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Influence of front-of-package nutrition labels on beverage healthiness perceptions: Results from a randomized experiment

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ABSTRACT

The current study explored the influence of three summary indicator front-of-pack (FOP) nutrition labels on consumer perceptions of the healthiness of different beverage products. In 2016, a total of 675 respondents in southwestern Ontario aged 16 and over viewed images of soda, unflavoured milk and chocolate milk displaying one of four FOP label conditions (no FOP label, numeric rating, health star rating (HSR), or simplified traffic light (STL)), and rated the products' healthiness. Participants also indicated their preference for summary indicator versus nutrient-specific FOP labels. Logistic regression models comparing correct responses across label conditions found no differences across label conditions for unflavoured milk or soda. Consumers in the HSR and STL conditions were more likely to correctly perceive a chocolate milk beverage as 'moderately healthy' ($p = 0.004$, $p = 0.016$). No differences in responses were identified across sociodemographic groups. Most respondents (93%) indicated that they would like to see a health rating or nutrient-specific information on the front of food products. Results of this study suggest that the influence of FOP labels may vary based on the nutritional quality of food products, and may have the greatest influence on consumer perceptions of 'nutritionally ambiguous' foods. Consumers indicated almost unanimous support for implementing FOP nutrition labelling systems.

1. Introduction

Poor diet is an important risk factor for numerous chronic diseases (World Health Organization, Food and Agriculture Organization of the United States, 2003). Recent shifts towards predominantly processed and calorie-dense diets have led to increasing rates of overweight and obesity in both high-income countries and low- and middle-income countries (World Health Organization, 2016; Popkin, 2001). In 2014, it was estimated that the global economic impact of obesity was approximately $2.0 trillion per year (McKinsey Global Institute, 2014).

Nutrition labelling is an intervention that has been used to support healthier dietary intakes at the population level (Roberto and Khandpur, 2014). In Canada, as in most other countries, food manufacturers are required to disclose the nutrient information of their foods via tables or panels displayed on the back of their food packages (Government of Canada, 2015). Many consumers report using these nutrition panels (Cowburn and Stockley, 2005; Canadian Council of Food and Nutrition, 2008); however, the nutrition information presented on the back of packages requires a high level of health literacy, and many consumers struggle to interpret the quantitative information, particularly with respect to serving size and percent daily values (Cowburn and Stockley, 2005; Acton et al., 2016; Hobin et al., 2016; Vanderlee et al., 2015).

Simplified 'interpretive' nutrition labels have emerged as an important intervention to complement the quantitative information provided on back-of-package nutrition panels. A range of interpretive front-of-package (FOP) labelling systems have been implemented internationally, most of which can be categorized as either 'nutrient-specific' or 'summary indicator' labelling systems. Nutrient-specific systems display the amounts of specific nutrients, often within the context of other information, such as percent daily values, colour-coded traffic light systems, or interpretive text indicating the recommended frequency of consumption (UK Department of Health, 2016; Freire et al., 2016; Center for Science in the Public Interest, 2015). Nutrient-specific systems typically highlight 'negative' nutrients such as sugar, sodium, or saturated fat, although some systems also highlight 'positive' nutrients such as protein or calcium. In contrast, summary indicator systems assign one overall health rating to products based on

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algorithms that consider the entire nutrient profile of a product. Summary indicators typically communicate the overall dietary quality of products using a single numeric scale (e.g. 1–100), or via three- or five-level star ratings (NuVal, 2017; Australian Government Department of Health and Ageing, 2016; Guiding Stars, 2017; Olstad et al., 2015). Although colour-coded traffic light systems have most commonly been used in nutrient-specific systems, simplified traffic light systems have also been tested for use in summary indicator labels (UK Food Standards Agency, 2004).

An increasing number of countries have implemented, or are developing, FOP labelling systems; however, there is no consensus on whether nutrient-specific or summary indicator systems represent best practice. Summary indicator systems have been implemented in countries such as Australia and New Zealand (the 'Health Star Rating'), while France has developed the 5-Colour Nutri-Score system (Australian Government Department of Health and Ageing, 2016; World Health Organization, 2017). In contrast, countries such as Ecuador, Chile and the UK have opted for nutrient-specific formats, as has Health Canada in their proposed FOP labelling system (UK Department of Health, 2016; Freire et al., 2016; Center for Science in the Public Interest, 2015; Health Canada, 2016).

Several studies have compared the impact of nutrient-specific versus summary indicator labels on consumer perceptions and food choices (Hersey et al., 2013; Hawley et al., 2013; Cecchini and Warin, 2016); however, there is less evidence comparing the relative effectiveness of different summary indicators (Emrich et al., 2014; Méjean et al., 2014; Savoie et al., 2013; Feunekes et al., 2008; Ducrot et al., 2015). Research to date has suggested that summary indicators are generally effective at communicating the healthiness of products to consumers (Watson et al., 2014; Talati et al., 2017), but evidence comparing the relative effectiveness of different summary indicator formats is lacking. In addition, few studies have explored potential differences in consumers' interpretation of FOP labels across different sociodemographic groups such as age, gender or ethnicity.

