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The impact of price and nutrition labelling on sugary drink purchases: Results from an experimental marketplace study

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ABSTRACT

Objective: To examine the effect of front-of-package (FOP) nutrition labelling and sugary drink taxation on consumer beverage purchases.
Methods: A total of 675 respondents aged 16 years and older participated in an experimental marketplace study using a 4 × 5 within-between group design. Participants were randomised to one of four labelling conditions (no label; star rating; high sugar symbol; health warning) and completed five within-subject purchase tasks. Beverage prices in each task corresponded to 'tax' conditions: 0%, 10%, 20%, 30% and a variable tax proportional to free sugar level. In each task, participants selected from 20 commercially available beverages; upon conclusion, one of five selections was randomly chosen for purchase.
Results: As price increased, participants were significantly less likely to select a sugary drink, and selected drinks with fewer calories and less free sugar ($p < 0.001$ for all). The overall effect of labelling was not statistically significant, although there was a trend for the 'high sugar' label to reduce the likelihood of selecting a sugary drink ($p = 0.11$) and encouraging participants to select drinks with less free sugar ($p = 0.11$).
Conclusions: Increasing price was associated with reduced sugary drink purchases. Enhanced FOP labelling results highlight the need for further research to investigate their potential impact. The study adds empirical support for taxation to reduce sugary drink consumption.

1. Introduction

Excess sugar intake is increasingly recognised as a public health concern due to its contribution to energy intake and obesity (World Health Organization, 2003). Higher intake of added sugars compromises the nutrient quality of diets by replacing essential nutrients and increasing the overall energy density of foods (Moshtaghian et al., 2016).

In countries such as Canada, beverages account for the largest source of added sugar intake (Danyliw, Vatanparast, Nikpartow, & Whiting, 2011; Nikpartow, Danyliw, Whiting, Lim, & Vatanparast, 2012). In 2004—the most recent national estimates in Canada—beverages accounted for 44% of the total sugar consumed by children and adolescents, and 35% of sugar intake among adults, with significantly higher proportions for 'added' versus 'total' sugars (Langlois & Garriguet, 2011). Most studies to date have relied upon the traditional definition of 'added sugar' when measuring sugar-sweetened beverages (SSBs), which includes most sugars added to foods or beverages during manufacturing or preparation, but excludes those naturally present in fruit juices (Mann & Fleck, 2014). SSBs are typically defined as regular soft drinks, fruit drinks, fruit juice <100%, sports drinks, energy drinks and sweetened tea and coffee. However, an increasing number of studies are using the World Health Organization's criteria for 'free sugar' to measure 'sugary drinks', which include flavoured or sweetened milk, and 100% fruit juice (World Health Organization, 2015). Recent analyses of the Canadian food supply identified high levels of free sugar across all of these beverage categories (Acton, Vanderlee, Hobin, & Hammond, 2017; Bernstein et al., 2016).

A range of observational studies and trials indicate that high consumption of SSBs is associated with an increased risk of Type 2 diabetes, metabolic syndrome, cardiovascular disease, dental caries, and several cancers, primarily through its association with weight gain (Malik, Popkin, Bray, Després, & Hu, 2010, 2013;

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Marshall, 2013; Renehan, Tyson, Egger, Heller, & Zwahlen, 2008; Song et al., 2016). Globally, an estimated 184,000 deaths per year are directly attributable to SSB intake (Singh et al., 2015).

In an effort to address the health burden from sugary drinks, several countries have implemented targeted interventions at the policy level, such as enhanced food labelling regulations. In Canada, the amount of total sugar in a product is displayed on the back or side of pre-packaged foods as part of the Nutrition Facts table (NFt). The NFt is widely used in Canada, but requires high levels of health literacy and many consumers struggle to interpret the quantitative information (Acton, Vanderlee, White, & Hammond, 2016; Cowburn & Stockley, 2005; Hobin et al., 2016). In particular, few consumers have an intuitive understanding of the recommended 'limits' on sugar intake (Vanderlee, White, Bordes, Hobin, & Hammond, 2015). Consequently, non-numerical, 'interpretive' food labels have emerged as an important complement to the quantitative information presented in NFts. The most common FOP formats include health 'star ratings' and nutrient-specific 'traffic light' symbols (Australian Government Department of Health and Ageing, 2017; Center for Science in the Public Interest, 2016; UK Department of Health, 2016). Whereas star ratings seek to provide an overall measure of nutrition quality, traffic light formats are typically used to highlight 'high' levels of a nutrient based on a threshold. Research to date suggests that the traffic light format may be more effective in discouraging consumption of 'negative nutrients', such as sugar, in pre-packaged foods (Cecchini & Warin, 2016; Hawley et al., 2013). This is consistent with preliminary evidence from countries such as Australia and Ecuador, which have recently implemented star rating systems and FOP 'traffic light' labels for sugar, respectively (Freire, Waters, Rivas-Mariño, Nguyen, & Rivas, 2016; Hamlin & McNeill, 2016). More recently, 'warning labels' have emerged as an alternative labelling option to communicate the risks associated with overconsumption of particular nutrients. For example, the city of San Francisco has implemented health warning labels on certain print and billboard SSB advertisements (Schillinger & Jacobson, 2016), with the potential to apply warnings directly on product containers (Roberto, Wong, Musicus, & Hammond, 2016). Overall, FOP labels represent a promising intervention for enhancing sugar labeling; however, there is no clear consensus about which format would be most effective in reducing free sugar intake.

