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Influence of front-of-pack labelling and regulated nutrition claims on consumers' perceptions of product healthfulness and purchase intentions: A randomized controlled trial

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ABSTRACT

Mandatory front-of-pack (FOP) labelling was proposed in Canada to highlight foods with high contents of sugars, sodium and/or saturated fats, which would be displayed on labels along with the mandatory Nutrition Facts table and voluntary nutrition claims. In an online survey, participants (n = 1997) were randomized to one of four FOP labelling conditions: 1) control, 2) warning label, 3) health star rating or 4) traffic light labelling. Participants were shown four drinks (a healthier drink with or without a disease risk reduction claim, a healthier drink with or without a nutrient content claim, a less healthy drink with or without a disease risk reduction claim and a less healthy drink with or without a nutrient content claim) in random order and one at a time. Participants rated perceived product healthfulness and purchase intentions using a 7-point Likert scale. Participants could access the Nutrition Facts table while viewing labels. Results showed less healthy drinks displaying any FOP labelling were perceived as *less healthy* compared to the control. In healthier drinks, health star rating and traffic light labelling created a 'halo' effect, which was not observed with warning labels. Similar results were observed with purchase intentions. Drinks displaying a disease risk reduction claim were perceived as *healthier* than those without ($p < 0.001$) regardless of product's healthfulness. The effect of a nutrient content claim was not significantly different. The effect of FOP labelling and claims was mitigated for those who used the Nutrition Facts table. FOP labelling was likely helpful for consumers with different levels of health literacy. Overall, FOP labelling had significantly stronger influence than nutrition claims on consumers' perceptions; however, the effect of each FOP label varied on healthier and less healthy drinks.

1. Introduction

Poor diet quality is a major risk factor for obesity and non-communicable diseases (NCDs) (Afshin, Sur, Fay, & et al., 2019). Unhealthy diets are known to largely include foods with high contents of nutrients of public health concern, such as sodium, sugars and/or saturated fats (Monteiro, Moubarac, Cannon, Ng, & Popkin, 2013) and therefore interventions that influence changes towards healthier diets have been proposed (Cobiac & Scarborough, 2017; O'Flaherty et al., 2016; Pearson-Stuttard et al., 2018; Swinburn, Sacks, & Ravussin, 2009). One example of such interventions is nutrition labelling (Rayner et al., 2013; World Health Organization, 2004). While most countries require mandatory nutrition information to be displayed on food labels in the form of a Nutrition Facts table or panel (CODEX Alimentarius, 1985; European Union, 2011; Food and Drug Administration, 2006; Government of Canada, 2003), consumers have reported difficulties understanding that nutrition information or rarely using it, especially among those with low health literacy (Malloy-Weir & Cooper, 2017; Persoskie, Hennessy, & Nelson, 2017; Soederberg Miller & Cassady, 2015). In addition to the Nutrition Facts table, food labels often display voluntary nutrition claims (i.e., nutrient content claims and disease risk reduction claims), although the conditions for the use of these claims are regulated by governments (CODEX Alimentarius, 1985; Government of Canada, 2003). Nutrient content claims are those that

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"describe the amount of a nutrient in a food" (e.g, "*Low in sodium*"); and disease risk reduction claims are statements that "link a food or constituent of a food to reducing the risk of developing a diet-related disease or condition" (Government of Canada, 2003; Health Canada, 2003); for example, "*A healthy diet low in saturated and trans fats may reduce the risk of heart disease. (Naming the food) is free of saturated and trans fats*". However, these nutrition claims, which are used at the discretion of food manufacturers to highlight particular attributes of the food (Hoefkens & Verbeke, 2013; Wills, Storcksdieck genannt Bonsmann, Kolka, & Grunert, 2012; World Health Organization, 2004), can mislead consumers since they are used to highlight positive characteristics of the food, but do not warn consumers about the content of nutrients of public health concern (Chandon & Wansink, 2012; Nestle & Ludwig, 2010). Consequently, a number of countries are now introducing front-of-pack (FOP) labelling to discourage the selection of foods with less favourable nutritional quality and to encourage product reformulation by manufacturers (Ares et al., 2018; Arrúa, Machín, et al., 2017; Kanter, Vanderlee, & Vandevijvere, 2018; Ni Mhurchu, Eyles, & Choi, 2017).

Among the different types of FOP labelling systems that have been introduced worldwide, summary indicator systems and nutrient-specific systems are the most commonly implemented. Summary indicator systems (e.g., health star rating) use a nutrient threshold-based symbol or score to provide a semi-directive assessment of the overall nutrient content of foods, typically incorporating both positive and negative nutrients (Bix et al., 2015; Egnell, Talati, Hercberg, Pettigrew, & Julia, 2018; Kelly & Jewell, 2018; Roodenburg, 2017; van Kleef & Dagevos, 2015). The health star rating is considered a semi-directive system because some nutritional guidance is given to the consumers (e.g., more stars reflect better nutritional quality) (Hodgkins et al., 2012). Nutrient-specific systems use symbols to display the amount of select nutrients or calories per serving that provide either a semi-directive assessment of the nutritional quality, in which consumers are being communicated specific levels nutrients (green, yellow, red) (e.g., traffic light labelling), or a directive assessment in which a decision about the nutritional quality of the food has already being made on behalf of the consumers (e.g., 'high in' warning labels) (Bix et al., 2015; Egnell et al., 2018; Hodgkins et al., 2012; Kelly & Jewell, 2018; Roodenburg, 2017; van Kleef & Dagevos, 2015).

Health Canada issued a regulatory proposal that would require mandatory FOP symbols (in the form of 'high in' warning labels) on food packages to highlight foods with high contents of sugars, sodium and/or saturated fats (Government of Canada, 2018). If approved, products that exceed certain thresholds for these nutrients would require 'high in' warning labels to be displayed on packages, along with other mandatory nutrition information such as the Nutrition Facts table and the Ingredients List. However, many of these same products may concurrently display nutrition claims, if a product qualifies for one or more regulated nutrition claims. Under the proposed system, consumers would likely find food labels with conflicting information: positive nutrients or components will be highlighted by nutrition claims and negative nutrients would be emphasized by FOP labels on the same product.