Although most labelling systems target all packaged food and beverage products, beverages provide a useful canvas for comparing FOP labelling systems across products. Beverage products, particularly sugary drinks, are the focus of much recent public health attention (World Health Organization, 2018; Jones et al., 2017; Centers for Disease Control and Prevention, 2017). Sugary drinks contribute a substantial volume of caloric energy due to their high sugar content; they provide little to no nutritional value and are associated with poorer dietary quality; and they lead to lower feelings of satiety compared to foods, resulting in higher energy intake overall (Malik et al., 2010; Malik et al., 2006). In addition, beverages have simple nutrient profiles relative to foods and are easily recognizable by most consumers regardless of brand or variety, making them a useful product category for comparisons.

The current study sought to investigate the relative impact of three summary indicator formats on consumers' interpretation of the 'healthiness' of beverage products: numeric, star, and simplified traffic light labels. The study also examined potential differences in efficacy across sociodemographic groups, as well as consumer preferences between nutrient-specific and summary indicator labels. Results from this study have the potential to guide and inform labelling policy in jurisdictions that are considering FOP summary indicator systems.

2. Methods

The study was conducted in September and October 2016 as a component of a larger study (Acton and Hammond, 2018). Ethical clearance was received from the Office of Research Ethics at the University of Waterloo. Written consent was obtained from all participants.

2.1. Participants

Participants aged 16 years and older were recruited using convenience sampling in a shopping mall in southwestern Ontario, Canada. Canadian research ethics guidelines do not require parental consent for individuals aged 16 years or older. Other than age, no other exclusion criteria were used in order to provide a heterogeneous sample of consumers. Research assistants approached potential participants to ask whether they were interested in participating in a "study on beverage purchasing", and provided no additional information on the nature of the study's research questions. A total of 686 participants completed the study (452 refusals, 14 incompletes); 11 participants were removed due to data quality concerns (e.g., due to significant cognitive difficulties, visual impairment, or visible influence from peers), resulting in a final analytic sample of 675.

2.2. Protocol

The study consisted of two components: 1) a between-group experiment examining the influence of various summary indicator labels and 2) a question administered after the experiment examining participants' preferences between a summary indicator and a nutrient-specific FOP label.

2.2.1. Summary indicator experiment

Participants were randomly assigned to one of four label conditions: no FOP labelling (control), a numeric rating (1 − 100), a health star rating (0.5–5 stars), or a simplified traffic light symbol (red, yellow, green). The FOP label designs within each condition were developed based on existing and proposed nutrition rating systems. The label design and product scoring of the numeric rating were based on the NuVal shelf price tag labelling system developed in the United States (NuVal, 2017), the health star ratings were based on Australia and New Zealand's Health Star Rating System (Australian Government Department of Health and Ageing, 2016), and the traffic light symbol was designed based on a simplified version of the traffic light system used in the United Kingdom (UK Department of Health, 2016; UK Food Standards Agency, 2004). All three rating systems take into account the broad nutritional profile and consider both positive and negative nutrients of a food or beverage product when assigning scores.

Within their assigned label condition, participants were shown three beverages: a 473 mL carton of Neilson unflavored 2% milk ('healthy'), a 473 mL carton of Neilson 1% chocolate milk ('moderately healthy'), and a 591 mL bottle of generic soda ('unhealthy'), all of which displayed the FOP label corresponding to the label condition that the participant was assigned to. The generic brand of soda was created for the current study to eliminate any pre-existing brand perceptions; the Neilson brand was selected for the milk products due to the brand's high availability in the region, and because there is little variation in the nutrient profiles across other brands of unflavoured and chocolate milks. The order in which the three beverages were presented to participants was randomized. Participants viewed the 'front' of each product, as well as an image of the 'back' of each product, which featured the Nutrition Facts table (NFt), required on all pre-packaged foods in Canada. Therefore, participants were presented with information on specific nutrient amounts for each product. Nutrient profiles reflected those of commercially available products for Neilson brand 2% unflavoured milk and 1% chocolate milk. The generic soda beverage was assigned a nutrient profile reflecting that of a regular/non-diet lemon-lime sports drink (Gatorade brand); this lower sugar profile was selected to ensure that the sugar content was not overly obvious to respondents. Images of the beverages with each label condition and their corresponding NFts are provided in Fig. 1.

Participants rated each of the three beverages using the same measure: "Would you consider this product to be…", with the response options 'unhealthy', 'moderately healthy' and 'healthy'. 'Don't know'

