

Supermarket top-up of Healthy Start vouchers increases fruit and vegetable purchases in low-income households

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Abstract

Stark, widening health and income inequalities in the United Kingdom underpin the need for increased support for low-income families to access affordable and nutritious foods. Using anonymised supermarket loyalty card transaction records, this study aimed to assess how an additional Healthy Start voucher (HSV) top-up of £2, redeemable only against fruit and vegetables (FVs), was associated with FV purchases among at-risk households. Transaction and redemption records from 150 loyalty card-holding households, living in northern England, who had engaged with the top-up scheme, were analysed to assess the potential overall population impact. Using a pre-post study design, 133 of these households' records from 2021 were compared with equivalent time periods in 2019 and 2020. Records were linked to product, customer and store data, permitting comparisons using Wilcoxon matched-pairs sign-ranked tests and relationships assessed with Spearman's Rho. These analyses demonstrated that 0.9 more portions of FV per day per household were purchased during the scheme compared to the 2019 baseline ($p=0.0017$). The percentage of FV weight within total baskets also increased by 1.6 percentage points ($p=0.0242$), although the proportional spend on FV did not change. During the scheme period, FV purchased was higher by 0.4 percentage points ($p=0.0012$) and 1.6 percentage points ($p=0.0062$) according to spend and weight, respectively, in top-up redeeming baskets compared to non-top-up redeeming baskets with at least one FV item and was associated with 5.5 more HSV 'Suggested' FV portions ($p<0.0001$). The median weight of FV purchased increased from 41.83 kg in 2019 to 54.14 kg in 2021 ($p=0.0017$). However, top-up vouchers were only redeemed on 9.1% of occasions where FV were purchased. In summary, this study provides novel data showing that safeguarding funds exclusively for FV can help to increase access to FV in low-income households. These results yield important insights to inform public policy aimed at levelling up health inequalities.

KEYWORDS

fruit and vegetable consumption, health inequality, Healthy Start vouchers, income inequality, supermarket transaction data

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INTRODUCTION

A healthy diet is unaffordable to 3 billion people globally, driven by high-income inequality and the high cost of food (FAO et al., 2021). In the United Kingdom, in order to meet the healthy and sustainable diet outlined in the government-recommended Eatwell Guide, the poorest 20% of households would need to spend 43% of their disposable income while the richest 20% would need to spend only 10% (Food Foundation, 2022). Stark inequalities are also observed in childhood obesity rates, with children from the most deprived areas of England being more than twice as likely to be obese than the least deprived (2020–2021 data showing 7.8% vs. 20.3% in reception, 14.3% vs. 33.8% in year 6); a gap that widened dramatically during the COVID-19 pandemic (Moore, 2022).

The Healthy Start scheme is run in England, Wales and Northern Ireland for low-income pregnant women (including those under 18 years old) and families with children under 4 years, receiving qualifying benefits or with a household income less than £16 190 per year (NHS, 2021). As well as free vitamins, it provides vouchers valid in more than 30 000 UK shops redeemable against certain types of infant formula, milk, fruit and vegetables, in accordance with the 'Healthy Start Food' regulated definition (Department for Health and Social Care, 2020). During the COVID-19 pandemic, the number of families eligible to receive Healthy Start vouchers (HSVs) drastically increased. Additionally, in April 2021 the UK government raised the HSV weekly amount from £3.10 to £4.25 to increase access to affordable and nutritious foods (NHS, 2022). Although this led to a short-term rise in HSV uptake, this has since been reversed as a result of digitisation, which has unfortunately created a barrier to uptake (Defeyter et al., 2022).

In a bid to support families through the pandemic and beyond, efforts have been made by several major supermarkets and other organisations to further increase the value of HSV, which could, in turn, motivate higher HSV take-up. In particular, Sainsbury's, the 2nd major UK supermarket by turnover (Retail Economics, 2022), topped-up the voucher value by £2 as part of their food donation programme (Sainsbury's, 2021b). The additional voucher was printed automatically at checkouts when an HSV was used in Sainsbury's superstores in England and could be used in the next transaction, that day, or later at any Sainsbury's store. The initiative ran from 15 February 2021 through 31 August 2021, dovetailing with the easing of COVID-19 restrictions in the United Kingdom (Institute of Government, 2022), and incorporates the date that the government-issued voucher value increased. The top-up voucher specified its intended use just for fresh and frozen fruit and vegetables, as opposed to the other eligible items HSVs can be redeemed against (e.g., infant formula, milk).

Increasing FV consumption has the potential to improve the overall diet (Fulton et al., 2016), and is associated with multiple health benefits including the reduction of cardiovascular disease and several cancers (World Health Organization, 2012). Lower-income groups are consistently observed to have less healthy diets and notably lower FV intake (Jenneson et al., 2020; Mackenbach et al., 2015; National Food Strategy, 2021; Parnham et al., 2021; Public Health England, 2019), therefore, increasing FV has the potential to contribute to reducing health disparities.

While initial analysis, completed by the retailer, of the first scheme period estimated an additional 1.2 million portions of FV were provided to those eligible nationally (Sainsbury's, 2021a), it did not assess the impact on whole basket purchasing patterns, the selection of fruit and vegetables purchased or demographic relationships. Therefore, the primary aim of this research was to assess the yearly changes in FV purchases from loyalty card-holding households (hereafter referred to as households) who used the HSV top-up scheme. Focusing on families living in Yorkshire and the Humber, a region of northern England where the government HSV uptake rate has been consistently higher than the national average (NHS, 2022), the number of FV portions, weight and spend of FV purchased, the proportion of FV within the whole basket, and type of FV were examined at a household level from 2019 (pre-pandemic). A secondary aim was to assess the effectiveness of the top-up voucher on increasing FV purchases in HSV top-up redeeming baskets versus non-top-up redeeming baskets within these HSV using households to examine basket level differences stratified by the use of a top-up voucher.

