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RESEARCH ARTICLE

Campus food service users' support for nudge strategies for fruit and vegetable-rich items: findings from a large Canadian national sample

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Abstract

Although customer support is critical to the wider uptake of nudging strategies to promote fruits and vegetables (FV) in institutional food service (FS) settings, empirical research is sparse and typically based on small convenience samples. An online survey was conducted to assess support, perceived effectiveness and intrusiveness of nine nudge types drawn from Münscher *et al.*'s Taxonomy of Choice Architecture. We focused on the setting of campus FSs across Canada. A national sample of post-secondary students regularly using campus FSs was used (*N* 1057). Support for changing the range of options (B3) was the highest, closely followed by changing option-related effort (B2) and changing option-related consequences (B4). Facilitating commitment (C2), changing default (B1) and providing a social reference point (A3) received lowest support. Furthermore, we extracted three clusters of respondents based on perceived effectiveness and intrusiveness of nudge types. Characterised by a relatively low level of perceived effectiveness and moderately high level of intrusiveness, Cluster 1 (61·7 % of the sample) reported the lowest support for nudges. Cluster 2 (26·6 %), characterised by intermediate effectiveness and low intrusiveness of nudging, reported a high level of support for nudges. Lastly, Cluster 3 (11·7 %), characterised by high perceived effectiveness of as well as high perceived intrusiveness, reported the highest level of support for nudges. Findings confirm overall support for FV nudging, with significant differences across nudge types. Differences in customers' acceptance and perception across nudge types offer campus FS operators initial priors in selecting nudges to promote FV.

Key words: Choice architecture: Consumer support: Food choice environment: Fruits and vegetables: Healthy eating: Nudging: Perceived effectiveness: Perceived intrusiveness

Nudging refers to a broad set of strategies that alter aspects of the immediate food choice environment, which do not involve substantial economic incentives or ban alternatives[1]. Given that young adults' intake of fruits and vegetables (FV) is well below national dietary guidelines in North America, nudging and other micro-environmental interventions in food service (FS) settings have been suggested as a promising approach to promote their consumption[2]. Diverse nudging techniques intended to increase the choice of healthy food items have been proposed and implemented in mass eating contexts with promising results despite variation in their effectiveness (see[3–8], for reviews). Although nudging has been described as respecting individuals' freedom of choice by its proponents[1], some critics have raised the concern that nudging does not always operate via individuals' autonomous decisions and therefore is not as liberty preserving as it is often depicted[9]. It has been suggested that nudges that are implemented without public support may backfire and lead people to intentionally avoid the target behaviour[10]. Thus, instrumental to the potential success of such approaches is the extent to which consumer will support or oppose the use of different types of nudging[11], for which types of foods and in what FS contexts. Recently, nutrition researchers interested in the use of nudging to promote healthy eating have called for research on customer support[6]. This line

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Table 1. Nudging types and strategies based on Taxonomy of Choice Architecture (TCA) and their description in the survey

Nudging type	Descriptor from TCA	Description in the survey
A1	Translate information	Food service operators change the format or style of posters or other communications about FV-rich items and healthy eating simpler, more familiar or attractive than before *For example, they may emphasise sensory satisfaction and short-term performance benefits of certain FV-rich items instead of long-term health benefits of eating FV (e.g. long life, less chance of heart disease) in posters around cafeterias and/or their website.*
A2	Make information visible	Food service operators try to make information about FV items more readily visible to users. *For example, FV-rich food items may now be clearly indicated with symbols, such as 'Health checks' or 'Traffic light' symbols (e.g. green light for healthy option, yellow light for caution; red light for less healthy option). Alternatively, FV-rich food items are now placed at the beginning or end of menu boards in order to make them stand out for customers.*
A3	Provide social reference point	Food service operators try to encourage cafeteria users to choose more FV-rich items by making reference to or alluding to what their peer or opinion leaders frequently choose and eat. *For example, a poster may be displayed in cafeterias that show popular FV-rich items with the number of customers who chose each last month.*
B1	Change default	Food service operators present FV-rich items as *default options* whenever possible while allowing customers to 'opt out' and ask for other less healthy items. *For example, FV-rich sides, such as broccoli spears or coleslaw, are now prominently displayed and offered as the 'default' or 'usual' side to main entrées (although a less healthy side is still available on request). Alternatively, servers may prompt cafeteria users to choose FV-rich items in a friendly manner (although users are free to choose other items).*
B2	Change option-related effort	Food service operators present FV-rich items in ways that make them easier to spot, reach and choose over other items. *For example, FV-rich items are displayed in areas that are more noticeable and easier to reach, such as eye-to-waist level of shelves, brightly lit displays or near checkout lines. Alternatively, FV-rich items or stations serving them are moved to the beginning of a cafeteria line or a central location so that they can be chosen with minimal effort.*
B3	Change range of options	Food service operators change the range or composition of FV-rich items so that they are perceived as more dominant or attractive, and thus more likely to be chosen. *For example, greater ranges of FV additions and options may be provided in stir-fry and/or pasta stations. Alternatively, more than one FV-rich side may be offered alongside less healthy sides so that users have greater choice of healthy sides.*
B4	Change option consequences	Food service operators try to offer micro-incentives or emphasise other perceived benefit of choosing FV-rich items. *For example, loyalty cards may be introduced such that small incentives are provided in return for frequent purchase of FV-rich items (e.g. one free whole fruit such as an apple or banana, after 5 eligible FV purchases).*
C1	Provide reminders	Food service operators try to remind cafeteria users about FV-rich items on offer at the right moment. *For example, a big TV monitor may be placed at the main entrance to a cafeteria and prominently display FV-rich items on offer for the meal occasion. Alternatively, customers may sign up for a food service app that alerts them with healthy items on offer at various locations on campus.*
C2	Facilitate commitment	Food service operators try to support cafeteria users who are committed to healthy eating by offering frequent feedback. *For example, cafeteria users are invited to sign up for a contest or an app that prompts them to set a personal goal for FV servings per day (or week), and provides weekly feedback on success based on their on-campus purchase record. Alternatively, cafeteria users are invited to sign up for an app that will track users' purchase of FV-rich items bought on campus and provides feedback on FV intake on campus for that week. (Would be available for interested students only).*

of research is of practical importance to policy makers, nutritionists and institutional FS operators.

Literature review and research questions

Taxonomy of nudging techniques for healthy eating

Several taxonomies have been proposed to organise diverse nudging techniques used in various studies. Thaler and Sunstein espoused the System 1 (i.e. the automatic and effortless route) *v.* System 2 (i.e. the deliberative and effortful route) distinction in order to discern nudging techniques that require minimal awareness (e.g. changing defaults) from those that prompt users' attention (e.g. posting a green sticker on healthy items). The most common taxonomies include the TIPPME[12], MINDSPACE[13,14], Cadario and Chandon's types of nudging for healthy eating[5] and Münscher *et al.*'s Taxonomy of Choice Architecture (TCA)[15]. The TCA consists of nine types of nudging under three high-order classes (see Table 1): (A) the class presenting decision-relevant information without altering the choice alternatives themselves (i.e. *decision information*), (B) the class altering the structure of choice alternatives and the decision-making format (i.e. *decision structure*) and (C) the class offering assistance in sticking to one's intentions to choose 'better' alternatives (i.e. *decision assistance*).

