Effects of environmental impact and nutrition labelling on food purchasing: an experimental online supermarket study

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Abstract

Nutrition labels and ecolabels can support consumers to make healthier and more sustainable choices, and the former is now widespread. But there is no information on the impact of ecolabels in the presence of nutrition labels. The aims of this study were primarily to examine whether (1) ecolabels are effective at promoting sustainable purchasing behaviour if presented alongside nutrition labels; (2) and secondarily, whether nutrition labels are effective at promoting healthier purchasing if presented alongside ecolabels. Participants (N=2730) visited an experimental online supermarket platform, and were randomised to see products with (1) environmental impact labels only; (2) nutrition (NutriScore) labels only; (3) both environmental and nutrition labels; (4) no labels. Linear regressions compared the mean environmental impact scores (EIS; primary outcome) and health scores of products in participants' shopping baskets across each condition. Compared to control (no labels) there were significant reductions in the EIS when environmental impact labels were presented: Alone (-1.2, 95%CI: -2.0 to -0.4) or With nutrition labels (-1.9, 95%CI: -2.7 to -1.0), with no evidence of differences in effectiveness between these two conditions. There was no evidence of an impact of nutrition labels on either the EIS or the healthiness of purchases, regardless of whether ecolabels were also present. Environmental impact labels may be effective at encouraging more sustainable purchases alone or when used alongside nutrition labels. Despite the evidence that healthier diets are usually more sustainable, there was no evidence that nutrition labelling alone altered the environmental impact of food purchased, albeit for labels for which there was also no evidence of effectiveness at altering the healthiness of purchases.

Keywords: ecolabels; nutrition labels; food; purchase; sustainability

Introduction

Transitioning to sustainable and healthy diets is essential to meeting the UN Sustainable Development Goals and Paris Agreement (Food & Agriculture Organisation & World Health Organization, 2019). Considerable dietary shifts will be required, including large reductions in consumption of red meat and increases in consumption of sustainable and healthier foods (Willett et al., 2019). Providing health and environmental information on food products at the point of purchase may help consumers to make purchases in line with these goals (Anastasiou, Miller, & Dickinson, 2019; Brown, Harris, Potter, & Knai, 2020; Cecchini & Warin, 2016; Julia & Hercberg, 2017; Macdiarmid, Cerroni, Kalentakis, & Reynolds, 2020).

Labelling products with environmental impact information promotes the selection of more sustainable food choices (Julia & Hercberg, 2017; Sonnenberg et al., 2013). The World Resources Institute (WRI) reports that consumer interest in environmental impact labelling (hereafter: ecolabelling) of meals and food products is rising. In a poll of UK adults in March 2020, approximately 35% of 2000 respondents felt it is important to know brands they are buying are "taking action to reduce the product's footprint", up from only 24% of respondents in 2016 (World Resources Institute, 2020b). Further, the WRI previously found that 75% of UK adults say they would prefer to eat in restaurants displaying environmental impact details on their menus (World Resources Institute, 2020a). Labelling to encourage healthier choices is already used in many countries and evidence from systematic reviews suggests it is effective (Crockett et al., 2018). While the health and environmental impacts of a product do not always overlap (i.e. healthier foods do not always have a lower environmental impact compared to less healthy foods and vice versa), evidence suggests that healthier foods tend to be more sustainable (Clark, Springmann, Hill, & Tilman, 2019), so it is possible that nutrition labels are serving a dual purpose, though this has not been formally tested.

Evidence from a recent systematic review suggests that ecolabels encourage the selection of products with lower environmental impacts (Potter et al., 2021), and this is reflected in studies using experimental online supermarkets (Kanay et al., 2021; Muller, Lacroix, & Ruffieux, 2019; Vanclay et al., 2011)(Potter et al, in submission). However, these benefits may be attenuated if consumers are presented with both health and environmental impact information simultaneously, because of the increased amount of information or if information is perceived to be conflicting (e.g. if a product is sustainable but unhealthy). Previous research investigating the use of multiple health or nutrition labels found the presence of multiple labels was rarely beneficial (Barreiro-Hurle, Gracia, & De-Magistris, 2010).

Little experimental research has explored whether the simultaneous presence of ecolabels and nutrition labels attenuates the effectiveness of either individual label. Two papers highlight sets of choice experiments that each examined consumer food selections between specific products and their healthy and/or sustainable alternatives (indicated via text and/or a logo) (Hoek, Pearson, James, Lawrence, & Friel, 2017; Macdiarmid et al., 2020). However, these experiments included only a very limited number of products. One study only indicated 'positive' benefits (i.e. highlighting options as healthier or more sustainable) (Hoek et al., 2017), while the other consistently presented both health and sustainability information (Macdiarmid et al., 2020), so the effectiveness of seeing both labels vs. single labels in the presence of potentially conflicting information could not be assessed.

The primary aim of this study was to examine whether ecolabels remain effective at promoting the selection of more sustainable foods if presented alongside nutrition labels. We hypothesised that presenting both environmental impact and nutrition labels would be less effective at promoting sustainable purchasing compared to presenting ecolabels on their own. As a secondary aim, we explored whether presenting both labels undermines healthy purchasing compared to presenting

nutrition labels on their own. We also explored whether the effectiveness of each label (eco, nutrition, both) at promoting sustainable purchasing varied as a result of participant demographics.

METHODS

Participants

Adult participants aged 18 years or over were recruited from an online research panel (Dynata, http://www.dynata.com). Panel members who self-identified as vegetarian or vegan were excluded because some of the products on the shopping list were not suitable for vegetarians or vegans and participants were instructed to shop for foods they would be willing to eat. Only English-speaking panel members currently residing in the United Kingdom were eligible.

Study Design

This study was a 4-arm parallel design randomised controlled trial to test two labels (one providing an A-E grade regarding health impact and one an A-E grade on environmental impact), presented alone or in combination, compared to a no label control.