MATERIALS AND METHODS

Study design

This study was designed as a single-arm, pre-post, interventional trial examining FV purchases before and after the introduction of the HSV top-up vouchers, with the hypothesis that the use of top-up vouchers will be associated with higher FV purchases. As the COVID-19 lockdown period notably impacted purchasing patterns in the United Kingdom (Public Health England, 2020), transaction data from the top-up voucher scheme period (15 February 2021–31 August 2021), were compared with data from the same 6.5-month period in both 2019 (pre-pandemic) and 2020 (pandemic). This was done in a paired fashion, with each loyalty card holder's transactions compared between the scheme period in 2021, and the same calendar period in 2019 and 2020, uniquely representing time periods before, during and after government COVID-19-related restrictions on movement (Institute of Government, 2022).

Participants

The supermarket transaction records analysed came from loyalty card holders who consented to the supermarkets' data sharing agreement, and whose card was registered to the Yorkshire and the Humber region. As previously described (Clark et al., 2021), loyalty card holders were defined as 'primary' shoppers if they had regularly purchased from a variety of food groups since 2016. Importantly, they needed to have redeemed at least one top-up voucher during the scheme period, from which it was assumed that they were households who participated in the Healthy Start scheme. Top-up vouchers were issued (printed with receipts) upon presentation of a government HSV during the checkout process by an automated process. Loyalty card holders were excluded if they did not register at least one transaction within the 2021 scheme period and the two defined comparison periods; 15 February 2019 to 31 August 2019 and 15 February 2020 to 31 August 2020. Transactions made by these households outside the region were also included. Records from shoppers registered to other regions, but who had shopped within the Yorkshire and the Humber region, were not included.

Loyalty card data

Each loyalty card holder ('the sample') was pseudonymised by a unique hashed identifier (ID) and linked to customer demographic information detailing their loyalty, gender, and age band. Deprivation was assessed at a store level rather than the household level to minimise statistical bias resulting from the 'ecological fallacy' (Freedman, 1999), whereby household-level inferences would be made from neighbourhood-level data. Non-food and drink items and online transaction data were excluded from the loyalty card data analysed (HSV top-up vouchers could not be redeemed online). Stores were categorised by deprivation status, by first matching the store's postcode to the Lower Layer Super Output Area (LSOA) (Office for National Statistics, 2020). Then the corresponding deciles for both the Index of Multiple Deprivation (IMD) and Income Deprivation Affecting Children Index (IDACI) for each store's LSOA were mapped (Ministry of Housing Communities & Local Government, 2019a, 2019b).

Product and nutrition information

As part of the data cleaning process, all weights were converted to grams, and a density of 1.0 was assumed for all product weights given in centilitres, millimetres

TABLE 1 Fruit and vegetable (FV) definitions^a used in analysis.

Suggested ^b	All ^c
Plain, fresh and prepared fruit	Plain, fresh and prepared fruit
Plain, fresh and prepared vegetables	Plain, fresh and prepared vegetables
Plain, frozen, canned and packed fruit	Plain, frozen, canned and packed fruit
Plain, frozen, canned and packed vegetables	Plain, frozen, canned and packed vegetables
	Dried fruit
	Fresh, frozen and dried herbs and spices
	Fruit smoothie blends
	Fruit juices and smoothies
	Plain fruit and nut mixes
	Fresh and prepared veg with additions
	Frozen, canned and packaged veg with additions
	Frozen, canned and packaged fruit with additions
	Dried fruit with additions
	Fruit snacking
	Vegetable snacking
	Vegetable-based sauces and dips
	Fruit and nut mixes with coatings and additions
	Infant vegetables
	Infant fruits

^aAll FV were an estimated 80 g per portion, except for dried fruit, plain fruit and nut mixes, dried fruit with additions, and fruit and nut mixes with coatings and additions (30 g/portion) and fruit smoothie blends and fruit juices and smoothies (150 g/portion).

^bDefined by the Healthy Start regulation and specified by the top-up voucher scheme.

^cDefined by the broad Eatwell Guide definition of FV.

and litres. Where possible, missing data (e.g., product weights) were manually curated. Standard portion weights and edible conversion factors were applied (Food Standards Agency, 2002; Public Health England, 2021), and each product item was tagged to a food group. To facilitate data analyses, the FV types were categorised (Table 1) as 'Suggested' (defined by the Healthy Start regulation and specified by the top-up voucher) and 'All' (the broad Eatwell Guide definition of FV). Pulses were not included in any of the fruit and vegetable definitions, as they were not eligible according to Healthy Start regulation during the baseline phases for this study. Healthy Start extended its eligibility criteria to include pulses in October 2020, but for the purposes of all our analyses, they were excluded. The FV weights were transformed to generate FV portions for each of the 'Suggested' and 'All' categorisations using the NHS recommendation for adult portions (NHS, 2018). Total portions purchased were further transformed to generate average daily portions by dividing by the number of days (198 in the 2019 and 2021 scheme period and 199 in 2020). Portions included in composite foods were not possible to calculate due to a lack of quantitative ingredient declaration information.

Data aggregation

Data were aggregated at a household level for each time period for the pre-post analysis. This was first done at a basket level, then summed or averaged to generate household-level data, which resulted in three sets of mean values for each household in the 2019, 2020 and 2021 time periods. This was done instead of taking a population level mean so that household size effects were controlled, given the data could not be weighted by household size. Variables were calculated for each total household's spend (£) and associated average total weekly spend (£), total weight (kg), FV spend (£), FV weight (kg), FV portions and associated average daily portions, proportion of FV in the average basket by spend (%) and weight (%), and proportion of each FV subcategory by the total FV weight (%). Average weekly spend was calculated by dividing by the number of days in the scheme (198 in 2019 and 2021, 199 in 2020), then multiplying by 7.

