Landman Economics

Estimating excess industry revenues from high-risk consumption in the tobacco, alcohol and food sectors

Howard Reed, Landman Economics

June 2023

Acknowledgements

The author would like to participants in a roundtable seminar discussion in February 2023 for their comments on draft versions of the results.

The data from Understanding Society and the National Diet and Nutrition Survey used in this report were made available through the UK Data Archive.

This research was funded by Cancer Research UK (Grant PICADV-Feb22\100004).

Contents

1 Introduction 3
2 Data 4
2.1 Survey datasets 4
2.1.1 The National Diet and Nutrition Survey 4
2.1.2 The Living Costs and Food Survey 4
2.2 Aggregate spending data 5
3 Methodology 6
3.1 Modelling high-risk expenditure for each project group 6
3.1.1 Tobacco 6
3.1.2 Alcohol 6
3.1.3 Food 7
3.2 Aggregate expenditure on high-risk consumption 8
3.2.1 Total consumption expenditure on tobacco, alcohol and food 8
3.2.2 Estimating aggregate high-risk food expenditure (gross and net of tax) . 9
3.3 Analysis of patterns of high-risk consumption 10
3.4 Limitations of the methodology 11
4 High-risk consumption in the National Diet and Nutrition Survey 12
4.1 The proportion of consumers engaging in high-risk consumption 12
4.2 Analysis of high-risk food consumption by guideline category 13
4.3 Regression analysis of characteristics associated with high-risk consumption 14
4.4 High-risk consumption as proportion of total consumption for each product category 23
4.5 Correlation between high-risk consumption for different product categories 23
5 Results: Aggregate high-risk expenditure on tobacco, alcohol and food 24
5.1 Aggregate pre-tax expenditure 24
5.2 Aggregate high-risk consumption 24
6 Conclusions 26
Appendix A: Patterns of spending on alcohol and food – comparison of the 2019/20 and 2020/21 LCFS 27
Appendix B: Survey evidence on the incidence of excess weight (obesity and overweight) by age group in England and comparison with the National Diet and Nutrition Survey 28
Bibliography 31

1 Introduction

This research report is a part of the wider cross-risk-factor project and is designed to support the project narrative by using survey-based microdata and government guidelines on the consumption of tobacco, alcohol and various foods to quantify how much consumers are spending on products that exceed the recommended level of consumption. The research aims to answer the question: to what extent do the alcohol, tobacco and food industries benefit from excess revenues received from high-risk consumption of these commodities? Conversely, if everyone in the UK consumed these commodities only up to the recommended level (zero in the case of tobacco, within government guidelines in the case of alcohol and foods), how much would industry lose and how much would households gain?

The aim of this research is to quantify how much consumers are spending on tobacco, alcohol and food products that exceed recommended levels of consumption (described as “high-risk” consumption in this report) and what percentage of revenues (net of tax) in the tobacco, alcohol and food production industries is due to high-risk consumption. The empirical methodology for estimating the extent of high-risk consumption is different for each of the product groups, although the methodologies set out here are designed to be as comparable as possible between the three product groups.

The structure of this report is as follows. Section 2 outlines the two survey datasets used for the analysis – the National Diet and Nutrition Survey (NDNS) and the Living Costs and Food Survey (LCFS), and also introduces the Office for National Statistics’ *Consumer Trends* data which is used as the main source of data on household expenditure. Section 3 explains the methodology used to model high-risk consumption of tobacco, alcohol and food products. The results from the analysis are presented in two sections. Section 4 presents estimates from the NDNS for the proportion of individuals who are engaged in high-risk consumption of tobacco, alcohol and food and the proportion of overall expenditure on each product category which is high-risk. This section also contains a more detailed assessment of the patterns of high-risk consumption according to the characteristics of people in the NDNS (e.g. age group, gender, ethnicity, household income and deprivation). Section 5 presents estimates of aggregate high-risk expenditure on tobacco, alcohol and food, showing the extent to which the alcohol, tobacco and food industries benefit from excess revenues received from high-risk consumption. Section 6 offers conclusions.

2 Data

2.1 Survey datasets

Several UK survey datasets contain information on consumption of tobacco, alcohol and food (or some subset of these). This report uses two survey datasets as detailed below.

2.1.1 The National Diet and Nutrition Survey

The National Diet and Nutrition Survey (NDNS) is a cross-sectional survey with a continuous programme of fieldwork, designed to assess the diet, nutrient intake and nutritional status of the general population aged 1.5 years and over living in private households in the UK (NatCen Social Research, 2022). The NDNS provides the only source of nationally representative data on the types and quantities of foods consumed by individuals, from which estimates of nutrient intake for the population are derived. Results are used by government to monitor progress toward diet and nutrition objectives of UK Health Departments and develop policy interventions.

This report uses Years 9, 10 and 11 of the NDNS (data collected in the 2016/17, 2017/18 and 2018/19 tax years) to model high-risk consumption on tobacco, alcohol and food. The details of the variables used and the empirical approach are outlined in Section 3 (Methodology) below.

The overall NDNS dataset for Years 9-11 contains 3,558 individuals. The analysis of food consumption in this report uses 3,150 individuals (those aged 4 and over) and the tobacco and alcohol analyses use 2,084 individuals (those aged 16 and over). We exclude children aged under 4 from the food analysis because the govt does not publish recommended figures for dietary intake for under-4s. We exclude children aged under 16 from the tobacco and alcohol analyses because the NDNS does not collect data on tobacco and alcohol consumption for children aged under 16.

2.1.2 The Living Costs and Food Survey

The Living Costs and Food Survey (LCFS) is a household survey which contains detailed information on spending on cigarettes, handrolling tobacco and other tobacco products, alcoholic drinks by category (e.g. beer, cider, wine, spirits) and a wide range of different food categories.

This report uses the LCFS data for 2019/20 financial year. Although the data for 2020/21 are the most recent data publicly available, consumption patterns in

2020/21 were significantly affected by the Covid-19 pandemic (as outlined in Appendix A of this report) and 2019/20 is likely to be a more typical pattern of expenditure, particularly with respect to the balance between expenditure on food and alcohol for home consumption and consumption in restaurants, bars, pubs etc. The 2021/22 LCFS data had not yet been released at the time of writing this report.

The 2019/20 LCFS dataset has a sample size of 5,438 households.

