Traffic-light Nutrition Labeling Preferences among Ecuadorian Children

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Abstract

This study evaluates the effect of traffic-light (TL) nutritional label attributes on Ecuadorian children's food choices. Data was collected from a survey of 1,179 Ecuadorian students attending public middle and high school in three major cities located in the southern region of the country (Machala, Loja, and Zamora). The survey instrument included two sets of choice experiments: one with yogurt products and the other with soft drinks (sodas and juice). In the choice scenarios, children were presented with two products that differed in price and the TL label colors for sugar, salt, and fat. Children's product selections in the choice experiments were analyzed using mixed logit models. Results indicate that children are willing to pay increasing premium levels for products with yellow, green, and "does not contain…" labels compared to products with red labels. Overall, study findings offer evidence that TL labels are effective at helping children make food choices consistent with preferences for food products with TL labels representing healthier alternatives.

Keywords: Nutrition, Labeling, Choice Experiment, Children, Willingness to Pay, Ecuador.

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"Children and drunks always speak the *truth." Proverb*

Global obesity has been on the rise for decades, prompting many countries to adopt policies to address this widespread health problem. Worldwide, the rate of obesity has doubled since 1980 (Fox et al., 2019). While commonly thought to affect wealthier, high-income countries, lower- and middle-income countries are experiencing similar trends, prompting more investigation into both the causes of obesity and policy solutions (Malik et al., 2020). At the height of this obesity trend, the global COVID-19 pandemic compelled even more focus onto risk factors for more severe COVID-19 complications. Obesity was determined to be one of the top risk factors, as higher degrees of obesity were linked to increased COVID-19 hospitalizations, intensive care admissions, need for specialized equipment such as ventilators, and mortality (Yang et al., 2021).

Nutrition labeling is at the forefront of the battle to inform and influence healthy food choices among consumers. While many countries have a combination of mandatory and voluntary nutrition labeling requirements and specifications, the efficacy of nutrition labeling policies is largely focused on adult consumers (Jensen et al, 2022; Hall et al. 2022). According to the World Health Organization (2022), 340 million children under the age of 5 and 340 million aged 5-19 are overweight or obese. Lower- and middle-income countries have seen dramatic increases in childhood obesity and worldwide, more people are overweight than underweight. For example, Africa has experienced a 24% increase in obesity for children under 5 in the last two decades (WHO, 2022).

Ecuador, a middle-income country in the northwestern part of South America, is this study's focus. Results from the 2012 and 2018 National Nutrition and Health Survey conducted in Ecuador (ENSANUT) show that overweight and obesity are present in a large proportion of the population, including children: 29.9% of kids (5 to 11 years) and 26.0% of adolescents (12 to 19 years) (INEC, 2018). Experts attribute the high levels of obesity and overweight to an inadequate diet and a lack of physical activity (OMS, 2016). Aiming to improve the diets of the Ecuadorian population, the Ecuadorian Ministry of Public Health introduced in 2013 the regulation for the labeling of processed food products and beverages (MIP, 2013). The regulation required using a traffic-light (TL) nutritional labeling system in the packages of all processed food products.

The TL nutritional system provides consumers with graphical nutritional information about content levels (high, medium, low, and no content) for fat, sugar, and salt in processed food products and beverages (Sandoval et al., 2019) (Figure 1). More recently, Bolivia, Chile, and Peru have introduced similar laws regulating the labeling of processed products (OPS, 2020). There is limited literature evaluating the use, preferences for, and effect of the TL nutritional label implemented in Ecuador almost a decade ago. Most of these studies were carried out using data one or two years after implementing the TL system and are qualitative or use samples that do not represent the Ecuadorian population (Peñaherrera et al., 2019; Poveda, 2016; Díaz et al., 2017). Finally, very few studies have evaluated preferences for TL labels among Ecuadorian children. This is important as children in developing countries, such as Ecuador, have a lot of freedom to purchase food at school or in the streets. Therefore, the main objective of this study is to evaluate the effect of TL nutritional label attributes on Ecuadorian children's food choices.

Literature Review

The literature review is organized as follows. First, we discuss food and nutritional labeling standards, particularly TL nutritional labeling. The literature is narrowed even further for nutritional labeling studies on children.

The general standards used around the globe for food labeling are primarily based on the Codex Alimentarius (Codex Alimentarius Commission, 1999). These standards recommend using food labels that include the food name, ingredients, weight, name and address of manufacturer/packer/vender, date, instructions, and notice of ionizing radiation. Although, each government can regulate these standards, leading to considerable variability between nations (Meijer, 2021), most countries utilize a mix of voluntary and mandatory labeling practices, but generally include some information about nutrition.

Two main nutritional labels are used for package products (FAO, WHO, 2001). The first one is the nutrient declaration/facts label, which provides consumers with a summary of the nutrient composition of the food product. The second type of nutrition label is the supplementary nutrition information label. These supplementary labels are included to facilitate consumers' understanding of the nutritional content of food products and are recommended by the World Health Organization (WHO, 2022). Supplementary nutritional labels generally fall into two categories: interpretative and noninterpretive. Interpretative labels use symbols, figures, and/or cautionary text to inform about the healthfulness or nutrient content. TL labels, nutrient scores, nutrient warnings, and health warnings are the most used interpretative nutrition information labels (Song et al., 2021). Noninterpretive labels, in contrast, convey information using numbers.

There is already a body of literature evaluating the effectiveness of TL and other interpretative labels modifying several outcomes, including understanding, label and products' perceptions, purchases, and consumption. Song et al. (2021) provides a meta-analysis of this literature covering 156 studies, including 97 studies related to TL labels. These authors find that TL labels increase the likelihood of choosing healthier products and are the governments' most endorsed labeling system. Of the 156 studies reviewed, 88% had a population of adults, leaving out a large population of younger individuals with rising obesity rates. The meta-analysis only identified 30 studies evaluating the effects of TL labels on behavioral changes (intended or actual).

