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Changing the default order of food items in an online grocery store may nudge healthier food choices

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ABSTRACT

Restructuring food environments, such as online grocery stores, has the potential to improve consumer health by encouraging healthier food choices. The aim of this study was to investigate whether repositioning foods within an experimental online grocery store can be used to nudge healthier choices. Specifically, we investigated whether repositioning product categories displayed on the website main page, and repositioning individual products within those categories, will influence selection. Adults residing in Australia ($n = 175$) were randomised to either intervention (high-fibre foods on top) or comparator condition (high-fibre foods on the bottom). Participants completed a shopping task using the experimental online grocery store, with a budget of up to AU$100 to for one person's weekly groceries. The results of this study show that the total fibre content per 100 kcal per cart ($p < .001$) and total fibre content per cart ($p = .036$) was higher in the intervention compared to comparator condition. Moreover, no statistical difference between conditions was found for the total number of fibre-source foods ($p = .67$), the total energy per cart ($p = .17$), and the total grocery price per cart ($p = .70$) indicating no evidence of implications for affordability. Approximately half of the participants (48%) reported that they would like to have the option to sort foods based on a specific nutrient criterion when shopping online. This study specifically showed that presenting higher-fibre products and product categories higher up on the online grocery store can increase the fibre content of customers' purchases. These findings have important implications for consumers, digital platform operators, researchers in health and food domains, and for policy makers.

1. Background

Food environments, such as retail and hospitality settings, have a major influence on what and how much people eat (Hill et al., 2003), which in turn impacts overall health and wellbeing (WHO, 2021). Attempts to promote healthy eating by focusing on educating consumers have had a limited success (Bucher et al., 2013; Marteau et al., 2012). While nutrition education and nutrition information can provide consumers with knowledge to make informed food choices, this does not generally translate into action (Bucher et al., 2013). The Determinants of Nutrition and Eating (DONE) interactive framework (Stok et al., 2017) emphasises that environmental factors have a greater influence on food choices, especially when compared to individual and interpersonal factors. In addition, they are highly influential and modifiable (i.e., how feasible or easy it is to change) (Stok et al., 2017), therefore, environmental factors should be key targets for interventions and policy changes.

Most food choices have traditionally occurred in physical environments, such as supermarkets and restaurants. However, increasing technology capability and accessibility are shifting food choices to digital environments (Grand View, 2022). This shift to online shopping includes online grocery shopping, technology-facilitated delivery services, and pre-ordering systems. Following the recent COVID-19 pandemic, online food purchasing increased drastically, and consumers are now even more accustomed to ordering food online (OJDS, 2022). For example, in Australia almost one-quarter (23%) of the household food budget was spent ordering food online in 2022 (Spryker, 2022). Moreover, 28.3% of US consumers purchased almost all of their groceries online based on the survey conducted in 2022, and the US online grocery sales are expected to grow at a rate of 18% per year between 2023 and 2025 (XStak, 2022). Similar trends are also seen in Europe, where the online grocery delivery market is expected to grow at a compound annual rate of 17.2% from 2023 to 2028 (Mordor Intelligence, 2023). In addition, advances in user interface (UI) design through

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websites and mobile applications could potentially make online grocery shopping and meal ordering easier. While factors such as the proximity of different food products to the checkout have been greatly investigated in physical environments (Golding et al., 2022; Maas et al., 2012), the evidence of their effect in online stores is lacking. In digital environments, factors such as the much lower effort needed to place an item into a basket or cart, the colour scheme and design of the online store, or product ratings, might have a big impact on food choices (CMA, 2022). However, research into how different UI variables online influence consumers' decision-making processes is currently lacking.

Since food and eating environments have such a profound influence on food choices, strategically modifying them can be an effective strategy to promote healthy eating and healthy food choices (Marteau et al., 2011; Thaler & Sunstein, 2008). The term *nudging* describes a strategic environmental change that alters people's behaviour in a predictable way, without forbidding any options in a paternalistic manner or directly changing economic incentives (Thaler & Sunstein, 2008). This knowledge can be strategically exploited, for example by depleting consumers cognitive resources and triggering impulse purchases (Verplanken & Sato, 2011), or by saliently placing products to increase sales. It has been shown that retailers aim to promote sales by strategically influencing consumers' decision-making (Roschk et al., 2017). However, since online services are widely used and could provide opportunities to promote healthier food choices and eating patterns, *digital nudging*, defined as "the use of UI design elements to guide people's behaviour in digital choice environments" (Weinmann et al., 2016), is becoming more relevant.

Over the last few years, some research on how to strategically improve food environments to encourage healthier choices in digital environments has been conducted. For example, researchers found that descriptive norms (i.e., "ecological" labels) can encourage sustainable grocery shopping (more ecological products purchased) (Demarque et al., 2015). In addition, exposure to behavioural nudges in form of a health message (highlighting the health benefits of reducing meat consumption to reduce the risk of diabetes) is an effective strategy to encourage meat eaters to purchase plant-based meat alternatives (Segovia et al., 2023). Further, it was found that offering product swap suggestions within the food category did not reduce the energy density of food purchases in an online grocery store (Forwood et al., 2015). A recent bibliometric analysis confirmed that digital nudging is a rapidly growing field with strong historical roots in psychology (Piper et al., 2021, pp. 1–12). However, what is not well understood is how different UI elements influence product perception and choice. A scoping review conducted in early 2022 identified only 15 studies on digital nudging in online grocery stores (Valenčič et al., 2022). The included studies have focused on applying different (already established) nutrition label(s) (e.g., Nutri Score) (Blitstein et al., 2020; Finkelstein et al., 2019, 2020, 2021; Sacks et al., 2011; Shin et al., 2020), healthier swap suggestions (Bunten et al., 2021; Forwood et al., 2015; Huang et al., 2006), default options (Coffino et al., 2020; Coffino & Hormes, 2018), increasing salience (Blom et al., 2021), or a combination of strategies (Koutoukidis et al., 2019; Marty et al., 2020; Stuber et al., 2022). The research showed that different nudging strategies can have mixed results and varied effects on food selection. Therefore, more studies regarding effective strategies for specific dietary aspects are needed in a digital setting to avoid adverse effects.

