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Do sugar warning labels influence parents' selection of a labeled snack for their children? A randomized trial in a virtual convenience store

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ABSTRACT

Despite growing evidence that warning labels reduce purchases of sugary drinks, less is known about warnings' impact on purchases of sugary snacks. This paper aimed to experimentally test whether a front-of-package label warning about high sugar content ("sugar warning label") would reduce parents' likelihood of selecting a labeled snack versus a non-labeled snack for their child in a food store setting. Participants (n = 2,219 parents of at least one child aged 1-5y) were recruited via an online panel and asked to complete a shopping task in a virtual convenience store. Participants were randomized to one of three labeling conditions: barcode control, text-only sugar warning label, or pictorial sugar warning label. Participants viewed two granola snacks, one labeled and one unlabeled, and selected one for purchase. A post-shopping survey measured secondary outcomes. Predictions and analyses were preregistered on www.clinicaltrials.gov (NCT04381481). Participants exposed to the text or pictorial sugar warning labels were less likely to select the labeled snack than those in the barcode control group (21%, 18%, and 34% respectively; $p < 0.001$ for both comparisons of warning to control). Relative to the barcode control label, the text and pictorial sugar warning labels resulted in greater attention, anticipated social interactions, negative affect, cognitive elaboration, and perceived message effectiveness, as well as lower perceptions of healthfulness, appeal, and intentions to purchase or consume the product ($p < 0.001$ for all comparisons of warnings to control). There were no differences in outcomes between text and pictorial sugar warning labels. In conclusion, text and pictorial sugar warning labels reduced parents' likelihood of selecting a labeled granola snack for their children. These results contribute to a growing body of evidence showing that warning labels influence food purchasing behaviors.

1. Introduction

Children's consumption of foods with added sugar is a pressing public health concern worldwide. In the US, Australia, and Europe, average intake of added or free sugar among children remains above the international recommendations of 5% (Azais-Braesco et al., 2017; Lei et al., 2016; Russo et al., 2020; WHO, 2015). Data on added sugar intake in other regions is sparser due to lack of mandatory labeling requirements and national dietary intake data, but available studies indicate that pediatric added sugar intake is already high in some low-

Abbreviations: SNAP, Supplemental Nutrition Assistance Program; WIC, Special Supplemental Nutrition Program for Women, Infants, and Children; PME, Perceived Message Effectiveness; NFP, Nutrition Facts Panel.

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and middle-income settings (Maunder et al., 2015; Pries et al., 2019), and that overall sales of foods and drinks high in added sugar are rapidly increasing across the globe (Popkin & Hawkes, 2016).

In children, excess sugar intake is linked to increased weight gain and increased cardiometabolic risk (Vos et al., 2017). Public policies are an important strategy to reduce sugar intake because of their ability to change the food environment to support healthier choices rather than focusing on individual behavior (Chriqui, 2013). Policies that require warning labels about sugar on the front of products are a promising strategy to help inform consumers of high-sugar products and aid in reducing consumption of added sugar.

Indeed, labels warning of sugar content ("sugar warning labels") applied to the front of product packaging are increasingly being implemented across the globe. These warning labels typically include a text statement that the product is "high in sugar," with some variability in shape, size, and color. In 2016, Chile was the first country to implement a mandatory system of warning labels on the front of packages indicating high sugar content as well as other nutrients of concern (Corvalán et al., 2019), followed by Peru, Israel, Mexico, and Uruguay. Brazil and Colombia are currently in the process of implementation (Resolución Número, 2021; World Cancer Research Fund International, 2017). Although in Chile the introduction of warning labels was accompanied by other interventions (e.g., advertisement restrictions), initial results from evaluation studies suggest that warning labels reduced intake of added sugar, with one study finding a 24% relative decline in purchases of sugar-sweetened beverages after implementation (Taillie et al., 2020c).

In addition, a growing body of experimental evidence demonstrates that nutrient warning labels are easy for consumers to understand, help them identify products high in nutrients of concern, and discourage purchasing of such products (Grummon & Hall, 2020; Taillie et al., 2020a). However, most previous relevant experimental studies have tested labels warning of multiple nutrients rather than just sugar (e.g., calories, sodium, saturated fat), so the effect of sugar warnings labels specifically is less clear. Studies that have focused on sugar warning labels have focused predominantly on sugar-sweetened beverages (Clarke et al., 2020), finding that sugar warning labels are perceived to be effective at making consumers concerned with the health effects of drinking sugary drinks, making sugary drinks seem unpleasant, discouraging sugary drink consumption (Hall et al., 2021), and reducing parents' selection of sugary drinks (Mantzari et al., 2018).