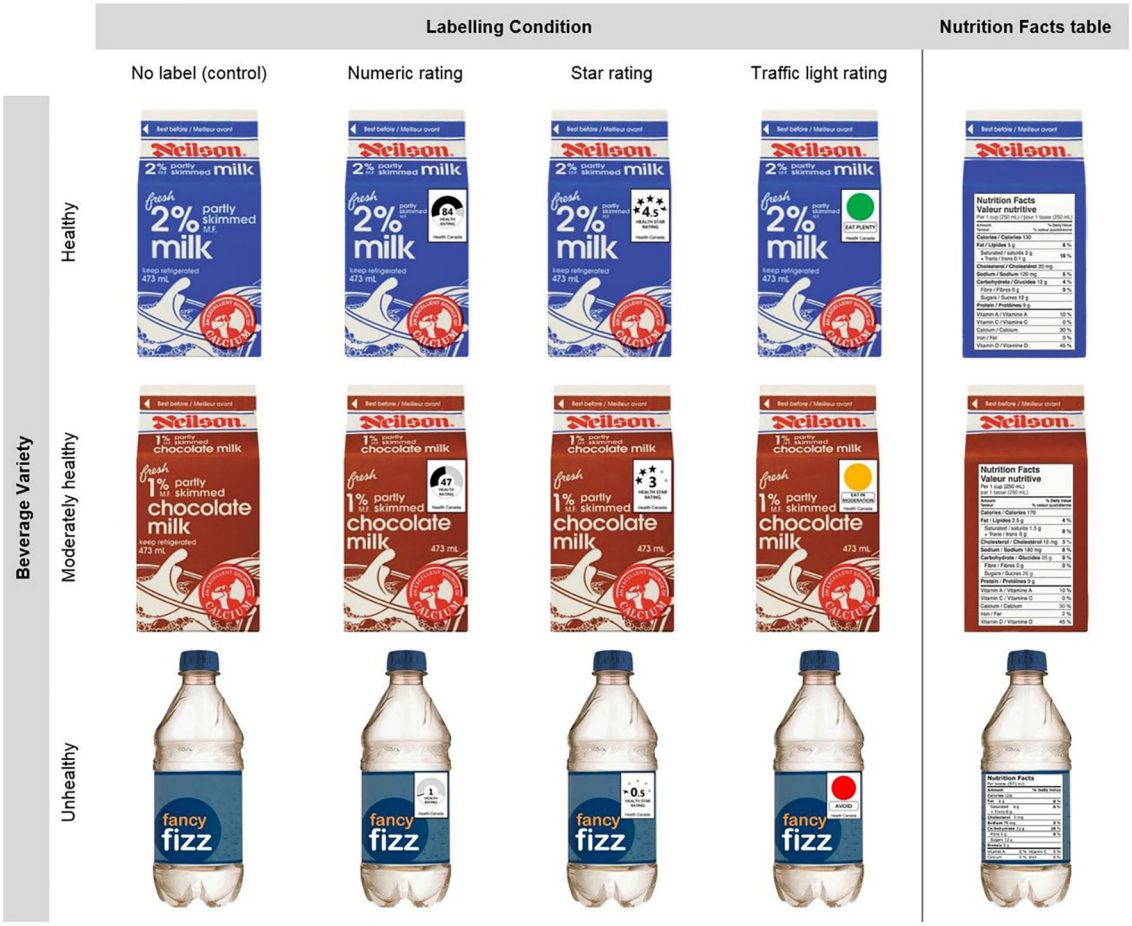

Fig. 1. Beverage images with label conditions and corresponding Nutrition Facts tables.

and 'refuse to answer' were also available as valid response options for each question. Responses for the unflavoured milk, chocolate milk and soda were coded as 'correct' based on responses of 'healthy', 'moderately healthy', and 'unhealthy', respectively.

2.2.2. Preference for summary indicator versus nutrient-specific FOP labelling

Upon conclusion of the FOP labelling experiment, all participants were asked, "What information would you most like to see on the front of food and beverage products?", with the response options: 'a rating of how healthy the product is overall', 'warnings for high levels of specific nutrients, such as sugar or sodium', 'both of the above', 'neither of the above', 'something else', 'don't know', or 'refuse to answer'. Sample images were provided corresponding to the first two response options: a health star rating label was provided as an example of an overall rating, and a symbol denoting 'high sugar' was provided as an example of a nutrient-specific label (see Fig. 2).

2.2.3. Sociodemographic measures

Participants reported their age, gender, ethnicity, height and weight. Age was collected as an open-ended continuous variable, but has been categorized in the sample characteristics table. Self-reported height and weight were used to calculate body mass index (BMI), which was categorized into "underweight", "normal weight", "overweight" and "obese" using the World Health Organization (WHO) thresholds (World Health Organization, n.d.-a). BMI for participants 19 years of age or younger were calculated using BMI-for-age percentile growth charts as recommended by the Centre for Disease Control and Prevention and WHO guidelines (World Health Organization, n.d.-b; Centers for Disease Control and Prevention, n.d.).

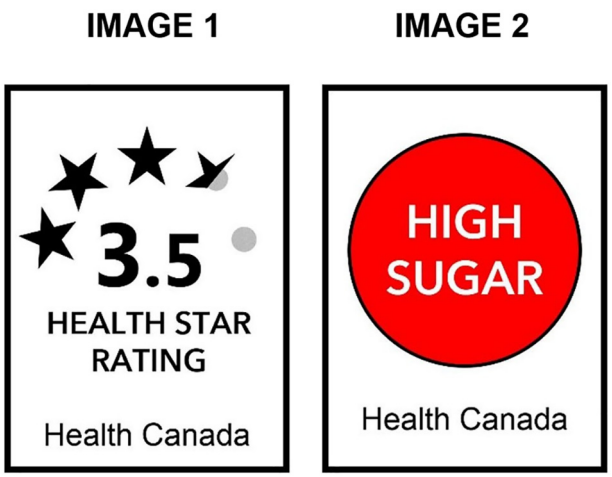

Fig. 2. Images displayed for the survey question, "What information would you most like to see on the front of food and beverage products?", corresponding to the following response options: "a rating of how healthy the product is overall (e.g., IMAGE 1)", and "warnings for high levels of specific nutrients, such as sugar or sodium (e.g., IMAGE 2)".