Studies in physical food choice environments have shown that 'effort' targeted nudges can influence food choice. For example, in a systematic review by Bucher et al. (2016), it was concluded that food positioning influences food choice if it alters the levels of effort to obtain the food, i.e., if there is a reduced effort to obtain healthy foods, people selected more healthy foods. Moreoever, studies in physical store environments show the importance of assortment organisation and shelf arrangement on consumer's shopping effort, product perceptions, purchase decisions, and overall store impressions (van Herpen, 2016). For example, it has been shown that placing healthy foods closer to the checkout in a real-life supermarket can increase healthy food purchases (Huitink et al., 2020; Sigurdsson et al., 2014). Findings of shelf placement of products reported mixed results. Some studies suggest that placing products at the eye-level is the best option to promote sales (e.g., (van Herpen et al., 2012)). However, a study conducted in a major supermarket retailer in New Zealand, found that eye-levelled shelf placement alone, was not an effective strategy to increase purchases of healthier breakfast cereals (Young et al., 2020). Similarly, even though consumers believe that popular products are centrally positioned in the product category, a field study showed that their beliefs about how retailers organise product displays in stores do not reflect the real marketplace (Valenzuela et al., 2013). As it can be seen, product placement within the product categories in physical environments impacts consumers' choices, however the effectiveness might vary among categories.

The effects of product (re)positioning have also been investigated within online grocery stores. For example, an observational study of online grocery shoppers found that consumers are likely to select products that appear closer to the top of a category (Anesbury et al., 2016). Similarly, it has been shown that products have a higher probability of selection when placed on the first-screen or located next to a consumer's highly-preferred product, which indicates that shelf arrangement could guide replacement decisions towards specific items (Breugelmans et al., 2007). Furthermore, recent studies found that product placement can lower energy and several micro- and macronutrients in a mock online grocery store (Howe et al., 2022), and that altering product order based on lower saturated fat content can reduce the saturated fat purchased (Koutoukidis et al., 2019). In contrast, a study by Bunten et al. found that reordering of products while using promotional banners did not influence healthier purchases (Bunten et al., 2022). Therefore, more research is needed to confirm the effectiveness of product placement in digital settings and to investigate whether this strategy is effective for different food products and for different variables (e.g., nutrients, price, environmental impact).

Therefore, the aim of the current study was to investigate whether reordering healthier foods by making them obtainable with minimal effort encourages the selection of healthier foods within an experimental online grocery store. In this study, the focus is on repositioning the order of foods presented online according to their dietary fibre content. This nutrient was selected because dietary fibre has been shown to have important benefits for gastrointestinal health, and higher intakes are also associated with a lower risk of chronic diseases such as cardiovascular diseases, type II diabetes, specific cancers, and all-cause mortality (Gill et al., 2021). Moreover, research indicates that for every 10 g/day increase in dietary fibre, the risk of coronary heart disease is reduced by 14% and the risk of coronary mortality by 27%, as reported in a pooled analysis of prospective cohort studies (Pereira et al., 2004). Additionally, Howarth et al. (2001) summarised the effects of dietary fibre on hunger, satiety, energy intake, and body composition in healthy people and found that a 10% decrease in total energy intake was associated with a body weight reduction of 1.9 kg over 3.8 months when consuming an additional 14 g of dietary fibre per day. However, current intakes do not meet recommended daily dietary fibre intake targets (Koroušić Seljak et al., 2021), and on average, adults worldwide consume less than 20 g of dietary fibre per day (Mayor, 2019), instead of the recommended 25–35 g per day (depending on the country) (Gill et al., 2021).

Given the evidence for repositioning interventions described above, we hypothesised that reordering products within an online grocery store according to fibre content, and thereby making them obtainable with less effort could lead to healthier choices and increase the amount of fibre per online shopping occasion. Specifically, we hypothesised that the nudge would result in shopping carts having a higher total fibre content per 100 kcal. In addition, the energy content (kcal) of the cart was hypothesised to be reduced. Nevertheless, we are aware that high-fibre foods, such as whole grain bread, are not necessarily lower in energy. While high-fibre containing foods have less energy that is biologically available, this is not acknowledged in nutrient databases or on food labels.

2. Methods

2.1. Participants

Participants aged 18 years or older residing in Australia and regularly shopping online (at least once a month) were recruited online in November and December 2022 via a QuestionPro research panel (QuestionPro, 2023). Participants were randomised to either intervention (higher-fibre foods positioned at the top of the webpage within each food category, and Fruits and Vegetables category listed first on the webpage) or comparator condition (higher-fibre foods at the bottom of the webpage within each food category, and Fruits and Vegetables category listed last on the website), see Fig. 1 for more details. Randomisation was performed by QuestionPro, and links to two different experimental online grocery stores were sent to each research panel. Participants and researchers were blinded to group allocation. No personal-identifying information was recorded during the research study. Ethical approval for the current study was obtained from the University of Newcastle Human Research Ethics Committee (Approval number H-2022-0240).

