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# Brazilian Front-of-Package Labeling: A Choice-Based Conjoint and Eye-Tracking Study on the Role of the Magnifying Glass Symbol Versus All-Text Warnings

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## ABSTRACT

Front-of-package labeling (FoPL) systems often use text and visuals to help communicate information about nutrients potentially linked to chronic diseases. While systems like the European Nutri-Score and the Latin black octagon emphasize clear warnings, the magnifying glass, adopted in Brazil and Canada, lacks clarity in its semiotic interpretation, warranting further study. This research conducted two experiments to assess the magnifying glass's impact on consumer choices: one with eye-tracking ($n = 30$) and another without ($n = 408$). Fot this, mock packages of dulce de leche were developed for the study. These packages featured statements such as "High in added sugar," "High in saturated fat," and "High in added sugar and saturated fat," presented with or without the magnifying glass symbol. Results showed that combining "High in (...)" warnings with the magnifying glass had a weaker effect on reducing product choice than text-only labels. Additionally, dual-nutrient warnings (sugar and saturated fat) consistently had a stronger negative effect on choices than single-nutrient warnings, regardless of the symbol.

## 1 | Introduction

The excessive intake of foods rich in sodium, saturated fat, and sugar has been strongly associated with the development of noncommunicable chronic diseases (NCDs) (Abu Bakar et al. 2022), motivating public health agencies to promote actions aimed at reducing the consumption of these nutrients. Among the various proposed actions to assist consumers in making healthier choices, front-of-pack labeling (FoPL) systems have been developed to increase transparency in communication between manufacturers and consumers, facilitating the understanding of foods' composition and nutritional value (Shephard 2020). However, the effectiveness and underlying mechanisms related to the ability of FoPL systems to influence consumer choices still lack sufficient evidence to be better elucidated (Folwarczny et al. 2024). Similarly, scant information exists regarding the diverse symbolic associations arising from various FoPL systems.

The World Health Organization stated that it has no intentions of categorically defining the pictorial format and textual content of FoPL systems (WHO 2021). However, conceptual definitions guide the development of different FoPL systems worldwide, such as the proposal by the Codex Alimentarius (2021). It suggests the adoption of symbols, graphics, text, or a combination

**Practical Applications**

- This research suggests that the use of the magnifying glass icon in front-of-package labeling systems, associated with nutritional warnings for high levels of nutrients linked to noncommunicable chronic diseases, may soften the negative impact of these warnings on consumer choice.
- For the food industry, this could mean less impact on sales volume by designing labels that comply with health regulations but are less likely to discourage customers from purchasing the products.

of these elements prominently displayed on food packaging, that is, in the consumer's primary field of view, to facilitate immediate understanding. Additionally, FoPL should adhere to the underlying nutritional profile of the product, considering the nutritional quality or nutrients associated with NCDs.

The design and implementation details of FoPL systems have sparked disagreements among countries, particularly, regarding whether their adoption should be voluntary or mandatory (Codex Alimentarius 2021; Ganderats-Fuentes and Morgan 2023). Moreover, there are differing views on the primary function of these systems: whether they should provide objective information (informative systems) or interpret data for consumers (interpretive systems). Interpretive systems are more emphatic and include, for instance, the nutritional warning system FoPL (PAHO 2020). Common examples of interpretive systems are the "Keyhole" and "Nutri-Score," which offer consumers an evaluation of the nutritional quality of the product and issue a value judgment. In contrast, informative systems, such as the "Nutrinform battery" and "Facts up front" simply present nutritional information without making any judgment on whether the food is better or worse. The Front-of-Pack Warning Labeling proposed by the Pan American Health Organization (PAHO 2020) is an example of an FoPL warning system. It employs a black octagon on a white background (high contrast), featuring expressions like "HIGH IN" in capital letters, alerting consumers to the presence of high levels of nutrients linked to NCDs.

The utilization of various pictorial forms and colors in FoPLs has been linked to their capacity to capture visual attention and enhance information processing (Roberto et al. 2021). Nevertheless, there is a scarcity of studies assessing consumers' perceptions of FoPL systems that incorporate both image-based and text-based information compared to those using only text. Consequently, there is limited understanding of how consumers' symbolic associations, influenced by the pictorial structure of FoPLs, reflect in their choices.

In the European Union, for example, the voluntary adoption of the "Nutriscore model" has been proposed, using a scale from A to E and colors ranging from green to red to indicate the nutritional value of the product (Folkvord et al. 2021; Janssen and Bogaert 2023). In the United Kingdom, the voluntary use of the Multiple Traffic Light Labeling is recommended, where red, yellow, and green colors respectively indicate high, medium, or low levels of fat, saturated fat, sugars, and salt (Hagmann and Siegrist 2020). PAHO, in turn, recommends that countries in the Americas adopt Front-of-Pack Warning Labeling on a mandatory basis, already implemented in countries like Uruguay, Peru, and Mexico. Ecuador has adopted its own traffic light nutritional system. In Brazil, a FoPL system based on the "High in (...)" warnings, as proposed by PAHO, was adopted with modifications: the text is presented in lowercase letters and accompanied by an image of a magnifying glass (black on a white background) instead of the black octagon with uppercase letters (ANVISA 2020). In Canada, the food industry has until January 1, 2026, to voluntarily include a front-of-pack label featuring a magnifying glass; after this date, the use of FoPL will become mandatory (Health Canada 2023). However, magnifying glass-structured FoPLs present some ambiguity, as they incorporate a seemingly neutral figure (the magnifying glass) associated with warning statements such as "High in saturated fat/added sugars/sodium." The precise reason for the inclusion of the magnifying glass figure in Brazil remains unknown.

In this context, given the uncertainty about the impact of incorporating the magnifying glass symbol in FoPL and its potential role as a pictorial element that might influence the perception of the textual warning (High in (...)), this research proposes the following initial hypothesis:

**Hypothesis 1.** *The structuring of the FoPL system with the magnifying glass image alongside the statement "High in (...)" influences the probability of the food product being chosen.*

Additionally, recognizing the influence of subjective factors in the process of analyzing and understanding food product labels and their direct relationship with the food choice process, three additional dimensions were incorporated into the study. This is because it has been emphasized that the consumer's decision-making process is strongly influenced by internal beliefs and attitudes, and therefore, auxiliary dimensions can affect the selection of food products containing high levels of nutrients related to NCDs, such as *dulce de leche*. In this scenario, dimensions involving health consciousness, concern for body weight, and basic nutritional knowledge can be incorporated into the modeling, assuming the following hypotheses:

**Hypothesis 2.** *Lower levels of health consciousness increase the probability of the product being chosen.*

**Hypothesis 3.** *Lower levels of concern about body weight increase the probability of the product being chosen.*

**Hypothesis 4.** *Increased knowledge in basic nutrition reduces the probability of the product being chosen.*

In this context, this study assessed how the "High in" information associated with a magnifying glass in the FoPL affects the product choice when compared to the same information presented purely in a textual form. Additionally, it was verified whether the combination of a magnifying glass and textual claim elicited a different visual inspection behavior compared to purely textual information. To investigate consumers' choice process, mock dulce de leche were created and evaluated (with and without eye-tracking) in an online questionnaire structured as a discrete choice experiment to mimic a real choice process.

## 2 | Materials and Methods

### 2.1 | Overview

In order to broaden the analysis of how the variation in information present in the FoPL system is perceived by the consumer and how it impacts food choices, the data collection was segmented into two phases, as suggested by Leon et al. (2020). Therefore, a discrete choice task was structured using a complete factorial design, balanced and randomized block, since only one factor/attribute was evaluated in the study: the structure of the FoPL system (assessed at seven levels).

