

Evaluation of Interventions in Online Grocery Shopping for Sustainability and Health: An Adaptive Design Randomized Controlled Trial

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Abstract

Effective interventions are needed to promote more sustainable and healthier food choices for both human and planetary health. This study will evaluate two interventions in two independent adaptive design randomised controlled trials (one 2-arm and one 3-arm trial) within the same study population (a factorial design is not powered). The interventions are (i) eco-labelling, which will provide participants with information on the environmental impact of their food purchases using a score ranging from A (most sustainable) to G (least sustainable); and (ii) price discounts on alternative products with a better sustainability profile (and equal or better nutritional profile) in place of specific products in their basket. To implement these interventions, we will use a browser extension on online shopping websites for one or multiple large UK supermarkets, accessed using the Google Chrome browser on a desktop or laptop computer. We will assess the effect of these interventions on the average eco-score of the basket (primary outcome) as well as its nutritional content (secondary outcome). Health outcomes of the intervention will be modelled using nutrition scores.

¹ The SALIENT consortium – researchers from the Universities of Oxford, Cambridge, Birmingham, Liverpool, Warwick, Hertfordshire, LSHTM, and the research institutes NESTA and BIT – were awarded funding for the ESRC’s call ‘Food system trials to encourage healthy, sustainable diets. In the co-design phase of this grant, which ran from 3 January 2023 to 31 May 2023, the consortium has worked with the public, the Programme Board (representatives from DEFRA, FSA, DLUHC, DHSC, DfE and the Cabinet Office) and many food system partners from the retail, catering and community support sectors to co-design a series of trials to understand what works, for whom, in what circumstances, and why for promoting healthy, sustainable and equitable diets across multiple settings in the food system in England.

Executive summary

What is already known?

- The food system is responsible for more than one third of total global greenhouse emissions, while also contributing to land degradation and biodiversity loss. It will be necessary to reduce emissions from the food system to achieve agreed climate targets including a maximum global temperature increase of 1.5°C.
- Poor diets are responsible for 1 in 7 deaths in the UK. More environmentally sustainable diets are likely to be better for human health as well.
- Effective interventions are urgently needed to promote more sustainable and healthier food choices for both human and planetary health.
- Online grocery shopping is on an upward trend and understanding behaviour in this setting is therefore increasingly important. As well as elucidating effective approaches to shift online shopping towards healthy and sustainable purchases, studies of interventions in the online shopping environment also provide an opportunity to examine the behaviour of many consumers, which would be more difficult and more costly in physical supermarkets.
- There are no existing randomised controlled trials examining sustainability outcomes in real (not simulated) online grocery stores. Previous work has focused on healthier choices. Most of these studies found that economic interventions, such as price discounts, show the most promise, and a few found swaps to be effective as well.
- There are no existing randomised controlled trials evaluating the effect of price interventions in real online grocery stores. The setting of all previous studies on price interventions was either a physical supermarket or a simulated online supermarket. The very limited number of studies on swaps (2 studies) and information interventions (3 studies) in real online grocery stores provide mixed evidence, indicating that these interventions may prompt healthier purchasing in some circumstances for some people.
- Studying actual shopping behaviour in real online grocery stores is important because consumers often behave differently in simulated environments. For example, it has previously been noted that nutrition labelling appeared 17 times more effective in laboratory studies than real grocery settings.
- We have shown in a pilot study that it is feasible to run a field trial on an actual online supermarket website using a bespoke browser extension and have learned valuable lessons on how to implement such a trial.

What does this study add?

- This will be the first study to provide causal evidence on interventions to promote sustainable food purchases from a large sample of consumers in a real online grocery shopping environment.
- We will add to the evidence base on how choice architecture influences purchasing behaviours and provide evidence on two interventions: (i) eco-labelling, which will provide participants with information on the environmental impact of their prospective food purchases using a score ranging from A (most sustainable) to G (least sustainable); and (ii) price discounts on alternative products with a better sustainability profile (and equal or better nutritional profile) offered in place of specific products in participants' baskets.
- Our study results will also allow us to calculate consumers' willingness to pay for more sustainable groceries.

- As secondary outcomes, we will look at whether either intervention affects total purchases. We will also examine the impact on the nutritional composition of purchases and (modelled) health outcomes.
- This study will provide evidence about the potential for eco-labels, or for food subsidies that could alter the prices of sustainable food relative to less sustainable food, to change consumer behaviour to meet health and sustainability goals.

How will we determine this?

- A large-scale cross-sectional randomised controlled trial with real consumers doing their usual shopping over a two-month period on the website of a large UK supermarket. The trial will be implemented using an adaptive design in up to five waves for cost reasons.
- Members of the public were involved in the design of this study and associated study materials.
- Participants will be recruited from the UK Prolific panel and will be compensated for their participation in this study. The Prolific panel is not representative of the UK population but provides good coverage of different socio-economic and demographic groups. We will only recruit participants who are the primary grocery shoppers for their household and who report buying groceries online at least once a month.
- Participants will be randomly allocated into different arms at the start of the trial. The two interventions will be independently randomised within the same study population so that there are effectively two independent trials. One of these will be a 2-arm trial (eco-labels on or off) and the other one a 3-arm trial (price discount of £1 or £0.50 or no discount). The study is not powered to detect any interaction between the two interventions being tested.
- To implement the interventions, we will use a browser extension (plug-in) that manipulates the supermarket website when participants access it through the Google Chrome browser on a desktop or laptop computer.
- The plug-in will collect data on product selections, substitutions and purchases. Additionally, survey participants will be surveyed for information on demographics and attitudes towards food shopping and sustainability.
- We will assess the effect of these interventions on the average eco-score of the basket (primary outcome) as well as its nutritional content (secondary outcome). Health outcomes of the intervention will be modelled using nutrition scores.
- A separate process evaluation will consider what worked, for whom, and in what circumstances.

Background

Our food systems play a pivotal role in environmental degradation. Between 1990 and 2015 the production, distribution and preparation of food contributed more than one-third to total greenhouse gas emissions globally, significantly impacting global warming, land degradation, and biodiversity loss (Crippa et al., 2021; Smith et al., 2014). Addressing these challenges requires changes in diet (Willett et al., 2019). Even if all other fossil fuel emissions were halted immediately, emissions from the food system alone would prevent us from achieving the Paris target of global warming by no more than 1.5 degrees (Clark et al., 2020). Effective policies and interventions that promote sustainable food choices are needed and will have large impacts. For example, if 50 to 75% of the global population adopts a plant-rich diet by 2050, global carbon dioxide emissions would go down by 54-78 gigatons (Accuardi et al., 2020), and global land use for agriculture would decrease by 75% (Ritchie, 2021) mainly due to the reduction in land used for grazing.

More sustainable diets are often better for health as well. Poor diets are responsible for one in seven preventable deaths annually in the UK (Afshin et al., 2019). Poor diet has been linked to increased risk of cancer and cardiovascular disease, as well as worse mental and dental health (Mahboobi et al., 2021; Milajerdi et al., 2018; Mujcic & J Oswald, 2016; Naghshi et al., 2020; Oyeboode et al., 2014; Pagliai et al., 2021; Saghafian et al., 2018). Overweight and obesity are highly prevalent in the UK in both adults (64%) and children (40%) and their direct and indirect costs to our society are estimated to be £58 billion per year (Palmer, 2022). Differences in diets across socio-economic groups generate substantial inequalities in long-term health and economic outcomes (England et al., 2013). The health co-benefits from a nutritious diet provide further urgency to adopt policies that encourage sustainable and healthy food choices.