Participants were excluded if they completed the study (both online surveys and the shopping task) in less than half the median time (i.e., 300 s); purchased less than 5 products from less than two food group categories; spent less than AU$50 or more than AU$150; or had a body mass index (BMI) less than 15 or more than 35. In addition, participants whose 'Purchasing order number' could not be linked to a survey

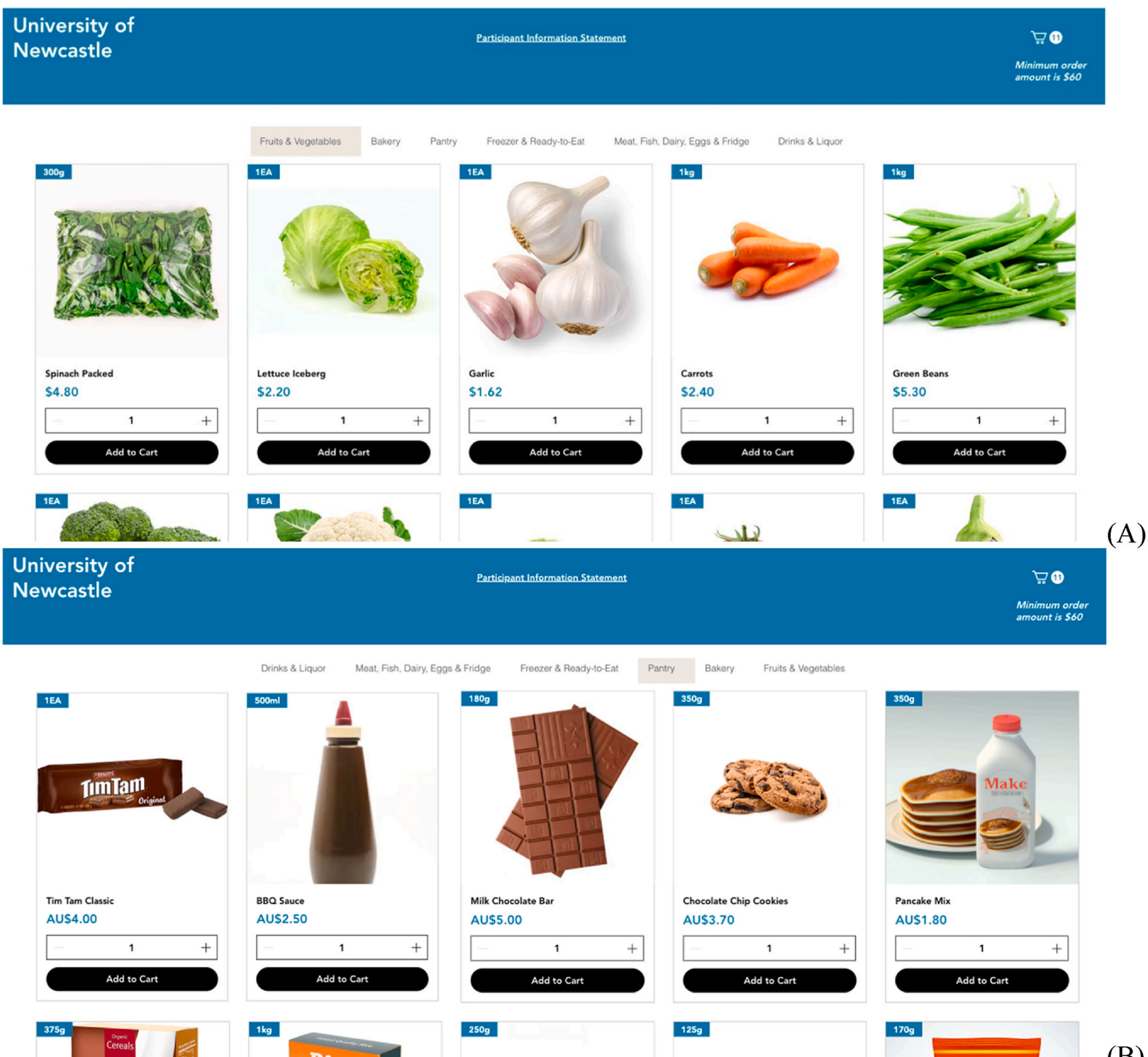

Fig. 1. An example of the *Fruits and Vegetables* category as it appeared in the intervention experimental online store (A) and of *Pantry* category as it appeared in the comparator experimental online store (B). For each of the products, the displayed price is related to the quantity indicated in the upper left corner (e.g., EA means 'each'). Note: the image of the pancake mix was created using DALL-E (DALL-E, 2022).

number were also excluded.

2.2. Experimental online grocery store

An experimental online grocery store was designed for the purpose of this study using the Wix.com Ltd. software, which provides templates for online stores that can relatively easily be 'stocked' with products. Previous studies have shown that using an experimental store is a valid method for investigating consumer behaviours and food choices (Finkelstein et al., 2019; Forwood et al., 2015). The experimental online grocery store designed for the current study contained 188 commonly purchased Australian food and beverage products. Relevant foods from the Australian eating survey (Collins et al., 2014) were selected, and a group of five Australians who regularly shop online have reviewed the list of foods for missing items that they think people frequently consume.