2.2 Aggregate spending data

For data on aggregate spending, this report uses the Office for National Statistics' *Consumer Trends* dataset (ONS, 2023). The Consumer Trends dataset presents household final consumption expenditure (HHFCE) for the UK, including all spending on goods and services by members of UK households. This report uses the *Consumer Trends* data for 2022. For tobacco and food this provides a comprehensive measure of aggregate final expenditure on these products at market prices (i.e. including VAT and excise duties where levied). For alcohol, the *Consumer Trends* measure includes only spending on alcoholic drinks purchased from supermarkets or off-licences to be consumed at home. It does not include spending on alcoholic drinks purchased at licensed premises such as pubs, bars, clubs, restaurants and hotels for consumption on the premises. The *Consumer Trends* dataset includes estimates for overall expenditure at restaurants, hotels and other premises, which includes a subcategory of expenditure at "restaurants, cafes etc"[1]. According to the notes accompanying the dataset, this measure "includes alcoholic beverages sold for immediate consumption away from the home by hotels, restaurants, cafes, bars, kiosks, street vendors, automatic vending machines etc" (ONS 2023, note 3).

This report includes an estimate of spending on alcoholic drinks purchased at licensed premises ("on-trade" spending) which is derived from an analysis of the LCFS data on on-trade spending, combined with the *Consumer Trends* hotels and restaurants spending estimate (using a methodology described in detail in Section 3 below). This is added to the *Consumer Trends* statistic for spending on alcoholic drinks purchased from supermarkets or off-licences ("off-trade" spending) to produce a total estimate for spending on alcohol.

[1] This measure has COICOP identifier code 11.1.1 and CDID identifier code ADXO.

3 Methodology

3.1 Modelling high-risk expenditure for each project group

3.1.1 Tobacco

Tobacco is the most straightforward of the three product categories to model because the Government agrees that *any* tobacco consumption above zero is harmful, and hence any consumption of tobacco is high-risk.

The NDNS data records number of cigarettes smoked per week (the *cigdya* variable) – this variable is used as the measure of smoking in the population in this dataset[2].

3.1.2 Alcohol

Modelling high-risk consumption of alcohol is more difficult than for tobacco because recommended consumption for adults is not zero. Instead, the Chief Medical Officers for the UK recommend maximum consumption of 14 units of alcohol per adult per week (Department of Health *et al,* 2016). Specifically, the guidelines state "if you regularly drink as much as 14 units per week, it is best to spread your drinking evenly over 3 or more days". However, we were not able to account for the distribution of drinking across the week as part of our analysis due to limitations in the NDNS data as described in the next paragraph.

The NDNS data contain information on the number of grams of alcohol which survey respondents drink per day (averaged over the diary period in the survey, which is three or four days). One unit of alcohol is equal to 8 grams. Dividing the consumption guideline of 14 units by 7 and multiplying by 8 gives an average daily consumption limit of 16 grams of alcohol. We define high-risk consumption of alcohol as any average daily intake above 16 grams. So, for example, if an adult in the NDNS reports drinking 25 grams of alcohol per day, their high risk consumption in grams is equal to

$$a_i^H = \max\left((a_i - a_i^L), 0\right),$$

where a_i is the individual's total daily alcohol consumption (25 grams in this example) and a_i^L is recommended maximum daily consumption (16 grams for each individual). So in this example, high-risk consumption is equal to 9 grams.

[2] Survey datasets in the UK have a tendency to under-report the full extent of expenditure on tobacco. For example, as reported in Reed (2021) analysis of the Living Costs and Food Survey (LCFS) data for 2018/19 finds that grossed-up expenditure on tobacco in the LCFS is almost 3 times lower than the aggregate figure based on HMRC excise duty receipts. Because the analysis in this report uses data from the ONS *Consumer Trends* survey for aggregate tobacco expenditure, survey under-reporting of tobacco expenditure is less of a problem than in Reed (2021).

The total proportion of alcohol consumption across the population that is high-risk is then calculated as:

$$A^H = \frac{\sum_{i=1}^{N} a_i^H}{\sum_{i=1}^{N} a_i}$$

i.e. the sum of high-risk alcohol consumption across the population divided by the sum of total consumption across the population.

3.1.3 Food

Modelling high-risk expenditure on food is the most complex of the three product categories because there are a number of criteria according to which food can be "high-risk". The Public Health England publication *Government Dietary Recommendations* (PHE, 2016) gives recommendations for maximum daily intake of certain categories of food ingredient for children and adults including:

- Fat (including saturated fat, polyunsaturated fat and monounsaturated fat);
- Free sugars (comprising any sugars added to food or drinks such as biscuits, chocolate, breakfast cereals and fizzy drinks, plus sugar in honey, syrups, juices and smoothies);
- Salt.

Our definition of "high-risk" food consumption is consumption in excess of the guidelines set out in *Government Dietary Recommendations* across any of the three dietary components (1) saturated fats, (2) free sugars and (3) salt. The recommended amounts for each of these ingredients are shown in Table 3.1 below.

Table 3.1a. Recommended maximum daily amounts for dietary components by age group: males

Age group	Saturated fat (g)		Free sugars (g)		Salt (g)	
	Male	Female	Male	Female	Male	Female
1	n/a	n/a	n/a	n/a	2.0	2.0
2-3	n/a	n/a	15	13	2.0	2.0
4-6	18	17	20	18	3.0	3.0
7-10	22	21	24	23	5.0	5.0
11-14	31	24	33	27	6.0	6.0
15-18	31	24	33	27	6.0	6.0
19-64	31	24	33	27	6.0	6.0
65-74	29	23	31	26	6.0	6.0
75+	28	23	31	25	6.0	6.0

Source: PHE (2016)

As with alcohol above, the NDNS dataset provides information on the amount of saturated fat, free sugars and salt which each person in the survey consumes per day (based on an average over the diary response period of three or four days).

For each individual *i* aged 4 and over in the NDNS, the proportion of food consumption which is defined as high risk is calculated according to the following equation:

$$f_i^H = \frac{(f_i^{FS} + f_i^{SF} + f_i^{SL})}{3}$$

Where:

- $f_i^{FS} = \max(((c_i^{FS} - g_i^{FS})/g_i^{FS}), 0)$ is the proportion of consumption of free sugars c_i^{FS} in excess of recommended maximum daily amounts g_i^{FS} (if any)
- $f_i^{SF} = \max(((c_i^{SF} - g_i^{SF})/g_i^{SF}), 0)$ is the proportion of consumption of saturated fats c_i^{SF} in excess of recommended maximum daily amounts g_i^{SF} (if any)
- $f_i^{SL} = \max(((c_i^{SL} - g_i^{SL})/g_i^{SL}), 0)$ is the proportion of consumption of salt c_i^{SL} in excess of recommended maximum daily amounts g_i^{SL} (if any)

In other words, the measure of high-risk food consumption used in this report assigns an equal weighting to each dietary component.

To give a numerical example, suppose that a 35-year-old woman in the NDNS consumes 31 grams of saturated fat, 40 grams of free sugars and 4 grams of salt. Based on the figures in Table 3.1a, her proportion of high-risk consumption of saturated fat in excess of the recommended daily amounts is

((31-24)/24) = 0.292.

Her proportion of high-risk consumption of free sugars is

((40-27)/27) = 0.481.

Her proportion of high-risk consumption of salt is zero because she is consuming less than the recommended maximum daily salt consumption for her age group (which is 6 grams, from Table 3.1a).