The market share of online grocery shopping was rising fast over the past decade, strongly accelerated at the early stages of the COVID-19 pandemic and now seems to have stabilised at about 12% (Statista, 2023). This creates an opportunity for evaluating interventions because the online environment can rapidly be adapted and facilitates data collection of large samples. A limitation of the online setting for health interventions is that families that are poorer or live in deprived areas are less likely to shop online (Ali et al., 2022) and will therefore be underrepresented in an online sample. For interventions aimed at improving sustainability, as in this study, this sample bias is not necessarily a limitation. There is little evidence of the correlation between the sustainability of grocery shopping and income or SES, and the results of our pilot study suggest that the correlation may be reversed. We found that online grocery baskets of shoppers with household income below £20,000 not only purchased substantially fewer and cheaper products, but products that were on average rated as more sustainable as well (Bentil et al., 2024). Therefore, the potential sustainability gain may be largest for wealthier shoppers.

A systematic review of randomised controlled trials of grocery store interventions, published up to 2017, included 35 studies of 89 interventions, mostly involving physical and simulated supermarkets. None of these studies focused on sustainability; instead, they aimed to promote healthier choices (Hartmann-Boyce et al., 2018). Economic interventions, such as price discounts, showed the most promising effects with eight of nine studies in real stores and all six in simulated environments significantly affecting purchasing behaviour. Swaps were also found to be promising based on two studies in real stores.

Our current understanding of effective interventions to change purchasing behaviours in online grocery shopping environments is more limited. A scoping review of studies published up to 2022 identified 15 articles (Valencic et al, 2023). Ten of these used simulated online stores, including several where the participants did not actually purchase or receive any groceries. The simulated store studies identified some promising interventions, including healthy swaps, which were effective in two RCTs included in the review (Koutoukidis et al, 2019; Payne Riches et al, 2019). Further studies in simulated online environments have examined interventions to promote sustainability including through information interventions such as carbon footprint or eco-labelling, with mixed results (Kanay et al, 2021; Panzone et al, 2021; Potter et al, 2022). It is unclear whether any effects detected in these virtual supermarket studies would transfer to real shopping conditions. For example, it has previously been noted that nutrition labelling appeared 17 times more effective in laboratory studies than real grocery settings (Dubois et al, 2021).

There are very few completed studies using real online stores, including five identified in the scoping review (Huang et al. 2006, Stuber et al. 2022, Sacks et al. 2011, Coffino et al. 2020, Coffino and Hormes 2018), and a further three additional identified through our searches (Bunten et al. 2022, Coffino et al. 2021, Anzman-Frasca 2022). These include trials of both information interventions and swaps, with mixed evidence on effectiveness of both interventions. All studies focused on driving healthier purchasing and none examined sustainability outcomes. None of these studies examines price interventions.

Regarding swaps, one study found that participants randomised to receive recommendations of alternative products lower in saturated fat when they had chosen to select products high in saturated fat, purchased less saturated fat overall (Huang et al, 2006). A second RCT trialled both information and swaps to promote healthy purchasing in an online grocery store in a factorial design. The swaps intervention involved displaying healthy alternative products on comparable unhealthy product pages (e.g.: wholegrain bread options on white bread product page) and introduced four standardised healthy products on the check-out page. This swaps intervention did not affect purchasing behaviour (Stuber et al, 2022). Neither swap intervention included any element of price matching or discounting.

The information intervention in Stuber et al. (2022) involved highlighting the convenience, tastiness and popularity of healthy food categories. This significantly increased the percentage of healthy purchases for participants living in deprived areas but had a significant adverse effect among shoppers from non-deprived areas where percentage of healthy purchases went down. In a further study, intervention participants were randomised to website banners (visual advertisements) that promoted healthier versions of the same products promoted to control participants. This resulted in healthier purchases of some items, but not others (Bunten et al, 2022). Finally, traffic-light labelling had no effect on the healthiness of purchases in one RCT (Sacks et al, 2011).

One other type of intervention has been trialled in real online grocery stores: the use of pre-filled grocery carts. All four studies of this type of intervention reported that participants in the intervention group made healthier purchases (Anzman-Frasca 2022; Coffino and Hormes, 2018; Coffino et al, 2021; Coffino et al, 2020).

Overall, the evidence from the very limited number of studies in real online grocery stores suggests that information and 'swaps' interventions can work for some people in some circumstances but

there have been no investigations of price interventions in this setting, and none of the identified studies examines sustainability outcomes. This is the evidence gap our study will seek to fill.

We aim to test two interventions, (i) eco-labels and (ii) price discounts on more sustainable alternative products, within a real online grocery shopping environment. The interventions are implemented by asking participants to download a browser extension (plug-in) that manipulates the appearance of the website of a large supermarket and collects data on their purchases there. The aim is to evaluate whether the interventions promote more sustainable food purchases. We will also consider the effect of the interventions on secondary outcomes including nutritional content of baskets and health.

Research Questions

1. What is the impact of (i) eco-labels and (ii) price discounts on more sustainable product alternatives, on the sustainability of groceries that are purchased, as measured by the average eco-score of all products in the shopping basket?
2. How do any changes in grocery purchases induced by each intervention affect the nutritional properties of purchased groceries, modelled health outcomes, and other co-benefits or unintended consequences?

We test the null hypothesis that eco-labels and price discounts have no effect on the purchase of more sustainable choices against the alternative that these interventions promote more sustainable choices. The two interventions will be independently randomised within the same study population so that these will be two independent tests. We will attempt to also test the hypothesis that both interventions together are more or less effective than the sum of both (factorial design), but we do not expect that this test will be significant with the number of participants that we are able to recruit.

Policy Implications

Reducing carbon emissions and improving diets are priorities for the UK. The current government has made a legal commitment to reduce the UK's carbon emissions to net zero by 2050 and protect 30% of UK land for nature by 2030 (*Net Zero Strategy: Build Back Greener*, 2021). The government's climate change committee says we must change our diets to meet these targets (*Land Use: Policies for a Net Zero UK - Climate Change Committee*, n.d.). A government commissioned independent review of the food system recommended a 30% increase in fruit and vegetable consumption, a 25% reduction in food high in fat, salt, and sugar and a 30% reduction in meat for health and environmental reasons (Food Strategy, n.d.). Successive governments have also published more than 14 obesity strategies, including numerous policies to increase fruit and vegetable consumption, demonstrating sustained political interest in this area (Theis & White, 2021). Designing policy to support these changes requires high-quality large-scale evidence on the effectiveness of interventions.