Although these findings suggest that warning labels hold promise, it is important to understand the impact of sugar warning labels on consumers' perceptions and decisions to purchase not only beverages, but foods as well. Added sugar from foods accounts for a large and growing proportion of added sugar in children's diets (Bailey et al., 2018). In addition, most current literature on nutrient warning labels focuses on text statements only. However, evidence suggests that the use of icons or images can enhance the effectiveness of labels (Donnelly et al., 2018; Hall et al., 2020; Rosenblatt et al., 2019). Finally, most existing studies of food labeling have relied on self-reported data or exposure to warnings outside the context of a retail environment. A more realistic point-of-purchase setting is needed to test the causal impact of nutrient warning labels on parents' decisions to purchase labeled snacks for their children.

The objective of this study was to experimentally test whether a sugar warning label ("high in added sugar") would reduce the likelihood of parents selecting a labeled versus a non-labeled snack to purchase for their children in a virtual convenience store. A secondary objective was to test whether a sugar warning label that included an icon (e.g., a pictorial warning) would have a bigger impact on selection of a labeled snack than a sugar warning comprised of text only. This study also assessed parents' perceptions of healthfulness of the snack, snack appeal, and intentions to purchase and consume the snack. Finally, parents' reactions to the labels and perceptions of the labeled product were also examined.

The primary hypothesis was that sugar warning labels would reduce parents' likelihood of selecting a labeled snack for purchase compared to a control label. The secondary hypothesis was that pictorial warning labels would result in reduced selection of labeled snacks compared to text-only warning labels.

2. Methods

The Institutional Review Boards at the University of North Carolina approved the study. The study was preregistered on ClinicalTrials.gov prior to beginning data collection (NCT04381481).

2.1. Participants

Participants (n = 2,219) were recruited via online convenience sample through two panel research companies, Kantar (www.kantar.com) and CloudResearch (www.cloudresearch.com). Study criteria included: current US resident; age ≥18 years old; and being a parent (or guardian) of at least one child between ages 1–5 years. This experiment was conducted as an ancillary study of a trial focused on assessing parents' decisions to select a fruit drink for their child. Because of this, an additional criterion was that the child of interest for the survey (i.e., the child with the most recent birthday) must have consumed at least one fruit drink within the past week.

2.2. Stimuli development

2.2.1. Products

Individual-sized bags of granola bites were chosen as the product on which warning labels would appear, because they represent a snack category that would be appealing to children. A visual communication expert created two mock brands of granola bites to control for established brand preferences (Lazard et al., 2018). The brands were designed to look similar in terms of size, color scheme, and other front-of-package elements (e.g., information about net weight of contents). The specific mock brands used in this study were selected based on a pre-test experiment showing that participants rated each brand similarly in terms of perceptions of healthfulness and product appeal (n = 1,002 US adults recruited through Amazon Mechanical Turk). Nutrition facts label information, including ingredients and nutrients, was based on similar real-life products and developed by a registered dietitian. Both mock brands had the same nutritional information. Both products would be considered high-in sugar using criteria from the warning label policy of Chile, the first country to require warning labels on high-sugar products (e.g., contains added sugar and has >10 g total sugar per 100 g of product). In this case, the snacks contained 7 g of total sugar per serving (24 g in product). The key difference between the two products was that one product contained a front-of-package label (text warning, pictorial warning, or barcode control label, depending on study arm) and the other product had no front-of-package label.