The experimental online grocery store was designed to resemble an actual online grocery store (see Fig. 1), but it did not take any payment nor arrange delivery of the purchased foods. Products were grouped into six categories: (i) Fruits and Vegetables, (ii) Bakery, (iii) Pantry, (iv) Freezer and Ready-to-Eat, (v) Meat, Fish, Dairy, Eggs and Fridge, and (vi) Drinks and Liquor. All products included a picture of the item, item name, price in Australian dollars, and quantity or unit size (e.g., 4 pack, 120g). Images of generic, non-branded products were used (with the exception of Tim Tams and Vegemite, which are commonly eaten in Australia) to avoid breaching copyright and control for effects of branding. For products where no suitable images were available, synthetic images were generated via the AI toolDALL-E (DALL-E, 2022). Participants could add and remove products from their cart and review the order summary before proceeding to checkout.

In both versions of the experimental stores, the categories as well as the products within categories were reordered. The reordering was conducted by researchers of the study. In the intervention store, categories were ordered as followed: Fruits and Vegetables; Bakery; Pantry; Freezer and Ready-to-Eat; Meat, Fish, Dairy, Eggs and Fridge; and Drinks and Liquor. The products within each of these categories were reordered ascendingly based on the dietary fibre content per 100 kcal. That means that the foods with the highest content of dietary fibre per 100 kcal within each category were placed on top of the screen, and the foods with the lowest dietary fibre content were at the bottom. Participants had to scroll and/or go to the next page to locate the products. For example, wholegrain products within the category 'Bakery' were at the top, whereas white-flour products and baked sweets were located at the bottom. In the comparator store, the order of categories and products was inverted. That means that the first category was Drinks and Liquor, followed by Meat, Fish, Dairy, Eggs and Fridge; Freezer and Ready-to-Eat; Pantry; Bakery; and Fruits and Vegetables. The products with the lowest content of dietary fibre per 100 kcal within each category were placed at the top, while the products with the highest dietary fibre content were at the bottom. The exact order of all products within each category for both experimental stores is presented in Supplementary files S1 and S2.

2.3. Measures and materials

Participants completed a pre-task survey, a shopping task and a post-task survey.

2.3.1. Pre-task survey

At the beginning of the survey, participants received a personal information statement, and consent was obtained online prior to data collection. Participants were asked to provide information on gender ("Woman", "Man", "Non-binary", "Prefer not to say" or "Other (specify)"), year of birth, height (centimetres), weight (kilograms), highest educational level or qualification obtained ("Postgraduate degree", "Bachelor's degree", "Trade certificate/TAFE qualification", "Year 8–12 or equivalent", "Did not attend school"), and lastly their typical eating pattern ("Omnivore", "Vegetarian", "Vegan" or "Other (specify)").

2.3.2. Online shopping task

After finishing the pre-task survey, participants had to read the instructions regarding the shopping task. The shopping task required them to use the experimental online grocery store and spend up to AU$100 to shop online for weekly groceries they would typically purchase for one person (the minimum order amount was AU$60). They were made aware that the online grocery store website was not a real commercial website and that they would not be required to spend any money and would not receive the groceries. They were instructed to purchase groceries that they would typically buy each week and to choose a similar item if something they wanted was not available. As the experimental store resembled a real online store, participants had to provide shipping details, but were advised to enter dummy data (e.g., mockup@gmail.com as an email address). Additionally, they were instructed to remember or copy the order number received after placing their order, as they needed to enter it into the post-task survey for verification of completion. Lastly, they were given a link that redirected them to either an intervention or comparator experimental online grocery store.

2.3.3. Post-task survey

Upon finalising the shopping task, participants were asked to complete the post-task survey, which was adapted from measures used in similar studies such as (Bunten et al., 2021; Forwood et al., 2015). Firstly, they had to enter the order number that they had received at checkout. After entering a valid order number, participants were asked to indicate how often they had purchased groceries online over the past year ("Not at all in the last year", "Less than once a month", "1–3 times a month", "Once a week", "More than once a week"), what proportion of their groceries they shopped for online (0–100%), whether they were the main person responsible for grocery shopping in the household, how many people currently live in their household, and what their average total household income per month was before tax. Additionally, they were asked to indicate how they found the online shopping experience (from poor to excellent). Participants were also debriefed that the foods were arranged according to the dietary fibre content, which may have increased or decreased their effort in locating a particular product, and asked to indicate their level of agreement regarding the following statement: "*The possibility to reorder foods based on a certain nutrient is something I would like to have when I do my usual online shopping.*" (from strongly disagree to strongly agree). They were also asked to choose their top three criteria for food choices and purchases (price, appearance, taste, habits, healthiness, environmental impact, convenience, special offers, special diet, or to specify other). Lastly, they had the opportunity to provide additional comments.

2.4. Outcomes

The primary outcomes were the differences (mean/median) between the two conditions for total fibre content per 100 kcal and the number of fibre-source foods within shopping carts. Secondary outcomes were differences (mean/median) between the two conditions in total energy (kcal) per shopping cart, total fibre (g) per cart, total price (AU$) of the shopping cart, total fibre content per dollar (AU$), and total energy per dollar (AU$).

