Impact of nutrient warning labels on choice of ultra-processed food and drinks high in sugar, sodium, and saturated fat in Colombia: A randomized controlled trial

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Abstract

Background

Front-of-package nutrient warning labels are one promising policy to inform healthier food choices and purchasing decisions. This study aimed to identify the impact of nutrient warning labels on product selection and the ability to correctly identify products with an excess of critical nutrients, among other outcomes in Colombia.

Methods

We conducted an online randomized experiment among 8,061 Colombian adults in October 2020. Participants were randomly assigned to a front-of-package label condition: nutrient warning, guideline daily amounts (GDA), Nutri-Score, or a no-label condition. First, they viewed a fruit drink with added sugar that was labeled per their assigned condition and one without added sugar, which was only labeled in the GDA and Nutri-Score conditions, and completed selection tasks. The primary outcomes were 1) selection of the fruit drink with added sugar as the fruit drink they would rather buy and 2) correctly identifying which fruit drink was higher in sugar. Next, they viewed four food products (cookies, yogurt, sliced bread, and breakfast cereal) with their assigned condition and answered a series of questions. Finally, they selected which of the three label types would most discourage them from consuming a specified ultra-processed food.

Results

Fewer participants in the nutrient warning condition (20%) selected the added sugar fruit drink as the product they would rather buy compared to 24% in the GDA condition ($p<.01$), 29% in the no-label condition, and 33% in the Nutri-Score condition (both, $p<.001$). More participants in the nutrient warning condition (88%) correctly identified the fruit drink higher in sugar compared to the no-label condition (68%) and the Nutri-Score condition (65%) (both, $p<.001$). More participants in the GDA condition (91%) correctly identified the fruit drink higher in sugar compared to the nutrient warning condition ($p<.01$). Most participants (72%) selected the nutrient warning label as most discouraging, while only 20% selected the GDA label and 9% selected the Nutri-Score label.

Conclusions

Nutrient warning labels are a promising policy strategy to prevent obesity and diet-related non-communicable diseases in Colombia. Future research is needed to understand the impact of nutrient warning labels on actual ultra-processed food purchases in Colombia.

Trial Registration: NCT04567004

Background

The global obesity pandemic and diet-related non-communicable diseases (NCD) have become great health challenges, posing risks to the health and lives of individuals, the well-being of families, economic development [1, 2], and the sustainability of the food system [3]. Ultra-processed foods and beverages are generally low in beneficial nutrients like fiber, protein, micronutrients, and bioactive compounds [4–6], and they are mostly high in nutrients related to chronic diseases such as sugar, sodium, and saturated fat [7]. There is compelling evidence about the link between the shift from consumption of unprocessed foods to ultra-processed foods and the increase in obesity and diet-related NCD [8–11].

Colombia is not immune to such health challenges. According to the Colombian National Nutritional Health Surveys (ENSIN) conducted in 2010 and 2015, the rate of overweight and obesity increased in all age groups. The rate increased from 18.8% to 24.4% in school-aged children (5-12 years old), 15.5% to 17.9% in adolescents (13-17 years old), and 51.2% to 56.4% in adults (18-64 years old) [12, 13].

To address the rising prevalence in overweight, obesity and diet-related NCD, scholars, advocates and policymakers are increasingly calling for policies to communicate the health risks of consuming ultra-processed foods and to discourage their consumption [14, 15]. Front-of-package labels have emerged as one promising policy to guide and influence consumers to make healthier food choices and purchasing decisions [16]. Many countries in the world have applied different front-of-package designs such as guideline daily amounts (GDA) labels, Nutri-Score labels, and nutrient warning labels [17]. Currently, in Latin America, front-of-package nutrient warning labels are required in Peru, Uruguay, Chile, and Mexico. Colombia is considering implementing them as well. In 2016, the Colombian Ministry of Health proposed a regulation to require front-of-package nutrient warning labels [18]. In addition, the Senate is scheduled to debate a bill which would require implementation of a nutrient warning label in Colombia [19].