2.2.2. Labels

Fig. 1 presents images of the labeled and non-labeled granola snack products used in the virtual convenience store. Depending on study arm, the labeled granola snack product displayed one of three types of labels: a text sugar warning, a pictorial sugar warning, and a barcode control label. Both warning labels consisted of a black square with text indicating "WARNING: High in added sugar" (Grummon et al., 2019a). The pictorial warning also included an image of a glass full of sugar cubes with a red background. A pre-test experiment of added sugar images (e.g., glass of sugar, pile of sugar with a spoon, cubes of sugar, scoop of sugar, and cubes of sugar with exclamation points) indicated that a glass full of sugar cubes was the image most likely to discourage purchasing a snack high in added sugar. Similar to previous studies (Grummon et al., 2019b), a barcode was used as a control label to control for the effect of having a label on the front of the package and also allows all participants

Fig. 1. Images of labeled and non-labeled granola bites products created for virtual convenience store shopping experiment.
Panel A) Granola bites with labels, depending on study arm: A) text-only warning label (black box with text: "WARNING: High in added sugar."; B) pictorial warning label (red box with text: "WARNING: High in added sugar."); and C) barcode control label. Panel B) Non-labeled granola bites. . (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

to respond to questions about a label.

2.2.3. Virtual convenience store

This experiment was implemented through iShoppe, a 3-D virtual convenience store developed by a team of researchers and graphic designers at RTI International. The store was designed to resemble a real-world convenience store and has previously been used in experiments on point-of-purchase interventions for tobacco products (Guillory et al., 2020; Kim et al., 2014) and nutrition labeling (Blitstein et al., 2020). The store included shelves with snacks, a fountain drink section, coolers, restrooms, and a check-out counter with a clerk. The products in the store were 3-D, and participants were able to view all sides of the granola products and read the nutrition information on the back of the package (e.g., the nutrition facts panel and ingredients list). The granola snacks in this experiment were located on a small wire rack on top of the check-out counter (Supplemental Figure 1).

2.3. Procedures

Participants provided electronic informed consent before completing an online shopping task in the virtual convenience store.

The study was a randomized experiment with a between-subjects design. Participants were randomized using a 1:1:1 allocation ratio to assign them to view one of three labels on one of the two granola snacks: a barcode control label, a text sugar warning, or a pictorial sugar warning. The other granola snack did not have a label in any condition. Accordingly, in each condition, participants had a choice between a labeled and a non-labeled granola snack.

Upon entering iShoppe, participants were instructed on how to move through the store and directed to complete the shopping task. First, participants had to select two beverages for their child from the beverage coolers as part of an experiment of fruit drink marketing claims. Then, as they proceeded to the checkout counter, they were instructed to select a granola snack for their child before checking out. At the checkout counter, they viewed the two granola bite snacks side by side (one labeled, one non-labeled). The participants had to compare the products side by side and select one granola snack for their child. Participants were required to choose one snack for purchase to complete the shopping task. After the shopping task, participants completed an online survey programmed in Qualtrics. First, to assess secondary outcomes that could not be measured in the store, participants saw an image of the labeled snack per their assigned condition and answered questions related to the snack as we have done in prior studies (Grummon et al., 2019b; Hall et al., 2022). Then, they saw an image of the two snacks (labeled and non-labeled) and answered questions about which snack they would choose, to assess comparability in selection in the context of a survey versus in the store. Finally, they saw an image of the label in isolation (i.e., not on the snack) and were asked to assess the label itself. During the survey, participants were also asked to respond to questions relating to fruit drinks and other products. For their participation, participants received previously agreed upon incentives from the panel companies.

2.4. Measures

Participant characteristics included the parent's self-identified age,

gender, race and ethnicity, sexual orientation, educational attainment, household income, participation in the Supplemental Nutrition Assistance Program (SNAP), participation in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC), body mass index; and the age, gender, and race/ethnicity of the child for whom the parent shopped.

The primary outcome was the percent of participants who selected the labeled granola snack compared to the non-labeled granola snack during the shopping task. The secondary outcome was the percent of participants who selected the labeled granola snack compared to the non-labeled granola snack as the snack they would most want to buy for their child in the post-shopping task survey. We also recorded whether the participant viewed the product's nutrition facts label during the shopping visit.

Additional outcomes from the post-shopping survey included constructs predictive of behavior change according to our conceptual framework for warning labels (Taillie et al., 2020a) (Supplemental Figure 2). These included intentions to purchase the labeled snack ("How likely would you be to buy this snack in the next week, if it were available?"; range 1–5, not at all likely to very likely), perceived healthfulness ("How healthy would it be for your child to eat this snack every day?"; range 1–5, very unhealthy to very healthy), and perceived product appeal ("How appealing would your child find this snack?"; range 1–5, very unappealing to very appealing). The survey also assessed participants' intentions to give the labeled snack to their child and consume the snack themselves (range 1–5, not at all likely to extremely likely, for each item).