Following the TCA framework, Mertens *et al.* conducted a meta-analysis of 455 nudge effect sizes[8]. They reported that food choices were particularly responsive to choice architecture interventions. Furthermore, effectiveness in behaviour change varied substantially across nudge type. Changing the default (B1) had the largest mean effect size, followed by other nudge types targeting decision structure (i.e. B2–B4). Nudge types targeting decision information (A1–A3) and those

offering decision assistance (C1 and C2) had smaller *n* effect sizes. Breakdown of effect sizes by the nine specific types of nudges were not reported, but overall effect sizes by class were $d = 0{\cdot}86$ (0·56, 1·17) for decision structure (B), followed by $d = 0{\cdot}52$ (0·20, 0·84) for decision information (A) and $d = 0{\cdot}44$ (0·28, 0·59) for decision assistance (C). However, it should be noted that Mertens *et al.*'s meta-analysis included a sizeable number of laboratory experiments in which nudging was implemented in short period.

Customer support for the use of nudging techniques for healthy eating

Another important consideration in implementing nudges is acceptability to customers. Nudge techniques intended to promote FV are likely to be noticed by users of campus food services within days, who may perceive certain changes as limiting their freedom of choice. One consistent finding across domains is that System 1 nudges, or those that take advantage of people's inattention or perceptive bias, typically by altering certain aspects of the set of alternatives (e.g. offering fruits as a default salad with the option of substitution), are perceived as reducing customers' sense of agency over their behaviour and thus receive lower support from the public compared to System 2 nudges, or those that prompt reflective thinking, typically by making information about the target item more salient at the time of decision making (e.g. placing a large green sticker on healthy desserts)[16–18]. This poses a dilemma for FS planning to use nudges that change certain aspects of decision structure, especially, changing defaults, which are known to be more effective than other nudge types. However, given that changing defaults has been consistently used over other nudges (e.g. placing target items closer to customers) as a prime example of System 1 nudging in these studies, further research is necessary to verify whether other nudge types modifying aspects of decision structure (i.e. B2–B4) also receive low support.

Researchers have recently started to assess customers' support for more specific types of food nudging beyond the dichotomy of System 1 *v.* 2 nudging. Furthermore, they have explored correlates of support for individual nudges. Evers *et al.* investigated citizens' approval of three nudges intended to promote healthy eating: placing healthy foods in more visible places, making healthier snacks more accessible, and placing smaller plates for diners to help them eat smaller portion sizes[19]. The smaller plate as a new default was perceived as more intrusive and received significantly lower support than the others. Furthermore, perceived intrusiveness of nudging negatively predicted support ratings. It was also found that support for nudges was higher when the choice architect was considered trustworthy.

In a survey asking about support for nudges intended to increase visibility of healthy food items (akin to B2) and nudges affixing labels for (un)healthiness (akin to A2) in university cafeteria settings, Djupegot and Hansen[20] found that support for each nudge was more strongly associated with perceived effectiveness than with (the lack of) perceived intrusiveness although both were significant predictors of support.

Cadario and Chandon asked American online survey participants to indicate their support for and perceived effectiveness of seven types of healthy eating nudges[21], that had emerged from the authors' typology of nudging for healthy eating[5]: descriptive labelling, evaluative labelling, salience enhancement, healthy eating calls, hedonic enhancements and convenience enhancements. Participants were asked to estimate the amount of calorie reduction that each nudging type would lead to. The authors found that descriptive labelling and evaluative labelling, which are mainly intended to provide information (akin to A2), received the highest approval as well as the highest perceived effectiveness ratings. In contrast, portion size reductions and convenience enhancements (akin to B1), which likely involve little deliberation on the part of consumers, received substantially lower approval and perceived effectiveness in helping people reduce caloric intake.

As summarised above, recent studies have further expanded our understanding of customers' support for different healthy eating nudges and begun to explore correlates of support. However, there are still some issues that await further investigation. Findings from previous studies are difficult to compare due to the diversity of nudge typologies used, focus of intervention (e.g. restricting calories, healthy foods) and restricted range of nudging types included. Furthermore, food choice motives[22], such as healthiness, convenience, pleasure and familiarity, which are found to be associated with frequent consumption of FV[23], have not been examined in conjunction with support for different nudging types.

To begin to address campus FS customers' support for diverse FV nudge types, we conducted an online survey with a convenience sample (*n* 298) of undergraduate students attending one Canadian university[24]. Participants were asked to rate support for, as well as perceived effectiveness and intrusiveness of twenty nudge scenarios intended to promote FV-rich items. These scenarios were classified into the nine nudge types of the TCA based on researcher consensus[15]. Overall ratings were favourable with some nudge types receiving significantly higher support than others. Specifically, changing the range of options (B3) and changing option-related consequences (B4) received the highest support, followed by changing option-related effort (B2) and making information visible (A2). Translating information (A1), changing defaults (B1) and providing reminders or facilitating commitment (C1 and C2 together) were less popular types of nudging. Providing social reference points (A3) was least supported. Furthermore, support for nudge types was positively associated with the belief that FS have a role in promoting healthy eating, perceived importance of FV intake, trustworthiness of the choice architect and female gender, broadly in line with previous findings[19,25]. Lastly, support for all types of nudges was positively predicted by perceived effectiveness of each nudge and negatively predicted by perceived intrusiveness above and beyond the contribution of general beliefs about healthy eating and nudging[19,20].

However, the present study had several limitations as well. First, given the use of a convenience sample drawn from one university, the findings may have reflected peculiarities of participants' perception of their campus FS. Furthermore, as with other researchers[19–21], we compared mean support across types of nudging and did not address the possibility of a small number of meaningfully different clusters of respondents.

Lastly, we used our own judgment in assigning the twenty specific nudge tactics to TCA nudge types, which may not be free of subjective bias.

Current study

We pursued three research questions in this study.

RQ #1: We aimed to re-examine FS users' differences in support for TCA nudge types in a larger, nationally representative sample of Canadian undergraduate students[24]. Furthermore, we decided to directly describe each nudge type with an example.
RQ #2: We aimed to investigate the contribution of food choice motives to the degree of support for nudge types intended to promote FV-rich items above and beyond nudge-specific perception (e.g. perceived effectiveness and intrusiveness of each nudge) as well as personal-level variables. Food choice motives may significantly predict support for some nudge types.
RQ #3: We aimed to explore the heterogeneity of FS users in their support for healthy eating nudge types and identify a small number of segments of those sharing similar perceptions. Given previous findings that perceived effectiveness and intrusiveness of nudging have unique associations with support[19–21], we explored this heterogeneity based on *perceived effectiveness and intrusiveness of nudge types*.