There is emerging evidence that of the different front-of-package labels, nutrient warning labels, similar to the ones implemented in other Latin American countries, may be most effective at helping consumers to identify unhealthy foods and discourage them from selecting those food products [15]. A recent online randomized controlled trial in Colombia that assessed perceptions of and reactions to different nutrient warning label designs, concluded that the octagonal nutrient warning label performed best, and participants overwhelmingly selected it as the nutrient warning label that most discouraged them from wanting to consume an ultra-processed food product [20]. However, despite evidence supporting the octagonal nutrient warning label as the most effective nutrient warning label, there has not been an evaluation in Colombia of the effectiveness of a nutrient warning label compared to other types of front-of-package nutrient systems. Therefore, the objective of this study was to identify the impact of the nutrient warning label on product selection and ability to correctly identify products higher in sugar, in addition to other outcomes, compared to GDA labels, Nutri-Score labels, and a no-label condition in Colombia.

Methods

The study was approved by the institutional review board at the University of North Carolina at Chapel Hill and designated as exempt from review at Universidad Nacional de Colombia. Prior to participating in the study, participants acknowleged their informed consent. We pre-registered the design, hypotheses, and analytic plan on ClinicalTrials.gov (#NCT04567004).

Study design and procedures

The final labels tested are shown in Figure 1. As the study's purpose was to inform Colombia's front-of-package labeling policy, we set out to test front-of-package labels that could be proposed as a result of the policy. Provided this, we decided to test a nutrient warning label, a guideline daily amounts (GDA) label, and a Nutri-Score label as well as a no-label alternative.

We selected the nutrient warning label based on the nutrient warning that performed best in our previous study investigating front-of-package nutrient warning labels. In our previous study, the octagonal nutrient warning elicited the highest perceived message effectiveness (PME) and was the label that most participants selected as discouraging them from purchasing ultra-processed foods and sugary drinks high in nutrients of concern) [20]. The octagonal nutrient warning label was a black octagon that contained a statement about the product containing excess of a nutrient of concern (sugar, sodium, or saturated fat). For example, "EXCESO DE AZÚCAR" (Excess sugar). The octagon also contained "MINSALUD" indicating the message was authorized by the Colombian Ministry of Health and the text "EVITAR SU ALTO CONSUMO" (Avoid high consumption). To determine if a product would receive a nutrient warning label, we used the Chilean Ministry of Health's third stage cutoff limits for sugar, sodium, and saturated fat [21].

The GDA label included Spanish text above the GDA figure stating the product serving size. Below the serving size, a row of light blue blocks listed the Calories, total fat, saturated fat, sugar, and sodium per serving, as well as percentages indicating what percent of the GDA the serving contained. Underneath the light blue blocks, Spanish text explained the percentages were based on the guideline daily amounts for a 2,000-Calorie diet [22].

The Nutri-Score label system, which is currently used voluntarily in some European countries [23], is a color coded and letter rated (A-E) system. A dark green "A" indicates the best nutritional value and a dark red "E" indicates the worst nutritional value. A product's letter rating is determined based on a point system. A higher point value indicates a less healthy product. The more calories, sugar, sodium, and saturated fat a product contains, the more points it receives. However, a product can also receive negative points for containing fiber, protein, and fruits and vegetables, which can decrease the product's total points [24].

Finally, we decided to also test a no-label condition. Previous experiments on nutrient warning labels have used a neutral barcode as a control in order to measure perceptions of and reactions to front-of-package labels [20]. However, in this study, we wanted to test actual policies that could be implemented by the Colombian government. It is possible that the government could decide to not implement a front-of-

package labelling system (status quo), so we also tested a no-label condition to measure the outcomes of maintaining the status quo compared to implementing the nutrient warning label. We used the Peruvian warning labeling guidelines to design the size and placement of the label conditions [25].

Product development and applied labels

Images of the products can be found in Figure A1. We selected food and drink products from categories that are commonly consumed in Colombia and may not be commonly identified as products high in nutrients of concern. We modeled the products after real Colombian ultra-processed products that are high in nutrients of concern (sugar, sodium, and saturated fat). We used three products we had previously tested (fruit drink, oatmeal cookies, and sliced bread) [20], and the same graphic designer who developed our previous products helped in the development of three new products: a no-sugar-added fruit drink, breakfast cereal, and strawberry yogurt. The breakfast cereal was slightly different from the other products because it contained excess amounts of both sugar and sodium. Therefore, the breakfast cereal fashioned two nutrient warning labels, while the other products only had one. All products contained fictional brand names to avoid consumer brand loyalty bias.