Finally, participants assessed the label itself (i.e., reactions to the label). Outcomes included perceived message effectiveness (PME) using a validated measure shown to predict behavior change in the context of tobacco (Baig et al., 2018, 2021) ("How much does this label …" "… make you concerned about the health effects of consuming this product?; " "make consuming this product seem unpleasant to you?; " and "discourage you from wanting to consume this product?"; range 1–5, not at all likely to extremely likely). Additional label reactions included learning something new ("Did you learn something new from the label?"; range 0–1, no/yes) as well as anticipated social interactions ("How likely are you to talk about this label with others in the next week?"; range 1–5, not at all likely to extremely likely), grabbing attention ("How much does this label grab your attention?"; range 1–5, not at all to a great deal); negative affect ("How much does this label make you feel scared?"; range 1–5, not at all to a great deal); and cognitive elaboration ("How much does this label make you think about the health problems caused by eating this snack?"; range 1–5, not at all to a great deal) (Taillie et al., 2020a).

Although we pre-registered additional items from the shopping experiment (e.g., participants' assessment of which product contained more added sugar and which product was healthier), we opted not analyze these data because there was not one correct answer (the nutrition facts panels of both products were the same).

2.5. Analysis

First, demographic characteristics were compared between label conditions using chi-square tests for categorical variables and t-tests for continuous variables.

For the main outcome, likelihood of selecting the labeled snack in the virtual store, and for all other dichotomous outcomes, logistic regression models were used where the independent variable was warning condition. Linear regression models were used for predictions with Likert-style outcomes and scales, one for each outcome. Although the Shapiro-Wilk test for normality showed that data were not normally distributed, ordinal logistic regression models revealed a similar pattern of results (i.e., same direction, same pattern of statistical significance), so the linear regression models were retained for ease of interpretation. For each model, the margins command in Stata was used for significance testing of control vs. each warning message separately, as well as each warning message compared to each other. Bonferroni corrections accounted for multiple tests within each model (e.g., comparing each warning arm to the control label and each warning arm to each other). A critical alpha of 0.05 was used for all models to determine statistical significance. Cohen's d was calculated for the main outcome of selecting the labeled snack, to facilitate comparisons of effect size to other experimental studies of warning labels (Cohen, 1988).

A series of logistic regressions which included an interaction term between label condition and participant characteristic explored whether participant characteristics modified the effect of warning labels on snack choice. Although not pre-registered, because the main effects of each warning type (text and pictorial) were similar in magnitude, both warning label conditions were combined for moderation analyses to improve statistical power. Participant characteristics included race/ethnicity of parent (White non-Hispanic vs. Black non-Hispanic vs. Hispanic); educational attainment ($\leq$high school or $>$ high school), household income ($<$75,000 or $\geq$$75,000/year), and whether the participant viewed the product's nutrition facts label during the shopping visit. For each model, Wald chi-square tests were used to test the statistical significance of the interaction term. All analyses were Bonferroni-corrected for multiple comparisons.

Finally, our pre-registration stated that the main prediction was that the label would reduce the likelihood of selecting the "higher sugar" granola snack. However, in the actual experiment, the amount of sugar listed in the nutrition facts panel was the same for labeled and non-labeled granola snacks. Thus, the tested hypothesis was that the warning label would decrease selection of the labeled snack. To understand whether label condition affected viewing the nutrition facts panel, we analyzed an additional outcome: viewing of the nutrition facts panel by study arm.

Because this experiment was an ancillary study, no *a priori* sample size calculation was conducted.

3. Results

Socio-demographic characteristics of the sample are presented in Table 1. There were no significant differences in means or proportions of characteristics by study arm. Participants' mean age was 34.8 years ($\pm$7.6), most (63%) identified as women, 17% identified as non-Hispanic Black or African American, and 33% identified as Hispanic. With regard to socio-economic characteristics, 34% had a high school diploma or less, while 32% had a household income less than $50,000. Twenty percent reported using SNAP in the past year, while 13% reported using WIC. About half (54%) reported reading the nutrition facts label often or all the time. Only 12% of participants viewed the back of package nutritional information. Unadjusted descriptive results can be found in Supplemental Table 1.