Methods

Participants

Participants were recruited via a Canadian research panel company in August–September 2021. Since most post-secondary campus FSs were either closed or in curtailed operation due to COVID-19 since mid-March 2020, it was deemed necessary to have participants look back to their typical on-campus food settings before the onset of COVID-19 in responding to our survey questions. Therefore, we decided to recruit individuals who were attending a Canadian post-secondary educational institution in the 2019–2020 academic year. We also recruited a sample roughly proportionate to the ratio of undergraduate enrolment across provinces. The data collection was approved by the University of Guelph Research Ethics Board.

Measures

The online survey included the following measures as well as demographic questions (e.g. gender, age, ethnicity, meal plan use, special diet). Questions were adapted from our previous survey[24] as well as from those used by previous researchers[16–19,26], and finalised after conducting cognitive interviews with six undergraduate students. A set of eligibility questions were used so that only participants who had purchased meals on campus at least once a month before COVID-19 outbreak were allowed to proceed.

Food choice motives. We used the short version of the Food Choice Questionnaire (FCQ)[27], adapted from the work of Steptoe *et al.*[22]. Eleven food choice motives were measured: healthy, convenient to buy, affordable, familiar, pleasurable, natural, environmentally friendly, animal friendly, fairly-traded, helpful in weight control and helpful in mood management. Specifically, in response to the question, 'It was important to me that the food I chose from a campus eatery on a typical school day was [healthy]', participants were asked to indicate the degree of importance of each motive on a 5-point scale, ranging from 1 (not important) to 5 (very important).

Support, perceived effectiveness and perceived intrusiveness of nudge types. A short description of each of the nine nudge types was provided to participants, one at a time (see the right-most column in Table 1). The degree of support for each nudge type was assessed (i.e. Would you support this change if it is to be introduced at your on-campus food locations?) on a 4-point scale (1 = 'disapprove very much'; 2 = 'somewhat disapprove'; 3 = 'somewhat approve'; 4 = 'approve very much'). Perceived effectiveness was measured (i.e. 'Do you think this change would influence OTHER STUDENTS to choose more FV-rich items if introduced at your on-campus food locations?') on a 4-point scale (1 = 'not at all likely'; 2 = 'somewhat unlikely'; 3 = 'somewhat likely'; 4 = 'very likely'). Perceived intrusiveness was measured (i.e. 'How intrusive would you find this change if introduced at your on-campus food locations?') on a 4-point scale (1 = 'not at all intrusive'; 2 = 'somewhat not intrusive'; 3 = 'somewhat intrusive'; 4 = 'very intrusive').

Trustworthiness of choice architect. Participants were asked the extent to which the nudge ideas were designed and implemented out of concern for people's well-being and health on a 5-point scale (1 = 'strongly disagree'; 5 = 'strongly agree').

Beliefs about FS's role in promoting healthy eating. Participants were asked whether their campus FS should actively promote healthier food choices on a 5-point scale (1 = 'strongly disagree'; 5 = 'strongly agree').

Perceived importance of intake of FV. Participants were asked the degree of importance of including a lot of FV in their diet on a 5-point scale (1 = 'not at all important'; 5 = 'extremely important').

Self-report of the number of servings of daily FV intake. Participants were asked to indicate the number of servings of total fruit, fruit juice, total vegetables, dark green/orange vegetables and potatoes they ate past month, from never to 6 or more times/day. Categories and serving sizes were taken from the 2007 Eating Well with Canada's Food Guide[28]. One serving was defined as 1 whole fruit or 125 ml (~100 g) of fresh or frozen fruits or 100 % fruit juice. For potato and vegetables, one serving was defined as 125 ml (~100 g) of fresh, frozen or cooked vegetables or 250 ml of raw leafy vegetables.

Statistical analysis

Descriptive analysis was completed using SPSS 28. Most variables were approximately normally distributed, and others have shown that parametric methods are very robust to

Table 2. Means of support for, perceived effectiveness and perceived intrusiveness of nudge types

Nudge type	Descriptor	Means of support	Means of perceived effectiveness	Means of perceived intrusiveness
A1	Translate information	2·88^{c}	2·77^{cd}	2·39^{bc}
A2	Make information visible	2·94^{bc}	2·84^{bc}	2·44^{b}
A3	Provide social reference point	2·79^{cd}	2·72de	2·45^{ab}
B1	Change default	2·86^{cd}	2·80^{bcd}	2·52^{a}
B2	Change option-related effort	3·02^{b}	2·88^{ab}	2·31^{c}
B3	Change range of options	3·10^{a}	2·95^{a}	2·26^{cd}
B4	Change option consequences	2·98^{b}	2·89^{ab}	2·35^{bc}
C1	Provide reminders	2·87^{c}	2·73de	2·45^{ab}
C2	Facilitate commitment	2·76^{d}	2·67^{e}	2·57^{a}

Note: Support, perceived effectiveness and perceived intrusiveness were measured on the 4-point Likert scale (1 = disapprove very much/not at all effective/not at all intrusive; 4 = approve very much/very effective/very intrusive).
Means that bear different superscripts in each column are significantly different at $P < 0·05$ with Games-Howell *post-hoc* comparison.

unequal variances and non-normal distributions such as seen in ordinal data[29,30]. The Likert scales were therefore regarded as continuous variables, which allowed the use of parametric statistical analysis. Support for the nine nudge types as well as their perceived effectiveness and intrusiveness were analysed by repeated measures ANOVA. The food choice motive items underwent principal component analysis in order to reduce them to a smaller number of factors, which were entered as predictors of support. MPlus v.8 was used to conduct latent profile analysis (LPA) and extract clusters based on perceived effectiveness and intrusiveness of nudge types.

Results

Sample characteristics

Overall, 1256 respondents completed the informed consent and affirmed having attended a post-secondary institution in the 2019–2020 academic year. 71·6 % of them reported attending a four-year university, and 28·4 % a two-year college or another programme. Twenty percent of respondents completed 1–2 semesters by the end of the 2019–2020 academic year, 31 % 3–4 semesters, 19 % 5–6 semesters and 26 % had 7 or more semesters. The rest did not complete the question. Furthermore, 50·7 % attended a university or college in the province of Ontario, 14·1 % in British Columbia, 12·8 % in Quebec, 11·0 % in Alberta and the rest in other provinces and territories. About 45·8 % reported having had a meal plan in the 2019–2020 academic year. Among 1111 respondents who passed all the eligibility criteria, 54 (4·8 %) dropped out of the survey, leaving 1037 for our data analyses. Among 1035 participants who disclosed their gender at the end of the survey, 61·5 % of them were female, and 35·3 % were male.