2.3. Analysis

Statistical analyses were conducted using SPSS software (version 24.0; IBM Corp., Armonk, NY; 2015). Chi-square tests were used to test

for sociodemographic differences between experimental conditions to ensure successful randomization in the between-group experiment. Descriptive statistics were used to identify participant responses in each task by label condition. To examine the effect of label condition on correct responses, binary logistic regression models were fitted for each of the three beverage tasks, where 1 = correct, and 0 = incorrect/don't know. All three models included a predictor variable for *label condition* (control, numeric, star rating, traffic light). Dummy variable coding was used to explore all possible contrasts between the four *label condition* categories. To explore potential moderating effects of the sociodemographic characteristics, additional binary regression models were fitted for each of the three outcomes, with predictor variables for *age* (continuous, 16–82), *gender* (male, female), *ethnicity* (white, non-white, indigenous) and *BMI* (underweight, normal weight, overweight, obese, not reported) in addition to *label condition*. Interaction terms between label condition and each of the sociodemographic variables were included in the models to test for moderation. Descriptive statistics were used to examine participants' preferences between summary indicator and nutrient-specific FOP nutrition labels. The significance threshold was set at 0.05 for all tests.

3. Results

Sample characteristics are presented in Table 1. There were no significant differences in sociodemographic measures between the experimental conditions assigned in the between-group experiment, indicating that randomization was successful.

3.1. Impact of FOP label conditions

Table 2 shows responses across all experimental conditions for each of the three beverage tasks. Overall, a majority of participants across all conditions perceived unflavoured milk to be “healthy”, soda to be “unhealthy”, and chocolate milk to be “moderately healthy”.

Fig. 3 illustrates the proportion of participants who reported the “correct” response for each beverage by experimental condition. There were no significant differences in the proportion of respondents who correctly perceived the unflavoured milk as “healthy” between any of the conditions (see Fig. 3a) (all $p > 0.05$).

In contrast, for chocolate milk, participants who viewed beverages with a health star rating were significantly more likely to correctly identify the chocolate milk as ‘moderately healthy’ than participants who saw no enhanced FOP labelling (see Fig. 3b) (OR = 1.96, 95% CI 1.24—3.09, $p = 0.004$). This was also true for participants who viewed beverages with a simplified traffic light symbol compared to no enhanced label (OR = 1.70, 95% CI 1.11—2.63, $p = 0.02$). However, participants who viewed the numeric rating were no more likely to correctly identify chocolate milk as ‘moderately healthy’ than those in the control condition (OR = 1.38, 95% CI 0.89—2.13, $p = 0.15$). There were also no significant differences when comparing the numeric rating to the star rating (OR = 1.42, 95% CI 0.88—2.28, $p = 0.15$) or traffic light symbol (OR = 1.24, 95% CI 0.79—1.94, $p = 0.36$). The health star and traffic light groups also did not significantly differ from one another (OR = 0.871, 95% CI 0.54—1.40, $p = 0.57$).

Finally, we examined the proportion of participants in each label condition who correctly identified the soda beverage as ‘unhealthy’. Similarly to unflavoured milk, there were no significant differences in correct responses between any of the conditions (see Fig. 3c) (all $p > 0.05$).

3.2. Sociodemographic influences on correct responses

None of the interactions between label condition and the sociodemographic variables *age*, *gender*, *ethnicity*, or *BMI* revealed significant moderating effects on correct responses for any of the three beverage tasks (all $p > 0.1$).

3.3. FOP label format preference

When asked which form of nutrition information they would most like to see on the front of food and beverage products, the largest proportion of participants (45%) indicated that they would like to see *both* an overall health rating and nutrient-specific information. Similar numbers of participants indicated a preference for either an overall health rating (24%) or nutrient-specific labels (25%), while 4% of participants selected ‘neither of the above’, 2% indicated ‘something else’, and 1% selected ‘don't know’.

4. Discussion

The findings suggest that summary indicator labels were most impactful when communicating the nutrition level of a ‘moderately’ or ‘ambiguously’ healthy beverage product. None of the labels tested had a significant impact on beverage perceptions for products people already

Table 1
Sample sociodemographic characteristics overall (n = 675) and by label condition.

Characteristic	Total sample		Control (no label)		Numeric rating		Star rating		Traffic light		Chi square tests of independence	
	% (n)		% (n)		% (n)		% (n)		% (n)		X^2 (*p* value)	
Age											8.2	(0.77)
16–18	15.1%	(102)	14.4%	(26)	13.5%	(22)	17.5%	(27)	15.2%	(27)		
19–21	27.3%	(184)	25.0%	(45)	26.4%	(43)	26.6%	(41)	30.9%	(55)		
22–24	13.8%	(93)	17.8%	(32)	16.0%	(26)	11.0%	(17)	10.1%	(18)		
25–45	25.0%	(169)	23.9%	(43)	27.0%	(44)	25.3%	(39)	24.2%	(43)		
46+	18.8%	(127)	18.9%	(34)	17.2%	(28)	19.5%	(30)	19.7%	(35)		
Gender											0.9	(0.84)
Male	46.1%	(311)	46.7%	(84)	47.2%	(77)	42.9%	(66)	47.2%	(84)		
Female	53.9%	(364)	53.3%	(96)	52.8%	(86)	57.1%	(88)	52.8%	(94)		
Ethnicity											6.6	(0.36)
White	52.6%	(355)	57.2%	(103)	49.1%	(80)	55.2%	(85)	48.9%	(87)		
Non-white/not reported	44.9%	(303)	40.0%	(72)	49.7%	(81)	41.6%	(64)	48.3%	(86)		
Indigenous	2.5%	(17)	2.8%	(5)	1.2%	(2)	3.2%	(5)	2.8%	(5)		
Body mass index (kg/m^2)											7.8	(0.80)
Underweight (< 18.5)	4.1%	(28)	5.0%	(9)	3.7%	(6)	1.9%	(3)	5.6%	(10)		
Normal weight (18.5–24.9)	47.9%	(323)	47.2%	(85)	45.4%	(74)	50.6%	(78)	48.3%	(86)		
Overweight (25.0–29.9)	23.3%	(157)	25.6%	(46)	27.0%	(44)	22.1%	(34)	18.5%	(33)		
Obese (30+)	14.8%	(100)	13.3%	(24)	14.7%	(24)	14.9%	(23)	16.3%	(29)		
Not reported	9.9%	(67)	8.9%	(16)	9.2%	(15)	10.4%	(16)	11.2%	(20)		