For each labelling system, the presence or absence of the label (nutrient warnings) or content of the labels (Nutri-score, GDA) depended on the nutritional composition of the product. Thus, we created nutrition profiles for each product, based on similar Colombian products. Table 1 provides each product's nutritional profile and the corresponding label applied.

Table 1. Product nutrition details as well as label applied to each product

Product	Nutrition profile	GDA Label (% of GDA)	Nutri-Score Label	Nutrient Nutrient warning Label
No-sugar added fruit drink	Calories: 33.8 Fat: 0g Saturated Fat: 0g Sugars: 15.8g Sodium: 33.8mg	Calories: 2% Fat: 0% Saturated fat: 0% Sugars: 18% Sodium: 1%	B	None
Fruit drink	Calories: 168.8 Fat: 0g Saturated Fat: 0g Sugars: 39.4g Sodium: 28.1mg	Calories: 8% Fat: 0% Saturated Fat: 0% Sugars: 44% Sodium: 0%	B	Excess sugar
Strawberry yogurt	Calories: 170 Fat: 5g Saturated Fat: 3g Sugars: 24g Sodium: 75mg	Calories: 9% Fat: 7% Saturated Fat: 15% Sugars: 27% Sodium: 1%	B	Excess sugar
Oatmeal cookies	Calories: 700 Fat: 35g Saturated Fat: 15g Sugars: 15g Sodium: 200mg	Calories: 35% Fat: 50% Saturated Fat: 75% Sugars: 17% Sodium: 3%	C	Excess saturated fat
Sliced bread	Calories: 100 Fat: 2g Saturated Fat: 1g Sugars: 0g Sodium:180mg	Calories: 5% Fat: 3% Saturated Fat: 5% Sugars: 0% Sodium: 3%	B	Excess salt/sodium
Cereal	Calories: 130 Fat: 2.5g Saturated Fat: 0g Sugars: 6g Sodium: 135mg	Calories: 7% Fat: 4% Saturated Fat: 0% Sugars: 7% Sodium: 2%	C	Excess sugar; Excess salt/sodium

Participants

In October 2020, we recruited an online national convenience sample of 8,061 adults in Colombia to participate in an experiment. We recruited participants through Offerwise, a market research company with over 300,000 panel participants in Colombia. Inclusion criteria included presently residing in Colombia and being older than 18 years old and younger than 65 years old. We excluded panel members that participated in a previous study of ours investigating the efficacy of different front-of-package nutrient warning labels [20]. We set sample quotas for gender to reflect the Colombian population and for education level (half high school graduate or less, half college degree or higher) to ensure our sample was powered to detect differences in the primary outcome by education level. Participants earned a pre-determined amount of points from Offerwise for completing the study. Participants are able to convert points into money once they accumulate a specified amount.

Procedures

Participants completed an online survey programmed in Spanish using Qualtrics survey software. After providing informed consent, participants were randomized to one of the four front-of-package label conditions: nutrient warning label, Nutri-Score label, GDA label, or a no-label condition. They first completed a selection task, where they were asked a series of questions about two fruit drinks, one of which was healthier (no added sugar) and one of which was less healthy (contained 39.4 grams of sugar). The fruit drinks were displayed according to their randomly assigned condition.

Next, participants completed single product assessment tasks. They viewed a prompt that read: *"The next questions are about food products. You will look at a few different products and answer questions about each one. Please keep in mind that this study seeks to evaluate your survey responses and not the sale of the product."* Then, they answered a series of questions about the yogurt, cookies, and sliced bread, which showed their assigned label on them. The participants answered all questions about one product at a time (displayed in random order). After these three products, the participants answered one more set of questions about the breakfast cereal. The breakfast cereal was always displayed last as the nutrient warning label condition contained two labels.