Thus, in the first part of the study, a standard general discrete choice experiment (DCE_STD) was conducted with 408 participants ($n = 408$), whose eye activity was not tracked. Meanwhile, in the second phase, the same questionnaire was used to conduct a discrete choice experiment with 32 participants ($n = 30$) whose eye activity was tracked (DCE + ET). Figure 1 provides a general overview of the experiment. Both phases adhered to the CHERRIES guidelines for conducting and reporting online surveys, with the following details:

A pilot test was conducted with 30 individuals from the Department of Food Science and Technology, many of whom had prior experience with research questionnaires. The pilot aimed to ensure clarity of the questions and functionality of the Compusense platform. Feedback from pilot participants helped refine the wording of certain items and address minor interface issues. The estimated response time after the pilot was approximately 10 min.

No monetary or material incentives were provided to participants in either phase of the study. Participants voluntarily engaged in the research without compensation, as noted in the recruitment posters.

Data collection occurred from June 2023 to February 2024. The DCE_STD phase was completed by November 2023, and the DCE + ET phase concluded in February 2024.

The questionnaire was developed using the Compusense platform. It consisted of the 6 sociodemographic questions, 21 discrete choice tasks, 1 question about *dulce de leche* consumption habits, 7 questions from the Health Consciousness Scale (HCS) subscale, three questions from the Weight Status Control Scale (WCS), and 10 questions from the Objective Nutrition Knowledge Questionnaire.

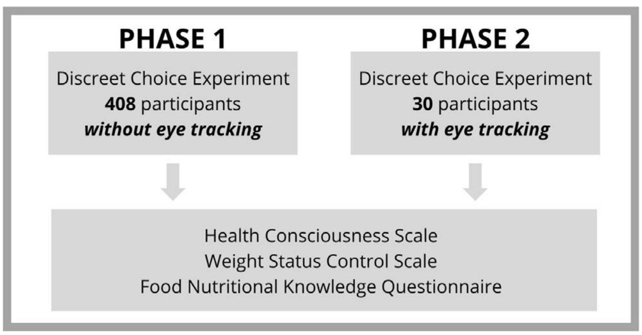


**FIGURE 1** | Scope of data collection.

The survey was divided across 10 screens, ensuring that respondents did not experience fatigue. Adaptive questioning was not used; all participants received the same questions. The layout was optimized for desktop and mobile viewing to maximize accessibility. Responses were submitted through secure HTTPS connections, and no cookies were used to track individual respondents.

Given the importance of complete datasets in discrete choice experiments, special attention was given to incomplete responses. Participants who did not complete the entire survey were excluded from the final analysis. Of the 774 participants who started the survey, 365 dropped out (47.3%). These non-responses were excluded, and dropout patterns were checked for systematic bias.

For the DCE + ET, participants were recruited on the campus of the Experimental Psycholinguistics Laboratory (LAPEX) at the Faculty of Letters of the Federal University of Rio de Janeiro (FL-UFRJ). For the DCE_STD (without eye tracking), participants were invited through posters shared on social media. Consumers were informed that their eye activity would be monitored; however, they were not told that the research involved FoPL on the labels. This research was approved by the Ethics Committee of the Federal Institute of Rio de Janeiro, under registration number 72095317.0.0000.5268.

This sample size adheres to the minimum recommended of at least 20 respondents per choice set (Lancsar and Louviere 2008), as, with only one factor/attribute under analysis, only one choice set was generated, including all hypothetical products that were evaluated in pairs by all participants. Additionally, it has been suggested that samples above 200 participants provide reliable results in DCEs (Richetin et al. 2022; Yang et al. 2015) and that the precision of results increases rapidly when sample sizes approach 150 and then stabilizes around 300 observations (Johnson et al. 2013).

The groups used in the two phases were independent, meaning that no participant from the first phase participated in the second. Thus, after completing the choice task in both phases, participants responded to three short questionnaires involving the HCS (Gould 1990; Menon and Chavadi 2022; Parashar et al. 2023); WCS (Bazzani et al. 2020), and Objective Nutrition Knowledge Questionnaire (Andrews et al. 2021).

The product used as a model for the FoPL analysis in this study (*dulce de leche*) may carry warnings related to sugar and fat. Therefore, factors known to influence health-related food choices—such as awareness of their own health, concerns about body weight, and the level of basic nutrition knowledge—were also assessed through a questionnaire. These dimensions may affect the level of attention consumers pay to FoPL and, consequently, influence their decision-making process.

In this context, the inclusion of the HCS, WCS, and Food Nutritional Knowledge Questionnaire in the discrete choice experiment questionnaire aimed to capture information about subjective dimensions that can influence the food choice process and the interpretation of FoPL claims. Subjective dimensions, which can be considered latent variables, are crucial in discrete choice experiments analyzed with logit models, as they can be significantly associated with consumer behavior and decision-making


**FIGURE 2** | Hypothetical products evaluated in the discrete choice experiment.

**TABLE 1** | Investigated levels for the “front-of-package nutritional labeling” attribute.

| Code | Definition |
|---|---|
| TEX_SUG_FAT | Declaration of “High in added sugar and saturated fat” as plain text |
| MGS_SUG_FAT | Declaration “High in added sugar and saturated fat” associated with magnifying glass[a] |
| TEX_SUG | Declaration of “High in added sugar” as plain text |
| MGS_SUG | Declaration “High in added sugar” associated with magnifying glass[a] |
| TEX_FAT | Declaration of “High in saturated fat” as plain text |
| MGS_FAT | Declaration “High in saturated fat” associated with magnifying glass[a] |
| NON | No information presented |

[a]As established by RDC No. 429/2020 and IN 75/2020. (BRASIL 2020).

(Lahoz et al. 2023). This is because both stimuli (FoPL system and dulce de leche) can be associated with consumers' subjective perceptions. FoPL, due to its warning about nutrients with potential negative health impacts, and dulce de leche as a study product, being associated with desserts and food indulgence.

Furthermore, the basic nutrition knowledge questionnaire assumes that an understanding of nutrition can make the use of labels more accessible, and consequently, the transmission and absorption of the intended information in communication. Levy and Fein (1998) highlighted how knowledge impacts consumers' ability to perform tasks related to the use of nutritional labels.

## 2.2 | Design

Mock packages (Figure 2) were created by a graphic designer to resemble existing food products in the Brazilian market. Table 1


**FIGURE 3** | Area of interest evaluated on the dulce de leche labels.

presents the levels of the "front-of-package labeling system structure" attribute (FoPL System) that were manipulated in the simulated packaging.

In each choice task, a pair of hypothetical products (dulce de leche) was presented to participants for them to indicate their purchase preference. The labels were identical except in the investigated area of interest (AOI) (Figure 3), where the levels of the attribute (FoPL system) were presented.

Seven levels of this attribute were evaluated; thus, seven hypothetical products were generated (Figure 2), each representing one of the levels of the FoPL System attribute. Therefore, in the experiment, each participant evaluated 21 possible pairs (Table 2), where each pair represented the comparison between two of the seven attribute levels. We chose to conduct a complete factorial experiment, encompassing the combination of the seven labels in all possible pairs, to ensure that all possible combinations were judged by all participants.

In experiments of moderate complexity, it has been observed that up to 17 choice tasks do not compromise the reliability of results (Bech et al. 2011). In this study, as only one attribute was evaluated, and its levels were easily comprehensible, 21 choice tasks were conducted (Table 2), after being internally validated with a subsample of 30 participants who were not included in the final data synthesis. The order of presentation of the slide pairs was randomized for each participant. This was done to minimize drag and carryover effects.

