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Digital nudging at the university canteen: an online study with American young adults

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Abstract

Resource scarcity, the effects of climate change, food insecurity, and health issues related to dietary choices have prompted policymakers to develop new strategies to encourage populations to opt for healthy and sustainable (HS) diets. In this context, nudging strategies are promising tools to promote healthy and sustainable dietary behaviors. However, nudges are context-dependent as a specific nudging intervention should be employed in a specific context. This research aims at determining the effects of different nudges on students' food choices in the context of a hypothetical online pre-ordering system of the college canteen. An experimental study was conducted in the USA with 1400 American college students (18–24 years old). We used a between-subject design with one control and three treatment groups—i.e., a HS logo to identify HS dishes, dish placement (the order in which dishes are displayed on the menu), and a combination of the two nudges. Our main results showed that the logo and logo plus placement led to a significantly increased selection of HS dishes among students who already had strong HS eating behaviors. In addition, individual characteristics (e.g., being flexitarian or vegetarian, being on a low-calorie diet, being a graduate student, and living in dormitories on college campuses) also affected their HS food choices; thus, the population traits, living conditions, and eating habits should be taken into consideration in order to establish successful nudging techniques.

Keywords: Healthy and sustainable diets, Food choice, Consumer behavior, Logo, Dish placement, Online survey

Introduction

Dietary changes toward healthier and more sustainable food consumption are becoming a pressing issue. Society's growing concerns for resource scarcity, the impact of climate change, food insecurity, health problems associated with dietary habits, and the social and environmental effects of food production and consumption have prompted policymakers to develop new strategies to encourage populations to consume healthier and more sustainable foods (Ammann et al. 2023; Annunziata et al. 2019). Specific food and dietary patterns have indeed the potential to benefit both human health and the planet (Willett et al. 2019). For instance, research has shown that legumes, nuts, seeds, fruit,

and vegetables, along with being healthy reference foods, also have generally a lower environmental impact than other food categories (e.g., animal products), with plant-based diet being promising for both the environment and our health (Agyemang et al. 2022; Willett et al. 2019). In order to achieve the adoption of healthy and sustainable (HS) food consumption, governmental measures are strongly required. As a matter of fact, several national programs have been implemented over the last years, including the National Food Plan in Australia (DAFF 2013), the American National School Lunch Program (USDA 2024), the European Farm-to-Fork Strategy (European Commission 2020), and the Sustainable Development Goals of the United Nations (United Nations 2020). In addition to these, some universities are collaborating in joint programs—e.g., the Menus of Change (https://www.menusofchange.org/)—to make campuses an enabling environment for healthy and sustainable choices (Franchini et al. 2023a, b).

However, shifting consumers' eating habits is not an easy process as this type of behavior is usually established in the early years of life and will mostly remain unchanged afterward (Poobalan et al. 2014; Scaglioni et al. 2018). In addition, the dietary habits of young adults who are attending college and are living away from home for the first time may be significantly affected by the change in their lifestyles (Sogari et al. 2018). Many young adults face daily food-related decisions for the first time and have to balance their taste, time, finances, and other factors (Poobalan et al. 2014; Roa-Goyes and Pickering 2024). Hence, finding interventions that could assist them in having meals that are HS is a priority to support their everyday choices and shape the dietary decisions of future generations (Annunziata et al. 2019).

In this context, nudging is a well-known intervention that aims at modifying decision structures (choice architecture) to gently assist individuals in performing a particularly preferred activity rather than restricting or imposing on their behavior (Laiou et al. 2021; Thaler and Sunstein 2008; Vecchio and Cavallo 2019). Previous studies on adolescents and young adults identified promising effects of nudging strategies on this population group (Franchini et al. 2023a, b; Sogari et al. 2019, 2024; Turnwald et al. 2019). For instance, a 2019 field study with US university students found that psychological health messages (e.g., reduction of fatigue linked to the vitamin content) placed at the campus dining hall increase students' probability of choosing wholegrain pasta over the no-message condition or the physiological health claim (e.g., favoring a healthy weight through the high fiber content) condition (Sogari et al. 2019). Another study tested the effects of taste- and health-focused labels on American students' selection of vegetables at the university dining hall and showed that taste-focused labels were able to increase students' vegetable intake (Turnwald et al. 2019). Nudges can also be used to steer consumers toward more sustainable dietary choices. For instance, Franchini et al. (2023a, b) showed that students were more likely to choose sustainable options (i.e., less impactful dishes in terms of carbon footprint) when placed at the beginning of the menu (Franchini et al. 2023a, b). Despite these encouraging outcomes, nudging is a context-specific tool (Hauser et al. 2018; Vugts and Havermans 2022) and, thus, it is crucial to continue researching to identify nudging strategies that fit both the target population and the context/situation.

During the last years, several American colleges have developed pre-ordering apps for their canteens—e.g., Eatery Cornell Dining (Cornell University), Culinary Services

App (Ohio University), and GET mobile App (University of San Diego). Research also suggests that online pre-ordering systems could be of help to reach a wide population range and to target strategies to steer consumers' choices (Delaney et al. 2022). Therefore, finding nudging interventions that could apply to the online pre-ordering system is crucial to encourage healthy and sustainable decisions. However, among different types of nudging, only some nudges can be used in the online context, such as labeling, placement, prompting, and user-interface designs (Andreani et al. 2023; Delaney et al. 2017; Fechner and Herder 2021; Futtrup et al. 2021; Manippa et al. 2023; Miller et al. 2016; Mohr et al. 2019; Sogari et al. 2019). As the literature on the effects of nudging interventions in online food ordering environments is scarce (Delaney et al. 2023; Gynell et al. 2022), this study aimed at testing different nudges—labeling (i.e., using a specific logo to identify HS dishes), menu re-arrangement (i.e., changing the order of dishes on the menu), and their combination—as potential strategies to steer students' food choices in the online environment.

Finally, the main objectives of our study were (1) determining the effects of different nudges on university students' food choices in the context of the online pre-ordering system of the university canteen and (2) investigating the influence of consumers' sociodemographic and eating habits on the effectiveness of nudging interventions.

Nudging in university canteens

Nudging has received increasing attention over the past years, with a growing scientific literature on the topic, especially focusing on strategies to promote healthy and sustainable diets (Almeida et al. 2024; Vecchio and Cavallo 2019).