2.5. Analysis

Declaring dietary fibre on nutrition labels is currently not mandatory in Europe (European Parliament and Council, 2011) or Australia (unless a nutrition claim about fibre is made on the label) (Food Standards Australia & New Zealand, 2020). Therefore, to be able to sort the products used in the experimental store based on their dietary fibre content, the dietary fibre data was obtained from the Australian food composition database (AUSNUT 2011-13). In the database, nutrient values were presented per 100 g edible portion, and energy was presented in kilojoules (kJ). These values were used to calculate kilocalories (kcal) per 100 g, kcal per unit, dietary fibre per unit, and dietary fibre per 100 kcal. Each product was coded as a 'source of fibre' or not, based on the Codex Alimentarius: Guidelines for use of Nutrition and health claims (Codex Committee on Food Labelling, 2013, p. 8), where foods containing at least 1.5 g/100 kcal of dietary fibre were considered as being a 'source of fibre'.

Descriptive statistics were used to describe the properties of participants using Microsoft Excel and R software (Field et al., 2012) (v. 4.2.0, for iOS). Demographic details were summarised with frequencies, means/medians, and standard deviations (SD) as appropriate. Outcome data was tested for normality using the Shapiro–Wilk test, and the homogeneity of variances was tested using Levene's test, using R software; p-values < .05 were considered statistically significant. Chi-square tests and Wilcoxon rank-sum tests were performed to check whether the conditions were well matched for sample baseline characteristics. Non-parametric data of total fibre content per 100 kcal, total number of fibre-source foods, total energy (kcal) per shopping cart, and total price of shopping cart contents were analysed using Wilcoxon rank-sum tests. Medians (Mdn) and significance were reported.

The hypothesis was that reordering products according to dietary fibre content would result in shopping carts containing more total fibre content per 100 kcal and a lower energy content. All hypotheses and methods for data cleaning and analysis were registered on the AsPredicted platform (AsPredicted, 2022) prior to study commencement (trial registration number: #114183).

3. Results

3.1. Participants

A total of 303 adults completed the study. Of those, 128 were excluded based on the exclusion criteria described in section 2.1 (31 participants completed the study in less than 300 seconds, 54 reported a BMI less than 15 or more than 35, and 43 participants purchased less than five products from less than two food group categories or spent less than AU$50 or more than AU$150). Therefore, data from 175 adults was included in the final analysis. Participants were randomised into the intervention (n = 82) and comparator (n = 93) conditions. On average, participants needed 17.3 minutes to complete the study.

The mean age of participants was 38.6 years (±15.3), and 72.6% identified as female (n = 127), 26.3% as male (n = 46), and 1.1% as non-binary (n = 2). The majority (90.3%) of participants were the main person responsible for grocery shopping in their household. The average BMI of the sample was 25.0 kg/m^2 (±4.6). In addition, the greatest proportion of participants had a trade certificate or TAFE qualification (29.7%), followed by a bachelor's degree (28.6%), year 8–12 or equivalent (22.3%), and postgraduate degree (19.4%). The majority were omnivores (89.7%), followed by vegetarians (6.9%), vegans (1.1%) and 2.3% of participants followed other eating patterns. The greatest proportion of participants (30.9%) lived in a household of two people, and the lowest proportion lived in a household of six or more people (7.4%). See Table 1 for more details. In addition, 44.6% of participants had a mean total household income per month before tax of less than AU $5′000, followed by AU$5000–10.000 (36.6%), and 19.9% had more than AU$10.000. Participants on average purchased 33.6% of their groceries online, and over the past year the greatest proportion (27.4%) purchased groceries online less than once a month (see Table 1 for more details). When asked about the top three factors that affect their decisions when purchasing foods online, most participants selected price (86.9%), taste (66.3%), and healthiness (33.1%), whereas environmental factors were the least important (5.7%). See Table 1 for more details. There was no significant difference between groups in terms of demographics.

Table 1
Sample baseline characteristics.

Variable	Total (n = 175)	Condition: Intervention (n = 82)	Condition: Comparator (n = 93)
Age in years M (SD)	38.6 (15.3)	39.6 (15.4)	37.7 (15.2)
BMI M (SD)	25.0 (4.6)	25.5 (4.3)	24.7 (4.9)
Gender n (%)			
Woman	127 (72.6)	57 (32.6)	70 (40.0)
Man	46 (26.3)	25 (14.3)	21 (12.0)
Non-binary	2 (1.1)	0 (0.0)	2 (1.1)
Education n (%)			
Postgraduate degree	34 (19.4)	16 (9.1)	18 (10.3)
Bachelor's degree	50 (28.6)	29 (16.7)	21 (12.2)
Trade certificate/TAFE qualification	52 (29.7)	25 (14.3)	27 (15.4)
Year 8–12 or equivalent	39 (22.3)	12 (6.9)	27 (15.4)
Did not attend school	0 (0.0)	0 (0.0)	0 (0.0)
Eating patterns n (%)			
Omnivore	157 (89.7)	72 (41.1)	85 (48.6)
Vegetarian	12 (6.9)	7 (4.0)	5 (2.9)
Vegan	2 (1.1)	2 (1.1)	0 (0.0)
Other	4 (2.3)	1 (0.6)	3 (1.7)
Household size n (%)			
1 person	30 (17.1)	6 (3.4)	24 (13.7)
2 people	54 (30.9)	34 (19.4)	20 (11.4)
3 people	30 (17.1)	16 (9.1)	14 (8.0)
4 people	28 (16.0)	13 (7.4)	15 (8.6)
5 people	20 (11.4)	7 (4.0)	13 (7.4)
6 or more people	13 (7.4)	5 (3.4)	7 (4.0)
Income n (%)			
Less than AU$5000	78 (44.6)	34 (19.4)	44 (25.1)
AU$5000–10.000	64 (36.6)	35 (20.0)	29 (16.6)
More than AU$10.000	33 (18.9)	13 (7.4)	20 (11.4)
Frequency of online purchases in the last year n (%)			
Never	44 (25.1)	24 (13.7)	20 (11.4)
Less than once a month	48 (27.4)	18 (10.3)	30 (17.1)
1-3x a week	41 (23.4)	18 (10.3)	23 (13.1)
Once a week	35 (20.0)	19 (10.9)	16 (9.1)
More than once a week	7 (4.0)	3 (1.7)	4 (2.3)
Proportion of groceries purchased online %	33.6	32.6	34.5
Proportion of participants selecting factors affecting purchasing decision % (n)			
Price	86.9 (152)	40.6 (71)	46.3 (81)
Taste	66.3 (116)	31.4 (55)	34.9 (61)
Healthiness	33.1 (58)	12.6 (22)	20.6 (36)
Special offers	32.6 (57)	17.1 (30)	15.4 (27)
Convenience	22.3 (39)	9.7 (17)	12.6 (22)
Appearance	21.1 (37)	10.3 (18)	10.9 (19)
Habits	20.6 (36)	7.4 (13)	13.1 (23)
Special diet	10.3 (18)	6.3 (11)	4.0 (7)
Environmental factors	5.7 (10)	4.0 (7)	1.7 (3)
Other	1.1 (2)	1.1 (2)	0.0 (0)