The use of fiscal measures in the form of sugary drink taxes has also emerged as a prominent population-level intervention to reduce free sugar intake (Andreyeva, Long, & Brownell, 2010; Falbe et al., 2016; Powell, Chriqui, Khan, Wada, & Chaloupka, 2013). Economic theory suggests that increasing the price of foods high in free sugar will decrease consumption (Smith, Lin, & Lee, 2010), and a range of studies have demonstrated that food purchases are price elastic, particularly in the case of sugary drinks (Andreyeva et al., 2010). Excise taxes are the most common form of tax, which selectively increase the 'shelf price' of sugary beverages compared to the untaxed beverages. For example, in 2014 Mexico implemented a tax on SSBs, equivalent to approximately 10% of the price. In the first year, sales of taxed sugary beverages decreased by 6%, and an average reduction of 7.6% was seen after two years (Colchero, Rivera-Dommarco, Popkin, & Ng, 2017).

The existing evidence base on labelling and taxation has several limitations. The vast majority of research to date has focused on policies targeting SSBs, and not the expanded definition of sugary drinks. The inclusion of sugary drinks may have important implications for how consumers 'compensate' or select other 'substitute' beverages in response to a tax. In studies that exclude 100% fruit juices and flavoured milk from products subject to a tax, these drinks are available to consumers as alternative 'untaxed' options. It remains unclear how a tax based on sugary drinks would affect consumer purchases and estimates of price elasticity. There is also a lack of research on how the impact of taxation or labelling policy measures may vary across population sub-groups, which can't be assessed in most studies to date that analyze sales data. There is also only a limited number of studies that have investigated multiple interventions—such as FOP warnings and taxation together—to estimate any additive effects that may be present. Finally, there is a need for evidence on taxation and labelling policies in Canada. In 2016, the Canadian government officially proposed mandatory FOP warnings on pre-packaged products, including a 'high' warning for sugar, and is actively considering implementing a sugary drink tax (Health Canada, 2016; Blatchford & Bronskill, 2016). Both policies represent novel interventions and there is an immediate need for evidence to inform these measures.

The current study sought to experimentally test the impact of several FOP nutrition labelling formats and levels of taxation on consumer purchasing of sugary drinks, free sugar, and calories.

2. Methods

The study was conducted in September and October 2016. Ethical approval for the study was received from the Office of Research Ethics at the University of Waterloo.

2.1. Participants

Participants aged 16 years and older were recruited using convenience sampling in a shopping mall in southwestern Ontario, Canada. The shopping mall setting provided a high traffic volume for data collection, with a population of shoppers encompassing a variety of age groups and ethnicities. Research assistants were stationed at a booth in a high-traffic location in the shopping mall, and approached potential participants to ask whether they were interested in participating in the study. All interested participants were asked to provide their age prior to providing informed consent and beginning the study. A total of 686 participants completed the study; 11 participants were removed due to data quality concerns, for a final sample size of 675.

2.2. Protocol

The current study used an experimental marketplace design. The experimental marketplace is a design commonly used in the field of behavioural economics and marketing to study actual consumer behaviour (Collins, Vincent, Yu, Liu, & Epstein, 2014; Epstein et al., 2015; Quisenberry, Koffarnus, Hatz, Epstein, & Bickel, 2016), and provides the opportunity to manipulate price and other variables of interest in order to assess their influence on consumers' purchases. Participants are provided with a sum of money, and presented with multiple products available for purchase. If the participant does not spend the entire sum of money, they are allowed to keep the remainder, along with the product they selected. In this way, participants spend real money and incur a financial cost for their purchases, leading to more realistic product selections.