For the cross-sectional analysis, each household mean basket was calculated for top-up redeeming and non-redeeming baskets. To assess similar behaviours, non-redeeming baskets which made at least one 'All' FV purchase were used as a comparison, which removed a significant amount of non-redeeming baskets but kept all redeeming baskets in the sample. Variables calculated for each average basket were the same as above, excluding further transformations of weekly spend and daily FV portions as these could not be extrapolated from the basket-level data.

Statistical analysis

Statistical analysis was performed using Stata (Stata Statistical Software: release 17, StataCorp LLC).

All the outcome variables were tested for normality using the Skewness–Kurtosis. All the tests at a household and basket level were then analysed by the non-parametric Wilcoxon matched-pairs signed-rank tests. The proportion of each FV subcategory used mean values and paired *t*-tests as the most appropriate measure to provide insight into the proportions of each subcategory. Spearman's Rho was used to access the relationship between store deprivation status and household demographics to the number of redeeming baskets made.

RESULTS

Top-up scheme participants

Of 1383 loyalty card holders that engaged with the top-up scheme at least once, 150 were registered to the Yorkshire and the Humber region (Figure 1). Of these, 133 cardholders had shopped at least once between 15 February and 31 August in 2019 and 2020. Cardholders were predominantly (77%) female and half (53.3%) were between the ages of 18 and 44 years (Table 2). Cardholders followed over the 3 years were typically regular loyalty card users. Indeed, a total of 21 707 baskets over the three time periods; 7979 in 2019; 6428 in 2020; 7303 in 2021 were analysed for these card users (Figure 1) corresponding to approximately 8 baskets per month per cardholder in 2021.

During the scheme period, while a minority (10%) of loyalty card holders had 11 or more top-up voucher redeeming baskets, the majority (80%) had fewer than 5 redeeming baskets (Table 2). More than half ($n=71$) of the 133 top-up scheme users had only 1 redeeming basket during the 6.5-month period.

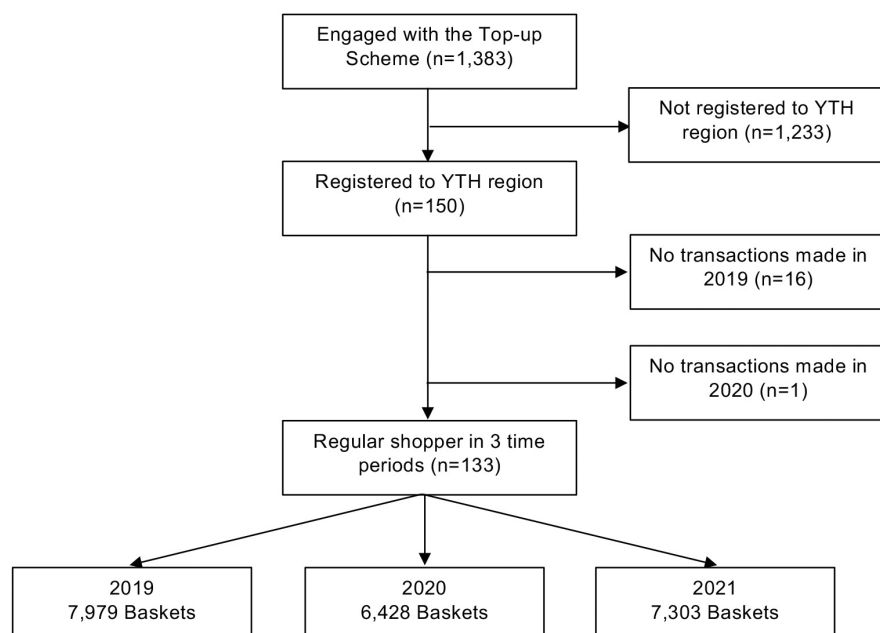


FIGURE 1 Flow chart describing the sample size of the longitudinal cohort. Each year relates to the scheme period or equivalent only (15 February–31 August). YTH, Yorkshire and the Humber.

TABLE 2 Top-up scheme participant characteristics.^a

Characteristic	Cross-sectional analysis		Longitudinal analysis
	Yorkshire and the Humber	Other regions ^b	Yorkshire and the Humber
Whole sample	150 (100.0)	1233 (100.0)	133 (100.0)
Gender			
Male	26 (17.3)	226 (18.3)	25 (18.8)
Female	117 (78.0)	937 (76.0)	103 (77.4)
Unknown	7 (4.7)	70 (5.7)	5 (3.8)
Age band			
18–34 years ^d	41 (27.3)	336 (27.2)	37 (27.8)
35–44 years	39 (26.0)	337 (27.3)	34 (25.6)
45–54 years	23 (15.3)	171 (13.9)	19 (14.3)
55–64 years	23 (15.3)	189 (15.3)	21 (15.8)
65 and over ^d	23 (15.5)	197 (15.9)	22 (16.5)
Unknown	1 (0.7)	3 (0.2)	0 (0.0)
Frequency ^c			
Once	78 (52.0)	665 (53.9)	71 (53.4)
Rare	44 (28.3)	330 (26.8)	36 (27.1)
Regular	17 (11.3)	166 (13.5)	16 (12.0)
Most regular	11 (7.3)	72 (5.8)	10 (7.5)

^aNumber (%).^bLoyalty card holders registered in the South East, East Midlands and West Midlands.^cRefers to how many Healthy Start voucher top-up redeeming baskets were made per loyalty card holder during the scheme: Once, 1 basket; Rare, 2–4 baskets; Regular, 5–10 baskets; Most Regular, 11+ baskets.^dAge bands aggregated to prevent potential disclosure.