3.2. Primary outcome

As hypothesised, the total fibre content per 100 kcal per cart was higher in the intervention shopping cart (Mdn = 1.62, IQR = 0.91) compared to the comparator condition (Mdn = 1.34, IQR = 0.73, p < .001). The total number of fibre-source foods (defined as containing at least 1.5 g/100 kcal (Codex Committee on Food Labelling, 2013) added to shopping carts was not significantly different between groups (p = .67). See Table 2 for more details.

3.3. Secondary outcomes

The total fibre content per cart was significantly higher in the intervention (Mdn = 270.3, IQR = 176.6) compared to the comparator condition (Mdn = 219.9, IQR = 150.4, p = .036). The total energy per cart was not statistically different (p = .17) between conditions. Results also indicate that the total grocery price per cart was not statistically different between conditions (p = .70). In addition, total fibre content

Table 2
Outcomes.

Condition	Total (n = 175)			Intervention (n = 82)			Comparator (n = 93)			Wilcoxon
	Mdn	*IQR*	*CI*	*Mdn*	*IQR*	*CI*	*Mdn*	*IQR*	*CI*	*W*
Fibre content g/100 kcal	1.45	0.8	1.4; 1.6	1.62	0.91	1.5; 1.9	1.34	0.73	1.2; 1.4	2487***
Fibre g/cart	245.9	166.8	212; 273	270.3	176.6	212; 312	219.9	150.4	190; 264	3111*
Number of fibre-source foods/cart	15	15.5	13; 18	15	14.8	12; 20	15	17	12; 20	3668.5
Energy kcal/cart	16'280	6'817	15'411; 17'083	15'840	6'654	14'194; 17'627	16'689	7'262	15'411; 18'131	4271
Price $AU/cart	99.0	7.8	98.2; 99.6	98.9	7.2	97.4; 99.7	99.1	7.9	97.7; 100	3943
Fibre g/$AU	2.48	1.44	2.3; 2.7	2.78	1.63	2.2; 3.1	2.37	1.3	2.0; 2.6	3003*
Energy kcal/$AU	164.5	66.0	156.7; 172.4	158.5	65.0	139.9; 174.0	170.3	64.8	159.4; 185.6	4300

*p < .05, **p < .01, ***p < .001, *Mdn* = Median, *IQR* = Inter quartile range, *CI* = 95% Confidence interval.

per dollar was significantly higher in the intervention (Mdn = 2.78, IQR = 1.63) compared to comparator condition (Mdn = 2.37, IQR = 1.3, p = .016), whereas total energy per dollar was not statistically different between conditions (p = .15). See Table 2 for more details. Note, while there is a clear effect on the fibre per 100 kcal, the results for total fibre should be interpreted with caution. If a Bonferroni correction for multiple testing is applied, i.e., the p-value multiplied by the number of comparisons, this is no longer significant. A post-hoc analysis across food categories revealed that the difference in fiber content per 100 kcal and total fibre content per cart was primarily driven by the categories Fruits and Vegetables, and Pantry. Analysis per food category can be found in the Supplementary file S3.

In the post-task survey, participants were asked to indicate their level of agreement regarding their preference regarding the possibility of sorting the foods based on a certain nutrient when shopping online. Results indicated that approximately half of all participants (48%) agreed or strongly agreed with the statement, and 39% neither agreed nor disagreed (Fig. 2). The distribution of the level of agreement was not significantly different between the intervention and comparator conditions (see Supplementary file S4).