The current study consisted of a set of purchasing tasks following a 4 × 5 between-within subject design to test the effects of enhanced FOP labelling formats (between subject) and sugary drink taxes (within subject). Following the experimental marketplace design, participants completed a series of five purchasing tasks, in which they were asked to purchase one beverage from a selection of 20 sugary and non-sugary drinks. An allotted budget of $5.00 CAD was available for each of the five tasks. Beverage prices ranged from $1.99 to $3.63, with an average of $2.81 CAD, and were selected based on standard retail prices within the surrounding shopping mall. A budget amount of $5.00 was selected in order to capture the maximum cost of any one beverage, while still providing change to participants as a form of remuneration for the study.

2.2.1. FOP labelling conditions

Each participant was randomly assigned to view beverages with one of four labelling conditions: no labelling changes, a *text health warning*, a *high sugar symbol*, or a *health star rating* (Fig. 1). Warning label conditions were designed to approximate existing regulatory practices (Australian Government Department of Health and Ageing, 2017; Freire et al., 2016; Roberto et al., 2016). The *text health warning* and *high sugar symbol* were displayed only on the 'sugary drinks', defined as those containing more than 5 g of free sugar per 100 mL. The *health star rating* was displayed on every beverage. Health star rating values were based on the Australian Health Star Rating System (Australian Government Department of Health and Ageing, 2017), with adaptations to better reflect the free sugar definition used in this study. See Table 1 for the health star rating values of all 20 beverages, as well as their categorisation as sugary or non-sugary drinks.

2.2.2. Tax conditions

Within their assigned labelling condition, each participant performed the five purchasing tasks. The beverage selection remained the same across the five purchasing tasks; however, the price of beverages varied in each to correspond to the 'tax' condition for sugary drinks. Tax conditions included a control condition (i.e., actual market value at the time of the study), a 10% price increase, 20% price increase, 30% price increase, and a variable price increase based on free sugar content. Tax conditions were selected based on existing regulatory practice. The 10%, 20% and 30% price increases in the tax conditions were applied only to beverages that met the criteria for 'sugary drinks', as defined above. The variable tax condition was assigned to beverages according to the following categories of free sugar levels: <2 g/100 ml: 0% (no price increase); 2–4.9 g/100 ml: +10%; 5–7.9 g/100 ml: +20%; 8–9.9 g/100 ml: +30%; >10 g/100 ml: +40%. The order in which participants encountered the five tax conditions was randomised.

2.2.3. Beverage selection for purchase tasks

For each purchase task, participants were presented with a selection of 20 commercially available beverages, which included leading brands from a range of sugary and non-sugary beverages (sodas, diet sodas, sports drinks, vitamin waters, fruit juices, milks, water). First, to ensure that participants had the opportunity to view the beverages and labels in the same size that they would on an actual beverage container, all 20 beverages were displayed individually to participants in full-size on the laptop screen for 3 s each. Beverages displayed the FOP label corresponding to the experimental condition to which the participant was assigned. After participants viewed each of the full-size beverage images in a randomised order, the beverages were then displayed together on the screen to mimic the visual display of beverages on a retail store shelf, including a 'tag' with individual prices (Fig. 2). Fig. 3 shows an example of two beverages with each label/price combination. After completing the survey, participants received their selected beverage and their unspent budget (ranging from $1.37 to $3.01 CAD) from one randomly selected task. Since the participants did not know which task would be their "real" purchase until the end of the survey, they treated each of the five tasks as a 'real purchase'. To ensure comprehension of the purchasing tasks, a research assistant guided participants through a practice purchasing task. Participants then continued with the five beverage purchasing tasks and the remainder of the survey independently using a laptop.

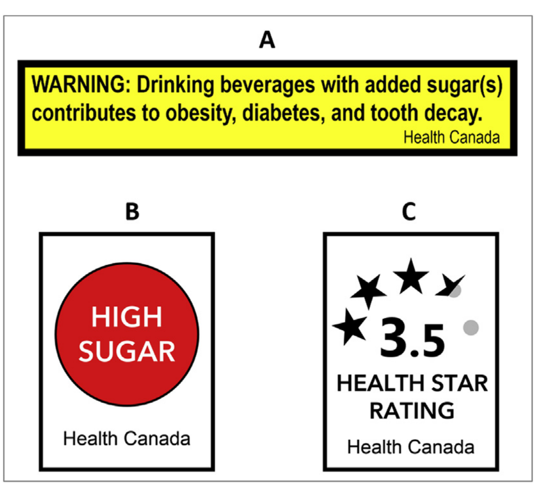

Fig. 1. Labelling formats: A. Text warning label; B. High sugar symbol; C. Health star rating (3.5 star rating shown here. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

2.2.4. Sociodemographic measures

Participants reported their age, gender, ethnicity, height and weight. Self-reported height and weight were used to calculate BMI, which was categorised into "underweight", "normal weight", "overweight" and "obese" using the WHO thresholds (World Health Organization, 2016a). BMIs for participants 19 years of age or younger were calculated using growth charts as recommended by CDC and WHO guidelines (Centers for Disease Control and Prevention, 2016; World Health Organization, 2016b).