**TABLE 2** | Experimental design for DCE (dulce de leche).

| | Position shown on screen | |
|---|---|---|
| **Choice tasks** | **Left** | **Right** |
| Slide 1 | NON | MGS_SUG |
| Slide 2 | MGS_SUG | TEX_FAT |
| Slide 3 | MGS_SUG_FAT | TEX_SUG_FAT |
| Slide 4 | TEX_SUG_FAT | MGS_FAT |
| Slide 5 | TEX_SUG | TEX_FAT |
| Slide 6 | NON | TEX_SUG_FAT |
| Slide 7 | MGS_SUG | MGS_FAT |
| Slide 8 | NON | MGS_SUG_FAT |
| Slide 9 | MGS_SUG | TEX_SUG |
| Slide 10 | MGS_FAT | TEX_SUG |
| Slide 11 | TEX_SUG_FAT | TEX_FAT |
| Slide 12 | MGS_SUG_FAT | MGS_FAT |
| Slide 13 | TEX_SUG | NON |
| Slide 14 | MGS_SUG_FAT | MGS_SUG |
| Slide 15 | MGS_FAT | NON |
| Slide 16 | TEX_SUG | MGS_SUG_FAT |
| Slide 17 | TEX_FAT | MGS_SUG_FAT |
| Slide 18 | MGS_FAT | TEX_FAT |
| Slide 19 | TEX_SUG_FAT | TEX_SUG |
| Slide 20 | TEX_FAT | NON |
| Slide 21 | TEX_SUG_FAT | MGS_SUG |

## 2.3 | Procedure

### 2.3.1 | DCE Without Eye Tracking

Initially, respondents answered sociodemographic questions, then engaged in a choice task with hypothetical chocolate ice creams to become familiar with the mechanics of the choice task. After completing the practice with chocolate ice creams, participants were instructed to begin the task with dulce de leche. During the subsequent experimental task, participants were presented with pairs of dulce de leche and asked, "Please evaluate the dulce de leche and indicate which product you would prefer to buy, or if you would not buy any of these products." The option "would not choose either of the two products" was included to mimic a real shopping experience where consumers may choose not to buy any of the available options (Lizin et al. 2022). Throughout the experiment, after every seven choice tasks, a blank screen containing a stimulus phrase to continue the tests was presented to participants to prevent monotony during the sessions.

### 2.3.2 | DCE With Eye Tracking

The biometric research was conducted using an eye tracker (Tobii T120) integrated with a 17″ monitor (refresh rate: 60 Hz, response time: 4 ms). This eye-tracking equipment captures eye movements at 120 Hz (or every 8.3 ms), operating at a distance of 50–80 cm from the eyes and capable of tracking head movements within a 30 × 22 cm window. Participants were seated in a chair positioned 80 cm away from the screen, ensuring their eyes were approximately 70 cm from the tracker.

The calibration process was performed using the equipment's software, which involved identifying the participants' eyes, followed by a task where they tracked a moving ball across the screen with their eyes. After the calibration, participants completed two training sessions with hypothetical chocolate ice cream choices, during which they were able to ask questions and clarify any doubts with the researchers. Once the calibration and training phases were completed, participants were presented with a white screen displaying a small black cross at the center for 5 s. This screen was then replaced, initiating the discrete choice task with the evaluation of sweets and between each choice task, the small black cross screen was shown for 5 s.

There was no time limit for completing the task; participants were simply instructed to proceed to the next screen once they had made their decision. Below the product images, three options were presented: "I choose the product on the left" under the left-hand product, "I would choose neither of the products shown" in the center between the products, and "I choose the product on the right" under the right-hand product. Participants were instructed to fixate on their chosen option for at least 5 s before proceeding to the next screen with a new set of sweets. A neutral white screen with a small black cross was shown before each task for 10 s to minimize sequencing effects and ensure that participants focused on a fixed point before viewing the products. Sociodemographic questions were presented before the discrete choice tasks, similar to the experiment without eye-tracking. Additionally, a hypothetical choice task involving chocolate ice cream was conducted before the main task, as in the noneye-tracking experiment.

The inspection of the AOI was the method used for data collection and reporting. This type of representation allows for the generation of statistical data related to participants' behavior in any area of the stimulus, correlating visual fixation with the analyzed metrics. The eye-tracking data related to AOIs included total fixation duration (duration of all fixations within an AOI) and number of visits (the number of times a participant fixated on an AOI) (Mitterer-Daltoé et al. 2014).

#### 2.3.3 | HCS

Given that consumers' food choice behavior has become increasingly rationalized, that is, individuals tend to reflect more on the food products they purchase (Hoffmann et al. 2020). As originally proposed by Gould (1990), in this study, HCS data were collected using a seven-point Likert scale, ranging from "completely agree" to "completely disagree" for each stated sentence. The sentences used in the HCS are shown in Table 3.

#### 2.3.4 | WCS

WCS may be relevant in studies on preferences for candies and desserts due to the influence of body image concerns and food choices (Sun 2008). Additionally, statements present in FoPL systems, besides being associated with nutrients related to the development of NCDs, are also linked to weight gain, especially added sugars and saturated fats. Therefore, individuals may have distinct preferences for foods, including sweets. In this study, WCS data were collected using a seven-point Likert scale, ranging from "strongly agree" to "strongly disagree" for each stated sentence (Table 4).

**TABLE 3** | Sentences evaluated on the "health consciousness scale."

| Sentence | Code |
|---|---|
| "I reflect about my health a lot." | HCS1 |
| "I am very involved with my health" | HCS2 |
| "I am usually aware of my health" | HCS3 |
| "I am constantly examining my health" | HCS4 |
| "I am alert to changes in my health" | HCS5 |
| "I am very self-conscious about my health" | HCS6 |
| "I notice how I feel physically as I go through the day" | HCS7 |

*Source:* translated and adapted from Gould (1990).

**TABLE 4** | Sentences evaluated with "weight status control scale."

| Sentence | Code |
|---|---|
| "I am trying to lose weight" | WSC1 |
| "I do not want to gain more weight" | WSC2 |
| "I have not been doing anything to regulate my weight" | WSC3 |

*Source:* translated and adapted from (Bazzani et al. 2020).

#### 2.3.5 | Objective Nutrition Knowledge Measure

In this study, the objective nutrition knowledge questionnaire proposed by Andrews et al. (2021) in their study involving FoPLs was adapted to include questions about sugar and incorporated into the theoretical model. The assessed questions can be seen in Table 5.

#### 2.3.6 | Variables Used in the Models

The logit model was used to analyze the data from the discrete choice experiment, being appropriate for estimating the probability of choice between different alternatives based on explanatory variables (Hauber et al. 2016). The logit model allows for an analysis of how both product-related and consumer-related factors influence decision-making. The explanatory variables included in the logit models for the experiments with and without eye tracking are presented in Tables 6 and 7.

The variables used in the logit model include both product attributes and consumer characteristics. Product attributes involve the presence or absence of warnings about added sugar and saturated fat content, presented either visually (with a magnifying glass) or textually. Consumer characteristics cover factors such as consumption frequency, sex, age range, marital status, education level, income, health and weight concerns, as well as

**TABLE 5** | Objective nutrition knowledge measure.

**Vegetables, fruits, and grain products provide**

A. Complex carbohydrates

B. Dietary fiber

C. **Both complex carbohydrates and dietary fiber**

D. Neither complex carbohydrates or dietary fiber

E. Don't know

**Which food group provides protein, B vitamins, iron, and zinc?**

A. **Meat, poultry, and fish**

B. Milk and dairy products

C. Fruits

D. Grain products such as bread, cereal, and rice

E. Don't know

**Nutrition guidelines suggest that no more than _______ percent of calories consumed in a day should come from saturated fat.**

A. 1%

B. **10%**

C. 20%

D. 30%

E. Don't know

**Cholesterol is found in**

A. Vegetables and vegetable oils

B. **Animal products like meat and dairy**

C. All foods containing fat or oil

D. None of the above

E. Don't know

**Normal blood pressure in adults is systolic less than _______ and diastolic less than _______.**

A. **120, 80 mmHg**

B. 180, 95 mmHg

C. 105, 95 mmHg

D. 200, 110 mmHg

E. Don't know

*Note:* Correct answers in bold.
*Source:* translated and adapted from (Bazzani et al. 2020).

nutrition knowledge. These variables were selected to capture the key factors that may influence participants' choices during the experiment.