Changes in fruit and vegetable purchases among scheme participants between 2019 and 2021

From 2019 to 2021, the total household purchases of the top-up scheme users ($n=133$ regular loyalty card shoppers) increased whether examined by spend (£) or weight ($p=0.0005$ and $p=0.0134$, respectively; [Table 3](#)). Total FV spend and weight also increased across all FV definitions, with the median weight of 'Suggested' FV purchased increasing from 41.83kg in 2019 to 54.14kg in 2021 ($p=0.0017$). The total spend on FV increased by less than £2.

Examining FV purchases as the proportion of total spend across 2019, 2020 and 2021 showed the proportion of FV spend increased for all categories of FV, 'Suggested' ([Figure 2a](#)), and 'All' ([Figure 2b](#)) between 2020 and 2021 with no significant changes between 2019 and 2020. In 2021, the median FV ('All') spend was 16.4 percent of total food and drink spend. Similarly, the proportion of FV weights increased over time, with the percentage of 'Suggested' FV significantly increasing

between 2019 and 2021 ($p=0.0245$; [Figure 2c](#)), and the 'All' ([Figure 2d](#)) categories increasing significantly between 2020 and 2021 ($p=0.0234$ and $p=0.0466$, respectively).

When examined in terms of portions of FV purchased, the data show that households were buying more portions of FV in both categories between 2021 and the two prior comparison periods, but there was no statistical difference between 2019 and 2020 ([Figure 3](#)). The number of portions of FV purchased increased by a similar amount regardless of the definition of FV ('Suggested'; $p=0.0017$, 'All'; $p=0.0070$); between 0.78–0.93 daily equivalents, a 29.3%–29.9% increase. There was a large variation among the baskets, with a wide range seen for all variables ([Table 3](#)).

Impact of the top-up vouchers: Comparisons of non-redeeming and Healthy Start vouchers top-up redeeming baskets

To assess the effect of the top-up voucher on increasing FV purchases within loyalty card-holding households, we compared HSV top-up redeeming baskets to non-redeeming baskets recorded during the time period in 2021. From a total of 7966 recorded baskets by the 150 engaged households, 5297 baskets included at least 1 'All' FV item, indicating that fruit or vegetables were purchased on that occasion. Of these, 484 were redeeming baskets accounting for a total of 492 top-up vouchers, while 4813 were non-redeeming baskets ([Table 4](#)). This indicates that top-up vouchers were only redeemed on 9.1% of occasions where FV were purchased. Baskets redeeming multiple top-up vouchers were made by 9 households, who recorded 34 baskets with 1 top-up voucher, 7 baskets with 2 top-up vouchers and 2 baskets with 3 top-up vouchers.

Households' baskets were larger when redeeming a top-up voucher, this was true for both spend ($p=0.0001$), and weight ($p=0.0001$) ([Table 4](#)). Redeeming baskets contained more FV portions, which was consistent across the 'Suggested' and 'All' FV categories, increasing for more inclusive definitions. More portions of FV were purchased per household per basket when redeeming top-up vouchers. Specifically, 5.5 more portions of 'Suggested' ($p<0.001$) FV and 9.3 for 'All' FV ($p<0.0001$) ([Table 4](#)).

Types of fruit and vegetables purchased in top-up redeeming baskets

Redeeming baskets were also made up of a larger proportion of FV according to both expenditure and weight.

TABLE 3 Comparisons of households' total purchases during scheme periods in the 2019 baseline and 2021.

Variable ^a	2019 ^b		2021 ^b		Wilcoxon test	
	Median	Range	Median	Range	Z	p-Value
Total basket						
Total spend, £	–	–	–	–	3.435	0.0005
Total weight, kg	–	–	–	–	2.465	0.0134
Suggested						
FV spend, £	–	–	–	–	3.801	0.0001
FV weight, kg	41.83	0.00–393.35	54.14	1.24–248.02	3.118	0.0017
FV spend % ^c	11.18	0.00–46.93	12.23	2.92–55.45	1.710	0.0872
FV weight % ^c	14.37	0.00–56.72	15.96	3.15–54.55	2.249	0.0245
FV portions (DE)	522.85 (2.64)	0.00–4916.85 (0.00–24.83)	676.79 (3.42)	15.45–3100.29 (0.08–15.66)	3.118	0.0017
All						
FV spend, £	–	–	–	–	3.395	0.0006
FV weight, kg	53.34	0.00–461.22	66.69	1.54–384.15	2.485	0.0126
FV spend % ^c	14.45	0.00–51.14	16.41	3.82–58.70	1.117	0.2653
FV weight % ^c	18.41	0.00–58.25	19.83	3.47–58.02	1.344	0.1799
FV portions (DE)	628.10 (3.17)	0.00–5916.50 (0.00–29.88)	811.90 (4.10)	17.45–4030.47 (0.09–20.26)	2.685	0.0070

Note: '–', Exact values suppressed given commercial sensitivity.

Abbreviations: DE, daily equivalents; FV, fruit and vegetable.

Values in bold are significant at 5% level ($p < 0.05$)

^aData were tested for normality using the Shapiro–Wilk tests. Differences between each household's ($n = 133$) mean values were assessed using Wilcoxon matched-pair signed-rank test.

^bTime period from 15 February to 31 August.

^cExpressed as a percentage of total food and drink spend and weight.

The large majority (98%, $n = 476$) of redeeming baskets purchased at least £2 of 'Suggested' FV. Notably, redeeming baskets contained significantly more plain, fresh and prepared fruit than non-redeeming baskets (mean difference [confidence interval]: 12.0% [8.17, 15.82]; $p < 0.001$), which represented the majority of each household's average redeeming basket (Figure 4). However, redeeming baskets contained proportionally less plain, fresh and prepared vegetables than non-redeeming baskets (–6.6% [–9.89, –3.30]; $p = 0.0001$). Purchases of frozen, canned and packaged FV categories were similar percentages in both basket types. This was also the case for the percentages of juices and smoothies, not suggested by the voucher, suggesting such categories remained similar regardless of voucher use.