If implemented, the interventions tested in this study could have significant policy implications, including:

- Improving diets and reducing carbon emissions: Implementation of eco-labels and price discounts has the potential to contribute to improving diets and reducing carbon emissions. By encouraging consumers to make healthier and more sustainable choices, these interventions can contribute to environmental sustainability and positively impact public health.
- Encouraging a positive response by the food industry: The increased awareness of sustainable purchasing fostered by these interventions may prompt food industries to reformulate their products. With consumers showing a preference for more sustainable options, the food industry could respond by developing and offering products that align with these preferences. This, in turn, may contribute to a broader shift toward more sustainable and environmentally friendly practices within the food industry.

The findings from this trial, synthesised with wider literature, will be able to support the justification of any decision to implement these interventions or re-direct attention to other policy options.

Theory of Change

The theory of change is different for eco-labels and price discounts on more sustainable alternative products. As a factorial design is likely not powered, we develop a theory of change for each separately and do not consider potential interactions between the two interventions.

A theory of change for eco-labels is presented in **Figure 1**. We anticipate that the evidence on the effectiveness of eco-labels that we will provide will inform decisions on mandatory labelling as a policy to support a sustainable food system. This, in turn, will contribute to increased availability of environmental impact information for all products, both online and in-store. Increased awareness may be expected to drive consumers toward making more sustainable food purchases, both online and in-store. Over time, this shift in consumer behaviour could result in a reduced overall purchase of unsustainable food products, increased demand for more sustainable products, and incentives for producers to reformulate their products to achieve better environmental impact scores, ultimately contributing to the establishment of a more sustainable food system. Additionally, the shift in diets may also improve public health outcomes.

The magnitude of the various channels represented by arrows in the ToC and the direction and size of the effects depend on the reasons why consumers are currently not purchasing sustainable groceries. The evidence we will provide should shed light on the following possibilities, where different hypotheses may be true for different people.

- If eco-labels provide information to shoppers who want to buy eco-friendly products but do not have information on what these products are and are unable to gather this information themselves, then we would expect that eco-labels increase purchases of more sustainable products relative to less sustainable ones.
- If shoppers ignore the information on the eco-labels because they do not care about sustainability, the prediction would be that there is no effect of eco-labels.
- If shoppers dislike being nudged to purchase sustainable products and rebel, then we can expect that introducing eco-labels decreases purchases of more sustainable products relative to less sustainable ones.
- If shoppers get discouraged due to the extra effort they need to put into their shopping decisions and/or because they are unhappy about their environmental footprint but feel

unwilling or unable to improve it (or at least unable to improve aggregate sustainability), then eco-labels would decrease purchases at the retail outlet where products are labelled, because shoppers would avoid this outlet, but would not affect the ratio of sustainable versus non-sustainable products.

The theory of change price discounts on more sustainable alternative products (**Figure 2**) has some similarities with the ToC for eco-labels, but there are important differences. Evidence on the effectiveness of price discounts on more sustainable product swaps from this study may inform pricing strategies of retailers interested in promoting sustainable food products or government subsidies or tax credits to encourage such pricing strategies. The effectiveness of swaps offering more sustainable alternatives for intended purchases may be limited without associated price discounts in a situation where the alternative products are (much) more expensive as is the case e.g. for many plant-based alternatives to meat and dairy. Offering price discounts on swaps for more sustainable alternatives to products in their basket ensures that all shoppers receive discounts that are relevant to them and can find them easily, while the swaps also serve as an opportunity to provide information about the sustainability of different food products, educating consumers about the environmental impact of their food purchases.

Interventions that induce a shift in consumer demand towards more sustainable food choices incentivize retailers to offer and promote more environmentally friendly products, potentially initiating demand-led transformation of the food system.