In addition to the general variables mentioned above, in the discrete choice experiment with eye tracking, the number of visits (saccades) and total fixation duration were included in the logit model to capture how participants' visual attention influences their choices in the discrete choice experiment with eye tracking.

The number of visits reflects the number of times a participant's gaze returns to an AOI (e.g., a warning about high sugar or saturated fat content). A higher number of visits suggests that the area is being revisited, which may indicate increased cognitive processing or consideration of that information at the time of choice (Jantathai et al. 2013).

Total fixation duration measures the total time a participant spends looking at a specific area. Longer fixations indicate a higher level of attention and processing of visual information,

**TABLE 6** | Variables used in the discrete choice experiment models.

| Name | Definition |
|---|---|
| MGS_SUG | Presence of the magnifying glass warning of high added sugar content. Dummy variable taking value of "1" when choosing the product containing LUPG and "0" when another product was chosen. |
| MGS_FAT | Presence of the magnifying glass warning of high sutured fat content. Dummy variable taking value of "1" when choosing the product containing the LUPG and "0" when another product was chosen. |
| MGS_SUG_FAT | Presence of the magnifying glass warning of high added sugar and sutured fat content. Dummy variable taking value of "1" when choosing the product containing the LUPAG and "0" when another product was chosen. |
| TEX_S | Presence of text informing about high added sugar content. Dummy variable taking value of "1" when choosing the product containing TEXA and "0" when another product was chosen. |
| TEX_F | Presence of text informing about high saturated fat content. Dummy variable taking value of "1" when choosing the product containing TEXG and "0" when another product was chosen. |
| TEX_SUG_FAT | Presence of text informing about high levels of saturated fat and added sugars. Dummy variable taking value of "1" when choosing the product containing TEXAG and "0" when another product was chosen. |
| NON[a] | No warning information on the label. Dummy variable taking value of "1" when choosing a product without any alert and "0" when another product was chosen. |
| CON_SPO[a] | Sporadic consumption of dulce de leche (consumes a few times a year, but not monthly). Dummy variable taking value of "1" when the consumer reports sporadic consumption and "0" when he reports frequent consumption. |
| CON_FREQ | Frequent consumption of dulce de leche (once or more times per month). Dummy variable taking value of "1" when the consumer reports frequent consumption and "0" when he reports sporadic consumption. |
| SEX_F | Consumer's biological sex. Binary, value "1" when reporting female biological sex and "0" when reporting male. |
| SEX_M[a] | Consumer's biological sex. Binary, value "1" when reporting male biological sex and "0" when reporting female. |
| AGE_18–36[a] | Age range. Dummy variable taking value of "1" when age reported range between 18 and 36 years old and "0" when another age is reported. |
| AGE_36_60 | Age range. Dummy variable taking value of "1" when age reported range between 36 and 60 years old and "0" when another age is reported. |
| AGE_60+ | Age range. Dummy variable taking value of "1" when age reported is above 60 years old and "0" when another age is reported. |
| MARI_M + SU[a] | Marital status. Dummy variable taking value of "1" when reported to be married or in a stable union and "0" when reporting another marital status. |
| MARI_S + D | Marital status. Dummy variable taking value of "1" when reported to be single, divorced, or widowed and "0" when reporting another marital status. |
| EDU_HI[a] | Education. Dummy variable taking value of "1" when he reported studying until high school and "0" when reporting studies up to higher education and/or postgraduate level. |
| EDU_C + PG | Education. Dummy variable taking value of "1" when reported studying until college and/or postgraduate studies and "0" when reported studying until high school. |
| INC_LOW[a] | Reported income. Dummy variable taking value of "1" when reported income up to two minimum wages (2630.00 BRL). when another income range is reported. |
| INC_MED | Reported income. Dummy variable taking value of "1" when reporting income between two and six minimum wages (2630.00–7920.00 BRL) and "0" when reporting another income range. |
| INC_HIG | Reported income. Dummy variable taking value of "1" when income above six minimum wages (7920.00 BRL) is reported and "0" when another income range is reported. |

(Continues)

| Name | Definition |
|---|---|
| HCS_LOW | Health awareness. Dummy variable taking value of "1" when there is a report of little concern about health (average HCS score below 4) and "0" when higher average levels of concern are reported. |
| HCS_HIG[a] | Health awareness. Dummy variable taking value of "1" when there is reported concern about health (average HCS score above 4) and "0" when indifference or little concern is reported. |
| WSC_LOW | Concern about weight. Dummy variable taking value of "1" when there is a report of low concern about current weight (average WSC score below 4) and "0" when indifference or a lot of concern is reported. |
| WSC_HIG[a] | Concern about weight. Dummy variable taking value of "1" when there is a report of concern about current weight (average WSC score above 4) and "0" when indifference or little concern is reported. |
| NUT_KNOW | Continuous variable. Reflects the average number of correct answers in the objective nutrition knowledge questionnaire. |

[a]Categories defined as "reference level."

suggesting that this information may have a greater impact on the consumer's final decision (Leon et al. 2020).

## 2.4 | Data Analysis

### 2.4.1 | Discrete Choice Experiment

These data were analyzed according to the Random Utility Theory proposed by McFadden (1973), which, in essence, assumes that the utility of individual $i$ in choosing alternative $j$, in choice situation $t$ ($U_{ijt}$), can be represented as:

$$U_{ijt} = \beta_i' x_{ijt} + \varepsilon_{ijt} \tag{1}$$

where $x_{ijt}$ is a vector of observed variables relative to individual alternative $j$ and $i$; $\beta' i$ is a vector of structural parameters that characterize choices; $\varepsilon_{ijt}$ is the unobserved error term, which is assumed to be independent of $\beta$ and $x$.

Models of random utility are differently derived based on the composition of unobserved factors $f$ ($\varepsilon ijt$). Given the logistic nature of the data in this study (chosen product "yes" or "no"), we opted to use a generalized linear model (glm~ logit) instead of analyzing via *Error Component Random Parameter logit* (best suited for models with three or more responses). Although in this study, three response options were available in the Discrete Choice Experiment (choose the right product, choose the left product, and not choose either of the two products), we decomposed it into only two, "choose" and "not choose," and the data in the corresponding row received the attributes of the chosen or not chosen product as the dependent variable. The option of not choosing given to consumers was considered with the aim of better approximating the experiment to a real choice experience (Van Loo et al. 2015).

Thus, two independent empirical models (logit) were estimated, the first for the data from Experiment 1 (without using Eye Tracking metrics) and the second for data from Experiment 2 (with the use of Eye Tracking metrics). The econometric analysis was conducted to estimate the probability of an individual choosing the product, taking into account the effects captured by the explanatory variables. This model was based on the cumulative statistical probability function (logistic), given by:

$$P_i = \frac{1}{1 + e^{-X_i \beta}} \tag{2}$$

where $P_i$ represents the probability of the occurrence of the event (i.e., probability of the dulce de leche being chosen); $X_i$ is a vector of explanatory variables, and $\beta$ is a vector of unknown parameters to be estimated through the method of maximum likelihood (Rees and Maddala 1985), which finds a combination of coefficients that maximizes the probability of the sample being observed. After estimating the logit model, the marginal effects of each attribute are calculated, determining their respective percentage in the variation of the individual's choice probability.

