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Strengthening food labeling policies in Brazil

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Strengthening food labeling policies in Brazil

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Editorial: Strengthening food labeling policies in Brazil

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Editorial on the Research Topic
Strengthening food labeling policies in Brazil

Food labeling policies can have different purposes, but consumers' right to protection, human rights to health and to adequate food, the rights of the child and all other interdependent human rights prevail. For this reason, research that seeks to inform the best policy options in fulfilling, protecting, and respecting these rights is paramount.

Brazil is known for novel research and action that have led to great advance of knowledge and policies on nutrition and health globally. Different sorts of edible and drinkable products have been historically defined as foods and manufactured and labeled to mimic foods.

Unhealthy edible and drinkable commodities industry have insisted on the use of market-forged categorization of products with the purpose of demonstrating an artificial diversification of alike products, for which labeling has been an instrument of consumer deception.

Labeling is often used to distort the real composition of products. Batti et al. found that half of the food products they assessed in Brazil that highlighted the term whole grain or related expressions on the front label did not have a whole-grain ingredient listed in the first position of the ingredients list. Barros et al. also revealed how the ingredients are listed on labels in ways that hide products real content and composition, showing that the use non-specific terms for listing industrially produced trans fatty acids (i-TFA) ingredients in foods that are sources of i-TFA increased in Brazil. Prates et al. have shown how the use of nutrition claims convey such deception, corroborating previous findings. Unfortunately, the labeling regulation in Brazil still allows the use of claims in products that are not recommended as part of a healthy diet, as Mais, Borges et al. described. Along these lines, Sato et al. also highlighted in their paper the importance of regulating other persuasive elements that can strengthen deception, such as mascots and cartoon characters.

Another important component of food products labeling not yet regulated in Brazil and most countries worldwide is branding. Alcantara et al.'s findings show brands should also be subject to regulation to help consumers take a more critical and better informed decision.

Mais, Borges et al. and Coutinho et al. also described others regulatory gaps in the Brazilian regulation, which resulted from interference of opposing commercial actors. Mais, Mialon et al. described the tactics and arguments of these opponents, which were mostly centered on a misconception of freedom of choice, used to favor regulated actors' interests.

Front-of-package labeling can be a powerful policy tool to improve food choices, but the ultimate outcome on how it can effectively improve diets and public help, depends on the system used and the criteria to define the products subject to regulations. This Research Topic highlights how Brazilian regulatory authorities failed to adopt the best policy option. Borges et al. and Tomaz et al. have shown Brazil has adopted one of the most permissive criteria to define products subject to regulation in Latin America, allowing three times more ultra-processed food products to omit warnings for sodium, four times more sugar-sweetened beverages and six times more dairy drinks to omit warnings for sugar, compared to the gold standard for the Region of the Americas (i.e., the Nutrient Profile Model of the Pan-American Health Organization) (1), which has been adopted by Mexico and other countries in the Region.

Silva et al. and other research have been extrapolating findings from the virtual environment and e-commerce to physical environments, and results tend to indicate that front-of-package labeling originally designed for to be applied to real size products, may need adaptations when used in virtual environments to preserve their effectiveness.

Santana et al.'s findings help us understand how warnings on excessive amounts of sugar help populations avoiding products with such warnings as they recognize the harmful effects of sugar intake. In assessing the best option to deliver this information to consumers and make it timely and relevant to their decision, the octagonal warning label performs best according to Scapin et al.. Fernandes et al. confirmed that, by demonstrating with objective measures from electroencephalograms, that textual warnings have the ability to neutralize strongly positive emotions triggered by ultra-processed products, allowing consumers to make a more critical appraisal of products.

The implications of the research featured in this topic, also highlights the importance of recognizing Brazil's work and focus on supporting, promoting and protecting healthy and adequate eating. The NOVA food classification (2) and the Brazilian dietary guidelines (3, 4) were the first to draw the world's attention for the need to bring a new purpose to how foods are categorized. So that policies can drive support, promote, and protect diets that are based on foods and the culinary preparations enabled by the great sociobiodiversity found in Brazil and worldwide.

This implies the importance of regulating ultra-processed products, by means of effective labeling and other policies that can have their application facilitated by such labeling regulations. An effective front-of-package warning label can help reducing demand for ultra-processed products, but can also ease the application, monitoring and enforcement of marketing and school food policies aimed at reducing demand for and offer of products featuring such warnings.

In addition, Brazil's official nutrition recommendations also call the attention for preventing distortion of policies that could mislead to an impression that policies that are actually designed to reduce demand and offer of ultra-processed products are aimed at reformulating them. Such distortion could deviate the national policy from its main mandate, jeopardizing the support, promotion, and protection of healthy diets based on unprocessed and minimally processed foods and culinary preparations and not on ultra-processed products being them reformulated or not.

Author contributions

FG wrote the first draft of the manuscript. All authors contributed to the conception of the editorial, manuscript revision, read, and approved the submitted version.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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SPANISH

Editorial: Fortalecimiento de las políticas de etiquetado de alimentos en Brasil

Las políticas de etiquetado de alimentos pueden tener diferentes propósitos, sin embargo, prevalecen el derecho de los consumidores a la protección, derechos humanos a la salud y a una alimentación adecuada, los derechos del niño y todos los otros derechos humanos interdependientes. Por esta razón, investigaciones que buscan informar las mejores opciones políticas en el cumplimiento, protección y respeto de estos derechos son primordiales.

Brasil es conocido por investigaciones y acciones novedosas que han llevado a un gran avance en el conocimiento y políticas sobre nutrición y salud a nivel mundial. Diferentes tipos de productos comestibles y bebibles se han definido históricamente como alimentos y fabricados y etiquetados para imitar alimentos.

La industria de productos comestibles y bebibles no saludables ha insistido en el uso de la categorización de productos fabricados con el propósito de demostrar una diversificación artificial de productos similares, por lo cual el etiquetado ha sido un instrumento de engaño al consumidor.

El etiquetado es comúnmente usado para distorsionar la composición real de los productos. Batti *et al.* encontró que la mitad de los productos alimenticios evaluados en Brasil que resaltaban el término grano integral o expresiones similares en la etiqueta frontal no tenían un ingrediente del tipo grano integral en la primera posición de la lista de ingredientes. Barros *et al.* también revelaron como los ingredientes se enumeran en las etiquetas de forma que esconda el contenido y la composición real de los productos, lo que demuestra que el uso de términos no-específicos para relacionar los ingredientes de ácidos grasos trans producidos industrialmente (AGT-PI) en alimentos que son fuente de AGT-PI aumentaron en Brasil. Prates *et al.* han mostrado como el uso de declaraciones nutricionales transmiten tal engaño, corroborando hallazgos previos. Desafortunadamente, el reglamento de etiquetado en Brasil todavía permite el uso de declaraciones en productos que no son recomendados como parte de una dieta saludable, como Mais, Borges *et al.* describieron. En esa misma línea, Sato *et al.* también destacaron en su artículo la importancia de reglamentar otros elementos persuasivos que pueden potenciar el engaño, como mascotas y personajes de dibujos animados.

Otro componente importante del etiquetado de productos alimenticios que aún no está regulado en Brasil y en la mayoría de los países del mundo es la marca. Los resultados de Alcantara *et al.* muestran que las marcas también deberían estar sujetas a regulación para ayudar a los consumidores a tomar una decisión más crítica y mejor informada.

Mais, Borges *et al.* y Coutinho *et al.* también describieron otras brechas reglamentarias en la regulación brasileña, que resultaron de la interferencia de actores comerciales opuestos. Mais, Mialon *et al.* describieron las tácticas y argumentos de esos opositores, que en su mayoría se centraban en una concepción errónea sobre la libertad de elección, usados para favorecer los intereses de los actores regulados.

El etiquetado frontal puede ser una herramienta política poderosa para mejorar la elección de alimentos, pero el resultado final sobre cómo pueden mejorar efectivamente las dietas y la ayuda pública depende del sistema usado y de los criterios para definir los productos sujetos a regulaciones. Este tema de investigación destaca cómo las autoridades reguladoras brasileñas fallaron en adoptar la mejor opción de política. Borges *et al.* y Tomaz *et al.* han mostrado que Brasil ha adoptado uno de los criterios más permisivos para definir productos sujetos a regulación en América Latina, permitiendo tres veces más productos alimenticios ultraprocesados por omitir advertencias de sodio, cuatro veces más bebidas azucaradas y seis veces más bebidas lácteas por omitir advertencias de azúcar, en comparación con el estándar de oro para la Región de las Américas (i. e., el Modelo de Perfil de Nutrientes de la Organización Panamericana de la Salud) (1), que ha sido adoptado por México y otros países en la región.

Silva *et al.* y otras investigaciones han estado extrapolando los hallazgos del entorno virtual y del comercio electrónico a los entornos físicos, y los resultados tienden a indicar que el etiquetado frontal originalmente diseñado para aplicarse a productos de tamaño real puede necesitar adaptaciones cuando se usa en entornos virtuales para preservar su eficacia.

Los hallazgos de Santana *et al.* nos ayudan a entender cómo las advertencias sobre cantidades excesivas de azúcar ayudan a las poblaciones a evitar productos con tales advertencias, ya que reconocen los efectos nocivos del consumo de azúcar. Al evaluar la mejor opción para entregar esta información a los consumidores y hacerla oportuna y relevante para su decisión, la etiqueta de advertencia octagonal funciona mejor de acuerdo con Scapin *et al.* Eso fue confirmado por Fernandes *et al.*, al demostrar con medidas objetivas a partir de electroencefalogramas que las advertencias textuales tienen la capacidad de neutralizar emociones fuertemente positivas provocadas por productos ultraprocesados, llevando a los consumidores a hacer una valoración más crítica de los productos.

Las implicaciones de la investigación presentada en este tema también resaltan la importancia de reconocer el trabajo brasileño y enfocarse en apoyar, promover y proteger una alimentación adecuada y saludable. La clasificación NOVA de alimentos (2) y las Guías Alimentarias Brasileñas (3, 4) fueron los primeros en llamar la atención del mundo sobre la necesidad de dar un nuevo propósito de como los alimentos son categorizados. Entonces, esas políticas pueden conducir al apoyo, promoción y protección de las dietas que son basadas en alimentos y preparaciones culinarias posibilitadas por la gran sociobiodiversidad encontrada en Brasil y alrededor del mundo.

Esto implica la importancia de regular los productos ultraprocesados, mediante un etiquetado efectivo y otras políticas que puedan facilitar su aplicación por dichas normas de etiquetado. Un etiquetado frontal de advertencia efectivo puede ayudar a reducir la demanda por productos ultraprocesados, pero también puede facilitar la aplicación, seguimiento y cumplimiento de las políticas de comercialización y alimentación escolar dirigidas a reducir la oferta y demanda de productos que presenten dichas advertencias.

Adicionalmente, las recomendaciones nutricionales oficiales de Brasil también llaman la atención para prevenir la distorsión de las políticas que podrían inducir al error dando la impresión de que las políticas que en realidad están diseñadas para reducir la oferta y demanda de productos ultraprocesados pretenden reformularlos. Tal distorsión, podría desviar la política nacional de su mandato principal poniendo en riesgo el apoyo, promoción y protección de dietas saludables basadas en alimentos no procesados o mínimamente procesados y preparaciones culinarias y no en productos ultraprocesados, siendo ellos reformulados o no.

Contribuciones de los autores

FG escribió el primer borrador del manuscrito. Todos los autores contribuyeron en la concepción del editorial, revisión del manuscrito, leyeron y apoyaron la versión enviada.

Conflicto de interés

Los autores declaran que la investigación fue conducida en ausencia de cualquier relación financiera o comercial que pueda ser interpretada como un potencial conflicto de interés.

Nota del editor

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PORTUGUESE

Editorial: Fortalecendo as políticas de rotulagem de alimentos no Brasil

As políticas de rotulagem de alimentos podem ter finalidades diversas, mas prevalecem o direito à proteção do consumidor, os direitos humanos à saúde e à alimentação adequada, os direitos da criança e os demais direitos humanos interdependentes. Por esse motivo, pesquisas que buscam informar as melhores opções políticas para cumprir, proteger e respeitar esses direitos são fundamentais.

O Brasil é conhecido por novas pesquisas e ações que levaram a um avanço no conhecimento e nas políticas de nutrição e saúde globalmente. Diferentes tipos de produtos comestíveis e bebíveis foram historicamente definidos como alimentos e fabricados e rotulados para imitar alimentos.

A indústria de *commodities* comestíveis e bebíveis não saudáveis tem insistido no uso de categorizações de produtos forjadas pelo mercado visando demonstrar uma diversificação artificial de produtos similares, para os quais a rotulagem tem sido um instrumento de engano do consumidor.

A rotulagem é frequentemente usada para distorcer a composição real dos produtos. Batti *et al*. descobriram que metade dos produtos alimentícios avaliados no Brasil que destacavam o termo grão integral ou expressões relacionadas no rótulo frontal não tinham um ingrediente de grão integral listado na primeira posição da lista de ingredientes. Dentro desse escopo, Barros *et al*. também mostraram como os ingredientes são listados nos rótulos para ocultar o verdadeiro conteúdo e a composição dos produtos, demonstrando que o uso de termos inespecíficos para listar ingredientes de ácidos graxos trans produzidos industrialmente (AGT-i) em alimentos fontes de AGT-i aumentou no Brasil. Prates *et al*. mostraram como o uso de alegações nutricionais transmite tal engano, corroborando descobertas anteriores. Infelizmente, a regulamentação da rotulagem no Brasil ainda permite o uso de alegações em produtos não recomendados como parte de uma alimentação saudável, conforme descrito por Mais, Borges *et al*. Nessa linha, Sato *et al*. também destacaram em seu trabalho a importância de regulamentar outros elementos persuasivos que podem fortalecer o engano, como mascotes e personagens de desenhos animados.

Outro componente importante da rotulagem de produtos alimentícios ainda não regulamentado no Brasil e na maioria dos países do mundo é a marca. As descobertas de Alcantara *et al*. indicam que as marcas também devem estar sujeitas à regulamentação para que os consumidores possam tomar uma decisão mais criteriosa e informada.

Mais, Borges *et al*. e Coutinho *et al*. também descrevem outras lacunas regulatórias na regulamentação brasileira, que resultaram da interferência de atores comerciais opostos. Mais, Mialon *et al*. descreveram as táticas e argumentos desses opositores, que se concentram principalmente em uma concepção equivocada de liberdade de escolha, usada para favorecer os interesses dos atores regulados.

A rotulagem frontal pode ser uma ferramenta política poderosa para melhorar as escolhas alimentares, mas o resultado sobre como ela pode efetivamente melhorar as dietas e a ajuda pública depende do sistema usado e dos critérios para definir os produtos sujeitos a regulações. Este tópico de pesquisa destaca como as autoridades reguladoras brasileiras falharam em adotar a melhor opção de política. Borges *et al.* e Tomaz *et al.* demonstraram que o Brasil adotou um dos critérios mais permissivos para definir produtos sujeitos a regulamentação na América Latina, permitindo que três vezes mais alimentos ultraprocessados omitissem advertências de sódio, quatro vezes mais bebidas adoçadas com açúcar e seis vezes mais bebidas lácteas omitissem advertências de açúcar, em comparação com o padrão-ouro para a Região das Américas (ou seja, o Modelo de Perfil de Nutrientes da Organização Pan-Americana da Saúde) (1), adotado pelo México e outros países da Região.

Silva *et al.* e outras pesquisas têm extrapolado os resultados do ambiente virtual e *e-commerce* para ambientes físicos, e os resultados sugerem que a rotulagem frontal, originalmente projetada para ser aplicada em produtos de tamanho real, pode requerer adaptações em ambientes virtuais para garantir a sua eficácia.

As descobertas de Santana *et al.* nos ajudam a entender como as advertências sobre quantidades excessivas de açúcar ajudam as populações a evitar produtos com tais advertências, pois reconhecem os efeitos nocivos da ingestão de açúcar. Ao avaliar a melhor opção para entregar essas informações aos consumidores e torná-las oportunas e relevantes para sua decisão, a rotulagem frontal de advertência octogonal apresenta o melhor desempenho, de acordo com Scapin *et al.* Fernandes *et al.* confirmaram que, ao demonstrar com medidas objetivas de eletroencefalogramas, advertências textuais têm a capacidade de neutralizar emoções positivas fortemente desencadeadas por produtos ultraprocessados, permitindo que os consumidores façam uma avaliação mais crítica dos produtos.

As implicações das pesquisas apresentadas neste tópico também destacam a importância de se reconhecer o trabalho do Brasil e focar no apoio, promoção e proteção da alimentação saudável e adequada. A classificação NOVA de alimentos (2) e o Guia Alimentar para a População Brasileira (3, 4) foram os primeiros a chamar a atenção do mundo para a necessidade de trazer um novo propósito para como os alimentos são categorizados. Sendo assim, as políticas poderão impulsionar, apoiar, promover e proteger dietas baseadas em alimentos e preparações culinárias possibilitadas pela grande sociobiodiversidade encontrada no Brasil e no mundo.
Isso implica na importância de regulamentar os produtos ultraprocessados, por meio de uma rotulagem efetiva e outras políticas que possam ter sua aplicação facilitada por tais regulamentações de rotulagem. Um rótulo frontal de advertência eficaz pode ajudar a reduzir a demanda por produtos ultraprocessados, mas também pode facilitar a aplicação, monitoramento e aplicação de políticas de publicidade e alimentação escolar destinadas a reduzir a demanda e a oferta de produtos com tais advertências.

Além disso, as recomendações nutricionais oficiais do Brasil também visam evitar vieses que possam levar à impressão de que as políticas que, na verdade, foram pensadas para reduzir a demanda e a oferta de produtos ultraprocessados, visam reformulá-los. Tal distorção poderia desviar a política nacional de seu mandato principal, comprometendo o apoio, a promoção e a proteção de uma alimentação saudável baseada em alimentos *in natura* e minimamente processados e preparações culinárias e não em produtos ultraprocessados, sejam eles reformulados ou não.

Contribuições do autor

FG escreveu o primeiro rascunho do manuscrito. Todos os autores contribuíram com a concepção do editorial, revisão do manuscrito, leram e aprovaram a versão submetida.

Conflito de interesses

Os autores declaram que a pesquisa foi conduzida na ausência de quaisquer relações comerciais ou financeiras que possam ser interpretadas como um potencial conflito de interesses.

Nota do editor

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Trans-Fat Labeling in Packaged Foods Sold in Brazil Before and After Changes in Regulatory Criteria for Trans-Fat-Free Claims on Food Labels

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Consumption of industrially produced trans-fat acids (TFA) is a public health concern. Therefore, it is important that information on TFA in packaged foods be clearly informed to consumers. This study aimed to assess the evolution of TFA information presented in packaged foods sold in Brazil in 2010 and 2013, before and after the introduction of stricter regulatory requirements for TFA-free claims on food labels. A repeated cross-sectional study was performed through food label censuses of all packaged foods available for sale in two stores from the same supermarket chain, totaling 2,327 foods products in 2010 and 3,176 in 2013. TFA-free claims and information indicating TFA in the ingredients list and nutrition facts label were analyzed by descriptive statistics and Pearson's chi-square test. There was a 14% decrease in the use of ingredients containing or potentially containing industrially produced TFA (i-TFA), according to analysis of the ingredients list. However, when analyzing foods by groups, it was found that this decrease was significant only for group A (bakery goods, bread, cereals, and related products; from 59 to 35%, $p < 0.001$). By contrast, food group F (gravies, sauces, ready-made seasonings, broths, soups, and ready-to-eat dishes) showed a 5% increase in i-TFA. The use of specific terms for i-TFA decreased between 2010 and 2013, but there was an increase in the use of alternative terms, such as vegetable fat and margarine, which do not allow consumers to reliably identify whether a food product is a possible source of i-TFA. There was an 18% decrease in the use of TFA-free claims in products containing or potentially containing i-TFA. However, almost one-third of foods sold in 2013 were false negatives, that is, foods reported to contain 0 g of TFA in the nutrition facts label or with TFA-free claims but displaying specific or alternative terms for i-TFA in the ingredients list. The results indicate that adoption of stricter requirements for TFA-free claims on food labels in Brazil helped reduce the prevalence of such claims but was not sufficient to decrease i-TFA in industrialized foods sold in supermarkets.

Keywords: trans-fat, partially hydrogenated oil, food ingredients, food labeling, nutrition labeling, food legislation, industrialized foods, census method

INTRODUCTION

Trans-fat acids (TFA) are unsaturated fatty acids containing a double bond in the trans, rather than in the cis, configuration (1). These fatty acids can be formed via natural biohydrogenation processes in the gut of ruminant animals or through industrial processes, mainly hydrogenation (2). Moderate consumption of naturally occurring TFA may be considered safe and even healthy (3, 4), although findings are contradictory depending on the type of fatty acid (5, 6). On the other hand, the deleterious effects of consumption of industrially produced TFA (i-TFA) are well established. For this reason, the focus of this study is i-TFA. Partially hydrogenated oils (PHO), produced by hydrogenation of vegetable oils in the presence of a metal catalyst at high temperatures under vacuum, are the major sources of i-TFA (7). PHO are widely used by the food industry because of their high adaptability to different applications, as they possess neutral taste, are solid at room temperature and resistant to repeated frying (1, 8), and have low cost and high palatability (9).

According to Wanders et al. (10), Brazil has one of the highest consumptions of TFA worldwide. According to the 2008/2009 national survey, the average daily consumption of TFA is 2.4 g (11), although this intake may be even higher, considering that the survey is based on a two-day self-report. i-TFA are considered unsafe for human consumption in any quantity, given their association with several diseases, mainly those of cardiovascular nature, as well as with increased risk for all-cause mortality (12–15). Because of the negative impacts of i-TFA on human health, the World Health Organization (WHO) has issued recommendations against their consumption since 2004 (16) and declared their eradication a goal to be achieved by 2023 (17). With this aim in view, the WHO launched in 2018 the REPLACE action package, a guide detailing strategies to help countries eliminate i-TFA from the food production system (18). The guide provides recommendations for the creation and monitoring of public policies and inclusion of i-TFA in nutrition labeling. In Brazil, nutrition information on TFA has been mandatory since 2003 (19). Furthermore, the country has taken the actions recommended by WHO, having modified regulatory criteria for TFA-free claims on food labels (2012) and, more recently, mandating the reduction and elimination of i-TFA from the food system (17, 20). This latter regulation, passed in 2019, bans the use of PHO in industrial food processes and food services as of 2023 (20). However, while this regulation does not come into effect, food labels remain the primary means of informing consumers about TFA in packaged foods (21), which is an important factor influencing food decisions and choices (22).

According to Brazilian and Mercosur legislation, food labeling is mandatory for all ready-for-sale foods packaged in the absence of the consumer. Labels must contain descriptive information on packaged foods and beverages, including the ingredients list (23) and nutrition labeling (19). The nutrition facts label must contain quantitative descriptions of energy value, carbohydrates, proteins, total fat, saturated fat, TFA, and sodium (19). Although TFA information is mandatory, current legislation has limitations that make it difficult for consumers to correctly identify TFA in food products by using food labels (24). One such example is the possibility for manufacturers to declare a TFA content of 0 g in the nutrition facts label when the product contains less than or equal to 0.2 g of TFA per serving, without any distinction between naturally occurring TFA and i-TFA.

In Brazil, there are specific requirements regulating the use of nutrition claims, which are defined as any representation that implies that a food product has specific nutritional properties (19). The 2003 regulation on nutrition claims was updated in 2012, when new conditions for application of nutrition claims on food labels were enacted. Some changes were related to TFA claims: the 2012 regulation states that manufacturers can label a product with the terms "zero trans," "0% trans-fat," or "does not contain trans-fat" if the food product contains less than or equal to 0.1 g of TFA per serving (whereas the limit of the 2003 regulation was 0.2 g), be it naturally occurring or i-TFA, provided that the sum of TFA and saturated fat does not exceed 1.5 g per serving (25). The regulation passed in 2019 does not change the parameters for TFA-free claims. For this reason, manufacturers will still be able to use TFA-free claims even when foods are sources of this type of fat, until TFA is completely banned.

It can be seen that, according to Brazilian legislation, manufacturers can declare a TFA content of zero in the nutrition facts label (19) or use a TFA-free claim (25) even for food products containing i-TFA. The only way for consumers to ascertain whether a product contains i-TFA is by reading the ingredients list, which, as per Brazilian and Mercosur legislation (23), must describe, in descending order of proportion, all substances used in the manufacture or preparation of a food product. Furthermore, in all foods that contain fat, the list of ingredients must state whether it is vegetable or animal fat, without specifying the industrial process used, with the exception of butter (23). Identifying i-TFA by using the ingredients list, however, might not be an easy task, as shown by a study analyzing the label of 2,327 packaged foods sold in Brazil in 2010. A total of 23 different terms for ingredients possibly containing i-TFA were identified, 14 of which clearly referred to hydrogenation, whereas the remaining 9 generated uncertainty as to whether the food product contained i-TFA or not (26). Furthermore, according to

Brazilian legislation (23), compound ingredients that correspond to less than 25% of the final product do not need to have their composition disclosed, which makes it even harder for consumers to have clear information about what they are buying.

It is important to monitor trends in TFA information presented on packaged food labels to assess the progression of this type of fat in foods available to the population (27). Despite the importance of this investigation, only three studies on the topic were identified, in which labels of different food groups were sampled in supermarkets and the data were used to determine the prevalence of TFA in packaged foods over time.

In Slovenia, Zupanic et al. (28) analyzed information on PHO in 8,557 prepackaged foods in 2015 and 14,072 prepackaged foods in 2017. The authors found that, despite the decrease of 2.4% in PHO information on food labels, a considerable proportion of foods still contained PHO in 2017, evidence that voluntary regulatory pressures might be insufficient to obtain satisfactory results concerning the use of PHO in packaged foods. In the Netherlands, Bend et al. (29) monitored, from 2006 to 2016, the nutrient content of 4,343 food products containing a logo used to identify healthier options. Overall TFA contents decreased by 48%, with a significant difference in 11 of the 27 food groups analyzed.

Lastly, a Canadian study conducted by Franco-Arellano et al. (30) analyzed the prevalence of PHO, hydrogenated fats, and/or both in 15,286 packaged food items in 2013 and 17,589 items in 2017 and determined the TFA content of the products. The use of TFA decreased significantly (from 0.8 to 0.2, 5 to 2.4, and 5.7 to 2.6%, respectively). As a result, there was a significant decrease in TFA content in almost all food groups, except for bakery products, for which there was an increase in TFA content. The authors concluded that voluntary measures to reduce TFA were not effective in Canada.

However, none of these studies investigated the effect of changes in regulations on TFA content, and there are no follow-up studies assessing TFA information on food labels in Brazil. In view of these observations, this study aimed to compare the prevalence of TFA on packaged food labels sold in Brazil in 2010 and 2013 and analyze how the change in legal requirements for TFA claims enforced in 2012 impacted TFA information on labels in packaged foods over time.

MATERIALS AND METHODS

A comparative analysis was performed using a repeated cross-sectional design, with two censuses of food labels, carried out in 2010 and 2013, in two stores from a large supermarket chain in Brazil.

Location and Data Collection

The initial sample included all labels of all packaged foods available for sale in two large supermarkets belonging to one of the 10 largest chains in Brazil. Places of data collection were chosen intentionally, aiming for the inclusion of foods from different brands found throughout the country. Data collection was carried out in two stores in 2010 and 2013. Of all manufacturers included in the database, at least 69% in 2010 and 70% in 2013 supplied their food products nationwide.

All packaged food products available for sale that met the criteria established by the Brazilian and Mercosur regulations on food labeling (19) were included in the censuses of food labels. Products not included in the study were those covered by different regulations (e.g., food for babies and toddlers) or those that did not require mandatory nutrition labeling (e.g., bakery products produced, packaged, and labeled in-store and meat and cheese cuts packaged and labeled in-store). Fresh foods, such as meats, vegetables, and fruits, are not subject to Brazilian legislation on food labeling and were therefore excluded from the study. Products without added fat in their composition, such as flours and rice, were also excluded.

Data Collection

Data collection was authorized by supermarket managers, who signed an informed consent form, and carried out by nutritionists and undergraduate and graduate students in Nutrition of the university where the study was conducted. All data collectors received theoretical and practical training. Collections took place in 2010 and 2013. **Figure 1** provides details about TFA legislation in Brazil and the data collection timeline.

The same type of information was obtained, but different collection instruments were used. The following information was collected: food type (product and flavor, trade name, and brand), nutrition facts label (serving size, serving size in household measure, and information on TFA provided by the manufacturer), TFA-free claims, and ingredients list.

In May 2010, data were collected on site and manually recorded on a form. Collected data were input into two separate databases, which were later checked for errors and validated. In 2013, data collection took place between October and December using the same form applied in 2010 but adapted to EpiCollect plus software, installed on Samsung Galaxy® Note 8.0 tablets. All sides of all packaged foods were photographed. Each collector was responsible for specific areas of the supermarket. Data was automatically transferred via Wi-Fi to EpiCollect plus software and subsequently exported to Microsoft Excel® version 2010. For quality control of data, 10% of food products were randomly selected for comparison between data and product photographs. A weighted kappa test was performed to verify data, with a result of 0.99, indicating reliability. After the test, any inconsistencies were rectified.

Data Analysis

Data from the 2010 food label census were analyzed by Silveira and collaborators in 2011 (26). For comparison of TFA information collected in the two food label censuses, 2013 data were analyzed in the same manner as 2010 data.

Food labels were evaluated using three indicators: (1) i-TFA terms, identified by reading the ingredients list of each food in the database, (2) declaration of TFA in the nutrition facts label, and (3) existence of TFA-free claims.