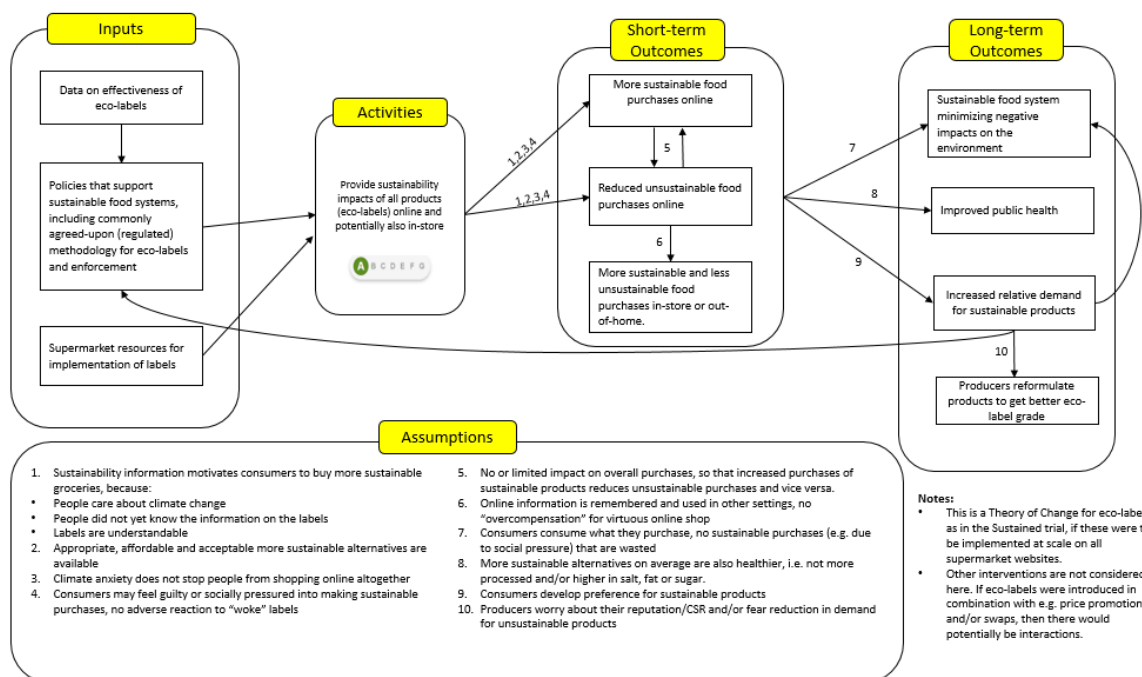


Figure 1: Theory of Change for eco-labels

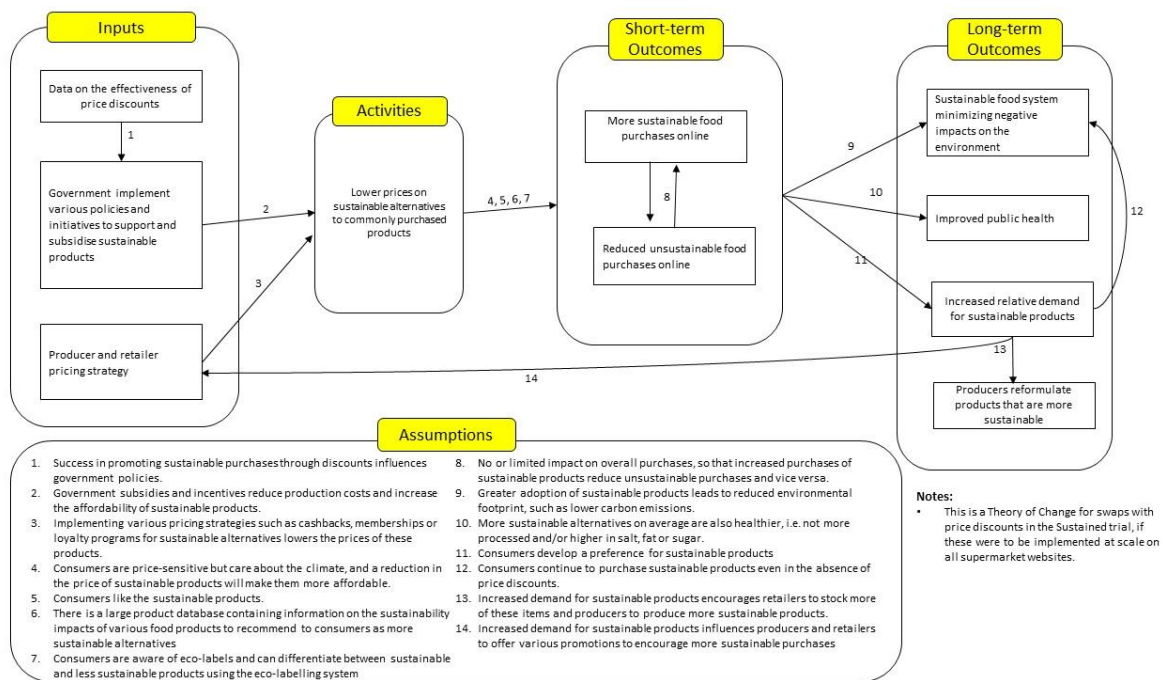


Figure 2: Theory of Change for swaps with price discounts

Public involvement

Public involvement groups were consulted at the co-design phase and around the piloting work. In the run-up to and during the piloting, one in-person workshop with the University of Hertfordshire (UH) young person's group (YPAG) and two online meetings with the UH adult public involvement group (PIRg) were held. The young person's group completed a workshop session using the browser extension (plug-in) as part of group work and feeding back to the larger group. In this workshop, participants were asked to consider their purchasing decisions for breakfast, packed lunch, and snacks. The adult group were introduced to the trial and the plug-in and invited to download it and report back on their experiences in structured online sessions. Not all the PIRg wanted or were able to download the plug-in, but all were happy to learn more about it and discuss.

Towards the end of the pilot and post-pilot, one-to-one meetings and peer feedback exercises were carried out with members of the SALIENT Community Network Group (CNG) in a more responsive or 'trouble shooting' capacity. Participants were tasked with addressing specific queries arising from the pilot and preparations for the trial, including looking for instances where the eco-labels were very unexpected, identifying aspects of the downloading processes that might discourage potential participants from taking part, and suggesting ways to reassure potential participants about cyber-security concerns. CNG members consulted their wider networks about these questions and reported back.

Setting, Recruitment and Study Design

This protocol has been informed by a pilot study, which was run in September and October 2023. Methods and results of the pilot are presented in Bentil et al. (2024).

Our setting is the online grocery shopping environment on the website of a large UK supermarket. We will use a browser extension (plug-in) to implement the interventions and collect purchase data.

Underlying the plug-in is a database with information on the environmental impact of over 160 thousand products. The plug-in was developed by Sustained (<https://sustained.com>) and customised based on our specifications. It can be used to display eco-labels and/or offer price discounts on more sustainable alternative products, depending on the participant's ID, which is randomly allocated to one of the arms of the trial. The plug-in also records information on products in the shopping basket, any swaps or clicks on the eco-labels, and products that are eventually purchased.

Participants will be recruited from the online research platform, Prolific (<https://www.prolific.com/>). To be eligible for the study, participants must:

- Be 18 years or older and located in the UK
- Be the primary grocery shopper of their household
- Frequently buy groceries online (at least once per month, self-reported)
- Usually shop at the supermarket(s) included in this study
- Usually use a laptop or desktop with the Google Chrome browser for online grocery shopping or be willing to do so for the duration of the study
- Consent to participate and be willing to download and install the plug-in and use it for the duration of the study
- Not have participated in the pilot study or previous wave(s) of the study.

These eligibility criteria are informed by the pilot study. We found that take-up is much lower among participants who were asked to shop at a different supermarket than where they usually shop, but participants who usually shop on a mobile device and therefore need to change their shopping behaviour to use the browser extension are no less likely to shop using the extension than those who usually use a desktop or laptop (Bentil et al., 2024).

The study will use a cross-sectional Randomised Controlled Trial (RCT) design. For participants in the intervention group, the intervention will be on from the start and there will not be a baseline period. The reason for this is that the results from our pilot study showed that inter-participant variation in the primary outcome was similar to intra-participant variation. Therefore, there is no efficiency gain from controlling for individual-specific fixed effects by comparing changes rather than levels of purchases. In a longitudinal design, some observations are lost, because some participants did not shop either in the baseline or in the intervention period, and our pilot results consistently showed a more precise estimation of the treatment effect in a cross-sectional design.

The trial will run over 8 weeks. If self-reported shopping frequency were accurate, our eligibility criteria would guarantee 2 shops per participant in a one-month trial. However, the pilot study showed that participants were shopping substantially less frequently than they said they would. On the other hand, we found that attrition did not increase over the one-month duration of the pilot, suggesting that a longer trial duration would be preferable. After the end of the trial period, participants are allowed and encouraged to keep using the plug-in and we will continue to collect their purchase data for use in future research. We will explicitly ask for consent for this post-intervention period of data collection at the start of the trial.

We will use an adaptive design for the RCT (**Figure 3**). An adaptive design, rather than the traditional fixed sample size RCT design, was chosen because uncertainty regarding recruitment rates and attrition makes determining the sample size challenging. The adaptive design will enable a reassessment of the sample size requirements and the potential to stop the trial early should interim analyses indicate success or futility, ensuring a more efficient allocation of resources and time (Pallmann et al., 2018).

The study will thus be implemented in phases or waves. We will approach Prolific panellists in four or five waves of 10,000 people, with the aim of recruiting around 700 participants in each wave, until we reach the sample size required for a 2-arm trial with a 2-month intervention period or until it becomes clear that it is futile to try and reach this sample size. As illustrated in **Figure 4**, we will use data from wave 1, anticipated to start in April 2024, to determine the number of people who shop during the trial (recruitment rate). Based on this information, we will recalculate the sample size requirements and continue with wave 2 only if it seems likely that after a maximum of five waves, we will successfully recruit a sufficiently large sample. This exercise is repeated after each wave. Between the second and third waves there is a two-months break to avoid the summer holidays, when shopping patterns may be atypical. We will use this break to consider whether we need to relax our eligibility criteria, add a fifth wave, add a second supermarket, increase compensation, or make other changes to the study design.

We have obtained ethical approval for our study from the University of Warwick's Humanities & Social Sciences Research Ethics Committee (reference: HSSREC 123/23-24). We will obtain written informed consent from participants through the online survey, which will start with an informed-consent form, approved by the HSSREC.