Studies evaluating the effectiveness of interpretative nutrition labels on children have mainly focused on children's perceptions (e.g., Lima et al., 2018, Ares et al., 2021a; Hémar-Nicolas et al., 2021) and much less on food preferences and choices (Saavedra-Garcia et al., 2022; Ares et al. 2021b). Saavedra-Garcia et al. (2022) studied Peruvian adolescents (10 to 14 years old) to determine if warning labels influenced purchase intention. The study concluded that warning labels did not influence healthier purchase intentions. Another study among children in grades 4 to 6 in Uruguay found that the inclusion of TL label had a minor effect on children's choice of cookies and no influence on the selection of orange juice (Arrúa et al., 2017). Both studies excluded price in the selection process. Studies evaluating the effectiveness of the TL label in children in Ecuador are also limited. The few studies we identified have focused on label knowledge and self-reported preferences and use (Cabrera et al., 2021; INEC, 2018; Galarza et al., 2019).

Our study uses choice experiments to determine the effect of TL nutritional label attribute levels on children's food choices, which reflects their preferences; thus, it aims to fill gaps in the literature related to interpretative nutrition labels' influence on children's food choices. Moreover, the experiments represent a more realistic situation where children are asked to make trade-offs between food quality attributes and the price paid, describing the scenario common in many countries where children make consumption and purchase decisions. The choice experiments use yogurt and soft drinks to evaluate the heterogeneity of the effects of TL on food choices. Finally, the study evaluates the impact of attribute levels (i.e., colors) rather than the presence or absence of the TL label, which has not been considered in previous research evaluating the effect of TL labels on children's food choices.

Methods

Data collection

Data was collected from a survey of 1,179 Ecuadorian students attending public middle and high school in three major cities located in the southern region of the country (Machala, Loja, and Zamora). The city of Machala is the capital of the Province of El Oro. It has a population of 261,422 inhabitants and 25,147 adolescents enrolled in middle school and high school. The city of Loja, the capital of the province of the same name, has a population of 214,855 and 28,745 adolescents enrolled in middle school and high school. Finally, Zamora, the capital of the Province of Zamora Chinchipe, has a population of 120,416 and 2,654 adolescents enrolled in these programs. The three cities represent populations of three geographic regions: the Coastal area (Machala), the Sierra (Loja), and the Amazon region (Zamora), but they belong to the same regional educational authority. Students selected were between 12 and 18 years of age. Middle school students are between the ages of 12 to 15 years old, and high school students are between 16 to 18 years old.

The survey was conducted from November 2020 to January 2021. The sample selection process was carried out in two stages. First, we randomly selected four educational establishments in each city. Second, about 100 students were randomly selected within each establishment. When the survey was conducted, students were receiving classes virtually due to lockdowns and restrictions imposed due to the SARS-CoV2 pandemic; thus, the survey was applied online using Qualtrics. Educational authorities within each institution provided all the tutor teachers' names and contacts (groups of students were assigned to tutor teachers that coordinated class activities), who subsequently gave the researchers access to the virtual classrooms to contact the participating students. Researchers explained the research objective to the students within the virtual classroom and shared the survey link for its application.

Texas Tech University's Institutional Review Board approved the study on November 20, 2020 (IRB2019-1182). The research protocol required authorization from the regional educational authority, each educational institution, parents and/or legal representatives of the participating adolescents, and the participating students (informed consent).

Survey development

A research group that included economists, public health, and education professionals from Ecuador and the United States developed a survey instrument. Given the study objectives, the survey was organized into three sections: 1) sociodemographic characteristics (age, province, gender, and grade); 2) students' use and knowledge of TL labels and purchasing habits at school; and 3) choice experiment scenarios to assess their preferences for nutrient attribute levels represented in traffic light labels.

To assess the understanding of the survey and the feasibility of its application in adolescents, a pilot test was conducted with 100 adolescents in the city of Loja (educational unit different from those who participated in the final survey). The time to complete the survey (average less than 8 minutes) and the quality of the responses (number of complete responses) were analyzed.

Some students were also informally interviewed to assess their understanding of the instrument. The information obtained in the pilot survey was used to refine the final survey instrument.

Students' knowledge of traffic light labels was evaluated using two questions: What components are included in the traffic light nutritional label? (one item) 2) What is the level of the nutritional content associated with each color on the traffic light label? (three items). A knowledge score was assigned from 0 to 4 points depending on the number of correct answers (Cabrera et al., 2021). Students' use was assessed using a question asking students about their frequency of TL label use. Finally, information on students' shopping habits was obtained using questions about the amount of money provided for buying food at school, the place of purchases (school, street, or stores), and the type of products purchased.

Choice experiment

The survey instrument comprised two sets of choice experiments. One included yogurt products and other soft drinks (sodas and juice). The first set of choice experiments had six scenarios. In each scenario, respondents faced two yogurt bottles with the same package, flavor, and a presentation of 150 g, but differed in price and the TL label colors for sugar, salt, and fat (Figure 2a). The second set of choice experiments also included six scenarios where respondents faced two bottles of soft drinks (soda or juice) of 600ml that differed in price and the traffic light label colors for sugar (Figure 2b). Yogurt was selected because it presents traffic light label colors of three ingredients considered in the labels: sugar, salt, and fat. Soft drinks were chosen because they are among the most popular beverages consumed by Ecuadorian adolescents (El Universo, 2014). Respondents were asked to select between two product profiles or a "none" option in each choice scenario (Figure 2).

Table 1 present the product attributes for yogurt and soft drinks. The non-price attributes (sugar, salt, and fat) were defined after reviewing the product database from the Kantar World Panel Company and a nutrient composition database of yogurt and soft drink products of the National Agency for Health Regulation, Control and Surveillance of Ecuador (ARCSA). Soft drinks TL label characteristics for salt (green) and fat ("it does not contain") did not vary across choice scenarios as most soft drink products in the country only differ in terms of the TL label characteristics for sugar. The price attributes included in the experiment were defined based on a sample of prices from four retail locations in the country (supermarkets and convenience stores) between October and November 2020. The average value of prices for yogurt was $0.71 for a 150g presentation and $0.57 for a 600 ml soft drink presentation. Consequently, price levels in the experiments were set using 5% and 15% values above and below the average observed price in those cities.