Using the 2010 database, Silveira et al. (26) identified ingredients that indicated the presence of TFA (specific terms)

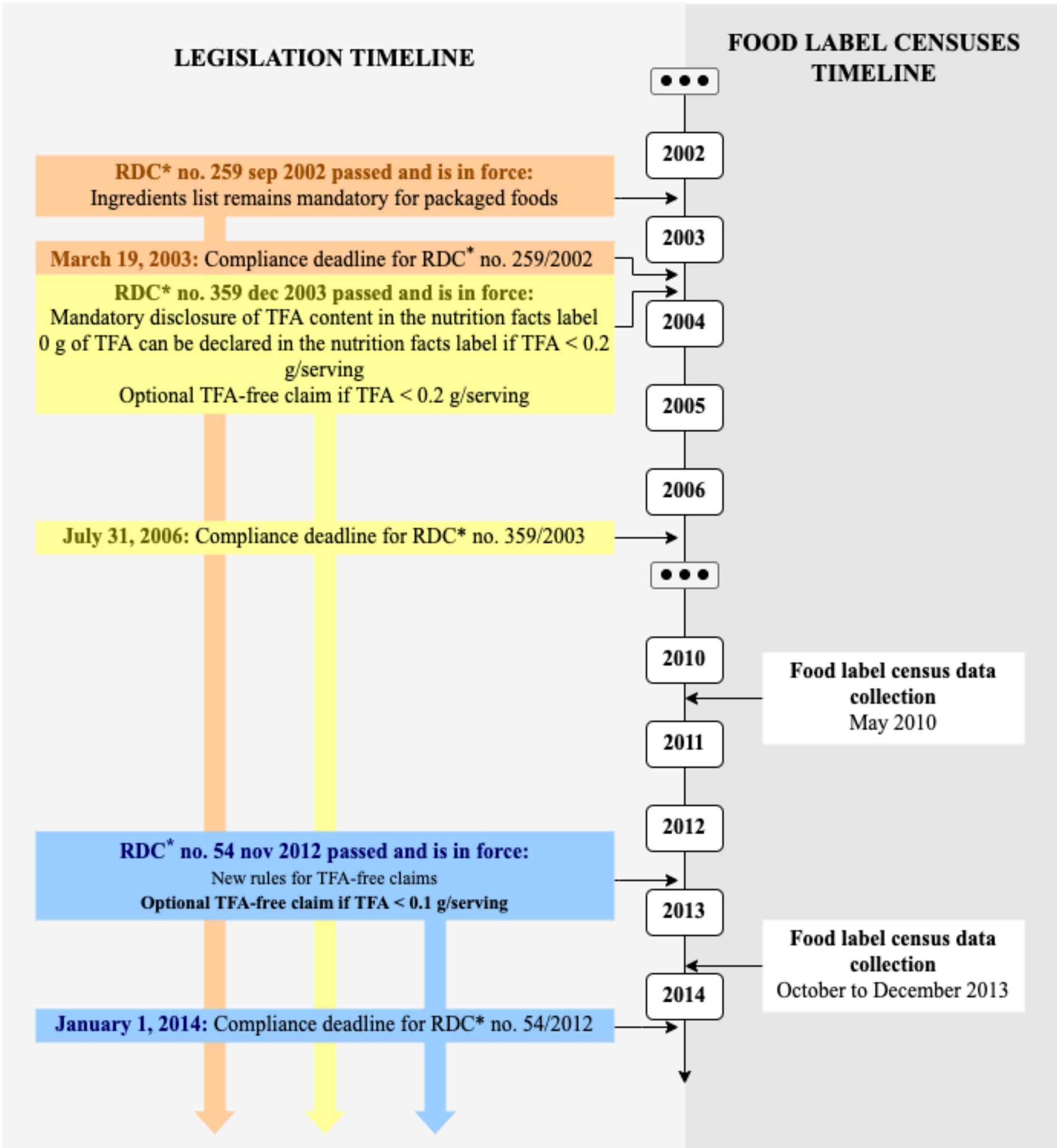

FIGURE 1 | Timeline (2002–2014) of legislation on trans-fat acid (TFA) food labeling and food label censuses. *RDC, Resolution of the Collegiate Board of Directors of the Brazilian Health Regulatory Agency.

and ingredients that could contain i-TFA (alternative terms, such as margarine).

For the 2013 database, three observers separately analyzed the ingredients list of all food labels to identify specific and alternative terms for i-TFA listed in the 2010 food label census and other terms that had not been identified in 2010. All terms were reviewed by a fourth researcher, and conflicting classifications were discussed in a meeting with experts from the research group. For analysis of the ingredients list, it was considered that if the food product contained specific i-TFA terms, it would be counted as a food product containing i-TFA. If the same product contained another ingredient with alternative terms, it would not be counted again to avoid overlapping results. In the case of foods with compound ingredients of unknown composition, the product was considered to contain alternative terms when these compound ingredients were identified as a source or possible source of i-TFA in another similar food. For example, in some food products containing chocolate drops, the composition of the ingredient was specified in parentheses, allowing to identify chocolate drops as a source or possible source of i-TFA. Thus, all food products that contained chocolate drops but did not specify the composition of the ingredient were also considered

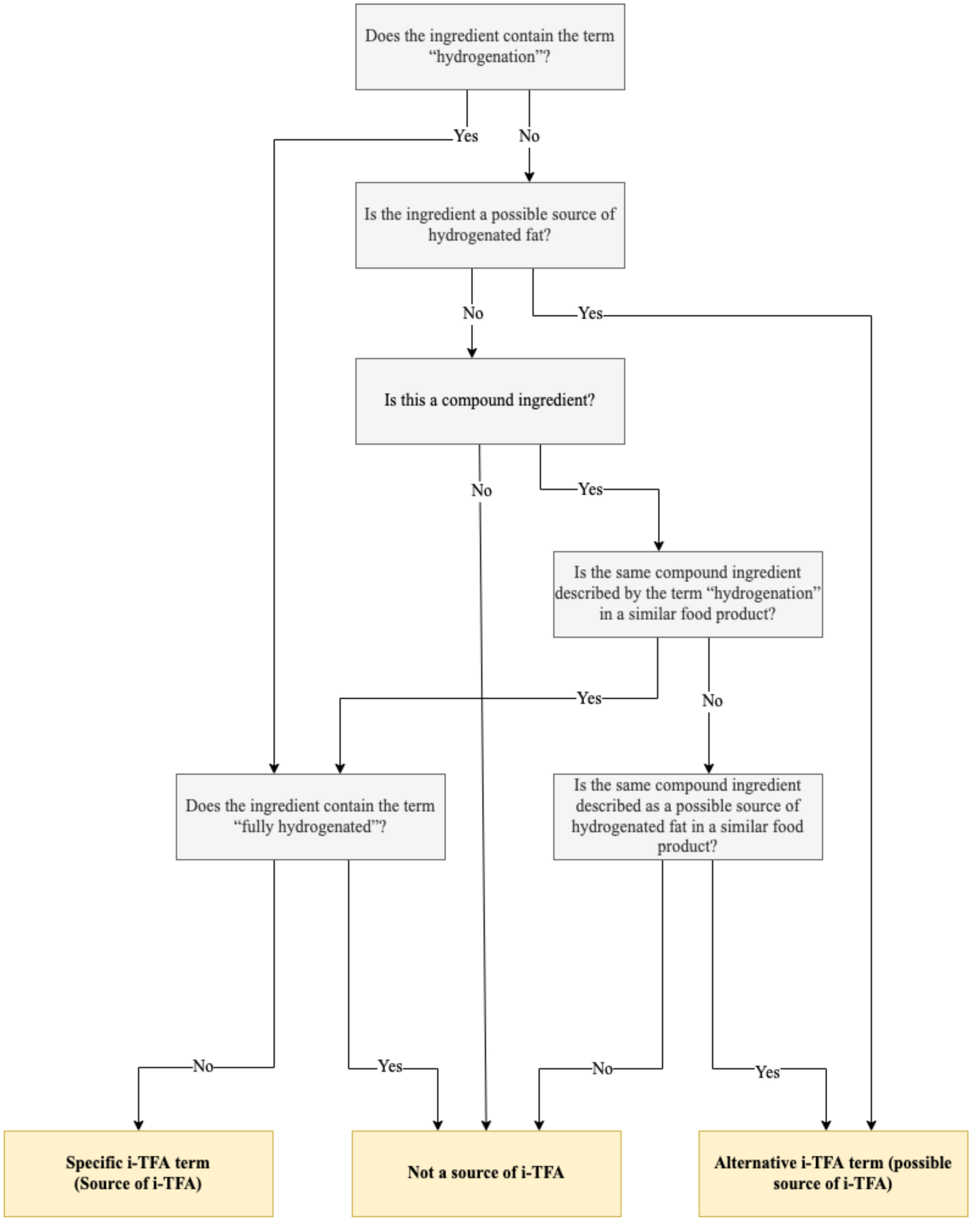

FIGURE 2 | Decision criteria for determining whether a packaged food ingredient is a source of industrially produced trans-fat acids (i-TFA), a possible source of i-TFA, or not a source of i-TFA.

to potentially contain i-TFA, as the ingredient was classified as an alternative term. **Figure 2** illustrates the decision tree used for each ingredient.

Descriptive analysis of the 2013 database was performed concerning the existence of specific and alternative terms in the ingredients list; results are expressed as absolute and relative frequencies. We also present the absolute and relative frequencies of foods containing i-TFA information on the ingredients list, nutrition facts label, and TFA-free claims, stratified by food groups according to Brazilian and Mercosur regulations (19). **Table 1** describes food groups with some examples.

A descriptive comparison of i-TFA terms identified in 2010 and 2013 food label censuses was performed. We also compared the prevalence of false negatives between i-TFA in the ingredients list and TFA information in the nutrition facts label and TFA-free claims between both food label censuses. A food product

TABLE 1 | Description of packaged food labels sampled in 2010 and 2013, stratified by food groups according to the Brazilian and Mercosur regulation on nutrition labeling (36).

Group	Description	Examples of food items
A	Bakery goods, bread, cereals, and related products	Salty crackers, cakes without filling
B	Milk and dairy products	Dairy drinks, ice cream powder mix
C	Meats, eggs, and seafood products	Sausages, meat pastes, burgers, chicken nuggets
D	Oils, fats, and nuts	Mayonnaise, salad dressings
E	Sugars, sugary foods, and snacks	Sweet biscuits, cakes with filling, ice cream
F	Gravies, sauces, ready-made seasonings, broths, soups, and ready-to-eat dishes	Ready-to-cook and ready-to-eat dishes, sauce mix

was considered a false negative if a source or possible source of i-TFA was identified in the ingredients list and the same product had a TFA-free claim or declared a TFA content of 0 g in the nutrition facts label.

Comparative analyses between food groups and the 2010 and 2013 food label censuses, as well as analysis of false negatives, were performed using Pearson's chi-square test. All statistical analyses were conducted using Stata version 13.0 (StataCorp LP).

RESULTS

In the 2010 and 2013 food label censuses, 2,327 and 3,176 food labels were analyzed, respectively. There was an increase of 36% in food products that met the criteria for analysis of TFA information (potential sources of TFA) between 2010 and 2013. Meats, eggs, and seafood products (group C) was the group with the greatest increase in number of foods, mainly because of the increased variety of burger, chicken nugget, and sausage products.

In 2010, 1,318 citations of ingredients capable of containing i-TFA were identified, 25% of which were designated by specific terms and 75% by alternative terms. In 2013, 1,411 citations of ingredients likely to contain i-TFA were identified, 19% of which were specific and 81% of which were alternative.

As shown in **Table 2**, in 2010, 13 specific i-TFA terms were identified, which appeared a total of 335 times in ingredients lists. In 2013, 15 specific terms were identified, appearing 268 times. Comparatively, nine specific terms were introduced to food labels between 2010 and 2013. Seven terms that had been identified in 2010 were not found in food labels analyzed in 2013.

In 2010, nine alternative terms were used 983 times in ingredients lists (**Table 3**). Of these, six were identified in 2013 in 909 occurrences. An additional 37 alternative terms were identified in 2013, with 234 occurrences. Therefore, the use of alternative terms increased in 2013 compared with 2010.

As shown in **Table 4**, 51% ($n = 1,175$) of the 2,327 industrialized foods analyzed in 2010 were potential sources of i-TFA. This number decreased significantly in 2013, when 36% ($n = 1,157$) of the 3,176 food products were potential sources of this type of fat ($p < 0.001$).

There were no differences ($p = 0.142$) in the proportion of food products with specific i-TFA terms between food label censuses (14% in 2010 and 8% in 2013). However, there was a significant decrease, from 37 to 28%, in the proportion of food products containing alternative terms ($p = 0.019$). In considering only food products that contained i-TFA terms, it was found that the proportion of specific terms decreased from 28 to 23% and that of alternative terms increased from 72 to 77% between 2010 and 2013 ($p < 0.001$).

When considering the entire sample, we found a decrease in the proportion of foods containing i-TFA, but only because group A had a large and significant reduction. In analyzing food groups separately, we found a decrease in foods containing i-TFA only in bakery goods, bread, cereals, and related products (group A; $p < 0.001$), with no differences in the other groups.

From 2010 to 2013, there was an increase in the absolute number of food products without i-TFA in sugars, sugary foods, and snacks (group E) and bakery goods, bread, cereals, and

TABLE 2 | Specific terms for sources of industrially produced trans-fat acids and their frequency of occurrence on the ingredients list of packaged foods sold in Brazilian supermarkets, as assessed by the food label census method in 2010 and 2013.

Specific terms	Census year	
	2010 ***n*** **(%)**	**2013** ***n*** **(%)**
Hydrogenated vegetable fat	305 (91.04)	228 (85.07)
Partially hydrogenated vegetable fat	1 (0.30)	8 (2.99)
Partially hydrogenated soybean and cotton oil	–	5 (1.87)
Hydrogenated palm oil	–	5 (1.87)
Vegetable hydrogenated fat	–	4 (1.49)
Partially hydrogenated soybean fat	2 (0.60)	3 (1.12)
Partially hydrogenated soybean oil	–	3 (1.12)
Hydrogenated fat	1 (0.30)	2 (0.75)
Hydrogenated soybean fat	4 (1.19)	2 (0.75)
Hydrogenated vegetable fat	–	2 (0.75)
Hydrogenated vegetable oil	8 (2.39)	2 (0.75)
Hydrogenated soybean oil	–	1 (0.37)
Hydrogenated vegetable oils	–	1 (0.37)
Partially hydrogenated soybean vegetable oil	–	1 (0.37)
Hydrogenated vegetable protein	–	1 (0.37)
Partially hydrogenated vegetable oil	6 (1.79)	–
Partially hydrogenated/interesterified fat	2 (0.60)	–
Liquid and hydrogenated vegetable oil	2 (0.60)	–
Hydrogenated	1 (0.30)	–
Hydrogenated vegetable margarine	1 (0.30)	–
Hydrogenated corn oil	1 (0.30)	–
Hydrogenated cotton, soybean, and palm oils	1 (0.30)	–
Total	335 (100.00)	268 (100.00)

TABLE 3 | Alternative terms for sources of industrially produced trans-fat acids and their frequency of occurrence on the ingredients list of packaged foods sold in Brazilian supermarkets, as assessed by the food label census method in 2010 and 2013.

Alternative terms	Census year	
	2010 *n* **(%)**	**2013** *n* **(%)**
Vegetable fat	771 (78.43)	728 (63.69)
Margarine	177 (18.01)	151 (13.21)
Condiment mix[a]	–	31 (2.71)
Requeijão[b]	–	25 (2.19)
Chicken broth	–	24 (2.10)
Seasoning[a]	–	15 (1.31)
Dairy-based blend with vegetable fat	11 (1.12)	14 (1.22)
Vegetable fats	–	13 (1.14)
Vegetable margarine	9 (0.92)	13 (1.14)
Creamy *requeijão*[b]	–	11 (0.96)
Meat broth	–	10 (0.87)
White chocolate	–	10 (0.87)
Milk chocolate	–	9 (0.79)
Ready-made condiment[a]	–	9 (0.79)
Dairy-based blend	–	8 (0.70)
Chocolate chips	–	8 (0.70)
Dark chocolate	–	6 (0.52)
Chocolate	–	5 (0.44)
Dark chocolate-flavored stripes	–	5 (0.44)
Milk chocolate-flavored frosting	–	4 (0.35)
Milk chocolate chips	–	4 (0.35)
Chocolate-flavored chips	–	4 (0.35)
Triglyceride mixture	–	4 (0.35)
Chocolate-flavored biscuit	–	3 (0.26)
Chocolate syrup	–	3 (0.26)
Filling[a]	–	3 (0.26)
Dark chocolate-flavored frosting	–	2 (0.17)
Nature-identical ready-made condiment[a]	–	2 (0.17)
Chocolate-flavored sprinkles	–	2 (0.17)
Fat	1 (0.10)	2 (0.17)
Organic vegetable fat	–	2 (0.17)
Marshmallow	–	2 (0.17)
Hardened olive oil	–	1 (0.09)
Broiler broth	–	1 (0.09)
Chocolate sprinkles	–	1 (0.09)
Chocolate-flavored diet frosting	–	1 (0.09)
Chocolate-flavored confectionary sprinkles	–	1 (0.09)
Chocolate-flavored confectionary	–	1 (0.09)
Vegetable cream	5 (0.51)	1 (0.09)
Vegetable oils and fats	–	1 (0.09)
Cocoa chips	–	1 (0.09)
Complete seasoning powder	–	1 (0.09)
Seasoning similar to[a]	–	1 (0.09)
Sunflower vegetable fat	5 (0.51)	–
Soybean vegetable fat	1 (0.10)	–
Dairy beverage mix	3 (0.31)	–
Total	983 (100.00)	1,143 (100.00)

[a]*Different flavors (e.g., cheese, ham, sausage, barbecue) were grouped under the same category.*
[b]*Requeijão: Brazilian creamy cheese spread.*

related products (group A). In group E, there were no differences between foods that were considered potential sources of i-TFA. Thus, although there was an increase in the diversity of group E foods without i-TFA, the number of foods with i-TFA remained unchanged from 2010 to 2013.

From 2010 to 2013, there was no difference in the proportion of foods containing more than 0 g of TFA, as declared in the nutrition facts label, considering the entire sample (**Table 4**). In analyzing food groups separately, we found an increase from 80 to 83% ($p < 0.001$) in the proportion of foods with 0 g of TFA in group E, attributed to the increase in the diversity of foods without i-TFA (identified by analysis of the ingredients list). In the group gravies, sauces, ready-made seasonings, broths, soups, and ready-to-eat dishes (group F), there was an increase from 15 to 24% ($p = 0.010$) in food products that declared more than 0 g of TFA. It was observed that 1% of foods in 2010 did not report TFA information on the nutrition facts label, and no changes were observed between food label censuses in this regard.

The proportion of foods with TFA-free claims decreased from 2010 to 2013 (from 22 to 14%, $p < 0.001$). However, among food groups, such a decrease was significant only in the group gravies, sauces, ready-made seasonings, broths, soups, and ready-to-eat dishes (group F; from 10.6 to 7.7%, $p < 0.001$). **Table 5** shows the prevalence of false negatives over time.

It was observed that the number of false negatives decreased ($p < 0.001$) from 2010 (37%) to 2013 (27%). However, such a reduction was significant only for foods of the group sugars, sugary foods, and snacks (group E; from 48% in 2010 to 42% in 2013, $p = 0.023$); no differences were observed for the other food groups. Furthermore, there was a reduction in the prevalence of false negatives between the ingredients list and TFA-free claims (13% in 2010 and 5% in 2013, $p < 0.001$). However, within groups, a significant reduction was observed only for gravies, sauces, ready-made seasonings, broths, soups, and ready-to-eat dishes (group F; 7% in 2010 and 5% in 2013, $p < 0.001$).

DISCUSSION

This study compared TFA information reported on the labels of packaged foods sold by a large supermarket chain in Brazil in 2010 and 2013 and analyzed how regulatory changes in 2012 (25) influenced the use of TFA in food formulations. In analyzing the ingredients list, we observed a decrease from 51 to 36% in the total number of foods containing i-TFA between 2010 and 2013. However, this result should be considered carefully, given that, within food groups, such a decrease in products with i-TFA was only significant for bakery goods, bread, cereals, and related products (group A). Of note, group A had the largest decrease in products with i-TFA, which might have influenced the results of the entire sample. Besides, there was an increase in the absolute number of foods containing i-TFA in groups E and F from 2010 to 2013. Thus, despite the decrease in the proportion of foods with i-TFA between food label censuses, it cannot be said that consumers had a higher possibility of choosing an i-TFA-free food, considering all available foods, in 2013 as compared with 2010.

TABLE 4 | Prevalence of trans-fat acids (TFA) in packaged foods sold in 2010 and 2013 in Brazil, as determined by analyzing the ingredients list, nutrition facts label, and TFA-free claims on food labels.

Food group[a]	N		Ingredients list										Nutrition facts label						Nutrition claims		
			Ingredients list (total)		p	Specific terms			Alternative terms			p	>0 g TFA			0 gTFA					
	2010	2013	2010	2013		2010	2013	p	2010	2013	p		2010	2013	p	2010	2013	p	2010	2013	p
	n	n	n (%)	n (%)		n (%)	n (%)		n (%)	n (%)			n (%)	n (%)		n (%)	n (%)		n (%)	n (%)	
A	724	801	426 (59)	283 (35)	**<0.001**	105(14)	79 (10)	0.442	321 (44)	204 (25)	0.116	**<0.001**	138(19)	87 (11)	0.730	582 (80)	710 (89)	0.448	240 (33)	180 (22)	0.427
B	375	327	23 (6)	19 (6)	0.990	6 (2)	6 (2)	0.758	17 (4)	13 (4)	0.431	0.990	55 (15)	31 (9)	0.815	317 (84)	296 (90)	0.949	0 (0)	5 (1)	–*
C	97	461	43 (44)	32 (7)	0.370	3 (3)	5 (1)	0.857	40 (41)	27 (6)	–*	0.370	24 (25)	22 (5)	0.623	73 (75)	153 (33)	0.684	22 (23)	10 (2)	–*
D	77	141	31 (40)	24 (17)	0.175	17 (22)	14 (10)	0.632	14 (18)	10 (7)	**0.012**	0.175	13 (17)	1 (1)	0.650	64 (83)	137 (97)	0.355	24 (31)	41 (29)	0.112
E	753	1146	504 (67)	633 (55)	0.655	168 (22)	125 (11)	0.126	336 (44)	508 (44)	0.495	0.655	146 (19)	163 (14)	**<0.001**	606(80)	949 (83)	**<0.001**	199(26)	176 (15)	0.536
F	301	300	150 (50)	166 (55)	0.246	25 (8)	36 (12)	0.199	125 (41)	130 (43)	0.054	0.246	45 (15)	72 (24)	**0.010**	256 (85)	215 (72)	**0.015**	32 (11)	23 (8)	**<0.001**
Total	2,327	3,176	1,177 (51)	1,157 (36)	**<0.001**	324(14)	265 (8)	0.142	853 (37)	892 (28)	**0.006**	**<0.001**	421(18)	376 (12)	0.052	1,898 (82)	2,460 (77)	0.178	517 (22)	435 (14)	**<0.001**

[a]*Food groups were classified according to the Brazilian and Mercosur regulation on nutrition labeling (36): group A, bakery goods, bread, cereals, and related products; group B, milk and dairy products; group C, meats, eggs, and seafood products; group D, oils, fats, and nuts; group E, sugars, sugary foods, and snacks; group F, gravies, sauces, ready-made seasonings, broths, soups, and ready-to-eat dishes.*
p-values were determined by Pearson's chi-square test (95% confidence intervals).
**Insufficient number of items in the category for analysis of statistical significance.*
Values in bold indicate that the differences are statistically significant at the 95% confidence intervals.

In a survey conducted in the United States of America, Rahkovsky et al. (31) analyzed 37,628 labels from a database made available by the food industry for the 2005–2010 period. The authors observed that, despite the significant decrease in the amount of i-TFA, the reported i-TFA content was considered high over time, amounting to about 1.52 g per serving. In the present study, there was no decrease in the number of foods listing TFA in the nutrition facts label between 2010 and 2013. Therefore, according to information presented in the nutrition facts label, there was no improvement in the proportion of foods considered potential sources of TFA between food label censuses.

It was observed that the use of specific and alternative terms in all foods decreased from 14% in 2010 to 8% in 2013 and from 39% in 2010 to 30% in 2013, respectively. However, for foods that were sources of i-TFA, there was an increase in the proportion of alternative terms, from 78% in 2010 to 82% in 2013. In other words, the possibility that the information shown on the food label did not correctly inform about i-TFA content increased. According to Silveira et al. (26), the lack of standardization in i-TFA terms may confuse consumers about the real composition of food, possibly inducing consumers to inadvertently choose foods containing i-TFA.

A study conducted in 2017 in Brazil analyzed 11,434 food and beverage labels (32). One-fifth of the food products were found to be potential sources of i-TFA, and 4.1% of i-TFA terms were identified as specific. Such percentages were lower than those found in the present study: 14% in 2010 and 8% in 2013. The 2017 study found that 14.6% of labels declaring i-TFA contained alternative terms. However, the method of the referred study differed from that of the current one: only "margarine," "vegetable fat," and "vegetable cream" were considered as alternative terms in the 2017 study. Here, 9 alternative terms were identified in 2010 and 37 in 2013. Given that the 2017 study only considered three alternative terms, it can be inferred that there was an underestimation of i-TFA content reported on food labels.

Regarding false negatives, despite changes in the criteria for using TFA-free claims in 2012 (25), it is still possible to report 0 g of TFA on the nutrition facts label if the content of TFA is less than 0.2 g per serving (19), which might confuse consumers (26). Such a weakness in legislation was confirmed by Hissanaga-Himelstein et al. (33), who determined the composition of saturated fat and i-TFA in biscuits and breads sold in Brazil by gas chromatography and compared the results with information reported on food labels. It was revealed that 92% of the evaluated products contained i-TFA, although only 33% reported this information on the nutrition facts label.

In Shanghai, Kong et al. (34) investigated the nutrition information of packaged foods in 2007/2008 and 2012/2013. Of the 1,995 foods analyzed, 77% would be required to report the TFA content in the nutrition facts label because they contained PHO, but only 7% disclosed this information. In the study of Wang et al. (35), the labels of 895 margarines sold in the United States of America were investigated over time (2001, 2006, and 2011). In 2001, 2.3% of all margarine types included i-TFA-free claims on the label. After a technical regulation that made it mandatory to inform the TFA content in the nutrition facts

TABLE 5 | Prevalence of false-negative information on trans-fat acids (TFA) in packaged foods sold in Brazil in 2010 and 2013, as identified by comparison of the nutrition facts label and TFA-free claims with the ingredients list.

Food group[a]	*N*		Nutrition facts label[b]		*p*	TFA-free claims[c]		*p*
	2010	2013	2010	2013		2010	2013	
	n	*n*	*n* (%)	*n* (%)		*n* (%)	*n* (%)	
A	724	801	299 (41)	196 (24)	0.188	128 (18)	54 (7)	0.495
B	375	327	18 (5)	19 (6)	0.885	0 (0)	0 (0)	–*
C	97	461	32 (33)	30 (6)	0.481	11 (11)	3 (1)	–*
D	77	141	25 (32)	23 (16)	0.281	0 (0)	3 (2)	–*
E	753	1146	365 (48)	481 (42)	**0.023**	141 (19)	100 (9)	0.843
F	301	300	124 (41)	96 (32)	0.181	20 (7)	16 (5)	**<0.001**
Total	2,327	3,176	863 (37)	845 (27)	**<0.001**	300(13)	176 (5)	**<0.001**

[a]Food groups were classified according to the Brazilian and Mercosur regulation on nutrition labeling (36): group A, bakery goods, bread, cereals, and related products; group B, milk and dairy products; group C, meats, eggs, and seafood products; group D, oils, fats, and nuts; group e, sugars, sugary foods, and snacks; group F, gravies, sauces, ready-made seasonings, broths, soups, and ready-to-eat dishes.
[b]Prevalence of foods with specific or alternative terms for i-TFA in the ingredients list and 0 g of TFA declared in the nutrition facts label, treated as false-negative information.
[c]Prevalence of foods with specific or alternative terms for i-TFA in the ingredients list and TFA-free claims, treated as false-negative information.
p-values were determined by Pearson's chi-square test (95% confidence intervals).
**Insufficient number of items in the category for analysis of statistical significance.*
Values in bold indicate that the differences are statistically significant at the 95% confidence intervals.

label was passed in 2006, the number of claims rose to 6.5%. Presumably, after reformulation of food products resulting from changes to legislation, the number of claims decreased to 3.1% in 2011. These findings show that public policies that do not allow false notification of TFA-free claims in the nutrition facts label or front-of-pack labels may promote the reformulation of foods with low i-TFA contents.

In the present study, we identified a decrease in the number of false-negative foods (10% reduction in the nutrition facts label and 8% reduction in TFA-free claims). However, despite this decrease, about one-third of foods containing i-TFA in 2013 received this classification; therefore, these food labels did not provide adequate information that would allow consumers to choose between consuming i-TFA or not. There was a greater decrease in the number of false negatives between TFA-free claims and the ingredients list than between the nutrition facts label and the ingredients list. This result might be due to changes in criteria for the use of TFA-free claims on food labels, effective as of 2012 (25): the TFA content permitted for displaying TFA-free claims in 2012 is half of that allowed in 2010. The 2019 regulation banning i-TFA in Brazil does not change the parameters for using TFA claims, allowing manufacturers to use a TFA-free claim if the food product contains less than 0.1 g of (naturally or industrially produced) TFA per serving and the total amount of TFA and saturated fat does not exceed 1.5 g per serving. For this reason, false negatives will continue to exist in the Brazilian market until i-TFA is completely banned.

Another limitation of Brazilian legislation is that it allows serving sizes to differ in $\pm$ 30% from the reference value (36). Kliemann et al. (37) observed that serving size might be associated with the declaration of i-TFA in nutrition information in Brazilian food products. Half of the 2,020 foods analyzed were likely to contain i-TFA according to the ingredients list, but analysis of the nutrition facts label indicated that about 40% were false negatives. TFA content and number of false negatives increased with increasing serving sizes up to the maximum value allowed, decreasing for foods with serving sizes above the threshold. According to Machado et al. (38), the use of smaller serving sizes and fractionation of serving sizes in household measures are some of the strategies used to avoid informing TFA content in the nutrition facts label in Brazil.

For sugars, sugary foods, and snacks (group E), there was an increase in the number of products containing i-TFA in the ingredients list and declaring a TFA content greater than 0 g in the nutrition facts label. On the other hand, there was a decrease in the number of false negatives. Aued-Pimentel et al. (39) analyzed the lipid content of 600 foods sold in Brazil between 2005 and 2018; it was identified that the TFA content of sugars, sugary foods, and snacks (group E) increased over time and was considered high (21 g of TFA/100 g).

Other studies have monitored i-TFA information on the labels of foods that could be classified as group E. Hooker et al. (40) analyzed the labels of 2,701 cookies in the United States and 965 cookies in Canada between 2006 and 2012 and found a decrease in i-TFA content in both countries. Zupanic et al. (28) monitored the food labels of 22,629 products between 2015 and 2017 in Slovenia and observed a decrease in i-TFA content in all food groups except cakes, muffins, and cookies, in which i-TFA contents remained high.

Steen Stender (41) has been collecting TFA information from biscuits, cakes, and wafers in supermarkets in 28 European countries and the former Soviet Union since 2012 (41–44). Studies evaluating TFA labeling over time have indicated a reduction in TFA content, although high TFA levels are still found in several countries. Furthermore, voluntary regulatory measures did not provide effective results in any country. In one of the studies, the authors highlighted the limitation of having considered only "partially hydrogenated fat" or similar terms for assessing TFA in the ingredients list (41). Therefore, the number of sources of i-TFA in the referred study would probably be higher if ingredients lists were analyzed individually and alternative terms were identified.

In the group gravies, sauces, ready-made seasonings, broths, soups, and ready-to-eat dishes (group F), there was an increase in the number of sources of i-TFA and no differences in the absolute number of foods between 2010 and 2013. We observed an increase in the number of foods with TFA, as identified in the nutrition facts label, indicating that there was an increase in the use of i-TFA in this group. In line with this finding, a decrease in the number of foods with TFA-free claims was observed, also possibly related to changes in legislation.