Preliminary analysis indicated overall support for all nudges, ranging from 63·6 % moderate to high supporting C2 (facilitating commitment) to 79·7 % supporting B3 (changing the range of options) (see Supplementary Table S1).

Next, we compared the means of support for the nine nudge types with repeated measures ANOVA. The overall model fit was good (*Wilks Lambda* = 0·85, F (8, 1019) = 22·08, $P < 0·001$). Within-subjects effects of the nudge type was significant (Greenhouse-Geisser F (7·69, 7892·12) = 26·59, $P < 0·001$). As shown in Table 2, the means for the nine nudge types were tightly located in the small range between 2·76 and 3·10 on the 4-point scale. Support for B3 was the highest, closely followed by B2 and B4. The least supported nudge type, C2 did not significantly differ from B1 and A3, which was significantly less popular than C1 and A1. Support for A2 was considered middling in the pack.

Perceived effectiveness ranged from 2·67 to 2·96, which was clearly greater than the mid-point of the scale used (i.e. 2·5) (see Table 2). Similar to support ratings, B3 was perceived as the highest in effectiveness in promoting FV, which was closely followed by B2 and B4. Again, C2 received the lowest perceived effectiveness rating, which did not significantly differ from C1 and A3.

In contrast, perceived intrusiveness followed a nearly opposite pattern of support ratings and perceived effectiveness. Perceived intrusiveness ranged from 2·26 to 2·57, which was close to the mid-point of the scale. B3 was perceived as the least intrusive, which was closely followed by B2, which did not significantly differ from A1 and B4. In contrast, C2 and B1 were perceived as the most intrusive nudge types, followed by C1 and A3.

Food choice motives

The descriptive data for the eleven food choice motive items are shown in Table 3. On average, affordability was the most important food choice motive, followed by convenience and pleasure. Other motives were rated somewhat less important: health, mood management, weight control, familiarity,

Table 3. Means of food choice motives

	N	Mean[a]	SD
Affordable	1051	4·06	1·03
Convenience	1051	3·81	1·01
Pleasure	1050	3·71	1·07
Healthy	1054	3·33	1·17
Environment friendly	1049	3·29	1·15
Mood management	1055	3·24	1·13
Familiar	1049	3·23	1·13
Helps control weight	1045	3·22	1·21
Natural	1046	3·19	1·15
Fair trade	1048	3·15	1·24
Animal friendly	1050	2·97	1·32

[a] Scale ranging from 1 (not important) to 5 (very important).

natural, environment friendly, fair trade and animal friendly. Principal component analysis showed that the 5-factor solution was the most interpretable. One factor loaded highly on motives of health, natural and weight control. Another factor loaded highly on motives of convenience, pleasure and affordable. A third factor loaded highly on environment friendly, animal friendly and fair trade. The fourth and fifth factors each consisted of one item: mood management and familiarity. Since Cronbach alpha numbers for the items loading highly on each of the first three factors were acceptable (alpha = 0·65, 0·66 and 0·79), three composite variables were created by taking the average of the items and were labelled: healthy motive, convenience motive and ethical motive for a total of five types of motives.

Association between support for nudge types and other variables

We explored which variables significantly predicted support ratings of the nine nudge types. Separate regressions for support rating of each nudge type were run by entering its perceived effectiveness and intrusiveness as well as gender, the two nudge-related beliefs, perceived importance of FV intake, the five composites of eating motives. Overall, as shown in Table 4, perceived effectiveness of a nudge type was the most substantial predictor of support. Perceived intrusiveness was a significant and negative predictor for all the nudge types, although its regression coefficients were substantially smaller than those of perceived effectiveness. Furthermore, the belief that nudging is implemented out of concern for users' well-being and health was also a significant predictor of all the nudge types. However, the belief that the FS unit at one's academic institution are allowed to actively promote healthier food choices was a significant predictor for A2 and B2 nudge types only. Moreover, perceived importance of FV intake was a significant predictor for all the nudge types except for C1 and C2.

Of the five types of food choice motives, some were found to be significant predictors of support ratings of nudge types. Healthy eating motive was a significant predictor for B1, B4, C1 and C2, familiarity eating motive for A3 and C1, and convenience eating motive for A1, A2, B2, B3 and B4. Gender was not a significant predictor for support of any nudge type.

Clustering of the sample: segmentation analyses

In order to address RQ #3, we used perceived effectiveness and perceived intrusiveness of nudge types as the base variables of LPA. Given that there were nine nudge types in our data, it was necessary to reduce the number of variables to be used as the base variables of the LPA. Based on the dimensions identified from the principal component analyses, we formed six new variables: perceived intrusiveness (effectiveness) of nudge type A1–3 (henceforth A), B2–3 (henceforth B2/B3) and C1–2 (henceforth C) by taking the average of the respective items. Thus, perceived effectiveness and intrusiveness ratings of A, B1, B2/B3, B4 and C were entered as the base variables of LPA.

We ran a series of LPAs varying the number of clusters to be extracted. Among them, the 3-cluster solution was substantially more interpretable than the 2- or 4-cluster solutions. As shown in Supplementary Table S2, in the 3-cluster solution, Cluster 3 (11·7 % of participants) was characterised by both high perceived effectiveness and high perceived intrusiveness of all the nudge categories. Cluster 2 (26·6 %) was found to perceive high effectiveness of all the nudge categories, albeit somewhat lower than Cluster 3, as well as low intrusiveness of all the nudge categories. Cluster 1 (61·7 %) was found to perceive all the nudge categories as lower in effectiveness than the other two clusters and as moderately intrusive (i.e. straddling between Cluster 2 and 3).

We compared the three clusters in their support ratings of the nine nudge types with one-way ANOVA. The omnibus F statistics were significant for all the nudge types. Pair-wise comparisons showed significant differences in support for nudge types among the three clusters. As shown in Table 5 and Fig. 1, Cluster 3's support of all the nudge types was significantly higher than Cluster 2, which in turn was significantly higher than Cluster 1. It was notable that Cluster 2's support substantially varied across nudge types: their support for B2, B3 and B4 was significantly higher than for A1, A3, B1, C1 and C2 (Z's > 6·09, P's < 0·001).