2.3. Analysis

Statistical analyses were conducted using SPSS software (version 23.0; IBM Corp., Armonk, NY; 2015). Chi-square tests were used to test for socio-demographic differences between experimental conditions.

Following *a priori* hypotheses, we tested the effects of labelling and tax on three primary outcomes: the proportion of participants who purchased a sugary drink versus a non-sugary drink, the number of grams of free sugar purchased per task, and the number of calories purchased per task. Using the GENLINMIXED command in SPSS, a generalised linear mixed model was conducted to account for the correlated nature of the repeated-measures data, using a binomial distribution with a logit link to assess the effects of labelling and price on the outcome of 'likelihood of purchasing a sugary drink'. Using the same mixed model framework for repeated measures, a linear mixed model was used to model the effects of labelling and price on 'grams of free sugar purchased'. A second linear mixed model was used to model the effects of labelling and price on 'calories purchased'. All models were specified with an unstructured covariance matrix, and included indicator variables of *labelling format* and *tax level* to assess differences between these conditions, as well as a *purchase order* variable representing the order in which participants completed the purchasing tasks. Two-way interactions between *labelling format* and *tax level* were tested in all three models. All pairwise comparisons were examined in each model.

3. Results

Sample characteristics can be found in Table 2. There were no

Table 1
Details of beverages presented to participants.

Beverage	Flavour/variety	Container volume (mL)	Free sugar per container[a] (g)	Free sugar per 100 ml (g)	Calories per container (cal)	Sugary drink?	Base price ($CAD)	Variable tax category	Health star rating
Coca Cola		500	52	10.4	190	●	2.49	+40%	1/2
Diet Coke		500	0	0.0	0		2.49	–	★1/2
Pepsi		591	69	11.7	250	●	2.49	+40%	1/2
Diet Pepsi		591	0	0.0	0		2.49	–	★1/2
7-Up		591	63	10.7	240	●	2.49	+40%	1/2
Diet 7-Up		591	0	0.0	0		2.49	–	★1/2
Orange Crush		591	71	12.0	270	●	2.49	+40%	1/2
Gatorade Original Thirst Quencher	Lemon-Lime	591	34	5.8	140	●	2.59	+20%	★
Gatorade Original Thirst Quencher	Fruit Punch	591	34	5.8	140	●	2.59	+20%	★
Gatorade Low-Calorie G2	Fruit Punch	591	12	2.0	50		2.59	+10%	★1/2
Glacéau VitaminWater	"XXX" (Berry)	591	32	5.4	120	●	2.59	+20%	★
Glacéau VitaminWater	"Essential" (Orange)	591	32	5.4	120	●	2.59	+20%	★
Glacéau VitaminWater ZERO	"XOXOX" (Berry)	591	1	0.2	0		2.59	–	★1/2
Nestea Lemon Iced Tea		500	43	8.6	160	●	2.59	+30%	1/2
Minute Maid Lemonade		450	52	11.6	200	●	2.59	+40%	★
Minute Maid Apple Juice		450	48	10.7	210	●	2.59	+40%	★★
Minute Maid Orange Juice		450	45	10.0	220	●	2.59	+40%	★★
Neilson 2% White Milk		473	0	0.0	189		2.35	–	★★★★1/2
Neilson 1% Chocolate Milk		473	26	5.6	303	●	2.35	+20%	★★★
Aquafina Water		591	0	0.0	0		1.99	–	★★★★★

[a] For all beverages except *Neilson 2% White Milk* and *Neilson 1% Chocolate Milk*, free sugar values are equal to the amount of total sugar reported on the products' Nutrition Facts tables. Free sugar for Neilson 2% White Milk was assigned to be 0, aligning with the definition for free sugar. Free sugar for Neilson 1% Chocolate Milk was calculated by subtracting the total sugar found in an equal-sized Neilson 1% White Milk from the total sugar reported on the Nutrition Facts table of the chocolate variety.

Fig. 2. Beverage selection as displayed to participants. High sugar symbol × 30% tax condition shown here. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Fig. 3. Tax and labelling conditions: the first two of 20 beverages for each purchasing condition are shown here. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Table 2
Sociodemographic characteristics of sample overall and by labelling condition.