Therefore f_i^H for this woman is equal to ((0.292 + 0.481 + 0) / 3) = 0.258.

The sum of total food consumption across the population that is high risk, f_i^H, is then calculated as the average of f_i^H across the whole population.

3.2 Aggregate expenditure on high-risk consumption

3.2.1 Total consumption expenditure on tobacco, alcohol and food

Where available, estimates of total consumption in each product category are taken directly from the ONS *Consumer Trends* data. Consumer Trends gives aggregate spending information for tobacco and food. For alcohol, a figure is given for expenditure on “off-trade” alcoholic drinks (alcohol consumed at home or in other

domestic situations). However, no separate estimate is given for “on-trade” alcohol (consumed at licensed premises such as pubs, bars and restaurants). The LCFS contains detailed information on spending on different types of alcoholic drink (e.g. beer, cider, wine, spirits etc) and distinguishes between purchases for home consumption from supermarkets/off-licences etc, and purchases at hospitality venues (pubs, bars, restaurants etc). Therefore, we estimate a figure for on-trade alcohol consumption using the *Consumer Trends* estimate for total off-trade alcohol expenditure on “restaurants, cafes etc” and then use the Living Costs and Food Survey data to calculate total on-trade spending as a proportion of total off-trade spending (grossed up across the survey) and then assuming that the ratio of on-trade to off-trade spending is the same for the UK in aggregate as in the LCFS.

3.2.2 Estimating aggregate high-risk food expenditure (gross and net of tax)

Expenditure inclusive of tax

Expenditure on each product category inclusive of tax is calculated by applying the estimated proportion of high-risk spending from the NDNS analysis using the definitions in Section 3.1 above to the total consumption expenditure totals as defined in Section 3.2.1. For tobacco the proportion of “high-risk” spending in total spending is 100% by definition. For alcohol and food it depends on the distribution of consumption across these categories.

Expenditure net of tax

Industry revenues from high-risk consumption of food, alcohol and tobacco are net of taxes. The ONS *Consumer Trends* data (as modified by our calculations to include on-trade alcohol spending) gives consumption *including* indirect taxes (VAT and excise duties where applicable). To estimate industry revenues for each consumption category, it is necessary to estimate total indirect tax payments for each category. This is done using different approaches for each product category:

- For **tobacco**, we combine the ONS Consumer Trends estimates for total tobacco spending with data from HMRC on total excise duties (HMRC 2023a), plus an estimate of total VAT payments on tobacco products based on estimated total non-illicit tobacco expenditure (HMRC 2022). This gives a figure for total indirect tax revenues which we subtract from total tobacco consumption to give consumption net of taxes.
- For **alcohol** we use data from HMRC (2023b) on total excise duty revenue for each category of alcoholic drink (beer, cider, wine and spirits) and combine this with an estimate of total VAT payments on alcoholic drinks to give a figure for total indirect tax revenues for alcohol. This is then subtracted from total

alcohol consumption expenditure (including the adjustment for on-trade spending as outlined in subsection 3.2.1 above) to give an estimate of alcohol consumption net of taxes.

- For **food**, most food bought for preparation and consumption at home, and most prepared food for takeaway consumption, is zero-rated for VAT purposes and so we assume that there is no tax payment on these foods. In contrast, most food bought for eat-in consumption at venues such as restaurants, pubs and cafes is standard-rated for VAT. Therefore we assume that one-sixth of expenditure on eat-in food is VAT[3] and subtract this from total food expenditure to give total post-tax expenditure. The proportion of food expenditure which is eat-in expenditure at restaurants, cafes etc is estimated using the Living Costs and Food Survey 2019/20 microdata[4].

Aggregate high-risk expenditure

The estimates from NDNS of the proportion of consumption of alcohol and food which is high-risk are combined with the estimates of aggregate post-tax spending on alcohol and food as outlined above, to give final estimates for total expenditure on high-risk food and alcohol. For tobacco, we assume by definition that 100% of expenditure is high-risk. This gives us an estimate of what proportion of industry revenues in the tobacco, alcohol and food sector is derived from high-risk consumption of these products.

3.3 Analysis of patterns of high-risk consumption

The aggregate figure for spending on high-risk tobacco, alcohol and food in the UK can be broken down according to individual and household attributes in the population to give a more detailed distributional profile of high-risk spending on these products. This is achieved using a regression-based approach with a logistic specification, where the dependent variable is a dummy for whether the individual is engaged in high-risk consumption and the explanatory variables are the following:

- Gender
- Age group

[3] Given that the standard rate of VAT is 20 per cent, The proportion of VAT in expenditure on eat-in food is calculated as (20%/120%) or one-sixth, i.e. the VAT element divided by the full price including VAT.

[4] We use 2019/20 instead of the more recent 2020/21 data because the 2020/21 data were affected by Covid-19 lockdowns and underestimate expenditure on meals out.

- Household demographics (e.g. number of children in the household (if any), number of adults, age of adults (working age/pensioner)
- Ethnicity
- Disability (dummy variable for limiting health condition)
- Tertile of household income
- Quintile of household deprivation (based on data from the Indices of Multiple Deprivation for each household in the NDNS)[5].

We also analyse the proportion of respondents in the NDNS who engage in high-risk consumption for each of the three product categories, as well as the proportion who are high-risk consumers for more than one product category simultaneously (e.g. high-risk alcohol consumers who are also high-risk food consumers). Finally, we look at the statistical correlation between high-risk spending in each product category.

3.4 Limitations of the methodology

The main limitation of the methodology used here is the assumption that the proportion of high-risk *expenditure* in each product category is the same as the proportion of high-risk *consumption* in each product category. For tobacco, this assumption does not matter, because of the assumption that all consumption is high-risk. However, for alcohol, the assumption implies that there is no systematic relationship between quantity of alcohol consumed and the unit price of alcohol, i.e. that people who drink in excess of the CMO's recommended limit spend the same amount on alcohol per unit as people who drink below the limit. There is evidence that this is not the case; for example Pryce, Hollingsworth and Walker (2019) find that "heavy drinkers… are more likely to substitute with cheaper products when the price of alcohol increases". This assumption may also be problematic for high-risk food. However, it is a consequence of data limitations. There is no UK survey dataset with information on both the quantity of high-risk consumption (in terms of units of alcohol or amount of saturated fats, free sugars and salt consumed over a given period of time) *and* the amount spent on alcohol and food. The LCFS has data on expenditure, and the NDNS has data on consumption, but not both together. This means that I am unable to model the relationship between quantity of high-risk consumption and amount spent on each product directly.

[5] The quintiles of the Index of Multiple Deprivation (IMD) used in this report are a combination of the IMDs for each of the four UK countries (England, Scotland, Wales and Northern Ireland).