In the virtual shopping experiment, when presented with a choice of a labeled vs. non-labeled granola snack, participants in the text and pictorial warning label groups were less likely to select the labeled snack for purchase than those in the barcode control group (21%, 18%, and 34% respectively; $p < 0.001$ for both comparisons of warning to control; Fig. 2). The Cohen's d was 0.31 for text warnings and 0.37 for pictorial warnings. There were no statistically significant differences in snack selection between the text and pictorial warning label groups ($p = 0.743$). In the post-experiment survey, when presented again with the images of the labeled and non-labeled granola snacks, participants exposed to text and pictorial warnings were less likely to select the labeled snack as the snack they would most prefer to purchase for their child, compared to the barcode control (12%, 13%, and 38%, respectively; $p < 0.001$ for both comparisons of warning to control; Fig. 3). There were no statistically significant differences in outcomes between the text and pictorial warning label groups ($p = 1.000$). Full regression results for all models are reported in Supplemental Table 2.

There was no statistically significant difference in the percent of

Table 1
Characteristics of study participants in a virtual convenience store shopping experiment (n = 2,219).

	n	%
Study arm		
Barcode Control Label	741	33%
Text Warning Label	740	33%
Pictorial Warning Label	738	33%
Characteristic of the parent		
Age		
Mean in years (SD)	34.8	7.6
Gender		
Man	768	35%
Woman	1402	63%
Transgender or other gender identity	1	0%
No response	48	2%
Sexual orientation		
Straight or heterosexual	1997	90%
Gay, lesbian, bisexual, or another	173	8%
No response	49	2%
Race and Ethnicity		
Non-Hispanic White	1095	49%
Non-Hispanic Black	389	17%
Hispanic	735	33%
Education		
High school diploma or less	743	34%
College graduate	1428	64%
No response	48	2%
Household income, annual		
$0-$24,999	254	11%
$25,000-$49,999	459	21%
$50,000-$74,999	460	21%
$75,000+	990	45%
No response	56	2%
Used SNAP in the last year	445	20%
Used WIC in the last year	293	13%
Body mass index (BMI, kg/m^2)[a]		
Underweight (<18.5)	100	4%
Healthy Weight (18.5–24.9)	894	40%
Overweight (25.0–29.9)	576	26%
Obese (>29.9)	565	26%
No response	84	4%
Mean BMI (SD)	27.2	7.5
Viewed nutrition fact panel label during study	256	12%
Characteristics of the child the parent shopped for during experiment[b]		
Child Age		
Mean in years (SD)	3.5	1.3
Child Gender		
Boy	1201	54%
Girl	996	45%
Other gender identity	1	0%
No response	21	1%
Child Race and Ethnicity		
Non-Hispanic White	1051	48%
Non-Hispanic Black	357	16%
Hispanic	713	32%
Non-Hispanic other	75	3%
No response	23	1%

SD = Standard Deviation; SNAP = Supplemental Nutrition Assistance Program; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children.
Characteristics did not differ by between-subjects experimental labeling conditions.
[a] Self-reported.
[b] Asked about child ages 1–5 years with the most recent birthday.

participants who viewed the NFP information by condition type (13% in the control, 10% in the text warning, 11% in the pictorial warning group, p = 0.518 for control vs text; p = 1.000 for other comparisons) (Table 2).

Participant reactions to the labels also varied by label type (Table 2). Compared to the barcode control label, participants who saw text and pictorial warnings reported that they were more likely to learn something new from the label (75% and 77%, respectively, compared to 24% in the control label, p < 0.001 for both comparisons). Participants who saw text and pictorial warnings also reported higher anticipated social interactions, greater attention to the label, higher negative affect, and higher cognitive elaboration compared to the barcode control group (p < 0.001 for all comparisons). Participants who saw text and pictorial warnings perceived the labeled snack as less healthy and less appealing and had lower intentions to buy or consume the product, than did participants in the barcode control group (p < 0.001 for all comparisons). Finally, text and pictorial warnings elicited higher perceived message effectiveness (4.2 ± 0.9 and 4.3 ± 0.8) compared to the barcode control label (2.30 ± 1.3; p < 0.001 for both comparisons). There were no statistically significant differences between the pictorial and text warning arms for label reactions.