Participants were randomised to one of the four study conditions with five participants randomised into an intervention arm for every two randomised to the control (no label) group. Three label conditions were tested: i) ecolabel only, ii) nutrition label only, iii) both ecolabel and nutrition labels displayed simultaneously.

The study was conducted using an experimental online supermarket platform, developed by the University of Oxford, designed to emulate a real online supermarket for research purposes. The site was populated with approximately 20,000 supermarket products drawn from foodDB (April 2019), a

database of food and drinks available for purchase in six UK online supermarkets (Harrington, Adhikari, Rayner, & Scarborough, 2019). Data were collected and managed using the supermarket platform and the survey platform Qualtrics (www.Qualtrics.com).

The study protocol was prospectively registered online (Open Science Framework Ref. GKYDS). It was reviewed by, and received ethics approval through, the University of Oxford Central University Research Ethics Committee [R65010/RE004]. Informed consent was obtained from all participants.

Sample size

Based on findings from a previous study (Potter *et al*., in submission), we estimated that there would be an absolute difference of 6-10% in the Environment Score between the ecolabel condition and control. Based on recent evidence of the effectiveness of the Nutri-Score nutrition label (Vandevijvere et al., 2020), we estimated an absolute difference of approximately 9% between the nutrition label condition and control. To determine the sample size for this study, we used values from the two trial arms with the largest standard deviations in the results of Study 2 from Potter et al (in submission). The present study was powered to detect an absolute difference of 4% (SD1 = 23.6%, SD2 = 23.4%) in the Environment Score between each intervention group and a 6% difference between each intervention group and control.

We estimated a sample size of n = 344 for the control group and n = 859 for each intervention arm (total N = 2921), with the analysis powered to 90% and a two-sided $\alpha = 0.025$ (this is an adjusted p-value to allow for two comparisons of the primary outcome). In order to allow for a 15% non-compliance and attrition rate, we aimed to recruit 3359 participants in total (N = 395 control; 988 each intervention arm). Due to difficulties in recruitment, with the panel being unable to supply as many participants as initially thought, the study was ended before this target was achieved.

148

149*Labels*

150Images of ecolabels and/or nutrition labels were displayed underneath the food product on the
151experimental supermarket website.

152

153Ecolabels: The ecolabels chosen for this study comprise a background with a 'globe' outline and an
154A-E grade showing the product's environmental impact (shown in **Appendix A)**. They were selected
155as they showed one of the highest impacts on purchasing compared to other ecolabel formats
156tested in a previous study ([reference blinded] Study 2) and were felt to be more acceptable for
157store implementation than the other high impact labels (red circles on products with the worst
158environmental impact).

159

160Environmental impact was calculated per 100g of each product for four indicator variables
161(greenhouse gas emissions, scarcity weighted water stress [hereafter water use], land use related
162biodiversity loss, and eutrophication potential), based on products' ingredients, combined with data
163on impact from environmental life cycle assessment databases. More information on the derivation
164of the environmental impact scores can be found in **Appendix A**, and is described in further detail
165elsewhere (Clark et al., 2021). The four environmental indicators were then combined into a
166product-level EIS. Products were ranked based on their percentile score for each of the four
167indicators, and the mean percentile across the four indicators was calculated. To obtain A-E grades,
168we then split the environmental impact score into quintiles, whereby a value of A = an EIS of 1-20, B
169= 21-40, C = 41-60, D = 61-80, E = 81-100.

170

171Nutrition labels: For each product in the virtual online supermarket, nutrient and ingredient
172information (per 100g or ml) was obtained from the foodDB dataset (Harrington et al., 2019). From
173this, health scores were calculated using the NutriScore method (see **Appendix B** for details) (Julia,

Hercberg, & World Health Organization, 2017), with A-E values allocated to each product in the virtual supermarket database. The nutrition label logos are shown in **Appendix B**. The NutriScore is not widely used in the UK but was chosen to have a similar format to the ecolabel.

Procedure

Following online screening questions to ensure eligibility, participants provided electronic consent and were then directed to the supermarket platform to take part in the shopping task. They were asked questions about hunger before the shopping task, where participants were asked to purchase items to complete a shopping task of 10 items. See **Supplemental File 1** for an example of the welcome screen displayed to participants on the supermarket platform. The food items included in the list were chosen because they offer opportunities to purchase items within a range of categories that have a wide variation in environmental (and health) impact. The items on the shopping list were as follows:

1. A savoury snack for right now
2. Milk for everyday use
3. A ready meal
4. Cheese to use in a sandwich or light meal
5. A pizza (fresh or frozen)
6. A bar of chocolate
7. Nuts for snacking on
8. Meat, fish, or vegetarian alternative protein for main meal
9. Rice to accompany the main meal
10. Berries for dessert (fresh or frozen)

Afterwards participants were redirected to a post-test survey where they provided basic demographic information, household size, online grocery shopping habits, and measures of participants' level of awareness of the effects of meat on the environment (hereafter: meat knowledge) (Wunderlich & Smoller, 2019), frequency of meat consumption (hereafter: meat consumption), and level of intention to reduce meat consumption (hereafter: meat reduction).

Primary outcome

The primary outcome was the mean EIS of products placed in the shopping basket. A mean EIS of 1 would mean that only those products with the best environmental impact (falling into the 1st percentile) were selected, while a score of 100 would mean only those with the worst impact (falling into the 100th percentile) had been chosen.

Secondary outcomes

We explored differences in the four individual environmental indicators that comprised the EIS: i) greenhouse gas emissions (kg CO_2e), ii) water use (in litres), iii) eutrophication potential (gPO_4e), and iv) land use related biodiversity loss (species lost x 10^{-14}S). These analyses were conducted using the absolute values of indicators (rather than percentiles as in the EIS), logged to improve model fit.