Finally, the participants were randomly assigned to see the yogurt, cookies, or sliced bread again (one product only). However, this time, the product did not include a label. Instead, the three label types were listed underneath the product and the participant was asked questions about the labels. The study ended with standard demographic questions.

Measures

Our study had two primary outcomes, 1) selection of the less healthy fruit drink as the fruit drink the participant would rather buy and 2) correctly identifying which fruit drink was higher in sugar. Secondary outcomes included objective understanding, or the ability to correctly identify the less healthy fruit drink, ability to correctly identify if the products contained excess of nutrients of concern, perceived message effectiveness (PME), intentions to purchase the products, and the most discouraging label. All measures were cognitively tested with Colombians of different education levels to make sure the measures were properly adapted to the Colombian context and accessible to all education levels [26].

For the selection task, participants were asked to select one of the two fruit drinks for the following questions: *"Which of these products is MOST unhealthy?"*, *"Which of these products is higher in sugar?"*, and *"Which of these products would you rather buy?"* Both the order of the three questions and the position of each fruit drink (left or right) were randomized.

Next, for the questions about the yogurt, cookies, and sliced bread, we measured objective understanding, or whether participants could correctly identify if the product contained excess of the nutrient of concern (sugar, sodium, or saturated fat respectively) (yes/no?), and we measured the participants' likelihood of wanting to purchase the product in the next week if it were available (range from "very much" (coded as 5) to "not at all" (coded as 1)).

We also measured PME of the labels, using three items from the UNC perceived message effectiveness scale [27, 28]which read: *"How much does the label…" "make you worried about the health consequences of consuming this product?"* (range from "very much" (coded as 5) to "not at all" (coded as 1)), *"make consuming this product seem unpleasant to you?"* (range from "very much" (coded as 5) to "not at all" (coded as 1)), and *"discourage you from wanting to consume this product?"* (range from "very much" (coded as 5) to "not at all" (coded as 1)) . Because PME is specifically about labels, we did not measure PME for the no-label condition. For the breakfast cereal, we measured participants' ability to correctly identify if the product contained excess of the nutrients of concern (sugar and sodium), and we measured PME.

Finally, when participants viewed all three label types below one of the randomly selected products (yogurt, cookies, bread), they were asked to select which label would most discourage them from wanting to consume the product.

Analyses

All analyses were conducted in STATA version 16.0. A two-sided critical alpha of 0.05 was used to assess statistical significance. Using G.Power 3.1.9.4, we estimated that with a sample of ~8,000, alpha of 0.05, and 80% power, we could detect an effect of f=0.036. We excluded participants from analysis if they were duplicate responders (dropped all responses except first), completed the study in less than two minutes, or if they did not answer at least one primary or secondary outcome (see Figure 2).

We calculated unadjusted means (and standard deviations) and percentages for the primary and secondary outcomes. For our secondary outcome, PME, we took the average of the 3 items for each product type (Cronbach's alpha for each product type>.70). We then assessed whether primary and secondary outcomes varied by condition compared to the nutrient warning label. Because the breakfast cereal contained excess of two nutrients of concern, we examined whether the breakfast cereal outcomes exhibited the same pattern prior to adding them to the overall reported measures. We used linear regression for continuous outcomes (including PME) and logistic regression for binary outcomes. For outcomes that were assessed using repeated measures for multiple product types, we used mixed models treating the intercept as random at the respondent level to account for repeated measures. These models included the between-subjects factor (i.e., label type), the within-subjects factor (i.e., product type), and their interaction. We conducted pairwise comparisons of the predicted means or predicted percentages between each label type. We applied Holm's sequentially rejective procedure [29] to the primary outcomes, objective understanding, the ability to identify if the products contained excess of nutrients of concern, and the likelihood of purchasing the product if it were available to account for multiple comparisons.

To evaluate the most discouraging label, we examined the proportion of participants that selected each label type as the one that most discouraged them from consuming products high in sugar, sodium, or saturated fat.

Finally, to assess whether the effect of label type on the primary outcomes differed by education, we tested for an interaction of nutrient warning with education level specified as low (high school diploma or less) vs. high (college degree or higher) and used a Wald chunk test to determine the joint interaction. We conducted pairwise comparisons to predict percentages by label type and education level.