4. Discussion

The current study found that changing product order within an experimental online grocery store could influence which foods people added into their shopping cart. Specifically, changing the order of foods based on dietary fibre content influenced the total amount of fibre in the cart (an increase of 50.4g), the fibre content per 100 kcal per cart (an increase of 0.28g per 100 kcal), and the fibre per dollar spent (an increase of 0.41g per AU$). These results are promising and potentially

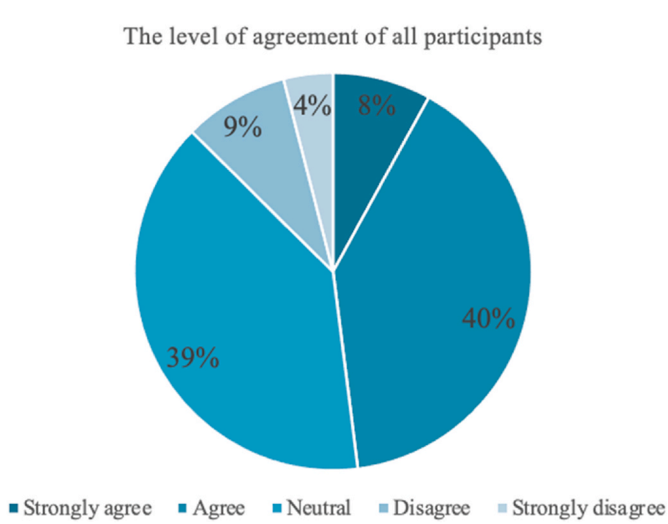

Fig. 2. Level of agreement with the statement: *'The possibility to reorder foods based on a certain nutrient is something I would like to have when I do my usual online shopping.'* among all participants.

have a high impact on influencing population intake and health risks, particularly as research shows the positive effects of adequate dietary fibre intake on humans' health.

Previous studies found that positional changes in real-life settings (e.g., cafeteria) had a positive influence on food choice overall and that nudging healthier food choices was successful (Baskin et al., 2016; Bucher et al., 2016; Dayan & Bar-Hillel, 2011; Romero & Biswas, 2016; van Kleef et al., 2018). Similarly, a study conducted in an experimental online grocery store showed that (re)positioning of food products based on lower saturated fat content leads to overall less saturated fat purchased (Koutoukidis et al., 2019). The current study adds to the evidence that modification of product order and food category arrangement based on nutrient criteria can be used to support and encourage healthier food choices in an online purchasing environment. In general, UI changes in online grocery stores can easily be customised, compared with real-life grocery store settings.

In the future, UIs could potentially be personalized for specific consumer needs. Sorting products based on different nutrient criteria (including sodium, saturated fat, free sugars, not just dietary fibre) could help personalise grocery purchasing to optimise nutrients intake and help meet their needs. This may help individuals who have specific dietary needs, follow special diets, accomplish environmental goals, or meet financial constraints, etc. The results of the current study indicated that almost 50% of consumers would want the option to sort foods presented online based on a specific nutrient when shopping online. A recent study implemented dynamic food labels with real-time feedback in an experimental online grocery store (Shin et al., 2020) where participants were able to switch between the displays of different nutrition labels and then access products according to specific nutritional content (total fat, saturated fat, sugar, calories per serving, etc.), and to sort products within a category. The researchers found that nutritional quality improved and the sugar content of purchased products decreased, compared to the control condition, with the features implemented found to be useful and user-friendly (Shin et al., 2020). Allowing consumers to reposition products themselves based on some parameter is a decision aid (Shi & Zhang, 2014), which can help consumers organise the information provided and make decisions relatively fast and effortless. Therefore, future online grocery stores should offer consumers the option to sort products according to their individual (dietary) needs. This offers multiple possibilities for online stores to encourage positive dietary changes that could potentially influence not only population health but also the overall environment, for example, by adding an environmental impact score as one of the options. We would like to emphasise that the effectiveness of this type of decision aid (sorting products by consumers) was not tested. The current study tested if changing the default order of products (order in which products are presented) can encourage the selection of healthier foods. However, with this study, we confirmed that a custom product sorting feature is something consumers would want to use online, and it could help personalise grocery shopping.

The current results highlighted that the price was most important factor affecting purchasing decisions, which is in agreement with other marketing research (DiSantis et al., 2013; Steenhuis et al., 2011). Since online stores commonly make decisions regarding product arrangement without consumer approval or awareness, it is likely that product arrangement focuses on maximising sales (Roschk et al., 2017) or is driven by brands paying for positioning within the stores. Future research should therefore investigate whether regulating the positioning of products is needed, or if consumers should be offered the option to choose how the products are presented to them. Results from the current study indicate that the total median cost of foods purchased per shopping cart was not significantly different between conditions. This may be because price is generally the most important shopping decision criteria and because consumers are more conscious about price compared to other factors. Of major importance is that the study also indicates that the order in which items are shown online may be a simple way to nudge healthy food choices without affecting consumers' overall budget or supermarket revenue.

Clearly, (online) stores can impact purchasing behaviours, by using strategic design and marketing to increase sales. The WHO report on obesity and overweight (WHO, 2021) indicates that industry should restrict marketing of foods high in sugars, salt and fats, and ensure that healthy and nutritious choices are available and affordable. However, research shows that food marketing is still mainly used to promote foods with less favourable nutritional composition (Folkvord & Hermans, 2020; Grigsby-Toussaint & Rooney, 2013; Harris & Fleming-Milici, 2019; Lavriša & Pravst, 2019; van der Bend et al., 2022). Since promoting healthy eating is challenging, implementing regulations regarding food marketing strategies is necessary.