Few studies have investigated the impact of FOP labelling and nutrition claims on consumers' perceptions of the healthfulness (i.e., nutritional quality) or purchase intentions of such products (Arrúa, Curutchet, et al., 2017; Maubach, Hoek, & Mather, 2014; McLean, Hoek, & Hedderley, 2012; Talati et al., 2016) and limited evidence is currently available on whether the effect of FOP labels and nutrition claims equally applies to healthier and less healthy foods (Talati et al., 2016). Among these studies, health star rating and traffic light labelling were the FOP labels most often evaluated together with claims (Maubach et al., 2014; McLean et al., 2012; Talati et al., 2016) and two studies have assessed 'high-in' warning labels in conjunction with claims (Acton & Hammond, 2018; Arrúa, Curutchet, et al., 2017). In addition, little is known whether consumers use the Nutrition Facts table to make their decisions, regardless of the presence of FOP labels or nutrition claims and if so, how Nutrition Facts table use could affect these decisions. Thus, the primary objective of this study was to examine the influence of different FOP labelling symbols (warning labels, health star rating and traffic light labelling) and nutrition claims (nutrient content claims and disease risk reduction claims) on consumers' perceptions of product healthfulness and purchase intentions of healthier and less healthy drinks, when presented together on a label. Secondary objectives were to determine differences on consumers' perceptions between those who use the Nutrition Facts table compared to those who do not, and participants' level of health literacy.

2. Methods

2.1. Study design and participants

This study was the third experimental task of a larger randomized-controlled online survey that investigated the efficacy of different FOP labels on food packages (#NCT03290118). The study was approved by University of Toronto Human Research Ethics board (Protocol ID 34393). An online consumer survey was conducted over a period of 3 weeks between September and October of 2017, after the first online public front-of-pack consultation held by Health Canada (November 2016 and January 2017). The sampling frame was set up to be nationally representative in terms of gender, age and province, based on 2011 census data, but because of other inclusion criteria (e.g., shopping habits, smartphone ownership) the final sample was not completely representative (i.e., participants were approximately 2 years younger than the median Canadian population, greater proportion of participants with college or university education). Participants were recruited from an active panel of over 400,000 Canadians maintained by a professional marketing company. All communication took place via the marketing company and participants' name and contact information were not provided to the research team. Participants were eligible to take part in the survey if they were 18 years or older and provided informed consent, spoke English as their primary language, resided in any province of Canada (the Northern Territories were excluded), did at least some of the household grocery shopping, owned a smartphone (version iPhone 3 or later or Android), and were able to complete the survey on a minimum 9.7in screen size device. Participants were invited via e-mail and remunerated $10 or the equivalent in Air Miles® (through the marketing company), once the survey was completed. A total of 2008 participants finished the survey; however, 11 participants were removed from the sample due to poor data quality. Criteria to identify poor data quality included if the respondent answered *Don't know* to the three main experimental tasks in the survey or if the respondent answered *Don't know* to three or more of five questions considered by the research team to be variables that are not typically sensitive for participants to report. Socio-demographic information including gender, age, household composition, education, household income and ethnicity, was also collected (self-reported). In addition, participants completed the Newest Vital Sign questionnaire, which is a six-question survey that measures level of health literacy. In this test, subjects are shown a Nutrition Facts table and questions that require them to interpret textual and numerical information (Weiss et al., 2005). The Newest Vital Sign has been adapted and validated for use in the Canadian population (Mansfield, Wahba, Gillis, Weiss, & L'Abbé, 2018). Participants were categorized as *likely low health literacy* (score 0–1), *possible low health literacy* (score 2–3), or *adequate health literacy* (score 4–6). Detailed information about the original test and the Canadian adaptation can be found elsewhere (Mansfield et al., 2018; Weiss et al., 2005). Before starting the online survey but after randomization, participants were asked to download and use a smartphone application, the FoodFlip© app, which is an app that provides nutrition information using different labelling formats (Nutrition Facts table, warning labels, health star rating or traffic light labelling). Once

Fig. 1. Fictitious label brands created for the survey.

participants completed the app task, they proceeded to the survey. Results for the app task will be described in a separate paper.

2.2. Experimental conditions

Mock labels of a juice-type drink were produced by a professional graphic design company based on similar Canadian food products, previously identified in the Food Label Information Program 2013. This database contains label information (e.g., Nutrition Facts table, Ingredients List, nutrition claims, photographs) of over 45,000 products (Bernstein, Schermel, Mills, & L'Abbe, 2016; Schermel, Emrich, Arcand, Wong, & L'Abbé, 2013). Such products were used as a source for product design, Nutrition Facts table information and nutrition claims. Four fictitious brands were created and were used in a randomized order in each of the four repetitions participants were exposed to in the evaluation tasks, in order to minimize the effect of branding (Fig. 1).

Product healthfulness, FOP labelling symbols and nutrition claims were manipulated across the images. Healthier and less healthy drinks were classified using the Food Standards Australia New Zealand Nutrient Profiling Scoring Criterion (FSANZ-NPSC) (Implementation Subcommittee for Food Regulation, 2014). This nutrient profiling system uses an algorithm that calculates a summary score based on each product's nutritional composition. A product gains points for nutrients to limit (calories, sodium, sugars and saturated fats) and points are deducted for nutrients to encourage (protein, fibre and fruit/vegetable/nuts and seeds/legume content). Products then are classified as "healthier" if they have an overall score of < 1 for beverages, < 28 cheese with calcium content of more than 320 mg/100 g and fats (e.g., oil, butter), and < 4 for the rest of foods. Otherwise products are considered as "less healthy"(Australia New Zealand Food Standards Code, 2013; Implementation Subcommittee for Food Regulation, 2014).

Three types of FOP labelling symbols were tested: warning labels, health star rating and traffic light labelling. A control condition (No FOP) was also included in the experimental design. The warning label condition was chosen since this is the type of FOP labelling scheme proposed by Health Canada (Government of Canada, 2018), although the final design has yet to be published. The warning labels were modelled after a similar system implemented in Chile (Government of Chile - Ministry of Health, 2012) and examples considered in the 2016 Health Canada's consultation document (Health Canada, 2016). The health star rating and traffic light labelling were also chosen since these two types of FOP labelling systems have been already voluntarily implemented in some countries and they are the FOP labelling systems most widely evaluated (De la Cruz-Góngora et al., 2017; Dunford, Poti, Xavier, Webster, & Taillie, 2017; Ni Mhurchu et al., 2017). Guideline Daily Amount or 'facts up front' labels were not selected as they do not interpret the nutrition information for consumers and have been reported to be the least effective FOP labelling system in guiding consumers towards healthier choices (De la Cruz-Góngora et al., 2017; Ducrot et al., 2016; Roberto et al., 2012). Nutrition information of comparable products in the Food Label Information Program was used to determine if the products would carry or not carry a warning label, the number of the stars in the health star rating condition and the colors of the traffic light labelling for healthier and less healthy drinks, respectively. Cut offs for the warning label were determine using Health Canada's proposal (Health Canada, 2016), the Australia New Zealand Health Star Rating system for the health star rating labels (Food Standards Australia New Zealand, 2014) and the United Kingdom Department of Health technical guidance for pre-packed products for the traffic light labelling (United Kingdom Department of Health, 2013) (Fig. 2 presents a summary of the experimental elements and treatment groups used in the survey, see Supplementary Table 1 for details on the cut offs).