SAS software was used for the experimental design of the choice experiments. For the yogurt experiment, the combination of all labels for sugar, salt, and fat and price levels resulted in a total of 72 (3x3x2x4) product profiles and 2,566 possible choice scenarios (C_{72}^{2}). For the soft drinks experiment, the combination of sugar labels, drinks, and price resulted in a total of 32 (4x2x4) product profiles and 496 possible choice scenarios (C_{32}^{2}). Fractional factorial design selection procedures were used to create 18 possible choice scenarios for yogurt and soft drinks. The choice scenarios were then blocked into three versions of the questionnaires for each product; therefore, every respondent was offered only six choice scenarios for yogurt and soft drinks, respectively.

Data Analysis

Discrete mixed logit regression procedures were used to model children's product selection in the choice experiments as a function of products' attributes (price and TL label colors for sugar, salt, and fat) (Figure 1). Results of the mixed logit models were subsequently used to estimate individual-level willingness to pay (WTP) values for the TL label colors for each nutrient. Finally, we analyze the effect of sociodemographic characteristics and TL label use and knowledge on children's WTP values for the TL colors using panel data regression models.

Discrete choice experiments can be rationalized using a random utility framework (Train 2003). Within this framework, consumer *n* is assumed to derive utility from choice alternative *j* in choice scenario *t*: $U_{njt} = V_{njt} + \varepsilon_{njt}$, where V_{njt} is the systematic component of utility, and ε_{njt} is a random component. The systematic component, V_{njt}, includes the utility derived from the product characteristics and it is assumed to be linear in parameters $V_{njt} = p_{jt}\alpha_n + \boldsymbol{x_{jt}}'\boldsymbol{\beta_n}$, where p_{jt} is the product price, $\boldsymbol{x_{jt}}$ is a vector of non-price attributes, and α_n and $\boldsymbol{\beta_n}$ are individual-level coefficients (i.e., they are random); thus, the utility model can be written as:

$$U_{njt} = p_{jt}\alpha_n + \boldsymbol{x_{jt}}'\boldsymbol{\beta_n} + \varepsilon_{njt}. \tag{1}$$

The behavioral model implies the consumer chooses alternative j if and only if $U_{njt} > U_{nit}, \forall\, i \neq j$. The probability that the consumer n chooses alternative j in choice occasion t is then

$$P_{njt} = Prob\left(p_{jt}\alpha_n + \boldsymbol{x'_{jt}}\boldsymbol{\beta_n} + \varepsilon_{njt} > p_{it}\alpha_n + \boldsymbol{x'_{it}}\boldsymbol{\beta_n} + \varepsilon_{nit}\right) \quad \forall\, i \neq j. \tag{2}$$

Estimation of the parameters of the utility model requires an assumption about the random components ε_{njt}'s. If these errors are assumed independently and identically distributed extreme value, the unconditional choice probability of individual n choosing j in choice occasion *t* is then (Train, 2003):

$$P_{njt} = \int_{\boldsymbol{\theta_n}} \frac{V_{njt}}{\sum_j e^{V_{njt}}} f(\boldsymbol{\theta_n}|\Gamma) d\boldsymbol{\theta_n}\ , \tag{3}$$

where $\boldsymbol{\theta_n} = [\boldsymbol{\beta'_n}\ \alpha_n]'$ is the vector of coefficients, and $f(\boldsymbol{\theta_n}|\boldsymbol{\Gamma})$ represents the probability density function of the random coefficients in the population with parameters $\boldsymbol{\Gamma}$**.** Equation 3 is the basis for the specification of the likelihood function, considering the sequence of choices made by all respondents (Rigby and Burton, 2006; Train, 1998, 2003). Model parameters were estimated using simulated maximum likelihood (ML) procedures with 500 Halton draws in STATA.

Parameter estimates and simulation procedures were subsequently used to estimate the expected value of individuals' willingness to pay values $\boldsymbol{WTP_n}$ (i.e., estimates of E[$\boldsymbol{WTP_n}$]=$\boldsymbol{E}[-\boldsymbol{\beta_n}/\alpha_n]$) (Hess, 2007). It is important to emphasize that given the structure of the discrete choice model, large WTP values for an attribute are directly associated with higher probabilities of product selection.

Finally, the following panel data model was used to evaluate the association between sociodemographic characteristics ($\boldsymbol{z_n}$) and the WTP values for non-price attributes (WTP_{nk}):

$$WTP_{nk} = \gamma + \tau_k + \boldsymbol{z'_n}\,\boldsymbol{\delta} + \mu_n + e_{nk},$$

where WTP_{nk} corresponds to the willingness to pay value for an attribute level *k* (e.g., TL color within a nutrient category), relative to a baseline attribute level (e.g., the red color), μ_n is the individual level random error, e_{nk} is the idiosyncratic error, and γ, τ_k, and $\boldsymbol{\delta}$ are parameters. The data can be analyzed using panel data models given the presence of various attribute levels (i.e.,

$k>1$); thus, the τ_k coefficients can be interpreted as attribute level "fixed-effects." The model was estimated using a random-effects estimator in STATA.

Results

Sample characteristics

Table 2 present the results of the sample characteristics. The average age of the survey respondent was 14 years. The average daily amount students receive to make purchases at school was $1.12 every day for food purchases, with a median between $1 and $1.99. The sample was approximately equally split between male (47%) and female (53) and between middle school (56%) and high school students (44%). Concerning knowledge of TL labels, about 42% of respondents obtained a perfect knowledge score of 4 points, 22% received between 2 and 3 points, and 36% scored between 0 and 1 points. Summary statistics also show that almost 1 in 3 buy yogurt products, 1 in 4 buy juices and 1 in 5 buy soda products. Most students spend their money mainly in the school cafeteria (70%), but a high percentage also buy food in the street (18%) and other places (41%).