A strong aspect of the current study, as well as previous studies from our research group (26, 33, 38, 45), is the use of a reproducible, reference method to identify TFA information on food labels. One limitation is the fact that data were gathered from one Brazilian supermarket chain only. However, care was taken to choose a supermarket chain that was among the 10 largest in the country. Thus, foods sold in this supermarket chain were likely to have high national representativeness, added to the fact that, of all manufacturers, at least 69% in 2010 and 70% in 2013 supplied their food products nationwide. Although the data are from 2010 and 2013, as previously mentioned, the regulation passed in 2019 did not change the parameters for TFA labeling. Thus, consumers cannot be certain whether a given food product is a source of i-TFA until this type of fat is completely banned in 2023. Even though regulations for TFA-free claims are being revised worldwide, there were no studies analyzing the meaning of such changes for consumers through analysis of food labeling over time, until now. Future studies should monitor TFA information on Brazilian food labels to assess the impact of the latest regulatory measures on food products.

CONCLUSION

The change in criteria for using TFA-free claims imposed by Brazilian legislation in 2012 led to a decrease in the proportion of foods containing TFA and with such claims on the label. However, regulatory changes did not significantly influence the composition of packaged foods between 2010 and 2013. Although there was a decrease in the proportion of foods containing i-TFA, separate analysis of food groups revealed a significant decrease only for bakery goods, bread, cereals, and related products, which might have influenced the results for the entire sample.

The occurrence of false-negative products can be attributed to gaps in Brazilian legislation on i-TFA labeling. Therefore, it is important to review legislation to exclude the possibility of declaring "zero trans" (in claims and in the nutrition facts label) when products contain an ingredient that is a source of i-TFA and to standardize terms used to designate i-TFA. Even though it is expected that i-TFA will be eliminated in Brazil in 2023, consumers have the right to adequate information about food. The new regulation does not change parameters for TFA-free claims; therefore, false negatives may continue to exist until TFA is completely banned. Furthermore, food manufacturers are responsible for ensuring that TFA information is clear enough for consumers to understand whether the product is a source of i-TFA or not.

Knowledge about the consequences of indiscriminate use and consumption of TFA needs to be carefully considered when listing other fats as substitutes for i-TFA. For instance, more scientific evidence is needed on the health effects of interesterified fats, given that, in the past, TFA was considered safe and even beneficial (46).

Stimulated by the importance of food labeling as a tool to ensure consumers' right to information and promote healthier food choices, and the lack of follow-up studies on TFA information on food labels over time, this study provides evidence of the reality of Brazil regarding TFA information on food labels between 2010 and 2013. It also contributes to highlighting the existing weaknesses in Brazilian legislation concerning the declaration of TFA on food labels and is a potential source of data for comparing the situation in the country before elimination of TFA from food products, scheduled for 2023 (20).

DATA AVAILABILITY STATEMENT

The datasets presented in this article are not readily available because the database used in the article belongs to the Federal University of Santa Catarina and can be made available by request only in case of official partnership with the University. Requests to access the datasets should be directed to RP, nuppre@contato.ufsc.br.

AUTHOR CONTRIBUTIONS

BB was responsible for processing, analyzing, and interpreting data and drafting the manuscript. DH and AS contributed to data processing and analysis. GB and PU contributed to data interpretation and manuscript revision. RP was responsible for the design of the original study and contributed to student orientation and revision of the final manuscript. NK contributed to the design of the original study and to student orientation. AF was responsible for research coordination, student orientation, and revision of the manuscript. All authors approved the final version of the manuscript.

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ABSTRACTS

SPANISH

Etiquetado de grasas trans en alimentos envasados vendidos en Brasil antes y después de los cambios en los criterios regulatorios para declaraciones "libre de grasas trans" en las etiquetas de alimentos

El consumo de ácidos grasos trans (AGT) producidos industrialmente es un problema de salud pública. Por tanto, es importante que la información de AGT en alimentos envasados sea claramente informada a los consumidores. El objetivo de este estudio es acceder a la evolución de la información de AGT presentada en alimentos envasados vendidos en Brasil en el 2010 y el 2013, antes y después de la introducción de requisitos reglamentarios más estrictos para declaraciones "libre de AGT" en el etiquetado de alimentos. Se realizó un estudio transversal repetido mediante censos en etiquetas de alimentos de todos los alimentos envasados disponibles para la venta en dos tiendas de la misma cadena de supermercados, totalizando 2.327 productos alimenticios en el 2010 y 3.176 en el 2013. Declaraciones "libre de AGT" e información indicando AGT en la lista de ingredientes y en la tabla de información nutricional fueron analizadas por estadísticas descriptivas y la prueba chi-cuadrado de Pearson. Hubo una disminución del 14% en el uso de ingredientes conteniendo o potencialmente conteniendo AGT producidos industrialmente (AGT-i), de acuerdo con el análisis de la lista de ingredientes. Sin embargo, cuando se analizaron los alimentos por grupos, se encontró que esta disminución fue significativa solo para el grupo A (productos de panadería, pan, cereales, y productos relacionados; de 59% a 35%, $p < 0.001$). En contraste, el grupo de alimentos F (salsas, condimentos preparados, caldos, sopas y platos listos para comer) mostraron un aumento del 5% en AGT-i. El uso de términos específicos para AGT-i disminuyó entre el 2010 y el 2013, pero hubo un aumento del uso de términos alternativos, como "grasas vegetales" y "margarina", que no permiten a los consumidores identificar de manera confiable si un producto alimenticio es una posible fuente de AGT-i. Hubo una disminución del 18% en el uso de declaraciones "libre de AGT" en productos alimenticios conteniendo o potencialmente conteniendo AGT-i. No obstante, casi un tercio de los alimentos vendidos en el 2013 fueron falsos negativos, es decir, alimentos que se reportaron por contener 0 g de AGT en la tabla de información nutricional o con declaraciones "libre de AGT" pero que mostraban términos específicos o alternativos para AGT-i en la lista de ingredientes. Los resultados indican que la adopción de requerimientos más estrictos para declaraciones "libre de AGT" en las etiquetas de los alimentos en Brasil ayudó a reducir la prevalencia de tales declaraciones, pero no fue suficiente para disminuir los AGT-i en alimentos industrializados vendidos en supermercados.

Palabras clave: grasa trans, aceite parcialmente hidrogenado, etiquetado de alimentos, etiquetado nutricional, legislación de alimentos, alimentos industrializados, método de census.

PORTUGUESE

Rotulagem de gordura trans em alimentos embalados comercializados no Brasil antes e depois de mudanças nos critérios regulatórios para alegações "livre de gordura trans" em rótulos de alimentos

O consumo de ácidos graxos trans (AGT) produzidos industrialmente é um problema de saúde pública. Por isso, é importante que as informações sobre AGT em alimentos embalados sejam claramente informadas aos consumidores. Este estudo teve como objetivo avaliar a evolução das informações de AGT apresentadas em alimentos embalados comercializados no Brasil em 2010 e 2013, antes e depois da introdução de parâmetros regulatórios mais rígidos para alegações "livre de AGT" nos rótulos dos alimentos. Foi realizado um estudo transversal repetido por meio de censos de rótulos de todos os alimentos embalados disponíveis para venda em duas lojas da mesma rede de supermercados, totalizando 2.327 produtos alimentícios em 2010 e 3.176 em 2013. As alegações "livre de AGT" e as informações indicando AGT na lista de ingredientes e na tabela de informação nutricional foram analisadas por estatística descritiva e comparadas por teste qui-quadrado de Pearson. Houve uma redução de 14% no uso de ingredientes

contendo ou potencialmente contendo AGT produzidos industrialmente (AGT-i), de acordo com a análise da lista de ingredientes. No entanto, ao analisar os alimentos por grupos, verificou-se que essa diminuição foi significativa apenas para o grupo A (produtos de panificação, pães, cereais e produtos relacionados; de 59% para 35%, $p < 0,001$). Por outro lado, o grupo de alimentos F (molhos, temperos prontos, caldos, sopas e pratos preparados) apresentou um aumento de 5% de AGT-i. O uso de termos específicos para AGT-i diminuiu entre 2010 e 2013, mas houve um aumento no uso de termos alternativos, como "gordura vegetal" e "margarina", que não permitem o consumidor identificar de maneira confiável se um produto alimentício é possivelmente fonte de AGT-i. Houve uma redução de 18% no uso de alegações "livre de AGT" em produtos alimentícios contendo ou potencialmente contendo AGT-i. No entanto, quase um terço dos alimentos vendidos em 2013 eram falsos negativos, ou seja, alimentos notificando 0 g de AGT na tabela de informação nutricional ou com alegação "livre de AGT", mas exibindo termos específicos ou alternativos para AGT-i na lista de ingredientes. Os resultados indicam que a adoção de parâmetros regulatórios mais rígidos para alegações "livre de AGT" na rotulagem de alimentos no Brasil ajudou a reduzir a prevalência de tais alegações, mas não foi suficiente para diminuir o AGT-i nos alimentos industrializados comercializados em supermercados.

Palavras-chave: gordura trans, óleo parcialmente hidrogenado, rotulagem de alimentos, rotulagem nutricional, legislação de alimentos, alimentos industrializados, método de censo.

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University Students' Knowledge and Perceptions About Concepts, Recommendations, and Health Effects of Added Sugars

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It is recommended to limit added sugars to below 10% of the daily energy intake, as excessive consumption has been associated with several chronic non-communicable diseases. This exploratory qualitative study used focus groups to investigate the knowledge and perception of Brazilian university students about added sugars concepts, consumption recommendations, and health effects. Focus groups were led by a moderator using a semi-structured discussion guide. The focus groups were recorded, transcribed verbatim, and subjected to thematic analysis. Five focus groups were conducted with a total of 32 participants (50% women, mean age 23 years). Participants could not distinguish added sugars from sugars naturally present in foods and were unaware of the health impacts associated with excessive added sugar consumption, except for the risk of diabetes. Although most participants reported limiting sugar consumption, they had no knowledge of official consumption recommendations. Given that current public policy agendas aim to reduce added sugar intake, there is a need to strengthen strategies for disseminating information on added sugar concepts, recommendations, health effects and how to identify them in the foods products.

Keywords: sugary drinks, focus group, sugary foods, food labeling, healthy eating

INTRODUCTION

Sugars, chemically defined as monosaccharides and disaccharides, are included in the group of carbohydrates, together with starch and dietary fibers (1). Sugars can be classified as intrinsic sugars, which are naturally present in fruits, vegetables, and milk, and as added sugars, which include all types of sugars added to foods and beverages during processing, meal preparation, or at the time of consumption (2, 3). The term "free sugars" is often used to refer collectively to added sugars and sugars naturally present in honey, syrups, and fruit juices (4). The term "total sugars" refers to all types of sugars.

There is no evidence indicating harmful health effects associated with the consumption of intrinsic sugars. In contrast, several studies have been demonstrating association of excessive added sugar consumption and development or worsening of non-communicable diseases, such as hypertension, cardiovascular diseases, and dental caries (5–10). In 2015, the World Health Organization (WHO) published dietary guidelines recommending limited intake of free sugars to not exceed 5–10% of the total daily energy intake (4). Similarly, national dietary guidelines, such as the Dietary Guidelines for the Brazilian Population (11) and the US Dietary Guidelines (12), recommend limiting the consumption of foods and beverages containing high amounts of added sugars.

Despite such recommendations, global food supply data from 2000, 2006, and 2013 demonstrated that there has been an increase in sugar availability, mainly through sugary drinks. In addition, the Latin America region has the second highest consumption of sugary drinks per capita, with Brazil ranking among the top countries in sugary drink sales (13). Data from a budget survey conducted in Brazil between 2017 and 2018 with a nationally representative sample showed an elevated consumption of foods and beverages high in added sugars, particularly of ultra-processed foods (14). In addition, a cross-sectional study based on data from the Brazilian National Health Survey (NHS), conducted in 2013/2014 has demonstrated that young adults are the main consumers of sweet foods and soft drinks (15).

Although it is known that high consumption of added sugars is a worldwide problem and global recommendations for limiting added sugars have been in place since 2015, there is scarce scientific discussion on the topic. The few studies that have examined consumers' understanding and perceptions of added sugars demonstrated lack of understanding about sugar concepts, consumption, and recommendations (16–22). No studies conducted with Brazilian consumers were found. The investigation of perceptions regarding added sugar is particularly important among university students, since they are a subgroup of young adults with particular characteristics. They are usually in a phase of transition characterized by the development and consolidation of new habits and behaviors, including those related to food consumption (23). A review study showed that most university students have unhealthy eating behaviors, including high intake of fast foods, snacks, sweets, soft drinks, and alcoholic beverages and low intake of fruits and vegetables (24, 25).

Exploratory qualitative research can help to understand consumers' perceptions of issues related to sugar intake and thus guide the development of targeted strategies to limit added sugar consumption by specific populations. Considering the excessive intake of added sugars by the Brazilian population, particularly by young adults, and the lack of studies on the topic, this study aimed to investigate the knowledge and perceptions of university students about the concepts, consumption recommendations, and health effects of added sugars.

METHODS

Study Design and Participants

This qualitative investigation used the focus group method to examine the perception of university students about added sugars attitudes. The study was conducted with a convenient sample of university students from a major university located in a South capital city in Brazil. The targeted university has more than 30,000 undergraduate and postgraduate students enrolled in more than 100 on-campus courses. Students are from all parts of Brazil with different socioeconomical status.

Participants were recruited through printed and online posters containing information about the survey, an electronic address, and a QR code linked to an online questionnaire. The questionnaire was used to collect sociodemographic, anthropometric, and health data as well as information on time availability for participation in the study. A screening question about the use of food label was included. Only university students who reported paying attention to food labels were invited to participate. The printed posters were spread through the university campus close to areas with a high flow of students such as the library, the convention center, and the cafeterias. The online posters were published on the social medias of the research group. All students had equal access to the advertising materials, although the online posters were more likely to be viewed by health students than students from other schools.

The following eligibility criteria were used: (i) undergraduate and/or graduate university student aged 18 years and older, (ii) not enrolled in nutrition courses or holding a nutrition degree, (iii) not being part of the research study group, (iv) willingness to participate in the study and signing an informed consent form, and (v) completing the online recruitment form and appearing in person on the day of the focus group. Participants were contacted *via* e-mail and telephone to confirm their availability and schedule the face-to-face meeting. During recruitment, participants were asked to share recruitment information with friends and colleagues who met eligibility criteria without mentioning the content of the discussion, as a form of snowball sampling.

Focus Groups

Focus groups were conducted in Portuguese between May and June 2019. Each focus group had a minimum of 4 and a maximum of 10 participants, and sessions lasted up to 75 min. The endpoint of data collection was defined as the point of idea saturation, when new thoughts were not emerged by the participants. Focus groups were facilitated by one investigator (TS) supported by a research assistant (IPS). The investigator explained the importance of all participants contributing to the discussion and emphasized that there were no correct answers. All discussions were audio-recorded.

Focus groups were conducted using a semi-structured guide containing short open questions in an easy-to-understand language. Questions were designed to examine students' understanding of added sugar concepts, consumption recommendations, and health impacts. Some encouraging sentences (probes) were included between questions to stimulate discussion (e.g., "why?" "how?" "tell us more about it"). Prior to focus groups, the discussion guide was tested for clarity of wording and meaning with experts and members of our research group.

Data Processing and Analysis

Recorded audios were transcribed verbatim using *Speechnotes* and imported into MAXQDA® for analysis. Thematic analysis was used for extraction of codes, categories, and central themes (26). Three triangulation procedures were used to ensure data reliability. In the first triangulation, a second researcher independently coded 10% of the data, and the agreement between codes and themes was assessed. In the second triangulation, codes and categories were discussed with two researchers experienced in qualitative research and who have participated in the design of the survey. Finally, as a strategy to increase reliability, we used direct quotations from participants to illustrate the identified themes and conclusions.

Ethical Aspects

We obtained ethical approval from the Human Research Ethics Committee of the Federal University of Santa Catarina, Brazil (Protocol No. 3.063.750). All participants involved in this study gave written informed consent before participating. Consent was confirmed verbally before recording devices were turned on during focus groups.

RESULTS

Eighty university students filled in the recruitment questionnaire. All of them were contacted at least twice by the researchers to schedule a suitable time for participating in the focus groups. From the 80 respondents contacted, 32 (40%) were available to attend an in-person meeting. The 32 students were spread into five focus groups according to their availability. Overall participants' mean age was 23 $\pm$ 4.1 years, half of them were female and 75% were undergraduate students from different courses, such as health sciences, economics, engineering, and biology. Most participants (94%) did not report a diagnosis of chronic non-communicable diseases, and 22% reported dietary restrictions (mostly lactose intolerance). **Table 1** shows the participants' characteristics according to each focus group. No significant differences in participants' mean age and BMI between focus groups were found, demonstrating homogeneity across the groups.

Thematic analysis of focus group transcriptions revealed four major themes: (i) characterization and differentiation of types and sources of sugars, (ii) confusion about the concept and metabolism of sugars and carbohydrates, (iii) unawareness of recommendations for sugar consumption, and (iv) negative health impacts of sugar consumption.

Characterization and Differentiation of Types and Sources of Sugars

The participants associated sugars mainly with sensory characteristics, such as sweetness and tastiness, and their role as energy sources. Many students reported not knowing how to distinguish "natural" sugars from those added to foods and they also demonstrated difficulty in conceptualizing the different types of sugars. Students had different perceptions of sugar types and consumption sources. Packaged foods, particularly soft drinks, were cited as sources of sugars. Whereas some participants identified differences between sugars from a chemical point of view, others mentioned that there are differences between natural sugars and those present in packaged foods. Some participants had low or no knowledge about the differences between added and naturally occurring sugars.

> *"I know that some sugars have different names, so we often can't identify them. This kind of deceives the consumer, using large chemical names so we won't know what sugar is. I know these little tricks. (Focus group 4, female)"*

All focus groups discussed the different types of sugars found in foods. Some participants considered that fruit sugar is the best type of sugar. Honey was deemed to be as natural as fruit sugar. According to some participants, sugars differ in nutritional quality. Brown and organic sugar were reported as being nutritionally better than refined sugar, although price was cited as a major determinant of purchase intention. As the discussions progressed, students showed interest in reducing sugar consumption, particularly that of sugars added to homemade foods.

> *"I've tried several types of sugars to see what they're like. Price is also important; organic and brown sugar are much more expensive. I prefer brown sugar for its color. I read that the darker, the healthier. (Focus group 2, male)"*

Confusion About the Concept and Metabolism of Sugars and Carbohydrates

In some focus groups, participants associated the concept of sugars with that of carbohydrates. Some seemed to be confused about this point, assuming that all carbohydrates are sugars. Others believed that sugars were correlated with carbohydrates but could not clarify the relationship between the two components.

> *"That's a doubt I have. Sometimes it's written [on food labels] sugars and carbohydrates. Yeah, but aren't carbohydrates sugars?... For me, carbohydrates are sugars. (Focus group 5, male)"*

Some participants have also stated that sugars are metabolized differently in each organism, which is why they consider it difficult for some people to understand how much sugar they need to eat. Students believed that many people do not understand the relationship between consuming foods that contain carbohydrates and the provision of sugars to the body for energy supply.

> *"About this issue with carbohydrates... because people eat carbohydrates. For example, bread. People eat bread but they don't*

TABLE 1 | Focus group participants' characteristics.

	Focus group 1	Focus group 2	Focus group 3	Focus group 4	Focus group 5
Number of participants	8	6	4	5	9
Age mean years (SD)	24 (4.6)	25 (4.0)	22 (7.2)	22 (2.1)	21 (2.3)
% of female	75%	50%	50%	60%	33%
% of undergraduate students	75%	33%	75%	80%	100%
BMI mean kg/m^2 (SD)	23.4 (2.3)	24.3 (4.0)	21.5 (2.2)	25.3 (4.5)	24.5 (2.9)
% of people with dietary restrictions	22%	50%	25%	60%	11%

know that they're eating sugar. People eat pasta and they don't know that they're consuming sugar. So how many diabetics eat these foods unaware? (Focus group 5, female)"

Unawareness of Recommendations for Sugar Consumption

Most of the participants reported that consuming less sugar is better for health. Some mentioned that they have been trying to reduce daily sugar consumption, especially from the addition of sugars in homemade foods. Despite this concern, participants could not specify the amount of sugars they considered suitable for consumption. When participants were asked about how much sugar can be consumed as part of a healthy diet, most of them remained silent or generally answered "I do not know."

"I imagine that there is some recommendation for consumption [of sugars] but I have no idea how much it is (Focus group 3, female)."

In some focus groups, however, students cited values that were close to WHO thresholds. Some considered that sugar limits depend on the level of physical activity and/or individual energy expenditure. Only one student reported the WHO daily recommendation for sugar intake.

"I think it depends on a person's energy expenditure. If the person performs physical activity, they will need more carbohydrates, right? (Focus group 4, male)"

"I have a mobile app that tells me my ideal sugar intake. It says 47 g, almost 50 g. But it's just an app; it's not a reliable source, right [laughs]? (Focus group 5, male)"

Negative Health Impacts of Sugar Consumption

Participants associated excessive sugar consumption with negative health effects, particularly the development of diabetes. Other chronic diseases, such as obesity, cancer, and atherosclerosis, were also mentioned, as well as dental and thyroid problems. In addition, the relationship between sugar consumption and anxiety, stress, and depression was something that has emerged in all focus groups. According to some participants, consumption of high-sugar foods is common under these situations and may momentarily relieve tension.

"I rarely eat refined sugar. But at the end of the semester, I usually have a sweet tooth… I feel more like eating sweets when I'm stressed. (Focus group 1, male)"

Finally, few participants reported their perception that sugar consumption may lead to addictive behaviors and because of that is a nutrient that should be eaten with attention.

"Especially in periods of high demand, I like to eat a lot of sugar; if not, it feels like my body can't relax. So, I think it's an addictive thing and it's hard to stop. (Focus group 2, male)"

DISCUSSION

The results of the present study indicate that most participants could not distinguish intrinsic sugars from added sugars and deemed that the type of sugar (brown vs. refined) was more important than the fact of being added or intrinsic. Participants considered that sugar consumption can cause dependence and that excessive consumption is associated mainly with diabetes development and, less frequently, with other health problems such as obesity and tooth decay. In general, participants were unaware of sugar intake recommendations.

In the present study, participants identified sugars as energy sources. Similar results were observed in a qualitative study conducted in Australia, in which participants reported that high consumption of sugary drinks was associated with trying to prevent an energy deficit (17). The Australian study also showed that participants reported knowing that sugary drinks were not healthy but, nevertheless, found that daily consumption of these beverages was frequent and normal. A similar perception was expressed by the Brazilian university students who have participated in the present study; they mentioned consuming sugars regularly despite knowing the harmful effects of excessive sugar intake.

Participants reported that packaged foods, particularly soft drinks, contain high amounts of sugars. In a study in South Africa, consumers considered fruit-based soft drinks to be high in sugar but frequently consumed these products, mainly because of low prices, marketing strategies, and personal preferences (27). Participants also mentioned interest in reducing sugar intake, particularly from homemade foods. According to the 2017–2018 Brazilian Consumer Expenditure Survey, the Brazilian population has reduced sugar consumption: the purchase of crystal and refined sugars decreased by 50 and 40%, respectively, from 2002 to 2018 (14). These data suggest a trend in the reduction of sugar consumption at home, both at the table (added to juice, tea, and coffee) and in cooking (as an ingredient of cakes and desserts). However, packaged food consumption has increased, and these foods are high in added sugars (28, 29).

Study participants cared about the type of sugars, as they valued brown, organic, and fruit sugars instead of refined sugar. This perception is consistent with the results of a study conducted with adult consumers in Switzerland, which showed that using the label "fruit sugar" instead of "sugar" in packaged foods increased participants' perceived healthiness of the foods (30). Regarding the production type, a study analyzing adult consumers' perception of organic foods in Brazil showed that these products are perceived as healthier than the conventional and as they can improve the quality of life of the consumers (31). Other study conducted with Brazilian university students showed that food healthiness was associated with being natural and containing low amounts of additives (32), which can explain why the participants in our study valued organic sugar.

In the current study, participants demonstrated confusion or unawareness of the concepts of sugars, not being conscious about the types of sugars. This lack of information was also observed in a qualitative focus group study on the understanding of US consumers about sugar labeling. The US participants reported that the presence of added sugar labels indicated that food contained more sugar than usual, added by the manufacturer, making the product less desirable (33). A lack of understanding of these concepts is not restricted to consumers; it can also be observed in the scientific literature. An analysis of studies discussing the topic revealed a diversity of terms used to refer to sugars (including free sugars, added sugars, extrinsic sugars, and total sugars) and difficulty in reaching a consensus on definitions (3, 34). Many participants mistakenly related carbohydrate as a synonym for sugar. This finding agrees with those of a study conducted with 940 mothers in Taiwan: half of the subjects could not determine the sugar content of a food product because they did not know the difference between sugars and carbohydrates (35).

Many participants in the present study associated sugar consumption with pleasure or reward, often as compensation for hard work or physical exercise. Similarly, university students from the Emirates related added sugar consumption to emotional factors, stating that they consume more added sugars when feeling stressed (36). The perception that sugar can cause addiction was also emerged by some participants in our study. These results are similar to those found in a qualitative study with university students from Portugal, where sugar was simultaneously perceived as pleasurable and needed, but also as addictive and harmful (18). Some evidence has shown that adults present withdrawal symptoms after cessation of prolonged sucrose consumption, with behaviors similar to those of depression and anxiety (37–39).

Although WHO recommendations for free sugar consumption were published in 2015, 4 years before our data collection, only one student was able to accurately report the official values, demonstrating that almost all participants had no knowledge of the topic. Similarly, in a study conducted in Taiwan with 122 mothers, 40% of participants with high education could not inform WHO sugar recommendations, even after receiving face-to-face and online training on the topic and the proportion reached 80% when considering those who received online training only (40). These findings indicated that official consumption guidelines have a limited reach and are difficult to understand, which may lead to excessive or poorly informed sugar consumption. Although participants in our study were mostly unaware about the recommendations for sugar intake, they have mentioned some harmful effects of excessive intake of sugars. The development of diabetes was the most cited example of harmful effects associated with high sugar consumption, followed by obesity and tooth decay. In contrast, university students from Portugal have demonstrated few concerns about harmful effects of excessive consumption of added sugars by young adults and were mostly concerned about the negative impact of high sugar intake on body image (18).

Some limitations of this study need to be considered. We conducted a voluntary survey and because of the topic of the survey it is possible that individuals with more health concerns have been volunteered. Nevertheless, during focus groups, participants seemed to be unaware or confused about sugar consumption recommendations and they have demonstrated mixed feelings about health concerns. Another limitation is that the results of this study are not representative of individuals in other contexts, with different socioeconomic status, or from other parts of the country. However, care was taken in ensuring heterogeneity among participants regarding sex, field of study, and age, excluding students from nutrition courses. Nevertheless, future studies with students from other universities or with young adults out of the university environment are needed to produce a broader perspective and representativeness of the findings to the whole age group. In addition, we recommend that future studies investigate the source of nutritional information that students use to make their foods choices and what are their perceptions about artificial sweeteners, the main sugar alternative. Finally, the findings of this study can be used for planning large scale surveys or interventions investigating the topic in a bigger sample, as well as to subsidize discussions around interventions aiming to lower the sugar intake in the Brazilian population.

CONCLUSION

The current results demonstrate unawareness about the types of sugars and lack of knowledge about the recommendations for added sugar consumption among a sample of Brazilian university students. Some students considered carbohydrates to be synonyms for sugars or to have equal metabolic effects. Sugars were viewed as energy sources, deemed to be sweet and tasty, and considered more or less healthy depending on their sources.

Unawareness of consumption recommendations and the harmful health effects resulted from excessive added sugar intake can be reasons why young adults have a high intake of added sugars. Broad approach for disseminating the risks of excessive sugar consumption and interventions aiming to lower the sugar intake by these populations are strongly recommended.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Human Research Ethics Committee (CEPSH) at the Federal University of Santa Catarina (Under No. 3.063.750). The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

IS and TS was responsible for conceptualization, methodology, formal analysis, investigation, writing—original draft, and writing—review and editing. VR was responsible for conceptualization, methodology, formal analysis discussing, writing—original draft, and writing—review and editing. GB and PU were responsible for conceptualization and writing—review and editing. AF was responsible for conceptualization, methodology, formal analysis discussing, writing—original draft, writing—review and editing, and supervision. RP was responsible for conceptualization, methodology, writing—original draft, writing—review and editing, and supervision. All authors contributed to the article and approved the submitted version.

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ABSTRACTS

SPANISH

Conocimiento y percepción de estudiantes universitarios sobre conceptos, recomendaciones y efectos en la salud de los azúcares añadidos

Se recomienda limitar los azúcares añadidos por debajo del 10% del consumo diario de energía, ya que un consumo excesivo ha sido asociado con múltiples enfermedades crónicas no transmisibles. Este estudio cualitativo exploratorio utilizó grupos focales para investigar el conocimiento y la percepción de los estudiantes universitarios brasileños acerca de los conceptos de azúcares añadidos, recomendaciones de consumo y efectos en la salud. Los grupos focales fueron dirigidos por un moderador usando una guía de discusión semi-estructurada. Los grupos focales fueron grabados, transcritos textualmente y sometidos a análisis temático. Cinco grupos focales fueron conducidos con un total de 32 participantes (50% mujeres, edad promedio de 23 años). Los participantes no pudieron distinguir los azúcares añadidos de los azúcares naturalmente presentes en los alimentos y desconocían los impactos en la salud asociados con el consumo excesivo de azúcares añadidos, excepto por el riesgo de diabetes. Aunque la mayoría de los participantes reportó un limitado consumo de azúcar, ellos no tenían conocimiento de las recomendaciones oficiales de consumo. Dadas las agendas de políticas públicas actuales que pretenden reducir el consumo de azúcares añadidos, existe la necesidad de fortalecer las estrategias para la difusión de información sobre los conceptos de azúcares añadidos, recomendaciones, efectos en la salud y como identificarlos en los productos alimenticios.

Palabras clave: bebidas azucaradas, grupo focal, alimentos azucarados, etiquetado de alimentos, alimentación saludable.

PORTUGUESE

Percepções e conhecimento de estudantes universitários sobre conceitos, recomendações e efeitos na saúde de açúcares adicionados

É recomendado que se limite o consumo de açúcares de adição para menos de 10% da ingestão calórica diária devido à associação do seu consumo excessivo ao desenvolvimento de doenças crônicas não transmissíveis. Este estudo qualitativo exploratório utilizou grupos focais para investigar o conhecimento e a percepção de universitários brasileiros sobre conceitos de açúcares adicionados, recomendações de consumo e efeitos na saúde. Os grupos focais foram conduzidos por um moderador usando um roteiro de discussão semi-estruturado. Os grupos focais foram gravados, transcritos na íntegra e submetidos à análise temática. Cinco grupos focais foram conduzidos com um total de 32 participantes (50% mulheres, idade média de 23 anos). Os participantes relataram não conseguir distinguir os açúcares de adição dos açúcares naturalmente presentes nos alimentos e desconheciam os impactos na saúde associados ao consumo excessivo de açúcares de adição, exceto pelo risco de desenvolvimento de diabetes. Embora a maioria dos participantes tenha relatado limitar o consumo diário de açúcar, eles não tinham conhecimento das recomendações oficiais de consumo. Tendo em vista que as atuais agendas de políticas públicas visam à redução do consumo de açúcar de adição, é necessário fortalecer estratégias de divulgação de informações sobre os conceitos, as recomendações, os efeitos negativos à saúde e como identificar esses açúcares nos produtos alimentícios.