Two types of nutrition claims were selected: a nutrient content claim ('Excellent source of vitamins A & C') and a disease risk reduction claim ('A healthy diet rich in a variety of vegetables and fruit may help reduce the risk of heart disease'). Nutrient content claims are the most commonly type of claim used on food labels in the Canadian food supply, particularly claims those related to vitamins and minerals (Franco-Arellano, Bernstein, Norsen, Schermel, & L'Abbé, 2017).

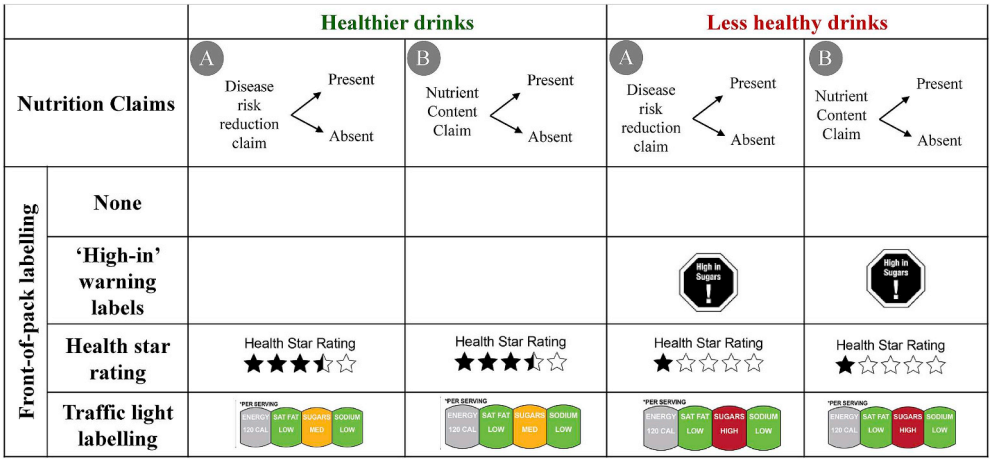

Fig. 2. Summary of the experimental elements created for the survey.[1].

[1]The following wording was used for each claim: Disease risk reduction claims: "A healthy diet rich in a variety of vegetables and fruit may help reduce the risk of heart disease"; Nutrient content claim: "Excellent source of vitamins A & C".

Although they little used in Canada, a disease risk reduction claim was chosen as earlier research has shown that products with this type of claims were perceived healthier than products with nutrient content claims among Canadians (Wong et al., 2013; Wong et al., 2014). In addition, limited data exist worldwide about the influence of disease risk reduction claims on consumers' knowledge, attitudes and perceptions, especially alongside FOP labels (Maubach et al., 2014; Talati et al., 2016). Thus, including a disease risk reduction claim in the study design can also generate data to inform the use of disease risk reduction claims among consumers. While it is unlikely that many fruit-type drinks would display disease risk reduction claims (as the use of such claim on fruit-type beverages would not be compliant with Canadian regulations), the claim was included in order to study the effects of both types of nutrition claims, in both healthier and less healthy products. To minimize the effect of the label design, FOP labels and nutrition claims were placed in the same location on each package and had similar font size and symbol size. It is important to highlight that the label design for the control and the warning label in healthier drinks was the same, as the healthier drink would not carry a warning label (See Supplementary Fig. 1 for an example of a label with each experimental element).

2.3. Experimental procedures

Participants were randomized to be in one of the FOP conditions in a 1:1:1:1 ratio (control, warning label, health star rating, traffic light labelling), which was maintained throughout the survey. Participants within each FOP condition were randomly shown four mock labels, one by one. Each time a mock label was shown, a different brand was also randomly displayed (Fig. 1) to avoid having a participant see the same brand with a different healthfulness or claim. Each mock label showed the following content, also randomly shown (Fig. 2):

- A healthier drink with either a disease risk reduction claim (i.e., present) or without a disease risk reduction claim (i.e., absent)
- A healthier drink with either a nutrient content claim (i.e., present) or without a nutrient content claim (i.e., absent)
- A less healthy drink with either disease risk reduction claim (i.e., present) or without a disease risk reduction claim (i.e., absent)
- A less healthy drink with either a nutrient content claim (i.e., present) or without a nutrient content claim (i.e., absent)

In each of the four repetitions, participants were asked to rate the perceived healthfulness of each drink (‘*How healthy do you think this product is?*‘) using a 7-point Likert scale where 1 = ‘Not at all healthy’ and 7 = ‘Very healthy’. Participants were also asked to rate purchase intentions (‘*How likely would you be to buy this product?*‘) using the 7-point Likert scale (1 = ‘Not likely’ at all, 7 = ‘Very likely’). For both questions, ‘Don't know’ and ‘Refuse’ options were also available. Participants were given the option to access the Nutrition Facts table while viewing the labels by clicking a hyperlink (in blue) at the bottom of the screen, below the mock label. The nutritional content of the Nutrition Facts table was modified according to the healthfulness of the drink (healthier, less healthy). In order to have power (0.80) to detect an effect size of 0.5 in the 7-point Likert scale (significance level of 0.05 two-sided and standard deviation of 1.95) and due the number of elements tested (healthfulness, disease risk reduction claim, nutrient content claim), eight independent questions were required to be answered by each participant within each FOP condition (four for product healthfulness and four for purchase intentions). The sample size estimated to conduct the analyses was 239 for each experimental group, pooled from the four questions for product healthfulness and four for purchase intentions mentioned above. The CONSORT diagram and checklist are in Supplementary Fig. 2 and Supplementary Table 2.

2.4. Statistical analyses

Generalized linear mixed analyses (GENLINMIXED, SPSS version 25) were used to account for repeated measures derived from the four questions responded by each participant. Perceived product healthfulness and purchase intentions were entered in the models as outcomes, while nutrition claims (disease risk reduction claim [presence or absence], nutrient content claim [presence or absence]) and FOP labelling (control, warning label, health star rating and traffic light labelling) were entered as effects. Pairwise comparisons among the four FOP labelling conditions were also tested. Additionally, an interaction term was tested between claims (disease risk reduction claim, nutrient content claim) and FOP labelling. Brand, gender, education, income, ethnicity and health literacy were entered in each model as covariates in the main analysis. Secondary analyses were conducted to determine differences among participants who clicked on the Nutrition Facts table compared to those that did not by conducting generalized linear mixed analyses stratified by Nutrition Facts table use. We also graphically assessed perceived product nutritional quality and healthy literacy by type of FOP label. Significant difference was set at $p < 0.01$ with Bonferroni adjustments for multiple comparisons.