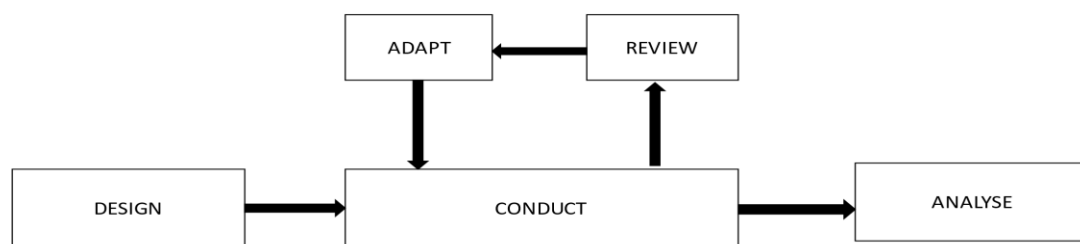


Figure 3: Schematic showing how an adaptive design is implemented, adapted from Pallmann et al. (2018)

	April	May	June	July	August	Sept	Oct	Nov
Wave 1								
Wave 2								
Wave 3								
Wave 4								

Figure 4: Schematic showing the waves of data collection to be implemented.

Data from each wave will be used to recalculate the sample size requirements and inform the decision whether or not to continue with the next wave. Data from waves 1 and 2 will also be used to decide whether we need to relax our eligibility criteria, add a fifth wave, add another supermarket, and/or increase compensation. Light yellow indicates the data collection period for each wave.

Study Interventions

We will evaluate the following two interventions:

1. *Eco-labelling*: Eco-labels provide consumers with information on the environmental impact of their food purchases, graded from A (lowest impact, most sustainable) to G (highest impact, least sustainable) based on an underlying numerical score ranging from 0 (most sustainable) to 500 (least sustainable). These environmental impact scores were calculated based on the ingredients in 1kg of each product, which are then linked to the life-cycle analysis (LCA) database Agribalyse. The scores take into account the environmental impact of a product in 16 categories, including land use, water scarcity, resource use, human health, wildlife damage, and climate change. More details on the methodology are provided in appendix A.
2. *Price discounts on more sustainable alternative products*: Price discounts will be offered through swaps at the first checkout screen. Participants will see a pop-up window suggesting a more sustainable alternative for a particular product in their basket, which is offered at a randomly varying price discount. The alternative products are selected to not cost £2.00 more than the original product, and price discounts will be offered at three levels: £1.00, £0.50 or no discount. The intention is that this will result in discounts being roughly equally spaced between 0 and 100% of the price difference between the original and the alternative products (explicitly offering percentage discounts is not feasible for technical reasons, because it would involve “live” scraping of the prices). We will use this information to calculate the willingness to pay for more sustainable products. As an example, a participant may be prompted to swap Greek yoghurt (500g) priced at £2.30 for dairy-free coconut yoghurt (600g) priced at £3.60, and the pop-up will notify participants that they can buy the coconut yoghurt for £2.60, £3.10 or the full price of £3.60, depending on the trial arm that the participant was assigned to. If the shopper accepts the swap, they will be reimbursed for the price discount. Each participant will get offered a swap for a (potentially discounted) alternative product on up to 3 products in their shopping basket. The products for which a swap is offered are randomly chosen from a list, composed by the researchers, of not-so-sustainable products with suitable alternatives. To avoid offering alternative products with an inferior macronutrient profile, alternative products on the list will be selected so that they are in the same or a better category for fat, sugar and salt content on the traffic-light label.

Randomisation

The randomisation is independent for each of the two interventions. We will randomly assign half of the sample to the eco-labels (intervention) group and the other half to the no eco-labels (control) group. Similarly, we will randomly assign participants to one of the three arms of the price discount trial so that roughly one third of participants will receive £1.00 price discounts on their swaps, one third will receive £0.50 discounts, and one third will not receive a price reduction on the alternative products that they are offered. This randomisation process is illustrated in **Figure 5**.



Figure 5: Schematic showing study groups and randomisation process for the 2-arm and 3-arm trials.

Data Collection Procedures

Prior to the collection of data, participants will be informed about the study and will need to provide written consent to participate, see appendix B for the PIC forms. They will also be asked to answer survey questions on eligibility, demographics and other background information, see appendix C for questionnaires. Informed consent forms and surveys will be administered using Qualtrics. We will recruit potential participants via the Prolific (<https://www.prolific.com/>). Participants will be compensated for completing the online surveys at a rate of £12 per hour, and for keeping the browser plug-in enabled while they shop for groceries using the Chrome browser. Compensation for grocery shopping will be a fixed amount of £10 per month (plus any price discounts) for participants who shop at least twice in that month, as recorded by the plug-in. Participants will receive regular reminders via the Prolific platform to prompt them to complete their usual grocery shopping on Chrome with the plug-in enabled throughout the duration of the trial.

Screening/baseline survey: At the start of the intervention period, we will survey potentially eligible participants to collect background characteristics, including age, gender, ethnicity, household income, household size and composition, as well as attitudes towards food shopping and sustainability, see appendix C for the questionnaire. The plug-in will be distributed as part of the baseline survey using a customised download link for each participant that includes their participant ID. The plug-in will remember this ID number and pass it on with all purchase data that are generated, allowing us to match the purchase data to the information collected through the surveys. The personalised download links will allow only a single installation for each ID number, to avoid multiple households using the same participant ID. When there is an attempt to use a download link for the second time, the user will get a message to contact the researcher for a second link if appropriate.

Grocery purchases: The plug-in will collect data on grocery purchases at the point of checkout. These data are collected for initiated, updated, purchased (paid for), and cancelled checkouts. For each product, the plug-in will record a detailed description of the product and pack size, including a retailer-specific ID number, the purchase price, the quantity purchased, as well as information on the product including the environmental impact scores (eco-scores).

Endline survey: This survey will be administered at the end of the intervention period to gather quantitative and qualitative data for process evaluations, see appendix C for the survey questionnaire.

Study Outcomes

Primary outcome

- The average eco-score of the basket of groceries purchased with a lower score meaning more sustainable purchases.² Using this outcome variable, we will estimate the effect size of introducing eco-labels (intervention 1) and the price-elasticity for sustainable alternative products (intervention 2), allowing us to calculate the willingness to pay for sustainable groceries. We aim to measure both short- and long-term responses to price discounts to see if trying a more sustainable alternative may shift demand persistently beyond a one-time purchase.

Secondary outcomes

- Basket eco-score for 16 impact categories of the Product Environmental Footprint (PEF): climate change, water use, resource use: minerals and metals, resource use: fossils, land use, ozone depletion, human toxicity: cancer, human toxicity: non-cancer, ionising radiation and human health, particulate matter, eutrophication: marine, acidification, eutrophication: terrestrial, eutrophication: freshwater, ecotoxicity: freshwater). This outcome will give some insight into what type of improvements can be expected from more sustainable grocery shopping because of our interventions. It is likely that the largest sustainability gains can be realised on the impact category climate change (greenhouse gas emissions).
- The nutritional value of the basket of groceries purchased, as measured by the Food Standard Agency's (FSA) Nutrient Profiling Model. We will use the changes in the nutritional composition of groceries purchased to model the health impact of our interventions if these were delivered at scale in the UK using the PRIMETIME model, a multi-state life table model, to calculate the impact of the interventions on diet-related diseases.
- Total cost of the shopping basket: The total cost of the shopping basket per household expressed in £, will be used, to understand the impact on grocery costs.
- Total number of products in the basket. This is primarily to check whether shoppers respond to eco-labels by buying more (less sustainable) products elsewhere (e.g. by adding them to their order on the mobile, or by buying them at a different supermarket).