Next, the three clusters were compared on individual-level variables The belief that nudging strategies are designed and implemented out of concern for people's well-being was significantly higher for Cluster 3 than for Cluster 2 (M = 4·41 *v.* 4·12, Z = 2·76, P = 0·02), which in turn was significantly higher for Cluster 1 (M = 4·41 *v.* 3·38, Z = 10·66, P < 0·001). Similarly, although the belief that the FS unit at one's academic institution are allowed to actively promote healthier food choices were only directionally higher for Cluster 3 than for Cluster 2 (M = 4·19 *v.* 4·10, Z = 0·81, P = 0·10), this belief was significantly stronger for Cluster 2 than for Cluster 1 (M = 4·19 *v.* 3·27, Z = 11·37, P < 0·001). Furthermore, perceived importance of FV intake was significantly higher for Cluster 3 than for Cluster 2 (M = 4·36 *v.* 3·98, Z = 3·18, P = 0·004), which in turn was significantly higher than Cluster 1 (M = 3·98 *v.* 3·49, Z = 6·13, P < 0·001).

Estimated servings of fruits, dark green or yellow vegetables and other vegetables did not significantly differ across the three clusters. The only exception was that Cluster 1 reported eating significantly fewer servings of fruits than Cluster 2 (M = 4·98 *v.* 5·70, Z = 5·42, P < 0·001) and Cluster 3 (M = 4·98 *v.* 6·09, Z = 2·48, P = 0·03). About 65·2 % of male participants and 59·3 % of female participants were classified into Cluster 1. As many as 31·7 % of female participants were classified into Cluster 2 whereas only 18·6 % of male participants were. About 8·9 % of female participants and 16·2 % of male participants were classified into Cluster 3.

The three clusters were also compared on food choice motives. As shown in Table 6, scores for Cluster 3 were significantly higher on ethical, health, familiarity and mood management motives than Cluster 2, which did not differ from Cluster 1. However, the score for Cluster 1 was significantly lower on the convenience motive than Clusters 2 and 3, which did not significantly differ from each other.

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Table 4. Regression analyses for support for the nine nudge types

	DV: A1 support (*R*-square = 0·24)					DV: A2 support (*R*-square = 0·27)					DV: A3 support (*R*-square = 0·26)				
predictors	B	SE	Beta	*t*	*P*	B	SE	Beta	*t*	*P*	B	SE	Beta	*t*	*P*
(Constant)	0·89	0·14		6·21	0·00	1·05	0·16		6·76	0·00	1·19	0·16		7·38	0·00
Trustworthiness	0·11	0·02	0·16	4·80	**0·00**	0·10	0·02	0·13	4·15	**0·00**	0·12	0·02	0·16	4·76	**0·00**
FS's role	0·01	0·02	0·02	0·54	0·59	0·07	0·02	0·09	2·80	**0·01**	0·01	0·02	0·02	0·59	0·55
Importance FV	0·09	0·02	0·15	4·44	**0·00**	0·05	0·02	0·07	2·01	**0·04**	0·06	0·02	0·08	2·56	**0·01**
Gender	0·02	0·04	0·01	0·49	0·63	0·02	0·04	0·01	0·42	0·67	−0·03	0·04	−0·02	−0·82	0·41
Ethical_m	−0·03	0·02	−0·04	−1·16	0·25	0·01	0·03	0·02	0·49	0·63	0·02	0·03	0·02	0·69	0·49
Conven_m	0·09	0·03	0·10	2·86	**0·00**	0·09	0·03	0·08	2·48	**0·01**	−0·02	0·04	−0·02	−0·58	0·56
Health_m	0·04	0·03	0·05	1·38	0·17	0·05	0·03	0·06	1·59	0·11	0·03	0·03	0·04	0·94	0·35
Familiar_m	0·03	0·02	0·05	1·76	0·08	0·02	0·02	0·02	0·72	0·47	0·05	0·02	0·06	2·09	**0·04**
Moodmgt_m	0·03	0·02	0·04	1·39	0·16	0·00	0·02	−0·01	−0·21	0·83	0·04	0·02	0·05	1·60	0·11
Perceived effectiveness	0·25	0·03	0·25	8·17	**0·00**	0·31	0·03	0·29	9·47	**0·00**	0·33	0·03	0·33	10·98	**0·00**
Perceived intrusiveness	−0·06	0·02	−0·07	−2·39	0·02	−0·15	0·02	−0·17	−5·88	**0·00**	−0·11	0·03	−0·13	−4·40	**0·00**

	DV: B1 support (*R*-square = 0·26)					DV: B2 support (*R*-square = 0·31)					DV: B3 support (*R*-square = 0·32)				
Predictors	B	SE	Beta	*t*	*P*	B	SE	Beta	*t*	*P*	B	SE	Beta	*t*	*P*
(Constant)	1·11	0·16		7·01	0·00	0·95	0·15		6·21	0·00	0·80	0·15		5·26	0·00
Trustworthiness	0·15	0·02	0·19	5·87	**0·00**	0·12	0·02	0·16	5·23	**0·00**	0·15	0·02	0·21	6·58	**0·00**
FS's role	0·04	0·02	0·06	1·76	0·08	0·11	0·02	0·15	4·67	**0·00**	0·02	0·02	0·03	0·87	0·39
Importance FV	0·05	0·02	0·07	2·06	**0·04**	0·08	0·02	0·12	3·83	**0·00**	0·06	0·02	0·08	2·62	**0·01**
Gender	0·00	0·04	0·00	−0·12	0·91	0·02	0·04	0·01	0·39	0·70	0·06	0·04	0·05	1·67	0·10
Ethical_m	0·02	0·03	0·02	0·60	0·55	−0·04	0·02	−0·05	−1·45	0·15	0·01	0·02	0·01	0·22	0·83
Conven_m	−0·01	0·03	−0·01	−0·16	0·88	0·07	0·03	0·07	2·04	**0·04**	0·10	0·03	0·10	2·98	**0·00**
Health_m	0·08	0·03	0·08	2·30	**0·02**	0·02	0·03	0·02	0·69	0·49	−0·03	0·03	−0·03	−0·93	0·35
Familiar_m	0·02	0·02	0·03	0·96	0·34	−0·03	0·02	−0·05	−1·55	0·12	0·02	0·02	0·03	1·06	0·29
Moodmgt_m	0·00	0·02	0·00	0·02	0·99	0·02	0·02	0·03	1·02	0·31	−0·01	0·02	−0·02	−0·68	0·50
Perceived effectiveness	0·32	0·03	0·32	10·65	**0·00**	0·30	0·03	0·30	10·29	**0·00**	0·38	0·03	0·37	12·54	**0·00**
Perceived intrusiveness	−0·14	0·03	−0·15	−5·43	**0·00**	−0·07	0·02	−0·08	−2·95	**0·00**	−0·03	0·02	−0·04	−1·33	0·18