3. Results

Demographic information from 1997 participants were included in the present study (Table 1). There were no significant differences among treatment groups, but income.

3.1. Effect of FOP labels and nutrition claims

The influence of FOP condition on perceived product's healthfulness was significantly different among all conditions ($p < 0.001$ in all cases); however, the direction of the influence differed between healthier and less healthy drinks (Fig. 3, Supplementary Table 3). In healthier drinks, irrespective of carrying a disease risk reduction claim or an nutrient content claim, products with health star rating and traffic light labelling were perceived as *healthier* than the control (pairwise comparisons vs the control, both $p < 0.001$) and the warning label condition, which did not carry any symbol (pairwise comparisons vs ‘high in’ warning labels, both $p < 0.001$). Health star rating and traffic light labelling were not significantly different from each other ($p = 0.509$) (Fig. 3a). In less healthy drinks, the three different FOP labelling systems had a significant influence on reducing consumers' perception of product healthfulness compared to the control (Fig. 3b). The health star rating had the greatest effect on decreasing consumers' perception of product healthfulness in less healthy drinks compared to the control ($p < 0.001$), followed by the warning label ($p < 0.001$) and traffic light labelling ($p = 0.009$). The similar pattern was seen in purchase intentions: in healthier drinks, health star rating and traffic light labelling showed a strong trend towards increased purchase intentions compared to the control ($p = 0.011$ and $p = 0.020$, respectively) although it did not reach statistical significance. The warning label showed a trend towards reducing purchase intentions compared to the control ($p = 0.020$). There was a statistical difference between the warning label and health star rating ($p < 0.001$) and the warning label and traffic light labelling ($p < 0.001$) (Fig. 3c). In less healthy drinks, all FOP symbols reduced purchase intentions compared to the control. The health star rating drove the most negative perception ($p \leq 0.001$), followed by warning label and traffic light labelling (both, $p < 0.001$ vs the control). There was no significant difference between the warning label and traffic light labelling ($p = 0.082$) (Fig. 3d).

The influence of regulated nutrition claims on perceived product's healthfulness differed by the type of nutrition claim presented, regardless of the FOP condition. Drinks with a disease risk reduction claim were perceived as significantly *healthier* compared to the same drink without a disease risk reduction claim in both the healthier drink

Table 1
Demographic information of participants included in the final analyses (n = 1997).

Demographic variables	All (n = 1997)	Control (n = 498)	'High in' warning labels (n = 501)	Health star rating (n = 499)	Traffic light labelling (n = 499)	Chi-square
Age (years)	**n (%)**	**n (%)**	**n (%)**	**n (%)**	**n (%)**	**p-value**
18–25	256 (12.8)	55 (11.0)	64 (12.8)	60 (12.0)	77 (15.4)	*0.56*
26–35	652 (32.6)	167 (33.5)	165 (32.9)	161 (32.3)	159 (31.9)	
36–45	493 (24.7)	133 (26.7)	125 (25.0)	126 (25.3)	109 (21.8)	
46–55	359 (18.0)	83 (16.7)	96 (19.2)	91 (18.2)	89 (17.8)	
55–65	176 (8.8)	46 (9.2)	39 (7.8)	44 (8.8)	47 (9.4)	
66 +	61 (3.1)	14 (2.8)	12 (2.4)	17 (3.4)	18 (3.6)	
Refused	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
Gender						
Male	957 (47.9)	258 (51.8)	233 (46.5)	235 (47.1)	231 (46.3)	*0.53*
Female	1037 (51.9)	239 (48.0)	267 (53.3)	264 (52.9)	267 (53.5)	
Another	3 (0.2)	1 (0.2)	1 (0.2)	0 (0)	1 (0.2)	
Education						
Did not graduate high school	36 (1.8)	11 (2.2)	6 (1.2)	7 (1.4)	12 (2.4)	*0.66*
High school graduation certificate or equivalent	324 (16.2)	71(14.3)	82 (16.4)	88 (17.6)	83 (16.6)	
Trades certificate or diploma	99 (4.9)	24 (4.8)	30 (6.0)	21 (4.2)	24 (4.8)	
Community college, technical college, or CEGEP	511 (25.6)	125 (25.1)	126 (25.1)	131 (39.1)	129 (25.9)	
University (undergraduate degree)	762 (38.2)	194 (39.0)	198 (39.5)	195 (39.1)	175 (35.1)	
Post-graduate degree (Master, PhD)	259 (13)	71 (14.3)	58 (11.6)	56 (11.2)	74 (14.8)	
Not stated	6 (0.3)	2 (0.4)	1 (0.2)	1 (0.2)	2 (0.4)	
Ethnicity						
White	1375 (68.9)	348 (69.9)	326 (69.1)	325 (65.1)	356 (71.3)	*0.08*
Non-white	589 (29.5)	140 (28.1)	147 (29.3)	161 (32.3)	141 (28.3)	
Not stated	33 (1.7)	10 (2)	8 (1.6)	13 (2.6)	2 (0.4)	
Household income						
$25,000 or less	169 (8.5)	49 (9.8)	38 (7.6)	31 (6.2)	51 (10.2)	*0.005*
$25,000$49,999	373 (18.7)	92 (18.5)	97 (19.4)	98 (19.6)	86 (17.2)	
$50,000-$74,999	409 (20.5)	92 (18.5)	96 (19.2)	106 (21.2)	115 (23.0)	
$75,000-$99,999	338 (16.9)	70 (14.1)	88 (17.6)	109 (21.8)	71 (14.2)	
$100,000-$124,999	274 (13.7)	80 (16.1)	74 (14.8)	51 (10.2)	69 (13.8)	
$125,000 or more	288 (14.4)	86 (17.3)	63 (12.6)	71 (14.2)	68 (13.6)	
Not stated	146 (7.3)	29 (5.8)	45 (9.0)	33 (6.6)	39 (7.8)	
Language primarily spoken at home						
English	1830 (91.6)	452 (90.8)	471 (94.0)	455 (91.2)	452 (90.6)	*0.14*
French	44 (2.2)	6 (1.2)	11 (2.2)	17 (3.4)	10 (2.0)	
Other	118 (5.9)	37 (7.4)	18 (3.6)	27 (5.4)	36 (7.2)	
Not stated	5 (0.3)	3 (0.6)	1 (0.2)	0 (0)	1 (0.2)	
Dependent children (< 18 years)						
Yes	758 (38)	204 (41.0)	186 (37.1)	193 (38.7)	175 (35.1)	*0.25*
No	1229 (61.5)	290 (58.2)	315 (62.9)	303 (60.7)	321 (64.3)	
Not stated	10 (0.5)	4 (0.8)	0 (0)	3 (0.6)	3 (0.6)	
Health literacy[a]						
Likely low health literacy	202 (10.1)	50 (10.0)	55 (11.0)	45 (9.0)	52 (10.4)	*0.25*
Possible low health literacy	263 (13.2)	74 (14.9)	51 (10.2)	76 (15.2)	62 (12.4)	
Adequate health literacy	1528 (76.5)	373 (74.9)	394 (74.9)	377 (75.6)	384 (77.0)	
Missing	4 (0.2)	1 (0.2)	1 (0.2)	1 (0.2)	1 (0.2)	
BMI %						
Underweight	60 (3.0)	11 (2.2)	11 (2.2)	25 (5.0)	13 (2.6)	*0.09*
Normal weight	773 (38.7)	185 (37.1)	184 (38.7)	201 (40.3)	193 (38.7)	
Overweight	566 (28.3)	154 (30.9)	140 (27.9)	140 (28.1)	132 (26.5)	
Obese	470 (23.5)	118 (23.7)	123 (24.6)	101 (20.2)	128 (25/7)	
Not stated	128 (6.4)	30 (6.0)	33 (6.6)	32 (6.4)	33 (6.6)	
Province %						
British Columbia	332 (16.6)	77 (15.5)	80 (16.0)	104 (20.8)	7(14.2)	*0.08*
Alberta	273 (13.7)	67 (13.5)	68 (13.6)	71 (14.2)	67 (13.4)	
Saskatchewan	69 (3.5)	16 (3.2)	21 (4.2)	17 (3.4)	15 (3.0)	
Manitoba	90 (4.5)	15 (3.0)	25 (5.0)	23 (4.6)	27 (5.4)	
Ontario	964 (48.3)	254 (51.0)	244 (48.7)	211 (42.3)	255 (51.1)	
Quebec	93 (4.7)	22 (4.4)	20 (4.0)	22 (4.4)	29 (5.8)	
Newfoundland/Labrador	37 (1.9)	8 (1.6)	14 (2.8)	7 (1.4)	8 (1.6)	
Nova Scotia	70 (3.5)	24 (4.8)	12 (2.4)	19 (3.8)	15 (3.0)	
New Brunswick	59 (3.0)	13 (2.6)	17 (3.4)	20 (4.0)	9 (1.8)	
Prince Edward Island	10 (0.5)	2 (0.4)	0 (0)	5 (1.0)	3 (0.6)	