Characteristic	Total sample ($n = 675$) %	Control ($n = 156$) %	High sugar symbol ($n = 166$) %	Text warning ($n = 176$) %	Star rating ($n = 177$) %
Age					
16–18	15.1%	12.2%	12.0%	15.3%	20.3%
19–24	41.0%	40.4%	48.8%	39.8%	35.6%
25–45	25.0%	25.0%	21.1%	26.1%	27.7%
46+	18.8%	22.4%	18.1%	18.8%	16.4%
Gender					
Male	46.1%	51.9%	41.0%	50.0%	41.8%
Female	53.9%	48.1%	59.0%	50.0%	58.2%
Ethnicity					
White	52.6%	51.9%	53.0%	51.7%	53.7%
Non-white/not reported	44.9%	46.2%	46.4%	46.1%	41.2%
Indigenous	2.5%	1.9%	0.6%	2.3%	5.1%
BMI (kg/m^2)					
Underweight (<18.5)	4.1%	5.8%	3.6%	4.5%	2.8%
Normal weight (18.5–24.9)	47.9%	48.1%	48.2%	50.6%	44.6%
Overweight (25.0–29.9)	23.3%	21.2%	23.5%	22.7%	25.4%
Obese (30 +)	14.8%	17.3%	15.7%	11.9%	14.7%
Not reported	9.9%	7.7%	9.0%	10.2%	12.4%

significant differences in sociodemographic measures between the experimental conditions (labelling format), indicating that randomisation was successful.

3.1. Sugary drinks purchased

The interaction variable *labelling format* × *tax level* was not significant (F[12, 3351] = 0.81, $p = 0.65$) and therefore was not included in the model.

Fig. 4(i) illustrates the proportion of participants who selected a sugary drink in each of the four labelling conditions. The main effect of labelling format was not significant (F[3, 3363] = 1.19, $p = 0.31$). There were no significant differences in the proportion of participants who purchased a sugary drink between the control condition and the *high sugar symbol* condition (−0.07; 95% CI -0.16, 0.02; $p = 0.11$), the *text health warning* condition (−0.02; 95% CI -0.11, 0.07; $p = 0.61$), or the *health star rating* condition (0.002; 95% CI -0.09, 0.09; $p = 0.97$). There were also no significant differences when comparing the *high sugar symbol* to the *text health warning* (0.05; 95% CI -0.04, 0.14; $p = 0.26$) or *health star rating* (0.08; 95% CI -0.01, 0.16; $p = 0.09$). The *text health warning* and *health star rating* also did not differ significantly from one another (0.03; 95% CI -0.06, 0.11; $p = 0.57$).

Fig. 4(ii) shows the proportion of participants who selected a sugary drink in each of the five tax conditions. The main effect of tax level was found to be significant (F[4, 3363] = 33.98, $p < 0.001$). There were significant differences in sugary drinks purchased between the control condition and each of the tax levels. Participants were less likely to purchase a sugary drink in the *10%*, *20%*, *30%* and *variable* tax conditions in comparison to the control condition (respectively, [-0.05; 95% CI -0.08, −0.02; $p = 0.004$], [-0.13; 95% CI -0.17, −0.10; $p < 0.001$], [-0.18; 95% CI -0.21, −0.14; $p < 0.001$], [-0.14; 95% CI -0.18, −0.11; $p < 0.001$]). The proportion of participants who purchased a sugary drink decreased significantly with each increasing tax level up to *30%*: participants were less likely to purchase a sugary drink in the *20%* tax condition in comparison to the *10%* tax condition (−0.08; 95% CI -0.12, −0.05; $p < 0.001$), they were less likely to purchase a sugary drink in the *30%* tax condition in comparison to the *20%* condition (−0.04; 95% CI -0.08, −0.01; $p = 0.01$), and they were similarly less likely to purchase a sugary drink in the *30%* tax condition in comparison to the *10%* condition (−0.13; 95% CI -0.16, −0.09; $p < 0.001$). The *variable* tax level resulted in lower sugary drink purchasing in comparison to the 10% condition (−0.09; 95% CI -0.13, −0.06; $p < 0.001$), but produced results statistically similar to the *20%* and *30%* tax levels (respectively, [-0.01; 95% CI -0.05, 0.02; $p = 0.48$], [0.03; 95% CI -0.002, 0.07; $p = 0.06$]).

3.2. Free sugar purchased

The interaction variable between *labelling format* × *tax level* was not significant (F[12, 2603] = 1.22, $p = 0.26$) and therefore was not included in the model.