	DV: B4 support (*R*-square = 0·38)					DV: C1 support (*R*-square = 0·30)					DV: C2 support (*R*-square = 0·30)				
Predictors	B	SE	Beta	*t*	*P*	B	SE	Beta	*t*	*P*	B	SE	Beta	*t*	*P*
(Constant)	0·52	0·16		3·34	0·00	0·80	0·16		5·04	0·00	0·87	0·16		5·41	0·00
Trustworthiness	0·20	0·02	0·24	8·07	**0·00**	0·14	0·02	0·18	5·80	**0·00**	0·13	0·03	0·16	4·98	**0·00**
FS's role	0·01	0·02	0·01	0·24	0·81	0·03	0·02	0·03	1·08	0·28	0·03	0·02	0·04	1·18	0·24
Importance FV	0·07	0·02	0·09	3·08	**0·00**	0·02	0·02	0·02	0·70	0·48	0·00	0·02	0·00	0·10	0·92
Gender	0·04	0·04	0·02	0·96	0·34	0·04	0·04	0·03	0·98	0·33	−0·02	0·04	−0·01	−0·51	0·61
Ethical_m	−0·01	0·03	−0·01	−0·42	0·67	−0·03	0·03	−0·04	−1·21	0·23	0·04	0·03	0·04	1·36	0·17
Conven_m	0·07	0·03	0·06	2·07	**0·04**	0·04	0·03	0·04	1·25	0·21	0·00	0·04	0·00	0·10	0·92
Health_m	0·07	0·03	0·07	2·08	**0·04**	0·07	0·03	0·08	2·16	**0·03**	0·08	0·03	0·08	2·35	**0·02**
Familiar_m	−0·01	0·02	−0·01	−0·42	0·68	0·05	0·02	0·07	2·37	**0·02**	−0·01	0·02	−0·01	−0·24	0·81
Moodmgt_m	−0·02	0·02	−0·02	−0·75	0·45	−0·01	0·02	−0·01	−0·36	0·72	0·01	0·02	0·02	0·63	0·53
Perceived effectiveness	0·40	0·03	0·40	14·75	**0·00**	0·41	0·03	0·41	14·16	**0·00**	0·44	0·03	0·43	15·15	**0·00**
Perceived intrusiveness	−0·06	0·02	−0·07	−2·72	**0·01**	−0·09	0·02	−0·11	−3·86	**0·00**	−0·10	0·02	−0·11	−4·09	**0·00**

Note: Trustworthines = Trustworthiness of choice architect; FS's role = Beliefs about FS's role in promoting healthy eating; Importance FV = Perceived importance of intake of FV; Ethical_m = Ethical motive of food choice; Conven_m = Convenience motive of food choice; Health_m = Health motive of food choice; Familiar_m = Familiarity motive of food choice; Perceived effectiveness = Perceived effectiveness of the respective nudge type; Perceived intrusiveness = Perceived intrusiveness of the respective nudge type. A1 nudge type = Translate information; A2 = Make information visible; A3 = Provide social reference point; B1 = Change default, B2 = Change option-related effort, B3 = Change the range of options; B4 = Changing option consequences; C1 = Provide reminders; C2 = Facilitate commitment. *P*-values with bold face type indicate that they are significant at 0·05 or less.

Table 5. Means of support for nudge type per cluster

	A1	A2	A3	B1	B2	B3	B4	C1	C2
Cluster 1	2·72[a]	2·72[a]	2·61[a]	2·69[a]	2·77[a]	2·84[a]	2·68[a]	2·66[a]	2·57[a]
Cluster 2	3·04[b]	3·23[b]	2·94[b]	3·04[b]	3·38[b]	3·48[b]	3·45[b]	3·15[b]	2·96[b]
Cluster 3	3·33[c]	3·43[b]	3·43[c]	3·34[c]	3·51[b]	3·61[b]	3·53[b]	3·35[c]	3·37[c]
F (2, 1054)	51·62	79·11	71·21	47·41	101·82	110·59	131·59	64·20	60·91
P	0·00	0·00	0·00	0·00	0·00	0·00	0·00	0·00	0·00

Note: Means that bear different subscripts in each column are significantly different at $P < 0{\cdot}05$ with Games-Howell *post-hoc* comparison.

Next, we compared the association between perceived effectiveness vis-à-vis perceived intrusiveness and support for nudge types per cluster. For this, support rating of each nudge was regressed on its perceived intrusiveness and effectiveness for the three clusters (see Supplementary Table S3 for results). For all the three clusters, regression coefficients of perceived effectiveness were positive and significant, ranging from 0·18 to 0·47. However, regression coefficients of perceived intrusiveness varied across the clusters: they were close to zero and non-significant (ranging from −0·08 to 0·05) for Cluster 1, negative and significant (ranging from −0·17 to −0·41) for Cluster 2 and positive and significant (ranging from 0·06 to 0·30) for Cluster 3. These findings indicated that while perceived effectiveness of nudges was consistently positively associated with support regardless of cluster membership, the association between perceived intrusiveness and support substantially varied: negligible for Cluster 1, negative for Cluster 2 and positive for Cluster 3.

Discussion

We pursued three research questions in this study. The first RQ was to re-examine the difference in FS customers' support