Palavras-chave: bebidas açucaradas, grupo focal, alimentos açucarados, rotulagem de alimentos, alimentação saudável.

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Consumers' Response to Sugar Label Formats in Packaged Foods: A Multi-Methods Study in Brazil

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Providing information about the sugar content of packaged foods on product labels is an important strategy to lower consumers' sugar intake. This study assessed the effect of exposure to different sugar labels on consumers' understanding of the sugar content of foods and their food choices. In the first phase, five focus groups were conducted with a convenience sample of Brazilian adults to explore their perceptions about food labelling in general and sugar labelling in particular. Based on the qualitative results, four sugar label formats were developed and subsequently tested in a five-arm study on 1,277 adults *via* a randomised controlled online survey. The formats were: (i) no sugar information—control, (ii) total and added sugar content displayed in the Nutrition Information Panel (NIP), (iii) a front-of-package (FoP) octagonal warning for "high-in-sugar" products, (iv) a FoP magnifying glass warning for "high-in-sugar" products, and (v) a "high-in-sugar" warning text embedded on the NIP. Participants from the focus groups reported being confused about the meaning of "sugar" and "added sugar" on food labels and indicated that more interpretive labels, such as the FoP warnings, would help them choose products with low sugar content. In the experiment, all intervention sugar label formats improved participants' understanding of the sugar content of the tested food products, with the FoP warnings (iii and iv) showing the best results. While non-significant differences among label conditions were observed for food choices, the FoP octagonal warning prompted participants to choose high-in-sugar products less often. Given current public policy agendas aiming to reduce added sugar intake, there is a need to strengthen food labelling policies and nutrition disclosure policies that target the display of added sugar and build consumer awareness in using these tools to avoid high-in-sugar products.

Keywords: food labelling, sugary foods, health claims, warning labels, consumer behaviour, trial

INTRODUCTION

Brazil, like many countries around the world, is facing the increasing burden of non-communicable diseases (NCDs) across its population (1, 2). Up to 4% of the global disease burden has been related to an unhealthy diet (3), making diet an important modifiable behavioural risk factor for NCDs. Of the several aspects of an unhealthy diet, the excessive consumption of sugar has been associated with the development or aggravation of several NCDs (4–6). "Sugars" is the generic name of a group of monosaccharides (glucose, galactose, and fructose) and disaccharides (sucrose, lactose, maltose, and trehalose). Colloquially, the term "sugar" is usually used to refer solely to sucrose or refined sugar—also known by table sugar (7). Sugars can be classified as intrinsic, added or free, and total for dietary purposes. Intrinsic sugars are found naturally within whole fruits, vegetables, dairy, and grains. Added sugars include sugars and syrups added during the processing of foods (such as sucrose or dextrose) (8). The definition of free sugar includes added sugars and further includes sugars found naturally within fruit juices and fruit purees of all concentrations. Total sugar include all sugar types (9). Further discussion around sugar definitions can be found elsewhere (7, 10). In Brazil, 64% of the adult population is eating more free sugar than recommended by the World Health Organization (WHO) (11), making the country the world's fourth-largest consumer of sucrose (12). Table sugar and sugary packaged foods are among the main sources of free sugars intake (13).

Following the recommendations in the WHO guidelines (9), many countries are considering regulations or public health policy measures aiming at lowering sugar intake in their population. Sugar labelling is located among these actions and has been gaining prominence in health agendas worldwide as a strategy to inform consumers about the sugar content of packaged foods. Countries such as the United States, Australia, New Zealand, and members of the European Union follow the Codex Alimentarius recommendation on food labelling, which states that total sugar content should be displayed on labels (14). Requirements for declaration of added sugar are now also being implemented in some countries. The United States, for example, required the inclusion of the amount of both total and added sugars in the nutrition facts panel by 2021 (15).

In Latin America, some countries have been establishing regulations on added sugar front-of-pack (FoP) warning labels to help consumers avoid high-in-sugar products. FoP labelling includes simplified information about nutritional content or health aspects of foods, and they are displayed on the front of the package to assist consumers make healthier food choices during their quick decision-making shopping process (16). In Chile, a FoP octagonal warning label stating "high-in-sugar" is mandatory for food products exceeding defined sugar content thresholds (17), and this same format has been implemented in Peru (18) and Uruguay (19) and approved to be implemented in Mexico (20).

In Brazil, 71% of the packaged food available for sale at the supermarket has at least one type of added sugar ingredient (21). However, it is not a requirement for total or added sugar contents to be displayed on labels as the listing of this information is not mandatory under Brazil's food labelling regulations from 2003—which is still enforced (22). In 2014, through The National Health Surveillance Agency (ANVISA—Agência Nacional de Vigilância Sanitária), the Brazilian Ministry of Health began debating the Brazilian food labelling regulation, including the implementation of a sugar label format. A preliminary report from this discussion reinforced the need to declare sugar on the back-of-pack Nutrition Information Panel (NIP) and to implement a FoP warning label for high-in-sugar products. At the time, a lack of evidence prevented ANVISA from deciding which format would be most effective to help Brazilian consumers identify sugar amounts through labels and discourage the selection of high-in-sugar foods (23). At the end of 2020, the Brazilian government announced the final changes for the food labelling regulation in Brazil. These changes included the mandatory declaration of total and added sugar content in grammes in the NIP and a FoP magnifying glass warning indicating that a product is high in sugar (24). The magnifying glass format was put forth by ANVISA and it seems to be based on discussions made by the government of Canada in 2017 (25), but without extensive evidence of this format efficacy on consumers' food choices (26). Although the changes in the Brazilian food labelling rules were published in 2020, food manufacturers are not mandated to apply these changes on the label of their products until October 2022. At the present point in time, the list of ingredients declared on the packages is the only mandatory information to consumers identify if a product has added sugar ingredients in its composition.

Studies investigating consumers' understanding of food labels and their influence on food choices in the Brazilian population are sparse (27–29), and they demonstrated a preference for labels in the form of FoP warnings. Given the gap in this area of research, this study focuses on sugar and provides additional information on consumer preference for the presentation of this information by exploring Brazilian consumers' responses to different sugar label formats. Specific study objectives include to: (a) explore consumer perceptions of what "sugar" means and which label features would help them to identify sugar ingredients in packaged foods; (b) compare the effectiveness of four different sugar label formats in improving consumers' understanding of the sugar levels in a set of products; and (c) evaluate the influence of the four label formats on consumers' food choices.

MATERIALS AND METHODS

A multi-method approach encompassing qualitative and quantitative phases was used to choose and test sugar label formats for packaged food products. Initially, focus groups were conducted with a convenience sample of young adult food-label users to explore perceptions of three pre-defined sugar label formats. The results were used to adapt the formats to be tested in a survey evaluating the influence of sugar label formats on consumers' understanding of the sugar content in packaged foods and food choices. These two data collection phases are described further below.

Qualitative Phase

Methods

Five focus groups were conducted in the city of Florianopolis (south Brazil) during June and July of 2019 with a convenience sample of 32 young adults (18–33 years). Young adults were chosen since they usually have a high intake of added sugar, mainly sourced from packaged food and beverages (13). Only participants who self-reported usually using food label information during their food shopping were included to ensure they had previous experience with the subject of this study. Rather than seek findings generalisation, this qualitative phase attempted to find examples of behaviours and clarify the thoughts and feelings of individuals with a previous experience of the phenomena of interest (food label use) in order to produce evidence for developing the quantitative phase of this study.

Focus group size ranged from four to nine participants, with a mean group size of six participants. The mean age was 23 years (±4.1), 50% of the sample was female, 75% were undergraduate students, and 31% had at least one dietary restriction (mainly in relation to lactose intolerance). Participants were recruited *via* posts on social media platforms for university study groups, flyers shared in the university campus, and snowballing among those registered for the study (i.e., participants who participate in the study were asked to invite relatives and friends to take part of the study). Individuals with training in nutrition were not included. Further details about the qualitative phase are available elsewhere (30).

The first author moderated all focus groups with the support of two observers who took notes. A semi-structured interview guide was developed based on the literature, including our previous systematic review investigating sugar labelling formats and consumers' understanding (31). The interview guide included open-ended questions that covered participants' perception of sugar (e.g., What do you understand by sugars? What do you think "total sugar" and "added sugar" declared on food labels mean?), food labelling use (e.g., What do you think about food labelling information?), and reactions (e.g., How would you identify if this is a high-in-sugar biscuit? Would this format assist you while choosing a food product?) to three different formats of food labels carrying information about sugar (**Figure 1**). The labels were fixed on real packages of a well-known brand of biscuit sold in Brazil. The order of presentation of the sugar label formats was from the least interpretative format (i), followed by some interpretation (ii), and, finally, the most interpretive one (iii). Participants had time to hold and observe the packages before they were invited to express their perceptions regarding the label formats, including how well they understood the information in each format and how useful this information would be for their food choices. The groups lasted from 45 to 70 min and were audio-recorded. The recordings were transcribed verbatim and imported into MAXQDA software (VERBI GmbH, Pty Ltd) for thematic analysis (32).

Findings

Most of the participants demonstrated a low understanding of sugar and which names sugar is called on food labels. Almost all participants indicated they had never heard the term "added sugars" before, and many of them were confused when both "total sugar" and "added sugar" information was presented on food labels. Many participants were also confused about the differences between sugars and carbohydrates, and assumed that these terms were synonymous. There was a consensus among participants that food labels should provide clear and easy-to-understand information about sugar to support consumers' food choices.

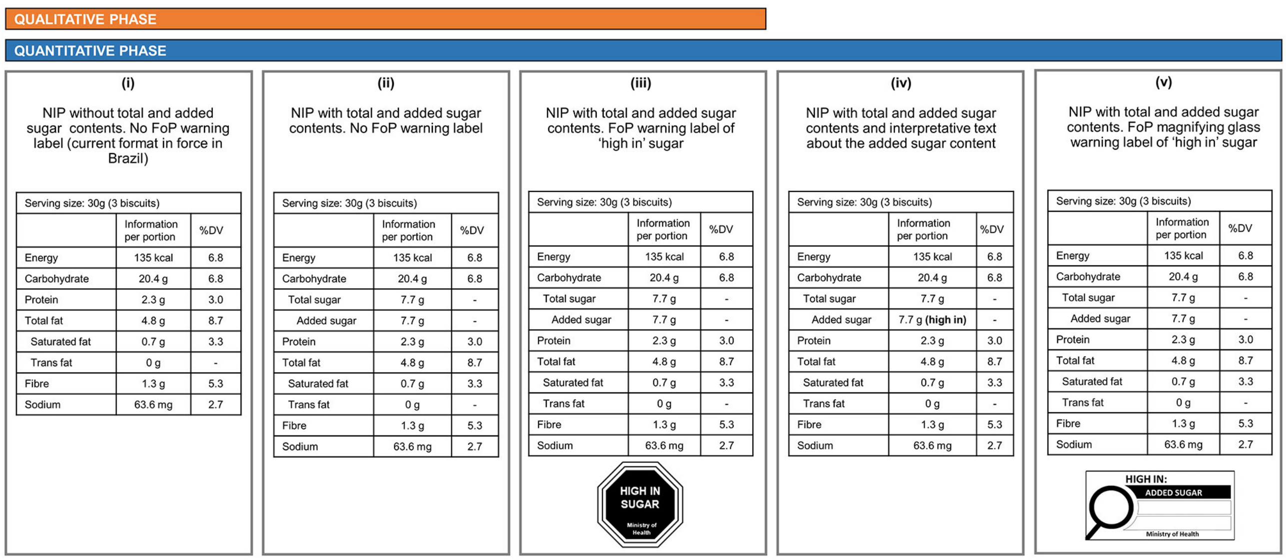
Participants unanimously perceived the first format [(i) no information about sugar on the NIP] as being the least useful for food choices. Many participants mentioned that with this format, they rely only on the confusing and small-font-size list of ingredients to determine the presence of sugar in a product and that the names of some sugar ingredients were unfamiliar to them. The second format [(ii) total sugar and added sugar contents listed in the NIP] was preferred over the first format to provide information about the exact quantity of sugar in a food product and to compare products within the same food category. Although participants at first demonstrated confusion about the differences in "total sugar" and "added sugar" contents, they found the space gap included in the heading "added sugars" under the "total sugar" sugar beneficial to identify those sugars were part of the total sugar content.

> *"Now I understood the logic here, this space gap [talking about the gap space in the headings for total and added sugar contents] is to show us that the added sugars are part of the total sugars and all of them are part of the carbohydrates. I always thought all carbs were sugar, but since the contents of carbohydrates and sugars are different here [format 2], I can see they are not the same thing!" (Male, focus group 1).*

When asked to evaluate if the biscuit had a high added sugar content, most participants experienced difficulty determining what constitutes "high" content only by looking at the total and added sugar content only. Some participants suggested including some kind of interpretation such as a "high-in-sugar" text close to the amount of sugar on the NIP for better understanding of the sugar content.

> *"I liked this format [format 2] because it gives me the information about the sugar content of this biscuit, but I think it would be good if they [food manufacturers] include some interpretation close to the sugar content to tell me "Caution, this is a high-in-sugar product"—that would help me as I don't know how to interpret the numbers here" (Female, focus group 4).*

The NIP + octagonal warning label (iii) was chosen as the most useful to obtain consumers' attention and facilitate quick interpretation of a product's sugar content. Many participants believed that this format could help consumers demystify which products are high in sugar but also have a health halo (e.g., cereal bars and whole-grain biscuits). As the discussions evolved, many participants suggested that format (iii) would suit their needs for



(i)

Serving size: 30g (3 biscuits)	Information per portion	%DV
Energy	135 kcal	6.8
Carbohydrate	20.4 g	6.8
Protein	2.3 g	3.0
Total fat	4.8 g	8.7
Saturated fat	0.7 g	3.3
Trans fat	0 g	-
Fibre	1.3 g	5.3
Sodium	63.6 mg	2.7

(ii), (iii), (v)

Serving size: 30g (3 biscuits)	Information per portion	%DV
Energy	135 kcal	6.8
Carbohydrate	20.4 g	6.8
Total sugar	7.7 g	-
Added sugar	7.7 g	-
Protein	2.3 g	3.0
Total fat	4.8 g	8.7
Saturated fat	0.7 g	3.3
Trans fat	0 g	-
Fibre	1.3 g	5.3
Sodium	63.6 mg	2.7

(iv)

Serving size: 30g (3 biscuits)	Information per portion	%DV
Energy	135 kcal	6.8
Carbohydrate	20.4 g	6.8
Total sugar	7.7 g	-
Added sugar	7.7 g **(high in)**	-
Protein	2.3 g	3.0
Total fat	4.8 g	8.7
Saturated fat	0.7 g	3.3
Trans fat	0 g	-
Fibre	1.3 g	5.3
Sodium	63.6 mg	2.7

FIGURE 1 | Sugar label conditions used in the qualitative and quantitative phases. The ingredient list of each product was also provided during the survey. Formats (i), (ii), and (iii) were used in the qualitative phase. All formats were used in the quantitative phase. NIP, Nutrition Information Panel; FoP, Front-of-Package; DV, Daily Value.

quantitative information about sugar (NIP) and a quick way to determine the sugar level of a product (warning) at the point of purchase, influencing their choice for lower sugar products. A few participants also indicated that any warnings or message on labels should be endorsed by the Health Ministry and that this endorsement should appears on labels. In addition, many participants felt that information voluntarily provided by the food industry is untrustworthy.

> *"For me, this format with a warning [format 3] would be the best as it gives me the information straight away (Male, focus group 2).*
> *But if someone needs to compare two products, the best for me would also have the sugar content information on the back. Then, even if I am choosing between two high-in-sugar products, I can see which of them is lower in sugar and pick that one... or I would probably avoid both [laugh] (Female, focus group 2)."*

Quantitative Phase

Label Conditions

For the quantitative phase of the study, the three label formats used in the qualitative phase [(i), (ii), and (iii)], and two more formats [(iv) and (v)] were included (**Figure 1**). Format (iv) was included because it was proposed by a public consultation for front-of-pack labels made by ANVISA which emerged in between the qualitative and quantitative phases of this study. This format includes a magnifying glass warning indicating when a product is high in sugar (**Figure 1**). Format (v) includes interpretive "high in" sugar text embedded in the NIP, which was suggested during the focus groups discussion. The two formats with FoP information [(iii) and (iv)] also had text saying "Ministry of Health of Brazil," as suggested during the focus groups. The decision to test sugar labelling formats for both the FoP and the back of pack (NIP) labels was made to align with the changes in the Brazilian food label rules, which will include modifications in both sources of nutritional information on food packages. Three food categories (whole-grain biscuit, cereal bar, and yoghourt) were tested in the quantitative phase. They were selected because they are commonly available in Brazilian supermarkets, have brands with different sugar levels, and are often misperceived as healthy.

Study Sample

An online randomised controlled experiment was conducted in Portuguese over a period of 6 weeks between May and June of 2020. Participants were recruited from posts on social media platforms of university study groups, e-mail lists of consumer association groups across Brazil, and via snowball technique. To avoid the possibility of the same person taking the survey multiple times, IP address information from the device used by the participant to take the survey was collected and duplicate IP address were removed. A virtual link providing access to the survey hosted on the Qualtrics® platform was created and shared in the ads for this study. People were eligible to participate if they were 18 years or older, provided consented to participate, and had access to a computer or tablet with internet access. At the beginning of the survey, participants were asked to provide information on sex, age, region of residence, education level, self-reported weight and height, dietary restrictions, and self-estimated level of health awareness and nutrition knowledge. They were also asked to declare the frequency of purchase of the tested food categories on a four-point scale ("Always," "Often," "Sometimes" and "Never"). Those who responded "Never" to all the three food categories were excluded to ensure responses reflected real-world food choice behaviours. A total of 1,524 people accessed the survey, of whom 1,277 fit the eligibility criteria and completed the survey (**Figure 2**).

Study Design and Stimuli

For each food category, a set of three food products with different levels of added sugar was created (total of nine different products). Two of the three food products were high-in-sugar options, as defined by the parameters established by the Nutrient Profile Model of the Pan-American Health Organization (33). To approximate the task with a real-world food choice scenario, food products selected for this study were well-known brands available in Brazilian supermarkets. All products under the same food category had their nutrition information standardised to the same serving size to help consumers compare the products during the tasks.

Following the sociodemographic, lifestyle and nutrition-related questions, participants were randomly allocated to a single label format and asked to complete choice and understanding tasks. The image of the product's front panel was provided on the left-hand side of the survey screen, with the respective NIP formats presented on the right-hand side. Participants allocated on FoP label formats [label conditions (iii) and (iv)] saw this information incorporated directly into the products' image of the front panel, affixed at the same place in each package, covering the same area on the packages. The list of ingredients of all foods was also provided on the screen for the five label conditions. Participants had the option to zoom in on the images of the food products during the tasks. Any other nutritional information or quality indicators (e.g., nutrition claims) were digitally removed from the packages to avoid unduly influencing participants' perceptions of the food products. Examples of the stimuli used in the survey are displayed in **Supplementary Figure S1**.

Study Procedures

Participants saw the same food products and responded to the same set of questions for all the label conditions. The presence and type of label format on the food products were the only aspects that differed across arms. To minimise priming participants to pay attention to the label formats and modify their choices accordingly, food choice was measured first for each product category, and then participants answer questions about sugar content of the presented products.

First, participants viewed the three sets of food products one at a time. For each set they were asked to select which of the three displayed products they would choose to purchase, with an "I would not choose any of these products" option also available. Participants who selected at least one product in this task were requested to indicate the main reason for their choice for each food category across the following options that had their order randomised: "Brand preference," "Nutritional information," and "Taste." In the second part of the survey, participants were presented with the same set of food products and asked to nominate which of the three products had the highest amount of sugar. All choice tasks were completed for all food categories first, followed by the understanding tasks for all food categories. The order of presentation of the food categories was randomised between respondents. Finally, the food label condition to which the participant has been assigned was presented as a medium-sized image in the middle of the screen and participants were asked "Did you notice this information on the label on the previous questions?" with a yes/no answer option. if they noticed the label while completing the survey. They were then requested to indicate on a 7-point Likert scale (1—totally disagree/7—totally agree) whether they agreed or disagreed with these statements: "This label influenced my food choices in this survey" and "This label makes it easy to understand the amount of sugar in the food product".

Statistical Analysis

Chi-squared and one-way ANOVA tests were conducted to test for differences in sociodemographic (age, sex, the region of living, and education) and health variables (BMI, health awareness, and nutrition knowledge) between label conditions at a 0.05 alpha level. For the understanding outcome, the proportions of participants who correctly nominated the product with the highest sugar content were calculated by food category and summarised for all categories (a maximum of three possible correct answers). For the food choice outcome, the proportions of participants who selected a high-in-sugar product were calculated for each product category and across all three food categories. For the questions "This label influenced my food choices in this survey" and "This label makes it easy to understand the amount of sugar in the food product," data were presented as the proportion of agreement by summarising the "Strongly agree," "Agree," and "Somewhat agree" points from the 7-points Likert scale.

Chi-squared tests were used to evaluate the relationship between label conditions and the understanding and food choice outcomes, with significance set at a Bonferroni-corrected alpha level of 0.01 [$\alpha/n = 0.05/5$] as suggested in the literature (34). Data were treated as dichotomous variables for the understanding outcome (selecting the correct vs. the wrong answers) and the food choice outcome (selecting a high-in-sugar product vs. a non-high-in-sugar product). Participants who selected the option "I wouldn't choose any of these products" during the food choice task had results presented separately and were removed from the association analysis for the related food category as they have not chosen any product. Sensitivity analyses were performed following the exclusion of participants who did not recall seeing the label intervention during the survey. A binary logistic regression model was used to test for differences in odds ratios for the understanding outcome by label condition. All analyses were conducted using STATA/IC software version 13.0 (College Station, TX: StataCorp. 2009).

Ethics

Both phases of this research were approved by the Ethics Committee of the University where the study was conducted (No. 3063750) and performed in accordance with the ethical standards laid out in the Declaration of Helsinki. All participants were volunteers and provided informed consent before completing the study.

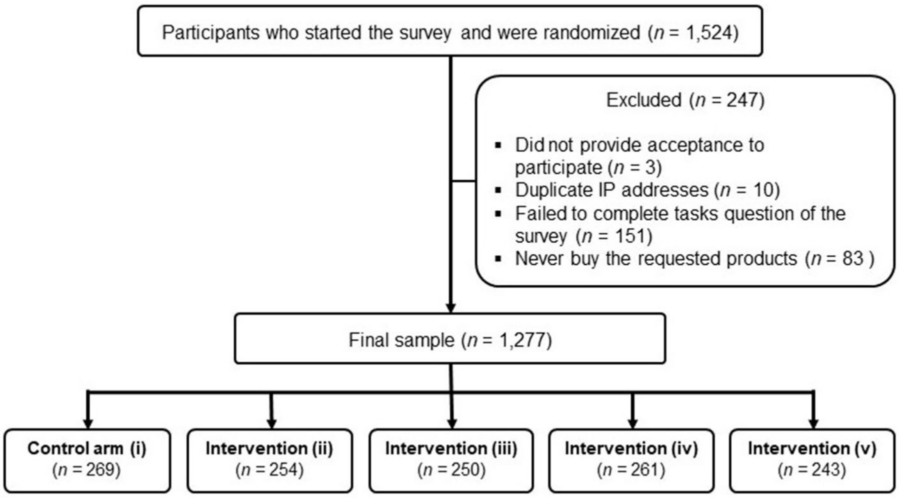


FIGURE 2 | Flowchart of the participants included in the study.

RESULTS

Participants' Characteristics

Sociodemographic, lifestyle and nutrition-related characteristics of the study population are presented in **Table 1**. The final sample included 1,277 Brazilian participants, of whom 78% were women, 72% were enrolled in or had an undergraduate degree, and the mean age was 33.0 (±11.7) years. Participants from all regions of the country were surveyed, with most living in the South and Southeast regions (79%). Most participants (84%) reported using food label information "always" or "often," and they presented a high median (5.7 for a 7-points Likert scale) of self-reported health awareness and nutrition knowledge. No significant differences in sociodemographic and health variables between label conditions were found.

Understanding (Primary Outcome)

The proportions of correct answers for each label condition and type of food are presented in **Table 2**. Compared to the control condition, the proportion of participants who correctly selected the product with the highest sugar content was significantly higher in all intervention groups, except in the case of the yoghourt category. Comparisons across the intervention formats showed no significant differences in the proportion of correct answers. In the sensitivity analyses, which included only participants who recalled seeing the label formats tested during the survey, results remained similar for whole-grain biscuit, yoghourt, and overall. For the cereal bar category, only interventions (iv) [proposed NIP plus magnifying glass warning] and (v) [proposed NIP plus high in sugar text] were significantly different from the control condition (**Supplementary Table S1**).

The odds ratio for the understanding outcome by label condition is presented in **Table 3**. Participants in all intervention conditions were more likely to identify products with the highest sugar compared to the control condition, although participants who saw the FoP conditions (iii and iv) had the highest odds ratios for that. The octagonal warning (iii) had the best performance for whole-grain biscuits, while the magnifying glass warning (iv) produced more correct answers for the cereal bar and yoghourt categories.

When asked whether the label format makes it easier to identify the sugar content of the product, participants in all intervention conditions had higher proportions of agreement than those in the control condition. A significant difference was also found when comparing the intervention conditions on this variable, with participants in the NIP only conditions [(ii) and (v)] found to have a higher proportion of agreement than participants in the NIP plus FoP conditions [(iii) and (iv)] (**Table 3**). However, this distinction between the intervention conditions was not found in the sensitivity analysis.

Food Choice (Secondary Outcome)

There were no significant differences in the proportions of participants who chose high-in-sugar products between the label conditions, overall or by food category. The FoP warning conditions had the lowest proportions of participants who chose products high-in-sugar for whole-grain biscuits and yoghourts, but the differences were not significant. Moreover, participants in the FoP octagonal warning condition (iii) had the lowest proportion of participants who chose high-in-sugar products through all three sets of food categories. In contrast, the control (i) and proposed NIP (ii) conditions had the highest proportion of agreement regarding the question of whether the label format influenced participants' choices (**Table 4**). Although results were not statistically significant, in general, FoP warning seems to be useful to influence consumers to choose products with lower sugar content. In sensitivity analyses, where only participants who recalled seeing the label formats tested during the survey were included, results remained similar (**Supplementary Table S1**). The proportion of participants who chose the "I would not choose any of these products" option

TABLE 1 | Participant characteristics, total and by label condition.

Characteristics	Total sample (*n* = 1,277)	i. Control group (*n* = 269)	ii. Proposed NIP (*n* = 254)	iii. Proposed NIP + FoP octagonal warning (*n* = 250)	iv. Proposed NIP + FoP magnifying glass warning (*n* = 261)	v. Proposed NIP + "high in sugar" text (*n* = 243)	*p*-value
Age mean years (SD)	33.0 (±12.7)	32.3 (±11.2)	32.8 (±11.8)	33.4 (±12.0)	33.9 (±12.5)	32.8 (±11.1)	0.560
Sex, *n* (%)							
Female	1,001 (78%)	211 (78%)	199 (78%)	194 (78%)	204 (78%)	193 (79%)	0.993
Male	276 (22%)	58 (22%)	55 (22%)	56 (22%)	57 (22%)	50 (21%)	
Education *n* (%)							
High school or less	353 (28%)	76 (28%)	75 (30%)	67 (27%)	71 (27%)	64 (26%)	0.676
Undergraduate	309 (24%)	70 (26%)	60 (24%)	54 (22%)	67 (26%)	58 (24%)	
MBA	219 (17%)	38 (14%)	43 (17%)	39 (16%)	53 (20%)	46 (19%)	
Master/PhD	396 (31%)	85 (32%)	76 (30 %)	90 (36%)	70 (27%)	75 (31%)	
BMI mean kg/square metre (SD)	24.2 (±4.3)	24.1 (±4.1)	24.3 (±4.3)	23.8 (±4.6)	24.6 (±4.5)	24.2 (±4.2)	0.252
Region of the country *n* (%)							
North/Northeast	171 (13%)	31 (12%)	33 (13%)	35 (14%)	36 (14%)	36 (15%)	0.925
Central-west	95 (7%)	16 (6%)	19 (8%)	21 (8%)	19 (7%)	20 (8%)	
South/Southeast	1,011 (79%)	222 (83%)	202 (80%)	194 (78%)	206 (79%)	187 (77%)	
Dietary restriction *n* (%)							
Yes	287 (23%)	60 (22%)	58 (23%)	57 (23%)	51 (20%)	61 (25%)	0.682
Frequency of nutrition label use[a] *n* (%)							
Always/often	1,057 (84%)	222 (85%)	199 (80%)	217 (87%)	223 (86%)	196 (81%)	0.107
Sometime/never	200 (15%)	38 (15%)	49 (20%)	32 (13%)	35 (14%)	46 (19%)	
Health awareness[b], mean (SD)	6.1 (±1.0)	6.0 (±1.0)	6.1 (±0.9)	6.1 (±1.0)	6.1 (±1.1)	6.0 (±1.0)	0.571
Nutrition knowledge[c], mean (SD)	5.7 (±1.4)	5.7 (±1.3)	5.6 (±1.5)	5.7 (±1.3)	5.6 (±1.3)	5.6 (±1.4)	0.543
Noticed the label in the survey, *n* (%)[a]	992 (79%)	227 (87%)[iii,iv]	218 (88%)[iii,iv]	166 (65%)[i,ii,v]	166 (64%)[i,ii,v]	215 (89%)[iii,iv]	<0.001

Number superscripts (e.g.,[i,ii,iii])indicate that a result is significantly different from the study condition with the corresponding number based on Bonferroni-corrected post hoc tests with an alpha set at 0.01. [a]Different sample size for this question (n = 1,257). [b]Measured by the question "I reflect a lot about my health" on a 7-point Likert scale, 1= strongly disagree, 7= strongly agree. [c]Measured by the question "I know a lot about Nutrition" on a 7-point Likert scale, 1= strongly disagree, 7= strongly agree. NIP, Nutrition Information Panel; FoP, Front-of-Package.

is shown in **Table 4**. While a low number of participants did not choose any product throughout all food categories (3.9%), higher proportions were found by food category with 32, 31, and 19% for the whole-grain biscuit, cereal bar, and yoghourt categories, respectively.

