5)</b>	<b>16.1 (9.9, 22.3)</b>	<b>312.0 (238.4, 385.6)</b>	<b>29.1 (22.3, 36.0)</b>
Bottled water	<b>-31.3 (-76.3, 13.7)</b>	<b>-4.4 (-10.6, 1.91)</b>	<b>-76.9 (-136.6, -17.2)</b>	<b>-9.89 (-17.6, -2.2)</b>	<b>-127.8 (-187.6, -68.1)</b>	<b>-15.4 (-22.6, -8.2)</b>
<i>Levy exempt drinks</i>						
Alcoholic drinks	-16.6 (-62.2, 28.9)	1.0 (-3.6, 1.7)	<b>-84.9 (-155.8, -14.0)</b>	<b>-4.81 (-8.8, -0.8)</b>	<b>-103.1 (-174.0, -32.2)</b>	<b>-5.8 (-9.8, -1.8)</b>
Milk and milk based drinks*	<b>-85.9 (-39.6, 132.2)</b>	<b>-2.3 (-3.6, -1.1)</b>	<b>106.4 (44.5, 168.3)</b>	<b>3.03 (1.3, 4.8)</b>	-32.8 (-94.6, 29.1)	-0.9 (-2.6, 0.8)
No added sugar fruit juices	5.9 (-13.9, 25.8)	1.2 (-2.9, 5.4)	-6.56 (-32.7, 19.6)	-1.33 (-6.6, 4.0)	6.95 (-19.2, 33.1)	1.5 (-4.0, 6.9)
Drinks sold as powders (g)	<b>-6.8 (-11.0, -2.57)</b>	<b>-6.8 (-10.9, -2.6)</b>	<b>9.3 (3.7, 14.9)</b>	<b>10.8 (4.3, 17.4)</b>	0.89 (-4.7, 6.5)	1.0 (-5.0, 6.9)
<i>Other categories</i>						
Confectionery (g)	-9.5 (-72.7, 53.7)	-2.3 (-17.7, 13.0)	40.6 (-42.1, 123.2)	11.9 (-12.3, 36.0)	36.3 (-46.4, 118.9)	10.5 (-13.4, 34.3)

**Bold** indicates a significant difference at the 95% confidence interval level.

\*Milk comprises drinks in the following categories: semi-skimmed; specific low fat % milk (e.g. 1% fat milk); whole milk; buttermilk; modified milk; other milk; other non-cows milk; rice drink; soya milk. Skimmed milk is excluded from all analysis in this paper due to missing data.



Supplementary Table 5d: Absolute and relative changes in sugar in drinks and confectionery (g) purchased per household per week (95% CI) in relation to the UK SDIL, March 2014 - March 2019 without toiletries as a control condition (weighted)

	Analysis 1: pre-post announcement (March 2014 – March 2018)		Analysis 2: pre-post implementation (March 2016 – March 2019)		Analysis 3: pre-post announcement & implementation (March 2014 – March 2019)	
	Level Change	Trend Change	Level Change	Trend Change	Level Change	Trend Change
<i>Levy liable drinks</i>						
High tier (≥8g sugar per 100ml)	3.9 (-0.4, 8.3)	7.6 (-0.78, 15.9)	<b>-19.6 (-25.3, -13.8)</b>	<b>-43.8 (-56.6, -30.9)</b>	<b>-16.1 (-21.8, -10.3)</b>	<b>-39.0 (-52.9, -25.0)</b>
Low tier (≥5g - <8g sugar per 100ml)	<b>-4.9 (-6.1, -3.8)</b>	<b>-40.3 (-49.6, -30.9)</b>	<b>-4.7 (-6.2, -3.2)</b>	<b>-70.9 (-93.3, -48.4)</b>	<b>-11.9 (-13.4, -10.4)</b>	<b>-86.0 (-96.8, -75.2)</b>
No levy (<5g sugar per 100ml)	<b>6.1 (4.9, 7.3)</b>	<b>77.7 (62.6, 92.8)</b>	<b>9.3 (7.8, 10.9)</b>	<b>52.5 (43.6, 61.4)</b>	<b>19.2 (17.6, 20.8)</b>	<b>240.9 (221.0, 260.8)</b>
>0g to <5g sugar per 100ml						
<i>Levy exempt drinks</i>						
Milk and milk based drinks*	<b>-4.2 (-6.4, -2.0)</b>	<b>-2.3 (-3.6, -1.1)</b>	<b>4.1 (1.1, 7.0)</b>	<b>2.4 (0.7, 4.2)</b>	<b>-3.2 (-6.5, -0.3)</b>	<b>-1.8 (-3.5, -0.1)</b>
No added sugar fruit juices	<b>2.6 (0.7, 4.6)</b>	<b>5.9 (1.5, 10.2)</b>	-1.8 (-4.3, 0.8)	-3.7 (-9.1, 1.6)	<b>2.6 (0.04, 5.2)</b>	<b>5.9 (0.08, 11.8)</b>
Drinks sold as powders (g)	0.4 (-1.2, 2.1)	2.1 (-5.9, 10.0)	-0.3 (-2.4, 1.9)	-1.3 (-12.5, 10.0)	0.9 (-1.3, 3.0)	4.7 (-7.2, 16.7)
<i>Other categories</i>						
Confectionery (g)	-5.9 (-42.0, 30.1)	-2.6 (-18.1, 13.0)	23.4 (-24.0, 70.7)	12.1 (-12.4, 36.7)	20.2 (-27.1, 67.6)	10.3 (-13.9, 34.5)

**Bold** indicates a significant difference at the 95% confidence interval level.

\*Milk comprises drinks in the following categories: semi-skimmed; specific low fat % milk (e.g. 1% fat milk); whole milk; buttermilk; modified milk; other milk; other non-cows milk; rice drink; soya milk. Skimmed milk is excluded from all analysis in this paper due to missing data.