Extensions: Further work that may be possible using the data collected during this trial includes:

- Evaluation of the interventions (eco-labels and price discounts on more sustainable alternatives) in combination with each other. We independently randomise interventions as in a factorial design so that we can do this, but the sample size (limited by feasibility) may not allow us the power to detect differences between groups with statistical significance.
- Heterogeneity in treatment effect by demographics, socio-economic characteristics, and other relevant participant characteristics, including previous knowledge about sustainable food (self-reported), attitudes toward food and sustainability, and purchase patterns.
- User clicks on the labels, which are also recorded by the plug-in, to further explore the decision-making process that leads to different choices.
- Observational study into the effect of regular price promotions offered by the supermarket on purchasing behaviour. These are different from the price discounts in our second

² We will also consider monotonic transformations of this measure of sustainability, e.g. the fraction of products in the basket with a grade of A-C.

intervention, because they are not targeted to the shopper in swaps for alternative products.

- Obfuscation study into long-term changes in attitudes due to our interventions. This means that we invite the study participants for a follow-up online survey well after the trial has ended, pretending to survey them about something completely different but including some questions to try and measure the long-run effect of the intervention. As an example, we could do a survey about grocery shopping, and introduce a question on whether shoppers consider the environment when they choose what products to buy. By asking this question in the same format as in the baseline survey, we will be able to compare the responses and document whether there were any changes in attitudes in the treatment group.
- Other extensions that may arise.

Quality Assurance

Download instructions: The pilot study and PPI work (see appendix D) revealed the importance of trust to convince participants to download and install the browser extension. To convey trustworthiness, we will design an image to upload onto the download page for the plug-in on the Google Chrome store including the logos of the universities that are involved in this study. We will also include a link to a website, hosted on SALIENT Food Trials domain, with pictures and email addresses of the investigators, a video with detailed download instructions, information on GDPR and data management, a link to the ethics approval for this study, and a form and email address for questions and concerns. Using a simple test question as part of the survey, we will make sure that participants open this link and read the information on the website. Through further PPI work, we will optimise the design of this website. Based on other studies using browser plug-ins on Prolific, we expect that we can increase the number of participants that download and install the plug-in from 25% in the pilot study to over 50%.

Label methodology: We also learned from the pilot and the PPI that participants are less likely to trust the labels (and therefore act on them) if they find them counterintuitive or think that they may be wrong. Therefore, we will provide information on how the labels are constructed and make this information accessible to participants by clicking on an information icon ⓘ that will be part of the labels. Again, we will do further PPI work to test out this approach.

Technical functionality: During the trial, the website of the supermarket will be monitored daily to ensure that the eco-labels are showing correctly and swaps with (discounted) more sustainable alternative products are being offered to participants, because updates to the website may undermine the functionality of the plug-in. We will also be able to view the data collected via the plug-in in real-time on a dashboard through Grafana, allowing us to monitor participants' engagement with the trial and detect any problems very quickly. The dashboard includes statistics on the number of plug-in installs, the number of participants in the intervention and control groups, and the number of purchases, including cancelled and checked-out purchases.

Sample Size Calculation

The sample size calculation is based on an assumed minimum meaningful effect size. If on average participants swap 2 out of 34 products (the average basket size in the pilot study) for a more sustainable alternative, upgrading the eco-score for that product from D to B (-14.5 points) or from F

to D (-35.0 points), then the expected effect size for the average basket score ranges from -0.85 points to -2.1 points. The standard deviation of the basket score across participants in our pilot study was 21 points. Therefore, to achieve a 5% significance level in a simple 2-arm trial, the required sample size ranges from 400 to 2760.

We expect that we need to survey about 10,000 potentially eligible Prolific panellists to recruit 2760 participants for this study. This number is based on the results of the pilot study and expected increases in recruitment rates based on improvements in the study design (34% of screened panellists are eligible for the study, and we assume that 50% of those eligible will download the browser extension, and 80% of those who install the extension will complete at least 2 grocery shops during the study period). With an expectation that we will run 4 waves (but with time and resources available to run 5 waves if necessary), we will start by contacting 2,500 participants for the baseline survey in wave 1, with numbers recruited at further waves determined after our sample size, recruitment rate and attrition numbers are updated.

Data Analysis

Data will be analysed in Stata SE 17 (Stata Corp LP, TX, US).

Descriptive statistics will be used to examine participants' socio-demographic characteristics and purchasing behaviour.

Difference-in-means tests will be used to assess the impact of eco-labels and price discounts on the primary outcome (average eco-score of baskets) and secondary outcomes by comparing the intervention (treatment) group to the comparator (control) group.

Process Evaluation

The process evaluation will be led by researchers at the London School of Hygiene and Tropical Medicine (LSHTM) under a separate protocol for ethical approval. The aim of process evaluation is to understand what works, for whom, under what circumstances, and why. Participants in the study and the plug-in developers (key Sustained members) will be interviewed using an interview guide, see appendix E. We will seek consent for participants to be contacted for these interviews in the endline survey.

Appendices

- A. Scoring methodology for Sustained eco-labels
- B. Participant Informed Consent (PIC) forms for screening/baseline and endline surveys
- C. Questionnaires for screening/baseline and endline surveys
- D. Summary of PPI work
- E. Interview guide for process evaluation

Timeline

Activities	2023							2024												2025		
	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M
Recruit research fellow																						
Ethics for pilot (Deadline 17/07 for Meeting 02/08- outcome 16/08)																						
App development																						
Pilot																						
Analyse pilot data, refine app and data collection as necessary																						
Ethics for main field experiments (Deadline 22/01 for meeting 07/02 outcome 21/02)																						
Study (Main study April-May = appropriate for avoiding school holidays, 3 months add on June-Aug)																						
Data analysis																						
Write-up and integration with other SALIENT findings																						
Dissemination + contingency																						