4 High-risk consumption in the National Diet and Nutrition Survey

This section presents the results for the analysis of high-risk consumption of tobacco, alcohol and food in the NDNS.

4.1 The proportion of consumers engaging in high-risk consumption

Table 4.1 shows the estimates from NDNS for the proportion of people aged 16 and above in the survey who are engaging in high-risk consumption of tobacco, alcohol and food. For tobacco this is the proportion of people aged 16+ who report smoking any cigarettes or hand-rolling tobacco. For alcohol it is the proportion of people whose weekly consumption is above the recommended weekly number of units of alcohol (as explained in Section 3.1 above). For food it is the proportion of people whose consumption of at least one of (a) saturated fat, (b) free sugars or (c) salt is above the recommended maximum levels.

Table 4.1. Proportion of NDNS respondents aged 16 and over engaging in high risk consumption

Product Category	Proportion (%)
Tobacco	13.6
Alcohol	24.9
Food	85.6
Tobacco and alcohol	3.4
Alcohol and food	22.8
Tobacco and food	11.8
Tobacco, alcohol and food	3.2

Source: analysis of NDNS Waves 9-11

Table 4.1 shows that just under 14% of respondents aged 16 or over in the NDNS are smokers, while just under a quarter of respondents exceed the recommended limits for alcohol consumption, and over 85% of respondents exceed at least one of the recommended limits for high-risk food consumption.

The NDNS collects data on food consumption for children aged under 16. For children aged between 4 and 15, 95.1 per cent consume at high-risk levels (based on government guidelines for saturated fat, free sugars and/or salt consumption).

The second set of four rows in Table 4.1 show the proportion of NDNS respondents aged 16 or over who are engaged in high-risk consumption of more than one of the product groups simultaneously. The most common combination is high-risk alcohol

and high-risk food consumption (just under 23% of respondents), followed by tobacco and high-risk food (just under 12% of respondents). Only 3.4% of respondents engage in tobacco and high-risk alcohol consumption, and only 3.2% in all three high-risk product categories simultaneously.

4.2 Analysis of high-risk food consumption by guideline category

The statistic for high-risk food consumption presented in Table 4.1 above is a composite of three different risk indicators for food ingredients: saturated fat, free sugars and salt. Table 4.2 presents a more in-depth analysis of high-risk food consumption by looking at the proportion of consumers in the NDNS who are engaged in high-risk consumption on any of the individual indicators – both in isolation and in combination. The sample used here is children and adults aged 4 and older in the NDNS. As reported above, over 95 per cent of people in the sample exceed government guidelines for at least one of the three food indicators.

Table 4.2. Proportion of NDNS respondents aged 4 and over engaged in high-risk consumption of saturated fats, free sugars and salt

High-risk food category	Proportion (%)
Saturated fats	39.5
Free sugars	71.1
Salt	68.9
Saturated fats and free sugars	34.0
Saturated fats and salt	34.4
Free sugars and salt	54.0
Saturated fats, free sugars and salt	29.9

Source: analysis of NDNS Waves 9-11

Looking at the individual indicators, the most commonly exceeded indicator is free sugars, with more than 71% of sample members exceeding recommended levels of consumption. The figure for salt is slightly lower than this (just under 69%) and the figure for saturated fats is significantly lower, at 39.5%.

Looking at the indicators in combination, 54% of sample members exceed guidelines for free sugar and salt consumption simultaneously, 34% for saturated fats and free sugars, and just over 34% for saturated fats and salt. Just under 30 per cent of the sample exceed the recommended guidelines for all three indicators simultaneously.

4.3 Regression analysis of characteristics associated with high-risk consumption

This subsection presents the results from regression analysis of the characteristics associated with high-risk consumption of each of the three product categories (analysed separately). Because the dependent variable (high-risk consumption) is binary, the regressions use a logistic specification with the coefficients for each variable expressed as odds ratios. An odds ratio of more than 1 for an explanatory variable indicates that the variable is *positively* associated with high-risk consumption, whereas an odds ratio of less than 1 indicates that the variable is *negatively* associated with high-risk consumption.

There are a number of different explanatory variables featured in the regressions. Table 4.3 shows the dummy variables included in the regressions for each category of explanatory variable, and the base category in each case.

The coefficients from the logisitic regressions have been reported as marginal effects to make them easily interpretable as percentage impacts. So for example, in table 4.4 below:

- a coefficient of 0.0621 for the most deprived quintile in the tobacco consumption regression means that individuals in the most deprived quintile are just over 6 per cent more likely to consume tobacco than individuals in the base deprivation category (3rd quintile).
- A coefficient of -0.0804 for the 65-74 year old age group means that individuals aged 65 to 74 are just over 8 per cent less likely to consume tobacco than individuals in the base age category (45 to 54 year olds)

Table 4.3. Explanatory variables in the NDNS regressions

Characteristic	Dummy variables included	Base category
Gender	Female	Male
Age (years)	4-10* 11-15* 16-24 25-34 35-44 55-64 65-74 75+	45-54
Household composition: Number of adults	2 adults 3 or more adults	1 adult
Household composition: number of children	1 child 2 or more children	No children
Ethnicity:	Mixed Black Asian Other	White
Disability	Disabled (limiting long standing health condition)	Not disabled
Income tertile	Missing income information 2nd (middle) tertile 3rd (top) tertile	1st (lowest) tertile
Deprivation (Index of Multiple Deprivation) quintile	1st (most deprived) quintile 2nd quintile 4th quintile 5th (least deprived) quintile	3rd quintile

*sample members aged 4-15 are included in the high-risk food regression but not in the tobacco or alcohol regressions.

High-risk tobacco consumption

Table 4.4 presents the results from the logistic regression analysis of tobacco consumption (this is identical to high-risk tobacco consumption, as we assume that all tobacco consumption is high-risk). The sample here is all individuals aged 16 or older in the Wave 9-11 NDNS. Where the coefficient on an explanatory variable is statistically significant at the 5% level, the table row for that coefficient is shaded grey.

There is no statistically significant association between gender and tobacco consumption controlling for other factors. Compared to the base age category (45 to 54), individuals aged 65 and over are significantly less likely to smoke (around 8% less likely for 65-74 year olds, almost 22% less likely for those aged 75 and over). Individuals in households with 2 or more adults are significantly less likely to smoke than those in single-adult households (around 0.6% less likely for 2-adult

households, just over 7% less likely for 3-adult households). Black and asian individuals are significantly less likely to smoke than white individuals (around 17% less likely for black individuals, around 22.5% less likely for asian individuals). There is an income gradient, with people in the middle or top income tertiles significantly less likely to smoke than the base category (lowest income tertile). Individuals in the middle tertile are just over 6% less likely to smoke, and those in the top tertile almost 12% less likely to smoke, than those in the bottom tertile. There is also a deprivation gradient, with people in the quintile of most deprived areas just over 6% more likely to smoke than the base category (3rd quintile of deprivation).