Choice experiments

The mixed logit models estimated using data from the yogurt and soft drinks choice experiments are presented in Table 3. Estimated coefficients represent parameters of the mean of the distribution of the random coefficients ($\alpha_n, \boldsymbol{\beta_n}$), and were all statistically significant at the

1% level. Except for the price coefficients, which do not have a direct interpretation,[1] all other coefficients can be interpreted as the effects of the attributes on the indirect utility function.

Focusing first on the TL color attributes represented with dummy variables, the less healthy colors were selected as the baseline attribute levels (red color for fat and sugar and yellow for sugar). Therefore, the positive estimated values indicate that children obtain higher levels of utility when consuming products with TL color labels representing healthier alternatives (i.e., lower fat, sugar, and salt). The negative signs for the alternative specific constant (ASC) indicate that children prefer to consume the selected rather than choosing the "none" option. Finally, the positive sign of the "juice" coefficient in the soft drinks model indicates children prefer juice to sodas.

Several estimated standard deviations of the coefficients' distributions were also significant, indicating heterogeneity in children's preferences for some product attributes. Model results suggest children have heterogeneous preferences for the "healthiest" label option in every nutrient and product combination; thus, in yogurt, heterogeneous preferences were found for green labels in sugar, salt, and fat. Heterogeneous preferences were identified in soda drinks for the "does not contain sugar" label.

Table 4 presents the estimated mean WTP values obtained from the yogurt models. These values represent the monetary values children are willing to pay, on average, for the TL label colors in a 150 ml yogurt product relative to the baseline attributes; thus, they can be interpreted as premiums. Children are willing to pay, on average, \$1.04 and \$1.20 premiums for yellow and

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[1] The price coefficients are assumed to have a lognormal distribution; thus, the estimated coefficient do not represent the mean of the distribution as is the case with the normal distribution.

green labels for fat, respectively, relative to the baseline red label. For the sugar attribute, the mean WTP was $0.88 and $1.09 more for the yellow and green labels for sugar, respectively, compared to the baseline attribute red sugar label. Finally, the calculated mean WTP for salt was $0.16 more for the green salt label compared to a yellow label.

The estimated mean WTP values for the soft drinks' attributes are presented in Table 5. The mean premium children are willing to pay for a juice was $0.25 relative to a soda product. Children are also willing to pay $0.78 more for a yellow label, $1.17 more for a green label, and $1.38 more for the "does not contain sugar label" relative to a product with a red label for sugar.

Panel Data Models Results

The results of regression models exploring the relationship between the WTP values and children's sociodemographic characteristics, and knowledge of the TL label are presented in Tables 6 and7. Three regression models were estimated for yogurt: one for WTP for fat yellow and green labels, one for sugar yellow and green labels WTP values, and one for WTP for salt green labels (Table6). Two regression models were estimated for soft drinks: one for WTP for juice and one for the WTP for a green sugar label (Table 7).

Regression model results using WTP values for TL colors in salt in yogurt products as the dependent variable did not show any statistically significant effects of sociodemographic characteristics and knowledge. The regression model results for fat in yogurt indicate that the premium children are WTP for a green label is $0.14 higher than the premium they are willing to pay for a yellow label (both relative to a red label). Gender and knowledge also were found to have a statistically significant effect on the premiums children are WTP for green and yellow labels, but both effects were small. Males are WTP $0.032 more for green and yellow labels than female children, and an additional point in the TL knowledge score is associated with a $0.018 decrease in the WTP premiums for these labels.

The regression model results for sugar also indicate that the premium children are WTP for a green label is higher ($0.174) than the premium they are willing to pay for a yellow label (both relative to a red label). Gender, grade level, money available, and knowledge had statistically significant effects on the WTP premiums for green and yellow labels (at least at the 10% level). Male children are WTP $0.029 more for green, and yellow labels than female children; high-school students are willing to pay less ($0.037) for these labels than middle-schoolers. An additional point in the TL knowledge score is associated with a $0.016 decrease in the WTP premiums for these labels. Finally, an extra dollar available for buying food at school is associated with a $0.013 increase in the premiums children are WTP for these labels for sugar.

Table 7 present the regression results for soft drinks. Children are WTP $0.323 and $0.510 higher premiums for a green and a "does not contain sugar" label than for a yellow label (all relative to a red sugar label). Concerning the sociodemographic characteristics, male children are willing to pay $0.06 more for yellow, green, or the "does not contain" sugar labels than female respondents. Moreover, an extra dollar per day in money available to buy food at school is associated with a $0.03 increase in the premium children are willing to pay for these three sugar labels. Regression results for the model using the premium for the juice attribute show no statistically significant effect of any explanatory variables.

Discussion

The use of supplementary nutrition labeling such as TL labels is one of the public policies implemented to improve dietary behavior. Most of the research on the effectiveness of

TL labels has been conducted with adults (Song et al., 2021). However, children make independent food purchases in many countries. In our sample, 92% reported receiving money to purchase food “at school.” Therefore, it is relevant to evaluate the effect of nutritional labels on their food preferences and choices. Moreover, most previous literature evaluating the effect of TL labels assessed their influence on various outcomes relative to a control scenario without the labels (Song et al., 2021) (i.e., the extensive margin). In contrast, this study evaluates the effect of variations in TL labels’ characteristics (i.e., colors and text) on children's food choices (i.e., the intensive margin).

The results show that students prefer products with TL labels representing healthier alternatives. This result was consistent across the three nutrients considered (far, sugar and salt) and both products (yogurt and soft drinks). In the case of yogurt products, children are willing to pay significant premiums for products with yellow and green labels relative to products with red labels. For yellow labels, the estimated premiums range from $0.88 per product in the case of sugar to $1.04 in the case of fat (Table4). The premiums for green labels range from $1.09 for sugar to $1.20 for fat. These values are substantial considering the range of prices used was between $0.50 to $0.90 per product. The difference in premiums between yellow and green colors in the labels is less than $0.20 per product; thus, significantly lower than the difference in the willingness to pay premiums between products with yellow and red labels.