[a] Assessed with the Canadian adaptation of the Newest Vital Sign questionnaire (Mansfield et al., 2018; Weiss et al., 2005).

and the less healthy drink (p = 0.004 and p = 0.032, respectively). No significant differences on product's perceived healthfulness were found between drinks carrying a nutrient content claim in both healthier or less healthy drinks (Fig. 3e and f). The influence of both type of claims (disease risk reduction claim, nutrient content claim) on purchase intentions was not statistically different for a healthier (Fig. 3g, p = 0.136 and p = 0.298, respectively) and less healthy drinks (Fig. 3h, p = 0.944 and p = 0.751, respectively). Only one interaction (out of eight) was found between the presence of a nutrient content claim and FOP symbols in the healthier drink on purchase intentions

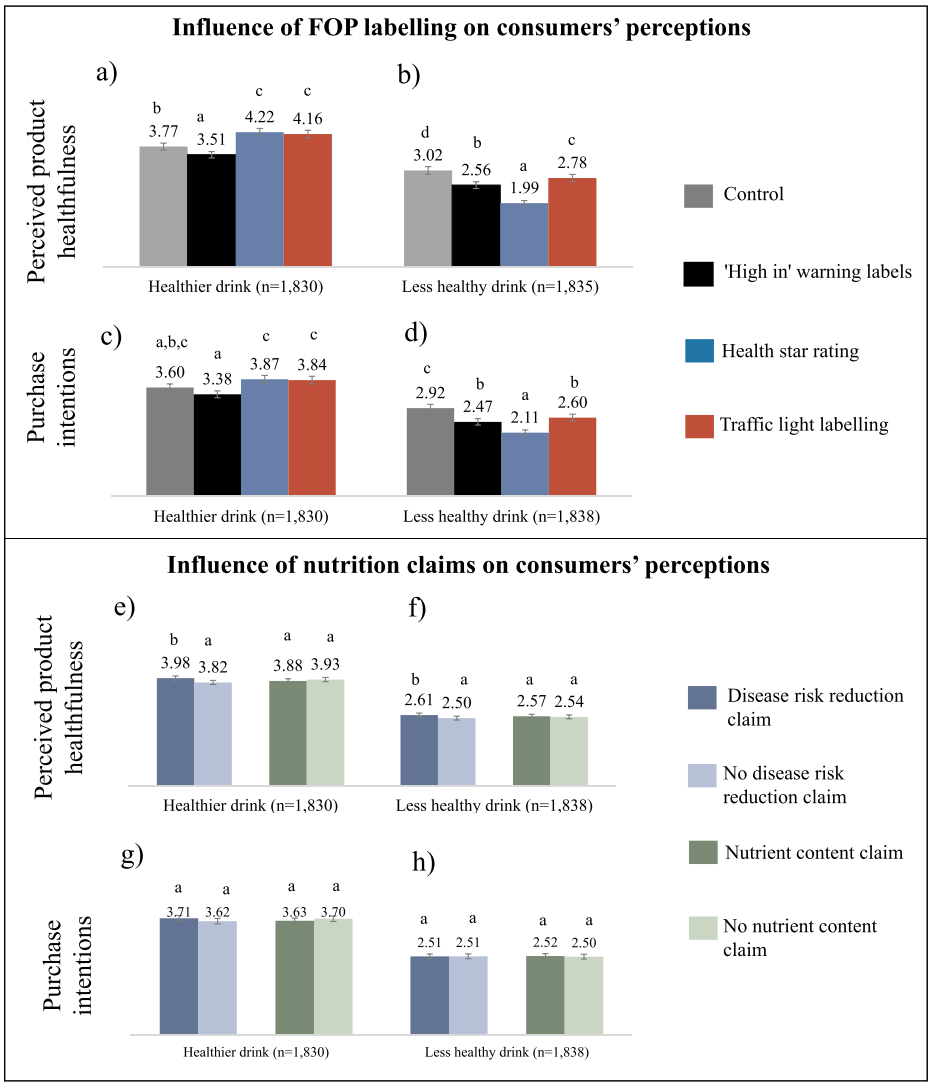

Fig. 3. Means of main effects for FOP labelling and nutrition claims on consumer perception of product healthfulness and purchase intentions (n = 1997)[1,2,3,4]. [1] Adjusted for juice-type drink brand, gender, education, income, ethnicity and health literacy. [2] Healthier and less healthy drinks were determined using the Food Standards Australia New Zealand Nutrient Profiling Scoring Criterion. [3]Error bars show the standard error of the mean (SEM). [4]Bars with different superscripts were significantly different, which was set at $p < 0.01$ with Bonferroni adjustments for multiple comparisons.