The most frequent reason for participants' food choices was "Nutrition information" across all three food categories (**Figure 3**). There were no differences between the reasons for participants' choices across the label conditions for the whole-grain biscuit and yoghourt categories. For the cereal bar category, participants more frequently selected "Nutritional information" in the proposed NIP plus magnifying glass condition (iv) than in the control (i), proposed NIP only (ii), and proposed NIP plus high in sugar text (v) conditions ($p < 0.05$).

DISCUSSION

Overall, our results showed a clear demand for sugar information to be made available on the labels of packaged foods to inform consumers during food shopping. Compared with the control condition, all the sugar label formats have increased study participants' understanding of the sugar content of the products. However, none of them significantly decreased consumers' choices for products high in sugar.

The findings for understanding from this study are in line with previous research from other countries that have shown that information about sugar on labels increases consumers' understanding of the sugar level of packaged foods (35–39). Participants who saw the FoP warning label conditions were more likely to correctly identify products with the highest content of sugar than participants in the NIP only conditions. These results are aligned with a key aim of FoP nutrition labels being to provide nutrition information in a more understandable way for consumers (16). In contrast to these experimental results, the participants perceived the NIP only conditions as more straightforward to identify the sugar content of the products than when FoP warning labels were also presented. This result may be partially due to the type of understanding task used in this survey, where participants had to identify the product with the highest sugar content. It requires consumers to check the sugar content in grammes in the NIP and then interpret it more than knowing if a product is high-in-sugar or not. A

TABLE 2 | Participants' understanding of the sugar content of the products and their perceived understanding of the labels [n (%)], by study arm (n = 1,277).

Outcomes	Total sample (n = 1,277)	i. Control group (n = 269)	ii. Proposed NIP (n = 254)	iii. Proposed NIP + FoP octagonal warning (n = 250)	iv. Proposed NIP + FoP magnifying glass warning (n = 261)	v. Proposed NIP + 'high in sugar' text (n = 243)	p-value
Understanding							
The proportion of correct answers about which product had the highest sugar content							
Whole-grain biscuits	1,125 (88)	208 (77)[ii,iii,iv,v]	234 (92)[i]	232 (93)[i]	234 (90)[i]	217 (89)[i]	<0.001
Cereal bars	1,204 (94)	234 (87)[ii,iii,iv,v]	241 (95)[i]	240 (96)[i]	253 (97)[i]	236 (97)[i]	<0.001
Yogurt	1,218 (95)	255 (95)	243 (96)	237 (95)	250 (96)	233 (96)	0.953
All products	1,060 (83)	178 (66)[ii,iii,iv,v]	220 (87)[i]	226 (90)[i]	226 (87)[i]	210 (86)[i]	<0.001
This label makes it easy to understand the amount of sugar in the food product [a,b]	843 (67)	133 (51)[ii,iii,iv,v]	199 (80)[i,iii,iv]	164 (66)[i,ii,v]	157 (61)[i,ii,v]	190 (79)[i,iii,iv]	<0.001

Number superscripts (e.g.,[i,ii,iii])indicate that a result is significantly different from the study condition with the corresponding number based on Bonferroni-corrected post hoc tests with an alpha set at 0.01. [a]Proportion of people who agree by the summarising points 5, 6, and 7 from a 7-points Likert scale where 1 = strongly disagree and 7 = strongly agree. [b]Different sample size for this question (n = 1,257).
NIP, Nutrition Information Panel; FoP, Front-of-Package.

TABLE 3 | Odds ratios (OR) and 95% confidence intervals (CI) for primary (understanding) outcome (n = 1,277).

Variables	OR (95%CI)		
	Whole-grain biscuit	Cereal bar	Yogurt
Label condition			
i. Control (ref)	–	–	–
ii. Proposed NIP	3.91 (2.24–6.83)*	2.85 (1.42–5.71)*	1.08 (0.46–2.53)
iii. Proposed NIP + FoP octagonal warning	4.02 (2.28–7.11)*	3.47 (1.61–7.31)*	0.88 (0.40–2.00)
iv. Proposed NIP + FoP magnifying glass warning	2.92 (1.76–4.86)*	5.74 (2.42–13.57)*	1.42 (0.58–3.48)
v. Proposed NIP + 'high in sugar' text	2.65 (1.59–4.40)*	5.26 (2.22–12.47)*	1.20 (0.50–2.87)

**p-value at <0.01.*
NIP, Nutrition Information Panel; FoP, Front-of-Package; CI, Confidence Interval.

previous study also found that nutrient warnings were perceived as not containing enough information for consumers' needs (40). In terms of consumers' understanding of the nutrition composition of foods, both sources of information (NIP and FoP) can therefore be useful in a complementary way. While the FoP warning labels allow consumers to correctly, quickly, and easily identify products containing excessive amounts of critical nutrients (41, 42), the NIP provides them with specific nutrient amounts to permit more detailed product comparisons.

Our results on consumer understanding identified differences according to food category. While participants' understanding was found to increase significantly for whole-grain biscuits and cereal bars, this was not the case for the yoghourt category. Participants in all study arms had high proportions of correct answers when asked to identify which yoghourt was the highest in sugar (above 94%). Some explanations could be attributed to this. First, yoghourt has been previously described in other populations as one of the products that consumers are more likely to read nutrition information for when shopping (43). Second, because all the carbohydrate content of yoghourts are sugars (naturally present as lactose or added from other sources), participants in the control group may have used the carbohydrate information available in the NIP as a guide to sugar content. This interpretation is reinforced by the fact that during our focus groups, participants incorrectly associated all the carbohydrate content of packaged food as equal to the sugar content. For the whole-grain biscuit and cereal bar categories, other sources of carbohydrates, such as flour or nuts, were present in the products' composition, and the carbohydrate content in the NIP by itself was not enough to help consumers identify the sugar content of these products.

Many studies have tested the influence of different label formats on consumers' food choices or purchases, and mixed results have been found according to the types of label and food category tested, the methodology used, and participants' nationality (37, 39, 44–50). A systematic review investigating sugar label formats and their influence on consumers' food choice has demonstrated that interpretive information (e.g., colours, "high in sugar" text, warnings, or health messages) is more effective than the standard NIP in encouraging consumers to choose foods with less sugar (31). The results of the present study showed that the sugar label formats tested did not

TABLE 4 | Participants' food choices for high-in-sugar products and perceived influence of the label in their choices [n (%)], by study arm ($n = 1,277$).

Outcomes	Total sample ($n = 1,277$)	i. Control group ($n = 269$)	ii. Proposed NIP ($n = 254$)	iii. Proposed NIP + FoP octagonal warning ($n = 250$)	iv. Proposed NIP + FoP magnifying glass warning ($n = 261$)	v. Proposed NIP + 'high in sugar' text ($n = 243$)	*p*-value
Food choice							
The proportion of participants who chose a high-in-sugar option							
Whole-grain biscuits	342 (27)	85 (32)	68 (27)	58 (23)	61 (23)	70 (29)	0.067
Cereal bars	484 (38)	97 (36)	96 (38)	92 (37)	97 (37)	102 (42)	0.568
Yogurts	273 (21)	66 (25)	55 (22)	43 (17)	60 (23)	49 (20)	0.156
All products	97 (8)	23 (9)	19 (8)	13 (5)	21 (8)	21 (9)	0.583
The proportion of participants who chose the 'I wouldn't choose any of these products' option							
Whole-grain biscuits	406 (32)	87 (32)	77 (30)	87 (35)	77 (30)	78 (32)	0.740
Cereal bars	394 (31)	92 (34)	80 (32)	71 (28)	78 (30)	73 (30)	0.670
Yogurts	248 (19)	55 (20)	54 (21)	40 (16)	50 (19)	49 (20)	0.610
All products	50 (4)	9 (3)	13 (5)	10 (4)	9 (3)	9 (4)	0.845
This label has influenced my food choices in this survey[a,b]	713 (57)	154 (59)[iv]	165 (67)[iii,iv]	124 (50)[ii]	123 (48)[i,ii,v]	147 (61)[iv]	<0.001

Number superscripts (e.g., [i,ii,iii]) indicate that a result is significantly different from the study condition with the corresponding number based on Bonferroni-corrected post hoc tests with an alpha set at 0.01. [a]*Proportion of people who agree by the summarising points 5, 6, and 7 from a 7-points Likert scale where 1 = strongly disagree and 7 = strongly agree.* [b]*Different sample size for this question (n = 1,257).*
NIP, Nutrition Information Panel; FoP, Front-of-Package.

significantly decrease consumers' choices for products high in sugar. Nevertheless, the proposed NIP plus an octagonal FoP label (iii) had the lowest proportion of participants choosing high-in-sugar products for whole-grain biscuits, yoghourts, and across all products. Studies conducted in neighbouring Latin American countries have demonstrated that FoP octagonal warning labels effectively reduce consumer choice of foods high in critical nutrients (47, 49, 51, 52).

The non-significant effects observed for food choice in the present study could be related to our sample's sociodemographic and behavioural profile. Most of the participants in our study were female and had a high educational level, and these factors have been previously described as influencing the use and understanding of nutritional information on labels (53, 54). In fact, 84% of the participants said they used nutritional information frequently during their routine shopping, which would explain the high proportion of participants who selected nutritional quality as the main reason for their choices during the survey. It is known that the use of nutritional information is associated with the level of understanding of this information by consumers (43, 54, 55), which can lead to healthier food choices (56, 57). In our results, a high proportion of participants (83%) correctly understood the sugar content of all products tested, which would help to explain the low proportion of participants who choose high-in-sugar products and the non-significant difference between the label conditions.

Study Limitations and Strengths

Strengths of our study include the inclusion of a qualitative phase to support the development of the subsequent survey, the voluntary participation of a large number of Brazilian consumers from various sociodemographic backgrounds, the investigation of two outcomes related to food label use (understanding and food choice), and the comparison across multiple types of sugar label formats using a randomised approach. In addition, a potential learning bias was minimised by testing the food choice task first and then objective understanding, as well as using randomisation of the presentation order across food categories. While product brand is understood to be a key aspect driving consumers' food choices (58), the impact of brand preference seemed to be minimal in our study. By asking participants why they had chosen specific food products, we were able to assess the impact of using real brands in this experiment. The results indicate that brand preference was the least frequent reason for their choices, with no differences found across the conditions. This may have been due to the fact that we had a high-educated and health-concerned sample of participants who give more importance to the nutritional aspects of food products rather than the products' brand.

Some limitations need to be acknowledged. The choice for young food label users for the focus groups was made to explore perceptions of an audience with lived experience on the topic of investigation (food label usage) who commonly have a high sugar intake. However, participant perspectives in the qualitative phase can be different from people with other socioeconomic characteristics, mainly because our sample was highly educated. In this sense, findings from the qualitative phase have limited generalisation. Similarly, although the online survey was shared with several groups of people, our sample has a sociodemographic profile different from the general adult

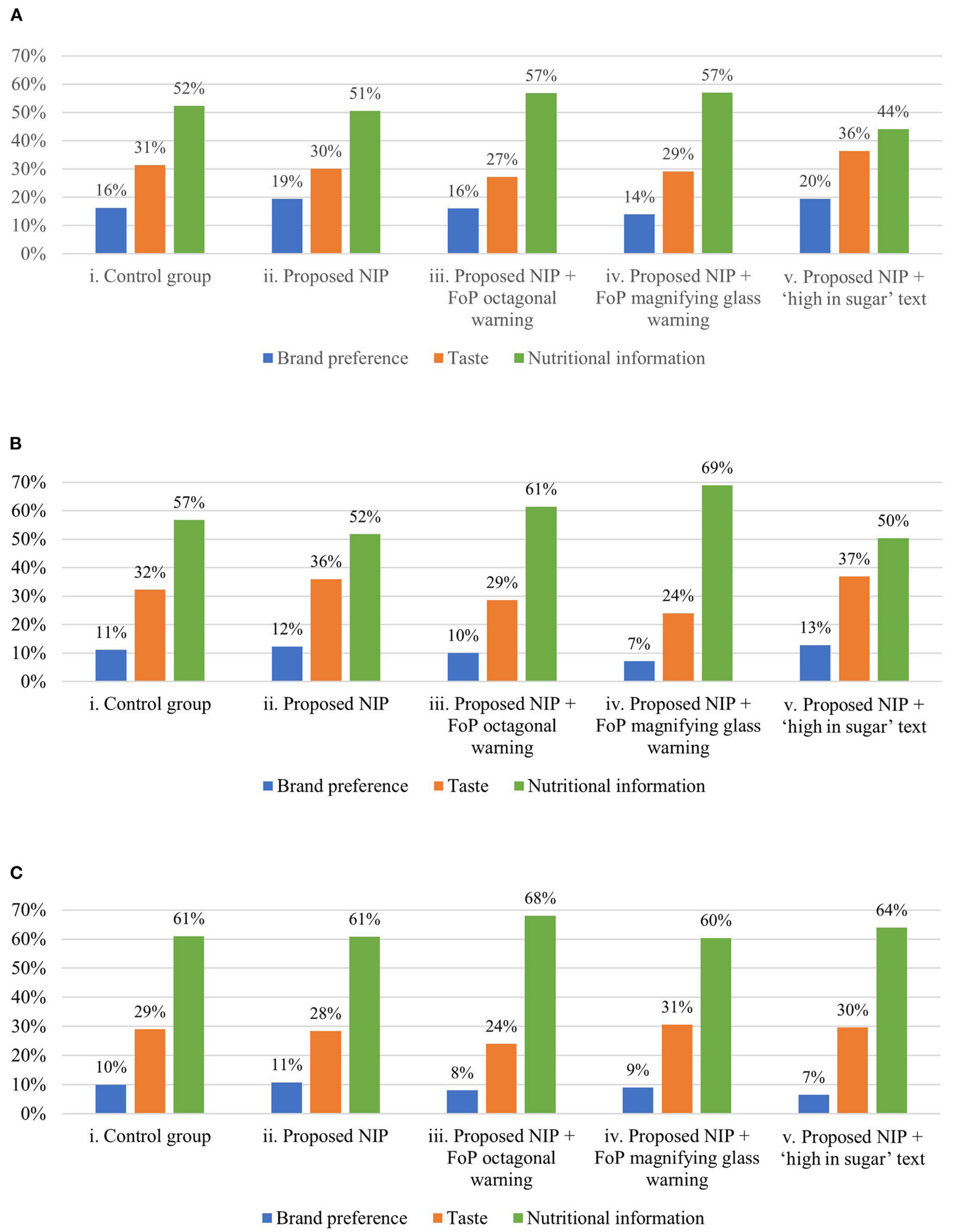


FIGURE 3 | Proportional distribution of each reason for participants' food choices, by food category. **(A)** Reason of product' choice: whole-grain biscuit. **(B)** Reason of product' choice: cereal bar. **(C)** Reason of product' choice: yoghurt. NIP, Nutrition Information Panel. FoP, Front-of-Package.

population in Brazil (59), requiring caution in the extrapolation of results. It is also important to note that certain elements of the study design are likely to have influenced the results. First, the study was conducted through an online platform, which was the only feasible way to get data collected due to the COVID-19 restrictions enforced in Brazil when the data was collected. Because we collected the data via an online platform that did not allow an interactive visualisation of the products, we only displayed the products' image of the front panel of the product. Because of this, the FoP formats were embedded in the images while the NIPs were displayed on the side. This arrangement gave FoP and back of pack (NIP + list of ingredients) information the same weight because participants saw them simultaneously, which is different from what they see for real-world packaged products. This may have driven participants to pay more attention to the NIP than the FoP, as we found in our results. However, a previous study has also reported a lower proportion of participants recalling seeing FoP black-and-white warning symbol during food choice tasks (45). We tried to minimise this effect by instructing participants to zoom in on the images of the products during the tasks, but we were unable to measure if they had done so. Nevertheless, caution should be taken when using our findings to inform public policies. Another point is that many participants selected the "I wouldn't choose any of these products" option during the food choice task, reducing the sample size for this outcome and reducing the statistical power to find significant differences between the groups.

It is also worth noting that only three food categories were tested, limiting the magnitude of the effects compared to studies measuring the overall shopping cart or in a real-world environment. However, in our case, the number of sets and products within the sets had to remain limited given that two outcomes were investigated in the same survey, and the questionnaire could not be too long for participants to complete. Finally, because the study was conducted before the approved changes in the food label rules in Brazil, we could not test the exact FoP format that will be implemented soon. However, our label condition (iv) [FoP magnifying glass warning] is similar to the approved format in Brazil, which allows for some inference of the effects found in our study to the approved format.

Practical Implications and Future Research

The results support the new changes in Brazil's label policy, requiring a mandatory declaration of the total and added sugar contents in grammes displayed in the nutrition information panel of all packaged foods available for sale in Brazil by October 2022. These changes will help consumers easily and quickly identify the sugar content of packaged foods during their shopping, allowing comparisons between products within the same food category. Moreover, although results were non-significant, participants who had seen the FoP conditions had the lowest proportion choosing high-in-sugar products, which suggests that the inclusion of a mandatory FoP is beneficial. Our evidence suggests that an octagonal front-of-pack warning similar to the one used in other Latin-American countries would have the best impact on incentivising Brazilian consumers to reduce their choices for products high in sugar. This is relevant considering recent evidence showing that most packaged foods and beverages sold in Brazil have added sugar ingredients in their composition (60), and that the Brazilian population is eating more added sugar than recommended by the WHO (11).

Furthermore, the enforcement of any FoP on labels should be complemented by government campaigns that educate consumers on how to use the labels and the differences between sugars naturally found in fruit, vegetables and dairy products and sugars added to the packaged food products, as well as the differences between sugars and carbohydrates. In addition, as found during the focus groups, participants seem to trust information endorsed by the Health Ministry more than any disclosure made by the food industry. Future researchers should use the newly approved FoP formats being implemented in Brazil to test consumers' perceptions, understanding, and food choices in larger samples. In addition, groups other than university students should be targeted for future qualitative research on food label perceptions to ensure representation of a wide range of views and experiences. We also suggest that real-world supermarkets studies be conducted to investigate the effects of sugar label formats during real decision-making processes.

CONCLUSIONS

Information about the sugar content of packaged foods displayed on either the NIP or FoP labels is a meaningful strategy to help Brazilian consumers compare products and correctly identify foods with higher sugar content among products within the same food category. While no significant difference across labels was observed for food choices, the sugar content displayed in the NIP plus an octagonal warning demonstrated the highest performance in stimulating consumers to avoid high-in-sugar products. Additional research is needed to understand how sugar label formats impact the understanding and food choices of Brazilian samples from different socioeconomic groups. Policymakers and researchers should be encouraged to investigate the efficacy of the approved food label changes in Brazil on consumer behaviour.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Human Research Ethics Committee (CEPSH) of the University of Santa Catarina (Process No. 3063750). The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

TS was responsible for conceptualisation, methodology, formal analysis, investigation, writing—original draft, and writing—review and editing. AF and RP were responsible for conceptualisation, methodology, writing—review and editing, and supervision. MS was responsible for formal analysis and writing—review and editing. SP was responsible for conceptualisation, methodology, resources, writing—review and editing, and supervision. NK, GB, and PU were responsible for conceptualisation and writing—review and editing. All authors contributed to the article and approved the submitted version.

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ABSTRACTS

SPANISH

Respuesta de los consumidores a los formatos de etiquetas para azúcares en alimentos envasados: un estudio multimétodos en Brasil

Proveer información sobre el contenido de azúcar de los alimentos envasados en las etiquetas de los productos es una estrategia importante para reducir la ingestión de azúcar de los consumidores. Este estudio evaluó el efecto de la exposición a diferentes etiquetas de azúcar en la comprensión de los consumidores sobre el contenido de azúcar en los alimentos y su elección alimentaria. En la primera fase, se condujeron cinco grupos focales con una muestra de conveniencia de adultos brasileños para explorar sus percepciones sobre el etiquetado de alimentos en general y el etiquetado de azúcares en particular. Basado en los resultados cualitativos, cuatro formatos de etiquetas de azúcar fueron desarrolladas y después probadas en un estudio de cinco brazos en 1.277 adultos por medio de una encuesta en línea controlada aleatoriamente. Los formatos fueron: (i) sin información de azúcares—control, (ii) contenido de azúcares añadidos y totales mostrados en la tabla de información nutricional (TIN), (iii) una advertencia octagonal frontal para productos "altos en azúcar", (iv) una advertencia frontal en formato de lupa para productos "altos en azúcar", y (v) un texto de advertencia "alto en azúcar" integrado en la TIN. Los participantes de los grupos focales reportaron estar confusos sobre el significado de "azúcar" y "azúcar añadido" en las etiquetas de alimentos e indicaron que las etiquetas más interpretativas, como las advertencias frontales, los ayudaría a elegir productos con bajo contenido de azúcar. En el experimento, todas las intervenciones de los formatos de etiquetas de azúcar mejoraron la comprensión de los participantes sobre el contenido de azúcar de los productos alimenticios probados, con las advertencias frontales (iii y iv) mostrando los mejores resultados. Mientras que diferencias no significativas entre las condiciones de las etiquetas fueron observadas para la elección de alimentos, la advertencia octagonal frontal provocó a los participantes a elegir productos altos en azúcar con menos frecuencia. Dadas las agendas de políticas públicas actuales que pretenden reducir el consumo de azúcares añadidos, existe la necesidad de fortalecer las políticas de etiquetado de alimentos y las políticas de divulgación sobre nutrición que se enfocan en la exhibición de azúcares añadidos y crean conciencia en el consumidor sobre el uso de estas herramientas para evitar productos con alto contenido de azúcar.

Palabras clave: etiquetado de alimentos, alimentos azucarados, declaraciones de salud, comportamiento del consumidor, ensayo.

PORTUGUESE

Resposta de consumidores a formatos de rótulos de açúcar em alimentos embalados: um estudo multimétodos no Brasil

Prover informações sobre o teor de açúcar nos rótulos de alimentos embalados é uma estratégia importante para reduzir a ingestão de açúcar pelos consumidores. Este estudo avaliou o efeito da exposição a diferentes formatos de rotulagem de açúcares na compreensão dos consumidores sobre o teor de açúcar de alimentos embalados e em suas escolhas alimentares. Na primeira fase, cinco grupos focais foram conduzidos com uma amostra de conveniência de adultos brasileiros para explorar suas percepções sobre rotulagem de alimentos em geral e rotulagem de açúcares em particular. Com base nos resultados qualitativos, quatro formatos de rotulagem de açúcar foram desenvolvidos e posteriormente testados em um ensaio randomizado controlado *online* de cinco braços com 1.277 adultos. Os formatos testados foram: (i) sem informações de açúcar—controle, (ii) apresentação do teor de açúcares totais e de adição na tabela de informação nutricional (TIN), (iii) um rótulo frontal de advertência no formato de octógono para produtos "altos em açúcar", (iv) rótulo frontal de advertência no formato de lupa para produtos "altos em açúcar", e (v) advertência textual "altos em açúcar" na TIN. Os participantes dos grupos focais relataram dificuldade em entender a diferença entre "açúcar" e "açúcar adicionado" nos rótulos dos alimentos e indicaram que rótulos mais interpretativos, como os rótulos frontais de advertência, os ajudariam a escolher produtos com menor quantidade de açúcar. No experimento, todos os formatos de rotulagem de açúcar testados melhoraram a compreensão dos participantes sobre o teor de açúcar dos alimentos embalados testados, com melhores resultados nos formatos com presença de advertências frontais (iii e iv). Enquanto diferenças não significativas entre os formatos de rótulos foram observadas para escolhas alimentares, o rótulo frontal de advertência no formato de octógono levou os participantes a escolherem alimentos com alto teor de açúcar com menos frequência. Considerando as atuais agendas de políticas públicas que visam reduzir a ingestão de açúcar, reforça-se a importância do fortalecimento das políticas de rotulagem de alimentos e políticas de divulgação sobre nutrição que apresentem informações sobre açúcar adicionado e construam conscientização para o uso dessas ferramentas para se evitar produtos altos em açúcar.

Palavras-chave: rotulagem nutricional, alimentos açucarados, alegações de saúde, rótulos de advertência, comportamento do consumidor, ensaio.

ORIGINAL RESEARCH
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How Do Nutritional Warnings Work on Commercial Products? Results From a Hypothetical Choice Experiment

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A large body of evidence assessing the effectiveness of front-of-package (FOP) nutrition labeling exists. Most experimental studies have been conducted with fictitious products. However, consumers' perception depends on several products extrinsic factors such as brand. Understanding how strong brand associations influence the effectiveness of FOP nutrition labeling schemes may be crucial to informing policymaking. In this context, the aim of this work was to evaluate the effect of five different variants of nutritional warnings labels (black magnifier, red magnifier, black octagon, black triangle, and red circle) on consumers' choice of commercial products, compared with two FOP nutrition labeling schemes: the guidelines daily amounts (GDAs) system and the traffic light system (TLS). An online randomized controlled trial with 1,932 participants was used to evaluate the effect of FOP nutrition labeling on participants' choices in eight sets of three commercial products, available in the Brazilian marketplace. A multinomial logistic regression model was used to evaluate the influence of FOP nutrition labeling on participants' likelihood of selecting the different products in the choice task. Results showed that nutritional warnings and the TLS significantly increased the likelihood of selecting none of the products instead of the least healthful product, or a healthier product, in at least one of the product categories compared with the GDA. Warnings tended to have a larger effect, suggesting their potential to encourage healthier food choices.

Keywords: nutritional warning, commercial products, brand, consumers' perception, food choice

INTRODUCTION

Different front-of-package (FOP) nutrition labeling schemes have been developed worldwide (1). However, each scheme presents a different graphic design and provides a different type of information (2–4). They are gaining popularity in the Latin American countries (5, 6). This policy tool aims at facilitating the identification of products with excessive content of sugar, saturated fat, and sodium, nutrients associated with non-communicable diseases (7). Among the whole range of FOP nutrition labeling schemes, warnings have been shown to be more efficient in increasing understanding and, consequently, reducing the perception of healthiness and the intention to purchase nutritionally inadequate foods, when compared to the traffic light system (TLS) or the Guideline Daily Amounts (8, 9). However, the majority of the studies have been conducted with fictitious products (10–12).

Consumers make numerous decisions in their daily life, and it seems unlikely that they allocate substantial cognitive effort and time to make each judgment (13–15). When consumers have to choose among familiar products, they are expected to rely on their mental references (e.g., brand awareness, price) (16). In this context, brands are expected to play a key role in consumers' decision-making process (17). Consumers tend to choose their usual brand in situations involving simple and repeated purchase decisions. Usually, it is only after purchase that consumers engage in a more detailed evaluation of products (18, 19). In contrast, when consumers face unknown products, they tend to perform a more in-depth analysis as they have greater uncertainty about them (20). For this reason, the ability of nutritional warnings to influence consumers' food choices is expected to be lower when facing familiar commercial products compared with unknown products.

Latin American countries such as Chile, Peru, Uruguay, and Mexico have adopted the black octagon as mandatory (5, 6, 21, 22). In Brazil, the Brazilian Health Regulatory Agency (ANVISA) approved, in 2020, a black rectangular format with a magnifying glass such as the Canadian proposal (23, 24). However, research on how the graphical design of nutritional warnings can influence people's ability to make more healthful food choices is still scarce. Although there is several research on the impact of black octagonal warning labels on consumers' choice of commercial products available in the market (25–27), studies involving the graphical design adopted in Brazil (a magnifier glass) are still scarce (9–11).

In this context, this study aimed to evaluate the effect of five different variants of nutritional warnings labels (black magnifier, red magnifier, black octagon, black triangle, and red circle) on consumer choice of commercial products, compared with the guidelines daily amounts (GDAs) and the traffic-light system (TLS).

MATERIALS AND METHODS

Participants

A total of 1,932 participants (18–65 years old) from the five geographical regions of Brazil were recruited by a marketing agency specialized in consumer studies. The characteristics of participants in terms of their socio-demographic characteristics are shown in **Table 1**. Participants were compensated for their participation and could choose between the following options: (i) entering a raffle for a voucher worth US$100, (ii) gaining US$ 0.7 credit for their cellphone, (iii) donating US$ 0.7 to an organization, or (iv) points in a fidelity program. Participants provided informed consent at the beginning of the questionnaire.

Front-of-Package Nutrition Labeling Schemes

In total, seven FOP nutrition labeling schemes were considered, including two widely studied schemes Guideline Daily Amounts (GDAs) system and the TLS, and five different warning labels, previously studied by Machín et al. (14). The warning labels differed in their color and shape and included red circles, black octagons, black triangles, and a red and a black magnifier.

The GDA system included quantitative nutritional information (calories, sugars, total fat, saturated fat, and sodium), expressed as content per portion and as a percentage of the recommended intake considering a 2,000 kcal diet (except for sugar). The TLS categorized the content of sugar, saturated fat, and sodium using text descriptors (low, medium, and high) and a color code (green, yellow, and red, respectively). As shown in **Figure 1**, separate warning signs were included for each key nutrient (sugar, saturated fat, and sodium) if their content was high using red circles, black octagons, or black triangles. The black and red magnifier consisted of a rectangular shape with a magnifier, accompanied by a text indicating the nutrients with a high content (sugar, saturated fat, and/or sodium).

The criteria of the Brazilian Health Regulatory Agency (28) were used to classify nutrient content as low/medium/high. The FOP nutrition labeling schemes were included on a series of food packages according to their nutritional characteristics. The GDA system and

TABLE 1 | Socio-demographic characteristics of participants in the online study (*n* = 1,932).