Results from the choice experiment with soft drinks, which only included different color labels for sugar, were consistent with those found with yogurt and reflect preferences for healthier alternatives. Premiums children are willing to pay for green, and yellow labels relative to a red label are significant and higher than the difference in premiums between green and yellow labels. Results also indicate that children are willing to pay a substantial premium for products with the “does not contain sugar” label. This premium is estimated to be even higher than the premium for a green label, revealing children’s preferences for products without sugar relative to products with any sugar content (ceteris paribus). The soft drinks choice experiment results also reflect children's preference for juices relative to sodas.

Overall, these results evaluating willingness to pay values for the attributes suggest children prefer to avoid products with red labels. Products with green labels are also preferred over products with yellow labels. Still, the difference in values between green and yellow label premiums is not as large as that observed between yellow and red colors. Therefore, children’s perceived level of healthfulness, as reflected by the colors in the TL labels, appears to be nonlinear. Larger gains in “healthfulness” seem to be perceived when choosing a product with a red label over one with a yellow label than when selecting a product with a green label over one with a red label or one with a “does not contain…” label relative to a product with a green label.

Although previous literature had found that relative to other interpretative supplementary nutritional labels, the TL labels caused more confusion (Song et al., 2021); this study’s WTP estimates for TL colors align with the final policy objective of reducing the purchase and consumption of products with high levels of sugar, fat, and salt.

How do the results of the study compare to previous similar literature? Results are consistent with Scarborough et al. (2015) research in the UK. These authors used online choice experiments and found that products with red labels were less likely to be selected as healthy than green-labeled products. However, in contrast to the present study (which did not find significant differences in TL colors' preferences across nutrients), they report that TL label colors for saturated fat and salt colors had a more substantial influence on decisions than colors for total fat and sugar. This study’s results are consistent with those obtained in Balcombe, Fraser, and Di

Falco (2010) in the UK. They found that consumers are willing to pay high premiums to purchase a food basket with green and yellow nutrient labels relative to a basket with red labels. They also report that consumers were more concerned about salt and saturated fat and much less about sugar and fat, which differs from our study. Note that both Scarborough et al. (2015) and Balcombe, Fraser, and Di Falco (2010) use ready meals instead of drink products, which may explain some differences.

The results of this study are also in line with a similar study conducted in Ecuador but targeting the adult population (Sarasty, 2020). The study used yogurt products of the same size and found a similar pattern of preferences for green and yellow labels over red labels, as measured by the premium values they were willing to pay for these attributes (about $1.00 per product). A smaller premium was found for green labels than for yellow ones ($0.20 per product or less) (Sarasty, 2020).

The regression models suggest that the heterogeneity of preferences for TL label colors is associated with some of the explanatory variables included in the models. Male children are willing to pay higher premiums for yellow and green labels than female children. Although the difference in premiums is not very large (between $0.01 and $0.06), this is somewhat concerning since the proportion of adult females in the Ecuadorian population that are overweight or obese (68%) is larger than the proportion of adult males with those conditions (61%) (INEC, 2018).

The amount of money available for buying food at school was also associated positively with the premiums children are willing to pay for yellow and green labels for sugar. Expenditure elasticities of the WTP pay values for green and yellow labels (calculated at mean values of expenditures and WTP) are inelastic (between 0.01 and 0.03). However, it should be noted that the estimated average premiums are already substantial; thus, these low expenditure elasticities only reflect slight differences in already “large” WTP values across children in various expenditure group levels.

Regression results also found a negative association between the premiums children are willing to pay for green and yellow labels and the TL label knowledge score. Although a positive association was expected, this result suggests TL labels can convey information about the healthfulness of the products even if children do not have a perfect understanding of their nutritional content. It is also possible that individuals with high knowledge about nutrition are less concerned about the nutrient content of specific food products and focus more broadly on the overall quality of the diet.

From a broader perspective, the study has shown that economic stated choice experiments can be used to analyze children’s preferences and demand for food products. Study results are consistent with rational economic behavior where children make choices considering the trade-offs between prices and other food product attributes (e.g., various nutrient concentration levels). Previous studies evaluating the effect of nutritional labels have omitted price as a product attribute. Its omission limits the analyses because preferences for non-price characteristics cannot be expressed in dollar values. Moreover, choice experiments without prices represent less realistic scenarios if children are already in charge of food product purchases.

Some limitations of this study need to be noted. First, we use stated choice experiments instead of actual shopping behavior. The use of hypothetical behaviors was necessary given the context of the COVID-19 pandemic. Stated choice experiments also offer more flexibility regarding the range of product attribute levels that can be studied while keeping other attributes fixed. This may not be possible if actual products are used because, for example, a specific branded product has a unique nutritional profile. Second, the study only used drink products, but preferences for TL colors may differ across product categories. Third, the choice experiments included TL labels on the front of the drinks; the label regulation in Ecuador gives companies the flexibility to place the TL label on the products' front part, side, or back. Finally, our study population was limited to middle and high school children in three cities. Future studies could focus on younger children's preferences for TL labels and other areas.

Conclusions

The increasing prevalence of obesity and overweight is prompting governments to implement public policies encouraging improved dietary habits. The implementation of such policies should be followed by their evaluation in all segments of the population (e.g., adults, children, etc.). Study findings offer evidence that TL nutritional labels adopted in Ecuador are effective at helping children make food choices consistent with preferences for food products with TL labels representing healthier alternatives. Therefore, the findings support the use of the TL labels to facilitate children's understanding of the nutritional quality of a product.

It needs to be emphasized that the study results do not necessarily imply that the adoption of the TL policy has been effective at changing children's dietary habits. Data on children's preferences for nutrient levels (as reflected by the TL colors) before the TL label policy was implemented is unavailable. However, study results can also be used to monitor children's preferences for nutrient levels as the label policy evolves (e.g., changing the label from the back of the package to the front). We believe that stated preferences data provide a lower-cost alternative for evaluating the effect of nutritional labeling policies, as actual purchase data from children is unavailable or difficult to access.