($p = 0.003$, Supplementary Table 3).

3.2. Secondary analyses

3.2.1. Use of Nutrition Facts table

Results showed that the majority of participants made their product judgment based solely on the information provided on the front of the label. Less than 30% of participants clicked on the Nutrition Facts table link when asked about perceived product healthfulness and far fewer ($n < 50$) clicked on the Nutrition Facts table when asked about purchase intentions. Therefore, detailed analyses related to the Nutrition Facts table use were limited to perceived product healthfulness (Table 2).

We found that the effect of FOP labelling and claims was different between Nutrition Facts table users and non-users. When participants did not click on the Nutrition Facts table, we found that the effect of the FOP symbols was significantly different in both healthier and less healthy drinks, regardless of whether the product carried or not a disease risk reduction claim or a nutrient content claim (all cases, $p < 0.001$). For example, participants in the control condition rated healthier drinks (Table 2a, Mean = 3.48, 95% CI = 3.31–3.65) and less healthy drinks (Table 2c, Mean = 3.45, 95% CI = 3.4–3.68) similarly, irrespective of whether or not the drink carried a disease risk reduction claim. Meanwhile, participants in the warning label rated healthier drinks (Table 2a, Mean = 3.17, 95% CI = 3.02–3.32) *healthier* than less healthy drinks (Table 2c, Mean = 2.71, 95% CI = 2.54–2.89), as did participants in the health star rating or traffic light labelling conditions, suggesting they were likely influenced by the FOP symbol. Data from participants who clicked on the Nutrition Facts table, showed that the effect of the FOP symbol was not significantly different for healthier drinks, regardless of whether the product carried a disease risk reduction claim (Table 2b, $p = 0.969$) or a nutrient content claim (Table 2f, $p = 0.797$). However, the effect of FOP labelling was significantly different if the product had a less healthy profile, regardless the presence of claims (Table 2d, $p = 0.002$; Table 2h, $p = 0.006$), which was mainly driven by the health star rating condition. Only one interaction between FOP labels and nutrition claim was found in participants who clicked at the Nutrition Facts table while evaluating less healthy drinks with or without nutrient content claims (Table 2h, $p < 0.001$).

Consistent with the overall results, the effect of a disease risk reduction claim was significantly different for healthier and less healthy drinks when participants did not click at the Nutrition Facts table

Table 2
Means of main effects (95% CI) and interaction for FOP labels and nutrition claims on perceived product healthfulness stratified by participants who clicked on the Nutrition Facts table (n = 1997)[a].

Clicked at the Nutrition Facts table while viewing products with/without a disease risk reduction claim	Healthier drink[b]		Less healthy drink[b]	
Nutrition Facts table	**a) Non-users (n = 1,297)**	**b) Users (n = 533)**	**c) Non-users (n = 1,316)**	**d) Users (n = 519)**
	71%	**29%**	**72%**	**28%**
Disease risk reduction claim	$F(1, 2556) = 8.384$, p-value = 0.004	$F(1, 1045) = 3.270$, p-value = 0.071	$F(1, 2596) = 6.562$, p-value = 0.010	$F(1, 1016) = 0.143$, p-value = 0.705
Presence	3.85 (3.73-3.97)	4.22 (4.02-4.44)	2.85 (2.73-2.97)	2.08 (1.92-2.26)
Absence	3.65 (3.53-3.78)	4.03 (3.88-4.22)	2.68 (2.57-2.80)	2.05 (1.89-2.17)
Front-of-Pack symbols	$F(3, 2556) = 66.757$, p-value < 0.001	$F(3, 1045) = 0.084$, p-value = 0.969	$F(3, 2596) = 85.437$, p-value < 0.001	$F(3, 1016) = 5.089$, p-value = 0.002
Control	3.48 (3.31-3.65)	4.12 (3.90-4.35)	3.45 (3.4-3.68)	2.21 (2.01-2.44)
High in' warning labels	3.17 (3.02-3.32)	4.12 (3.88-4.38)	2.71 (2.54-2.89)	2.23 (2.02-2.47)
Health star rating	4.25 (4.06-4.43)	4.17 (3.90-4.47)	2.08 (1.96-2.20)	1.81 (1.60-2.04)
Traffic light labelling	4.22 (4.04-4.40)	4.09 (3.79-4.42)	3.00 (2.83-2.17)	2.03 (1.77-2.32)
	Front-of-Pack symbols pairwise comparisons			
Control - 'High in' warning labels	p-value = 0.001	p-value = 1	p-value < 0.001	p-value = 0.873
Control - Health star rating	p-value < 0.001	p-value = 1	p-value < 0.001	p-value = 0.003
Control - Traffic light labelling	p-value < 0.001	p-value = 1	p-value < 0.001	p-value = 0.433
High in' warning labels - Health star rating	p-value < 0.001	p-value = 1	p-value < 0.001	p-value = 0.003
High in' warning labels - Traffic light labelling	p-value < 0.001	p-value = 1	p-value = 0.002	p-value = 0.433
Health star rating - Traffic light labelling	p-value = 0.789	p-value = 1	p-value < 0.001	p-value = 0.433
	Front-of-Pack X claim interactions			
FOP X Disease risk reduction claim	p-value = 0.053	p-value = 0.150	p-value = 0.053	p-value = 0.013
Clicked at the Nutrition Facts table while viewing products with/without a nutrient content claim	**Healthier drink[b]**		**Less healthy drink[b]**	
Nutrition Facts table	**e) Non-users (n = 1,308)**	**f) Users (n = 522)**	**g) Non-users (n = 1,333)**	**h) Users (n = 502)**
	71%	**29%**	**73%**	**27%**
Nutrient content claim	$F(1, 2578) = 0.005$, p-value = 0.943	$F(1, 1023) = 1.046$, p-value = 0.307	$F(1, 2630) = 0.558$, p-value = 0.455	$F(1, 982) = 0.656$, p-value = 0.418
Presence	3.72 (3.60-3.84)	4.17 (3.99-4.36)	2.78 (2.66-2.90)	2.11 (1.95-2.27)
Absence	3.72 (3.60-3.84)	4.27 (4.10-4.46)	2.73 (2.62-2.85)	2.03 (1.86-2.11)
Front-of-Pack symbols	$F(3, 2578) = 68.338$, p-value < 0.001	$F(3,1023) = 0.339$, p-value = 0.797	$F(3, 2630) = 84.388$, p-value < 0.001	$F(3, 982) = 4.184$, p-value = 0.006
Control	3.45 (3.32-3.67)	4.15 (3.94-3.37)	3.42 (3.21-3.65)	2.25 (2.06-2.48)
High in' warning labels	3.11 (2.96-3.26)	4.26 (4.02-4.52)	2.71 (2.55-2.89)	2.20 (1.98-2.44)
Health star rating	4.24 (4.05-4.43)	4.21 (3.94-4.46)	2.07 (1.95-2.19)	1.85 (1.67-2.09)
Traffic light labelling	4.17 (3.99-4.35)	4.26 (3.97-4.58)	3.00 (2.84-2.18)	1.98 (1.75-2.28)
	Front-of-Pack symbols pairwise comparisons			
Control - 'High in' warning labels	p-value < 0.001	p-value = 1	p-value < 0.001	p-value = 0.633
Control - Health star rating	p-value < 0.001	p-value = 1	p-value < 0.001	p-value = 0.007
Control - Traffic light labelling	p-value < 0.001	p-value = 1	p-value < 0.001	p-value = 0.214
High in' warning labels - Health star rating	p-value < 0.001	p-value = 1	p-value < 0.001	p-value = 0.032
High in' warning labels - Traffic light labelling	p-value < 0.001	p-value = 1	p-value = 0.002	p-value = 0.429
Health star rating - Traffic light labelling	p-value = 0.501	p-value = 1	p-value < 0.001	p-value = 0.573
	Front-of-Pack X claim interactions			
FOP X Nutrient content claim	p-value = 0.911	p-value = 0.842	p-value = 0.785	p-value < 0.001