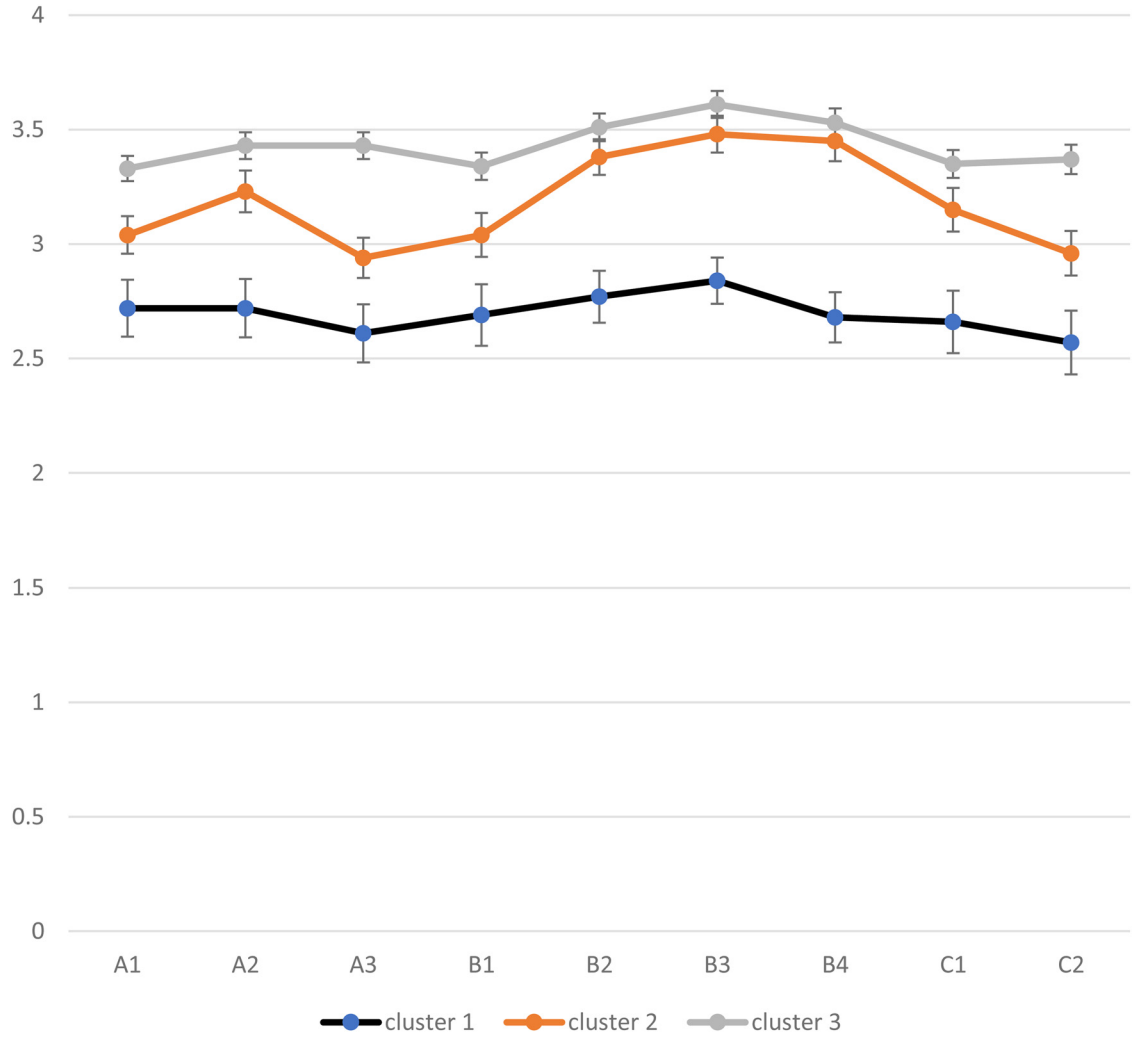

Fig. 1. Means of support for nudge types per consumer cluster with 95 % confidence levels.
Note: The 95% confidence intervals around each mean are indicated with bars

Table 6. Means of food choice motives per cluster

	Ethical	Convenience	Health	Familiarity	Mood mgt
Cluster 1	3·06[b]	3·65[b]	3·12[b]	3·15[b]	3·12[b]
Cluster 2	3·03[b]	4·18[a]	3·21[b]	3·13[b]	3·21[b]
Cluster 3	3·76[a]	4·26[a]	3·96[a]	3·87[a]	3·91[a]
F (2, 1039)	26·46	68·86	49·87	22·87	27·08
P	0·00	0·00	0·00	0·00	0·00
Total sample	3·14	3·86	3·24	3·23	3·24

Note: Means that bear different subscripts in each column are significantly different at $P < 0·05$ with Games-Howell *post-hoc* comparison.

for TCA nudge types intended to promote FV found in our previous study[24]. The second RQ was to investigate the contribution of food choice motives to support for nudge types above and beyond nudge-specific perception as well as other personal-level variables. The last RQ was to subtype FS customers based on perceived effectiveness and intrusiveness of the nine nudge types. The three RQs were successfully addressed by analysing a large Canadian sample.

Regarding RQ #1, we found that the order of mean support ratings for the nudge types obtained from our large sample were almost identical to Yi *et al.*'s findings[24]. Specifically, changing range of options (B3) received the highest support in both samples, followed by changing option-related effort (B2) and changing option-related consequences (B4). Furthermore, B3, B2 and B4 nudge types were perceived as the most effective and the least intrusive. This finding indicates that on average, campus FS customers appear to be open to nudges intended to alter some aspects of the structure of choice alternatives. However, the other nudge type classified under the class of decision structure, namely, changing default (B1), received substantially lower support and perceived effectiveness as well as much higher perceived intrusiveness than B3, B2 and B4 in both samples. Although respondents understood that they would be able to opt out of the default (i.e. FV-rich items), having to proactively ask for alternative options was probably considered bothersome. Low public support for default nudges is not new in the backdrop of previous studies; however, our finding sheds new light on the claim that System 1 nudging is not approved as much as System 2 nudging[16,18]. Given that B1–B4 are deemed System 1 nudging due to altering certain aspects of decision structure, our finding indicates that customers' support substantially varies across subtypes of System 1 nudging. Thus, the previous finding that System 1 nudging is not as preferred as System 2 nudging seems to be an artifact of the practice of mainly using changing defaults (B1) as examples of System 1 nudging, often ignoring other types of nudging that modify aspects of choice structure (e.g. B2–4). B2–B4 nudge types are likely to be embraced by campus FS more readily than changing defaults since they are not perceived as violating customers' sense of agency over choice.

Translating information (A1) and making information visible (A2), which target the presentation of information relevant to FV-items and thus are regarded prototypical System 2 nudging, were found to receive relatively high support ratings and perceived effectiveness in both samples. Given that System 2 nudging is often perceived as preserving customers' sense of agency[18], FS operators are encouraged to adopt the two nudges, such as displaying a favourable label for FV-rich food items or placing them on top of menu boards, without worrying about negative responses from their customers. One caveat is that the effect size of these nudge types was found to be relatively small in Mertens *et al.*'s meta-analysis[8].

Furthermore, providing a social reference point (A3) was one of the least supported nudge types in both studies. Despite consistent findings on the power of social norm on eating behaviour[31,32], our participants did not appear to acknowledge that their food choices may be influenced by their peers or opinion leaders. This may be due to the need for uniqueness, or the tendency to pursue dissimilarity relative to other people[33] in personal choices[34] and food choices[35]. Considering that human's emulation of other's choice occurs beyond consciousness[31,32], it is possible that the use of this nudge type in actual FS settings may not incur as much disapproval as in our survey. Similarly, facilitating commitment to frequent choice of FV-rich items (C2) as well as providing reminders about such options (C1), classified under the class of decision assistance in the TCA scheme, received lower support than other nudges in both studies. This reaction appears to stem from the widespread belief in the freedom of choice in the domains of food among post-secondary students who are not strongly committed to healthy eating[36,37].

With regard to the second RQ, we found that convenience motive was significantly associated with support for more popular nudge types intended to promote FV (i.e. B2, B3, B4, A1 and A2). It is possible that these nudge types were perceived as enhancing convenience in making food choices. In contrast, health motive was a significant predictor of support for less popular nudge types (i.e. C1, C2 and B1). This finding seems to indicate that strong healthy motive was required to support relatively unpopular nudge types. Lastly, the finding that familiarity motive of food choice was a significant predictor of support for the least supported nudge types (i.e. A3 and C1) was not easy to interpret. One interpretation is that individuals who tend to choose familiar food may feel that their food habits are difficult to change and hence appreciate timely reminders for FV-rich items on offer and/or relevant social reference point (e.g. endorsement or information denoting popularity of target food items). However, given relatively modest size of the association between motives and support for nudging, future re-examination is necessary.