Household and store-level predictors of top-up redemption frequency

Regular HSV shoppers frequented 135 stores during the scheme period. Of these stores, 79 were in the Yorkshire and the Humber region and accounted for 94.8% ($n = 7555$) of all recorded baskets. Age was a statistically significant predictor of redeeming basket

frequency ($r = -0.2607$, $p = 0.0013$), with younger customers recording more redeeming baskets. Neither gender ($p = 0.4080$), nor, surprisingly, loyalty status (a four-tier classification generated by the retailer, indicative of how regularly and comprehensively customers shop at this supermarket) ($p = 0.8735$) predicted the number of redeeming baskets made per household.

Most of the redeeming baskets 93.6% ($n = 453$) were purchased within Yorkshire and the Humber, making stores within the region a truer representation of households' residence, and the focus for deprivation analysis. Stores with high levels of deprivation had a higher percentage of redeeming baskets (Figure 5). Although correlations were weak, they were statistically significant for both the IMD ($r = -0.3288$ $p = 0.0373$) and IDACI ($r = -0.3265$ $p = 0.0400$) measures of deprivation. The same trend was observed for all baskets made by HSV regular households for both IMD ($r = -0.3528$ $p = 0.0177$) and IDACI ($r = -0.3512$ $p = 0.0187$). When including all stores outside the Yorkshire and the Humber, this correlation was weaker but still significant, except for the IDACI measure and the proportion of redeeming baskets ($r = -0.1553$ $p = 0.0754$), potentially due to the large proportion of stores redeeming no top-up vouchers.

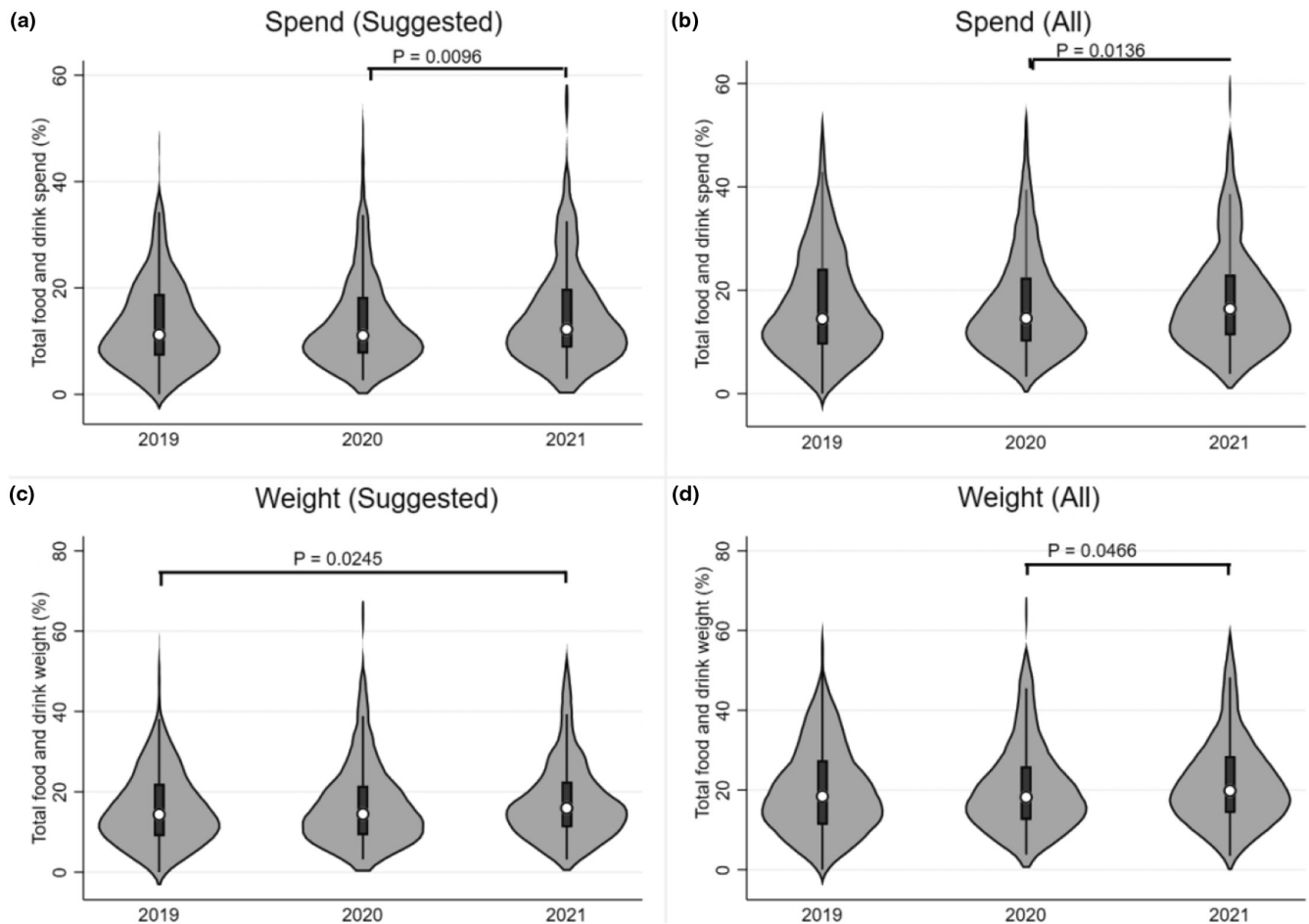


FIGURE 2 Changes in the proportion of total basket spend and weight on fruit and vegetable (FV) items. (a) Average spend on ‘Suggested’ FV (b) Average spend on ‘All’ FV (c) Average weight purchased on ‘Suggested’ FV (d) Average weight purchased on ‘All’ FV. Each year relates to the scheme period or equivalent only (15 February–31 August). Mean values calculated for each households’ total baskets ($n = 133$). Statistical significance tested by the Wilcoxon matched-pairs sign-rank test. Significance level displayed for $p > 0.05$. Median denoted by white dot. Interquartile range denoted by the thick black bar. The distribution of the data is denoted by stretched black lines filled with grey shading.