	Percentage of participants (%)
Gender	
Female	66
Male	34
Age (years)	
18–25	29
26–35	36
36–45	21
46–55	9
56–65	4
>65	1
Educational level	
Incomplete primary education	4
Primary education	3
Secondary education	54
University degree	32
Postgraduate	7
Socio-economic level*	
Low	5
Medium	81
High	13
Region of residence	
North	20
Northeast	19
Midwest	20
Southeast	22
South	20

**According to the Brazilian Institute of Geography and Statistics (IBGE).*

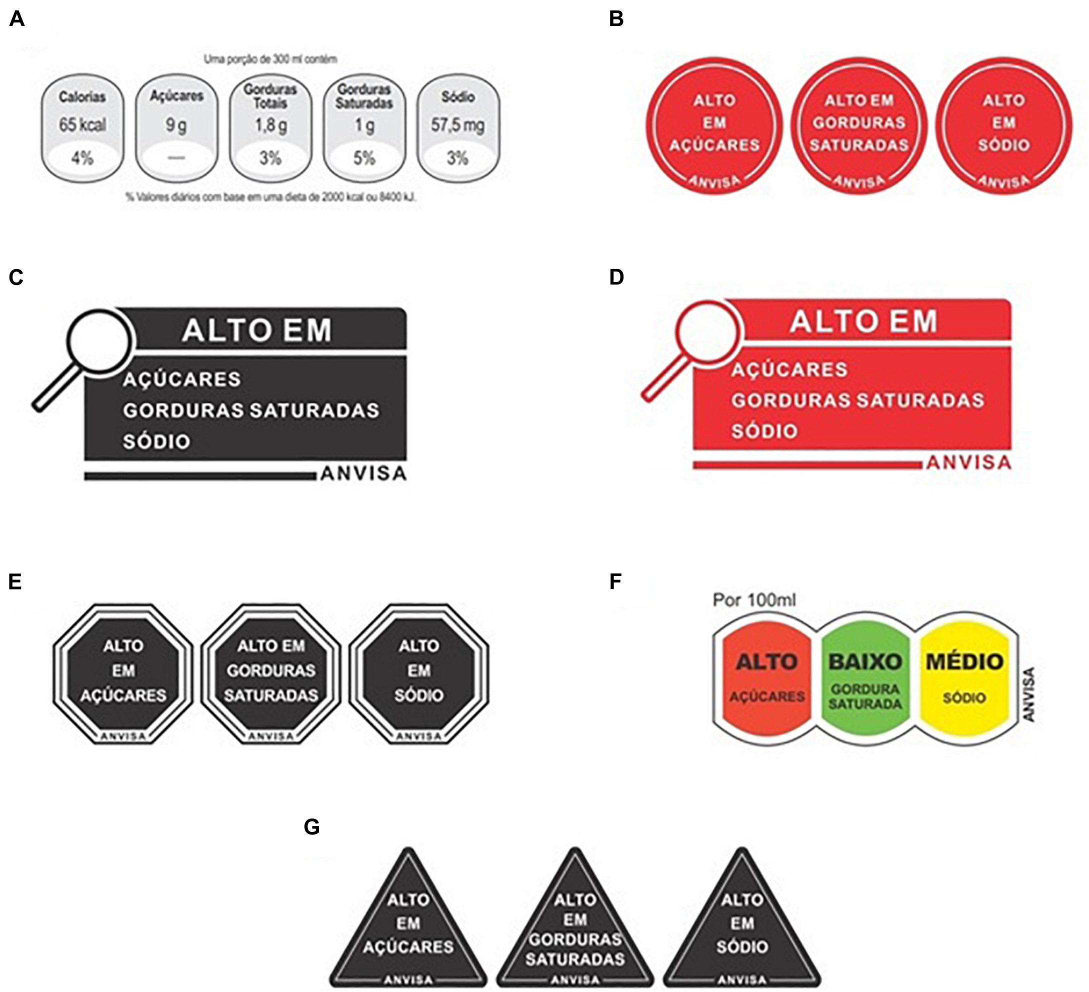

FIGURE 1 | Front-of-package nutrition labeling schemes considered in the study: **(A)** guidelines daily amounts (GDA) system, **(B)** red circle warning sign, **(C)** black magnifier warning sign, **(D)** red magnifier warning sign, **(E)** black octagon warning sign, **(F)** traffic-light system, **(G)** black triangle warning sign.

TLS were included in all the labels, whereas nutritional warnings were only included on the labels if the content of the target nutrients (sugar, saturated fat, and sodium) was classified as high.

Food Packages

In total, eight food categories were considered in this work: breakfast cereal, cereal bar, chocolate flavored milk, frozen lasagna, orange nectar, savory snack, sponge cake, and yogurt. These categories are frequently consumed in Brazil and usually contain high content of sugar, saturated fat, and/or sodium. For each category, three commercial products, available in the Brazilian marketplace were selected, corresponding to different brands and nutritional composition. Within each category, one of the products was selected to have lower content of at least one of the three key nutrients included in the FOP nutrition labeling schemes (sugar, saturated fat, and sodium). The nutritional composition of the selected products and their corresponding classification in low, medium, and high according to the criteria of the Brazilian Health Regulatory Agency (28) are shown in **Table 2**.

A total of 24 pictures of food packages were considered in this work, three pictures within each of the eight food categories. Each picture was modified digitally to include the seven different variants of the FOP nutrition labeling schemes (black magnifier, red magnifier, black octagon, black triangle, and red circle, as well as GDA and TLS). Thus, seven versions of eight series of the three food packages were created. The size of GDA system, black magnifier, red magnifier, and traffic light corresponded to 10% of the area of the front of the package, whereas the size of each separate warning label (red circle, black octagon, and black triangle) corresponded to 5% of the area (28). Schemes were inserted in different positions on the packages to keep all the relevant information from the original package visible. Examples of how packages were presented to participants are shown in **Figure 2**.

TABLE 2 | Nutritional composition of the products included in the study, and classification of nutrients associated with non-communicable diseases according to the criteria of the Brazilian Health Regulatory Agency (ANVISA) (32).

Category	Product*	Characteristics	Portion size (g or mL)	Calories (kcal/portion)	Sugars (g/portion)	Saturated fat (g/portion)	Sodium (mg/portion)	Classification of nutrient content**: Added sugar	Saturated fat	Sodium
Breakfast cereal	1*	Familiar brand and claims (whole cereal, less sugar, nutritious and tasty)	30	112	9.0	0.0	125	**High**	Low	**High**
	2	Familiar brand and no claims	30	115	2.4	0.0	125	Medium	Low	**High**
	3	Leading brand and claims (true corn, no colorants, with vitamins B + D)	30	116	12.0	0.0	75	**High**	Low	Medium
Cereal bar	1*	Nutrition claims (Gluten free, lactose free)	30	152	7.0	2.4	44	**High**	**High**	Medium
	2	Nutrition claims (Zero added sugar, source of fibers, zero sodium)	25	129	0.7	1.9	0	Low	**High**	Low
	3	Leading brand and nutrition claims (source of fibers, whole grains)	20	78	4.5	1.0	25	**High**	**High**	Medium
Chocolate flavored milk	1*	Nutrition claims (Source of vitamins A, B, E, D, B6, B1 e B12)	200	175	20.0	1.9	188	**High**	Medium	Medium
	2	Leading brand. Light version	180	97	12.0	1.1	115	**High**	Low	Medium
	3	Leading brand	200	130	18.0	2.0	115	**High**	Medium	Medium
Frozen lasagne	1*	Unfamiliar brand	300	497	0.0	8.3	1,878	Low	Medium	**High**
	2	Familiar brand	300	316	0.0	5.7	1,314	Low	Medium	**High**
	3	Leading brand	300	438	0.0	7.5	767	Low	Medium	Medium
Orange nectar	1	Unfamiliar brand, and claim (with apple juice)	200	52	13.0	0.0	0	**High**	Low	Low
	2	Light version and nutrition claims (0% added sugar, source of vitamin C, no preservatives, fruits, source of vitamins)	200	34	8.5	0.0	0	Medium	Low	Low
	3*	Leading brand and nutrition claims (added apple juice, to reduce added sugar, no added fibers)	200	83	20.0	0.0	0	**High**	Low	Low
Savory snack	1	Unfamiliar brand and nutrition claims (0% trans fats, 0% cholesterol, + protein, source of fibers, vitamins A and C, potassium, + iron, free artificial coloring)	25	112	0.0	1.1	200	Low	**High**	**High**
	2*	Leading brand and nutrition claim (produced with corn, with sunflower oil)	25	119	0.0	3.3	172	Low	**High**	**High**
	3	Unfamiliar brand. Organic version (whole, source of vitamin B1)	25	113	0.0	0.7	173	Low	Medium	**High**
Sponge cake	1*	Familiar brand	60	215	25.0	3.4	186	**High**	**High**	Medium
	2	Zero added sugar	60	191	0.2	2.3	115	Low	Medium	Medium
	3	Leading brand	60	220	20.0	3.7	199	**High**	**High**	Medium
Yogurt	1*	Claims (creamy, tasty)	170	156	20.0	2.4	230	**High**	Medium	Medium
	2	Zero fat e Nutrition claims (total calcium, rich in vitamin D, rich in calcium, no added sugar)	170	46	3.4	0.0	102	Low	Low	Medium
	3	Leading brand	170	144	18.0	3.3	72	**High**	Medium	Medium

**Least healthful option, **Nutritional warnings were only included on the labels if nutrient content was high.*
The word High in bold shows the cases.

Experimental Procedure

The participants received a link of the study by email. They were randomly allocated to one of the seven experimental conditions: (i) GDA ($n = 305$), (ii) red circle ($n = 263$), (iii) black magnifier ($n = 290$), (iv) red magnifier ($n = 263$), (v) black octagon ($n = 284$), (vi) traffic system ($n = 271$), and (vii) black triangle ($n = 256$). Each participant evaluated the eight product categories in only one of the experimental conditions, i.e., only one of the FOP nutrition labeling schemes. No significant differences were found among the seven groups in terms of their distribution according to gender ($\chi^2 = 12.03$, $p = 0.0613$), age ($\chi^2 = 20.38$, $p = 0.9063$), educational level ($\chi^2 = 16.00$, $p = 0.881$), socio-economic level ($\chi^2 = 7.53$, $p = 0.8204$), place of residence ($\chi^2 = 12.26$, $p = 0.9769$), and consumption frequency of the breakfast cereal ($\chi^2 = 36.65$, $p = 0.1876$), cereal bar ($\chi^2 = 28.38$, $p = 0.5505$), chocolate-flavored milk ($\chi^2 = 21.52$, $p = 0.8711$), frozen lasagna ($\chi^2 = 40.24$, $p = 0.1002$), orange nectar ($\chi^2 = 27.04$, $p = 0.6211$), sponge cake ($\chi^2 = 34.46$, $p = 0.2627$), and yogurt ($\chi^2 = 32.47$, $p = 0.3460$). The exceptions were consumption frequency of savory snack ($\chi^2 = 58.60$, $p = 0.0014$). The black triangle group was composed of a higher proportion of participants who reported never consuming savory snacks, whereas the percentage of consumers who reported consuming savory snack "once or three times a month," "four or six times for a week" and "once or more times for day" was higher for the GDA, black magnifier and black octagon, respectively.

Participants were asked to imagine that they were at the supermarket. They were presented with the eight sets of three packages and were asked to indicate the one they would buy. Participants had the option to choose none of the products. The presentation order of the categories was balanced across participants, as was the presentation order of the packages within each category.

Data Analysis

The frequency of selection of each product option for the eight categories was calculated for each experimental condition. For each product category, multinomial logistic regression models were used to evaluate the influence of FOP nutrition labeling (predictor variable) on participants' likelihood of making different decisions in the choice task. The categorical variable indicating the selected product was considered as the dependent variable, whereas the experimental condition (i.e., FOP nutrition labeling scheme) was considered as independent variable in the model. The GDA and one of the least healthful products (i.e., with the highest content of sugar, saturated fat, or sodium) were selected as references in the model. Results were presented as odds ratios with 95% CIs. All the data analyses were carried out using R software (29). A significance level of 5% was always considered.

RESULTS

The percentage of participants who selected each response option in the choice task for each of the product categories is shown in **Table 3**. Results from the multinomial logistic regression showed that FOP nutrition labeling schemes had a significant effect on the likelihood of selecting the products included in the choice set for all the categories, except for the savory snack (**Table 4**). Compared with the GDA, nutritional warnings and the TLS significantly increased the likelihood of selecting none of the products instead of the least healthful product or a healthier product, in at least one of the product categories. On the contrary, the percentage of participants who selected the least healthful product was higher for the GDA system.

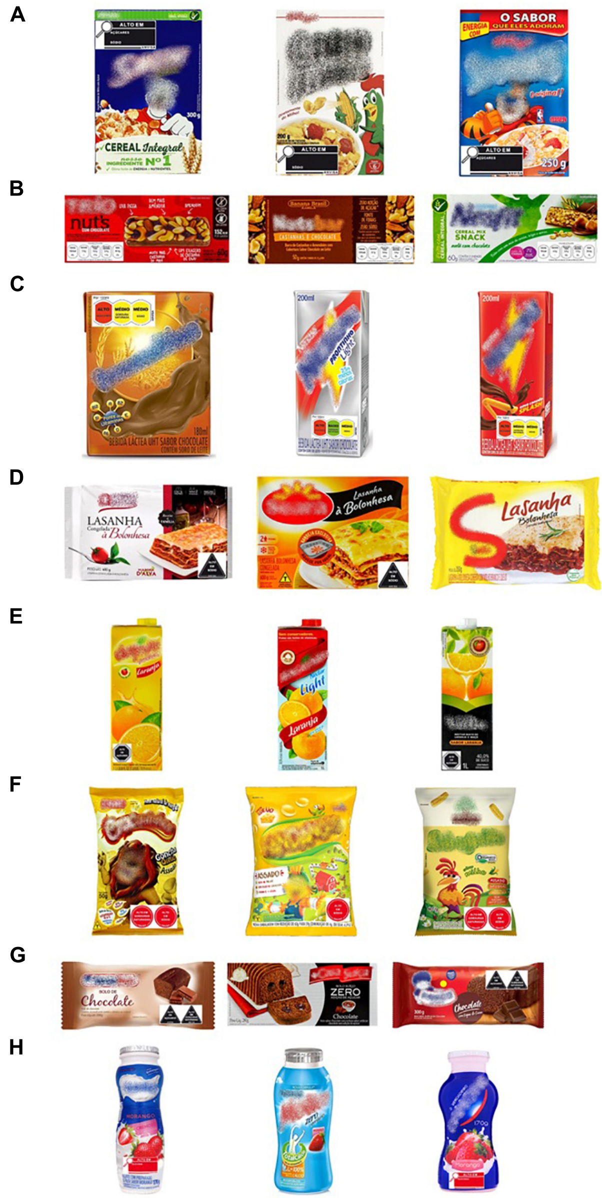

FIGURE 2 | Example of some of the packages used in the study: **(A)** breakfast cereal, **(B)** cereal bar, **(C)** chocolate flavored milk, **(D)** frozen lasagne, **(E)** orange nectar, **(F)** savory snack, **(G)** sponge cake, **(H)** yogurt.

For most categories, only a subset of the FOP nutrition labeling schemes had a significant effect on the likelihood of

TABLE 3 | Percentage of participants who selected each of the product in the choice task.

Category	Product	GDA	Traffic light	Black magnifier	Red magnifier	Black octagon	Black triangle	Red circle
Breakfast cereal	None	15%^{aB}	21%^{aB}	22%^{aB}	19%^{aB}	20%^{aB}	22%^{aB}	18%^{aB}
	Product 1	14%^{aBC}	15%^{aB}	15%^{aB}	16%^{aB}	1%^{aC}	11%^{aC}	13%^{aBC}
	Product 2	7%^{aC}	8%^{aC}	6%^{aC}	4%^{aC}	7%^{aC}	5%^{aC}	6%^{aC}
	Product 3	64%^{aA}	56%^{aA}	57%^{aA}	61%^{aA}	62%^{aA}	61%^{aA}	63%^{aA}
Cereal bar	None	18%$^{a\ B}$	22%$^{a\ B}$	23%$^{a\ B}$	23%$^{a\ B}$	23%$^{a\ B}$	20%$^{a\ B}$	27%$^{a\ B}$
	Product 1	14%^{aB}	12%^{aC}	10%^{aC}	10%^{aC}	13%^{aC}	11%^{aC}	11%^{aC}
	Product 2	14%$^{a\ B}$	18%^{aBC}	17%^{aBC}	14%^{aBC}	15%^{aBC}	18%^{aBC}	15%^{aC}
	Product 3	54%^{aA}	48%^{aA}	50%^{aA}	52%^{aA}	49%^{aA}	51%^{aA}	47%^{aA}
Chocolate flavored milk	None	7%^{bC}	15%$^{a\ B}$	16%^{aBC}	13%$^{a\ B}$	14%^{aB}	13%$^{a\ B}$	15%^{aB}
	Product 1	23%$^{a\ B}$	15%$^{a\ B}$	22%$^{a\ B}$	19%$^{a\ B}$	18%$^{a\ B}$	16%$^{a\ B}$	16%$^{a\ B}$
	Product 2	11%$^{a\ C}$	13%$^{a\ B}$	8%$^{a\ C}$	14%$^{a\ B}$	13%$^{a\ B}$	11%$^{a\ B}$	11%$^{a\ B}$
	Product 3	59%$^{a\ A}$	56%$^{a\ A}$	54%$^{a\ A}$	54%$^{a\ A}$	54%$^{a\ A}$	61%$^{a\ A}$	57%$^{a\ A}$
Frozen Lasagne	None	17%$^{a\ B}$	16%$^{a\ B}$	13%^{aC}	17%$^{a\ B}$	11%$^{a\ B}$	15%^{aC}	11%^{aC}
	Product 1	10%$^{a\ B}$	14%$^{a\ B}$	13%^{aC}	12%$^{a\ B}$	13%$^{a\ B}$	10%^{aC}	11%^{aC}
	Product 2	38%$^{a\ A}$	32%$^{a\ A}$	27%$^{a\ B}$	33%$^{a\ A}$	34%$^{a\ A}$	32%$^{a\ B}$	33%$^{a\ B}$
	Product 3	35%$^{b\ A}$	39%$^{a\ A}$	48%$^{a\ A}$	38%$^{a\ A}$	42%$^{a\ A}$	43%$^{a\ A}$	46%$^{a\ A}$
Orange nectar	None	14%$^{a\ B}$	21%$^{a\ B}$	15%$^{a\ B}$	16%$^{a\ B}$	17%$^{a\ B}$	18%$^{a\ B}$	19%^{a}
	Product 1	21%$^{a\ B}$	15%$^{a\ B}$	16%$^{a\ B}$	17%$^{a\ B}$	15%$^{a\ B}$	17%$^{a\ B}$	16%$^{a\ B}$
	Product 2	13%$^{a\ B}$	13%$^{a\ B}$	21%$^{a\ B}$	19%$^{a\ B}$	21%$^{a\ B}$	21%$^{a\ B}$	17%$^{a\ B}$
	Product 3	51%^{aA}	51%^{aA}	48%^{aA}	48%^{aA}	46%^{aA}	45%^{aA}	48%^{aA}
Savory snack	None	14%$^{a\ B}$	21%$^{a\ B}$	21%$^{a\ B}$	22%$^{a\ B}$	19%$^{a\ B}$	22%$^{a\ B}$	16%$^{a\ B}$
	Product 1	9%$^{a\ B}$	7%^{aC}	6%^{aC}	6%^{aC}	7%^{aC}	10%^{aC}	9%^{aBC}
	Product 2	8%$^{a\ B}$	10%^{aC}	7%^{aC}	6%^{aC}	10%^{aC}	8%^{aC}	7%^{aC}
	Product 3	69%$^{a\ A}$	62%$^{a\ A}$	66%$^{a\ A}$	65%$^{a\ A}$	65%$^{a\ A}$	60%$^{a\ A}$	68%$^{a\ A}$
Sponge cake	None	21%$^{a\ A}$	26%$^{a\ AB}$	19%$^{a\ B}$	24%$^{a\ AB}$	20%$^{a\ B}$	2%$^{a\ B}$	21%$^{a\ B}$
	Product 1	26%$^{a\ A}$	17%$^{a\ B}$	23%$^{a\ AB}$	20%$^{a\ B}$	25%$^{a\ AB}$	23%$^{a\ B}$	19%$^{a\ B}$
	Product 2	27%$^{a\ A}$	32%$^{a\ A}$	30%$^{a\ A}$	32%$^{a\ A}$	32%$^{a\ A}$	36%$^{a\ A}$	35%$^{a\ A}$
	Product 3	27%$^{a\ A}$	25%$^{a\ AB}$	28%$^{a\ AB}$	24%$^{a\ AB}$	23%$^{a\ B}$	20%$^{a\ B}$	26%$^{a\ AB}$
Yogurt	None	9%^{aC}	9%^{aC}	6%^{aC}	7%^{aC}	6%^{aC}	7%^{aC}	6%^{aC}
	Product 1	13%^{aBC}	15%^{aBC}	19%^{aB}	14%^{aC}	14%^{aC}	17%^{aB}	12%^{aC}
	Product 2	20%$^{a\ B}$	23%$^{a\ B}$	23%$^{a\ B}$	25%$^{a\ B}$	29%$^{a\ B}$	24%$^{a\ B}$	24%$^{a\ B}$
	Product 3	58%$^{a\ A}$	53%$^{a\ A}$	52%$^{a\ A}$	54%$^{a\ A}$	51%$^{a\ A}$	52%$^{a\ A}$	58%$^{a\ A}$

Average values with some lowercase letters within the same row are not significantly different according to Tukey's test ($p < 0.05$). Average values with different uppercase letters within the same column and for the same product category are significantly different according to Tukey's test ($p < 0.05$).

selecting the different product alternatives included in the choice sets compared with the GDA system. However, for the chocolate-flavored milk all the nutritional warnings and the TLS had a significant effect on the likelihood of selecting none of the products. As shown in **Table 4**, the likelihood of selecting none of the products instead of the least healthful product was significantly higher for participants who evaluated the products with any of the five warnings or the TFL compared with those who evaluated them with the GDA system.

DISCUSSION

This work compared the effect of warning labels on the participants' choice of commercial products across eight categories, compared with the two of the most widely studied FOP nutrition labeling schemes, the GDA and the TLS. Results showed that, compared to the GDA, warnings labels and the TLS tended to encourage the choice of the healthier products. This confirms the effectiveness of interpretive FOP nutrition labeling schemes for encouraging healthier food choices (3, 8, 9, 11, 30, 31).

For all categories, except savory snack, at least one of the FOP nutrition labeling schemes encouraged the selection of "none of products" or the most healthful alternative within the category. This suggests that the inclusion of nutritional warnings and the TLS encouraged both category abandonment (increased the likelihood of selecting none of the products instead of the least healthful product) and product substitution on the participants' choices (increased the likelihood of selecting a product different from the least healthful alternative), extending results from Deliza et al. (11) to commercial products. The efficacy of FOP nutrition labeling schemes in modifying consumers' choices of commercial products has been reported previously by several studies (25–27, 32). Only for the savory snack, the inclusion of warning labels and the TLS did not have a significant effect on the participants' choice. The lack of effect can be explained considering the pre-conceived

TABLE 4 | Results of the multinomial logistic regression model exploring the effect of front-of-pack nutrition labeling schemes on participants' likelihood of selecting different products for each of the categories compared to the GDA and the least healthful products, expressed as odd ratios with their corresponding 95% confidence interval (between brackets).

Category	Product	Traffic light	Black magnifier	Red magnifier	Black octagon	Black triangle	Red circle
Breakfast cereal	None	**1.56 (1.00–2.4)**	**1.58 (1.03–2.44)**	1.26 (0.80–1.98)	1.31 (0.85–2.03)	1.48 (0.95–2.30)	1.21 (0.77–1.90)
	Product 2	1.22 (0.75–1.99)	1.24 (0.77–1.98)	1.24 (0.77–1.99)	0.81 (0.49–1.35)	0.86 (0.51–1.44)	0.93 (0.56–1.53)
	Product 3	1.34 (0.71–2.53)	1.01 (0.52–1.96)	0.58 (0.26–1.26)	1.05 (0.55–2.00)	0.83 (0.41–1.68)	0.96 (0.49–1.87)
Cereal bar	None	1.36 (0.88–2.10)	1.37 (0.90–2.08)	1.30 (0.84–1.99)	1.36 (0.89–2.09)	1.19 (0.77–1.86)	**1.71 (1.12–2.60)**
	Product 2	0.95 (0.57–1.58)	0.74 (0.44–1.24)	0.73 (0.43–1.24)	0.99 (0.60–1.61)	0.77 (0.46–1.32)	0.87 (0.52–1.47)
	Product 3	1.51 (0.95–2.42)	1.28 (0.80–2.06)	1.08 (0.66–1.76)	1.20 (0.74–1.94)	1.41 (0.88–2.27)	1.23 (0.75–2.01)
Chocolate flavored milk	None	**3.11 (1.63–5.91)**	**2.27 (1.2–4.20)**	**2.96 (1.17–4.25)**	**2.56 (1.36–4.81)**	**2.63 (1.35–5.10)**	**2.96 (1.55–5.64)**
	Product 2	1.42 (0.92–2.21)	0.98 (0.66–1.47)	1.37 (0.73–1.70)	1.18 (0.78–1.80)	1.53 (0.98–2.38)	1.37 (0.89–2.13)
	Product 3	1.72 (0.93–3.15)	0.78 (0.42–1.46)	1.39 (0.82–2.68)	1.53 (0.85–2.76)	1.39 (0.73–2.63)	1.39 (0.74–2.59)
Frozen Lasagne	None	1.15 (0.70–1.88)	1.13 (0.68–1.88)	1.20 (0.74–1.96)	0.76 (0.45–1.27)	1.06 (0.64–1.76)	0.77 (0.45–1.32)
	Product 2	1.68 (0.96–2.93)	**1.87 (1.07–3.29)**	1.45 (0.82–2.57)	1.45 (0.83–2.52)	1.19 (0.65–2.17)	1.27 (0.71–2.28)
	Product 3	1.34 (0.91–1.97)	**1.96 (1.34–2.87)**	1.27 (0.86–1.88)	1.34 (0.92–1.95)	**1.48 (1.00–2.18)**	**1.53 (1.04–2.23)**
Orange nectar	None	1.43 (0.91–2.25)	1.09 (0.68–1.76)	1.15 0.71–1.88)	1.32 (0.82–2.10)	1.39 (0.86–2.24)	1.41 (0.88–2.25)
	Product 1	0.69 (0.44–1.09)	0.79 (0.51–1.23)	0.88 (0.57–1.37)	0.76 (0.49–1.20)	0.90 (0.57–1.41)	0.82 (0.52–1.29)
	Product 2	1.01 (0.61–1.67)	**1.70 (1.07–2.69)**	1.55 (0.96–2.50)	**1.80 (1.14–2.86)**	**1.80 (1.12–2.89)**	1.36 (0.84–2.22)
Savory snack	None	1.26 (0.64–2.47)	1.73 (0.86–3.48)	2.07 (0.99–4.30)	1.17 (0.59–2.30)	1.59 (0.78–3.21)	1.39 (0.66–2.92)
	Product 1	0.65 (0.29–1.45)	0.75 (0.32–1.74)	0.82 (0.34–1.97)	0.69 (0.31–1.52)	1.10 (0.50–2.44)	1.18 (0.52–2.69)
	Product 3	0.74 (0.41–1.32)	1.08 (0.58–1.99)	1.20 (0.63–2.29)	0.81 (0.45–1.44)	0.87 (0.47–1.61)	1.18 (0.63–2.24)
Sponge cake	None	1.34 (0.84–2.14)	0.87 (0.54–1.40)	1.25 (0.77–2.01)	1.09 (0.67–1.77)	1.29 (0.78–2.13)	1.02 (0.63–1.66)
	Product 2	0.73 (0.45–1.18)	0.87 (0.35–1.36)	0.87 (0.54–1.41)	1.13 (0.72–1.79)	1.20 (0.74–1.95)	0.75 (0.54–1.41)
	Product 3	1.27 (0.81–1.97)	1.09 (0.71–1.67)	1.33 (0.85–2.09)	1.40 (0.90–2.17)	**1.73 (1.09–2.73)**	1.32 (0.85–2.05)
Yogurt	None	1.14 (0.63–2.08)	0.77 (0.40–1.47)	0.86 (0.45–1.63)	0.85 (0.45–1.61)	0.92 (0.48–1.75)	0.72 (0.37–1.39)
	Product 2	1.27 (0.78–2.06)	1.54 (0.97–2.45)	1.09 (0.66–1.79)	1.23 (0.76–2.00)	1.40 (0.86–2.26)	0.82 (0.53–1.47)
	Product 3	1.26 (0.83–1.91)	1.31 (0.87–1.97)	1.34 (0.89–2.02)	**1.63 (1.09–2.43)**	1.35 (0.89–2.06)	1.22 (0.81–1.85)

Odd ratios highlighted with bold characters are significantly different from 1 for a confidence level of 95%.

unhealthfulness of this food category. Participants may have ignored health-related information when making their choice of savory snacks because of their perceived unhealthfulness (33). Previous studies have shown that interpretative FOP nutrition labeling does not greatly modify the healthfulness perception and choice of unhealthful products (8, 25). In fact, 60–69% of the participants selected Product 3, which corresponded to the leading brand in the Brazilian market of the savory snack. Reliance on brand information can be related to the association of leading brand with quality (34–36).

Similar results were observed for breakfast cereals with the black magnifier and TLS, and cereal bar with the red circle. It is worth mention that the inclusion of nutrition claims such as "whole grains," "source of fiber" in the three cereal bar options could have created a healthy halo that increased healthfulness perception and purchase intention and, consequently, reduced the influence of warnings. However, results from this work do not enable to evaluate how the inclusion of nutrition claims moderated the effect of warning labels on consumers' choice given that commercial products differing in a wide range of characteristics (e.g., brand, package design, nutrition claims) were used. Several studies have shown that nutrition claims, such as "high in fiber," create healthy halo effects and encourage the consumers' to increase their purchase intention (37–43). However, in the context of the implementation of warning labels previous studies have shown that, although nutrition claims increased perceived healthfulness and purchase intention, their effect is expected to be lower than that of the warning labels (26, 44, 45).

On the contrary, results demonstrated that all warnings and TLS encouraged consumers of not selecting any product within the chocolate flavored milk category. One explanation for such achievement might be related to the fact that the front-of-pack nutrition labeling schemes had a greater influence on the healthfulness perception of products with a positive and healthful image (8, 46, 47).

The presence of warnings promoted product substitution within-category for frozen lasagna, orange nectar, sponge cake, and yogurt. For sponge cake and yogurt, the leading brands were chosen. The healthiest versions of the products in these categories contained the information "no added sugar," which may have negatively influenced expectations about the sensory and hedonic characteristics of the healthy products. Ares et al. (25) argued that consumers desire healthful product to be like their usual product in the expected sensory characteristics. The inclusion of information about changes in formulation, such as "no added sugar," may lead to the reduced hedonic expectations, discouraging consumers from choosing the most healthful products within the category. In this sense, Reis et al. (48) reported that information about sugar reduction affected consumers' sensory and hedonic perception.

For frozen lasagna and orange nectar, warnings seem to have induced consumers to choose the healthiest products. In particular, for frozen lasagna, the healthiest option corresponded to the leading brand. Ares et al. (49) suggested that it may be easier for consumers to change their usual choice when the healthful alternative is offered by the leading brand, as compared to when it is offered by an unknown one. When consumers have to choose among relatively similar products, they are expected to simplify their evaluation of alternatives by considering references about these products that are stored in their minds (e.g., brand awareness, price) (50).

Regarding the comparison of the different warning labels, results showed a slight advantage in favor of the black octagon, black triangle, and red circle compared with the red magnifier, in agreement with results from Deliza et al. (11). This difference in the effectiveness of warnings can be explained by the warning signs that are familiar to the consumers (11, 33, 51).

It is important to highlight some limitations of the study. First, a hypothetical choice task was considered and, therefore, it does not necessarily reflect what consumers would do when facing the choice of real products in a real environment. Second, price information was not provided to the participants, which could have acted as a mediator of the effect of the different FOP nutrition labeling schemes. The experimental design did not allow us to assess the effect of the commercial brands or other characteristics of the products on the consumers' choices. Another limitation of the study is that the position of the FOP nutrition labeling schemes varied across products. Thus, changes in the position of the schemes across products could have influenced their effect on the participants' choices. Finally, it is worth mentioning that the regulation approved by the Brazilian Health Regulatory Agency introduced the black magnifier as FOP nutrition labeling scheme to be used in Brazil, which will enter into force in October 2022 (24). Further research should focus on a more in-depth understanding of the effect of this scheme on food purchase decisions, and identify individual- and product-related effects that may act as moderators.