Results

Descriptive statistics

Participant characteristics are listed in Table 2. Raw means and proportions can be found in Tables A1 and A2.

Table 2. Socio-demographic characteristics (n=8,061)

	n	%
Label condition		
No label	2113	26.2%
Nutri-Score	1974	24.5%
Nutrient warning	1999	24.8%
GDA	1975	24.5%
Age		
18-24	3028	37.6%
25-34	2488	30.9%
35-44	1603	19.9%
45-54	723	9.0%
55-64	219	2.7%
Gender		
Man	3910	48.5%
Woman	4118	51.1%
Other gender identity	33	0.4%
Body mass index (BMI, kg/m^2)		
Underweight (<18.5)	546	7.1%
Healthy weight (18.5-24.9)	4148	53.6%
Overweight (25.0 - 29.9)	2153	27.8%
Obese (>29.9)	891	11.5%
Mean BMI (SD)	24.8	6.7
Education level		
Low (High school diploma or less)	4010	49.7%
High (College degree or higher)	4051	50.3%
Region		
Atlantica	1094	13.7%
Oriental	1189	14.9%
Central	1655	20.7%
Pacifica	1095	13.7%
Orinoquia	87	1.1%
Bogota	2856	35.8%
Children in household (ages 0-18)		
Yes	5,286	66%
Ethnicity		
Indigenous	138	1.7%
Afro-descendent	445	5.6%
White	2192	27.4%
Mestizo	3258	40.8%
Other ethnic group	497	6.2%
No ethnic group	1462	18.3%
Financial situation		
Can pay bills and buy additional things	2213	27.8%
Can pay bills and buy what is needed	3470	43.5%
Can pay bills but not buy everything that is needed	1674	21%
Can’t pay the bills	616	7.7%

Note. Missing demographic data ranged from 0% to 4.01%.

Choice experiment

In the fruit drink selection task, the nutrient warning label was more effective than the no-label, GDA, and Nutri-Score conditions at decreasing the percentage of people who wanted to purchase the less-healthy fruit drink. Twenty percent of participants in the nutrient warning condition selected the less healthy fruit drink as the drink they most wanted to buy compared to 24% in the GDA condition, 29% in the no-label condition, and 33% in the Nutri-Score condition ($p<.001$ for Nutri-Score and no-label conditions compared to the nutrient warning, adjusted; $p<0.01$ for GDA condition compared to the nutrient warning, adjusted) (see Figure 3).

The nutrient warning label was also more effective at helping consumers identify which fruit drink was higher in sugar, relative to the no-label and Nutri-score conditions; while only 65% in the Nutri-Score condition and 68% in the no-label condition correctly identified the fruit drink higher in sugar, 88% in the nutrient warning condition were able to correctly identify which fruit drink was higher in sugar ($p<0.001$ for both conditions compared to the nutrient warning, adjusted). The GDA label was more effective than the nutrient warning label with 91% of participants in the GDA condition correctly identifying which fruit drink was higher in sugar ($p<0.01$ compared to the nutrient warning, adjusted).

Finally, when asked which fruit drink was less healthy, the nutrient warning label increased the likelihood of correctly identifying the less healthy fruit drink with 87% in the nutrient warning condition making the correct identification compared to 68% in the Nutri-Score condition and 71% in the no-label condition ($p<.001$ for both conditions compared to the nutrient warning, adjusted). There were no differences between the nutrient warning and GDA labels.

Interaction of label type and education

There were no significant interactions between education level and condition ($p=0.521$). In particular, the difference between education levels in selecting the less healthy fruit drink was similar among each condition compared to the difference between education levels in the nutrient warning condition (see Figure 4). In other words, education level had a similar interaction across all conditions compared to the nutrient warning condition.

However, the difference between high versus low education levels on the likelihood of correctly identifying the fruit drink higher in sugar was greater in the Nutri-Score condition compared to the nutrient warning condition ($p<0.01$) (Figure 5). In other words, education level had a greater interaction in the Nutri-Score group compared to the nutrient warning condition.