In nonlinear models, the estimated coefficient is not equivalent to the marginal effect of the dependent variable on the probability of the consumer making a choice. In other words, the marginal effect will not be well estimated by $\beta$ itself and by:

$$\partial P(Y=1) / \partial X = \beta \frac{e^{-X_i \beta}}{\left(1 + e^{-X_i \beta}\right)^2} \tag{3}$$

that is, by multiplying the estimated coefficient $\beta$ of each explanatory variable with the density function of the logistic distribution. Consequently, the MgE was obtained through the partial derivative of the choice probability curve concerning the independent variable, keeping the values of the other independent variables constant (Tavares-Filho et al. 2023). This resulted in determining the instantaneous rate of change of the probability curve at the point, equivalent to the slope of the tangent line to the probability curve at that specific value. The tangent line represented a linear approximation of the probability curve at the selected point. Therefore, the MgE value could be interpreted as the effect of a 1-unit change in the independent variable on the probability of choice (Glasgow 2022).

### 2.4.2 | Discrete Choice With Eye Tracking

The eye tracking data were included in the logit model both as continuous variables (Total Fixation Duration) and as discrete variables (Fixation Count).

**TABLE 7** | Variables related to fixation and saccade metrics used in the discrete choice experiment model with eye tracking.

| Code | Definition |
|---|---|
| VCLA | Visit count. Discrete. Number of saccades (visits) occurring in the area of interest when presented with the information "High in added sugar" structured alongside the magnifying glass image. |
| VCLG | Visit count. Discrete. Number of saccades (visits) occurring in the area of interest when presented with the information "High in saturated fat" structured alongside the magnifying glass image. |
| VCLAG | Visit count. Discrete. Number of saccades (visits) occurring in the area of interest when presented with the information "High in added sugar and saturated fat" structured alongside the magnifying glass image. |
| VCTA | Visit count. Discrete. Number of saccades (visits) occurring in the area of interest when presented with the information "High in added sugar" presented as plain text. |
| VCTG | Visit count. Discrete. Number of saccades (visits) occurring in the area of interest when presented with the information "High in saturated fat" presented as plain text. |
| VCTAG | Visit count. Discrete. Number of saccades (visits) occurring in the area of interest when presented with the information "High in added sugar and saturated fat" presented as plain text. |
| VCNON[a] | Visit count. Discreet. Number of saccades (visits) occurring in the area of interest when no information (FOLP) was presented. |
| TFDLA | Continuous. Duration (in ms) of all fixations within the area of interest (AOI) when presented with the information "High in added sugar" structured alongside the magnifying glass image. |
| TFDLG | Continuous. Duration (in ms) of all fixations within the AOI when presented with the information "High in saturated fat" structured alongside the magnifying glass image. |
| TFDLAG | Continuous. Duration (in ms) of all fixations within the AOI when presented with the information "High in added sugar and saturated fat" structured alongside the magnifying glass image. |
| TFDTA | Continuous. Duration (in ms) of all fixations within the AOI when presented with the information "High in added sugar" presented as plain text. |
| TFDTG | Continuous. Duration (in ms) of all fixations within the AOI when presented with the information "High in saturated fat" presented as plain text. |
| TFDTAG | Continuous. Duration (in ms) of all fixations within the AOI when presented with the information "High in added sugar and saturated fat" presented as plain text. |
| TFDNON[a] | Continuous. Duration (in ms) of all fixations within the AOI when no information (FOLP) was presented. |

[a]Categories defined as "reference level" in logit model estimation.

### 2.4.3 | HCS, WCS, and Objective Nutritional Knowledge

Initially, the WCS, Objective Nutritional Knowledge, and HCSs were translated and culturally adapted to the Portuguese language. Then, a validation was carried out through an internal pretest with 30 participants. Subsequently, a Confirmatory Factor Analysis of the questionnaire with the mentioned scales was conducted, aiming to capture information related to dimensions of awareness regarding one's health and weight control. The metrics used to assess the reliability of the questionnaire were the Comparative Fit Index (CFI), Tucker–Lewis Index (TLI), root mean square error of approximation (RMSEA) with 90% confidence intervals (lower and upper), and standardized root mean square residual (SRMR).

The Kaiser–Meyer–Olkin (KMO) test was additionally conducted on the HCS and WCS data to assess the suitability of the data for confirmatory factor analysis. A threshold value of 0.6 was adopted as the minimum cutoff to validate data quality. KMO values below 0.6 indicate inadequate sampling (Fernandes da Silva et al. 2023). Confirmatory factor analysis was chosen over exploratory analysis because two dimensions, concern for health and concern for body weight, were determined a priori.

The data treatment applied to the responses obtained in HCS and WSC involved first obtaining the mean of the item responses for each scale, resulting in an average value for HCS and WSC for each respondent. Subsequently, each respondent was classified into one of two categories: highly health-conscious and concerned (individuals with an average score in HCS above 4) or less health-conscious and concerned (individuals with an average score in HCS below 4). The same principle was used to classify individuals regarding the control of their own weight, highly concerned and engaged in weight loss, and less concerned and engaged in weight loss. Thus, both categories for both scales were included in the logit model to assess whether being less or more health-conscious/concerned (and less or more concerned/engaged in weight loss) were associated with changes in the probability of choosing the product.

Regarding the Basic Nutrition Knowledge Questionnaire (NUT_KNOW), a score was obtained for each participant based on the number of correct answers observed for each participant in the ONK. Once discretized, the correct answers for each participant were entered into the logit model as a continuous variable to observe whether unit increases in correct answers were associated with changes in the probability of choosing the product. Given

**TABLE 8** | General sociodemographic characterization of the consumer samples that participated in the discrete choice experiment with and without eye tracking.

| Demographic descriptor | Proportion in the sample | |
|---|---|---|
| | DCE_STD | DCE + ET |
| Birth sex | | |
| Feminine | 65.93% | 53.33% |
| Masculine | 34.07% | 46.67% |
| Age group (years) | | |
| 18–36 | 74.02% | 83.33% |
| 36–60 | 21.08% | 16.67% |
| 60+ | 4.90% | 0 |
| Marital status | | |
| Single, divorced or widowed | 72.05% | 86.67% |
| Married or stable union | 27.95% | 13.33% |
| Education level | | |
| Up to high school | 40.45% | 46.67% |
| Higher education or postgraduate | 59.55% | 53.33% |
| Income (minimum wages/month) | | |
| Up to 2 | 15.20% | 50% |
| 2–6 | 54.17% | 40% |
| Over 6 | 15.93% | — |

Abbreviations: DCE + ET: Discrete choice with eye tracking; DCE_STD: Discrete choice without eye tracking.

the heterogeneity of the questions assessed in the objective nutritional knowledge questionnaire, no factor analysis was conducted on this questionnaire (Bazzani et al. 2020).

The software used for fitting the logit model and Confirmatory Factor Analysis was the R Program (R Core Team 2024), with the glm package adjusted for logistic modeling and the lavaan package for CFA.

## 3 | Results

### 3.1 | General Characteristics of the Sample and Models

The sociodemographic profile of the participants involved in the discrete choice experiments is shown in Table 8. While there are some differences between the DCE_STD and DCE + ET samples, these can be attributed to the recruitment methods used. The DCE_STD sample was recruited online, which resulted in a more diverse range of sociodemographic characteristics. On the other hand, the DCE + ET sample, recruited in person at a liberal arts college, presents higher proportions of younger individuals and participants with higher education levels. These characteristics are typical of a university-based population, and this skewness should be acknowledged when interpreting the results. The average time to complete the questionnaires was nine and a half minutes.

In both generated logit models (with and without eye-tracking), the absence of FoPL was used as the reference level (base variable) to better understand the impact of structured FoPL with and without the magnifying glass (Andrews et al. 2011). In other words, all hypothetical products containing FoPL were compared to the hypothetical product without any FoPL. When analyzing the estimated coefficients in both models (Tables 9 and 10), it is observed that the (negative) signs found for MGS_SUG, MGS_FAT, MGS_SUG_FAT, TEX_SUG, TEX_FAT, and TEX_SUG_FAT were consistent with the theoretical expectations, meaning that the presence of any FoPL on the label reduced the probability of the product being chosen.