Significant difference was set at p < 0.01 with Bonferroni adjustments for multiple comparisons. 95% CI – 95% Confidence Intervals.
[a] Adjusted for juice-type drink brand, gender, education, income ethnicity and health literacy.
[b] Healthier and less healthy drinks were determined using the Food Standards Australia New Zealand Nutrient Profiling Scoring Criterion.

(Table 2a, p = 0.004 and Table 2c, p = 0.010, respectively), but not for Nutrition Facts table users (Table 2b, p = 0.071 and Table 2d, p = 0.705, respectively for healthier and less healthy drinks). The presence of a nutrient content claim did not have a significant difference between Nutrition Facts table users and non-users in both healthier or less healthy drinks.

3.2.2. Effects of health literacy

Secondary analyses were conducted to determine the extent of the effect of health literacy on perceived product healthfulness, by type of FOP label. Fig. 4 shows that overall participants with likely or possible low health literacy tended to rate products *healthier* compared to those with adequate health literacy. Among those with adequate health literacy, the warning label appears to be the system that better helps reduce perceived nutritional quality, followed by the health star rating.

4. Discussion

This study assessed the influence of three different FOP labelling systems (warning label, health star rating, traffic light labelling) that

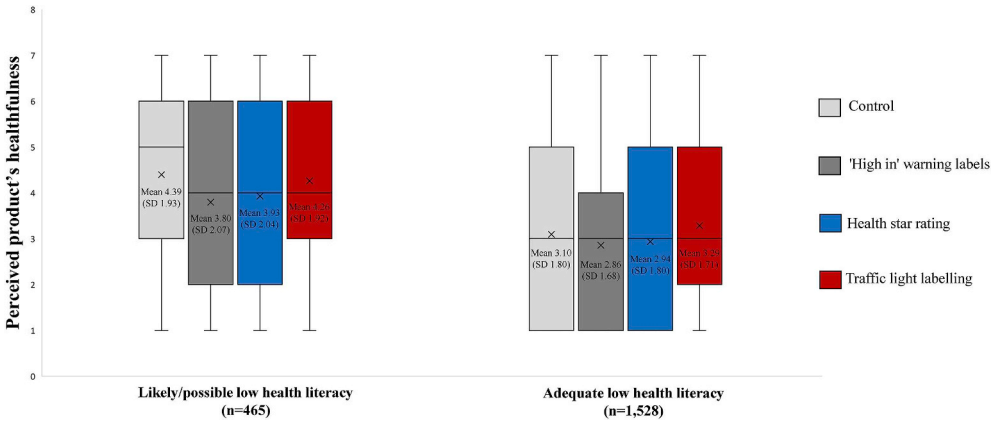

Fig. 4. Perceived product's healthfulness (means and standard deviation) of participants with likely/possible low and adequate health literacy by FOP label condition (n = 1997)[1].
[1]Health literacy was assessed with the Newest Vital Sign© questionnaire, which is a six-questions survey that measures the level of health literacy, which has been adapted and validated for use in Canadian population (Mansfield ED, Wahba R, Gillis DE, Weiss BD, L'Abbé M. Canadian adaptation of the Newest Vital Sign©, a health literacy assessment tool. Public Health Nutr 2018:1–8). Participants where categorized as "likely low health literacy" (score 0–1)/ "possible low health literacy" (score 2–3), or "adequate health literacy" (score 4–6). SD – Standard Deviation.

highlight nutrients of public health concern and nutrition claims that highlight positive nutrients, when presented together on the label, on consumers' perception of product healthfulness and purchase intentions in healthy and less healthy drinks.

Overall results support the growing body of evidence that FOP labelling influences consumers' assessment of product healthfulness and, to a less extent, purchase intentions (Egnell et al., 2018; Ikonen, Sotgiu, Aydinli, & Verlegh, 2019; van Herpen, Hieke, & van Trijp, 2013). This study also showed that the performance of each FOP labelling scheme differed by the nutritional quality of the drink (i.e., product's 'healthfulness'). For example, the three FOP symbols significantly reduced the perceived product healthfulness of less healthy drinks compared to the control, with the health star rating the labelling system leading to lower ratings. This finding is consistent with previous research that has indicated consumers are likely to be influenced by 'negative' labelling (Arrúa, Machín, et al., 2017; Scarborough et al., 2015). In contrast, healthier drinks that displayed health star rating and traffic light labelling were perceived as *healthier* than the control, which could be indicative of a 'halo effect' or a 'positive bias' (i.e., when consumers evaluate products more favourably as a result of on-pack nutrition information (Ikonen, Sotgiu, Aydinli, & Verlegh, 2019; Talati et al., 2016). Although the warning label condition in the healthier drink, which did not display a warning label sign, had more negative perceptions than the control, the reasons are unclear. This could be due to an overall more negative perception of foods among those participants who viewed the warning label condition throughout the survey, although this is not supported in other research conducted as part of this study (unpublished). The FOP warning label system uses the absence of a warning to indicate healthfulness, which is the opposite of other systems that acknowledge healthfulness by additional green or yellow lights, or more stars. Nevertheless, it is important to highlight that regulators considering the implementation of any FOP system should also anticipate unintended consequences (e.g., 'halo' effect) that could arise from the use of any FOP labelling system.