DISCUSSION

This study assessed the effect of additional fiscal support redeemable only against fruit and vegetables, among households who used HSVs and a supermarket-led top-up voucher scheme. Analysis of supermarket loyalty card transaction data showed that, in comparison to 2019, low-income households who redeemed at least one top-up voucher purchased a total of 0.9 more FV portions per day during the trial period in 2021. Use of the top-up voucher was associated with a significantly higher proportion of plain, fresh and prepared fruit purchased. Moreover, we observed a relationship between deprivation and top-up voucher redemption rate, indicating the scheme delivered needed support to those shopping in the most deprived areas. These results yield important insights for public health policy, suggesting that safeguarding funds specifically for FV is an effective way to increase FV provision to low-income households. While customers did not

spend an ‘additional’ £2 on FV purchases, the voucher did ensure that at least £2 was spent on FV, which is particularly important at times of economic strain, and we found that voucher use was associated with significantly higher FV purchases.

Our results are in line with those of others that show financial incentives will increase purchases of fruit and vegetables among lower-income households with children (Andreyeva & Luedicke, 2015; Moran et al., 2019). Moreover, in this intervention, we observed the largest increases in the percentage of ‘Suggested’ FV purchased by weight, suggesting that top-up vouchers effectively increased HSV-recommended food products as opposed to other items such as juice or dried fruit. In essence, top-up vouchers were used as intended; 98% of baskets contained at least £2 worth of ‘Suggested’ FV, and they were associated with an increased number of ‘Suggested’ FV portions purchased by 5.5 portions when compared with the non-redeeming baskets. Concurring with these findings, a US supermarket

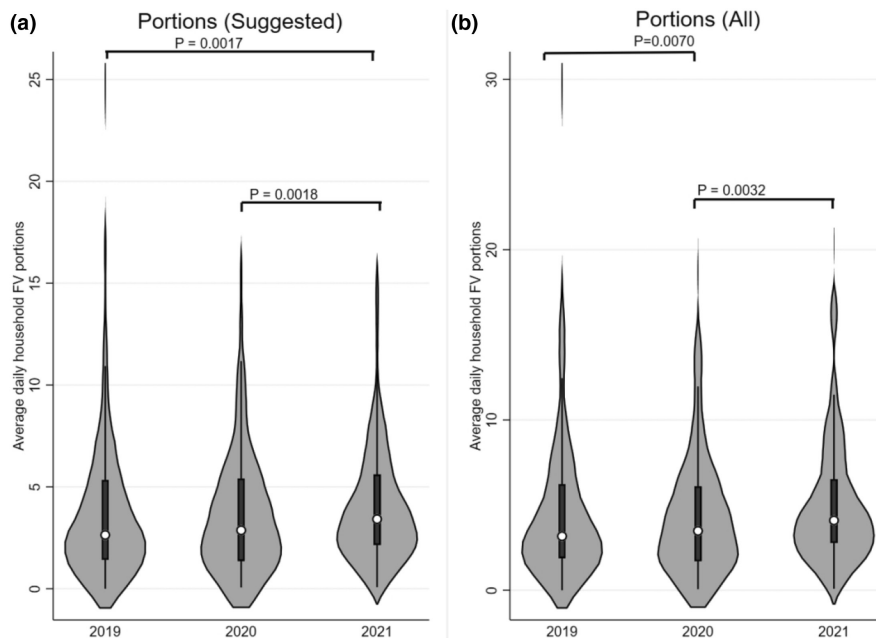


FIGURE 3 Change in daily portions of fruit and vegetables (FV) purchased. (a) Number of FV portions purchased per day per household according to 'Suggested' definition (b) Number of 'All' FV portions purchased per day per household. Each year relates to the scheme period or equivalent only (15 February–31 August). Mean values calculated for each households' total baskets ($n = 133$). Statistical significance tested by the Wilcoxon matched-pairs sign-rank test. Significance level displayed for $p > 0.05$. Median denoted by white dot. Interquartile range denoted by the thick black bar. The distribution of the data is denoted by stretched black lines filled with grey shading.

TABLE 4 Comparisons of non-redeeming and Healthy Start voucher top-up redeeming baskets.^a

Variable ^b	Non-redeeming ($n = 4813$)		Redeeming ($n = 484$)		Wilcoxon test	
	Median	Range	Median	Range	Z	p-Value
Total basket						
Total spend, £	–	–	–	–	3.958	0.0001
Total weight, kg	–	–	–	–	3.960	0.0001
Suggested						
FV spend, £	–	–	–	–	4.132	<0.0001
FV weight, kg	1.84	0.46–10.52	2.28	0.35–12.80	5.466	<0.0001
FV spend ^c %	20.14	4.38–100.00	20.53	2.97–100.00	3.221	0.0012
FV weight ^c %	21.99	6.34–100.00	23.61	3.90–100.00	2.723	0.0062
FV portions	22.99	5.81–131.54	28.45	4.38–159.98	5.466	<0.0001
All						
FV spend, £	–	–	–	–	6.877	<0.0001
FV weight, kg	2.14	0.47–14.47	2.88	0.35–14.62	6.299	<0.0001
FV spend ^c %	23.28	6.72–100.00	25.53	4.51–100.00	3.648	0.0002
FV weight ^c %	26.08	6.78–100.00	28.74	5.06–100.00	3.168	0.0014
FV portions	25.12	4.98–159.57	34.44	4.38–182.71	6.495	<0.0001

Note: '–' represents exact values suppressed due to commercial sensitivity.

Abbreviation: FV, fruit and vegetable.

^aPurchasing at least 1 FV item.