References

Ares, Gastón, Lucía Antúnez, Florencia Alcaire, Leticia Vidal, and Isabel Bove. 2021. "Listening to the voices of adolescents for the design of strategies to promote healthy eating: an exploratory study in a Latin American country." Public Health Nutrition 24(17): 5953-5962.

Ares, Gastón, Lucía Antúnez, Magela Cabrera, and Anne Marie Thow. 2021. "Analysis of the policy process for the implementation of nutritional warning labels in Uruguay." Public Health Nutrition 24(17): 5927-5940.

Arrúa, Alejandra, María Rosa Curutchet, Natalia Rey, Patricia Barreto, Nadya Golovchenko, Andrea Sellanes, Guillermo Velazco, Medy Winokur, Ana Giménez, and Gastón Ares. 2017. "Impact of front-of-pack nutrition information and label design on children's choice of two snack foods: Comparison of warnings and the traffic-light system." Appetite 116: 139-146.

Balcombe K, Fraser I & Di Falco S. 2010. "Traffic lights and food choice: A choice experiment examining the relationship between nutritional food labels and price." *Food Policy* **35**, 211–220. Elsevier.

Cabrera-Parra, T.V,, Palacios, K., Carpio, C., Sarasty, O., González, M.S., Benítez-Miranda, P., Azuero-Jaramillo, K. and Carrión, J.P., 2022. Etiquetado nutricional tipo semáforo: conocimiento, uso y preferencias en los adolescentes ecuatorianos: Etiquetado nutricional tipo semáforo en Ecuador. *Revista Española de Nutrición Humana y Dietética*, *26*.

Carson RT & Czajkowski M (2019) A new baseline model for estimating willingness to pay from discrete choice models. *J. Environ. Econ. Manage.* **95**, 57–61. Elsevier.

Codex Alimentarius Commission. 1999. Codex General Standard for the Labeling of Prepackaged Foods (Codex Stan 1 – 1985, Rev. 1 – 1991, Amended 1999). Rome, Italy: FAO/WHO.

Díaz AA, Veliz PM, Rivas-Mariño G, et al. 2017. Etiquetado de alimentos en Ecuador: implementación, resultados y acciones pendientes. Rev. Panam. Salud Pública, e54. SciELO Public Health.

El Universo. (2014). Jóvenes entre 15 y 19 años, el mayor grupo de consumidores de gaseosas en Ecuador. Salud. https://www.eluniverso.com/vida-estilo/2014/05/06/nota/2928006/jovenes-15-19-anos-mayor-grupo-consumidores-gaseosas-ecuador/

FAO, WHO. Codex Alimentarius guidelines on nutrition labelling. 2001. https://www.fao.org/3/y2770e/y2770e06.htm#bm06Fox, Ashley, Wenhui Feng, and Victor Asal. 2019. "What is driving global obesity trends? Globalization or “modernization”?." Globalization and Health 15(1): 1-16.

Fieller, E.C., 1954. Some problems in interval estimation. *Journal of the Royal Statistical Society: Series B (Methodological)*, *16*(2), pp.175-185.

Galarza G, Robles J, Chávez V, Pazmiño K, Castro J. Conocimientos, opiniones y uso del etiquetado nutricional de alimentos procesados en adolescentes ecuatorianos según tipo de colegio. Perspectivas de Nutrición. 2019;21(2):0–1.

Hall, Marissa G., Allison J. Lazard, Isabella CA Higgins, Jonathan L. Blitstein, Emily W. Duffy, Eva Greenthal, Sarah Sorscher, and Lindsey Smith Taillie. 2022. "Nutrition-related claims lead parents to choose less healthy drinks for young children: a randomized trial in a virtual convenience store." The American Journal of Clinical Nutrition 115(4): 1144-1154.

Hémar-Nicolas, V., Hapsari, H.P., Angka, S. and Olsen, A., 2021. How cartoon characters and claims influence children's attitude towards a snack vegetable–An explorative cross-cultural comparison between Indonesia and Denmark. *Food Quality and Preference*, *87*, p.104031.

Instituto Nacional de Estadísticas y Censos (INEC). 2018. Encuesta Nacional de Salud y Nutrición. *Ensanut*, 47. Quito-Ecuador: ; https://www.ecuadorencifras.gob.ec/salud-salud-reproductiva-y-nutricion/ (accessed June 2021).

Jensen, Melissa L., Yoon Y. Choi, Frances Fleming-Milici, and Jennifer L. Harris. 2022. "Caregivers' Understanding of Ingredients in Drinks Served to Young Children: Opportunities for Nutrition Education and Improved Labeling." Current Developments in Nutrition 6(1): p.151.

Kantar World Panel (2019) Kantar World Panel. https://www.kantarworldpanel.com/global.

Lima, Mayara, Gaston Ares, and Rosires Deliza. 2018. "How do front of pack nutrition labels affect healthfulness perception of foods targeted at children? Insights from Brazilian children and parents." Food Quality and Preference 64: 111-119.

Malik, Vasanti S., Walter C. Willet, and Frank B. Hu. 2020. "Nearly a decade on—trends, risk factors and policy implications in global obesity." Nature Reviews Endocrinology 16(11): 615-616.

Meijer, G. W., Detzel, P., Grunert, K. G., Robert, M. C., & Stancu, V. 2021. "Towards effective labeling of foods. An international perspective on safety and nutrition." Trends in Food Science & Technology 118: 45-56.

Ministerio de Industria y Productividad (MIP). Resolución No. 14 511. INEN. 2013.

OPS, OMS. El etiquetado frontal como instrumento de política para prevenir enfermedades no transmisibles en la Región de las Américas [Internet]. 2020. Disponible en: https://iris.paho.org/bitstream/handle/10665.2/53013/OPSNMHRF200033_spa.pdf?sequence=5&isAllowed=y.

OMS. Informe de la comisión para acabar con la obesidad infantil: Informe de la Directora General [Internet]. Vol. 1, Organización Mundial de la Salud. Geneve; 2016. Disponible en: http://apps.who.int/gb/ebwha/pdf_files/WHA69/A69_8-sp.pdf

Peñaherrera V, Carpio C, Sandoval L, et al. 2019. Efecto del etiquetado de semáforo en el contenido nutricional y el consumo de bebidas gaseosas en Ecuador. Rev. Panam. Salud Pública, e177. SciELO Public Health.