References

- Accuardi, Z. et al. (2020). Plant-rich diets. Project Drawdown. Retrieved from <https://drawdown.org/solutions/plant-rich-diets>
- Afshin, A., Sur, P. J., Fay, K. A., Cornaby, L., Ferrara, G., Salama, J. S., Mullany, E. C., Abate, K. H., Abbafati, C., Abebe, Z., Afarideh, M., Aggarwal, A., Agrawal, S., Akinyemiju, T., Alahdab, F., Bacha, U., Bachman, V. F., Badali, H., Badawi, A., ... Murray, C. J. L. (2019). Health effects of dietary risks in 195 countries, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017. *The Lancet*, 393(10184), 1958–1972. [https://doi.org/10.1016/S0140-6736\(19\)30041-8](https://doi.org/10.1016/S0140-6736(19)30041-8)
- Ali, S. H., Lloyd-Montgomery, J., Lowery, C. M., Vedovato, G. M., & Trude, A. C. B. (2022). Equity-Promoting Strategies in Online Grocery Shopping: Recommendations Provided by Households of Low Income. *Journal of Nutrition Education and Behavior*, 54(11), 998–1010. <https://doi.org/10.1016/J.JNEB.2022.08.007>
- Anzman-Frasca S, McGovern L, Ferrante MJ, et al. Effects of a grocery shopping intervention designed to improve diet adherence in diabetes: a randomized trial. *Obesity* (Silver Spring). 2023; 31(1): 62-73. doi:10.1002/oby.23588
- Bentil H, Oyebode O, van Rens T. Eco-Labels in Real Online Grocery Shopping: Insights from a Pilot Trial on Promoting Sustainable Food Choices, mimeo, 2024
- Bunten, A., Shute, B., Golding, S. E., Charlton, C., Porter, L., Willis, Z., Gold, N., Saei, A., Tempest, B., Sritharan, N., Arambepola, R., Yau, A., & Chadborn, T. (2022). Encouraging healthier grocery purchases online: A randomised controlled trial and lessons learned. *Nutrition Bulletin*, 47(2), 217–229. <https://doi.org/10.1111/NBU.12552>
- Clark, M. A. et al. (2020). Global food system emissions could preclude achieving the 1.5° and 2°C climate change targets. *Science* 370,705-708(2020). DOI:10.1126/science.aba7357
- Coffino, J. A., Han, G. T., Evans, E. W., Luba, R., & Hormes, J. M. (2021). A Default Option to Improve Nutrition for Adults With Low Income Using a Prefilled Online Grocery Shopping Cart. *Journal of Nutrition Education and Behavior*, 53(9), 759–769. <https://doi.org/10.1016/J.JNEB.2021.06.011>
- Coffino, J. A., Udo, T., & Hormes, J. M. (2020). Nudging while online grocery shopping: A randomized feasibility trial to enhance nutrition in individuals with food insecurity. *Appetite*, 152, 104714. <https://doi.org/10.1016/J.APPET.2020.104714>
- Crippa, M., Solazzo, E., Guizzardi, D., Monforti-Ferrario, F., Tubiello, F. N., & Leip, A. (2021). Food systems are responsible for a third of global anthropogenic GHG emissions. *Nature Food* 2:3, 2(3), 198–209. <https://doi.org/10.1038/s43016-021-00225-9>
- Dubois, P., Albuquerque, P., Allais, O., Bonnet, C., Bertail, P., Combris, P., Lahlou, S., Rigal, N., Ruffieux, B., & Chandon, P. (2021). Effects of front-of-pack labels on the nutritional quality of supermarket food purchases: evidence from a large-scale randomized controlled trial. *Journal of the Academy of Marketing Science*, 49(1), 119–138. <https://doi.org/10.1007/S11747-020-00723-5/FIGURES/7>
- England, P. H., Roberts, K., Cavill, N., Hancock, C., & Rutter, H. (2013). *Social and economic inequalities in diet and physical activity*. <https://researchportal.bath.ac.uk/en/publications/social-and-economic-inequalities-in-diet-and-physical-activity>

Farvid, M. S., Sidahmed, E., Spence, N. D., Mante Angua, K., Rosner, B. A., & Barnett, J. B. (2021). Consumption of red meat and processed meat and cancer incidence: a systematic review and meta-analysis of prospective studies. *European Journal of Epidemiology* 2021 36:9, 36(9), 937–951. <https://doi.org/10.1007/S10654-021-00741-9>

Food Strategy, N. (n.d.). National Food Strategy Independent Review.

Hartmann-Boyce J, Bianchi F, Piernas C, Payne Riches S, Frie K, Nourse R, Jebb SA. Grocery store interventions to change food purchasing behaviors: a systematic review of randomized controlled trials. *Am J Clin Nutr*. 2018 Jun 1;107(6):1004-1016. doi: 10.1093/ajcn/nqy045. PMID: 29868912; PMCID: PMC5985731.

Huang, A., Barzi, F., Huxley, R., Denyer, G., Rohrlach, B., Jayne, K., & Neal, B. (2006). The Effects on Saturated Fat Purchases of Providing Internet Shoppers with Purchase - Specific Dietary Advice: A Randomised Trial. *PLOS Clinical Trials*, 1(5), e22. <https://doi.org/10.1371/JOURNAL.PCTR.0010022>

Jansen L, van Kleef E, Van Loo EJ. The use of food swaps to encourage healthier online food choices: a randomized controlled trial. *Int J Behav Nutr Phys Act*. 2021 Dec 4;18(1):156. doi: 10.1186/s12966-021-01222-8. PMID: 34863208; PMCID: PMC8642761.

Kanay A, Hilton D, Charalambides L, Corrége JB, Inaudi E, Waroquier E, Cézéra S. Making the carbon basket count: Goal setting promotes sustainable consumption in a simulated online supermarket. *Journal of Economic Psychology*, Volume 83, 2021,doi.org/10.1016/j.joep.2020.102348.

Koutoukidis, D. A., Jebb, S. A., Ordóñez-Mena, J. M., Noreik, M., Tsiountsioura, M., Kennedy, S., Payne-Riches, S., Aveyard, P., & Piernas, C. (2019). Prominent positioning and food swaps are effective interventions to reduce the saturated fat content of the shopping basket in an experimental online supermarket: A randomized controlled trial. *International Journal of Behavioral Nutrition and Physical Activity*, 16(1), 1–14. <https://doi.org/10.1186/S12966-019-0810-9/TABLES/4>

Land use: Policies for a Net Zero UK - Climate Change Committee. (n.d.). Retrieved February 28, 2023, from <https://www.theccc.org.uk/publication/land-use-policies-for-a-net-zero-uk/>

Leenders, M., Sluijs, I., Ros, M. M., Boshuizen, H. C., Siersema, P. D., Ferrari, P., Weikert, C., Tjønneland, A., Olsen, A., Boutron-Ruault, M.-C. C., Clavel-Chapelon, F., Nailler, L., Teucher, B., Li, K., Boeing, H., Bergmann, M. M., Trichopoulou, A., Lagiou, P., Trichopoulos, D., ... Bueno-de-Mesquita, H. B. (2013). Fruit and vegetable consumption and mortality: European prospective investigation into cancer and nutrition. *American Journal of Epidemiology*, 178(4), 590–602. <https://doi.org/10.1093/aje/kwt006>

Mahboobi, Z., Pakdaman, A., Yazdani, R., Azadbakht, L., & Montazeri, A. (2021). Dietary free sugar and dental caries in children: A systematic review on longitudinal studies. *Health Promotion Perspectives*, 11(3), 271. <https://doi.org/10.34172/HPP.2021.35>

Milajerdi, A., Namazi, N., Larijani, B., & Azadbakht, L. (2018). The Association of Dietary Quality Indices and Cancer Mortality: A Systematic Review and Meta-analysis of Cohort Studies. <https://doi.org/10.1080/01635581.2018.1502331>, 70(7), 1091–1105. <https://doi.org/10.1080/01635581.2018.1502331>

Mujcic, R., & J Oswald, A. (2016). Evolution of Well-Being and Happiness After Increases in Consumption of Fruit and Vegetables. *American Journal of Public Health*, 106(8), 1504–1510. <http://view.ncbi.nlm.nih.gov/pubmed/27400354>

Naghshi, S., Sadeghi, O., Willett, W. C., & Esmailzadeh, A. (2020). Dietary intake of total, animal, and plant proteins and risk of all cause, cardiovascular, and cancer mortality: systematic review and dose-response meta-analysis of prospective cohort studies. *BMJ*, 370, 2412. <https://doi.org/10.1136/BMJ.M2412>

Net Zero Strategy: Build Back Greener. (2021).