^bData were tested for normality using the Shapiro–Wilk tests. Differences between each customer mean variable were assessed using Wilcoxon matched-pair signed-rank test.

^cExpressed as a percentage of total food and drink spend and weight.

intervention found low-income households bought 10.5 more FV portions a week when a 50% refund of FV was offered (Phipps et al., 2015). Interestingly, this served as

a disincentive when lowered to 25%, raising the question of whether a lower top-up voucher amount would have had a similar effect. With the £2 top-up voucher

FIGURE 4 Proportion of fruit and vegetables (FV) purchased in each households' ($n = 150$) mean non-redeeming and redeeming baskets. Calculated as a proportion by total weight (kg) purchased for each household. Bold denotes significantly different from non-redeeming. FV, fruit & vegetable; redeeming, Healthy Start voucher top-up redeeming baskets; non-redeeming, non-redeeming baskets.

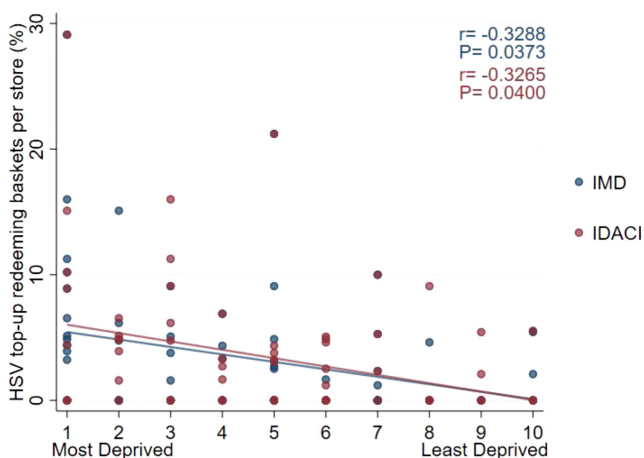
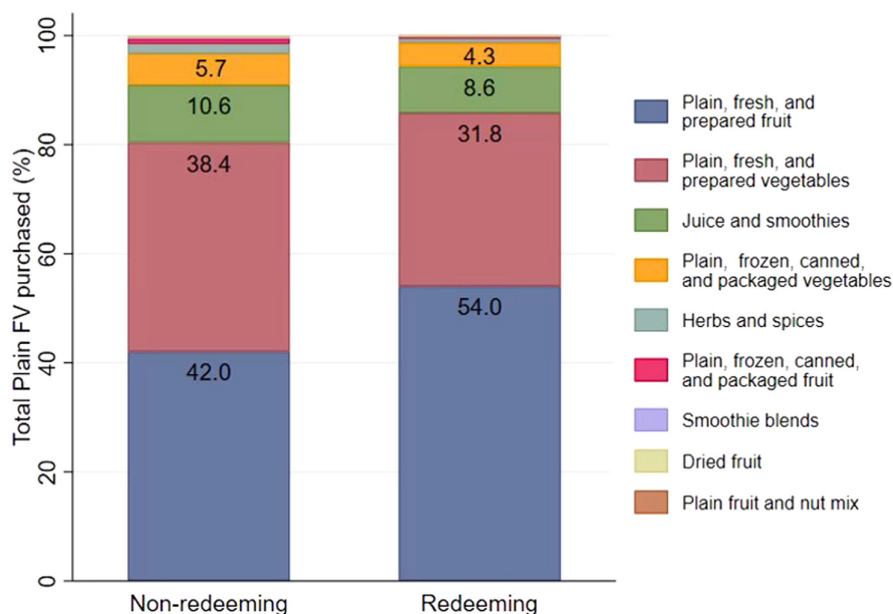


FIGURE 5 Relationship between deprivation and Healthy Start voucher (HSV) top-up voucher redemption rate for stores within the Yorkshire and the Humber region. Each store was assigned an IMD and IDACI decile. HSV top-up redeeming baskets per store (%) refers to the proportion of HSV top-up redeeming baskets recorded out of all baskets made by the households ($n = 150$) in each store. IDACI, Income Deprivation affecting children index; IMD, Index of Multiple Deprivation.

used in this intervention, households purchased more FV than those not using a top-up voucher. Provided purchases extrapolate to FV consumption, this shift could have a strong nutritional benefit (World Health Organization, 2012). For children in particular, cost-benefit analyses of early years nutrition interventions show strongly favourable economic and social benefits including increased lifetime earnings and savings to the NHS (Impact on Urban Health, 2022).

The analyses highlight that HSV households predominantly chose to buy fresh FV, despite canned products being permissible during the 2021 study period (Department for Health and Social Care, 2020),

and UK government advice that frozen and canned fruit and vegetables help the voucher 'go further' (HM Government, 2020). Our observations that redeeming baskets were comprised of 12% proportionally more fruit than non-redeeming baskets match US findings that when cash-value vouchers were supplied to low-income families, sales were dominated by fresh FV, with twice as many fresh fruit purchases (Andreyeva & Luedicke, 2015). Similarly, in separate work, incentivised shoppers (50% refund on FV), increased spending on fresh produce specifically (Moran et al., 2019). Fruit is deemed expensive by HSV using parents (Lucas et al., 2015), and childhood FV interventions have been found to be more successful for fruit intake than vegetable intake (Evans et al., 2012). Therefore, the low-income households in this study were perhaps purchasing fruits that were unaffordable without the top-up, and more likely to be accepted by children (Daniel, 2016).