Fig. 4(iii) shows the number of grams of free sugar purchased per task in each of the four labelling conditions. The main effect of labelling format was not significant (F[3, 671] = 0.90, $p = 0.44$). There were no significant differences in grams of free sugar purchased between the control condition and the *high sugar symbol* condition (−3.18; 95% CI -7.14, 0.77; $p = 0.11$), the *text health warning* condition (−1.47; 95% CI -5.37, 2.43; $p = 0.46$), or the *health star rating* condition (−2.28; 95% CI -6.17, 1.62; $p = 0.25$). There were also no significant differences when comparing the *health sugar symbol* to the *text health warning* (−1.71; 95% CI -5.55, 2.13; $p = 0.38$) or *health star rating* (−0.90; 95% CI -4.73, 2.93; $p = 0.64$). The *text health warning* and *health star rating* also did not differ significantly from one another (0.81; 95% CI -2.97, 4.58; $p = 0.68$).

Fig. 4(iv) shows the number of grams of free sugar purchased per task in each of the five tax conditions. The main effect of tax level was found to be significant (F[4, 2625] = 33.67, $p < 0.001$). There were significant differences in grams of free sugar purchased between the control condition and each of the tax levels. Participants purchased significantly fewer grams of free sugar in each of the *10%*, *20%*, *30%* and *variable* tax conditions in comparison to the control condition (respectively, [-2.16; 95% CI -3.63, −0.68; $p = 0.004$], [-4.88; 95% CI -6.37, −3.40; $p < 0.001$], [-6.64; 95% CI -8.13, −5.16; $p < 0.001$], [-7.47; 95% CI -8.96, −5.99; $p < 0.001$]). The amount of free sugar purchased per task decreased significantly with each increasing tax level up to 30%: participants purchased fewer grams of free sugar in the *20%* tax condition in comparison to the *10%* tax condition (−2.73; 95% CI -4.21, −1.24; $p < 0.001$), they purchased additionally fewer grams of free sugar in the *30%* tax condition in comparison to the *20%* condition (−1.76; 95% CI -3.24, −0.28; $p = 0.02$), and they purchased fewer grams in the *20%* tax condition in comparison to the *10%* condition (−2.73; 95% CI -4.21, −1.24; $p < 0.001$). The *variable* tax level resulted in lower amounts of free sugar purchased in comparison to the *10%* condition (−5.32; 95% CI -6.80, −3.83; $p < 0.001$) and the *20%* condition (−2.59; 95% CI -4.07, −1.12; $p = 0.001$), but produced similar free sugar outcomes to the *30%* tax level (−0.83; 95% CI -2.31, 0.65; $p = 0.27$).

3.3. Calories purchased

The interaction variable *labelling format* × *tax level* was not significant (F[12, 2571] = 1.19, $p = 0.29$) and therefore was not included in the model.

Fig. 4(v) shows the number of calories purchased per task in each of the four labelling conditions. The main effect of labelling format was not significant (F[3671] = 0.79, $p = 0.50$). There were no significant differences in calories purchased between the control condition and the *high sugar symbol* condition (−8.65; 95% CI -29.08, 11.78; $p = 0.41$), the *text health warning* condition (−1.89; 95% CI -22.04, 18.26; $p = 0.85$), or the *health star rating* condition (6.70; 95% CI -13.42, 26.83; $p = 0.51$). There were also no significant differences when comparing the *high sugar symbol* to the *text health warning* (−6.76; 95% CI -26.58, 13.07; $p = 0.50$) or *health star rating* (−15.35; 95% CI -35.15, 4.44; $p = 0.13$). The *text health warning* and *health star rating* also did not differ significantly from one another (−8.60; 95% CI -28.10, 10.91; $p = 0.39$).

Fig. 4(vi) shows the number of calories purchased per task in each of the five tax conditions. As with the previous two outcomes, tax level had a significant effect on calories purchased (F[4, 2590] = 16.66, $p < 0.001$). There were significant differences in calories purchased between the control condition and each of the tax levels except the *10%* tax condition. Participants purchased significantly fewer calories in the *20%*, *30%* and *variable* tax conditions in comparison to the control condition (respectively, [-19.44; 95% CI -26.91, −11.96; $p < 0.001$], [-27.96; 95% CI -35.48, −20.44; $p < 0.001$], [-19.15; 95% CI -26.67, −11.63; $p < 0.001$]), while the *10%* level showed a modest but non-significant decrease in comparison to the control (−7.20; 95% CI -14.69, 0.28; $p = 0.06$). Participants purchased fewer calories in the *20%* tax condition in comparison to the *10%* tax condition (−12.23; 95% CI -19.76, −4.71; $p = 0.001$), and purchased fewer calories in the *30%* tax condition in comparison to the *20%* condition (−8.53; 95% CI -16.03, −1.03; $p = 0.03$), and purchased fewer calories in the *30%* tax condition in comparison to the *10%* tax condition (−20.76; 95% CI -28.24, −13.27; $p < 0.001$). The *variable* tax condition resulted in fewer purchased calories than the 10% tax condition (−11.94; 95% CI -19.42, −4.47; $p = 0.002$) and a higher number of calories than the 30% tax condition (8.81; 95% CI 1.32, 16.31; $p = 0.021$), but produced similar calorie outcomes to the *20%* tax level (0.29; 95% CI -7.15, 7.73; $p = 0.94$).