Table 4.4. Results from logistic regression analysis of characteristics associated with tobacco consumption

				95% confidence intervals	
Characteristic	**Coefficient (marginal effect)**	**z-statistic**	**P> |z|**	**Lower**	**Upper**
Female	-0.0137	-0.80	0.426	0.637	1.209
Age:					
16-24	-0.0046	-0.11	0.909	0.454	2.019
25-34	0.0355	1.35	0.176	0.859	2.284
35-44	0.0495	1.95	0.052	0.996	2.571
55-64	-0.0030	-0.11	0.912	0.585	1.614
65-74	-0.0804	-2.57	0.010	0.260	0.833
75+	-0.2166	-4.31	0.000	0.050	0.326
Household composition:					
2 adults	-0.0058	-3.13	0.002	0.408	0.813
3 adults	-0.0704	-2.93	0.003	0.328	0.801
1 child	0.0160	0.66	0.508	0.742	1.829
2 or more children	0.0324	1.42	0.155	0.890	2.081
Ethnicity:					
Mixed	0.0408	0.56	0.573	0.381	5.697
Black	-0.1658	-2.52	0.012	0.061	0.705
Asian	-0.2245	-3.83	0.000	0.040	0.352
Other	-0.0001	-0.00	0.999	0.213	4.694
Disabled	0.0209	1.19	0.232	0.881	1.690
Income tertile:					
missing	-0.0497	-1.93	0.054	0.386	1.008
2nd	-0.0619	-3.00	0.003	0.378	0.816
3rd	-0.1174	-4.52	0.000	0.202	0.532
Quintile of IMD:					
1st (most deprived)	0.0621	2.30	0.021	1.092	2.981
2nd	0.0343	1.32	0.187	0.853	2.251
4th	-0.0292	-0.97	0.334	0.431	1.331
5th (least deprived)	-0.0337	-1.14	0.253	0.418	1.258
constant	0.412	2.76	0.006	0.219	0.772
Number of observations	2,084				
Chi-squared (24)	139.07				
Prob > chi^2	0.000				
Pseudo R^2	0.1211				

Source: analysis of NDNS Waves 9-11

Note: shaded coefficients are statistically significant at the 5% level

High-risk alcohol consumption

Table 4.5 presents the results from the logistic regression analysis of high-risk alcohol consumption (consumption in excess of the CMO's weekly alcohol guidelines of 14 units per week). The sample here is all individuals aged 16 or older in the Wave 9-11 NDNS.

There is a significant gender effect, with women around 12% less likely to engage in high-risk alcohol consumption than men. By age, the only significant result is that 65 to 74 year olds are around 9% more likely to engage in high-risk alcohol consumption than the base category (45 to 54 year olds). There are no significant household composition effects. Looking at results by ethnicity, black and asian individuals are less likely to engage in high-risk alcohol consumption than white individuals (around 26% less likely for black individuals, and 36.5% less likely for asian individuals). There are no significant differences in high-risk alcohol consumption for disabled individuals compared to non-disabled individuals. There is an income gradient, with individuals in the top income tertile around 11% more likely to engage in high-risk consumption than the base category (lowest tertile). There are no significant associations between high-risk alcohol consumption and Index of Multiple Deprivation.

Table 4.5. Results from logistic regression analysis of characteristics associated with high-risk alcohol consumption

				95% confidence intervals	
Characteristic	**Coefficient (marginal effect)**	**z-statistic**	**P> |z|**	**Lower**	**Upper**
Female	-.01198	-5.33	0.000	0.387	0.645
Age:					
16-24	-0.0418	-0.71	0.475	0.404	1.525
25-34	0.0078	0.20	0.843	0.670	1.634
35-44	0.0352	0.97	0.330	0.813	1.851
55-64	0.0540	1.47	0.143	0.900	2.078
65-74	0.0918	2.32	0.020	1.086	2.666
75+	-0.0233	-0.49	0.627	0.506	1.507
Household composition:					
2 adults	-0.0145	-0.56	0.573	0.687	1.231
3 adults	0.0130	0.37	0.712	0.726	1.608
1 child	0.0142	0.39	0.696	0.719	1.639
2 or more children	0.0060	0.17	0.862	0.699	1.534
Ethnicity:					
Mixed	-0.0309	-0.24	0.814	0.188	3.716
Black	-0.2615	-2.02	0.044	0.051	0.957
Asian	-0.3651	-4.20	0.000	0.045	0.324
Other	-0.0417	-0.31	0.757	0.170	3.624
Disabled	-0.0227	-0.96	0.336	0.671	1.146
Income tertile:					
missing	0.0003	0.01	0.993	0.637	1.576
2nd	0.0132	0.39	0.695	0.736	1.584
3rd	0.1107	3.37	0.001	1.308	2.758
Quintile of IMD:					
1st (most deprived)	-0.0427	-1.08	0.280	0.498	1.223
2nd	0.0024	0.07	0.948	0.671	1.532
4th	-0.0148	-0.41	0.683	0.609	1.385
5th (least deprived)	-0.0056	-0.16	0.872	0.654	1.433
constant	0.398	-3.30	0.001	0.230	0.688
Number of observations	2,084				
Chi-squared (24)	109.11				
Prob > chi^2	0.000				
Pseudo R^2	0.0744				

Source: analysis of NDNS Waves 9-11

Note: shaded coefficients are statistically significant at the 5% level

High-risk food consumption

Table 4.6 presents the results from the logistic regression analysis of high-risk food consumption. This regression uses the sample of all adults and children aged 4 or over in the NDNS. The results show a clear gender differential, with women and girls significantly less likely to engage in high-risk food consumption than men and boys. There is a clear age gradient, with children and young adults (up to 35) significantly more likely[6] to engage in high-risk food consumption than adults in the base age category (45 to 54). 4-5 year olds are over 25 per cent more likely to engage in high-risk food consumption than 45 to 54 year olds, while 11-15 year olds are just under 9% more likely and 25-34 year olds 6.5% more likely. Note that this is a very different risk pattern by age group compared to the incidence of obesity by age group, as shown in Appendix B of this report, which compares statistics for obesity in the 2021 Health Survey for England for children and adults with statistics for high-risk food consumption from the England subsample of the NDNS. The incidence of obesity in the population increases by age group for children and young adults, reaching a peak level between ages 45 and 74.

There is no significant association between household composition and high-risk food consumption. There are significant differences by ethnicity, with black and asian individuals being less likely to engage in high-risk food consumption than white individuals (the base category) – around 9.5% less likely for both groups. There is no significant association between disability and high-risk food consumption. There are no significant associations between income tertile or IMD quintile and high-risk food consumption.

[6] Note that the coefficient for 18 to 24 year olds falls just short of significance at the 5% level. However, it is jointly significant when tested jointly with the other coefficients in the age groups 4 to 34.