Nudges were defined in 2008 by Thaler and Sunstein as "any aspect of the choice architecture that alters people's behavior in a predictable way without forbidding any options or significantly changing their economic incentives. Putting fruit at eye level counts as a nudge; banning junk food does not." (Thaler and Sunstein 2008). Thus, nudges to promote HS eating encompass a wide range of easy-to-implement and low-cost changes and can be classified into the main categories: (1) cognitively oriented, which aim at modifying what consumers know, such as the use of labels on the food packaging; (2) affectively oriented, which seek to influence how consumers feel, such as with hedonic dish descriptions on menus; and (3) behaviorally oriented, which try to change what consumers do, for instance by implementing healthier default options at the restaurant level (Cadario and Chandon 2020).

However, despite the increasing interest in these kinds of interventions, results are still heterogeneous and may vary across different target groups and/or contexts (Hummel and Maedche 2019). More specifically, when it comes to nudging at on-campus dining, research shows promising results to steer students' food choices toward healthier and more sustainable options (Cesareo et al. 2022; Kratzer et al. 2024). Most of these studies focused on in-person environments and tested different types of nudges—either on their own or using a multi-strategy approach—to reduce or increase the consumption of target foods. For instance, Mikkelsen et al. (2021) suggested that the re-arrangement of the location of sugar-sweetened beverages at the college canteen supports the reduction in the purchasing of these products (Mikkelsen et al. 2021). In another study, food re-arrangement was used in combination with posters and an increased offer of healthy

food to increase fruit consumption among German students, showing promising results (Bender et al. 2016). Other studies aiming at developing strategies to foster healthy and sustainable food choices in university canteens found positive outcomes also for other types of nudges, such as nutritional information provision (Cerezo-Prieto & Frutos-Esteban 2021; Sogari et al. 2024), using healthier default options (van Kleef et al. 2018), and variation in the portion size (Vermote et al. 2018). Also placement strategies—where menu items are re-arranged and displayed in a specific order—and labeling nudges have proved to be effective in steering students' decisions in in-person, on-campus dining (Franchini et al. 2023a, b; Karolyova et al. 2023; Migliavada et al. 2022). A meta-analysis published in 2023 by Pandey et al. on nudging strategies to foster sustainable food consumption at the university canteen found that modifying the menu, increasing availability, and information provision through labels and lectures were the most effective tools in this context. In addition, the authors suggested that the combination of more nudging strategies could be an effective approach to influence students (Pandey et al. 2023). However, it has to be noted that not all nudges have shown positive results. For instance, in the study by Ohlhausen and Langenthe (2020), the use of decoy dishes (i.e., an additional option added to a choice set to change the relative attractiveness of the other alternatives) resulted in the opposite expected outcome, i.e., a decreased choice frequency of the target dishes (Ohlhausen and Langen 2020). As a matter of fact, research is still needed to offer detailed nudging implications to practitioners and policymakers depending on the target group and the context under investigation (Hummel and Maedche 2019). In addition, despite the increasing literature on the nudging effects on university students, little research has focused on online ordering systems of the university canteen (e.g., (Andreani et al. 2023; Wongprawmas et al. 2023)). Results from these studies agree that students involved in food-related subjects or who already adopt healthy and sustainable food behaviors are the most influenced by nudging strategies (Andreani et al. 2023; Wongprawmas et al. 2023). Therefore, in order to increase the scientific literature on the topic, we tested the impact of digital nudges on university students and provided new insights to policymakers and canteen managers to support the adoption of healthy and sustainable dietary behaviors in these settings.

Material and methods

A hypothetical food choice task that simulated an online meal selection was developed to investigate the effect of nudging interventions on American university students. The study was approved by the local institutional review board (Institutional Review Board for Human Participants, Cornell University, IRB0144167). The work was carried out following the international ethical guidelines for research involving humans established in the Declaration of Helsinki. All subjects approved an electronic consent form before participation.

Study design

The effect of nudging interventions on the hypothetical food choice (meal task) was examined using a between-subjects design with three treatments and a control group, and participants were randomly assigned to one of these four groups. In each treatment group, nudges were used either on their own or in combination: In treatment 1 (Tr.1), a

HS logo (which was developed during previous qualitative research) was displayed next to HS dishes; in treatment 2 (Tr.2) HS dishes were placed at the beginning of each meal course; treatment 3 included a combination of the two nudges. Finally, in the control group, the menu was presented without any nudge.

In order to control the effect of dish placement in Tr.2 and Tr.3, menus were presented in a particular order according to the group. In the control, generic (non-HS) and HS dishes were arranged alternately in each meal course. The same order was kept for Tr.1 (HS Logo), with the HS logo displayed next to the HS dishes. Dishes in Tr.2 (Placement) and Tr.3 (Logo & Placement) were arranged according to their HS scores within each course, starting from the dish with the highest score to the one with the lowest.

Online survey

An online questionnaire was administered to US students using Qualtrics survey software (Qualtrics 2022) between April and May 2022. Participants were invited to complete the questionnaire, including the interactive meal task, by using an electronic device (i.e., their laptops, tablets, or mobile devices). The questionnaire comprised three main sections—pre-experimental, experimental, and post-experimental—and took approximately 14 min to complete.

The pre-experimental section included screening questions (i.e., being 18–24 years old and being a college/university student) and questions about participants' age, gender, academic status (e.g., being a freshperson—i.e., being a first-year student—or being an undergraduate/graduate student), and hunger level.

During the experimental part, students were asked to complete a hypothetical meal task using a simulated online website/app of the university canteen. They were asked to pretend they were about to pre-order their "all-you-care-to-eat" meal" (pay a fixed price and choose as many dishes as they wish from the menu), which is common practice in several US college/university canteens. In addition, they were asked to select at least one dish for the meal. Before starting the meal task, participants read a cheap talk message, which reminded them to provide more considered answers that reflected their preferences for the decisions to reduce the hypothetical bias (Tonsor and Shupp 2011).

> *Please consider that the selected dishes represent the amount of food you will consume for one meal. Previous studies have demonstrated that people often state to order a higher amount of food than what they are actually willing to eat. Therefore, even though your choice is hypothetical, it is important that you make your upcoming selections like you would if you were facing these exact choices in a canteen and you're going to consume them.*

Successively, participants were presented with the menu (with or without nudges, depending on the assigned group—refer to Sect. 3.1) and selected the dishes for their meal. The total number of dishes selected, the ratio of HS to generic dishes selected, and the percentage of selected HS dishes per total were recorded. After selecting the dishes for their hypothetical meal, participants could see a list of their selections and were asked to confirm or remove the chosen dishes for the meal.