Poveda Guevara AF. 2016. Impact of sugar, salt and fat warning labels in processed food: A qualitative approach. Univ. CIENCIAS Soc. Y HUMANAS, 49–60. Univ Politecnica Salesiana Ecuador-Salesian Polytecnic Univ Calle Turuhuayo.

Rigby, D., and M. Burton. "Modeling disinterest and dislike: A bounded bayesian mixed logit model of the UK market for GM food." *Environmental and Resource Economics* 33, 4(2006):485–509.

Sarasty, O. 2020. "Effect of the traffic-light system for nutrition labeling in processed food products in the Ecuadorian population." MSc. Thesis in Agricultural and Applied Economics. Texas Tech University, Lubbock, Texas, USA.

Saavedra-Garcia, Lorena, Miguel Moscoso-Porras, and Francisco Diez-Canseco. 2022. "An Experimental Study Evaluating the Influence of Front-of-Package Warning Labels on

Adolescent's Purchase Intention of Processed Food Products." International Journal of Environmental Research and Public Health 19(3): 1094.

Sandoval LA, Carpio CE & Sanchez-Plata M. 2019. The effect of 'Traffic-Light' nutritional labeling in carbonated soft drink purchases in Ecuador. PLoS One, e0222866. Public Library of Science San Francisco, CA USA.

Scarborough P, Matthews A, Eyles H, et al. (2015) Reds are more important than greens: how UK supermarket shoppers use the different information on a traffic light nutrition label in a choice experiment. *Int. J. Behav. Nutr. Phys. Act.* **12**, 1–9. BioMed Central.

Song, Jing, Mhairi K. Brown, Monique Tan, Graham A. MacGregor, Jacqui Webster, Norm RC Campbell, Kathy Trieu, Cliona Ni Mhurchu, Laura K. Cobb, and Feng J. He. 2021. "Impact of color-coded and warning nutrition labeling schemes: A systematic review and network meta-analysis." PLoS medicine 18(10): e1003765.

Train, K. "Recreation demand models with taste differences over people." *Land Economics*. 74, 2(1998):230-239.

Train, K. *Discrete choice methods with simulation*. Cambridge University Press, 2003.

World Health Organization (WHO). "Obesity and overweight." 2022. Available at: https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight, Accessed 7th Apr 2022

Yang, J., Tian, C., Chen, Y., Zhu, C., Chi, H., & Li, J. 2021. Obesity aggravates COVID-19: an updated systematic review and meta-analysis. Journal of Medical Virology, 93(5), 2662-2674.

Table 1. Attributes and levels for the choice experiments

Product	Attribute	Level
Yogurt	Fat label	Red label
		Yellow label
		Green label
	Sugar label	Red label
		Yellow label
		Green label
	Salt label	Yellow label
		Green label
	Price	$0.50
		$0.65
		$0.75
		$0.90
Soft drinks	Type of drink	Soda
		Juice
	Sugar label	Red label
		Yellow label
		Green label
		Does not contain sugar[a]
	Price	$0.50
		$0.55
		$0.60
		$0.65

[a]This is the statement included in the TL label when the ingredient is not present.

Table 2. Sample summary statistics (n=1,172)

Variable	Mean (Std. Dev)	Percentage (n)
Age years (Std. Dev)	14.41 (1.82)	
Gender		
Male		47.44 (556)
Female		52.56 (616)
Education		
Middle School		56.23 (659)
High School		43.77 (513)
Lunch money		
Less than $1.00		18.43 (216)
$1.00 - $1.99		55.55 (651)
$2.00 - $2.99		12.37 (145)
$3.00 or more		4.27 (50)
None		7.42 (87)
Knowledge		
Low (0 to 1 points)		36.01 (422)
Medium (2 to 3 points)		22.10 (259)
High (4 points)		41.89 (491)
Purchasing location		
School Cafeteria		69.62 (816)
Street vendors		17.49 (205)
Stores and supermarkets		41.04 (481)
Most consumed products		
Packed snacks (potato chips, corn chips, and peanuts)		41.47 (486)
Bakery products (cupcakes, toasts, and cookies)		43.60 (511)
Fruit		30.03 (352)
Chocolate and candies		23.72 (278)
Water		30.97 (363)
Soda		20.48 (240)
Juice		25.60 (300)
Yogurt		28.16 (330)
Ice cream		34.81 (408)

Table 3. Mixed Logit Estimation Results

	Model for yogurt	Model for soft drinks
Attribute	**Coefficient**	**Coefficient**
Yellow label fat	1.698 *** (0.066)	
Green label fat	1.958 *** (0.068)	
Yellow label sugar	1.442 *** (0.064)	1.618 *** (0.072)
Green label sugar	1.772 *** (0.067)	2.437 *** (0.080)
Does not contain sugar		2.884 *** (0.102)
Green label salt	0.266 *** (0.049)	
Juice		0.511 *** (0.065)
ASC	-1.123 *** (0.170)	-2.213 *** (0.267)
Price	0.487 *** (0.101)	0.734 *** (0.213)
	Standard deviation	**Standard deviation**
Yellow label fat	0.008 (0.173)	
Green label fat	0.409 ** (0.189)	
Yellow label sugar	0.035 (0.157)	0.033 (0.138)
Green label sugar	0.462 *** (0.130)	0.008 (0.187)
Does not contain sugar		1.584 *** (0.110)
Green label salt	0.534 *** (0.095)	
Juice		1.483 *** (0.085)
ASC	2.833 *** (0.146)	2.102 *** (0.239)
Observations	20,754	20,754
Log-likelihood	-5284.5705	-5325.4741
Wald χ 2	1534.92	1351.28

Notes: Panel Mixed Logit model using 500 Halton draws. Attributes assigned a normal distribution with the exception of price that was designed to follow a lognormal distribution. ASC, alternative specific constant. Notes: ***, **, * indicate significance at the 1%, 5%, and 10%, respectively. Values in parenthesis indicate the standard error of the coefficient.