An additional outcome focused on the nutrition content of the basket. For each participant, a Health Score was calculated by averaging the nutrient score value for each food product across all items in the shopping basket (see **Appendix B** for calculation of the nutrient score at the product level).

Alongside the Health Score, we explored differences in the nutrient composition of the shopping basket, including the total energy (kcal), energy density (kcal/100g), salt (g/100g) , fibre (g/100g), and total carbohydrate, fat, saturated fat, sugar, expressed as % energy. We adjusted for total

energy to place the focus on the nutritional composition of the foods selected and not the total amount (in g) of the food purchased.

Finally, we examined differences in the overall cost of the shopping basket, expressed as £/100g.

Data analysis

Prior to data analysis, shopping basket data from all participants who completed the task was verified by comparing the purchased items to the shopping list. We only analysed data from participants who purchased at least one product from at least 5 out of 10 categories of the shopping list. When participants purchased more than the 10 items requested, we included all items bought.

The primary aim of this study was to estimate the effect on the total EIS when products were presented with ecolabels alongside nutrition labels (Eco&Nutrition), compared to (a) no labels and (b) ecolabels on their own. The significance criterion was set to $p<0.025$ for these analyses (Bonferroni's adjustment). Exploratory analyses looked at the impact of nutrition labels alone on environmental impact.

Participant characteristics were included in the primary linear regression model. These included participant age, gender, education, income, meat reduction, meat knowledge, meat consumption, and baseline hunger and fullness (see **Supplemental File 2** for survey questions and coding).

Linear regressions also explored differences by study condition in individual environmental indicator values, given the change in the percentile-based EIS may not be indicative of the absolute change in environmental impact.

In addition, linear regression was used to explore the effects on the Health Score of purchased items when products were presented with ecolabels alongside nutrition labels (Eco&Nutrition), compared to (a) no labels and (b) nutrition labels on their own. This was supplemented by exploring the nutrient composition of the shopping basket between conditions. Exploratory analyses looked at the impact of ecolabels alone on health impact.

Linear regressions also explored the cost of the shopping basket.

Exploratory secondary analyses included interaction terms in separate linear regression models to determine whether the impact of label on environmental scores varied due to participant characteristics. In order to correct the type 1 error rate for the fact that there were two primary comparisons, we used the Holm-Bonferroni method of adjustment (Holm, 1979). The smaller P value will be compared to an alpha of 0.025 and if this is significant, the larger P value will be compared to an alpha of 0.05.

Statistical analyses were conducted in STATA (Stata Statistical Software: Release 14. College Station, TX: StataCorp LP).

RESULTS

Participant characteristics

A total of 2,730 respondents consented to participate, of those 2,488 provided demographic information. Participants were on average 41.7 years old (SD: 13.3 years), 55.3% were female, and they purchased 10.1 items on average (**Table 1;** see **Supplementary Table 1** for other variables included in models).

Effects on sustainability of purchasing

The linear regression model found a significant reduction in the EIS compared with control (mean EIS=62.6; s.d. 5.9) for the Ecolabel Only (mean difference= -1.2, 95%CI: -2.1 to -0.4, p= 0.005) and Eco&Nutrition labels conditions (mean difference= -1.9, 95%CI: -2.7 to -1.0, p< 0.001) (**Table 2**). There was no evidence that the Nutrition Only label impacted on EIS compared to control (mean difference= -0.1, 95%CI: -1.0 to 0.7, p=0.751). Comparing study conditions we found no evidence of any difference in effectiveness between presenting both environment and nutrition labels simultaneously (Eco&Nutrition) and presenting only ecolabels in EIS (mean difference= -0.7, 95%CI: -1.3 to -0.1, p=0.026) (**Supplemental Table 2**).

For Eco-Only labels, the percentage change for the four environmental indicators compared to control varied from -1% to -12%, with significant reductions observed only in water use (**Supplemental Table 3**). For Eco&Nutrition, reductions varied between -5% to -11%, and were significant for all bar biodiversity loss. For Nutrition labels only, no significant changes were found in individual environmental indicators, with percentage changes varying between 0% to a 4% increase.

Effects on healthiness of purchasing

There was no evidence of any differences between any of the label conditions and control in the Health Score of products in the shopping basket (**Table 2**), nor any evidence of differences between label conditions (**Supplemental Table 2**). For individual nutrients, participants in the condition where the Eco&Nutrition labels were presented together had baskets with lower fat and saturated fat compared to control, and higher carbohydrate content compared to control (-1.3%; -0.7% and 1.7% respectively). No other individual nutrient differences were observed between groups (**Table 2**).

Effects on cost of the shopping basket

There were no significant differences in the cost of the shopping basket for any of the label conditions compared to control, nor between intervention groups (**Table 2**).

Additional exploratory analyses

Environment Impact Scores were significantly higher in participants who were male, between the ages of 45-54 [compared to those aged 18-24], or those who earned an annual income of over £75,000 [compared to less than £15,000] (**Supplemental Table 4**). They were significantly lower for participants with Bachelor's or postgraduate degrees [compared to up to 4 GCSEs]. Those who believed that eating meat was harmful to the environment had lower EIS compared to those who believed it was beneficial, had no effect or responded 'Don't know'. Similarly, those who reported having already reduced their meat consumption had lower EIS compared to those who had no desire to change, or who wanted to eat more, or wanted to reduce their consumption. There were no significant associations between meat consumption, baseline hunger or fullness on the EIS of products in participants' shopping baskets.

There were no significant interactions between intervention condition and participant characteristics (including participant age, gender, income, education, meat consumption, meat knowledge, meat reduction, baseline hunger, or baseline fullness).

DISCUSSION

Environmental impact labels were effective at reducing the environmental impact of products purchased, both when presented by themselves, and when shown alongside nutrition labels. There was no evidence of a difference in effectiveness when the environmental and nutrition labels were

presented together compared to environmental labels by themselves in either the environmental impact or the healthiness of the shopping basket. Nor was there evidence that the addition of environmental impact labels changed the healthiness of the basket, compared to showing nutrition labels alone.