4. Discussion

The current study highlights the efficacy of taxation strategies and the need for further research to investigate the potential of

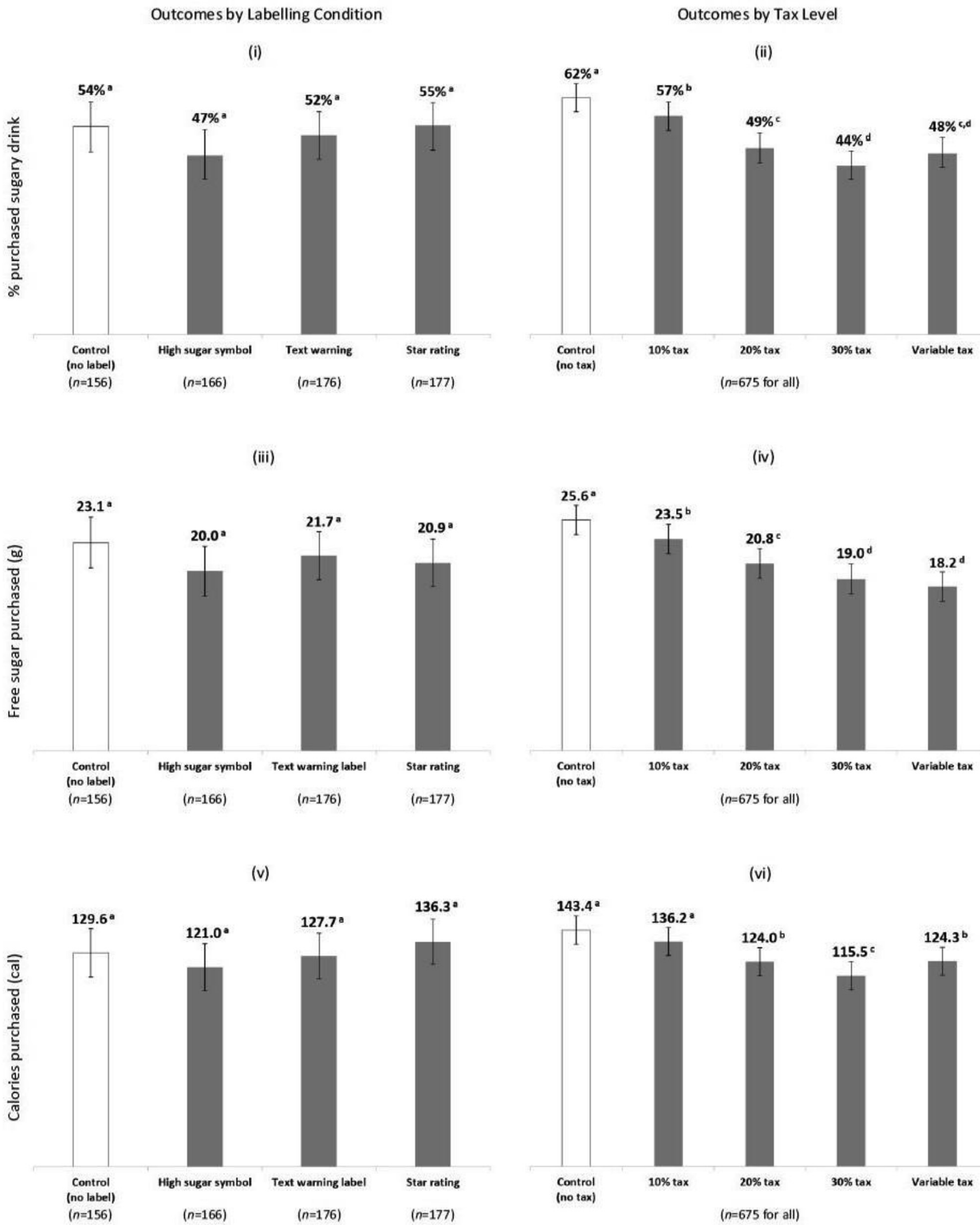

Fig. 4. Outcomes by labelling condition and tax level: (i) proportion of participants who selected a sugary drink, by labelling condition; (ii) proportion of participants who selected a sugary drink, by tax condition; (iii) grams of free sugar per purchase, by labelling condition; (iv) grams of free sugar per purchase, by tax condition; (v) number of calories per purchase, by labelling condition; (vi) number of calories per purchase, by tax condition. Different letters indicate significant differences at the $p < 0.05$ level. Error bars represent 95% confidence intervals.