After completing the meal task, participants concluded the survey with the post-experimental section. This section comprised questions about respondents' opinions on

nudging interventions, the percentage of plant-based food they usually consume, their dietary habits (e.g., adopting a specific food regime, being on a low-calorie diet), their perceived health status, their attitude toward HS food, their willingness to purchase/consume HS dishes over the following months, their physiological condition (e.g., pregnancy, breastfeeding), diet-related pathological statuses (e.g., cardiovascular disease, diabetes, food intolerances, or allergies), and additional socio-demographic questions (e.g., their region of origin). Furthermore, participants' physical activity level was investigated through a five-choice, closed-ended questionnaire to define the weekly time spent on Moderate Physical Activity (MPA) and Vigorous Physical Activity (VPA). Following the WHO recommendations (WHO 2020), respondents were categorized into two groups based on their answers. Respondents were considered in compliance with the WHO recommendations if they completed at least 150–300 min of Moderate to Vigorous Physical Activity (MVPA), 60–90 min of VPA, or a combination of 90–150 min of MVPA and 30–60 min of VPA. Otherwise, the respondents' physical activity was classified as non-compliant with the guidelines. The post-experimental part of the survey also included the Sustainable-HEalthy-Diet (SHED) index (Tepper et al. 2021) to assess the sustainability and health of participants' eating behaviors.

We decided to employ the SHED index because—to the best of our knowledge—it is the only index that takes into account consumers' behavior (through self-reported behavior) rather than attitudes. Furthermore, the SHED index is based on the planetary healthy diet proposed by the EAT-Lancet Commission and the Mediterranean Diet score (Alexandropoulou et al. 2022; Tepper et al. 2021). The scale is a multiple-choice validated questionnaire developed by Tepper et al. (2021). Considering the SHED index, participants were then divided into tertiles: low (1st tertile; scores ≤ 59), medium (2nd tertile; scores 60–79), and high (3rd tertile; scores 80–150) sustainable and healthy eating habits. The individual items and the type of scales used are provided in Appendix Table 4.

Menu

The menu used in the meal choice task reflected the usual dishes available in the US college canteens. Five different meal courses were offered on the menu: first course (carbohydrate-based), second course (protein-based), main dish (carbohydrate- and protein-based), side dish (vegetable-based), and dessert or fruit. To assist participants in the task, a list of the main ingredients for each dish was listed under the dish name. A group of nutrition experts chose the dishes to display on the menu based on what is usually offered in US college canteens, the nutritional value, and the climate impact. The final menu comprised 20 dishes: 10 generic dishes and 10 HS dishes; thus, each course included two generic dishes and two HS dishes. The composition of the menu is presented in Table 5.

The FAO and EAT-Lancet guidelines for a healthy and sustainable diet were used to define the HS dishes (FAO and WHO 2019; The Eat-Lancet Commission 2019). Based on the American dietary recommendations (USDA 2020), the nutritional value of each dish was evaluated. The evaluation took into account the following criteria: (1) the optimum meal composition based on the Healthy Eating Plate provided by the Department of Nutrition, Harvard T.H. Chan School of Public Health (Harvard T.H. Chan School

of Public Health 2011); (2) the calorie and nutritional value in terms of macronutrients, based on the assumption that the entire meal should make up 35–40% of a reference daily energy need of 2000 kcal. Based on a dataset provided by the Barilla Center for Food and Nutrition (Petersson et al. 2021), the carbon footprint indicator, i.e., greenhouse gas emissions expressed as g CO_2 equivalent (CO_2 eq) was calculated for each dish to determine the sustainability score. A maximum of 1000 g CO_2 eq was considered as the cutoff to define a sustainable menu. Only dishes that adhered to the dietary recommendations and had a carbon footprint $\leq$ 500 g CO_2 eq (1000 g CO_2 eq for main dishes) were classified as "HS", while dishes that did not adhere to the recommendations and/or had a higher impact were classified as "non-HS" (generic dishes).

Recruitment

Eligible participants were recruited via a market research company using a stratified sampling method according to the gender and the region of origin of US young adults (18–24 years old).

During the survey, attention questions were used to exclude careless respondents and ensure high-quality data (Berinsky et al. 2014; Huang et al. 2015; Kung et al. 2018). Before the analysis, students who took more than 60 min or less than 40% of the median completion time (4.7 min) to complete the questionnaire were removed as suggested in previous studies (Boase et al. 2019; Lugtig and Toepoel 2015; Zhang and Conrad 2014). Similarly, outliers for the total number of selected and confirmed dishes (> 11 plates) were calculated using an interquartile range method and excluded from the analysis. Finally, participants who self-identified as vegans were also excluded prior to data analysis. Instead of pre-screening questions, these participants were identified after the meal task to avoid diet-related questions impacting food choices in the subsequent section. Vegan participants were excluded because, in the proposed menu, there were few options suitable for vegan consumption and, thus, their choices were inevitably toward those dishes.

The final sample included a total of 1400 students, which is more than the sample size of 1095 needed according to the power analysis performed with G*Power 3.1.9.7 (statistical test = ANOVA; effect size f = 0.10; $\alpha = 0.05$; power $(1-\beta) = 0.8$; df: 3) (Faul et al. 2007). The final gender distribution was similar to that of US students (Male:Female = 45:55), and the region of origin distribution was similar to that of the 18–24-year-old population in 2020 as reported in the data record provided by the United States Census Bureau (USCB) referred to January 1, 2021 (https://www.census.gov/programs-surveys/popest/technical-documentation/research/evaluation-estimates/2020-evaluation-estimates/2010s-state-detail.html).

Sample characteristics

The sample characteristics are reported in Table 1. Around 60% of participants were female, and the average age was 20.9 ± 1.8 years old. The majority of participants were undergraduate (68%), non-freshperson (79%), Caucasian (55%), enrolled in human and