Strengths of this study include the randomised controlled design and the use of a large range of potential products that participants could select from, on a platform resembling real online supermarket websites. Participants did not receive their shopping, however, and were asked to shop according to a set list, limiting the ecological validity of the shopping context. In particular, the hypothetical nature of the task may decrease the consequences of acting on any social desirability bias. The short and specific shopping list – alongside estimations used to calculate the environmental indicator scores – could lead to inaccuracies in the overall degree of environmental impact. It is important to note that this would not lead to differential imprecision between study groups, so would not affect the key findings within this proof-of-principle study. In addition, vegetarians and vegans were excluded, and their responses to the labels may differ to meat-eaters.

This study directly compared the presentation of ecolabels alone, to providing health and environmental impact information simultaneously. We hypothesised that there might be reduced impact on environmental outcomes in the latter scenario as a result of information overload or information perceived as conflicting. However, there was no evidence of diminished effectiveness in this study. This supports the feasibility of introducing environmental impact labels in retail settings, alongside nutrition labelling already in use in North America and Europe (Miller & Cassady, 2015). It should be noted, however, that different combinations of logos or scoring systems for health and EIS could potentially influence their relative salience and/or impact.

A second consideration in this context is the impact on the healthiness of the basket when including both labels simultaneously (over just nutrition labels), given, for example, novel ecolabels could draw attention away from nutritional labelling. There was again no evidence that the addition of environmental impact labels changed the healthiness of the basket. However, in this study there was also no evidence that the nutrition labels had any impact on the healthiness of products in the basket as measured by mean product NutriScore (there were reductions in both total and saturated fat when both labels were shown, compared to control). NutriScore was selected for the study as a health score system recommended and used in multiple European countries (Julia, Etilé, & Hercberg, 2018), and that matches the A to E grades used in the most promising environmental impact logo following initial studies of effectiveness (Potter et al, in submission). While some previous studies have suggested that NutriScore labels are effective at improving the healthiness of purchases (Julia et al., 2017), other studies on nutritional labelling have found only small or mixed effects (Crockett et al., 2018; Hamlin & McNeill, 2018). Evidence on the effects of nutritional labelling on grocery store purchases is particularly limited, with the systematic review by Crockett et al (2018) identifying just one very low quality study (suggesting fewer healthier purchases following nutritional labelling). It is important to note that the NutriScore system is not widely used in the UK, where it is more common to provide information on individual nutrients in the so called multiple traffic light system. Further work should explore whether similar findings are obtained for participants for whom nutritional labels may be more familiar.

A recent systematic review exploring the effects of ecolabels on selection, purchase and consumption of food products found that ecolabel effectiveness may vary as a result of individual characteristics, including age, gender, and level of education (Potter et al., 2021). Furthermore, there was evidence that ecolabels may be particularly effective at reducing the environmental impact score of the shopping basket for participants who believed eating meat was harmful to the environment or who reported having already reduced the amount of meat in their diet. However,

results from the current study did not find any evidence that the ecolabels were more effective in any particular participant group. This suggests these labels are having a population-wide impact, including affecting those for whom behaviour change might be most impactful.

In conclusion, the current study adds to evidence that ecolabels can promote more sustainable food selection and finds no evidence that the addition of environmental impact labels alongside existing nutrition labels would attenuate the impact either label would have on environmental or health outcomes if presented in isolation. This adds to the evidence base on the feasibility and effectiveness of environmental impact labelling as an important measure to change dietary behaviour to improve planetary health.

Ethics

The study was reviewed by, and received ethics approval through, the University of Oxford Central University Research Ethics Committee [R65010/RE004]. Informed consent was obtained from all participants.

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Author Contributions

All authors contributed to the concept and design of the studies. CP, RP, and KF developed the study on the survey platform. MC developed the program to generate the ecolabel values. CP performed the experiments and collected the study data. PB, RP, and CP analysed and interpreted the data. CP and RP wrote the paper and generated the tables and figures. All authors discussed the results and implications and commented on the manuscript.

Availability of data

The dataset is available in the Open Science Framework [currently being formatted for sharing; links to be added].

Declarations of interest

None

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Table 1. Baseline characteristics of the study participants.