To address the last RQ, we used perceived effectiveness and intrusiveness of nudge types as base variables for segmentation. We believe that this approach offers more interesting insights than extracting clusters based on their support scores for nudge types. For example, Kawa *et al.*[25] recently extracted three clusters of German college students based on their support scores for ten nudge tactics derived from MINDSPACE typology[14], via a k-means non-hierarchical cluster analysis. While Kawa *et al.*'s identification of three clusters (i.e. high support, low support and intermediate support for nudging) appears to share some similarity with our findings, it was difficult for the authors to make inferences as to how their differences in support for nudging techniques may be explained.

Characterised by relatively low perceived effectiveness and intermediate intrusiveness of nudging, Cluster 1's approval ratings were consistently the lowest. This is in part consistent with their relatively low perceived importance of regularly eating FV. However, it is noteworthy that their mean support ratings were somewhat higher than the mid-point, indicating that they were not against the use of any nudge type in the absolute sense. Among Cluster 1 respondents, despite their relatively high perception of intrusiveness of nudging, the association between perceived intrusiveness and support for nudging was close to zero. It is possible Cluster 1 respondents believe they are impervious to attempts to promote FV-rich items via nudging although it may be effective in modifying their peers' choice. This interpretation is in line with research on the false uniqueness effect[38], which leads people with egocentric disposition to erroneously believe that they will be less subject to persuasion attempts or other behavioural change tactics than their peers[39]. Furthermore, the dissociation between support for nudging and perceived intrusiveness among Cluster 1 respondents suggests that even if FS try to reduce customer concern about intrusiveness of nudging, Cluster 1's support for nudging for healthy eating may not increase.

Characterised by high perceived effectiveness as well as low intrusiveness of all the nudge types, Cluster 2's support for nudging was in between the other two clusters. Including a higher ratio of females than the other clusters, Cluster 2 members reported greater intake of FV and assigned higher importance to consumption of FV than Cluster 1. In contrast to the other clusters, whose support ratings were stable across nudges, Cluster 2 displayed quite substantially higher support for B2–B4 nudge types than other nudges. The relatively high support ratings for B2–B4 in the whole sample were in part largely driven by Cluster 2's strong preference for them. Furthermore, it was only among Cluster 2 respondents that the previous finding that perceived intrusiveness was negatively associated with support[20,24] was replicated: the more intrusive a nudge is perceived, the less support received. This indicates that FS may try to reduce perceived intrusiveness of nudging, especially, the types involving changing defaults, commitment to or reminders for FV options in order to increase Cluster 2's support for the use of nudging for promoting FV.

Lastly, Cluster 3 indicated mixed perception about nudging: high perceived effectiveness as well as high intrusiveness of all the nudge types. Despite their extremely high perception of high intrusiveness, Cluster 3 supported all the nudge types more strongly than the other clusters. In fact, it was only among Cluster 3 respondents that perceived intrusiveness was positively associated with support for nudging; the higher perceived intrusiveness, the higher the support. This odd finding can be interpreted as Cluster 3 respondents willingly tolerating nudging tactics that they believe restrict their freedom of choice (almost like 'necessary evils') because they are likely to be effective in increasing the choice of FV-rich meals. This belief appears to be related to their strong belief in the importance of including a lot of FV in their diet. Cluster 3's current intake of fruits, dark green or orange vegetables and other vegetables was adequate (although not significantly differing from Cluster 2), and they were open to consuming more FV with the help of nudging. Furthermore, given the finding that Cluster 3 rated all the food choice motives more positively than the other clusters, respondents in this cluster are likely to be more interested in food and potentially more involved in food-related activities. Considering that Cluster 3 indicated higher trust in choice architects for healthy eating as well as more favourable beliefs about FS's role in promoting healthy choices than the other clusters, campus FS are encouraged to involve them in designing and implementing nudges.

Our study has several strong points over our previous study. The use of a national sample of students of post-secondary academic institutions who regularly eat at campus cafeterias enabled us to go beyond findings from students attending one university. Furthermore, our use of a wide array of nudge types derived from the Münscher *et al.*'s TCA made it possible to assess FS users' support for less studied nudge types (e.g. facilitating commitment to healthy eating, changing range of food options, providing social reference point for FV). We encourage nutrition researchers to use a wide range of nudging techniques in assessing customers' support for nudging as well as the effectiveness of nudging in promoting healthy eating since this ensures the comparability of findings across empirical studies.

However, our study is not without limitations. We intentionally did not include interventions considered beyond the scope of nudging (e.g. reduced price for FV-rich items, removal of unhealthy food items from cafeterias). Furthermore, although we tried our best to describe nudge interventions in the survey, our respondents' perception of them may not necessarily match their actual reaction to them if they are implemented in campus food locations. However, given that it takes a great deal of coordination and time for any nudging intervention to get implemented in day-to-day FS operation, findings from our survey offer reasonable prior estimates.

Our findings offer ample practical implications for campus FS operators, which have a dual mandate of offering healthy food for students while maintaining profit[40]. It is worthwhile for FS operators to consider users' support of a nudge type vis-à-vis its estimated effect size in behaviour change since the two do not always go in the same direction. For example, given our finding that the nudge type involving changing defaults received relatively low support, many FS are likely to be hesitant to adopt it to promote FV despite its high effect size estimates in Mertens *et al.*'s meta-analysis. Furthermore, as illustrated in Wansink and Just's field study with children, customers may start to opt out of the default en masse after the first few days if the default option (e.g. apple slices) is substantially less preferred than alternative options (e.g. French fries)[41]. In the case of the class of decision assistance nudge types (C1 and C2), they are also least likely to be adopted by FSs given their relatively small effect size and low support ratings. However, high perceived intrusiveness of them may be tempered if student groups committed to healthy eating and campus food operators jointly initiate the process of implementing them in campus food locations. In contrast, translating information (A1) and making information visible (A2) are safe options for nudging that are perceived as

respecting FS users' sense of agency although their effect size was found to be relatively small in Mertens *et al.*'s meta-analysis[8]. Lastly, the other nudge types targeting decision structure, namely, changing the range of options (B3), changing required effort (B2) and changing consequences (B4), appear to be the most promising nudging tactics for campus FS given their relatively high effect size in Mertens *et al.*'s meta-analysis[8] as well as high support ratings confirmed in the current study.

Supplementary material

The supplementary material for this article can be found at https://doi.org/10.1017/jns.2023.80.

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Equal contribution to formation of research questions and planning of methodology; S. Y. and P. B. mainly responsible for construction of the survey and data collection; S. Y. mainly responsible for data analyses; S. Y. and P. B. responsible for manuscript preparation.

This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving research study participants were approved by the University of Guelph Research Ethics Board (REB #19-11-042). Written informed consent was obtained from all subjects/patients.

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