Table 2
Participant responses to "Would you consider this product to be…" for unflavoured milk, chocolate milk and soda (%, n).

	All participants		Control (no FOP label)		Numeric rating		Health star rating		Traffic light symbol	
Unflavoured milk										
Unhealthy	4.1%	(28)	6.1%	(11)	2.5%	(4)	1.9%	(3)	5.6%	(10)
Moderately healthy	23.0%	(155)	21.1%	(38)	27.6%	(45)	21.4%	(33)	21.9%	(39)
Healthy[a]	72.6%	(490)	72.8%	(131)	68.7%	(112)	76.6%	(118)	72.5%	(129)
Don't know	0.3%	(2)	0.0%	(0)	1.2%	(2)	0.0%	(0)	0.0%	(0)
Chocolate milk										
Unhealthy	17.8%	(120)	24.4%	(44)	14.7%	(24)	13.6%	(21)	17.4%	(31)
Moderately healthy[a]	64.7%	(437)	56.1%	(101)	63.8%	(104)	71.4%	(110)	68.5%	(122)
Healthy	16.7%	(113)	19.4%	(35)	19.6%	(32)	14.3%	(22)	13.5%	(24)
Don't know	0.7%	(5)	0.0%	(0)	1.8%	(3)	0.6%	(1)	0.6%	(1)
Soda										
Unhealthy[a]	73.1%	(493)	71.7%	(129)	72.2%	(117)	70.1%	(108)	78.1%	(139)
Moderately healthy	21.2%	(143)	26.1%	(47)	19.1%	(31)	21.4%	(33)	18.0%	(32)
Healthy	3.6%	(24)	2.2%	(4)	4.3%	(7)	5.8%	(9)	2.2%	(4)
Don't know	2.1%	(14)	0.0%	(0)	4.3%	(7)	2.6%	(4)	1.7%	(3)

[a] Indicates the intended correct response.

believe are healthy (i.e., unflavoured milk) or unhealthy (i.e., a regular soda). This suggests that pre-existing consumer perceptions may be an important moderator for the impact of nutrition labels and may account for some mixed findings in the literature. Nutrition labels may be more likely to have an impact on perceptions of processed foods that are often marketed and perceived as healthy alternatives, as is the case for chocolate milk, fruit drinks and other sugary beverages. In the current study, both the star ratings and the traffic light label led participants to more accurate perceptions of chocolate milk as a 'moderately healthy' beverage.

Among the three summary indicators tested in this study, the health star rating and the simplified traffic light label were the only two label formats that produced significantly more correct answers than the control condition; albeit only for the chocolate milk product. This may be because both 'stars' and the colours used in the traffic light have more intrinsic meaning than a numeric scale alone, particularly if the range of the scale is not integrated into the label and the labelling system is unfamiliar to consumers. It is unclear whether these differences would persist in the presence of a public education campaign or greater consumer familiarity with a labelling program over time. Given the potential salience of a red 'stop light', it might be expected that traffic light labelling would be more effective in communicating 'unhealthy' beverages. In the soda beverage task, a greater proportion of respondents did answer correctly if they saw the red traffic light label compared to other conditions; however, these differences were not statistically significant.

Our exploratory analyses did not find evidence for moderating effects of sociodemographic variables suggesting that consumers across age, gender, ethnicity, and BMI were equally able to interpret the labels tested, but these results should be replicated in larger samples before conclusions can be drawn. If true, this would be in contrast to research finding that the NFts on the back of food packages are often associated with lower levels of comprehension among older, male, non-white participants with higher BMI (Sinclair et al., 2013; Campos et al., 2011).

Results from the preference task that was completed following the experiment indicated that the vast majority of participants supported some form of FOP labels: either nutrient-specific FOP labels, summary indicator labels, or both. These results replicate those that have been found elsewhere: consumers are supportive of an interpretive nutrition labelling system for the front of packaged foods and beverages (Emrich et al., 2014). The high levels of support suggest that consumers perceive FOP labels to have a unique benefit above and beyond the information already contained in the nutrition factors table on the back of packages.