	Control	**Ecolabel Only**	**Nutrition label Only**	**Both Labels**	**Total**
N	309	812	802	807	2730
Age, mean+ SD	43.1 + 13.3	41.6 + 13.3	41.4 + 13.3	41.4 + 13.3	41.7 + 13.3
Age category, *n* (%)					
18 - 24 years	30 (9.7%)	109 (13.4%)	101 (12.5%)	104 (12.9%)	344 (12.6%)
25 - 34 years	50 (16.2%)	129 (15.9%)	155 (19.3%)	144 (17.8%)	478 (17.5%)
35 - 44 years	57 (18.5%)	167 (20.6%)	160 (20.0%)	168 (20.8%)	552 (20.2%)
45 - 54 years	74 (24.0%)	196 (24.1%)	168 (21.0%)	172 (21.3%)	610 (22.3%)
55+ years	98 (31.7%)	211 (26.0%)	218 (27.2%)	219 (27.1%)	746 (27.3%)
Gender, % female	51.7	56.5	54.2	56.6	55.3
Household size, *n* (%)					
1	57 (20.9%)	126 (17.0%)	136 (18.6%)	138 (18.6)	457 (18.4%)
2	93 (34.1%)	265 (35.7%)	249 (34.1%)	224 (30.2%)	831 (33.4%)
3	58 (21.3%)	155 (20.9%)	155 (21.2%)	162 (21.9%)	530 (21.3%)
4	52 (19.1%)	133 (17.9%)	122 (16.7%)	144 (19.4%)	451 (18.1%)
5	5 (1.8%)	43 (5.8%)	49 (6.7%)	50 (6.8%)	147 (5.9%)
6+	8 (2.9%)	21 (2.8%)	20 (2.7%)	23 (3.1%)	72 (2.9%)
Items purchased, mean + SD	9.9 + 1.8	10.2 + 4.3	10.2 + 2.9	10.1 + 3.2	10.1 + 3.4
Education, *n* (%)					
Up to 4 GCSEs	48 (17.6)	92 (12.4)	95 (13.0)	90 (12.2)	325 (13.1)
5 or more GCSEs	41 (15.0)	160 (21.5)	129 (17.7)	132 (17.8)	462 (18.6)
2 or more A-levels	65 (23.8)	186 (25.0)	193 (26.4)	204 (27.5)	648 (26.1)
Bachelor's degree	76 (27.8)	216 (29.1)	207 (28.3)	204 (27.5)	703 (28.3)
Post-graduate degree	38 (13.9)	88 (11.8)	101 (13.8)	104 (14.0)	331 (13.3)
Prefer not to say	5 (1.8)	1 (0.1)	6 (0.8)	7 (0.9)	19 (0.8)
Income, *n* (%)					
Less than £15k	70 (25.6%)	194 (26.1%)	188 (25.7%)	187 (25.2%)	639 (25.7%)
£15k - £24,999	57 (20.9%)	155 (20.9%)	158 (21.6%)	150 (20.2%)	520 (20.9%)
£25k - £39,999	64 (23.4%)	180 (24.2%)	161 (22.0%)	182 (24.6%)	587 (23.6%)
£40k - £75,000	56 (20.5%)	131 (17.6%)	131 (17.9%)	118 (15.9%)	436 (17.5%)
Over £75k	10 (3.7%)	30 (4.0%)	40 (5.5%)	29 (3.9%)	109 (4.4%)
Prefer not to say	16 (5.9%)	53 (7.1%)	53 (7.3%)	75 (10.1%)	197 (7.9%)

Note: N and items purchased are based on the 2730 participants who completed the study; 2488 participants provided demographic data for the other variables reported in this table

Table 2. Comparison of the environmental impact score, health score, cost, and nutrient composition of the shopping basket between trial groups.

	Control	**Ecolabel only vs Control**	**Nutrition label only vs Control**	**Both labels vs Control**
N	***309***	***812***	***802***	***807***
Environmental Impact Score	62.56 + 5.93	-1.21 (-2.05, -0.37)*	-0.14 (-1.00, 0.70)	-1.88 (-2.72, -1.04)**
Health Score	40.76 ± 3.32	0.24 (-0.20, 0.69)	0.07 (-0.38, 0.52)	-0.01 (-0.46, 0.44)
Energy, kcal/g	1.83 ± 0.40	0.00 (-0.05, 0.06)	0.00 (-0.05, 0.06)	0.00 (-0.05, 0.05)
Fat, %energy	45.44 ± 8.80	-0.53 (-1.67, 0.63)	-0.56 (-1.72, -0.59)	-1.34 (-2.49, -0.19)*
Saturated fat, %energy	19.42 ± 4.79	-0.29 (-0.91, 0.33)	-0.34 (-0.96, 0.28)	-0.71 (-1.32, 0.09)*
Carbohydrate, %energy	35.7 ± 10.27	0.66 (-0.71, 2.02)	0.58 (-0.79, 1.94)	1.65 (0.29, 3.02)*
Sugar, %energy	10.94 ± 3.60	-0.01 (-0.51, 0.53)	-0.09 (-0.61, 0.43)	-0.20 (-0.72, 0.32)
Protein, %energy	19.65 ± 4.13	-0.13 (-0.67, 0.42)	-0.02 (-0.57, 0.52)	-0.33 (-0.87, 0.22)
Fibre, g/100g	1.44 ± 0.47	-0.02 (-0.08, 0.05)	0.02 (-0.05, 0.09)	0.00 (-0.07, 0.06)
Salt, *g/100g*	0.21 ± 0.22	0.00 (-0.03, 0.04)	0.00 (-0.04, 0.03)	0.00 (-0.04, 0.03)
Cost, *£/100 g*	0.53 ± 0.15	0.00 (-0.02, 0.03)	0.00 (-0.02, 0.02)	0.00 (-0.02, 0.02)

Note. Values are means ± SDs in column 1 and mean differences (95% CIs) in the other three columns. *p <.05 **p <.001

APPENDIX A: CALCULATION OF THE ENVIRONMENTAL IMPACT SCORE (EIS)

Product-level environmental impact: Four indicator variables

Four variables were calculated for each product, namely the environmental impact per 100g of product for: greenhouse gas emissions; scarcity weighted freshwater withdrawals ('water use'); land use related biodiversity loss ('biodiversity loss'); and eutrophication potential ('water pollution').

These indicator scores were generated by:

(1) using the ingredient lists available for each product to identify the relative composition of ingredients if available (e.g. 10% ingredient X);
(2) estimate the relative composition of ingredients where composition information was not provided, using information from similar products and UK labelling regulations;
(3) link each ingredient to a global environmental life cycle assessment (LCA) database; and
(4) calculate the environmental impact per 100g of product for each of the four environmental indicators, based on the composition of each ingredient, the type of ingredient (e.g. a mushroom, a tomato, or poultry meat), and environmental information in the database.

Added variation

Some product categories had a limited number of unique products (e.g. fresh berries). As such most products within that product category had very similar environmental impact scores. However, because the purpose of these studies was to examine how consumers might respond to product-specific environmental information, we introduced variability in the environmental impact scores to ensure that more sustainable and less sustainable products were available for selection within these product categories.