CONCLUSION

Warnings tended to encourage category abandonment and within-category product substitution, which suggests that they could contribute to the healthier food choices. Besides, the presence of nutrition claims may have influenced the perceived healthfulness of the products. Therefore, it is important to regulate their use to avoid misperceptions about the healthiness of products. Further research is needed to further explore the differences between warning labels and the joint influence of nutrition claims and warnings on the consumers' food choices.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Brazilian Research Ethics Committee. The participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

MA: formal analysis and writing—original draft. GA: methodology, conceptualization, and writing—review. RD: writing—review, editing, resources, and supervision. All authors contributed to the article and approved the submitted version.

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ABSTRACTS

SPANISH

¿Como funcionan las advertencias nutricionales en los productos comerciales? Resultados de un experimento de elección hipotética

Hay un gran cuerpo de evidencias evaluando la efectividad del etiquetado nutricional frontal (ENF). La mayoría de los estudios experimentales han sido conducidos con productos ficticios. Sin embargo, la percepción de los consumidores depende de varios factores extrínsecos de los productos, como la marca. Comprender cuán fuertemente las asociaciones de marca influyen en la efectividad de los esquemas de ENF debe ser crucial para informar la formulación de políticas. En este contexto, el objetivo de este trabajo fue evaluar el efecto de cinco diferentes variantes del etiquetado nutricional de advertencia (lupa negra, lupa roja, octágono negro, triángulo negro y círculo rojo) sobre la elección de productos comerciales por consumidores, comparados con dos esquemas de ENF: el sistema de cantidades diarias de referencia (del inglés *Guideline Daily Amounts* - GDA) y el sistema tipo semáforo. Un ensayo aleatorizado controlado en línea con 1.932 participantes fue utilizado para evaluar el efecto del ENF sobre la elección de los participantes en ocho conjuntos de tres productos comerciales disponibles en el mercado brasileño. Un modelo de regresión logística multinomial fue utilizado para evaluar la influencia del ENF en la probabilidad de que los participantes seleccionen los diferentes productos en la tarea de elección. Los resultados mostraron que las advertencias nutricionales y el semáforo aumentaron significativamente la probabilidad de no seleccionar ninguno de los productos en lugar del producto menos saludable, o un producto más saludable, en al menos una de las categorías de productos en comparación con el GDA. Las advertencias tendieron a poseer un efecto mayor, lo que sugiere su potencial para incentivar la elección de alimentos más saludables.

Palabras clave: advertencia nutricional, produtos comerciales, marca, percepção do consumidor, escolha alimentar.

PORTUGUESE

Como funcionam as advertências nutricionais em produtos comerciais? Resultados de um experimento de escolha hipotética

Existe um grande corpo de evidências avaliando a eficácia da rotulagem nutricional frontal (RNF). A maioria dos estudos experimentais foram realizados com produtos fictícios. Entretanto, a percepção dos consumidores depende de vários fatores extrínsecos aos produtos, como a marca. Compreender como fortes associações de marca influenciam a eficácia da RNF pode ser crucial para a formulação de políticas públicas. Neste contexto, o objetivo deste estudo foi avaliar o efeito de cinco variações de rótulos de advertência nutricional (lupa preta, lupa vermelha, octógono preto, triângulo preto e círculo vermelho) na escolha dos consumidores, em comparação com dois modelos de RNF: valor diário de referência (*Guidelines Daily Amounts* - GDA) e o sistema de semáforo. Um estudo randomizado controlado *online*, com 1.932 participantes, foi utilizado para avaliar o efeito da RNF na escolha dos participantes em oito conjuntos de três produtos disponíveis em mercados brasileiros. Um modelo de regressão logística multinomial foi usado para avaliar a influência da RNF na probabilidade dos participantes selecionarem os diferentes produtos na tarefa de escolha. Os resultados mostraram que as advertências nutricionais e o semáforo aumentaram, significativamente, a probabilidade de selecionar nenhum dos produtos em vez do menos saudável, ou o produto mais saudável, em pelo menos uma das categorias de produtos, quando comparado com o GDA. As advertências tendem a ter um maior efeito, sugerindo o seu potencial de encorajar escolhas alimentares saudáveis.

Palavras-chave: advertência nutricional, produtos comerciais, marca, percepção de consumidores, escolha alimentar.

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"I Like the One With Minions": The Influence of Marketing on Packages of Ultra-Processed Snacks on Children's Food Choices

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Objective: This study aimed to assess the most consumed school snacks using the free listing and understand how marketing strategies on food labels influenced children's perceptions of snacks *via* focus groups.

Design: The study design involved free lists and semi-structured focus group interviews.

Setting: São Paulo, Brazil.

Participants: A total of 69 children were involved in this study.

Phenomenon of Interest: Children's perceptions of food labels.

Analysis: Food groups mentioned on the free lists were analyzed for their frequency and priority of occurrence. The focus groups were analyzed through content analysis.

Results: Juices and chips were the most salient snacks, with availability and flavor as reasons for their consumption. Children found images on labels appealing, which created a desire for the food, although could be deceptive. Snacks perceived as healthy were encouraged by parents, and children could more easily convince them to buy snacks with health claims. Colors and brands were important to catch children's attention and make the snack recognizable. Television commercials and mascots reinforced marketing strategies on labels.

Conclusions and Implications: Our results point to the need for public health strategies to deal with the obesity epidemic through creating and implementing specific legislation to regulate food labels to discourage the consumption of unhealthy snacks and prohibit food marketing targeted at children.

Keywords: ultra-processed foods, snacks, children, food label, food marketing, focus groups

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INTRODUCTION

Food marketing refers to any form of commercial communication or message that is designed to increase the recognition, appeal, and consumption of particular food products (1). It involves a set of persuasive and sophisticated techniques (2) used by food manufacturers to promote their products through different vehicles of promotion, like television, social media, and product packing, *via* varying marketing strategies, including product placement and design (3). In this context, food packages serve as a powerful marketing tool at the point of purchase (4). Visual and informational front-of-package marketing cues constitute salient elements of the food environment that may influence consumers' decisions on what to buy, what to eat, and how much to eat (5, 6).

Several marketing strategies on food packages are targeted specifically at children and adolescents (7). This is because first, frequent marketing exposure to food promotions at earlier stages of life can contribute to a strong positive effect toward specific brands and products and create loyal consumers in the future (8), and second, food advertising causes "pestering" by children. "Pester power" is defined as the children's influence over adult purchasing through demands and requests and has been associated with parents buying less healthy foods (9, 10).

The most common techniques used on food packages to persuade children include compelling graphic elements like the use of bright colors; promotional, licensed, or cartoon characters; celebrity endorsers; sportspersons; graphic references to fun and play; and premium collectible offers with toys and child-friendly lettering (11). A systematic review of the persuasiveness of front-of-package marketing cues on food packages for children has shown that this audience was more likely to choose a product that has an endorser and/or illustrations (6). Similarly, Elliot (12) found that children from 6 to 12 years of age were strongly influenced by package designs featuring characters, particular colors, and pictures of the product (12).

Child-oriented marketing strategies are commonly used on labels of ultra-processed food products (UPFs) (13–15) that are positively associated with obesity (16, 17) and a range of other non-communicable chronic diseases (NCDs) (18–21). UPFs are ready-to-eat or heat formulations made by assembling food substances (e.g., sugars, oils and fats, proteins, starches, and fibers) and "cosmetic" additives (e.g., flavors, flavor enhancers, colors, emulsifiers, and sweeteners) through a series of industrial processing. They are highly profitable branded products distributed on an industrial scale with a poor nutritional profile (22, 23). Given their convenience and palatability, these products are frequently marketed to and consumed by children as snacks at school (24).

In Brazil, data from the National Survey of Schooler Health (*Pesquisa Nacional de Saúde do Escolar* – PeNSE) conducted in 2019 with 11,851,941 schoolers showed that 97.3% of schoolers had consumed UPFs the day before, with crackers being the most consumed snack (49.3%), followed by cookies (46.8%), breads (42.0%), and sodas (40.8). Although 75.3% of participants affirmed that the school offered meals, 48.0% of participants never or rarely ate them. Additionally, the consumption of foods from school canteens and informal selling points in the schools' surroundings were reported by 48.8 and 48.7%, respectively. Foods and drinks most available in canteens were baked goods, fruit juices, and sodas. In informal selling points, they were sodas, crisps, and deep-fried goods (25).

There is growing evidence demonstrating that the marketing of energy-dense and nutrient-poor foods can negatively influence children's food attitudes, preferences, and consumption, leading to adverse health outcomes (26). A recent systematic review carried out by Smith and colleagues (3) reinforced the detrimental effects of food marketing techniques aimed at children and adolescents from 0 to 18 years, particularly those used in TV/movies and product packaging. However, the review also highlighted a lack of qualitative research that investigates children's opinions about food labels and how they interpret information presented; only 3 out of 71 studies identified applied qualitative methods (3). Moreover, only two studies were not conducted in the global north, although childhood overweight and obesity are major concerns in most global south countries. To fill this gap, the objective of this study was to assess how children in São Paulo, Brazil, perceived labels of ultra-processed snacks that they found most appealing. Specifically, this study aimed to (1) highlight the food and drink items mostly consumed as snacks at school using free lists and uncover the rationale behind the choices and (2) understand how marketing strategies on UPF labels influenced children's perceptions of snacks.

METHODS

Study Design

We conducted a qualitative study with focus groups (FGs) that incorporated a free lists exercise. FG is a research technique that produces data through interaction. The free lists exercise aimed to complement information produced from FG discussions by eliciting the most relevant food and drink snacks for children in the school context. Materials and methods are reported below, following the Standards for Reporting Qualitative Research (SRQR) (27) and the Consolidated Criteria for Reporting Qualitative Research (COREQ) (28).

Sampling and Setting

A total of 69 participants provided data that were used in this study. Participants were recruited by convenience, through a Brazilian research firm, from a database of potential participants. Participants were approached by email, and the inclusion criteria were as follows: (1) ages between 7 and 12 years, (2) living in urban regions of São Paulo municipality, and (3) agreeing to participate and having parental consent. The exclusion criterion was having parents working in the health sector and/or in the food or tobacco industries. Nobody refused to participate in the study, and no participants dropped out. None of the authors had any interaction with the participants prior to or during the FGs. Participants had no information about the researchers or the FG moderator. Nine FGs were conducted during the day, between 1 and 8 August 2019, in a research facility in São Paulo, Brazil.

The FGs were stratified by age range (7–9 and 10–12 years) and socioeconomic status (SES) (A+B1 and B2+C). Stratification was justified as follows: (1) children in the same FG are recommended not to be more than 2 years apart in age (29) and (2) SES could affect food availability and the experiences and perceptions with food labels (30, 31). SES was assessed prior to the children being recruited according to the criteria based on the households' possession of goods proposed by the "Brazilian Association of Research Companies" (30). The criteria covered the following: (1) the number of bathrooms, domestic employers, automobiles, personal computers, dishwashers, refrigerators, freezers, washing machines, DVD players, microwave ovens, motorcycles, and clothes driers in the household; (2) the householder education; and (3) the access to public utility services (piped water and paved street). Based on the responses, the household is classified from A (high SES) to E (low SES).

Ethics Committee

Procedures involving research study participants were approved by the Research Ethics Committee of the Public Health School at the São Paulo University (protocol no. 3.441.247). Written informed consent was obtained from all participants' caretakers, and verbal assent was obtained from all participants before the focus groups.

Data Collection

We used data triangulation of FG and free lists to assess food and drink items mostly consumed at school by the participants. The listing activity and the FG guide were pretested with a group of children aged 7–9 years, B2+C SES. These data were not included in the final sample. In our study, foods and drinks considered "desired snacks to eat at school" were expected to be relatively similar across participants, as: (1) children's eating practices are highly influenced by their peers (32), (2) classification of foods as acceptable to compose a specific meal (as a snack to eat at school) is culturally shared (33, 34), and (3) desirability of foods are products of social interactions (35). Most foods and drinks considered appropriate snacks to eat at school were likely to be common across participants, allowing for the identification of the most salient products.

All free lists and FGs were conducted in Portuguese, by a female, trained moderator who graduated in social sciences and who specialized in data collection with children. At the time of the study, the moderator was employed by the Brazilian research firm responsible for recruiting the participants, having vast experience in conducting FGs. Also participating in FGs were one note-taker and one to three observers behind a one-way mirror who were also taking notes.

For the free lists exercise, at the beginning of FGs, after an ice-breaker question ("What shows or cartoons do you like to watch?"), we asked participants to individually write a list of desired snacks to eat at school. Children were given 5 min to make a list as complete as possible. During the time taken to complete the task, the moderator ensured that the children were not communicating with each other or seeing each other's lists. The literature on free lists suggests that about 30 participants are needed to provide a representative sample (36), and this study had 69 participants.

After the lists were completed and collected (approximately 10 min), the moderator started the FG discussion. Based on the foods and drinks presented in the free lists, the interview guide approached: (1) snacks (foods and drinks) consumed at school, (2) reasons for and frequency of consuming them, and (3) opinions and perceptions about the food and beverage packages. The average FG duration was 1 h and 5 min. The audio was recorded and transcribed verbatim. Transcripts were read by PdMS, and data saturation was considered reached after eight FGs, meaning that no relevant new information was identified in the last FG (37).

Analysis

Food lists were analyzed for the most salient foods and drinks using the data analyses software Free-List Analysis under Microsoft Excel (FLAME v1.1). First, the foods and drinks listed were grouped into 12 broad food categories by two researchers (PdMS and NK). In the analysis, triangulation of free lists and FG was used to inform free list categories based on children's own food classification during FG discussions. As not all children described foods' characteristics with the same specificity, grouping foods served to unify similar foods. For instance, one child wrote "natural juice" and the other "juice," hindering UPF classification. In cases in which the food or drink's process level was not clear, triangulation of data allowed consulting FG discussions to assess more detailed information about the item. Also, categories did not distinguish between similar snacks with different food flavors and brands (e.g., grapes and apples were classified as fruits).

Food groups were analyzed for their frequency of occurrence, in addition to Smith's S salient measure. This measure was computed based on the number of times each food and drink was mentioned and how much priority they were given in the lists (i.e., mentioned first vs. lower down): $S = [(L - Rj + 1)/L]/N$, where L is the length of each list, Rj is the rank of item J in the list, and N is the number of lists in the sample (38). Thus, the salience analysis did not allow high prioritization of an item rarely mentioned by most participants, allowing a better representation of the whole group's perspectives on an item's importance (39).

The FG discussions were analyzed using content analysis, as described by Bernard, Wütlich, and Ryan (40). We used an inductive approach, which allowed new codes to emerge from our data. In this step, data triangulation contributed to the creation of the codes related to the most liked snacks to eat at school, as results from the free lists confirmed the relevance of the emergent codes. The triangulation of researchers during the coding process aimed to aggregate multiple views and increase the robustness of the analysis. First, one researcher (PdMS) read all transcripts, highlighting important information and making memos. Exploratory coding was performed using a cutting and sorting approach, in which similar information was grouped together, forming sets of emergent codes. A codebook was built that included, for each code, short and detailed description, inclusion and exclusion criteria, typical and atypical examples, and an example named "close but no," which illustrated the code's limits. The codebook was applied by two other researchers (LAM and FHML) to all transcripts. Agreement between coders was assessed through Cohen's kappa coefficient (41) for inter-rater reliability (kappa = 0.91). All analyses were performed using MAXQDA 2020.

TABLE 1 | Characteristics of the participants ($n = 69$).

Children's characteristics	Number of participants, *n* (%)
Age range (years)	
7–9	30 (43.5%)
10–12	39 (56.5%)
SES	
A+B1	31 (44.9%)
B2+C	38 (55.1%)
Gender	
Male	35 (50.7%)
Female	34 (49.3%)
Type of school	
Public	27 (39.1%)
Private	42 (60.9%)

São Paulo, 2019.
SES, socioeconomic status; A+B1, high SES, according to the Brazilian Criteria; B2+C, low SES, according to the Brazilian Criteria.

TABLE 2 | Themes, subthemes, and codes that emerged through content analysis of nine focus groups in São Paulo, 2019.

Themes	Subthemes	Codes
Ultra-processed food and drink products consumed at school	Most liked snacks to eat at school	Juice
		Chips
		Cake
		Soda
		Breads
		Yogurt
		Cookies and crackers
	Reasons to eat it at school	Flavor
		Giving energy/satiating
		Healthy
		Others
	Food rules	Food rules
Packages and labels	Product brands	Product brands
	Design elements on the label	Colors
		Words
		Shapes
	Marketing elements on the label	Characters
		Information about the product
		Giveaways, games, and promotions
	Perceptions about the label	Feelings toward the food
		Labels' qualities
		Placement
		Changes
Other media that reinforce labels' information	Television commercials	Television commercials

RESULTS

A total of 69 children composed the nine FGs. More details about the participants' age range, SES, gender, and type of school are presented in **Table 1**.

Food groups identified through free lists were juices, chips, fruits and vegetables, cakes, sodas, bread, milk and yogurt, cookies and crackers, candies and chocolates, fast foods, and water and coconut water. The 30 codes produced through the content analysis were classified into 10 themes, five concerning ultra-processed snacks consumed at school—highlighting what was most consumed, why (reasons for eating them) and how/when (based on rules associated with them); four about their packages and labels—concerning their design, marketing strategies, and participants' perceptions about them; and one about other media that reinforce labels' information—more specifically, about television commercials. The coding tree is presented in **Table 2**.

Ultra-Processed Food and Drink Products Consumed at School

Subthemes about UPF included *most liked snacks to eat at school* (juice, chips, cake, soda, breads, yogurt, and cookies and crackers) and *reasons to eat it at school* (flavor, giving energy/satiating, healthy, and others). How often children took a certain food or beverage to school was explained by *food rules*. Further details are described below.

The main foods and beverages mentioned in the FGs reflected the most salient foods in the free lists exercise (**Figure 1**), which also included one non-UPF item—fruits and vegetables. However, Smith's index shows that, although they were frequently mentioned, they were included in the lists in lower positions, therefore not being the first choices thought by children.

Juice was the most mentioned food/drink in free lists and had the most coded segments. It was sometimes referred to as "packaged juice." The main reason for drinking it at school was the flavor, followed by being considered healthy and giving energy. Other reasons were related to being refreshing. Its relevance in the context of school meals is reinforced by being the only food/drink most cited as "always eaten/drunk." It was the second most accessible food/drink by some children in school, following sodas. However, unlike soda, juice was often served at school meals—"At my school, they give us juice" (7–9 years, A-B1).

Chips were the second most mentioned food/drink, mainly liked by children because of their flavor. Other reasons for taking it to school were being crunchy and giving energy/satiating. They were consumed at school sometimes, either brought from home or bought at the canteen. All other foods/drinks were also mainly consumed at school because of their flavors, except breads, which were consumed for giving energy/satiating. Cake and soda were the only foods/drinks to

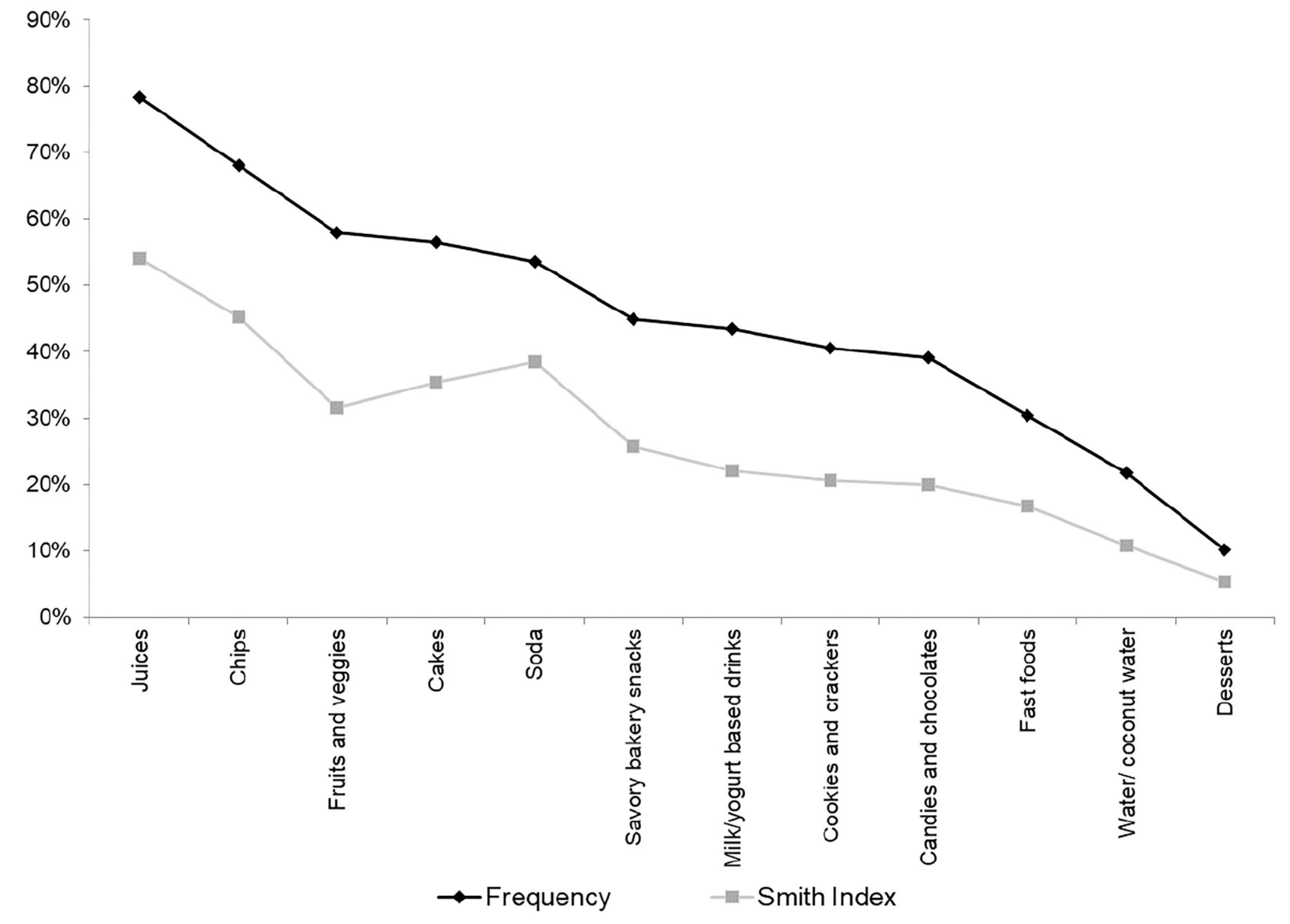

FIGURE 1 | Free lists results by the frequency of the foods/drinks, São Paulo, 2019.

which being healthy was not a reason for eating/drinking them at school.

All food rules mentioned by children were related to eating healthy foods. Almost all rules were taught and set by their mothers, often being related to having specific days to eat what was considered "unhealthy"—"Friday is 'cheat day', we call it that" (10–12 years, A-B1). Other contributors to perpetuating food rules were doctors—"I went to the pediatrician and she told me that I can't eat it [cookies and crackers] all the time otherwise I will have high blood pressure, this type of stuff, so I only eat it on weekends or Fridays" (10–12 years, B2-C)—and schools—"In my school we can't bring chips from Monday to Wednesday" (10–12 years, A-B1).

The foods/drinks most often linked with food rules were juice and soda. While sodas were unhealthy for having "a lot of sugar," juices were "free" for children to drink—"My mom lets me take juice to school every day" (7–9 years, A-B1). In this case, the social rule was reinforced by peers where—"Almost everyone takes juice to school" (7–9 years, A-B1).

Ultra-Processed Food Packages and Labels

Subthemes about UPF packages and labels included *product brands*, *design elements on the label* (colors, words, and shapes), *marketing elements on the label* (characters, information about the product, giveaways, games, and promotions), and *perceptions about the label* (feelings toward the food, labels' qualities, placement, and changes).

Product brands were frequently cited, especially cookies and crackers brands (24.29%), followed by sodas (17.14%) and chips (15.71%). Brands commonly replaced the food's name—"[I take to school] a bag of chips, a *Coke*® [soda brand]… but not every day" (10–12 years, B2-C)—or were used to indicate preference—"I really like *Natural One*® [juice brand], it is made from the fruit. It says so in the bottle" (10–12 years, A-B1). Alongside the brand names, children were well informed about other aspects of the product—"Mini *Oreo*® [cookie brand] has a new package and new flavors" (10–12 years, B2-C), being mentioned when images on the labels were described. The most cited image among brands were characters—"*Toddy*® [chocolate milk brand] has a little cow" (10–12 years, A-B1), followed by colors—"The [label] color that everyone knows is *Coke*® [soda brand]" (10–12 years, B2-C).

Overall, the most cited design element on the labels was related to color, followed by characters. Colors were mainly mentioned for being eye-catching—"The red is very flashy, strong color..." (10–12 years, A-B1), but children also recognized that they reinforced information about the product—"Sometimes the color distinguishes the flavor" (10–12 years, B2-C). Characters were mainly products' mascots—"A farmer with a yellow round face. He's the corn" (7–9 years, A-B1). They also included famous cartoons—"I like the ones with the *Minions*®" and personalities—"There is a soccer player saying that it's good. The package changes, but the player remains" (10–12 years, B2-C).

Marketing elements on the label depicted products' characteristics like foods' flavors, but also included ingredients—"[the chips] are made with actual potatoes" (7–9 years, A-B1). Information about ingredients also made the product very appealing—"The cookies packaging shows the chocolate drops... makes you drool" (10–12 years, B2-C). However, information was not always accurate—"Cookies... there is one with a nice photo on the package, but when you open it, it's like half a dozen of chocolate drops" (10–12 years, A-B1). Another main cited marketing element were surprise and collectible giveaways—"[this bag of chips] comes with a surprise, a sticker. You can collect the stickers, my cousin does" (7–9 years, B2-C), games—"Sometimes I see it [puzzle] and I solve it before drinking the juice. I solve the puzzles in the ones [food packages] I know that have it, as *Yakult*® [fermented milk drink brand] with the *Sponge Bob*®" (10-12, A-B1), and promotions—"*Ruffles*® [chips brand] has a promotion that they take you on a trip" (10–12 years, B2-C). Packages and label formats, and the words on them, were much less mentioned. The expiration date and ingredients were also mentioned by the children.

Most perceptions around packages and labels concerned feelings toward the food, which included it being flavorful and the desire to buy or eat it—"There is a picture that makes your mouth water... makes you want to eat it" (7–9 years, A-B1). One child mentioned craving the food very badly—"I got anxious because I saw the package and it had many *Doritos*® [chips brand], all those colors... I wanted to eat it right away" (7–9 years, A-B1). The second most mentioned perception was related to the label's qualities, in which children classified food labels, as eye-catching and appetizing, but, for some, "usually deceptive" (10–12 years, A-B1). Finally, during the conversation about the information on food labels, children mentioned another media that reinforced the information presented on food labels, "television commercials"—"There are TV commercials with the mascot" (10–12 years, B2-C).

DISCUSSION

Our study focused on children's most salient and desirable snacks to be eaten at school, unveiling the centrality of UPF, with the most frequently reported being juices and chips. The main reason for choosing a food/drink for a snack was flavor (as exemplified by the chips, the most liked salty snack), followed by giving energy/satiating and being healthy (as exemplified by juices, which were seen as healthy). Health concerns were taught by the adults, with children perceiving that they could rely on health claims to convince parents to allow them to buy/eat ultra-processed snacks. Different food characteristics were perceived by children to be promoted on food labels, influencing them to desire the product. Persuasive information about the products was transmitted by images, or even just by the product's brand, and was reinforced by other media, such as TV commercials.

While Letona et al. (42) have also described salty package snacks as one of the most reported purchased products among Guatemalan children, fruit drinks just appeared in fifth place, after sodas, candies, and pastries. In this sense, the presence of fruits and vegetables in third place in this study suggests a higher presence of *in natura*/minimally processed foods among our participants' school snacks. This observation highlights the importance of schools' food environment to children's food choices, as has been described by a systematic review conducted by Driessen et al. (43), and presents another mechanism through which schools may affect food choices and food rules. Thus, the amount of ultra-processed snacks consumed by children will be impacted by what is available to buy, what is given for free, and what is allowed to (bring to) eat there. This is particularly important considering the predominance of unhealthy snacks available in school canteens and food stores close to schools in Brazil (44, 45).

Corroborating Letona et al.'s (42) observations, our participants preferred snacks primarily because of their taste. Snack labels explore the foods' hyper-palatability, which is achieved in UPF through a myriad of additives (22). Thus, hedonic attributes competed with healthy ones to compose children's snack choices. The importance given to foods' healthiness in our study can be understood by the high presence of food rules in our participants' discourses, reinforcing the influence of nutrition education through parents/health professionals.

Claims related to health and nutrition have been described in food packages to attract children's attention in Guatemala (11), Uruguay (13), Canada (46), Australia (47), and Costa Rica (15). These studies show that, despite the claims, foods were classified as having low nutritional quality. When analyzing temporal tendencies, Elliott (48) described that, in Canada, child-targeted foods did not improve nutritionally over time, despite a significant increase of nutrition claims on their packages. However, health claims persuade consumers to incorrectly think that a food is healthier or that a product contains certain healthy foods (41). Our observations add to the current discussion on the persuasion effects of nutrition and health claims, as they did not only mislead parents' perceptions of foods but they also taught children erroneously which foods were healthy. Additionally, such claims were used by children to persuade their parents to buy the foods that contained them. Combined with the above-presented information, our results support the need of regulations that promote accurate information of the food's healthiness so food choices can be made more consciously by children and their caregivers.

In this study, children recognized strategies used by the food industry to make their products more appealing. In Uruguay, Gimenez et al. (13) have identified that bright colors and cartoon characters were the main marketing strategies among foods targeted at children. This resonates with the elements mentioned as important to our participants, suggesting the efficiency of these food marketing strategies. Similarly, Gamboa-Gamboa et al. (15) found that more than 40% of savory UPF snacks (n= 2,042) mostly consumed by Costa Rican children at school had at least one promotional character, with cartoons and company-owned characters appearing in 74% of them. Resonating with these observations, our participants mentioned games/puzzles as the main giveaways on food products. Although authors have described a diversity of promotions, including prizes (49), toys, and collectibles (11), games/puzzles might be convenient because of their low cost and easy access. However, this practice is worrying as it may induce children to build unhealthy food choices, as most foods with giveaways are ultra-processed (13) and the consumption of such foods starts being associated with fun. We suggest that the persuasive elements in UPF labeling highlighted in this study should be avoided even for the promotion of healthy snack options, as the reinforcement of attributes to increase the desire to eat is considered a way to take advantage of the lack of judgment of children under 12 years of age according to the Brazilian Consumers Defense Code (*Código de Defesa do Consumidor* - CDC) (50).