Table 4.6. Results from logistic regression analysis of characteristics associated with high-risk food consumption

				95% confidence intervals	
Characteristic	**Coefficient (marginal effect)**	**z-statistic**	**P> |z|**	**Lower**	**Upper**
Female	-0.0831	-4.97	0.000	0.343	0.628
Age:					
4-10	0.2533	5.89	0.000	4.761	22.569
11-15	0.0869	3.16	0.002	1.357	3.668
16-24	0.0740	1.94	0.053	0.992	3.954
25-34	0.0650	2.11	0.034	1.045	3.181
35-44	0.0416	1.45	0.148	0.872	2.472
55-64	-0.0295	-1.08	0.280	0.465	1.248
65-74	-0.0094	-0.32	0.749	0.540	1.558
75+	-0.0067	-0.20	0.838	0.519	1.704
Household composition:					
2 adults	0.0069	0.39	0.699	0.770	1.477
3 adults	-0.0035	-0.15	0.882	0.632	1.484
1 child	-0.0286	-1.15	0.249	0.491	1.203
2 or more children	-0.0243	-1.04	0.301	0.522	1.222
Ethnicity:					
Mixed	(omitted)	n/a	n/a		
Black	-0.0950	-2.36	0.018	0.201	0.862
Asian	-0.0949	-3.27	0.001	0.246	0.705
Other	0.0421	0.67	0.502	0.474	4.588
Disabled	-0.0079	-0.48	0.634	0.688	1.256
Income tertile:					
missing	0.0000	0.00	0.999	0.642	1.556
2nd	-0.0079	-0.36	0.715	0.628	1.377
3rd	-0.0204	-0.91	0.364	0.551	1.244
Quintile of IMD:					
1st (most deprived)	0.0090	0.36	0.717	0.692	1.707
2nd	0.0159	0.66	0.508	0.750	1.787
4th	-0.0241	-1.01	0.313	0.520	1.233
5th (least deprived)	0.0105	0.42	0.677	0.699	1.737
constant	10.040	7.31	0.000	5.411	18.630
Number of observations	3,198				
Chi-squared (24)	98.04				
Prob > chi^2	0.000				
Pseudo R^2	0.066				

Source: analysis of NDNS Waves 9-11, sample of respondents aged 4 and older

Note: shaded coefficients are statistically significant at the 5% level

4.4 High-risk consumption as proportion of total consumption for each product category

Table 4.7 presents estimates for the proportion of consumption of each product category which is high risk. For tobacco, we assume that all consumption is high-risk. For alcohol and tobacco the proportions of high-risk consumption are estimated using the NDNS survey. The proportion of high-risk consumption for alcohol is estimated to be just over 43%, somewhat higher than for food (just under 29%). Note that these estimates are different from the estimates in Table 4.2 above because Table 4.2 shows the proportion of *individuals* in the NDNS who engage in any high-risk consumption of each product, whereas Table 4.7 shows the proportion of *total consumption* which is high-risk in each case.

Table 4.7 Estimates of high-risk consumption as a proportion of total consumption

Product Category	Estimate (%)	Source
Tobacco	100.0	Assumed
Alcohol	43.4	Analysis of NDNS Waves 9-11
Food	28.8	Analysis of NDNS Waves 9-11

4.5 Correlation between high-risk consumption for different product categories

Table 4.8 shows the statistical correlation between high-risk consumption in each product category. In theory the correlation could be positive or negative. A statistic of 1 between two product categories would mean that the consumption patterns for each of those products was exactly the same, while a coefficient of zero would mean that there was no tendency for high-risk consumers of one product category to also be high-risk consumers in the other product category. The results show that there is a slight positive correlation between each type of high-risk consumption. Food and alcohol consumption have the strongest positive correlation (just under 0.13) while tobacco has a smaller correlation of just under 0.06 for both food and alcohol.

Table 4.8. Correlation between high-risk consumption in each product category

	Food	Alcohol	Tobacco
Food	1.000		
Alcohol	**0.129**	1.000	
Tobacco	**0.059**	**0.059**	1.000

Source: analysis of NDNS Waves 9-11

5 Results: Aggregate high-risk expenditure on tobacco, alcohol and food

5.1 Aggregate pre-tax expenditure

Table 5.1 shows total aggregate expenditure on each product category as shown in the 2022 ONS *Consumer Trends* data, adjusted where necessary using household expenditure data from the Living Costs and Food Survey. Food had the largest aggregate expenditure (just under £127 billion), followed by alcohol (just over £46 billion) and tobacco (just over £25 billion).

Table 5.1. Estimates of aggregate UK expenditure, 2022

Product Category	**Estimate (£bn)**	**Source**
Tobacco - total	**25.13**	ONS *Consumer Trends*
Alcohol:		
Off-trade (consumption at home)	23.29	ONS *Consumer Trends*
On-trade	22.55	Author's calculations from *Consumer Trends* and LCFS
Alcohol - Total	**45.84**	
Food:		
Food prepared at home	73.50	Author's calculations from *Consumer Trends* and LCFS
Takeaway food	4.74	Author's calculations from *Consumer Trends* and LCFS
Food eaten on premises	48.50	Author's calculations from *Consumer Trends* and LCFS
Food - Total	**126.74**	ONS *Consumer Trends*

5.2 Aggregate high-risk consumption

Table 5.2 shows post-tax consumption compared to pre-tax consumption in each product category and the amount of revenue which the tobacco, alcohol and food industry (and associated intermediaries) derive from high-risk spending for each product. Post-tax expenditure for each product category is estimated using the methodologies set out in subsection 3.2.2 above. Tobacco is the most highly taxed of the three product categories, with tax accounting for around 71% of total spending, compared to 44% for alcohol and 6% for food.

The final column of Table 5.2 shows the revenue which industry derives from high-risk spending for each product. These estimates are calculated by multiplying total post-tax revenues for each product by the proportion of high-risk expenditure for that product (as set out in Table 4.7 above). In 2022, the tobacco, alcohol and food

industries (and associated intermediaries such as retailers and distributors of each product) derived around £52.7 billion of revenue from high-risk spending, according to these estimates. Revenue from high-risk food spending (£34.2 billion) represented around 65% of total high-risk industry revenue, compared to £11.2 billion for alcohol (21%) and £7.3 billion for tobacco (14%).

Table 5.2. Post-tax consumption and the high-risk component of consumption, 2022

Product Category	Pre-tax (£bn)	Post-tax (£bn)	Revenue derived from high-risk spending (£bn)
Tobacco	25.13	7.34	**7.34**
Alcohol	45.84	25.70	**11.16**
Food	126.74	118.65	**34.17**
Total	197.71	151.69	**52.67**

Source: Estimates from Table 5.1 and Table 4.7 combined with HMRC (2022, 2023a, 2023b)

6 Conclusions

This report has shown that, using UK government definitions of “high-risk” consumption of tobacco, alcohol and food, the tobacco, alcohol and food industries derived almost £53 billion of revenues from high-risk consumption in 2022. Across the three industries as a whole, high-risk consumption comprised more than one-third of total revenues. To put this in perspective, the Office for National Statistics estimates that UK Gross Domestic Product in the 2022-23 tax year was £2,520 billion (Office for Budget Responsibility, 2023). We estimate that industry revenue from high-risk consumption amounted to over 2 per cent of UK GDP over this period.