Single product assessment of yogurt, bread, cookies, and cereal high in sugar, sodium, saturated fat, or sugar and sodium

In the single product assessment tasks, compared to the no-label, Nutri-Score, and GDA conditions, the nutrient warning was more effective in helping participants to correctly identify that the product contained excess of the nutrient of concern and more effective in decreasing the participants' likelihood

of wanting to purchase the product if it were available (Table 3; p<.001 for each condition compared to the nutrient warning label). While 75% of participants in the nutrient warning condition correctly identified that the product contained excess of the nutrient of concern, only 23% in the no-label condition, 26% in the Nutri-Score condition, and 43% in the GDA condition were able to do so. The nutrient warning also led to greater perceived message effectiveness compared to both the Nutri-Score and GDA (p<.001 for each condition compared to the nutrient warning label; PME not applicable in the no-label condition).

Table 3. Predicted percent and predicted means of secondary outcomes, by label type

	Correctly identified product as having excess of nutrient			Likelihood of purchasing the product in the next week if it were available			PME		
	%	SE (pp)	*p*	Mean	SE	*p*	*Mean*	*SE*	*p*
Condition									
Nutrient warning	75%	0.01	(ref)	2.58	0.02	(ref)	3.86	0.02	(ref)
No label	23%	0.01	<.001	3.51	0.02	<.001	-	-	-
Nutri-Score	26%	0.01	<.001	3.49	0.02	<.001	2.70	0.02	<.001
GDA	43%	0.01	<.001	3.23	0.02	<.001	2.97	0.02	<.001

Other outcomes

Participants overwhelmingly selected the nutrient warning label as the one that most discouraged them from wanting to consume a product high in sugar, saturated fat, or sodium (Figure 6). Seventy-two percent of participants selected the nutrient warning label as most discouraging compared to only 20% selecting the GDA label and 9% selecting the Nutri-Score label.

Discussion

This online randomized control trial aimed to assess the impact of nutrient warning labels on product selection and identification of less healthy products, among other outcomes, compared to GDA labels, Nutri-Score labels, and no label, among adults aged 18 to 64 years in Colombia. In general, the pattern of results suggests that nutrient warning labels are most effective at achieving desired outcomes. The nutrient warning labels were more effective than other label types at discouraging Colombian consumers from wanting to purchase the less healthy fruit drink. Furthermore, they were more effective in decreasing the likelihood of wanting to purchase products high in sugar, sodium, and saturated fat; increasing the ability to correctly identify the products that contained excess of these nutrients of concern; as well as, increasing PME. When comparing the GDA, Nutri-Score, and nutrient warning labels, consumers were most likely to select the nutrient warning label as the one that most discouraged them from wanting to consume products high in sugar, saturated fat, or sodium. The difference between high and low

education levels on product selection was similar among all conditions, compared to the nutrient warning, suggesting that a nutrient warning label policy would not differentially affect adults with low versus high educational levels more than any other label or no-label policy. These results illustrate the benefits of nutrient warning labels and support the need for policies in Colombia that require this labeling system on products high in nutrients of concern.

The findings of this study regarding nutrient warnings are consistent with prior studies conducted in several Latin American countries [30]. Although the pattern of results suggests that nutrient warnings consistently performed best relative to the GDA, Nutri-Score, and no-label conditions, it is important to note that the GDA label had a slightly better performance (91%) than the octagonal nutrient warning label (88%) at helping consumers identify which fruit drink was higher in sugar when comparing two fruit drinks. One possible reason for this could be due to the large difference in sugar content of the two fruit drinks. While the healthier fruit drink contained 18% of the daily value of sugar, the less healthy fruit drink contained 44% of the daily value of sugar; a difference of 26 percentage points. In a real life shopping situation, the ability to closely compare GDA labels on different products might be more limited as people have less time to examine the labels in detail [31]. In addition, the nutrient warning label performed better than the GDA on the majority of other outcomes, including: helping consumers to correctly identify products as having excess of sugar, saturated fat, or sodium; discouraging purchasing the product in the next week if it were available; and increasing perceived message effectiveness.