One surprising finding was, perhaps, the low number of vouchers redeemed, given the pressing need for fiscal support in low-income families with top-up vouchers only being redeemed on 9.1% of occasions where FV were purchased. That said, the scheme had a higher uptake than similar campaigns run by Sainsbury's. During the trial period, almost 38 000 top-up vouchers were used nationally, which was 17% of all vouchers printed. This was higher than typical redemption rates of other types of printed vouchers at the time (IGD, 2022). Our study considered HSV users that had engaged with the retailer top-up scheme in the Yorkshire and the Humber region, and these users represented only 0.4% of active HSV users in the region in August 2021 (NHS, 2023b). However, in addition to the higher average redemption rate than other schemes, the government HSV scheme is not utilised by all those eligible (NHS, 2023a). If households redeemed their government HSV weekly, up to 26 top-up vouchers (or 52 for

expectant mothers and families with infants) could have been redeemed per household, yet most households had only one redeeming basket. As households could use multiple government HSV in the same transactions, perhaps the scheme would have been more effective if the top-up voucher was printed alongside the government HSV. Alternatively, an immediate discount at check-out may be more impactful than a coupon to be redeemed in the future, something which has been shown in a previous supermarket-based fiscal incentive (coupon for 50% off) intervention in low-income families in the United States (Polacsek et al., 2018). This may be more feasible in the context of the move to digitisation.

This work comes at a critical time with a focus both in the United Kingdom and internationally on tackling diet-related inequalities and creating an equitable food system. We observed a significant linear relationship between redemption rates of the scheme and store location in relation to multiple indices of deprivation (IMD and IDACI deciles), with the highest uptake in the most deprived store locations, underscoring the need for additional support for the poorest families. Our data augment and are consistent with both national dietary survey data that shows FV intake increases with household income (Public Health England, 2019), and transaction analysis which demonstrates the most deprived households purchase 1.5 fewer portions FV a day than the least deprived (Jenneson et al., 2020). While the recent policy paper *Levelling Up in the United Kingdom* acknowledges that the healthy life expectancy deprivation gap is partially driven by access to a healthy diet (Department for Levelling Up Housing and Communities, 2022), it was disappointing that the government's food strategy paper released in June 2022 (Department for Environment Food and Rural Affairs, 2022) did not address the recommendations made to expand the Healthy Start programme in the National Food Strategy published in 2021 (National Food Strategy, 2021).

Our study had some limitations. We only had access to data for loyalty card users and the subgroup analysed was non-random and only accounted for a small proportion of Healthy Start-using households, not a complete representation (NHS, 2022). Missing household demographic data meant variables such as family size and age could not be controlled for. Multiple households could be using one loyalty card, households may forget their loyalty card on occasion and it was unlikely that these households would shop exclusively at the retailer. We did not have access to HSV usage data, so it was unknown what transactions HSVs were redeemed against. Nor could we know if any households became eligible or ineligible during the intervention period, the amount of HSV they received per week, or the effect of the increased government value (from £3.10 to £4.25/week in April 2021). In addition, we observed an

overall increase in total household purchases by spend and weight between 2019 and 2021 which may be explained by shifts in purchasing during the pandemic when more out-of-home food retailers were shut down. In sum, it was not possible to isolate the effect of the £2 top-up alone or confirm the causal effect of the observations. Furthermore, these data represent purchases of FV, but we cannot be certain that they were actually consumed, or by whom.

Nonetheless, a major strength of this study was our use of a large transactional dataset and examination of within-family purchasing patterns across multiple years. Loyalty card data are a reliable indicator of household purchases (Tin et al., 2007) and have a large application for evaluating interventions and policies (Jenneson et al., 2022). The top-up voucher allowed for the identification of low-income households and examining their transaction data longitudinally, as well as comparing non-redeeming and redeeming baskets, has yielded rich insights into how this population were shopping. Previous research has been conflicting, with some reports showing that the provision of HSVs alone does not increase FV purchases (Parnham et al., 2021; Scantlebury et al., 2018). Whereas, others have reported a positive benefit of HSV provision on FV purchases (Griffith et al., 2018), and women enrolled on the programme have also reported increased quantity and variety of FV purchased (Lucas et al., 2015; McFadden et al., 2014). These variable findings may be because some families will use HSV to increase FV purchases, while others will use them to shift food expenditure to other household essentials (Ohly et al., 2017). In this study, the percentage of FV by both spend and weight was larger in household shopping baskets purchased when redeeming the top-up vouchers. Our results support the existing literature that the use of supermarket initiatives can effectively improve consumer purchasing and potentially dietary intakes and health (Mah et al., 2019).

CONCLUSION

This study provides novel insights into how low-income households in the north of England shopped before, during and emerging from the COVID-19 pandemic. The data show that a supermarket-led scheme of fiscal top-up to government HSVs, when specifically ring-fenced for FV, increased FV purchases in low-income households that used the top-up vouchers. The number of FV portions purchased per household increased by an average of 0.9 portions per day, and the use of the top-up voucher was associated with a significantly higher proportion of plain, fresh and prepared fruit purchased. The results are consistent with those from other public health programmes that show safeguarding funds for FV purchases increases FV

access for at-risk households and should inform future public health policy aimed at levelling up food poverty and health inequalities. However, take-up of the top-up vouchers was low, and consideration should be given towards ways of increasing take-up for future schemes.

AUTHOR CONTRIBUTIONS

M.T., N.S. and M.A.M. conceptualised the study. M.T., D.A.O., A.D., T.R. and E.L. investigated the study. M.T. did the formal analysis. M.T. and J.B.M. contributed to methodology and writing—original manuscript preparation. J.B.M. and M.A.M. supervised the study and administered the project. M.T., J.B.M., N.S. and M.A.M. contributed to writing—review and editing.

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CONFLICT OF INTEREST STATEMENT

While the data were provided by Sainsbury's, the company played no role in the data analysis or interpretation. At the time of submission, M.T. and N.S. work for Sainsbury's and T.R. and E.L. are former Sainsbury's employees. At the time of analysis, M.T. was an undergraduate nutrition student at the University of Leeds supervised by M.A.M. and J.B.M.

DATA AVAILABILITY STATEMENT

Due to the commercial nature of the data used in this research, it is not possible for data to be published alongside the article.

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