To do this, we identified individual producers with environmental performance data equivalent to the 25th percentile (e.g. a more sustainable producer), 50th percentile (median sustainable producer), and 75th percentile impacts (a less sustainable producer) across all producers for each food category and for each environmental indicator within the environmental LCA databases. When calculating the environmental impact scores (as described above), we then randomly assigned products to have all their ingredients sourced from a more sustainable producer, a median sustainable producer, or a less sustainable producer.

Combining the four indicators to produce A-E grades

To combine the four environmental indicators into an environmental impact score for each product, we ranked products based on their percentile score (rather than absolute values) for each of the four indicators. To arrive at a single environmental impact score for each product, we then took the mean percentile across the four indicators. Scores range from 1 (lowest impact product) to 100 (highest impact product) based on the percentile environmental impact score of each product. To obtain A-E grades, we then split the environmental impact score into quintiles, whereby a value of A = an environmental impact score of 1-20, B = 21-40, C = 41-60, D = 61-80, E = 81-100.

Logo images:

APPENDIX B: CALCULATION OF THE BASKET HEALTH SCORE

The Nutri-Score nutrient scoring algorithm:

The algorithm gives points for each element in the nutrition table (per 100 g or ml) - that means nutrients to limit (energy, sugars, saturated fatty acids, salt) as well as nutrients to encourage (proteins, fibre, percentage of fruit, vegetables, nuts, rapeseed oil, walnut oil and olive oil). We then subtract the positive points from the negative ones and convert the result to the Nutri-Score table.

Ranking each nutrient:

Bad nutrients are given a score from 0-10 each (total sum of 0-40) and good nutrients are given a score of 0-5 each (total sum of 0-15) based on the thresholds listed below. The "good points" are subtracted from the "bad points" to result in a numeric score with a potential range of -15 (best possible) to 40 (worst possible). Foods are then graded on A-E based on their numeric score.

Points	Energy (kJ)	Sugar (g)	Saturated fatty acids (g)	Sodium (mg)
0	≤ 335	≤ 4,5	≤ 1	≤ 90
1	> 335	> 4,5	> 1	> 90
2	> 670	> 9	> 2	> 180
3	>1005	> 13,5	> 3	> 270
4	> 1340	> 18	> 4	> 360
5	> 1675	> 22,5	> 5	> 450
6	> 2010	> 27	> 6	> 540
7	> 2345	> 31	> 7	> 630
8	> 2680	> 36	> 8	> 720
9	> 3015	> 40	> 9	> 810
10	> 3350	> 45	> 10	> 900
TOTAL	1 point	0 points	0 points	7 points

Points	Fruit, vegetables (%)	Fibers (g)	Proteins (g)
0	≤ 40	≤ 0,9	≤ 1,6
1	> 40	> 0,9	> 1,6
2	> 60	> 1,9	> 3,2
3	-	> 2,8	> 4,8
4	-	> 3,7	> 6,4
5	> 80	> 4,7	> 8,0
TOTAL	0 points	5 points	5 points

Class	Score ranges	Colour
A	Min to - 1	Dark green
B	0 – 2	Light green
C	3 – 10	Yellow
D	11 - 18	Orange
E	19 – max	Dark orange

576**Logo images:**

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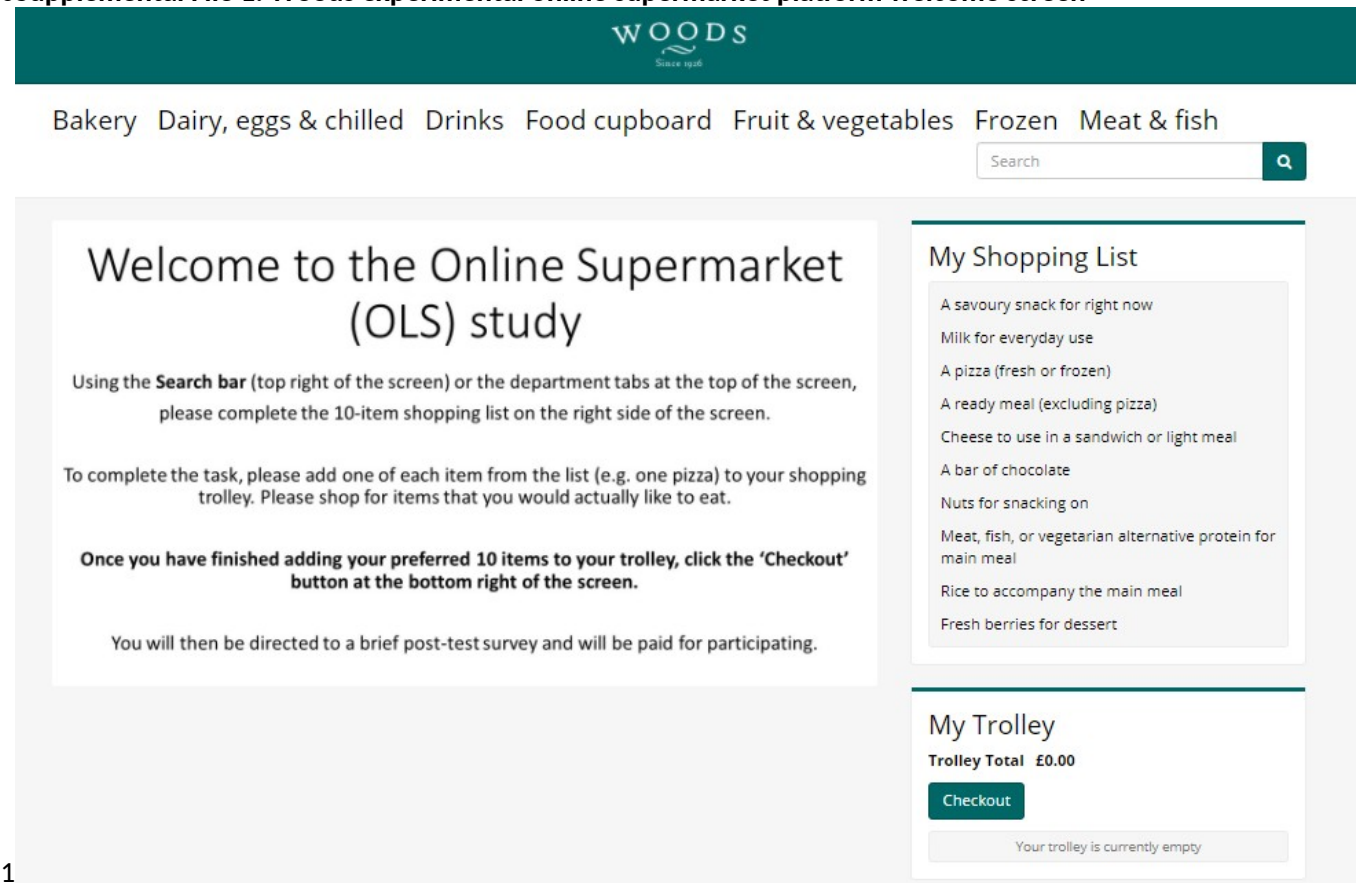
Supplemental File 1. Woods experimental online supermarket platform welcome screen