Table 1 Socio-demographic variables, % of the total sample, and by group

Item		Total	Control	Tr.1 Logo	Tr.2 Placement	Tr.3 Logo and placement	*p* value
	n	1400	363	350	349	338	
	%	100	25.9	25.0	24.9	24.2	
Age[1]	Mean (SD)	20.9 (1.8)	20.9 (1.7)	21.0 (1.8)	20.9 (1.8)	20.9 (1.8)	0.941
Gender[2]	Male	37.0	36.1	41.7	35.2	34.9	0.129
	Female	59.5	59.2	55.7	60.2	63.0	
	Non-binary or prefer not to reply	3.5	4.7	2.6	4.6	2.1	
Ethnicity[2,a]	American Indian /Alaska Native	2.7	2.5	3.4	1.4	3.6	0.282
	Asian/Pacific Islander	12.3	11.3	12.9	11.2	13.9	0.646
	African-American	22.9	19.8	22.9	23.8	25.4	0.345
	Caucasian	54.6	55.4	55.1	55.9	51.8	0.695
	Latino	19.8	20.9	17.4	20.3	20.4	0.641
	Native American	2.4	2.5	1.7	2.0	3.3	0.568
	Other	0.9	1.1	1.1	1.1	0.3	0.584
Academic status[2]	Undergraduate	67.9	64.5	65.7	69.9	71.9	0.119
	Graduate	32.1	35.5	34.3	30.1	28.1	
Freshperson[2]	Being freshperson	21.0	20.9	18.6	22.9	21.6	0.553
Study fields[2]	Food studies	14.4	12.1	13.1	16.6	15.7	0.652
	Medicine	12.5	12.7	13.1	10.6	13.6	
	Sciences & Technology	25.9	26.7	25.4	24.6	26.9	
	Human & Social	45.4	46.6	46.9	47.0	41.1	
	Others	1.8	1.9	1.4	1.1	2.7	
Residence[2]	Dormitory on campus	20.1	17.9	21.4	20.6	20.7	0.937
	Outside campus by myself	12.7	13.5	12.9	12.0	12.4	
	Outside campus with my partner	9.0	10.5	8.0	8.3	9.2	
	Outside campus with roommates	14.1	16.3	13.4	14.6	12.1	
	Parents' house	41.4	38.8	41.4	41.8	43.8	
	Others	2.6	3.0	2.9	2.6	1.8	
Region of Origin[2,b]	North-East	20.7	19.6	21.1	23.5	18.6	0.860
	Mid-West	22.0	22.6	22.6	20.1	22.8	
	South	40.1	40.5	41.1	38.7	39.9	
	West	17.2	17.4	15.1	17.8	18.6	

[1] ANOVA

[2] Pearson Chi-square. SD = Standard deviation

[a] Participants could choose more than one answer

[b] Region of Origin: North-East (New England, Middle Atlantic), Mid-West (East North Central, West North Central), South (South Atlantic, East South Central, West South Central), and West (Mountain, Pacific)

social courses (45%), lived in their parents' house (41%), and originated from the south (40%). Socio-demographics did not differ across groups.

Data analysis

Data were analyzed using Statistical Package for the Social Sciences (SPSS 28.0). Descriptive statistics were performed for the entire sample and for each group. One-way

ANOVA, Pearson Chi-square, and Kruskal–Wallis tests for independent samples were performed to determine the existence of significant differences between the control and treatment groups in socio-demographic data, eating habits, and their perception of healthy and sustainable eating. One-way ANOVA analyses were used to determine whether the number of selected HS dishes differed between the interventions and the control group and Tukey's HSD tests were used for post hoc analysis.

Multivariate regression was used to examine the factors influencing participants' healthy and sustainable food choices. The dependent variable was the number of selected HS dishes, whereas the explanatory variables included the presence of nudges (Logo, Placement, and Logo and Placement intervention), healthy and sustainable eating habits (the tertile of SHED index), being on a low-calorie diet, being flexitarian or vegetarian, being a graduate student, and living in a dormitory on campus. The presence of a nudging intervention was treated as a binary variable, with 1 suggesting the presence of nudges (Logo, Placement, or Logo & Placement) and 0 indicating their absence. The tertile of the SHED index was a categorical variable (1 = the participant belongs to the 1st tertile of the SHED index, 2 = the 2nd tertile, 3 = the 3rd tertile). Being on a low-calorie diet, adopting a flexitarian or vegetarian diet, being a graduate student, and living in a dormitory on campus were all considered dummy variables (1 = yes, 0 = no).

Apart from estimating this model for the full sample, the same model was also estimated separately for participants in 2 groups: (1) the 1st& 2nd tertile and (2) the 3rd tertile of the SHED index, hence removing the SHED tertile variable. Other variables, such as additional demographics, eating habits, health status, and opinion variables, were also introduced in the models to simultaneously control their influence on the HS food choice. However, due to their lack of significance and poor fit, they were not included in the final model.

Results

Samples' eating habits and lifestyle

Table 2 shows variables related to eating habits and lifestyle. A share of 47% of participants described themselves as being physically active, according to WHO guidelines, and most participants reported having a good health status. About one-third of the respondents declared having at least one pathological condition (i.e., gastrointestinal disorders, eating disorders, etc.) and 15% suffered from food intolerances or allergies. Most of the respondents (78%) were omnivores, and 19% were on a low-calorie diet. Eating habits and related health issues did not differ across groups, except for physical activity, as participants in Tr.2 reported that they spent significantly more time on physical activities than the others.

Meal task results

Descriptive statistics of the dishes selected in the hypothetical meal task and results from the ANOVA tests are presented in Table 6. The ANOVA showed no statistically significant effect of the interventions (nudges) on the number of selected HS dishes ($F(3, 1396) = 1.41$, $p = 0.240$) or on the percentage of selected HS dishes ($F(3, 1396) = 1.73$, $p = 0.158$) compared to the control.

Table 2 Eating habits and other characteristics of the total sample and by group

Item		Total	Control	Tr.1 Logo	Tr.2 Placement	Tr.3 Logo and placement	*p* value
	n	1400	363	350	349	338	
	%	100	25.9	25.0	24.9	24.2	
Physical activity[1]	MVPA/VPA adherence to WHO guidelines	47.4	44.9[a,b]	47.7[a,b]	54.7[b]	42.3[a]	0.008
Self-reported health condition[2]	Median (IQR)	4.0 (3.0–4.0)	4.0 (3.0–4.0)	4.0 (3.0–4.0)	4.0 (3.0–4.0)	4.0 (3.0–4.0)	0.399
Illness[1]	Having illness	35.0	34.7	34.9	38.1	32.2	0.453
Food intolerance/allergies[1]	Having food intolerance/allergies	15.4	14.6	16.9	16.0	13.9	0.696
Food regimen[1]	Omnivore	78.1	75.5	78.9	79.7	78.4	0.397
	Vegetarian	5.4	5.5	7.1	3.7	5.0	
	Flexitarian[a]	10.6	12.1	9.4	10.6	10.1	
	Pescatarian	2.2	1.9	1.4	3.4	2.1	
	Other	3.8	5.0	3.2	2.6	4.4	
Low-calorie diet[1]	Being on a low-calorie diet	19.2	20.7	20.0	18.9	17.2	0.667
% plant-based consumption[3]	Mean (SD)	43.5 (24.2)	45.4 (25.0)	43.6 (24.0)	43.1 (23.2)	41.9 (24.6)	0.286
SHED index[3]	Mean (SD)	70.7 (24.2)	70.9 (24.2)	69.9 (22.6)	71.9 (23.9)	70.1 (26.2)	0.692
Tertiles of the SHED index[2]	1st Tertile	33.4	33.6	34.0	30.9	35.2	0.312
	2nd Tertile	33.4	30.6	38.9	34.1	30.2	
	3rd Tertile	33.1	35.8	27.1	35.0	34.6	