Considering the rapid global growth rate in online grocery markets (Precedence research Online Grocery Market), digital nudges promoting healthy and sustainable food choices have enormous potential to support public health. However, there is also the risk that companies abuse strategic changes to increase profits, without considering effects on diet, individual- and planetary health outcomes (Roschk et al., 2017). This raises ethical questions, which should be addressed through corporate responsibility and embedded in policy. Currently, access to transparent information about which nudging strategies are being used in online stores, is lacking. This means understanding the impact of individual (or a combination of) nudging strategies on purchasing choices is also limited. Hence, gaining access to such information could assist researchers to further investigate how to personalise UIs to benefit consumers and encourage them to make healthier food choices.

4.1. Strengths and limitations

There is a debate on the effectiveness of nudging to alter behaviour (Congiu & Moscati, 2022; Marchiori et al., 2017) and hence a call for better study design and trial registration. Hypotheses were pre-registered, and data will be publicly available for future research and comparison purposes. Despite the contributions of the current study, limitations need acknowledgment. Firstly, there was no condition with a random order of products. In the current study, both conditions have been modified (one that favours high-fibre products, and one that favours low-fibre products). Therefore, while we can conclude that favourably sorted products (at the top of the category/product lists) can increase the dietary fibre content in the shopping cart compared to unfavourably sorted products (at the bottom of the category/product lists), we cannot conclude if this is true for a random order of food products. Thus, future studies should include an intervention arm that randomly presents foods, or include a 'true' control condition that mimics current supermarket organisation (e.g., based on relevance) to make a more valid comparison.

Moreover, we would like to acknowledge that the intervention and comparator conditions differ in two aspects, (i) repositioning of the categories and (ii) repositioning of the products within each individual category. Hence, understanding which one of these design features is primarily driving the effects needs to further be investigated. In addition, future studies should validate choices from the experimental store by comparing them to actual online purchases. This would confirm whether choices in an experimental store translate to real-life situations by validating what consumers have actually purchased when spending their own money. However, other online studies have shown that choices made in experimental stores are a valid proxy for real consumer choices (Waterlander et al., 2015).

As reported by the recruitment panel provider, a relatively large number of participants did not complete the study, and the data was excluded from analysis. This was likely because the participant burden was relatively high, as multiple steps were needed to be performed by the participants. Future studies should reduce the burden by removing the need to enter 'dummy checkout details' and automatically redirecting participants back to the post-task survey. However, working with a prebuild platform allowed us to design a realistic experimental online store environment with relatively little effort. Lastly, the current study used a limited set of generic non-branded products (except from TimTams and Vegemite). Future studies could use more foods and could further investigate how brands, loyalty and familiarity with products moderate nudging effects. Despite these limitations, the current study is one of the first to investigate a product order 'nudge' based on nutrient information not commonly available on food labels, and has implications for practice and scope for further research.

5. Conclusion

The current study indicates that repositioning high-fibre food products at the top of the category/product lists in an experimental online grocery store could influence food choice towards healthier purchase decisions. However, the benefits of this kind of repositioning compared to a random order of food products or a condition that mimics the current online shop organisation, still need to be investigated. For consumers, this research provides insight regarding how UIs related to what people see when ordering food online can consciously or unconsciously affect food choice decisions, both positively and negatively. It can show consumers that the default option selected by retailers might not be the best option if they want to select more healthful foods. Moreover, consumers could "demand" from retailers to apply health-promoting UIs in their online stores. For digital platform operators (i.e., online grocery stores), this research could inform UI design guidelines. Digital platform operators could help design supportive UIs, which will improve consumers' wellbeing. Based on this and similar research, they could develop policies and guidelines on how to build health-promoting online grocery stores. For researchers in health promotion, nutrition and dietetics, this project provides important theoretical knowledge that advances the field and may inform the development of interventions to promote healthy food choices. Given that people are not meeting recommended daily intakes for many nutrients (e.g., iron, protein), opportunities exist to implement repositioning of food products to optimise food and/or nutrient intake based on individual needs or preferences. Based on the results of this study, other researchers could conduct further research to examine which strategies are most effective, in general or for specific parameters. For example, repositioning might be effective for dietary fibre, but may not be for other nutrients. Conducting more studies in similar settings, registering the analysis plans and hypotheses, and publishing the results and thus avoiding publication bias, would help researchers to better understand consumer behaviour in digital environments. Lastly, for policymakers, results could inform whether regulations and/or codes of practice regarding design changes (digital nudges) within online food choice settings are needed to protect consumers (e.g., food delivery apps, online school meal ordering systems). Establishing regulations on how to provide consumers with adequate information to make healthier choices could support healthful food choices among consumers. Currently, in many online stores, the products are sorted by relevance, price, or 'special deals', which does not necessary support healthful decision-making. It is therefore necessarily to establish new codes of conduct for the design of online grocery stores to support and protect consumers. Additionally, policies that allow access to transparent data and information from the food industry and digital platform operators that could assist when designing UI, are warranted.

Author's contributions

EV and TB designed the experiment and constructed the experimental grocery store. EV prepared and analysed the data and was responsible for the first drafting of the manuscript. EB, CEC, BKS and TB provided critical manuscript feedback. All authors read and approved the final manuscript.

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Ethical statement

The research has been performed in accordance with the Declaration of Helsinki and has been approved by the University of Newcastle Human Research Ethics Committee (Approval number H-2022-0240).

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The dataset used will be available on Zenodo (zenodo.org) after acceptance.

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6 List of abbreviations

UI user interface
BMI body mass index

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.appet.2023.107072.

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