Supplemental File 2

Part 1: BASELINE ASSESSMENT

SCREENING QUESTIONS (Pre-shopping)

1. Age
   - Under 18 years old
   - 18 years old or over

2. Do you currently reside in the UK?
   - Yes
   - No

3. Are you fluent in English?
   - Yes
   - No

4. Are you vegetarian or vegan?
   - Yes
   - No

5. How hungry are you right now?
   - Scale: not at all – extremely

6. How full are you right now?
   - Scale: not at all - extremely

Part 2: POST TEST SURVEY

1. Demographic characteristics
   1) Gender: o Male o Female o Other o Prefer not to say
   2) Age (years): Drop down menu(range of 18-99) o Prefer not to say

2. Household size – "How many people live at your house, including you?

3. Individual income per year
   1) Less than £15,000
   2) £15,000 - £24,999
   3) £25,000 - £39,999
   4) £40,000 - £75,000
   5) Over £75,000
   6) Prefer not to say

4. What is the highest educational qualification you have achieved?
   1) None
   2) Up to 4 GCSE's (Including 1-4 O Levels/CSE/GCSEs (any grades), Foundation Diploma, NVQ level 1, Foundation GNVQ or equivalents)
   3) 5 or more GCSE's or 1 A-level (Including 5+ GCSEs (Grades A*-C),1 A Level/ 2-3 AS Levels, NVQ level 2, Intermediate GNVQ, City and Guilds Craft, BTEC First/General Diploma, RSA Diploma, Apprenticeship or equivalents)
   4) 2 or more A-levels (Including 2+ A Levels, 4+ AS Levels, NVQ Level 3, Advanced GNVQ, City and Guilds Advanced Craft, ONC, OND, BTEC National, RSA Advanced Diploma or equivalents)
   5) Bachelor's degree (Including BA, BSc, NVQ Level 4-5, HNC, HND, RSA Higher Diploma, BTEC Higher level or equivalents)
   6) Post-Graduate degree or qualification (Including Higher Degrees e.g. MA, PhD, PGCE, Professional qualifications e.g. teaching, nursing, accountancy or equivalents)
   7) Prefer not to say

5. "How often do you look at the front of package nutrition labels when doing your usual grocery shop?"
   1) Always
   2) Often
   3) Sometimes
   4) Rarely
   5) Never

6. Now we would like to know a little about your eating habits. Please think only of what you ate *yesterday* when answering the following questions. "Did you eat any meat or poultry yesterday? (Think about curry, stirfry, sandwiches, pie fillings, sausages/burgers, liver, pâté or mince.)" No / Yes

   6a. If YES, "How much of each type of meat listed below did you eat yesterday?"

Meat	**Amount**	**None**	**1**	**2**	**3**	**4**	**5+**
Sausage	Each						
Beef (e.g. roast, steak, mince, curry, burger)	Serving						

Pork (e.g. roast, chops, sweet and sour)	Serving						
Lamb or mutton (e.g. roast, chops, stew, burger)	Serving						
Chicken or turkey in breadcrumbs or deep fried (e.g. nuggets, KFC)	Serving						
Chicken or turkey (e.g. roast, drumsticks, curry)	Serving						
Bacon	Rasher						
Ham, Parma ham, salami, pastrami, cured meats	Slice						
Liver or liver pâté	Serving						
Other (e.g. duck, goose, kidney)	Serving						

7. "Did you eat any fish or seafood yesterday?" No / Yes

10a. If YES – "How much of each type of fish listed below did you eat yesterday?"

Fish	**Amount**	**None**	**1**	**2**	**3**	**4**	**5+**
Tinned tuna	Serving						
Oily fish (e.g. salmon, tinned salmon, herring, mackerel, sardines, fresh tuna steak)	Serving						
Breaded fish (e.g. fish fingers) or fish cakes	Serving						
Battered fish	Serving						
White fish (e.g. cod, haddock, fish pie)	Serving						
Prawns	Serving						
Lobster or crab	Serving						
Shellfish (e.g. mussels, scallops)	Serving						
Other	Serving						

8. Meat knowledge: "The following statement best reflects my beliefs regarding the impact of producing meat and meat products on the environment:"

1) I believe that producing meat and meat products has a harmful effect on the environment.
2) I do not know how producing meat and meat products affects the environment.
3) I believe that producing meat and meat products has no effect on the environment.
4) I believe that producing meat and meat products has a beneficial effect on the environment.

9. Meat reduction: "Have you considered reducing the amount of meat that you eat?"

1) Yes, I've reduced the amount of meat I eat in the past 5 years.
2) Yes, I would like to reduce the amount of meat I eat, but haven't yet.
3) No, I'm happy with the amount of meat I eat / don't eat.
4) No, I would like to eat more meat.