### 3.2 | Confirmatory Factor Analysis

Table 11 presents the metrics used to evaluate the factor structure of the questionnaire containing questions from HCS and WSC. Initially, the adequacy of the data for factor analysis was observed (KMO > 0.6). Regarding the CFA metrics, a satisfactory fit of the data was observed, with values of the main indicators close to the more stringent cutoff proposed by Hu and Bentler (1999), including a CFI close to 0.95, TLI close to 0.95, SRMR close to 0.08, and RMSEA close to 0.06. The observed parameters were in alignment with the proposed cutoffs for more subjective questionnaires (Perry et al. 2015). Hopwood and Donnellan (2010) illustrated the difficulty of achieving very rigorous cutoffs when examining eight common personality instruments, suggesting the application of more flexible cutoffs, for example, CFI and TLI > 0.90, RMSEA < 0.10.

### 3.3 | Impact of FoPL on Stated Preference

The parameters used to interpret the impact of the explanatory variables assessed in this study (Table 6) are presented in Table 9. Specifically, Table 9 shows the values associated with the estimated regression coefficient for each explanatory variable, its associated standard error, the $z$-value (coefficient divided by its standard error), the probability of observing a $z$-value as extreme or more extreme than the observed one, and the marginal effects. Marginal effects were chosen as they clearly demonstrate the change in the probability of the outcome (product choice) when the predictor or independent variable varies by one unit. Probabilities were estimated via marginal effects because analyzing the regression coefficient and its sign (positive or negative) provides information about the direction but not directly about the magnitude of the variable's effect.

In this regard, concerning the “FoPL system”, it can be observed (Table 9) that all evaluated levels negatively affected the probability of the product being chosen. However, it was noted that the three investigated pieces of information, “High in added sugar,” “High in saturated fat,” and “High in added sugar and saturated fat,” showed greater reductions in the probability of the product being chosen when presented in plain text written in

**TABLE 9** | Estimates of the coefficients of the logit model and respective marginal effect values for discrete choice without eye tracking.

| | logit model DCE_STD | | | | |
|---|---|---|---|---|---|
| | **Coefficients** | **Standard error** | ***z* value** | **Pr(>\|*z*\|)** | **Marginal effects** |
| (Intercept) | 1.705 | 0.116 | 14.711 | **<0.001** | — |
| MGS_SUG | −0.808 | 0.095 | −8.493 | **<0.001** | **−0.176** |
| MGS_FAT | −1.545 | 0.095 | −16.351 | **<0.001** | **−0.367** |
| MGS_SUG_FAT | −2.005 | 0.095 | −21.024 | **<0.001** | **−0.417** |
| TEX_SUG | −1.667 | 0.094 | −17.769 | **<0.001** | **−0.393** |
| TEX_FAT | −1.73 | 0.095 | −18.2 | **<0.001** | **−0.395** |
| TEX_SUG_FAT | −2.38 | 0.098 | −24.223 | **<0.001** | **−0.547** |
| CON_FREQ | 0.368 | 0.064 | 5.787 | **<0.001** | **0.073** |
| SEX_M | −0.215 | 0.05 | −4.316 | **<0.001** | **−0.051** |
| AGE_36_60 | 0.107 | 0.067 | 1.607 | 0.108 | 0.025 |
| AGE_60p | −0.12 | 0.071 | −1.702 | 0.089 | −0.028 |
| EDU_C_PG | −0.393 | 0.05 | −7.806 | **<0.001** | **−0.071** |
| INC_MED | 0.111 | 0.062 | 1.772 | 0.076 | 0.026 |
| INC_HIG | −0.206 | 0.072 | −2.858 | **0.004** | **−0.049** |
| HCS_LOW | 0.022 | 0.063 | 0.351 | 0.726 | 0.005 |
| WSC_LOW | 0.381 | 0.046 | 8.198 | **<0.001** | **0.090** |
| NUT_KNOW | 0.026 | 0.013 | 1.94 | 0.052 | 0.006 |

*Note:* Values in bold indicate significance with a *p*-value less than 0.05.

lowercase black letters than when presented structured together with the magnifying glass icon.

In this study, the presence of the information "High in added sugar" when presented structured with the magnifying glass icon (MGS_SUG) resulted in a 17.6% reduction in the probability of the product being chosen, while presenting the same information in plain text caused a 39.3% reduction. For the information, "High in saturated fat," the reduction in the probability of the product being chosen was −36.7% in the FoPL system with the magnifying glass and −39.5% for the same information in plain text. A similar result was observed for the statement "High in added sugar and saturated fat" structured with the magnifying glass (−41.7%) and as plain text (−54.7%). Additionally, it can be observed that for both systems, the information about high levels of both nutrients (High in added sugar and fat) caused the greatest reductions in the probability of the product being chosen. It is also noteworthy that the presence of saturated fat in the product seems to negatively affect consumer choice more than the presence of added sugar when compared individually.

The body weight status (WSC Scale) yielded results aligned with the theoretical expectation, that is, low concern and engagement with weight reduction "WCS_LOW" were associated with a +9.0% increase in the probability of choosing the dulce de leche compared to individuals with high concern and engagement with weight reduction. Regarding basic nutrition knowledge, it can be observed that increases in scores obtained in the Objective Nutrition Knowledge Questionnaire (NUT_KNOW) did not result in changes in the probability of choosing the product.

Regarding the evaluated sociodemographic characteristics, it can be observed that the frequent consumption of dulce de leche (CON_FREQ) increases the probability of choosing the product (+7.3%). Being male (SEX_M) is related to a 5.1% reduction in the probability of choosing the product compared to being female. Educational level is also associated with changes in the probability of choosing the product, with completion of higher education (with or without postgraduate education) reducing the probability of choice by 7.1% compared to having completed only high school. High average family income is associated with a −4.9% probability of choosing the product compared to having low family income. Jáuregui observed that in products containing different FOP systems, the nutritional quality of the shopping cart tended to be lower among individuals with low levels of income, education, and nutritional knowledge.

### 3.4 | Stated Preference With Eye-Tracking Monitoring

Like the overall experiment (without eye-tracking), the coefficients in the DCE + ET logit model also exhibited signs consistent with theoretical expectations. The model including eye-tracking metrics ($n = 30$) encompassed most of the variables from the overall model, in addition to incorporating specific eye-tracking variables (as detailed in Table 10). Many sociodemographic

**TABLE 10** | Estimates of the coefficients of the logit model and respective marginal effect values for discrete choice with eye tracking.