enhanced FOP nutrition labelling. The overall effect of labelling was more modest than price in the current study. There was a consistent trend towards a reduction in the likelihood of purchasing a sugary drink, grams of free sugar purchased, and number of calories purchased when participants saw beverages labelled with a *high sugar symbol*: a notable 7 percent fewer participants purchased a sugary drink—and they purchased approximately 3 fewer grams of free sugar and 9 fewer calories—if they saw beverages with the *high sugar symbol* than those who saw beverages with no enhanced FOP labelling. However, these differences failed to reach conventional levels of statistical significance. The *text health warning* label also showed modest reductions in all three outcomes, though to a lesser extent. Results from the *health star rating* were mixed: star ratings demonstrated no impact on the proportion of participants who purchased a sugary drink, a modest reduction in the grams of free sugar purchased, and an increase in the number of calories purchased. These mixed results may reflect the nature of a health star rating, which is based on the overall nutrient profile of food products rather than being sugar-specific. The increase in calories purchased among those who viewed the *health star rating* may be due to the high star ratings assigned to milk products, which contain more calories. Ultimately, these results emphasise that an overall health rating, like the health stars used in this study, are less desirable for the reduction of specific food products or nutrients. Overall, although the effect of enhanced FOP labelling was not found to be statistically significant for the three outcomes, there was a consistent trend for the positive impact of the *high sugar symbol* for improving the healthfulness of consumers' beverage purchases. The trends seen in these results are consistent with much of the existing literature on enhanced FOP nutrition labelling. The traffic light system, which is most closely represented by the "high sugar" symbol used in this study, is often identified as the strongest labelling format for communicating the presence of negative nutrients and reducing the purchasing of products containing them (Cecchini & Warin, 2016; Freire et al., 2016; Hawley et al., 2013).

The effect of price in this study, in contrast to labelling, did show a statistically significant impact on consumer purchasing. Increasing the price of sugary drinks relative to beverages without free sugars significantly decreased the likelihood that consumers would purchase a sugary drink when provided with a range of beverages. The 30% tax level resulted in the greatest reduction of sugary drink purchases, with the variable tax producing statistically similar results. As might be expected, when focusing on reductions in free sugar, the sugar-specific variable tax level showed the greatest reductions, but was again not statistically different from the 30% tax level. When focusing on calories purchased, the 30% tax level resulted in the greatest decrease in comparison to all other tax levels. The overall significant impact of price seen here on purchases of sugary drinks, free sugar and calories is generally consistent with what has been demonstrated in the existing literature in the area of both sugary beverage and food purchases in general (Andreyeva et al., 2010; Falbe et al., 2016; Powell et al., 2013).

We also examined possible additive effects by testing interactions between the tax and labelling conditions. No interaction effects were observed; however, given that multiple policies are often implemented in the same jurisdiction, the combined effect of policies warrants further investigation.

Our study has several potential limitations. Although the experimental purchasing task design attempts to mimic consumers' real purchasing behaviours as closely as possible, it may not represent how consumers naturally interact with labels and price in a real-world setting, particularly over the long term. The labels used in the purchasing tasks were unfamiliar to participants and were presented without any associated explanation, therefore the results are more likely to reflect consumers' responses to a FOP labelling system implemented with no associated education component, which is unlikely in the real world. Participants' unfamiliarity with the labels may have been a partial contributor to the lack of effect found across labelling conditions. Additionally, study participants were recruited using convenience sampling and may have under-represented certain sub-populations. Finally, a limited sample size may have contributed to insignificant results: the lack of significant results across labelling conditions may have largely been a result of inadequate sample sizes across each of the labelling conditions. Strengths of the study include the use of a randomised between-within study design, and the incorporation of actual monetary consequences for the purchase of real beverages.

5. Conclusion

These findings contribute to the growing evidence that taxation strategies may be an effective and important tool to reduce purchasing and consumption of sugary drinks. The effects of a "high sugar" label placed on the front of sugary drinks, though non-significant, suggest promising results for the reduction of sugary drink consumption, and future research should investigate similar labels with larger sample sizes. The results for both price and labelling represent important contributions to the body of evidence around nutrition policy strategies in the Canadian context.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.appet.2017.11.089

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