682**Supplemental Table 1.** Exploratory variables included in the regression model.

	Control (*n* = 273)	**Ecolabel only** (*n* = 743)	**Nutrition label only** (*n* = 731)	**Both labels** (*n* = 741)	**Total (n = 2488)**
Hunger, *n* (%)					
Not at all	81 (29.7%)	248 (33.4%)	241 (33.0%)	245 (33.1%)	815 (32.8%)
A little	122 (44.7%)	293 (39.4%)	275 (37.6)	287 (38.7%)	977 (39.3%)
Moderate	51 (18.7%)	151 (20.3%)	150 (20.5%)	151 (20.4%)	503 (20.2%)
Very	16 (5.9%)	37 (5.0%)	49 (6.7%)	42 (5.7%)	144 (5.8%)
Extremely	3 (1.1%)	14 (1.9%)	16 (2.2%)	16 (2.2%)	49 (2.0%)
Fullness, *n* (%)					
Not at all	86 (31.5%)	235 (31.6%)	243 (33.2%)	225 (30.4%)	789 (31.7%)
A little	69 (25.3%)	193 (26.0%)	198 (27.1%)	227 (30.6%)	687 (27.6%)
Moderate	92 (33.7%)	251 (33.8%)	218 (29.8%)	237 (32.0%)	798 (32.1%)
Very	22 (8.1%)	57 (7.7%)	61 (8.3%)	44 (5.9%)	184 (7.4%)
Extremely	4 (1.5%)	7 (0.9%)	11 (1.5%)	8 (1.1%)	30 (1.2%)
Meat and fish consumption quartile, *n* (%)					
First (lowest)	122 (47.1%)	304 (43.6%)	316 (44.0%)	317 (45.4%)	1059 (44.6%)
Second	57 (22.0%)	163 (23.4)	157 (21.8%)	147 (21.1%)	524 (22.1%)
Third	20 (7.7%)	86 (12.3%)	90 (12.5%)	83 (11.9%)	279 (11.8%)
Fourth (highest)	60 (23.2%)	144 (20.7%)	156 (21.7%)	151 (21.6%)	511 (21.5%)
Meat knowledge, n (%)					
Beneficial effect on environment	31 (11.4%)	58 (7.8%)	63 (8.6%)	67 (9.1%)	219 (8.8%)
No effect on environment	42 (15.4%)	123 (16.6%)	110 (15.1%)	89 (12.0%)	364 (14.7%)
Do not know	98 (36.0%)	251 (33.8%)	253 (34.7%)	266 (36.0%)	868 (35.05)
Harmful effect on environment	101 (37.1%)	310 (41.8%)	303 (41.6%)	318 (43.0%)	1032 (41.6%)
Meat reduction, n (%)					
Want to eat more meat	16 (5.9%)	25 (3.4%)	31 (4.3%)	25 (3.4%)	97 (3.9%)
No desire to change	113 (41.5%)	331 (44.6%)	333 (45.7%)	345 (46.6%)	1122 (45.2%)
Want to reduce	62 (22.8%)	144 (19.4%)	130 (17.8%)	159 (21.5%)	495 (19.9%)
Already reducing	81 (29.8%)	242 (32.6%)	235 (32.2%)	211 (28.5%)	769 (31.0%)

683
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685**Supplemental Table 2.** Comparison of (i) the mean environmental impact score and (ii) health score between study conditions

Outcome	Eco-Only vs Eco&Nutrition Mean difference (95% CI)	Nutrition-Only vs. Eco&Nutrition Mean difference (95% CI)	Eco-Only vs Nutrition-Only Mean difference (95% CI)
Environmental Impact Score	0.67 (0.08, 1.26)	1.80** (1.20, 2.39)	-1.12** (-1.72, -0.53)
Health Score	0.26 (-0.08, 0.59)	0.08 (-0.26, 0.42)	0.18 (-0.15, 0.51)

686
687*Note.* **p <=0.001
688
689

690**Supplemental Table 3.** Comparison of the individual environmental impact indicators between trial groups. Natural logs of absolute values were used in
691analyses; this is not comparable to Supplementary Table 1a where scores are based on percentiles (i.e. relative impact between products).

	Control	**Eco-Only vs Control**		**Nutrition-Only vs Control**		**Eco&Nutrition vs Control**	
	Mean (SD)	**Mean difference (95% CI)**	**% Change**	**Mean difference (95% CI)**	**% Change**	**Mean difference (95% CI)**	**% Change**
Greenhouse gas emissions	0.49 (0.47, 0.51)	-0.02 (-0.07, 0.03)	-2.0%	0.00 (-0.05, 0.05)	0.0%	-0.09 ** (-0.14, -0.03)	-8.6%
Biodiversity loss	11.57 (11.00, 12.17)	-0.01 (-0.07, 0.05)	-1.0%	0.04 (-0.02, 0.10)	4.1%	-0.05 (-0.11, 0.01)	-4.9%
Eutrophication potential	2.00 (1.93, 2.08)	-0.03 (-0.07, 0.02)	-3.0%	0.00 (-0.05, 0.05)	0.0%	-0.08 ** (-0.13, -0.03)	-7.7%
Water use	1966.3 (1869.4, 2068.3)	-0.12 ** (-0.18, -0.05)	-11.3%	0.00 (-0.07, 0.06)	0.0%	-0.12 ** (-0.19, -0.06)	-11.3%

692*Note*. Values are geometric means in column 1 and model coefficients with dependent variables being the natural logs of individual environmental indicators
693(95% CIs) in the columns 2, 4, and 6. %Change is calculated based on the exponentiated coefficients for individual environmental indicator scores **p
694<=0.001
695

Supplemental Table 4. Linear regression models, including adjusted models with interaction effects.
See Excel file