[1] Pearson Chi-square

[2] Kruskal–Wallis

[3] ANOVA test. IQR = Interquartile range, SD = Standard deviation. MVPA/VPA = Moderate Physical Activity/Vigorous Physical Activity. Different superscript letters in the same line denote significant differences from the post hoc tests. The absence of superscript letters indicates that there are no significant differences from the post hoc tests

The tertiles of the SHED index were calculated from the data: 1st tertile ≤ 59 scores; 2nd tertile 60–79 scores; 3rd tertile 80–150 scores

However, the effects of nudges differed when dividing participants based on their SHED index. As a matter of fact, respondents were divided into two groups: low and medium (1st and 2nd tertiles of the SHED) and high (3rd tertiles of the SHED) levels of HS eating. Results obtained after this categorization are reported in Fig. 1. Specifically, nudges had no effect on the selection of HS dishes for participants in the 1st and 2nd tertiles of the SHED index compared to the control ($F(3, 932 = 0.859)$, $p = 0.462$). For participants in the 3rd tertile of the SHED index, nudges had an impact on the choice of HS dishes when compared to the control ($F(3, 460 = 4.048)$, $p = 0.007$). A post hoc test using Tukey's HSD test for multiple comparisons found that the mean number of selected HS dishes was significantly different between the control and the HS logo group ($p = 0.007$, 95% CI = [−1.21, −0.14]). The HS logo (Tr.1) significantly affected the selection of HS dishes among students with high sustainable and healthy eating habits, while all interventions did not affect the choices of students with low and medium sustainable and healthy eating habits.

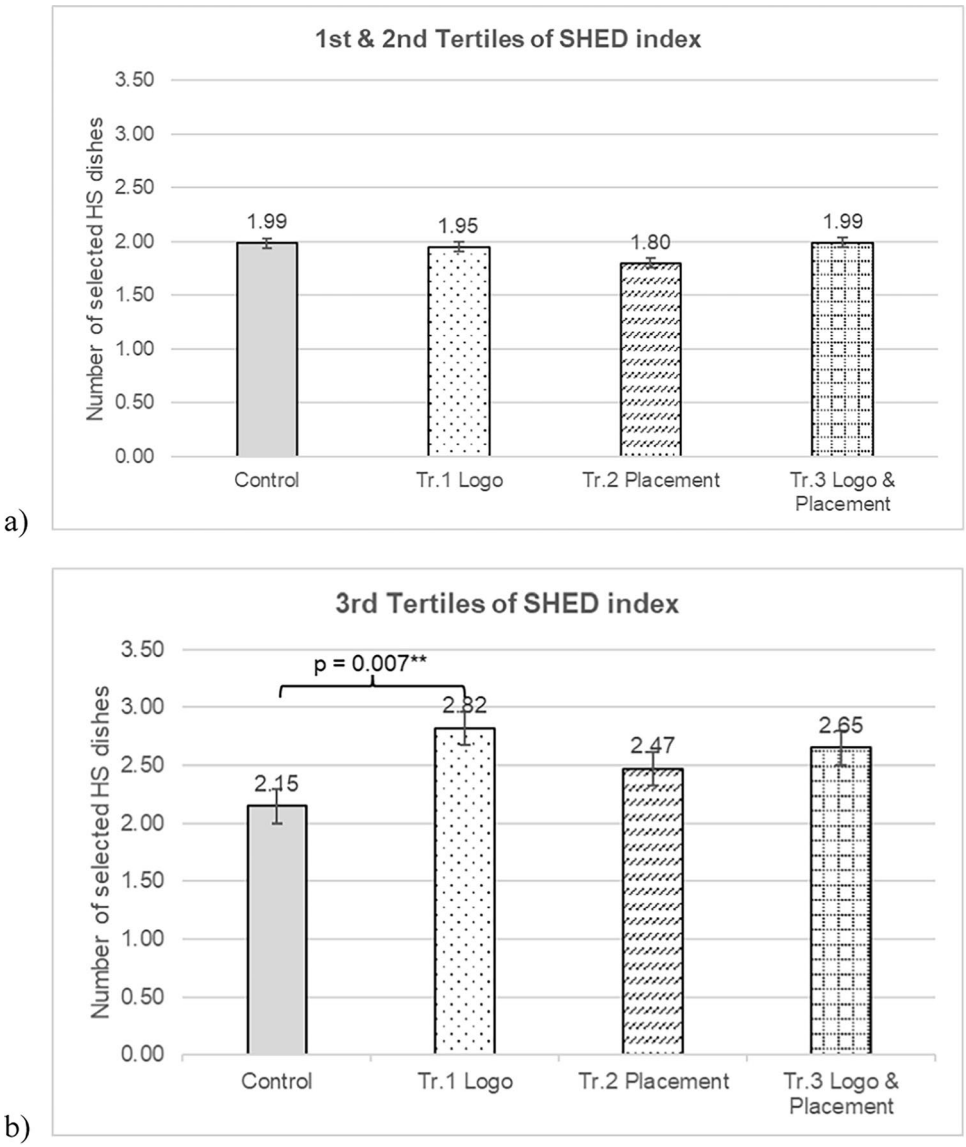

Fig. 1 Number of selected HS dishes during the hypothetical meal choice task. **a** People in the 1st and 2nd tertiles of the SHED index ($n=936$) and **b** people in the 3rd tertile of the SHED index ($n=464$). **Indicates significance at the 1% level

Finally, the intention to consume HS dishes was not significantly different among the control and treatment groups ($H(3)=0.228$, $p=0.973$).

The results of regression models

Table 3 presents the multiple regression estimates of the treatment effects on the number of selected HS dishes. Results from the total sample model show that the combination of the two nudges (logo and placement) has a positively affect ($p=0.046$) the number of HS dishes selected by respondents. In addition, the model indicates that other factors positively influence the variable of interest, which are: being flexitarians or vegetarians, being on a low-calorie diet, living in a dormitory on campus, already having strong HS eating habits (i.e., being in the 3rd tertile of the SHED index), and being a graduate student.