This study found that the nutrient warning labels performed better than Nutri-Score on several outcomes. These findings are similar to those of a study conducted in Uruguay, which reported that nutrient warnings were more effective than Nutri-Score in decreasing intentions to purchase unhealthy products [32]. This may be due to the fact that nutrient warning labels provide information in a binary fashion (either the product is high-in or not high-in) which can capture attention and facilitate better understanding compared to other labelling schemes. For example, in this research study, in the nutrient warning condition the fruit drink with added sugar contained an excess sugar warning and the fruit drink without added sugar did not contain a warning, making it easier to identify the less healthy product. Alternatively, in the Nutri-Score condition, based on the Nutri-Score point system, both fruit drinks had the same Nutri-Score of “B” making it more difficult to identify the less healthy product. Future research is needed to understand mediating factors on the pathway between label exposure and behavioral outcomes.

Regarding educational level moderation analyses, there were almost no significant differences in the difference between educational levels in each condition compared to the differences in the nutrient warning condition. This study provides evidence that the nutrient warning label would not exacerbate the difference between people of high versus low educational levels in their likelihood of selecting a less healthy fruit drink or in their ability to correctly identify a fruit drink higher in sugar. This is important considering the beneficial impact that promoting information on healthy food choices could have among the most vulnerable populations, such as those with lower levels of literacy and/or financial resources [33]. Alternatively, in this study the Nutri-Score label did have a greater difference between high versus low

education levels, compared to the nutrient warning, in the ability of the groups to correctly identify the fruit drink higher in sugar. This result was contrary to many other study findings [34, 35], Therefore, more studies must be conducted to understand the role of education and how this label is understood by Colombians and other Latin-American populations.

Strengths and limitations

This is the first randomized online experiment to be carried out in Colombia that assessed the effectiveness of several labelling nutrition systems. In addition, this study used standardized questions from previous studies, which have shown appropriate psychometric characteristics [20, 27, 28].

However, limitations to the research exist. Firstly, because this study examined real-world nutrition labels, we were unable to assess what specific characteristics of each label influenced participants' responses. Nevertheless, the use of real-world labels enabled us to study the effectiveness of labelling systems that could actually be implemented in Colombia. Secondly, although the study population included participants from different Colombian regions, most of them lived in urban areas, which could restrict the external validity of the study. However, the study population included adults from different Colombian regions with diverse social identities which may attenuate this external validity limitation. Finally, this study does not examine the impact of labels on real-world consumer behaviors. However, results from a recent meta-analysis [28] have found that nutrient warning labels are effective at reducing objectively measured purchases of sugar-sweetened beverages; and, the first study to evaluate a real-world nutrient warning label system found that after its implementation, purchases of sugar-sweetened beverages dropped by 24% [20].

Conclusion

Front-of-package nutrient warning labels are a promising policy strategy to help combat overweight, obesity, and diet-related NCD in Colombia. The overall pattern of results showed that nutrient warning labels decreased consumers' selection of an less healthy product and improved consumers' ability to identify a less healthy product, as well as when a product is high in nutrients of concern, when compared to no label, Nutri-Score label, and GDA. The one exception was that GDA performed better than the nutrient warning at helping participants to identify a high-sugar fruit drink, though the magnitude of the effect was small. Overall, the nutrient warning label most consistently performed best in achieving intended outcomes. Future research is needed to understand the impact of nutrient labels on actual ultra-processed food purchases in Colombia.

List Of Abbreviations

ENSIN - Colombian National Nutritional Health Survey

GDA – Guideline daily amounts

NCD – Non-communicable diseases

PME – Perceived message effectiveness

Declarations

Ethics approval and consent to participate

The study was approved by the institutional review board at the University of North Carolina at Chapel Hill (IRB #20-0401) and designated as exempt from review at Universidad Nacional de Colombia.

Consent for publication

Not applicable

Availability of data and materials

The datasets used and analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests

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Authors' contributions

Conceptualization, LST, LFG, MM; methodology, LST, MH, ICAH, NM, LFG, MM, MFP; formal analysis, ICAH, LST, MB; writing—original draft preparation, MM, ICAH, LFG; writing—review and editing, LST, MB, MH, NM, ICAH, LFG, MM, MFP; project administration, LST; funding acquisition, LFG, MM, LST. All authors have read and agreed to the published version of the manuscript.

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