When examining moderators, there were no statistically significant interactions by child characteristics (gender, age), parent characteristics (gender, education, race/ethnicity), or whether the parent viewed the nutrition facts panel during the shopping experiment (Table 3). Full regression results for interaction models are reported in Supplemental Table 3.

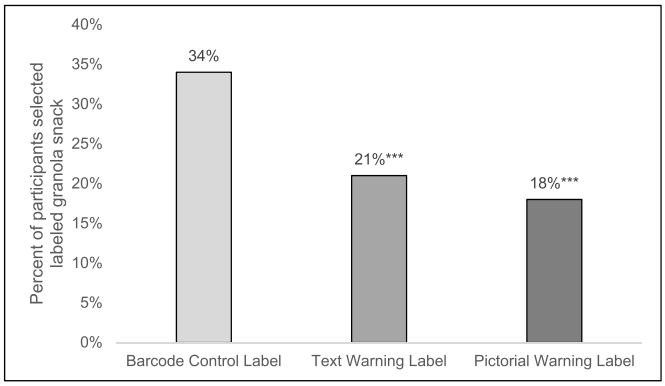

Fig. 2. Percent of participants in a virtual convenience store shopping experiment selecting to select a labeled granola snack product for their child over a non-labeled granola snack product, by study arm (n = 2,219). ***p < 0.0001 compared to barcode control. The comparison between the text warning and pictorial warning was not statistically significant (p = 0.743).

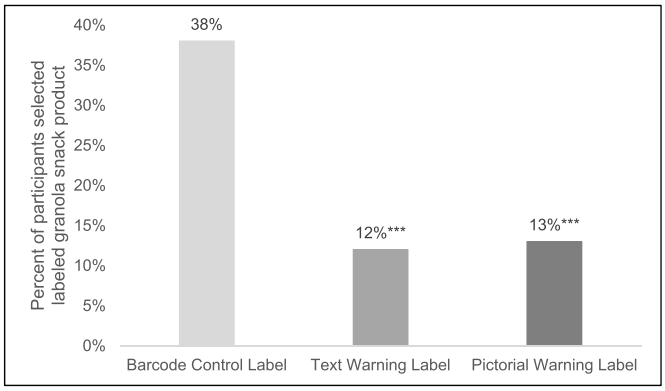

Fig. 3. Percent of participants in the post-shopping survey selecting a labeled granola snack product for their child over a non-labeled granola snack product, by study arm (n = 2,180). ***p < 0.0001 compared to barcode control. The comparison between the text warning and pictorial warning was not statistically significant (p = 1.00).

4. Discussion

The main result of this randomized trial of parents in a virtual convenience store was that both text-based and pictorial sugar warning labels led to fewer parents selecting a labeled sugary snack to purchase

Table 2
Participant reactions to sugar warning labels by study arm (n = 2,219).

Post-shopping survey question		Barcode Control Label		Text Warning Label			Pictorial Warning Label			
Outcomes, %	n	%	n	%	n	p-value, compared to control	%	n	p-value, compared to control	p-value, compared to Text Warning Label
Viewed NFP information[a]	2219	13%	95	11%	78	0.518	11%	83	1.000	1.000
Learned something new from label	2183	24%	172	75%	542	<0.001	77%	558	<0.001	1.000
Outcomes, means										
		Mean	**SD**	**Mean**	**SD**		**Mean**	**SD**		
Anticipated social interactions	2186	2.2	1.4	3.1	1.4	<0.001	3.1	1.4	<0.001	1.000
Label grabs attention	2184	2.5	1.4	4.4	.9	<0.001	4.4	0.9	<0.001	1.000
Label makes participants feel scared	2182	1.9	1.3	3.3	1.3	<0.001	3.4	1.3	<0.001	1.000
Thinking about health effects of labeled snack	2184	2.1	1.4	4.1	1.0	<0.001	4.1	1.0	<0.001	1.000
Product appeal	2184	3.7	1.1	3.5	1.3	<0.001	3.5	1.3	<0.001	1.000
Perceived healthfulness	2186	3.9	0.9	2.6	1.5	<0.001	2.5	1.4	<0.001	0.199
Intentions to give labeled snack to child	2184	3.6	1.1	2.6	1.4	<0.001	2.5	1.4	<0.001	0.237
Intentions to purchase labeled snack	2186	3.4	1.2	2.5	1.4	<0.001	2.4	1.4	<0.001	0.627
Intentions to consume labeled snack	2185	3.5	1.2	2.7	1.4	<0.001	2.6	1.4	<0.001	0.677
Perceived message effectiveness	2181	2.3	1.3	4.2	0.9	<0.001	4.3	0.8	<0.001	1.000