Our results also suggest the influence of a nutrition claim was mostly driven by the type of claim presented. A disease risk reduction claims significantly increased perceived product healthfulness in healthier and less healthy drinks, while no such difference was seen with a nutrient content claim. In addition, both types of nutrition claims had null influence on purchase intentions. Previous studies that have evaluated the role of nutrition claims in the presence of FOP labelling in less healthy foods have found that nutrition claims seem to have a limited influence on consumers' perceptions (Talati et al., 2016), which aligns with the results of the present study. Our results are also in line with other findings that have suggested that in the presence of FOP labelling symbols, nutrition claims are less significant predictors of consumers' perceptions not only in less healthy drinks, (Maubach et al., 2014; McLean et al., 2012; Talati et al., 2016), but also in healthier drinks. The lack of interaction between FOP labels and claims suggests that FOP labelling significantly influenced consumers' perceptions of product healthfulness and purchase intentions, regardless of the presence of nutrition claims.

This study also highlights that most participants did not use the Nutrition Facts table in this experimental task to assess the healthfulness of drinks, as less than 30% of participants clicked at the Nutrition Facts table. This result is comparable to other research that found only one-third of young adults were 'frequent' Nutrition Facts table users (Christoph, Larson, Laska, & Neumark-Sztainer, 2018). Thus, these results suggest that most participants evaluated product healthfulness and purchase intentions with the information provided on the front of the label. Overall, those who clicked on the Nutrition Facts table link rated drinks as *less healthy* than those who did not click on the Nutrition Facts table link. Among users, neither type of nutrition claims influenced participants' perception of product healthfulness and purchase intentions, regardless of the products' nutritional quality. Likewise, FOP labelling did not influence those who used the Nutrition Facts table if the product had a healthier nutritional profile. However, FOP labelling likely influenced participants who used the Nutrition Facts table when evaluating less healthy drinks, which supports other research that has indicated that FOP labelling is effective at discouraging consumption of unhealthy foods among the population (Arrúa, Machín, et al., 2017; Corvalán, Reyes, Garmendia, & Uauy, 2013; Moran & Roberto, 2018; Ni Mhurchu et al., 2017; Scarborough et al., 2015). This finding is especially important among those consumers who do not use, or do not understand the Nutrition Fact table (van Kleef & Dagevos, 2015; Wartella, lichtenstein, Yaktine, & Nathan, 2011). While consumers' health literacy can play an important role when assessing the nutritional quality of foods, our results suggest that the use of FOP labelling symbols (and particularly warning labels) could still help consumers to discriminate products with varying nutritional composition, even for those with adequate healthy literacy.

Limitations of this study include the use of an online survey as experimental design, which may not be generalizable to the real-world in-store purchasing setting. However, grocery online shopping is likely to become more common and continue to grow. Therefore, investigating other means of purchasing foods is essential to understand the continuing and evolving food purchasing environment and the effects of nutrition and food policies in this context. Second, we only tested FOP labelling and claims on drinks, which may limit generalization to a broader range of foods. Moreover, this type of beverage could be easily replaced with water. In solid foods, a replacement for a healthier product could be more challenging. Third, we tested healthier and less healthy drinks separately, which limits ranking foods with different nutritional quality. Future studies should include raking of foods with

varying nutritional composition. Fourth, we asked participants to rate products one by one, which may not represent when consumers compare two or more products together at the point of sale. Fifth, although the fictitious label brands were created to resemble products in the marketplace, it is likely that consumers may have preconceived notions about a product's nutritional quality in relation to brands. Healthfulness perceptions have been shown to be impacted by known/familiar brands (Ikonen, Sotgiu, Aydinli, & Verlegh, 2019); however, in our study, we used fictitious label brands in order to better understand our research objective. Last, since this study required the ownership of a smartphone, the sample was not representative of the Canadian population, although 92% of Canadians had access to Long-Term Evolution (LTE)-Advance network services in 2017 (The Canadian Radio-television and Telecommunications Commission (CRTC), 2019).

The strengths of this study included the use of a randomized experimental design with a sample size calculated to have adequate statistical power to detect differences. Another strength included the manipulation of the nutritional quality of the products to identify unintended consequences (i.e., halo effect or positive bias) of the implementation of FOP labelling systems among foods with different nutritional quality. We also tested the differences between participants who clicked (and presumably used) the Nutrition Facts table when evaluating products. Lastly, we examined consumers' perceptions of product healthfulness among participants with varying levels of health literacy.

5. Conclusions

While this study supports the broader literature suggesting that FOP labelling can help consumers when assessing less healthy food products, this study highlights potential differences between different FOP labelling systems when used also to assess healthier food products. Although the three different FOP systems tested (and particularly the health star rating) reduced the perceived healthfulness of less healthy drinks, the health star rating and traffic light labelling created a 'halo' effect in healthier drinks, which can jeopardize reformulation efforts, as companies might include protein/fibre ingredients to improve products' rating rather than reduce sodium, saturated fats and/or sugars. Thus, a warning label system could be an alternative as it performs similarly as the health star rating on less healthy drinks and does not create a halo effect on healthier drinks. In the presence of FOP labelling symbols, nutrition claims were less significant predictors of consumers' perceptions of healthy foods and reinforced the latter in less healthy foods. Most participants used the information that was provided on the front of the labels rather than the information provided on the Nutrition Facts table. FOP labelling was particularly useful when less healthy drinks were evaluated, even among Nutrition Facts table users. FOP labelling was also likely helpful for participants with different levels of health literacy. In the end, FOP labelling could be more useful than nutrition claims for consumers when assessing and purchasing products, particularly among consumers who do not use or understand the Nutrition Facts table.

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Authors' contributions

BFA, LV, MA, AO and ML were involved with the study conception, study design, mock label content and collected data. BFA conducted the research, analyzed the data and wrote the manuscript. LV was involved in the coordination with the marketing company. All authors critically reviewed the manuscript for important intellectual content and approved the final manuscript.

Declaration of competing interest

Prior coming to the University of Toronto Beatriz Franco-Arellano was a PepsiCo Mexico employee. Lana Vanderlee has no conflict of interests. Mavra Ahmed is a Mitacs Elevate Postdoctoral Fellow at the University of Toronto jointly funded by the Government of Canada Mitacs Program and the Nestlé Research Center. None of the previous companies/organizations were involved in any way in the present research. Angela Oh has no conflict of interests. Mary L'Abbé has received other research grants from the Canadian Institutes of Health Research, Canadian Stroke Network, Burroughs Wellcome Fund, Heart and Stroke Foundation of Canada, International Development Research Centre, University of Toronto (unrestricted research funds). The funding sponsors had no role in the design of the study, data collection and analyses, decision to publish, or preparation of the manuscript.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.appet.2020.104629.

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