This project has opened up opportunities for follow-up work. In particular, it would be useful to analyse the individual risk indicators for food consumption – exceeding the daily guidelines for saturated fat, free sugars and salt – in more detail. There is also more to be said regarding consumption significantly in excess of the recommended guidelines for tobacco, alcohol and food. This report used a simple binary specification (any consumption at all for tobacco, consumption in excess of government guidelines for alcohol and food) to identify “high-risk” consumers compared to other consumers, but it would be useful to analyses the characteristics of people whose consumption of each of the products exceeds the recommended guidelines by a large amount – “super high-risk” consumers, in other words – to establish if their characteristics differ from the overall high-risk sample.

Finally, as explained in Section 3.4 the main limitation of the methodology used to analyse high-risk consumption in this report is the assumption that the proportion of high-risk *expenditure* in each product category is the same as the proportion of high-risk *consumption* in each product category. It would be useful to be able to drop this assumption and analyse patterns of expenditure by high-risk consumers explicitly, but to do this we would need a data source which contains detailed information on the amount spent on alcohol and food (for example, food expenditure diaries) as well as consumption measured in units of alcohol, and grams of saturated fats, salt and sugar. The necessary consumption data could be calculated if the expenditure information were detailed enough to provide the necessary product information. A bespoke survey would be one way of collecting the required information to relax the assumption in this report.

Appendix A: Patterns of spending on alcohol and food – comparison of the 2019/20 and 2020/21 LCFS

This report uses Living Costs and Food Survey data for 2019/20 instead of 2020/21 because expenditure patterns in the 2020/21 data were substantially affected by the COVID-19 pandemic and associated lockdowns. As Table A.1 below shows, purchases of alcoholic drinks at licensed premises such as pubs, bars and restaurants accounted for over 49 per cent of total spending on alcohol in 2019/20 but only 13 per cent in 2020/21. Meanwhile, food purchased from restaurants and takeaway outlets accounted for almost 42 per cent of total food spending in 2019/20, compared to only just over 13 per cent in 2020/21.

Year	**2019/20**	**2020/21**
Alcohol purchased for home consumption	23.29	25.51
Alcohol purchased at licenced premises	22.55	3.76
Purchases at licensed premises as percentage of total	49.2%	12.8%
Food purchased for home preparation/consumption	91.90	101.48
Prepared food purchased at restaurants and other outlets (eat-in)	60.46	12.93
Prepared purchased at restaurants and other outlets (takeaway)	5.93	2.46
Eat-in and takeaway purchases at restaurants as percentage of total	41.8%	13.2%

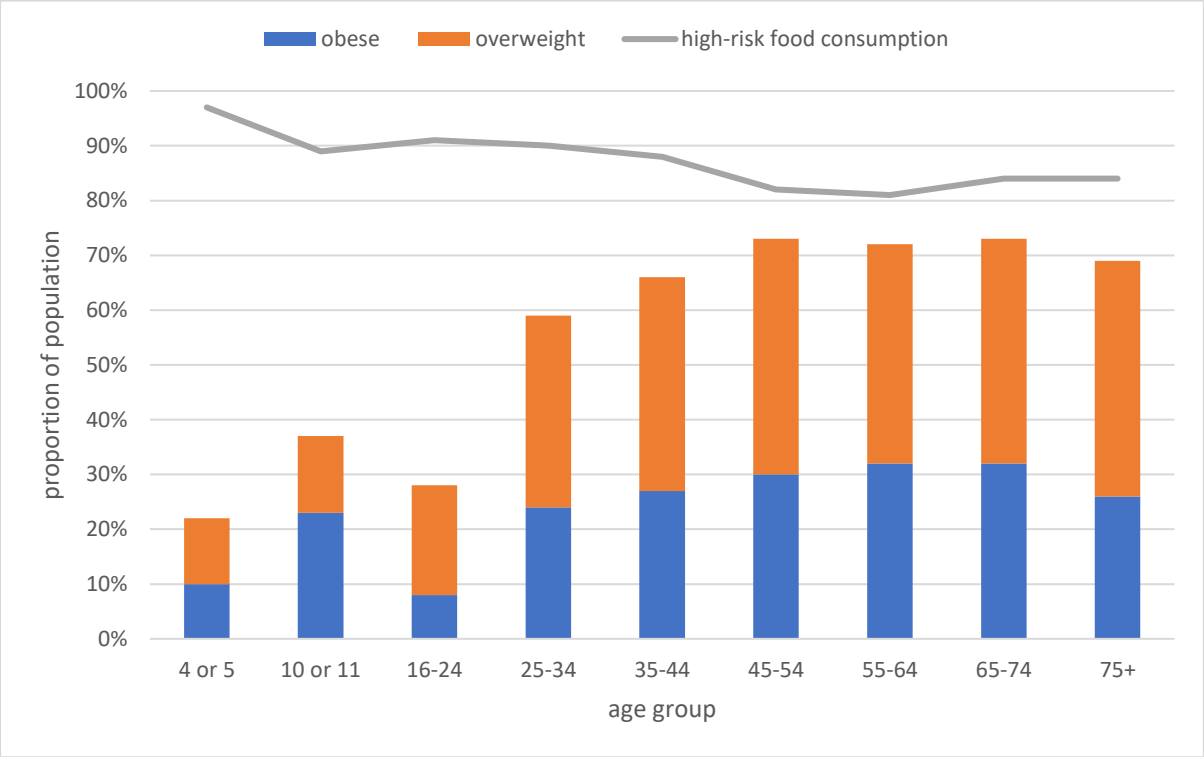
Source: analysis of 2019/20 and 2020/21 Living Costs and Food Survey

Appendix B: Survey evidence on the incidence of excess weight (obesity and overweight) by age group in England and comparison with the National Diet and Nutrition Survey

Figure B.1 presents survey evidence on the incidence of excess weight (the proportion of the population who are obese or overweight for children and adults in age groups in England using statistics summarised by Baker (2023). The obesity statistics for children are taken from NHS Digital's National Child Measurement Programme for 2021/22, while the statistics for adults are taken from the 2021 Health Survey for England. These statistics use definitions of 'obese' and 'overweight' calculated using the Body Mass Index (BMI), defined as weight divided by the square of height (kg/m^2). A person is classified as 'obese' if their BMI is 30 or higher, and 'overweight' if their BMI is between 25 and 30.