Strengths of the current study include the use of a randomized experimental design. Additionally, participants were presented with NFt information for the beverages throughout the summary indicator experiments. Limitations include the use of a non-probability based sample, meaning that the sample may not be representative of the Canadian population. In addition, although the images used in the experiments were designed to depict actual beverages as accurately as possible, the use of laptop-based tasks may not represent how consumers naturally interact with labels in a real-world setting. We also only tested three beverage products and do not know how such labels might influence perceptions of a wider range of food and beverage products. Further, we did not test beverage packages with any additional health claims or marketing; it is possible that FOP labels have less influence when competing with well-known branding and other marketing on packaging. Finally, our moderate sample size likely limited our power to test for interactions and we did not measure moderators such as numeracy or literacy that may be more predictive of label response.

5. Conclusions

The findings suggest that FOP summary indicator labels may be most impactful when communicating the healthiness of beverage products with 'moderately' or 'ambiguously' healthy nutrient profiles. In addition, more intuitive summary indicator labels, such as a star rating or traffic light symbol, showed the largest difference in outcomes in comparison to no FOP labelling. These results reemphasize for researchers and practitioners that the average consumer is of course not ignorant of basic nutrition knowledge; rather, consumers are most likely to find FOP labelling systems useful in cases when a product's nutrition profile, or 'healthiness', is less obvious. These experimental findings provide evidence that may help guide policy decisions in jurisdictions where a summary FOP nutrition labelling system is being considered. Future research should examine differences between interpretive labelling systems in their dissuasive effects for unhealthy foods, and whether these differences are similar to the impact on promoting healthier alternatives.

Conflict of interest

David Hammond has provided paid expert testimony on behalf of public health authorities in response to legal challenges from the food and beverage industry.

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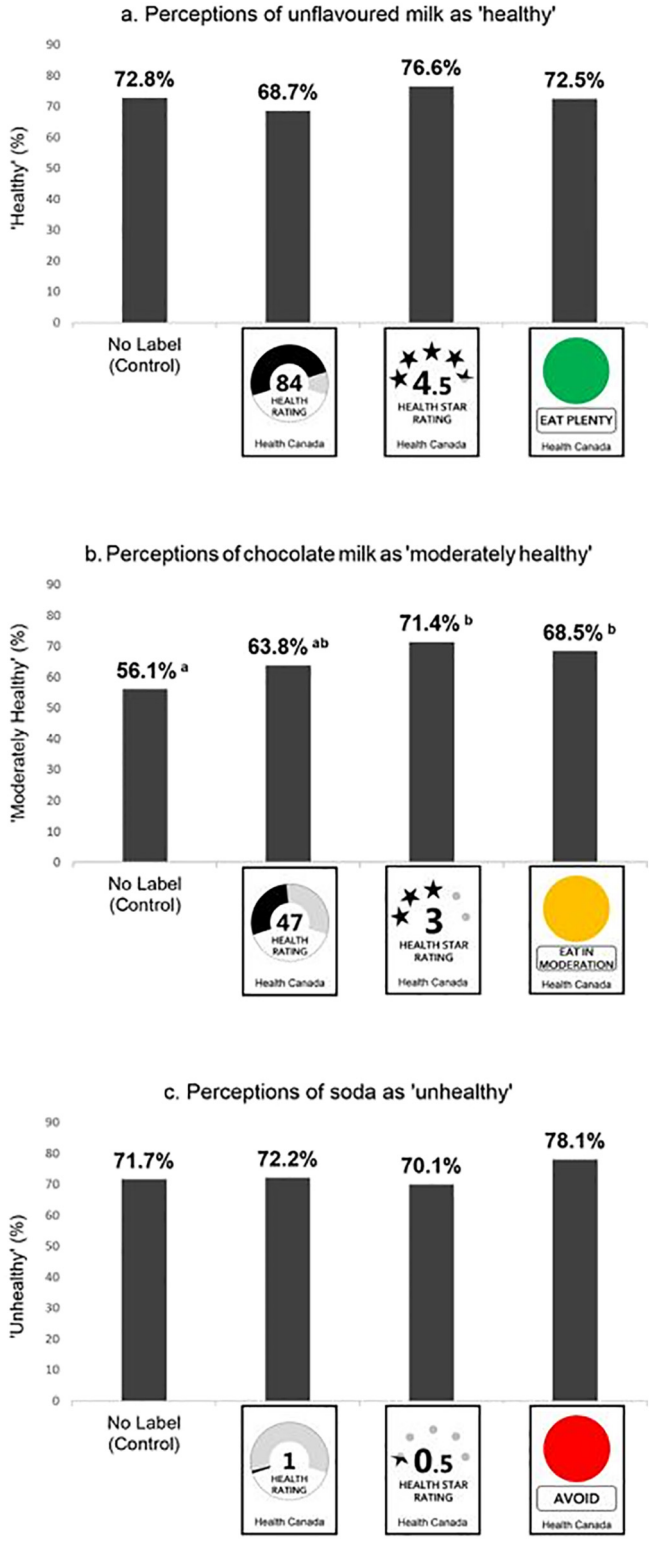

Fig. 3. Correct responses by label condition: (a) proportion of participants who correctly identified unflavoured milk as 'healthy'; (b) proportion of participants who correctly identified chocolate milk as 'moderately healthy'; (c) proportion of participants who correctly identified soda as 'unhealthy'. Different letters indicate significant differences in the odds of a correct response at the $p < 0.05$ level.

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References

Acton, R.B., Hammond, D., 2018. The impact of price and nutrition labelling on sugary drink purchases: results from an experimental marketplace study. Appetite 121, 129–137. https://doi.org/10.1016/J.APPET.2017.11.089.