Table 3 Regression analysis with the number of selected HS dishes as the dependent variable, total sample and split by SHED tertiles groups

	Total sample		1st and 2nd tertile—low and medium SHED index		3rd tertile—high SHED index	
Variable	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**
Treatment (base = Control)						
Logo	0.172	0.109	−0.032	0.130	0.617**	0.200
Placement	0.024	0.109	−0.152	0.134	0.352	0.187
Logo and placement	0.219*	0.110	0.057	0.135	0.516**	0.188
Tertile of SHED index (base = the 1st and 2nd tertile)						
3rd Tertile—strong HS eating habits	0.321***	0.088				
Being flexitarian or vegetarian	0.500***	0.110	0.568***	0.158	0.404**	0.154
Being on a low-calorie diet	0.478***	0.103	0.231	0.143	0.727***	0.149
Residence—dormitory on campus	0.336**	0.098	0.259*	0.121	0.414*	0.168
Being graduate student	0.278**	0.086	0.373***	0.107	0.141	0.144
Constant	1.583***	0.089	1.733***	0.105	1.638***	0.160
Number of observations	1,400		936		464	
R-squared	0.081		0.035		0.113	

Coef coefficient, *SE* Standard error

***p value < 0.001; **p value < 0.01; *p value < 0.05

When respondents were categorized based on their SHED index, the models showed different results. Students were divided into two groups: individuals with a low and medium (1st and 2nd tertile of the SHED index), and high (3rd tertile of the SHED index) level of HS eating habits. Results show that nudges, specifically logo and logo plus placement, were able to increase the number of selected HS dishes only for students falling in the 3rd tertile of the SHED index. In addition, for this group, other variables could positively influence their selection, such as being on a low-calorie diet, living in the dormitory on campus, and being flexitarians or vegetarians. For students with a low and medium level of HS eating habits, the factors able to positively impact the selection of HS dishes were being flexitarians or vegetarians, being a graduate student, and living in the dormitory on campus, yet the coefficient of determination remained rather low (R^2 being 0.035).

Discussion

The literature on nudging in the context of on-campus dining and students' eating behavior suggests a certain degree of variability in terms of the effectiveness of strategies to promote healthier and more sustainable food choices (Cesareo et al. 2022; Pandey et al. 2023). In our study, the combination of two nudges (logo and placement) positively affected the number of HS dishes selected by students when using a hypothetical online, pre-ordering app of the university canteen. A previous work by Delaney et al. (2023) also showed the positive effects of a multi-strategy approach involving traffic-light labeling, placement, prompting, and availability. Despite the focus of this study being primary

schools, the authors found that this integrated system significantly improved the nutrient composition of student recess purchases when applied in an online pre-ordering system (Delaney et al. 2023).

Since food choices are a very complex process and are influenced by several factors (individual, social, physical, and macro-level variables) (Giampietri et al. 2021; Leng et al. 2017; Schwartz et al. 2017), we classified participants into different groups according to their SHED index and evaluated whether different nudging interventions affect these groups differently. When dividing the sample according to respondents' HS eating habits (i.e., depending on their SHED index), results were different for each group. For people in the 3rd tertile of the SHED index, the logo alone and the combination of the two nudges were both able to significantly influence the selection of HS dishes. In addition, for students in this group, the logo treatment significantly increased the average number of selected HS dishes compared to the control group. Therefore, using nudging strategies that facilitate the identification of HS dishes (e.g., a HS logo) could facilitate the selection of these dishes by young adults who already adopt HS eating behaviors. This outcome emphasizes the critical role of the childhood stage in teaching and developing good eating habits, as already stated in the literature (Birch and Fisher 1998; Khan et al. 2022; Tarabashkina et al. 2017; Wongprawmas et al. 2022). In line with this, for students with a low and medium (1st and 2nd tertile of the SHED index) level of HS eating habits, nudges showed no significant effects. Thus, as found in previous studies (Andreani et al. 2023; Wongprawmas et al. 2023), students who already adopt HS food behaviors are more easily influenced by nudging strategies. Previous work on the use of logos to steer university students' food choices in the online environment found that those who are more involved in sustainability and health-related aspects in the process of selecting food are more influenced by the presence of an informative logo (i.e., a logo that highlights the health and sustainability benefits of a dish) (Andreani et al. 2023).

As a result, the identification and testing of other digital nudging strategies are needed to steer the food choices of students with low/medium levels of HS eating habits. Previously established food labels, default options, and swap suggestions were identified as promising strategies to apply in the online environment (Valenčič et al. 2023); therefore, future studies aiming at supporting HS food choices using an online, pre-ordering app of the university canteen could test these nudges, both on their own and in combination, and investigate the impact according to students' eating habits. In addition, since we found that nudges that facilitate the identification of HS dishes did not influence students with low/medium levels of HS eating habits, further research could focus on digital nudging strategies that aim at stressing the hedonistic aspects of those dishes, for instance through the use of indulgent dish descriptions (Jürkenbeck and Spiller 2021; Turnwald et al. 2017) instead of their healthiness and sustainable features. On this topic, a study conducted on a large university cafeteria in the US showed that labeling vegetables with indulgent descriptors (e.g., "twisted garlic-ginger butternut squash wedges")

increased the selection of these food items among students (Turnwald et al. 2017); thus, similar approaches could be tested in the online setting.

Despite research in the in-person environment showing that the re-arrangement of the location of food items can impact students' dietary behaviors, our study found no significant effect of dish re-arrangement (placement) in online settings when used on its own. A possible explanation for this result could be that a logo allows a quicker and more certain identification of a HS dish than placement; thus, at least for students who already have strong HS eating behaviors, a logo could be of further help than placement alone.

In addition to nudging, socio-demographic characteristics and dietary behaviors also impact students' choices. In our study, when considering the entire sample, being flexitarian or vegetarian, already having strong HS eating habits (i.e., being in the 3rd tertile of the SHED index), being on a low-calorie diet, living in a dormitory on campus, and being a graduate student, all positively affected the selection of HS dishes. When dividing the sample based on consumers' HS eating habits (low/medium *vs.* high SHED Index), being flexitarian or vegetarian, and living in a dormitory on campus were the only variables that positively influenced students' food choices in both groups. Living on campus positively impacted the selection of HS dishes. This could be explained by the idea that students who live out of home are more accountable for their own food choices and purchasing decisions, and thus pay more attention to HS aspects (Wongprawmas et al. 2023). Finally, flexitarian and vegetarian students selected more HS dishes in the meal task than non-flexitarians/vegetarians. This result could be because flexitarian and vegetarian diets usually have a beneficial impact on health and a lower impact on the environment (Yacoub Bach et al. 2023) and, thus, students selected healthier and more sustainable dishes as a consequence of their diet regimen. Despite highlighting some common characteristics between students with low/medium and high SHED index, certain individual elements influencing the food choice varied between the two groups. As very few studies have used the SHED index to investigate to what extent sociodemographic characteristics impact food choices and dietary behaviors, future studies could further investigate these aspects to support the development of target strategies.