The stacked bars in Figure B.1 show the proportion of the population in each age group who are obese (blue bars) or overweight (orange bars). The grey line on the Figure shows the proportion of the population in each age group who are high-risk consumers of food based on exceeding at least one of the three recommended maximums for food consumption (saturated fats, free sugars or salt) set out in Section 3.1.3 in the main report.

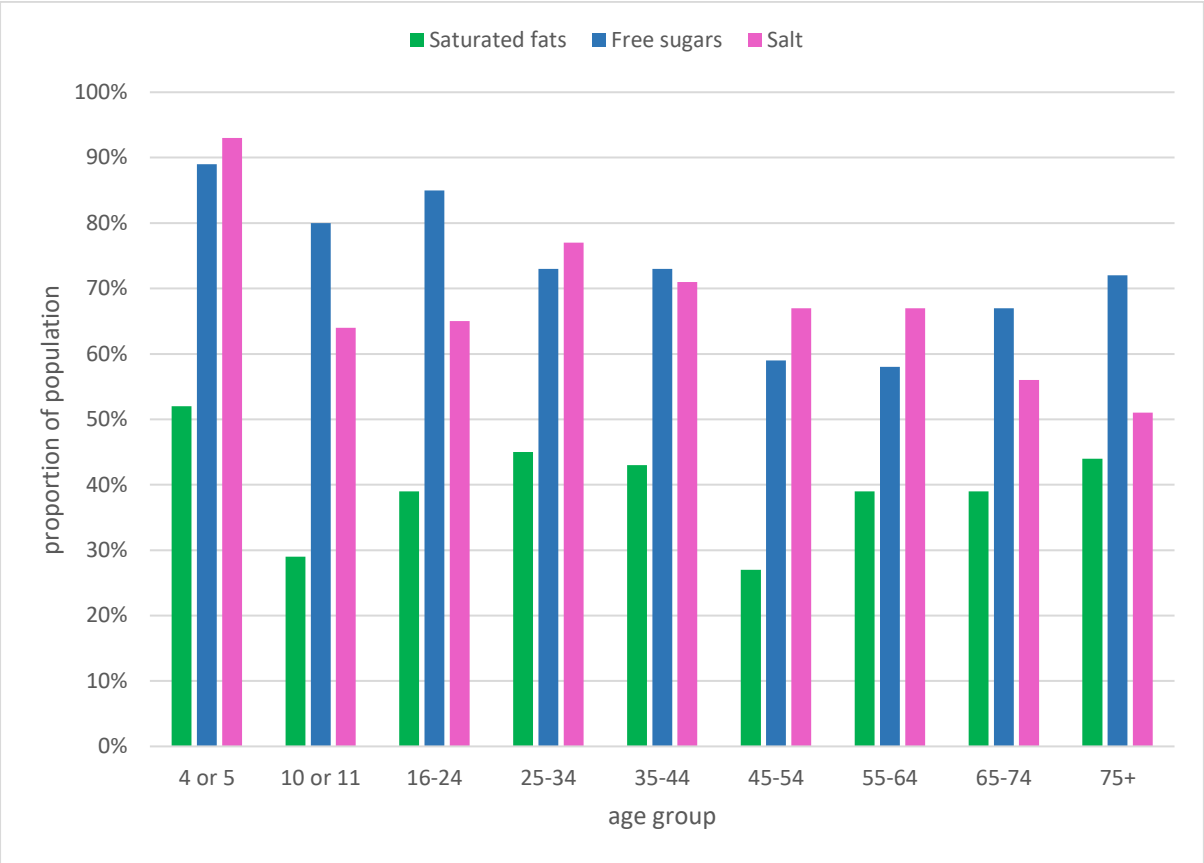
Figure B.1. Proportion of the population who are obese or overweight by age group and comparison with proportion who are high-risk food consumers: England



Sources: Child obesity statistics – National Child Measurement Programme 2021/22. Adult obesity statistics – Health Survey for England 2021. High-risk food consumption – author's analysis of National Diet and Nutrition Survey Waves 9-11.

Figure B.2 shows the population incidence of high-risk consumption by age group for each of the three high-risk food indicators in the NDNS – saturated fats, free sugars and salt. The proportion of 4 and 5 year olds consuming saturated fats in excess of recommended guidelines is higher than for any other age group. Apart from this, there is no strong relationship between age and the proportion of people in each age group who are high-risk consumers using the saturated fats measure. For free sugars, there is more of an age gradient; people aged 45 to 64 are less likely to be high risk consumers than younger or older age groups. The proportion of high-risk consumers of free sugars is highest for children and 16-24 year olds. For salt, the highest proportion of high-risk consumption is for 4-5 year old children. For adults, the population proportion of high-risk salt consumption is highest for 25-34 year olds and then falls for older age groups.

Figure B.2. Population incidence of high-risk consumption for the three high-risk food indicators used in this report



Source: author's analysis of National Diet and Nutrition Survey Waves 9-11.

Bibliography

Baker, C (2023), *Obesity statistics*, House of Commons Library Research Briefing. https://researchbriefings.files.parliament.uk/documents/SN03336/SN03336.pdf

Department of Health, Welsh Government, Northern Ireland Department of Health and Scottish Government (2016), *UK Chief Medical Officers' Low Risk Drinking Guidelines.* https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/545937/UK_CMOs__report.pdf

HMRC (2022), *Measuring tax gaps 2022 edition: tax gap estimates for 2020 to 2021*. https://www.gov.uk/government/statistics/measuring-tax-gaps

HMRC (2023a), *Tobacco Bulletin.* https://www.gov.uk/government/statistics/tobacco-bulletin

HMRC (2023b), *Alcohol Bulletin*. https://www.gov.uk/government/statistics/alcohol-bulletin

NatCen Social Research (2022) *National Diet and Nutrition Survey Rolling Programme Years 9-11 (2016/17 – 2018/19).* https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/943114/NDNS_UK_Y9-11_report.pdf

Office for Budget Responsibility (2023), *Public finances databank – May 2023.* https://obr.uk/download/public-finances-databank-may-2023/?tmstv=1686553844

Office for National Statistics (2023), *Consumer Trends, UK: October to December 2022.* https://www.ons.gov.uk/economy/nationalaccounts/satelliteaccounts/bulletins/consumertrends/octobertodecember2022

Pryce, R, Hollingsworth, H and Walker, I (2018), "Alcohol quantity and quality price elasticities: quantile regression estimates", *European Journal of Health Economics*, Vol 20, pp 439-454.

Public Health England (2016), *Government Dietary Recommendations: Government recommendations for energy and nutrients for male and females aged 1-18 years and 19+ years*. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/618167/government_dietary_recommendations.pdf

Reed, H (2021), *Estimates of poverty in the UK adjusted for expenditure on tobacco – 2021 update*, Action on Smoking and Health. https://ash.org.uk/uploads/Smoking-and-poverty-July-2021.pdf