Oyebode, O., Gordon-Dseagu, V., Walker, A., & Mindell, J. S. (2014). Fruit and vegetable consumption and all-cause, cancer and CVD mortality: Analysis of health survey for England data. *Journal of Epidemiology and Community Health*, 68(9). <https://doi.org/10.1136/jech-2013-203500>

Pagliai, G., Dinu, M., Madarena, M. P., Bonaccio, M., Iacoviello, L., & Sofi, F. (2021). Consumption of ultra-processed foods and health status: a systematic review and meta-analysis. *British Journal of Nutrition*, 125(3), 308–318. <https://doi.org/10.1017/S0007114520002688>

Palmer, D. (2022). Estimating the full costs of obesity. Frontier Economics: A report for Novo Nordisk.

Pallmann, P., Bedding, A.W., Choodari-Oskooei, B. et al. Adaptive designs in clinical trials: why use them, and how to run and report them. *BMC Med* 16, 29 (2018). <https://doi.org/10.1186/s12916-018-1017-7>

Panzone, L. A., Ulph, A., Hilton, D., Gortemaker, I., & Tajudeen, I. A. (2021). Sustainable by Design: Choice Architecture and the Carbon Footprint of Grocery Shopping. *Journal of Public Policy & Marketing*, 40(4), 463–486. <https://doi.org/10.1177/07439156211008898>

Papier, K., Knuppel, A., Syam, N., Jebb, S. A., & Key, T. J. (2023). Meat consumption and risk of ischemic heart disease: A systematic review and meta-analysis. *Critical Reviews in Food Science and Nutrition*, 63(3), 426–437. https://doi.org/10.1080/10408398.2021.1949575/SUPPL_FILE/BFSN_A_1949575_SM5775.DOCX

Payne Riches, S., Aveyard, P., Piernas, C., Rayner, M., & Jebb, S. A. (2019). Optimising swaps to reduce the salt content of food purchases in a virtual online supermarket: A randomised controlled trial. *Appetite*, 133, 378–386. <https://doi.org/10.1016/J.APPET.2018.11.028>

Potter C, Pechey R, Clark M, Frie K, Bateman PA, Cook B, Stewart C, Piernas C, Lynch J, Rayner M, Poore J, Jebb SA. Effects of environmental impact labels on the sustainability of food purchases: Two randomised controlled trials in an experimental online supermarket. *PLoS One*. 2022 Nov 3;17(11):e0272800. doi: 10.1371/journal.pone.0272800. PMID: 36327277; PMCID: PMC9632881.

Ritchie, H. (2021). If the world adopted a plant-based diet we would reduce global agricultural land use from 4 to 1 billion hectares. In *Our World in Data*. <https://ourworldindata.org/land-use-diets>

Sacks, G., Tikellis, K., Millar, L., & Swinburn, B. (2011). Impact of ‘traffic-light’ nutrition information on online food purchases in Australia. *Australian and New Zealand Journal of Public Health*, 35(2), 122–126. <https://doi.org/10.1111/J.1753-6405.2011.00684.X>

Saghafian, F., Malmir, H., Saneei, P., Milajerdi, A., Larijani, B., & Esmailzadeh, A. (2018). Fruit and vegetable consumption and risk of depression: accumulative evidence from an updated systematic review and meta-analysis of epidemiological studies. *British Journal of Nutrition*, 119(10), 1087–1101. <https://doi.org/10.1017/S0007114518000697>

Schruff-Lim, E. M., Van Loo, E. J., van der Lans, I. A. & van Trijp, C. M. H. (2024). Impact of food swap recommendations on dietary choices in an online supermarket: A randomized controlled trial.

Appetite, Volume 194, 2024, 107158, ISSN 0195-6663,
<https://doi.org/10.1016/j.appet.2023.107158>.

Smith, P., Clark, H., Dong, H., Elsiddig, E. A., Haberl, H., Harper, R., House, J., Jafari, M., Masera, O., Mbow, C., Ravindranath, N. H., Rice, C. W., Roble do Abad, C., Romanovskaya, A., Sperling, F., & Tubiello, F. (2014). *Chapter 11 - Agriculture, forestry and other land use (AFOLU)*.
http://www.ipcc.ch/pdf/assessment-report/ar5/wg3/ipcc_wg3_ar5_chapter11.pdf

Statista (2023). Online grocery shopping in the United Kingdom (UK) - statistics and facts. Retrieved from <https://www.statista.com/topics/3144/online-grocery-shopping-in-the-united-kingdom/#topicOverview>. Published by Statista Research Department on Dec 19, 2023

Stuber, J. M., Lakerveld, J., Kievitsbosch, L. W., Mackenbach, J. D., & Beulens, J. W. J. (2022). Nudging customers towards healthier food and beverage purchases in a real-life online supermarket: a multi-arm randomized controlled trial. *BMC Medicine*, 20(1), 1–13. <https://doi.org/10.1186/S12916-021-02205-Z/FIGURES/4>

Theis, D. R. Z., & White, M. (2021). Is Obesity Policy in England Fit for Purpose? Analysis of Government Strategies and Policies, 1992–2020. *The Milbank Quarterly*, 99(1), 126–170.
<https://doi.org/10.1111/1468-0009.12498>

UK online grocery market penetration 2015-2025 | Statista. (n.d.). Retrieved February 21, 2023, from <https://www.statista.com/statistics/1319926/online-grocery-market-penetration-rate-uk/>

Valenčič, E., Beckett, E., Collins, C. E., Seljak, B. K., & Bucher, T. (2023). Digital nudging in online grocery stores: A scoping review on current practices and gaps. *Trends in Food Science & Technology*, 131, 151–163. <https://doi.org/10.1016/J.TIFS.2022.10.018>

Willett, W., Rockström, J., Loken, B., Springmann, M., Lang, T., Vermeulen, S., Garnett, T., Tilman, D., DeClerck, F., Wood, A., Jonell, M., Clark, M., Gordon, L. J., Fanzo, J., Hawkes, C., Zurayk, R., Rivera, J. A., de Vries, W., Majele Sibanda, L., ... Murray, C. J. L. (2019). Food in the Anthropocene: the EAT–Lancet Commission on healthy diets from sustainable food systems. *Lancet*, 393(10170), 447–492.
[https://doi.org/10.1016/s0140-6736\(18\)31788-4](https://doi.org/10.1016/s0140-6736(18)31788-4)

Yip, C. S. C., Chan, W., & Fielding, R. (2019). The Associations of Fruit and Vegetable Intakes with Burden of Diseases: A Systematic Review of Meta-Analyses. *Journal of the Academy of Nutrition and Dietetics*, 119(3), 464–481. <https://doi.org/10.1016/J.JAND.2018.11.007>