All p-values are Bonferroni corrected for multiple comparisons.
[a] NFP = Nutrition Facts Panel. This outcome is from the in-store shopping experiment. All other outcomes reported are from the post-shopping survey.

Table 3
Percent of participants who selected labeled granola snack product during virtual convenience store shopping experiment, by study arm (n = 2,219).

	Barcode Control Label		Text/ Pictorial Warning Labels[a]		
	%	SE	%	SE	p-value for interaction[b]
Participant Characteristic					
Income					1.000
Less than $75,000	34	2	18	1	
Greater than or equal to $75,000	34	3	21	2	
Parental Education					0.364
Less than or equal to high school diploma	35	3	16	2	
More than a high school diploma	34	2	21	1	
Gender					0.238
Man	33	3	23	2	
Woman	35	2	17	1	
Race and ethnicity					1.000
Non-Hispanic White	32	2	17	1	
Non-Hispanic Black	34	4	22	2	
Hispanic, any race	38	3	22	2	
Viewed NFP[c]					1.000
No	34	2	20	1	
Yes	40	5	18	3	
Child Characteristic[d]					
Age of child					1.000
1 year old	33	6	19	3	
5 years old	35	3	18	2	
Gender of child					1.000
Boy	34	2	20	1	
Girl	35	2	19	2	

SE = Standard Error.
[a] Text and pictorial warning label groups combined.
[b] p-value is for the difference in the effect of warning labels between groups. All p-values are Bonferroni corrected for multiple comparisons.
[c] Participant viewed nutrition facts panel (NFP) during experiment.
[d] Child ages 1–5 with the most recent birthday for which participant was shopping for during experiment.

for their children, compared to parents who saw a barcode control label.

The findings that sugar warning labels reduced parents' likelihood of selecting labeled products by 13%–16% in a food store environment are in line with previous research. For example, Grummon et al. found that among a general adult population, health warning labels on sugary drinks led to a 13 percentage point decrease in selection of sugary drinks to purchase (Grummon et al., 2019b). Another recent study in a naturalistic food store environment found that, among a population of parents ages 2 to 12y, graphic health warning labels led to a 17 percentage point decrease in parents' purchases of sugary drinks for their children (Hall et al., 2022).

In the post-experiment survey, we found a similar pattern of results, with the warning labels leading to reduced selection of the labeled snack relative to the control. Interestingly, the size of the effect of warning labels was larger in the post-experiment survey, potentially due to differences in the format of exposure to stimuli or because the survey represented a second exposure to the stimuli. Whereas in the shopping task, the text-only warning and pictorial warning labels led to decreases in selection of 13% and 16% relative to the control, in the post-experiment survey, the text-only and pictorial warning labels led to decreases of 26% and 25%, respectively, relative to the control. Given that many experiments on food labeling rely on simplistic choice experiments rather than shopping tasks in food retail environments, further research is warranted to understand whether the use of simplistic choice experiments consistently results in larger effects. Still, it was encouraging that the pattern of results was consistent between the two methodologies.

The text and pictorial sugar warning labels also led to decreases in intention to purchase and consume the labeled snack, and they were perceived as more effective at discouraging consumption of high sugar snacks, relative to the barcode control label. Studies of labeling from other fields such as tobacco have found that perceived message effectiveness is a predictor of longer-term behavioral change (Noar et al., 2020). Change in intentions is an important step on the pathway between label exposure and behavioral change ((Taillie et al., 2020a)). Taken together with the results of the shopping experiment showing decreased selection of the labeled snack in the warning label conditions, this pattern of results suggests that exposure to sugar warning labels on

snacks could lead to decreased purchases of labeled snacks for young children. However, we acknowledge that future studies should evaluate the effects of these warnings in real-world settings as well as in the context of a wider variety of snack options to choose from.