| | logit model DCE + ET | | | | |
|---|---|---|---|---|---|
| | **Coefficients** | **Standard error** | ***z* value** | **Pr(> \|*z*\|)** | **Marginal effects** |
| (Intercept) | 0.601 | 0.71 | 0.845 | 0.398 | — |
| MGS_SUG | −0.574 | 0.339 | −1.696 | **0.090** | **−0.139** |
| MGS_FAT | −0.807 | 0.383 | −2.106 | **0.035** | **−0.167** |
| MGS_SUG_FAT | −1.157 | 0.369 | −3.132 | **0.002** | **−0.282** |
| TEX_SUG | −0.773 | 0.414 | −1.866 | **0.032** | **−0.199** |
| TEX_FAT | −0.751 | 0.448 | −1.677 | **0.014** | **−0.184** |
| TEX_SUG_FAT | −1.62 | 0.459 | −3.53 | **< 0.001** | **−0.381** |
| VC_MGS_SUG | 0.011 | 0.137 | 0.08 | 0.936 | 0.002 |
| VC_MGS_FAT | 0.086 | 0.129 | 0.666 | 0.505 | 0.024 |
| VC_MGS_SUG_FAT | 0.133 | 0.084 | 1.589 | 0.112 | 0.031 |
| VC_TEX_SUG | −0.048 | 0.11 | −0.441 | 0.659 | −0.011 |
| VC_TEX_FAT | −0.397 | 0.113 | −3.498 | **< 0.001** | **−0.094** |
| VC_TEX_SUG_FAT | −0.162 | 0.086 | −1.88 | **0.050** | **−0.038** |
| TF_MGS_SUG | 0.11 | 0.18 | 0.609 | 0.543 | 0.026 |
| TF_MGS_FAT | 0.087 | 0.227 | 0.382 | 0.702 | 0.02 |
| TF_MGS_SUG_FAT | −0.055 | 0.185 | −0.297 | 0.767 | −0.013 |
| TF_TEX_SUG | −0.162 | 0.157 | −1.033 | 0.302 | −0.038 |
| TF_TEX_FAT | 0.516 | 0.177 | 2.925 | 0.063 | 0.122 |
| TF_TEX_SUG_FAT | 0.01 | 0.114 | 0.089 | 0.929 | 0.002 |
| INC_MED | −0.244 | 0.321 | −0.76 | 0.447 | −0.059 |
| WSC_LOW | 1.132 | 0.232 | 4.874 | **< 0.001** | **0.273** |
| HCS_LOW | 0.138 | 0.217 | 0.636 | 0.525 | 0.033 |
| NUT_KNOW | −0.044 | 0.147 | −0.303 | 0.762 | −0.01 |

*Note:* Values in bold indicate significance with a *p*-value less than 0.05.

variables were removed from the model in the stepwise process (Sauerbrei et al. 2020) to enhance model fit, considering the limited sample size of 30 consumers, which posed challenges for model adjustment. However, variables related to the FoPL attribute and the scales were not removed in the stepwise process as they were considered crucial for the study. Thus, the definitive model for the eye-tracking experiment is presented in Table 10, including values for the estimated regression coefficient for each explanatory variable, the corresponding standard error, the *z*-value (coefficient divided by standard error), the probability of observing a *z*-value as extreme or more extreme than the observed, and the marginal effects.

The analysis of the coefficients observed in the DCE + ET logit model for the levels of the FoPL attribute indicates the same trend observed in the DCE_STD model, that is, the presence of any FoPL on the label reduces the probability of the product being chosen, with the exception of MGS_SUG, which was not significant in the model with eye-tracking metrics. Other trends observed in the overall model were also seen, such as a greater reduction in the probability of choosing the product when high-content claims were presented in simple text compared to the same claim structured along with the magnifying glass image. There is a greater reduction effect on the probability of choice when the dual information is presented, that is, the claim of high added sugar and saturated fat content simultaneously, with reductions of −38.1% when the information is presented in simple text and −28.2% when the information is structured along with the magnifying glass image. It was also observed that not attempting to control body weight or dieting for it increases the probability of choosing the product by 27.3%.

The inclusion of metrics related to eye-tracking (Table 7) indicated that the total fixation time in the AOI containing the FoPL system was not related to the consumer's choice probabilities, while the number of visits and inspections in the AOI was associated with a reduction in the probability of choosing the product when the information was presented in simple text. For example, increases in visits to the "High in Saturated Fat" information presented in text form without the magnifying

**TABLE 11** | Fit indices observed in the confirmatory factor analysis.

| Index | Value |
|---|---|
| Comparative fit index (CFI) | 0.912 |
| Tucker–Lewis Index (TLI) | 0.889 |
| RMSEA | 0.073 |
| 90% CI–lower | 0.058 |
| 90% CI—upper | 0.089 |
| SRMR | 0.049 |
| *Kaiser–Meyer–Olkin (KMO) test* | |
| HCS1 | 0.883 |
| HCS2 | 0.892 |
| HCS3 | 0.893 |
| HCS4 | 0.882 |
| HCS5 | 0.936 |
| HCS6 | 0.882 |
| HCS7 | 0.912 |
| WSC1 | 0.677 |
| WSC2 | 0.908 |
| WSC3 | 0.688 |
| Overall | **0.890** |

Abbreviations: HCS 1–7, sentences evaluated in the health consciousness scale; RMSEA, root mean square error of approximation; SRMR, root mean-square residual; WSC 1–3, sentences assessed on the weight status control scale.

glass were associated with a 9.4% reduction in the probability of choosing the *dulce de leche*, while increases in visits to the "High in Saturated Fat and Added Sugar" information in text form resulted in a 3.8% decrease in the likelihood of choosing the product. The number of visits, in turn, affected the probability of choosing the products, with a higher number of inspections in information structured as simple text being related to a reduction in the probability of choice.

## 4 | Discussion

This study investigated how the structuring of FoPL with the magnifying glass symbol influences consumers' food choices, in comparison to a text-only FoPL version and a control condition without any FoPL. The aim was to isolate and examine the specific contribution of the pictorial structure—namely, the magnifying glass icon—on consumers' attention and decision-making. By including a no-FoPL control, the study was able to evaluate not only the effectiveness of different FoPL designs but also the added impact of warning presence itself. That is, it examined whether the pictorial structure of the magnifying glass object is capable of reinforcing the warning about the high content of nutrients that are related to NCDs when consumed in excess. In this context, the results consistently showed that labels structured without the magnifying glass figure, that is, exclusively with textual warnings—such as "high in added sugar" or "high in saturated fat"—were more effective in discouraging product choice than equivalent messages presented together with the magnifying glass icon. This pattern was observed in both experimental phases, that is, in the general discrete choice task and the one combined with eye-tracking, suggesting that the pictorial structure of the magnifying glass seems to attenuate the perceived severity or salience of the warning. Interestingly, the *dulce de leche* labels with text-only warnings tended to elicit more visual revisits in eye tracking, which may indicate greater cognitive processing or a perception of greater seriousness. In contrast, the version with the magnifying glass may have promoted faster recognition but less elaboration, possibly framing the message in a less urgent or cautionary tone. The number of revisits has been proposed as a reliable proxy for visual attention and cognitive processing, sometimes considered more robust than total fixation time (Sáiz-Manzanares et al. 2023). This attenuation effect related to the presence of the magnifying glass symbol may be associated with theoretical semiotic issues concerning the role of visual symbols in consumer communication. According to Danesi (2021), effective warning signs rely on culturally embedded semiotic cues—such as sharp angles, high-contrast colors, and iconic shapes linked to alertness or danger (e.g., triangles, exclamation marks, stop signs). These elements trigger immediate interpretive responses based on shared social codes, a phenomenon that may not have occurred with the magnifying glass. In contrast, the magnifying glass symbol does not belong to the visual lexicon of risk. Instead, it suggests investigation, detail, or search, which may frame nutritional information as something to be explored rather than avoided. This could explain why, in our study, the presence of the magnifying glass reduced the behavioral deterrent effect of the warnings. Rather than reinforcing urgency, it may dilute it by introducing a neutral or analytical tone.

This finding highlights a potential mismatch between regulatory intent and symbolic communication. If the symbol designed to reinforce the warning effect instead weakens it, then the visual language of the labeling system may need to be revised. This is because semiotic design is most effective when aligned with the desired pragmatic outcome—especially in health communication contexts, where rapid comprehension and emotional salience are crucial (Hongqing and Fang 2024). While the mandatory use of the magnifying glass system in Brazil and its voluntary adoption in Canada until 2026 indicate growing regulatory attention (BRASIL 2020; Health Canada 2023), the lack of research may reflect a gap in understanding the impacts of this labeling on consumer perception.

Although the magnifying glass figure had not yet been studied in isolation as part of the warning label until the present study, its comparison with other FoPL systems has been previously examined. The comparison between the magnifying glass and other FoPL symbols, such as the red circle, red "stop sign," and "attention" triangle, suggests the possible disadvantage of the magnifying glass in terms of warning communication effectiveness (Goodman et al. 2018). Additionally, it receives less positive evaluations from consumers in helping them identify the healthier product compared to the triangular warning label (Khandpur et al. 2022). Previous studies, such as Goodman et al. (2018), suggest that the magnifying glass may not effectively convey the idea of warning or high levels, contrasting with more intuitive symbols.