Table 4. Estimated Marginal Willingness-to-Pay Estimates for yogurt ($/150g)

Attribute	WTP Calculation[a]	Mean WTP		95% Confidence Interval for the Mean[b]
Yellow label fat[c]	$\beta_{Yellow\ label\ fat}/\exp(\beta_{price})$	1.04	***	0.83 ~ 1.26
Green label fat[c]	$\beta_{Green\ label\ fat}/\exp(\beta_{price})$	1.20	***	0.95 ~ 1.45
Yellow label sugar[d]	$\beta_{Yellow\ label\ sugar}/\exp(\beta_{price})$	0.88	***	0.70 ~ 1.07
Green label sugar[d]	$\beta_{Green\ label\ sugar}/\exp(\beta_{price})$	1.09	***	0.86 ~ 1.32
Green label salt[e]	$\beta_{Greeb\ label\ salt}/\exp(\beta_{price})$	0.16	***	0.10 ~ 0.23

Notes: Notes: ***, **, * indicate significance at the 1%, 5%, and 10%, respectively.
[a]Carson and Czajkowski (2019), when price attribute follows a lognormal distribution and constraining the standard deviation of price to 0 and other variables follow a normal distribution.
[b] 95% confidence intervals found using Fieller (1954) method.
[c] Red label fat was assigned as the base attribute.
[d] Red label sugar was assigned as the base attribute.
[e] Yellow label salt was assigned as the base attribute.

Table 5. Estimated Marginal Willingness-to-Pay Estimates for soft drinks ($/600ml)

Attribute	WTP Calculation[a]	Mean WTP		95% Confidence Interval for the Mean[b]
Yellow label sugar [c]	$\beta_{Yellow\ label\ sugar}/\exp(\beta_{price})$	0.78	***	0.46 ~ 1.09
Green label sugar [c]	$\beta_{Green\ label\ sugar}/\exp(\beta_{price})$	1.17	***	0.69 ~ 1.65
Does not contain sugar [c]	$\beta_{Does\ not\ contain\ sugar}/\exp(\beta_{price})$	1.38	***	0.82 ~ 1.95
Juice [d]	$\beta_{Juice}/\exp(\beta_{price})$	0.25	***	0.13 ~ 0.36

Notes: ***, **, * indicate significance at the 1%, 5%, and 10%, respectively.
[a]Carson and Czajkowski (2019), when price attribute follows a lognormal distribution and constraining the standard deviation of price to 0, and other variables follow a normal distribution.
[b] 95% confidence intervals were found using Fieller's (1954) method.
[c] Red label sugar was used as the base attribute.
[d] Soda was used as the base attribute.

Table 6. Panel Data Regression Models: Yogurt

Parameter	Model for fat		Model for sugar		Model for salt	
Constant	0.875	***	0.727	***	0.144	***
	(0.071)		(0.062)		(0.041)	
Traffic label attribute						
Green label fat	0.140	***				
	(0.002)					
Green label sugar			0.174	***		
			(0.003)			
Respondent characteristics						
Age	0.004		0.005		-0.001	
	(0.005)		(0.004)		(0.003)	
Gender (1=male, 0=female)	0.032	**	0.029	**	0.011	
	(0.013)		(0.011)		(0.007)	
High School (1=Yes, 0=No)	-0.031		-0.037	**	0.004	
	(0.020)		(0.017)		(0.012)	
Lunch money ($/day)	0.011		0.013	*	0.001	
	(0.008)		(0.007)		(0.005)	
Knowledge (0 to 4 points)	-0.018	***	-0.016	***	0.002	
	(0.004)		(0.004)		(0.002)	
R^2		0.1259		0.2069		0.0031
Observations		2,106		2,106		1,053

Notes: ***, **, * indicate significance at the 1%, 5%, and 10%, respectively. Standard error in parenthesis.

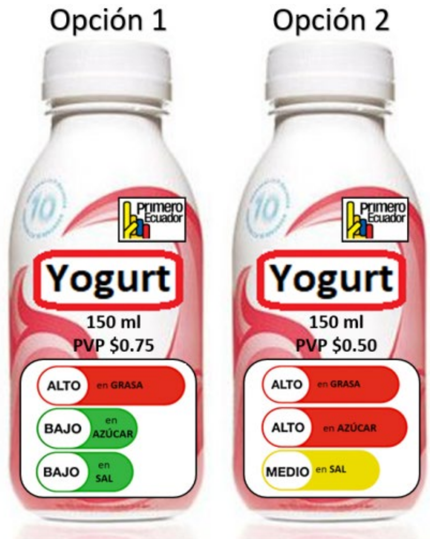
Table 7. Panel Data Regression Models: Soft drinks

Parameter	Model for juice		Model for sugar	
Constant	0.361	**	0.614	***
	(0.159)		(0.120)	
Traffic label attribute				
Green label sugar			0.323	***
			(0.003)	
Does not contain sugar			0.510	***
			(0.015)	
Respondent characteristics				
Age	-0.009		-0.001	
	(0.012)		(0.009)	
Gender (1=male, 0=female)	-0.014		0.056	***
	(0.027)		(0.021)	
High School (1=Yes, 0=No)	0.033		0.004	
	(0.044)		(0.033)	
Lunch money ($/day)	-0.024		0.030	**
	(0.016)		(0.014)	
Knowledge (0 to 4 points)	-0.009		-0.007	
	(0.009)		(0.007)	
R^2		0.0041		0.2235
Observations		1,053		3,159

Notes. ***indicates significance at 1%, ** indicates significance at 5%, and * indicates significance at 10%.

Figure 1. Traffic Light Label Colors and Nutrients of Ecuadorian Traffic-Light Nutritional Label System (Spanish: Alto= High; Medio= Medium; Bajo=Low).

a)



- Option 1
- Option 2
- None

b)

- Option 1
- Option 2
- None

Figure 2. Choice Experiments Examples: a) Yogurt Products and b) Soft Drink Products.