Snack choice and product perceptions did not differ between the text and pictorial sugar warning labels. Contrary to health behavior and communications theory (Petty & Cacioppo, 1986; Witte, 1992) and evidence from tobacco control literature, these results are unexpected in that pictorial warnings were projected to have a much larger effect than text warnings due to their ability to elicit greater attention, increase negative affect, and reduce purchasing intentions (Brewer et al., 2019; Hammond, 2011; Noar et al., 2017). For example, a recent study of health warnings by Hall et al. found that pictorial warnings had a greater impact on perceived message effectiveness (e.g., discouraging consumers from wanting to consume sugary drinks) than did text-only warnings (Hall et al., 2020). One possibility is that the type of pictorial warning used in this study (i.e., an image of sugar content) may be less effective relative to other types of pictorial warnings, such as images related to the health consequences of consuming excess added sugar. Indeed, one recent study of parents in the UK found that while pictorial warnings reduced sugary drink selection compared to no label or calorie information, a warning that contained a disease-related image lowered selection more than a warning that contained an image related to sugar content (Mantzari et al., 2018).

This study found that socio-demographic characteristics did not moderate the impact of warning labels on parents' decision to select the labeled snack. It was of particular interest to understand whether the sugar warning labels would have a larger impact among lower-educated parents (that is, those with a high school education or less) compared to those with higher education (those with greater than a high school education). Lower-educated households tend to purchase more sugary drinks and junk foods than higher-educated populations due to a variety of factors (Lacko et al., 2021) and thus have more to gain from labels that reduce purchases of these products. On the other hand, some evidence suggests that lower educated populations are less likely to use nutrition facts labels (Blitstein & Evans, 2006; Christoph et al., 2018). Our results that there was no moderation of warning label impact by education are consistent with previous studies (Acton et al., 2021; Grummon et al., 2019b; Roberto et al., 2016; L. Taillie, Hall, Popkin, Ng, & Murukutla, 2020a; L.S. Taillie et al., 2020b). These results suggest that a real-world application of warning labels would work well across groups.

This study has several limitations. First, while the 3D virtual convenience store was designed to look like a real-life convenience store, there are several differences between the experimental setting and a real-life convenience store. For example, there were fewer products available for purchase, no prices listed, no advertisements, promotions, or other marketing elements, and parents did not spend actual money or receive the product. In addition, a recent meta-analysis of health warning labels found that studies conducted in online settings reported larger effects than those conducted in laboratories using physical products (Clarke et al., 2020). Thus, there is a clear and pressing need for the observed effects to be replicated in field studies with a more naturalistic setting.

In addition, although the labeled snack would have been considered as high-in sugar by several international nutrition profile models based on relative contributions of sugar to total energy, the actual sugar content was relatively low and did not differ between the labeled and non-labeled products. The effect of the label may have been even greater for higher-sugar products or if there was variability in sugar between labeled and non-labeled snacks. However, only 12% of participants viewed the information about sugar content on the back of the package. Moreover, the effect of the warning labels did not vary for those who viewed the nutrition facts panel vs. those who did not. It would be useful to replicate this study in a real store environment with real products, as well as with an array of products ranging in sugar content, with high-sugar products that contain warnings and low-sugar products that do not. This will be important to ensure that sugar warning labels shift consumers from high-sugar options to lower-sugar alternatives. A final limitation is that in the analysis, intrinsically ordinal-scale Likert data were assumed to be on an interval scale.

5. Conclusions

This study found that compared to a barcode control label, text and pictorial sugar warning labels reduced parents' likelihood of selecting a labeled granola snack to purchase for their child, with text and pictorial warning labels performing similarly. Overall, these results contribute to the growing body of evidence that warning labels reduce purchases of products carrying the label.

Ethical statement

This study was reviewed and approved by the University of North Carolina Institutional Review Board (Study #19–3227).

Author Contributions

MGH, LST, AJL, and JLB designed the research study and acquired funding; AJL designed the study stimuli; ICAH managed the study; DRM analyzed the data; LST wrote the first draft of the paper. All authors read and approved the final manuscript. Data described in the manuscript, codebook, and analytic code will be made available upon request pending approval from the study principal investigators.

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Declaration of competing interest

There were no conflicts of interest to report.

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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.2022.106059.

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