Acton, R.B., Vanderlee, L., White, C., Hammond, D., 2016. The efficacy of calorie labelling formats on pre-packaged foods: an experimental study among adolescents and young adults in Canada. Can. J. Public Health 107 (3), 296. https://doi.org/10.17269/cjph.107.5513.

Australian Government Department of Health and Ageing, 2016. About health star ratings. http://healthstarrating.gov.au/internet/healthstarrating/publishing.nsf/Content/About-health-stars, Accessed date: 7 February 2017.

Campos, S., Doxey, J., Hammond, D., 2011. Nutrition labels on pre-packaged foods: a systematic review. Public Health Nutr. 14 (08), 1496–1506. https://doi.org/10.1017/S1368980010003290.

Canadian Council of Food and Nutrition, 2008. Tracking nutrition trends VII. https://www.cfdr.ca/Downloads/CCFN-docs/C1180—TNT-VII-FINAL-REPORT—full-report–Sept-1.aspx, Accessed date: 20 April 2017.

Cecchini, M., Warin, L., 2016. Impact of food labelling systems on food choices and eating behaviours: a systematic review and meta-analysis of randomized studies. Obes. Rev. 17 (3), 201–210. https://doi.org/10.1111/obr.12364.

Center for Science in the Public Interest, 2015. Nation of Chile's front-of-package nutrition labeling praised|Center for Science in the Public Interest. https://cspinet.org/new/201507201.html, Accessed date: 14 December 2016.

Centers for Disease Control and Prevention, 2017. Get the facts: sugar-sweetened beverages and consumption. https://www.cdc.gov/nutrition/data-statistics/sugar-sweetened-beverages-intake.html, Accessed date: 8 August 2018.

Centers for Disease Control and Prevention About child & teen BMI. http://www.cdc.gov/healthyweight/assessing/bmi/childrens_bmi/about_childrens_bmi.html, Accessed date: 8 December 2016.

Cowburn, G., Stockley, L., 2005. Consumer understanding and use of nutrition labelling: a systematic review. Public Health Nutr. 8 (1), 21–28. http://www.ncbi.nlm.nih.gov/pubmed/15705241, Accessed date: 24 February 2017.

Ducrot, P., Méjean, C., Julia, C., et al., 2015. Objective understanding of front-of-package nutrition labels among nutritionally at-risk individuals. Nutrients 7 (8), 7106–7125. https://doi.org/10.3390/nu7085325.

Emrich, T.E., Qi, Y., Mendoza, J.E., Lou, W., Cohen, J.E., L'Abbé, M.R., 2014. Consumer perceptions of the Nutrition Facts table and front-of-pack nutrition rating systems. Appl. Physiol. Nutr. Metab. 39 (4), 417–424. https://doi.org/10.1139/apnm-2013-0304.

Feunekes, G.I.J., Gortemaker, I.A., Willems, A.A., Lion, R., van den Kommer, M., 2008. Front-of-pack nutrition labelling: testing effectiveness of different nutrition labelling formats front-of-pack in four European countries. Appetite 50 (1), 57–70. https://doi.org/10.1016/j.appet.2007.05.009.

Freire, W.B., Waters, W.F., Rivas-Mariño, G., Nguyen, T., Rivas, P., September 2016. A qualitative study of consumer perceptions and use of traffic light food labelling in Ecuador. Public Health Nutr. 1–9. https://doi.org/10.1017/S1368980016002457.

Government of Canada, 2015. Nutrition facts tables. https://www.canada.ca/en/health-canada/services/understanding-food-labels/nutrition-facts-tables.html, Accessed date: 24 May 2017.

Guiding Stars, 2017. About. https://guidingstars.ca/about/, Accessed date: 21 April 2017.

Hawley, K.L., Roberto, C.A., Bragg, M.A., Liu, P.J., Schwartz, M.B., Brownell, K.D., 2013. The science on front-of-package food labels. Public Health Nutr. 16 (03), 430–439. https://doi.org/10.1017/S1368980012000754.

Health Canada, 2016. Toward front-of-package nutrition labels for Canadians: consultation document. Ottawa. https://www.canada.ca/content/dam/canada/health-canada/migration/health-system-systeme-sante/consultations/labels-nutrition-etiquetage/alt/labels-nutrition-etiquetage-eng.pdf, Accessed date: 8 March 2017.

Hersey, J.C., Wohlgenant, K.C., Arsenault, J.E., Kosa, K.M., Muth, M.K., 2013. Effects of front-of-package and shelf nutrition labeling systems on consumers. Nutr. Rev. 71 (1), 1–14. https://doi.org/10.1111/nure.12000.

Hobin, E., Shen-Tu, G., Sacco, J., et al., 2016. Comprehension and use of nutrition facts tables among adolescents and young adults in Canada. Can. J. Diet. Pract. Res. 77 (2), 59–65. https://doi.org/10.3148/cjdpr-2015-042.

Jones, A.C., Lennert Veerman, J., Hammond, D., 2017. The health and economic impact of a tax on sugary drinks in Canada. https://www.diabetes.ca/getattachment/Newsroom/Latest-News/Will-a-sugary-drinks-levy-benefit-Canadians/The-Health-and-Economic-Impact-of-a-Sugary-Drinks-Tax.pdf.aspx, Accessed date: 21 November 2017.