Finally, certain limitations of this study should be acknowledged. First, the hypothetical settings of our study could lead to hypothetical biases with an over- or under-estimation of the reality. To mitigate this limitation, we used the cheap talk technique; however, potential biases could still be present. Second, we did not include the price variable, which could affect students' decisions. To avoid the impact of the dish prices, we used an "all-you-care-to-eat" option (pay a fixed price and choose as many dishes as they wish from the menu). Although this is a common meal option in the US, we did not provide the price of the "all-you-care-to-eat" meal as well. Therefore, as a suggestion for future studies, we propose testing a similar nudging approach using a real, online, pre-ordering app, including the economic variable to define if similar results would be confirmed for real transactions. Another limitation of the present study is related to the low explained

variance found in the regression models. Although this low predictive power is common in other similar studies [e.g., Langen et al. (2022); Dolgopolova et al. (2021); and Mohr et al (2019)], given the large heterogeneity of factors able to affect human behavior, future studies might find useful to address this complex issue considering the effects of other variables too (e.g., attitude, subjective norms, etc.). In addition, we did not investigate consumers' understanding of the proposed logo, which did not allow us a deeper discussion and elaboration of our findings. For future research, we suggest investigating these aspects to provide more insights into how consumers perceive certain messages/logos.

Conclusions

The present study aimed at testing the impact of different nudges on university students' HS food choices when using a hypothetical, online, pre-ordering app of the university canteen. Results showed that students who already adopted HS eating are positively influenced by the presence of a logo identifying HS dishes and the combination of the logo and menu re-arrangement. Practitioners, canteen managers, and policymakers could use these findings to develop strategies that could encourage HS food choices in the university context. For instance, optimal menu design could be developed and tested to define whether such changes would steer the choice of consumers who do not already have strong HS eating habits. In addition, we suggest developing communication strategies to familiarize consumers with logos indicating the healthiness and sustainability of dishes, which could support the understanding—and potentially the use—of such indicators. Finally, promoting on-campus accommodations may be an additional strategy to prompt HS eating behaviors as our findings showed that living on campus could positively impact the selection of HS dishes.

Table 4 Overview of the measures used in the study

Measure	Items
Hunger	How hungry are you feeling now? (Bacon and Krpan 2018) (0 = Not hungry at all; 3 = Very hungry)
Food choice	Which dishes would you like to pre-order? The number of generic dishes and healthy & sustainable (HS) dishes was recorded
Intention to consume HS dish	How likely would you be willing to purchase/consume healthy and sustainable dishes over the next months? (1 = Very unlikely; 5 = Very likely)
% Plant-based consumption	What percentage of your diet is based on plant-based foods? Percentage (%)
SHED Index	SHED Index or Sustainable-HEalthy-Diet (Tepper et al. 2021) (R) means reverse score (S) sum of frequency*score indicated in brackets
	Healthy Eating (HE) (0 = Almost never true; 3 = Almost always true) HE1. As a main course, I prefer eating meat products (poultry, beef, fish) more times per week compared to plant-based food (grains, legumes, fruits, and vegetables) (R) HE2. During the week, I eat more plant-based food (grains, legumes, fruits, and vegetables) than animal-source foods (meat, dairy products, and eggs) HE3. I eat a variety of fruits and vegetables (at least 400 g/0.9 lb or 5 portions daily) HE4. I try to avoid meat and fatty meat products and prefer instead beans, legumes, lentils, fish, poultry, or low-fat meat HE5. I prefer buying and consuming low-salt products HE6. I try to avoid buying and consuming ultra-processed food products (e.g., biscuits, confectionery, pre-prepared meals, and snacks) HE7. I prefer drinking water (or carbonated water) as a main beverage HE8. I choose low-sugar foods HE9. I limit the consumption frequency of sweetened beverages and sweets HE10. I control the amount of salt I consume, and I limit adding salt to my meals
	Sustainable eating (SE) (0 = Almost never true; 3 = Almost always true) SE1. I separate waste SE2. I prefer buying and eating food made in the USA as much as possible SE3. I limit my meat consumption SE4. I try to eat crops that are reduced or free of pesticides and herbicides SE5. I try to consume organic food products on a regular basis SE6. I am aware and act to reduce food waste in my close environment SE7. I eat plant-based foods as an alternative to meat on a regular basis
	Fruits and vegetable purchasing location (BFV) Where do you buy fruits and vegetables? (0 = Never; 3 = Most of the time) BFV1. Home-grown (5) BFV2. Direct delivery/Box from the farmer (4) BFV3. Buy directly at a farm (4) BFV4. At the market (3) BFV5. At a grocery store, or at a small, non-chain grocery store (3) BFV6. At a green grocery (fruit & vegetable store) (3) BFV7. Supermarket—Home delivery (2) BFV8. Supermarket—Shop in person (2)
	Ready meals (RM) How frequently do you: (0 = Never; 5 = Daily or almost daily) RM1. Eat pre-prepared meals—frozen (-2) RM2. Eat pre-prepared meals—chilled (packed) (-1) RM3. Eat homemade or home-cooked food (not necessarily at your home) (2) RM4. Eat in restaurants, eateries, or cafeterias (1) RM5. Cook food by myself (or take part in preparing it) (2) RM6. Consume food cooked 1–3 days prior to eating (2)
	Water Kindly specify the type of water you drink and the frequency: (0 = Never; 3 = Most of the time) Water1. Tap water/Homemade carbonated water (2) Water2. Home water filters (0) Water3. Bottled mineral water (-1) Water4. Bottled sparkling water (carbonated water) (-1)

Table 4 (continued)