Sociocultural context and symbolic associations may play a crucial role in the effectiveness of FoPL systems (Batista et al. 2023). For instance, the lack of an inherent association of the magnifying glass figure with alerts or warnings may explain the less positive evaluations by consumers regarding how much the magnifying glass helps them identify healthier products. Exploring cultural perceptions regarding symbols used in FoPL could be vital to enhancing the effectiveness of the magnifying glass as a means of guiding healthier food choices. Additionally, unlike other systems proposed by public health agencies, the FoPL system containing the magnifying glass was an industry proposal (White-Barrow et al. 2023). Therefore, it was expected that this system would be less incisive. Furthermore, it is important to consider the potential impact of the mandatory use of the magnifying glass system in Brazil and its transition to mandatory use in Canada in 2026. This may provide a unique opportunity to assess how regulatory changes influence consumer acceptance and understanding of this specific type of labeling.

Additionally, it was observed that although structuring information with or without a magnifying glass changes the probability of product choice, the content of the information was a decisive factor in the selection process. That is, claims such as “High in (...)” indicating only one ingredient like “sugar” or “saturated fat” have less impact on consumer choice than statements indicating a high content of two ingredients, “sugar” and saturated fat. This supports the idea that FoPL is effective for communication with consumers, eliciting reasoning and emotional responses capable of influencing food choice behaviors (David et al. 2023). It was also noted that the statement indicating high saturated fat content exerted more pronounced negative effects on the likelihood of product selection compared to the declaration of high added sugar. Temme et al. (2011) reported that the presence of foods with a health logo in the market led to a percentage reduction in nutrient intake, specifically −2.5% for saturated fat, 0% for sodium, and −1% for sugar.

When evaluating auxiliary dimensions through validated instruments, it is noteworthy that “health consciousness” yielded results inconsistent with theoretical expectations (De-Magistris 2020; Hansen et al. 2018). Contrary to the initial hypothesis, no changes in the likelihood of product choice were identified, irrespective of individuals being classified as having low or high health consciousness. The inclusion of the health dimension in food choice questionnaires, as exemplified by the Food Choice Questionnaire (Steptoe et al. 1995), acknowledges the significance of the interaction between health concerns and consciousness in consumer decision-making. While this relationship is intuitively valid, especially when considering products with FoPL systems, a more in-depth analysis is required due to the complexity of factors influencing dietary choices, involving intricate trade-off relationships.

Observing individual and temporal variability in health consciousness and concern underscores the pressing need for more comprehensive studies in this domain. In line with this approach, van den Akker et al. (2022) found that the Nutri score encouraged the selection of healthier cereals. However, factors such as dietary practices and health-conscious behaviors during shopping did not significantly moderate this relationship, indicating the multifactorial complexity underlying food choice patterns.

However, apprehensions related to weight status yield results consistent with theoretical expectations, suggesting that the intention to reduce or control one's weight may be linked to a decrease in the likelihood of choosing the product. The cultural association of *dulce de leche* in Brazil as a symbol of pleasure and indulgence might have intensified the psychological effects of desire during attempts to lose weight, potentially amplifying the decision-making process. It has been reported that individuals seeking to lose weight often use the information provided on labels to guide their food choices (André et al. 2019; Hawley et al. 2013), but there is also some controversy. Natour et al. (2021) observed that being obese, with central obesity, and dissatisfied with current weight were not associated with more frequent label use.

Increases in the grades obtained in the Nutritional Knowledge Objective Questionnaire will not alter the probability of product selection. Miller et al. (2015) observed that nutritional knowledge is associated with greater precision in understanding FoPL systems, even when the consumer dispenses little attention to the inspection of labels. However, there is still no robust body of evidence that validates the impact of greater nutritional knowledge in the range of products contained in FoPL, especially as this knowledge represents a proxy related to the most healthy products identified via FoPL. Jáuregui et al. (2020) reported that participants with low income, low schooling, and low nutritional knowledge tend to choose food products with lower nutritional quality in general, in all the labeling conditions that contain FoPL. Steinhauser et al. (2019) report that consumers have greater nutritional knowledge and greater motivation for health care for more time for nutritional and health claims. However, these characteristics of the consumer do not affect the purchase decision.

Regarding the visual inspection metrics included in the model with eye tracking, the number of visits showed some relationship with choosing the product containing the FoPL. At the same time, the total duration of fixations was irrelevant. Callaway et al. (2021) reported that the number of fixations tends to increase as the decision becomes more complex for the subject. This suggests that evaluating products with FoPL structured as simple text may have encouraged consumers to reflect more on the decision and thus understand them as more complex. Thus, the frequency of visits to specific elements or information can offer valuable insights into the complexity of decision-making as an indirect indicator of complexity. In numerous studies investigating food product choices, the metric “total fixation duration” has frequently been utilized and reported (e.g., Gabor et al. 2020; Kim et al. 2020; Neuhofer et al. 2023; Tavares-Filho et al. 2023), largely influenced by established associations, often rooted in psychobiology, between total duration metrics and cognitive decision-making processes (Arieli et al. 2011; Brunyé and Gardony 2017). However, in this study, such associations were not observed for any of the labeling conditions, aligning with more recent associations supporting that total fixation duration is more closely related to the effect of decision goals and, to a lesser extent, preference formation. This suggests that total fixation duration cannot be interpreted as a direct proxy for preference (van der Laan et al. 2015). Fenko et al. (2018) also observed that visual attention to labels with health claims was a poor predictor of subsequent choice, even though fixation time was distinguished between products. In this study, consumers could have quickly learned about the presented FoPL systems so that in subsequent presentations (choice tasks), the recognition of information became faster and more intuitive regardless of the presentation (simple text or text and magnifying glass) (Reale and Flint 2016).

## 4.1 | Study Limitations

This study presents some significant limitations, primarily related to the specific characteristics of the sample. First, the sample composition shows a predominance of women (65.93% in the DC_STD group and 53.33% in the DC + ET group), which may introduce bias into the analysis, as gender differences can influence the perception and interpretation of FoPLs. Previous studies have indicated that women generally exhibit greater concern for health and healthy eating, which may have influenced the choices observed in this study (Szakály et al. 2018).

Additionally, the majority of participants fall within the 18–36 age group (74.02% in DC_STD and 83.33% in DC + ET), a demographic that may not adequately represent the perceptions and preferences of older age groups, which likely have different consumption patterns and levels of health concern (Benson et al. 2019). Another relevant point is that participants have a higher education level, which may affect their understanding and interpretation of the labels investigated. Individuals with higher educational attainment tend to have greater nutritional knowledge and higher engagement in healthy eating practices, which may differ significantly from the general population (Andrews et al. 2017).

# 5 | Conclusion

Mock packages of dulce with FoPL systems structured with the magnifying glass symbol associated with warning information such as "High in added sugar," "High in saturated fat," and "High in added sugar and saturated fat" led to fewer reductions in the probability of the product being chosen compared to labels containing the same warning information but presented in simple text, without the magnifying glass symbol. This observation may be connected to the restricted semiotic association of the magnifying glass's pictorial structure with alerts or warnings, potentially resulting in nonnegative symbolic associations for the consumer. The content of the warning information also differently affected the product choice process, with statements about high levels of two nutrients (sugar and fat) being more negatively impactful than each ingredient declared individually. This study provides important information on the use of FoPL on consumer choice, mainly the magnifying glass symbol associated with warning information, which is important for food industries, regulators and consumers.


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#### Conflicts of Interest

The authors declare no conflicts of interest.

#### Data Availability Statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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