Malik, V.S., Schulze, M.B., Hu, F.B., 2006. Intake of sugar-sweetened beverages and weight gain: a systematic review. Am. J. Clin. Nutr. 84 (2), 274–288. http://www.ncbi.nlm.nih.gov/pubmed/16895873, Accessed date: 19 September 2017.

Malik, V.S., Popkin, B.M., Bray, G.A., Després, J.-P., Hu, F.B., 2010. Sugar-sweetened beverages, obesity, type 2 diabetes mellitus, and cardiovascular disease risk. Circulation 121 (11). http://circ.ahajournals.org/content/121/11/1356.long, Accessed date: 30 March 2017.

McKinsey Global Institute, 2014. Overcoming obesity: an initial. https://www.mckinsey.com/~/media/McKinsey/Business%20Functions/Economic%20Studies%20TEMP/Our%20Insights/How%20the%20world%20could%20better%20fight%20obesity/

MGI_Overcoming_obesity_Full_report.ashx, Accessed date: 23 August 2018.
Méjean, C., Macouillard, P., Péneau, S., Lassale, C., Hercberg, S., Castetbon, K., 2014. Association of perception of front-of-pack labels with dietary, lifestyle and health characteristics. Blachier F, ed. PLoS One 9 (3), e90971. https://doi.org/10.1371/journal.pone.0090971.
NuVal, 2017. NuVal: how it works. https://www.nuval.com/How, Accessed date: 20 April 2017.
Olstad, D.L., Vermeer, J., McCargar, L.J., Prowse, R.J.L., Raine, K.D., 2015. Using traffic light labels to improve food selection in recreation and sport facility eating environments. Appetite 91, 329–335. https://doi.org/10.1016/j.appet.2015.04.057.
Popkin, B.M., 2001. The nutrition transition and obesity in the developing world. J. Nutr. 131 (3), 871S–873S. http://www.ncbi.nlm.nih.gov/pubmed/11238777, Accessed date: 20 April 2017.
Roberto, C.A., Khandpur, N., 2014. Improving the design of nutrition labels to promote healthier food choices and reasonable portion sizes. Int. J. Obes. 38, S25–S33. https://doi.org/10.1038/ijo.2014.86.
Savoie, N., Barlow Gale, K., Harvey, K.L., Binnie, M.A., Pasut, L., 2013. Consumer perceptions of front-of-package labelling systems and healthiness of foods. Can. J. Public Health 104 (5), e359–e363. http://www.ncbi.nlm.nih.gov/pubmed/24183175, Accessed date: 5 December 2017.
Sinclair, S., Hammond, D., Goodman, S., 2013. Sociodemographic differences in the comprehension of nutritional labels on food products. J. Nutr. Educ. Behav. 45 (6), 767–772. https://doi.org/10.1016/j.jneb.2013.04.262.
Talati, Z., Pettigrew, S., Ball, K., et al., 2017. The relative ability of different front-of-pack labels to assist consumers discriminate between healthy, moderately healthy, and unhealthy foods. Food Qual. Prefer. 59, 109–113. https://doi.org/10.1016/J.FOODQUAL.2017.02.010.
UK Department of Health, 2016. Front of pack nutrition labelling guidance. https://www.gov.uk/government/publications/front-of-pack-nutrition-labelling-guidance, Accessed date: 14 December 2016.
UK Food Standards Agency, 2004. Concept testing of alternative labelling of healthy/less healthy foods: research report. http://webarchive.nationalarchives.gov.uk/20131104005023/http://www.food.gov.uk/multimedia/pdfs/alternlab.pdf, Accessed date: 19 May 2017.
Vanderlee, L., White, C.M., Bordes, I., Hobin, E.P., Hammond, D., 2015. The efficacy of sugar labeling formats: implications for labeling policy. Obesity 23 (12), 2406–2413. https://doi.org/10.1002/oby.21316.
Watson, W.L., Kelly, B., Hector, D., et al., 2014. Can front-of-pack labelling schemes guide healthier food choices? Australian shoppers' responses to seven labelling formats. Appetite 72, 90–97. https://doi.org/10.1016/j.appet.2013.09.027.
World Health Organization, 2016. Obesity and overweight. http://www.who.int/mediacentre/factsheets/fs311/en/, Accessed date: 20 April 2017.
World Health Organization, 2017. France becomes one of the first countries in region to recommend colour-coded nutrition labelling system. http://www.euro.who.int/en/countries/france/news/news/2017/03/france-becomes-one-of-the-first-countries-in-region-to-recommend-colour-coded-nutrition-labelling-system, Accessed date: 24 May 2017.
World Health Organization, 2018. Reducing consumption of sugar-sweetened beverages to reduce the risk of unhealthy weight gain in adults. http://www.who.int/elena/titles/ssbs_adult_weight/en/, Accessed date: 14 December 2016.
World Health Organization BMI classification. http://apps.who.int/bmi/index.jsp?introPage=intro_3.html, Accessed date: 8 December 2016.
World Health Organization BMI-for-age (5–19 years). http://www.who.int/growthref/who2007_bmi_for_age/en/, Accessed date: 8 December 2016.
World Health Organization, Food and Agriculture Organization of the United States, 2003. Diet, Nutrition and the Prevention of Chronic Diseases: Report of a Joint WHO/FAO Expert Consultation. World Health Organization, Geneva.