Measure	Items
	Sodas At what frequency do you drink: (5 = Never; 0 = Daily or almost daily) Soda1. Soft drinks (e.g., Coca-Cola, Sprite, Nestea, etc.) (-2) Soda2. Diet beverages (e.g., Diet Coke, Diet Sprite, Coke Zero, Pepsi Max, etc.) (-1)
Reported health condition	In general, how would you rate your current health? (1 = Very bad; 5 = Very good)
Physical activity	The Nordic Physical Activity Questionnaire (NPAQ-short) (Danquah et al., 2018), a validated tool for assessing compliance with WHO guidelines (WHO 2020) on Moderate to Vigorous (MVPA) and Vigorous Physical Activity (VPA) **Physical activities in your free time** The following questions concern how physically active you are in your free time and during transport (including your commute to and from work/school/classes) **MVPA** On a typical week, how much time do you spend in total on moderate and vigorous physical activities where your heartbeat increases and you breathe faster (e.g., brisk walking, cycling as a means of transport or as exercise, heavy gardening, running or recreational sports). Only include activities that lasted at least 10 min at a time (1) Less than ½ an hour (less than 30 min) per week (2) ½ an hour—1 ½ hour (30–90 min) per week (3) 1 ½—2 ½ hours (90–150 min) per week (4) 2 ½—5 h (150–300 min) per week (5) More than 5 h (more than 300 min) per week **VPA** How much of the time that you spend on physical activities in a typical week, which you indicated above, do you spend in total on vigorous physical activities? This includes activities that get your heart racing, make you sweat and leave you so short of breath that speaking becomes difficult (e.g., swimming, running, cycling at high speeds, cardio training, weightlifting or team sports such as football). Only include activities that lasted at least 10 min at a time (1) Less than ½ an hour (less than 30 min) per week (2) ½ an hour–1 h (30–60 min) per week (3) 1–1 ½ hours (60–90 min) per week (4) 1 ½–2 ½ hours (90–150 min) per week (5) More than 2 ½ hours (more than 150 min) per week

For the intention to consume HS dishes, responses were transposed from a 5-semantic scale (1 = "Very Unlikely"—5 = "Very Likely") to binary responses: 0 = no (1 = "Very unlikely" to 3 = "Undecided") and 1 = yes (4 = "Likely" to 5 = "Very Likely"). For the SHED index, scores were calculated based on defined coefficients (Tepper et al. 2021)

Table 5 Menu items and main ingredients

Course	Food Item	Main ingredients
First course	Pasta with tomato sauce (HS)	Tomato sauce, **durum wheat pasta**, extra virgin olive oil, onion
	White rice with olive oil (HS)	White rice, extra virgin olive oil, onion
	Potato gnocchi with cheese	Potatoes, **00 flour**, **liquid cream**, **blue cheese**, **eggs**
	Lasagna	**Full-cream milk**, carrots, onions, **durum wheat semolina**, ground beef, tomato sauce, **eggs**
Second course	Lentil meatballs (HS)	**Bread crumbs**, dried lentils, **eggs**, potatoes, **grana cheese**
	Baked chicken legs (HS)	Chicken legs, extra virgin olive oil, paprika
	Caprese (Tomato Mozzarella salad)	Tomatoes, **mozzarella**, extra virgin olive oil, oregano
	Veal Milanese Cutlet	Veal, **bread crumbs**, **eggs**, **clarified butter**
Main course	Tuna, hard-boiled eggs, and toasted bread salad (HS)	Lettuce, **eggs**, **tuna**, **toasted bread**, extra virgin olive oil
	Pizza Margherita (HS)	**00 Flour**, **Manitoba flour**, tomato sauce, **mozzarella**
	Cheeseburger	Ground beef, **bun**, tomatoes, **cheddar**, shallot, **eggs**
	Kebab wrap	Veal, turkey, **greek yogurt**, lamb, **pita bread**, **mayonnaise**
Side dish	Salad (HS)	Salad, extra virgin olive oil
	Cooked vegetables (HS)	Zucchini, extra virgin olive oil
	Onion rings	**Peanut** oil, onions, **full-cream milk**, **00 flour**, **eggs**
	French fries	Potatoes, **peanut** oil, salt
Dessert	Fresh seasonal fruit (HS)	Seasonal fruit
	Yogurt (HS)	**Yogurt**
	Chocolate cake	**Eggs**, **butter**, **00 flour**, sugar, dark chocolate
	Apple pie	Apples, **00 flour**, **butter**, sugar, cinnamon

Bold characters indicate possible allergen ingredients

HS healthy and sustainable dish

Table 6 Descriptive statistics of selected dishes for a meal

		Control ($n=363$)	Tr.1 Logo ($n=350$)	Tr.2 Placement ($n=349$)	Tr.3 Logo and placement ($n=338$)	*p* value
No. of dishes (total)	Mean	4.3	4.3	4.3	4.4	0.750
	(SD)	(2.06)	(2.22)	(2.19)	(2.28)	
No. of dishes (generic)	Mean	2.2	2.2	2.3	2.2	0.855
	(SD)	(1.49)	(1.49)	(1.49)	(1.53)	
No. of dishes (HS)	Mean	2.0	2.2	2.0	2.2	0.240
	(SD)	(1.40)	(1.62)	(1.53)	(1.48)	
% Of HS in total dishes	Mean	47.8	49.2	46.0	50.8	0.158
	(SD)	(28.22)	(30.02)	(29.70)	(27.87)	
% Of people selecting at least 1 HS dish	Mean	87.6%	85.1%	83.7%	90.2%	0.060

ANOVA test. SD = Standard deviation

No. of total dishes = no. of generic dishes + no. of HS dishes

% of HS in total dishes = (no. of HS dishes × 100)/no. of total dishes

Appendix

See Tables 4, 5 and 6.

Abbreviations

ANOVA	Analysis of variance
BFV	Fruits and vegetable purchasing location
CI	Confidence interval
CO_2	Carbon dioxide
Coef.	Coefficient
DAFF	Department of Agriculture, Fisheries and Forestry, Australia
df	Degree of freedom
eq	Equivalent
FAO	Food and Agriculture Organization of the United Nations
g	Gram
HE	Healthy eating
HS	Healthy and sustainable
IQR	Interquartile range
MPA	Moderate Physical Activity
MVPA	Moderate to Vigorous Physical Activity
NPAQ	Nordic Physical Activity Questionnaire
RM	Ready meals
SD	Standard deviation
SE	Sustainable eating
SHED	Sustainable-HEalthy-Diet
SPSS	Statistical Package for the Social Sciences
SE	Standard error
Tr.	Treatment
Tukey's HSD	Tukey's honestly significant difference test
US	United States
USCB	United States Census Bureau
USDA	United States Department of Agriculture
VPA	Vigorous Physical Activity
WHO	World Health Organization

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Author contributions
GA helped in data curation, investigation, methodology, writing—original draft, writing—review and editing. RW was involved in conceptualization, data curation, formal analysis, investigation, methodology, writing—original draft. BB, AR, CF contributed to conceptualization, investigation, methodology, writing—review and editing. ID, CM, DM contributed to conceptualization, methodology, writing—review and editing. FS helped in conceptualization, methodology, supervision, writing—review and editing. MIG was involved in conceptualization, methodology, software, writing—review and editing. JR helped in methodology, supervision, writing—review and editing. GS contributed to conceptualization, investigation, methodology, writing—review and editing, project administration, supervision, funding acquisition.

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Availability of data and materials
Data are available upon request.

Declarations

Competing interests
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