Our results add to the current understanding of children's food package perception by revealing the importance given to food brands by them and illustrating a high presence of brands from transnational companies in their discourses. We argue that current food packages not only promote products' hedonic and healthy attributes but also create and perpetuate an image related to a brand, including through brand-specific characters (11) that progressively become familiar and trustworthy (51). According to Aerts and Smits' (52) observations in Belgium, the unhealthier the food product targeted at children, the more marketing strategies there were on its package. Thus, marketing strategies on packages are also a vehicle to promote unhealthy and unsustainable foods and beverages that pose a global risk to people and the planet (53).

Additional strategies that reinforce the ones on food packages, such as TV commercials, were cited by our participants and resonate with Mehta et al.'s (47) study that described a cross-promotion of 77% of foods marketed to children in Australia. We highlight that the concomitant utilization of diverse marketing strategies on different media may reinforce the food's marketing message that, presenting the same identity throughout all media, is easy for children to recognize and identify themselves.

Implications for Policy, Research, and Practices

In Brazil, the CDC already prohibits any kind of abusive marketing that takes advantage of the child's lack of judgment and experience (51). The Resolution n°163/2014 of the Brazilian Council for Children and Adolescents Rights (*Conselho Nacional dos Direitos da Criança e do Adolescente* - CONANDA) provides an interpretation of the CDC and the examples of abusive marketing, including the use of child characters, cartoons, promotions with awards or collectibles, excess of colors, etc (52). Despite the existence of legislation, the use of persuasive marketing strategies targeted at children is still quite common in Brazil, as shown by our results, demonstrating a lack of policy enforcement. In this sense, we highlight the need for specific regulation aimed to restrict marketing strategies of unhealthy food products, particularly those targeted at children, as well as sensitizing legal actors to this issue and raising consumers' awareness of their rights.

Latin America has examples of effective public policies in the last decade, combining the implementation of warning labels (black octagon) in foods with excessive amounts of critical nutrients together with the implementation of these warnings in all kinds of advertisements in Peru (53), the prohibition of advertisement directed to children in food labels with warnings in Chile (54) and México (55), and the ban on the sale of these products in and around schools in Chile (54). In Chile, where the implementation of a national law mandating front-of-package warning labels, restricting marketing, and banning school sales for products high in calories, sodium, sugar, or saturated fat began in 2016, scientific evidence has confirmed the reduction of purchases of high-in food products (50) and statistically significant reduction of sugar, sodium, and energy content of foods, especially dairy, confitures, and sugary beverages (54, 55). Considering these experiences, we point to the need of further research exploring the impacts of the package and label regulations in combination with other policies to restrict access to UPF in and around schools.

Health professionals and educators have a crucial role in promoting critical thinking about food marketing strategies. Actions targeted to children should focus on increasing children's advertising knowledge and help them engage critically with commercial messages in ways that are developmentally appropriate. Parents should be educated about food marketing along with the negative effects of high exposure to food marketing on children's food choices. Research on the area demands more engagement directly with young people to learn about the development of critical thinking across childhood (56).

Our study has some limitations. First, our results cannot be generalized to Brazil; however, we highlighted the heterogeneity of our sample in terms of SES and age, aimed to capture a diversity of children's views. Second, although not all food/drink snacks mentioned by children during FGs and the free lists were classified as UPF (22), we were able to focus on such foods by specifically exploring children's perceptions about product packaging and brands. Finally, as free lists were created simultaneously by all FG participants, one could worry about participants influencing one another doing it. However, the moderator was monitoring children at all times and assured no communication between the participants during the activity.

CONCLUSION

Our study shows that Brazilian children preferred ultra-processed snacks at school, choosing them mainly because of their taste. Other valued foods' attributes were their ability to provide energy and healthiness, with the last being learned from parents/health professionals and explored as a marketing strategy on UPF packages. Marketing strategies used in foods and beverages targeted at children were mentioned by our participants, pointing to the efficiency of such elements in catching their attention and promoting snacks' hedonic and nutritional characteristics. In this scenario, there is an urge for public health measures to deal with the obesity epidemic by creating and implementing specific legislation to regulate packages and labels to discourage the consumption of unhealthy snacks, as well as to prohibit food marketing targeted at children, considering their lack of discernment and experience to understand commercial messages and to regulate the availability of unhealthy snacks in the school food environment, that is supposed to be safe for children.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Ethics Committee of the Public Health School from the São Paulo University. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

PS, FL, and LM performed the content analysis. NK performed the free list analysis. PS wrote the first draft of the manuscript. FL, AM, LM, and NK wrote sections of the manuscript. All authors contributed to conception, design of the study, revision, read, and approved the submitted version.

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ABSTRACTS

SPANISH

"Me gusta el de los Minions": la influencia del *marketing* en envases de refrigerios ultraprocesados en las elecciones de alimentos de los niños

Objetivo: Este estudio tuvo por objetivo acceder los refrigerios más consumidos en el colegio usando el listado libre y comprender cómo las estrategias de *marketing* en las etiquetas de los alimentos influenciaron las percepciones de los niños sobre los refrigerios por medio de grupos focales.

Diseño metodológico: La metodología involucró listados libres y entrevistas semiestructuradas de grupos focales.
Local: São Paulo, Brasil.

Participantes: Un total de 69 niños fueron involucrados en este estudio.
Fenómeno de interés: Las percepciones de los niños sobre las etiquetas de alimentos.

Análisis: Los grupos de alimentos mencionados en los listados libres fueron analizados por su frecuencia y prioridad de aparición. Los grupos focales fueron analizados a través del análisis de contenido.

Resultados: Los jugos y las papas fritas fueron los refrigerios más destacados, con disponibilidad y sabor como razones para su consumo. A los niños les parecieron atractivas las imágenes en las etiquetas, lo que creó un deseo por la comida, aunque podría ser engañoso. Los padres alentaron los refrigerios percibidos como saludables, y los niños pudieron convencerlos más fácilmente de comprar refrigerios con declaraciones de salud. Los colores y las marcas fueron importantes para captar la atención de los niños y hacer que el refrigerio fuera reconocible. Comerciales de televisión y mascotas reforzaron las estrategias de *marketing* en las etiquetas.

Conclusiones e implicaciones: Nuestros resultados apuntan a la necesidad de estrategias de salud pública para combatir la epidemia de obesidad por medio de la creación e implementación de una legislación específica que reglamente las etiquetas de alimentos a fin de desmotivar el consumo de refrigerios no saludables y prohibir el *marketing* de alimentos direccionados a niños.

Palabras clave: alimentos ultraprocesados, niños, etiquetado de alimentos, *marketing* de alimentos, grupos focales.

PORTUGUESE

"Eu gosto daquele com os Minions": a influência da publicidade nas embalagens de lanches ultraprocessados na escolha alimentar infantil

Objetivo: Esse estudo teve como objetivo avaliar, por meio de uma listagem livre, os lanches mais consumidos em escolas e, por meio de grupos focais, entender como as estratégias de publicidade presentes nos rótulos de alimentos influenciam a percepção das crianças sobre os lanches.
Métodos: O desenho do estudo envolveu listagem livre e grupos focais, com entrevistas semi-estruturadas.
Local: São Paulo, Brasil.
Participantes: 69 crianças participaram do estudo.

Fenômeno de interesse: Percepções de crianças sobre rótulos de alimentos.
Análise: Os grupos de alimentos mencionados na listagem livre foram analisados de acordo com sua frequência e prioridade de ocorrência. Os grupos focais foram analisados considerando a análise de conteúdo.
Resultados: Sucos e salgadinhos de pacote foram os lanches que se destacaram, sendo a disponibilidade e o sabor as principais razões para o seu consumo. As crianças acharam as imagens dos rótulos atraentes, o que criou um desejo pelos alimentos, embora pudesse ser algo enganoso. Os lanches percebidos como saudáveis foram encorajados pelos pais,

e as crianças poderiam ser facilmente convencidas a comprar lanches com alegações de saudabilidade. As cores e as marcas foram importantes para chamar a atenção das crianças e tornar o lanche reconhecível. Comerciais de televisão e mascotes reforçaram as estratégias de publicidade nos rótulos.

Conclusões e implicações: Nossos resultados apontam para a necessidade de estratégias de saúde pública para lidar com a epidemia da obesidade, por meio da criação e da implementação de legislações específicas para regular o rótulo dos alimentos e desencorajar o consumo de lanches não saudáveis, além de proibir a publicidade de alimentos direcionada à criança.

Palavras-chave: alimentos ultraprocessados, lanches, crianças, rótulo de alimentos, grupos focais.

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Comparison of two front-of-pack nutrition labels for Brazilian consumers using a smartphone app in a real-world grocery store: A pilot randomized controlled study

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One of the suggestions for improving the understanding of food labels is implementing front-of-pack nutrition labeling (FoPNL), where nutritional information is objectively made available to consumers. Scientific data on the best FoPNL model to be adopted for the Brazilian population is still emerging, especially in real-world purchase situations. This study aims to evaluate/compare the proposed Brazilian and Mexican FoPNL systems, on different outcome measures, using an application, in dairy foods available in a supermarket aisle. This pilot randomized controlled trial in a real-world purchase situation was conducted in June/July 2021. A total of 230 participants were randomly allocated to one of the three study arms (Mexican and Brazilian FoPNL systems or control—nutritional information table and ingredients list). Using a smartphone, the participants scanned a product barcode and received the allocated FoPNL (with information about excessive added sugars, sodium, and/or saturated fat content) or the control. After, they answered questions related to our primary outcome (decision to buy or not to buy a product) and secondary outcomes (perceived healthiness, facilitation of a quick purchase decision, and identification of excess nutrients). The Mexican FoPNL system performed better in the primary outcome (3.74 ± 1.34) and "facilitation of a quick purchase decision" (3.59 ± 1.31), compared to the control (3.28 ± 1.45; $p = 0.043$ and 3.11 ± 1.42; $p = 0.029$). The Mexican FoPNL system performed better in supporting consumers to identify dairy foods, among the selected sample in this study, high in added sugars than the control (82.2% and 63.5% of correct answers, respectively; $p = 0.009$). For saturated fats, the Brazilian FoPNL resulted in 93.1% of correct answers against 48.2% for the control and 58.9% for the Mexican system ($p \leq 0.001$). The Mexican FoPNL system facilitated consumer decision-making on when to buy or not to buy a selected dairy product and in helping to quickly decide which dairy products to buy, among the selected sample in this study, compared to the control. Considering the right answers of critical nutrients in excess or not, both models of FoPNL, delivered by a smartphone app, performed well.

KEYWORDS

food labeling, nutritional labeling, mobile applications, front-of-pack nutrition labeling, warning labels

Introduction

Nutritional labeling aims to convey correct, precise, accurate, and conspicuous information to consumers and, consequently, influence their dietary decisions (1). However, most people do not correctly understand the complex information on food labels, such as the nutritional table and ingredients list (2–4). This problem contributes to reduced consumer interest in seeking information on labels and a preference for more salient information, such as nutritional claims, compromising the correct understanding of the nutritional profile of products (5–7).

Front-of-Pack Nutrition Labeling (FoPNL) has emerged as an alternative for better communication of nutrient content to consumers. The World Health Organization (WHO) recommends this strategy to aid healthier food choices since nutritional information would be displayed more clearly and encourage product reformulation (8). In some cases, the FoPNL provides clearer data on excessive nutrient content, such as calories, sugars, fats, and sodium (9).

Latin America has been leading the way regarding the FoPNL, with several countries opting to implement mandatory warning labels, especially the black octagon (Chile, Uruguay, and Mexico). For the implementation of FoPNL, it is also necessary that a nutritional profile model be implemented concurrently, serving as a parameter for identifying excessive nutrients in the food. The Mexican FoPNL label is a black octagon with the words "excess in" and uses a nutritional profile model with parameters for calories, sugars, saturated fats, trans fat, and sodium (10), based on the Pan-American Health Organization (PAHO) nutrient profile model (11). This Mexican system also includes a black box notice for the presence of caffeine and sweeteners in the products and that consumption is not suitable for children. Brazil has been discussing the topic for some years, and in 2020 it published legislation that proposes the implementation of the black magnifying glass model, with the words "high in" and a nutrient profile model with parameters for added sugars, saturated fats, and sodium, from October of 2022 (Table 1) (12, 13).

There is still no consensus on the best FoPNL label format and nutrient profile model, especially in a real-world purchase situation (in supermarkets, for example). A narrative review emphasizes the need for more studies in this setting (14). However, some labeling studies have used different strategies, such as the use of printed material on supermarket shelves (15), or a mobile application that provides nutritional information on-screen in the form of front-of-pack nutrition labeling for the consumer (16, 17).

The main objective of this study was to evaluate and compare the decision of to buy or not to buy a product (main outcome), perceived healthiness of selected products, facilitation of a quick purchase decision, and correct identification of excess nutrients of the Brazilian and Mexican FoPNL systems, through the use of an application for smartphones in a real-world purchase situation. The main hypothesis of our study is that the presence of FoPNL will have a positive impact on the evaluated outcomes, improving the understanding of healthiness, then the judgment and purchase decision, when compared to control.

Materials and methods

Trial design

The study was a randomized controlled trial with three-arms [Mexican FoPNL system, Brazilian FoPNL system, and control (nutritional information table and ingredients list)] delivered by a smartphone app and was approved by the Ethics Committee for Research with Human Beings of the Federal University of Minas Gerais, under protocol number 3.059.967.

Participants

The inclusion criteria consisted of agreeing to participate in the study; being over 18 years old; and owning a Smartphone. The exclusion criteria were professionals in the field of food and nutrition. All participants consented by signing the Informed Consent Form.

Interventions

Development of the RotulApp smartphone application and operation for the pilot study

The application consists of a smartphone platform available for free download (RotulApp, available on PlayStore for

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TABLE 1 Different front-of-pack nutrition labels and control and their respective parameters for categorizing excess added sugars, saturated fats, and sodium.

	Mexican FoPNL system	**Brazilian FoPNL system**	**Control**
	a 	b 	c  and Ingredients List
Parameters for sodium	≥ 1 mg per 1 kcal or ≥ 300 mg	Solid food ≥ 600 mg per 100 g Liquid food ≥ 300 mg per 100 mL	NA
Parameters for saturated fats	≥ 10% of the total energy value (kcal)	Solid food ≥ 6 g per 100 g Liquid food ≥ 3 g per 100 mL	NA
Parameters for added sugars	≥ 10% of the total energy value (kcal)[a]	Solid food ≥ 15 g per 100 g Liquid food ≥ 7.5g per 100 mL	NA

NA, Not applicable. [a]In the present study, we considered only added sugar instead of free sugar as Norma Oficial Mexicana regulates.

Android). Once installed, the participant completed their registration by answering a socioeconomic questionnaire on age, gender, education, income, profession, and marital status. Also, at the time of registration, the participant was randomized to one of the three arms of the study [Mexican FoPNL system [a] (black octagon, PAHO based nutritional profile model and "excess" descriptor), Brazilian FoPNL system [b] (magnifying glass, Brazilian Health Regulatory Agency (ANVISA) nutritional profile model and "high in" descriptor) and control [c] (nutritional information table and ingredients list, mandatory information displayed on foods in Brazil)] (Table 1).

RotulApp has a scanner system in which the participant when scanning the barcode of the product received one of the two front label models, according to randomization, or the control on his smartphone screen. The FoPNL models provided information on excessive levels of added sugars, saturated fats, and sodium, following previously determined parameters, as shown in Table 1.

By opening the application, the participant answered whether or not the presence at a grocery store and as soon as scanned and received a FoPNL model or the control, answered a brief questionnaire.

RotulApp database registration

The seven focus dairy food groups for the pilot study were: dairy drinks, milk curds (a fermented milk product made from warm milk and a bacterial yogurt starter), cream cheeses, yogurts, fermented kinds of milk, "petit Suisse" cheeses, and dairy desserts (n = 238 products). Brand-specific data for these products were collected in one supermarket in Belo Horizonte/MG in April of 2021. The collected products were positioned in a single aisle of the establishment and were chosen because national studies indicated that the labels of such products are the most consulted by consumers (18, 19).

The following product information was collected and incorporated into a product database: barcodes, the image of the front label of the products, and the image of the nutritional table and ingredients list. Data collection was performed using the Epicollect 5 software *via* smartphone, and the data were stored in the cloud. Subsequently, data were tabulated in Microsoft Excel version 2016 to classify each food according to the nutritional profile model of the allocated FoPNLs (Table 1). After that, results were incorporated into the RotulAPP application system, allowing the information in FoPNL format to be made available on the smartphone screen when scanning the products.

In Brazil, information on the content of sugars in foods is not mandatory on product labels, and only 49 of the 238 products in the study had this declaration. Therefore, we estimated the content of total sugars, adapting the method described by Scapin et al. (20), and then determined the added sugar content using the method proposed by the Pan American Health Organization (PAHO) (11).

Data collection

The application was available on the PlayStore for Android smartphones. The advertisement of the study was carried out through the creation of RotulApp's social media (Facebook and Instagram), in addition to flyers with information about the application, which were distributed in the supermarket, in Belo Horizonte, Minas Gerais, Brazil.

Recruitment (from June to July 2021) was undertaken online and in-store at a local supermarket closer to the University, where consumers were approached at the time of purchase (in a specific aisle of the establishment, with the registered products) and were invited to participate at the study. Participants who downloaded the application on their own cell phone received, on first use, a short online tutorial informing how and what types of products to scan. Participants who participated in the in-store data collection received instructions through an information flyer and the help of trained assistants. Overall, they were asked to scan the barcode of at least one product from the seven selected dairy food groups and then answer the questionnaire.

Two different randomization procedures were used, one at the time of the participant's registration on the platform (using their own smartphones) and the other using the Microsoft Excel version 2016 program for the in-store data collection participants, who used a specific smartphone, provided by the researchers, to data collection.

Outcomes

The primary outcome of this study was the decision of whether to buy or not to buy a product and the secondary outcomes were the perceived healthiness of selected products, facilitation of a quick purchase decision, and the identification of excess nutrients. Likert scales and 5-point scales were used to establish a value for each response, always in ascending order: "*Does this nutritional labeling model helps me decide when to buy or not buy a product?*" (Outcome: the decision of to buy or not to buy a product) and "*Does this nutritional labeling model help me quickly decide which products to buy?*" (Outcome: facilitation of a quick purchase decision) (*Strongly disagree = 1; Partially disagree = 2; Neither agree nor disagree = 3; Partially agree = 4; Totally agree =* 5). For the outcome of perceived healthiness, we used the question *"Is this product considered healthy?" (Not healthy = 1; Unhealthy = 2; Healthy = 3; Very healthy = 4; Extremely healthy = 5).*

TABLE 2 Differences between the three nutritional profile models (NPM) used in assessing understanding of the critical nutritional content of the products.

	Mexican NPM	Brazilian NPM	PAHO NPM
Parameters for sodium	≥ 1 mg per 1 kcal or ≥ 300 mg	Solid food ≥ 600 mg per 100 g Liquid food ≥ 300 mg per 100 mL	≥ 1 mg per 1 kcal
Parameters for saturated fats	≥ 10% of the total energy value (kcal)	Solid food ≥ 6 g per 100 g Liquid food ≥ 3 g per 100 mL	≥ 10% of the total energy value (kcal)
Parameters for added sugars	≥ 10% of the total energy value (kcal)*	Solid food ≥ 15 g per 100 g Liquid food ≥ 7.5 g per 100 mL	≥ 10% of the total energy value (kcal)*

*In the present study, we considered only added sugar instead of free sugar as Norma Oficial Mexicana regulates.

In assessing understanding of the critical nutritional content of the products—*"In your opinion, does the scanned product contain any excessive nutrient or any substance that could harm a healthy diet?,"* 1 point was allocated for each marked nutrient option that the consumer believes to be in excess in the product and 0 for the unmarked option. 1 point was also allocated for any nutrient in excess and 0 when the opposite, in two different situations: situation 1—primary approach: only applying PAHO's nutritional profile model for the three arms; situation 2—secondary approach: applying the nutritional profile model of ANVISA for the Brazilian FoPNL system, the nutritional profile model implemented in Mexico for the Mexican FoPNL system, and the nutritional profile model from PAHO for control (Table 2).

After that, a sum was made between the value of the response provided by the participant and the value categorized by the nutritional profile model, obtaining three possible values, 0 and 2, signaling the right answer (in the presence or absence of excessive nutrients) and 1 signaling the wrong answer. We also evaluated the ability of FoPNL models delivered by a smartphone app to support consumers to detect products with high content of critical nutrients. In all cases, only the assessments of added sugars, saturated fats, and sodium were analyzed. The same outcomes were also analyzed considering only products eligible for the Brazilian FoPNL system and presented as Supplementary Data.

Statistical methods

Differences between FoPNL models and control, delivered by a smartphone app, were statistically compared for all study outcomes. The results were statistically treated by analysis of variance (ANOVA) with *post-hoc* Tukey test (continuous variables) or Pearson's chi-square test or Fisher's exact test (categorical variables), considering $p \leq 0.05$ as significant. The normality of continuous data was verified using the Kolmogorov-Smirnov test. The statistical software IBM SPSS (Statistics for Windows, Version 20.0. Armonk, NY: IBM Corp) was used.

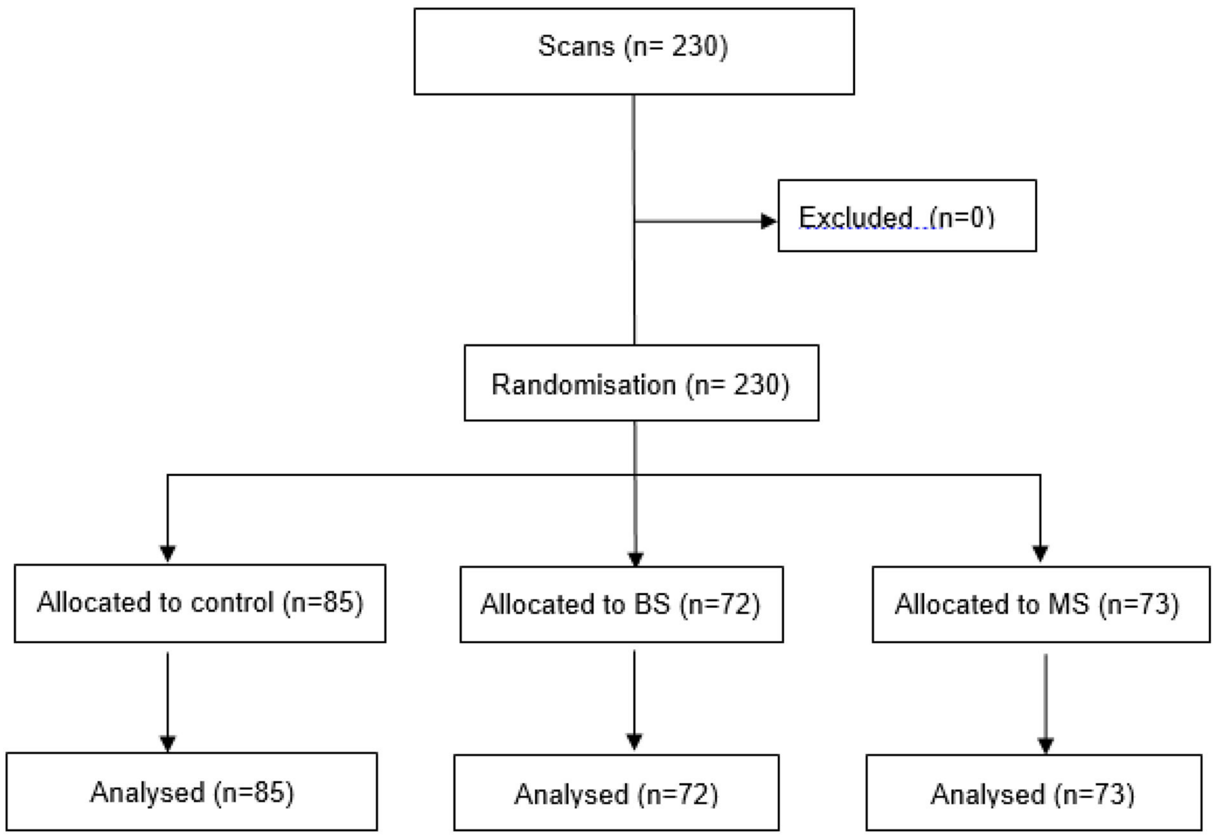

FIGURE 1
CONSORT diagram of scans through the trial. Brazilian System (BS), Mexican System (MS).

TABLE 3 Number of registered products for the pilot study ($n = 238$), number and percentage of scanned products ($n = 230$), grouped by category, and mean and SD of the evaluated nutrients (per 100 g or 100 ml).

Registered products by category (n)	Total number of scans (%)	Added sugars (g)	Saturated fats (g)	Sodium (mg)
		Mean (Standard deviation)		
Cream cheeses (3)	1 (0.5)	4.0 (NA)	2.6 (NA)	27.0 (NA)
Curds (3)	2 (0.9)	0.0 (0.0)	0.0 (0.0)	73.1 (0.0)
Dairy drinks (31)	12 (5.2)	7.8 (0.7)	0.8 (0.3)	41.1 (12.2)
Dairy desserts (6)	12 (5.2)	15.3 (3.0)	2.9 (0.4)	98.3 (56.1)
"Petit Suisse" cheeses (11)	14 (6.1)	5.3 (1.0)	2.0 (0.3)	66.1 (5.7)
Fermented milks (31)	50 (21.7)	6.3 (1.6)	0.4 (0.6)	38.7 (14.9)
Yogurts (153)	139 (60.4)	3.8 (2.8)	1.4 (1.1)	49.0 (11.9)
TOTAL (238)	230 (100.0)			

NA, Not applicable.

Results

Information was recorded for 238 available dairy products, divided into seven categories, with the yogurt category predominating with 153 products (64% of all dairy products). There were 230 scans of registered products (Figure 1).

The most scanned category was yogurt (n = 139 scans, 60% total scans), being also the most scanned in the three different arms of the study. Dairy desserts had the highest average content of added sugars, saturated fats, and sodium per 100 g (15.3 ± 3.0 g, 2.9 ± 0.4 g, and 98.3 ± 56.1 mg, respectively) (Tables 3, 4).

Table 3 also indicates the percentage of dairy products categorized as having an excess of at least one critical nutrient in the Brazilian FoPNL system and Mexican FoPNL system (26.4% and 100%, respectively). As a result, for the Brazilian FoPNL system, 73.6% of the eligible products for scanning did

TABLE 4 Number and percentage of scans, grouped by category and study arm.

Category	Control (*n* = 85)	BS (*n* = 72)	MS (*n* = 73)	Total (*n* = 230)	*P*-value
	N (% of products within the study arm)				
Cream cheeses	0 (0.0)	0 (0.0)	1 (1.4)	1	0.091
Curds	1 (1.2)	0 (0.0)	1 (1.4)	2	
Dairy drinks	3 (3.5)	4 (5.5)	5 (6.8)	12	
Dairy desserts	1 (1.2)	9 (12.5)	2 (2.7)	12	
"Petit Suisse" cheeses	4 (4.7)	7 (9.7)	3 (4.1)	14	
Fermented milks	21 (24.7)	12 (16.7)	17 (23.3)	50	
Yogurts	55 (64.7)	40 (55.6)	44 (60.3)	139	
n and % of eligible products for FoPNL	NA	19 (26.4)	73 (100.0)	NA	NA

NA, Not applicable; BS, Brazilian FoPNL System; MS, Mexican FoPNL System.
Pearson Chi-Square test.

TABLE 5 General characteristics and mean and SD of the age of participants in the RotulApp application, grouped by study arm.

General characteristics	Total (*n* = 230)	Control (*n* = 85)	BS (*n* = 72)	MS (*n* = 73)	P-value
Sex					
Male	87 (37.8%)	29 (34.1%)	24 (33.3%)	34 (46.6%)	0.175
Female	143 (62.2%)	56 (65.9%)	48 (66.7%)	39 (53.4%)	
Education					
First to eighth grade (complete and incomplete)	7 (3.0%)	1 (1.2%)[a]	2 (2.8%)[a]	4 (5.5%)[a]	0.003*
High school (complete and incomplete)	47 (20.4%)	14 (16.5%)[a]	13 (18.1%)[a]	20 (27.4%)[a]	
Graduation (complete and incomplete)	117 (50.9%)	50 (58.8%)[b]	45 (62.5%)[b]	22 (30.1%)[a]	
Postgraduate	59 (25.7%)	20 (23.5%)[ab]	12 (16.7%)[b]	27 (37.0%)[a]	
State					
Espírito Santo	1 (0.4%)	0 (0.0%)	0 (0.0%)	1 (1.4%)	0.425
Minas Gerais	228 (99.1%)	84 (98.8%)	72 (100.0%)	72 (98.6%)	
São Paulo	1 (0.4%)	1 (1.2%)	0 (0.0%)	0 (0.0%)	
Responsible for shopping?					
Yes	176 (76.5%)	67 (78.8%)[a]	44 (61.1%)[b]	65 (89.0%)[a]	<0.001*
No	54 (23.5%)	18 (21.2%)[a]	28 (38.9%)[b]	8 (11.0%)[a]	
Consume any study product?					
Yes	219 (95.2%)	82 (96.5%)	70 (97.2%)	67 (91.8%)	0.244
No	11 (4.8%)	3 (3.5%)	2 (2.8%)	6 (8.2%)	
Numerical parameters	**Total (*n* = 230)**	**Control (*n* = 85)**	**BS (*n* = 72)**	**MS (*n* = 73)**	
Age [Average (Standard Deviation)]	35.3 (11.2)	35.7 (10.8)	33.2 (10.6)	36.8 (12.1)	0.199

BS, Brazilian FoPNL System; MS, Mexican FoPNL System.
*P < 0.05—two-sided; different letters mean P < 0.05.
Pearson Chi-Square test.

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TABLE 6 Right and wrong answers about nutrient content, by study arm, considering different nutritional profile models.

In your opinion, does the scanned product contain any excessive nutrients or any substance that could harm a healthy diet?

	Control ($n = 85$)	BS ($n = 72$)	*P*-value	Control ($n = 85$)	MS ($n = 73$)	*P*-value	BS ($n = 72$)	MS ($n = 73$)	P-value
Situation 1) NP: OPAS for control, MS, and BS									
Sugars									
Right	54 (63.5%)	50 (69.4%)	0.435	54 (63.5%)	60 (82.2%)	0.009*	50 (69.4%)	60 (82.2%)	0.073
Wrong	31 (36.5%)	22 (30.6%)		31 (36.5%)	13 (17.8%)		22 (30.6%)	13 (17.8%)	
Saturated fats									
Right	41 (48.2%)	28 (38.9%)	0.240	41 (48.2%)	43 (58.9%)	0.180	28 (38.9%)	43 (58.9%)	0.016*
Wrong	44 (51.8%)	44 (61.1%)		44 (51.8%)	30 (41.1%)		44 (61.1%)	30 (41.1%)	
Sodium									
Right	60 (70.6%)	53 (73.6%)	0.674	60 (70.6%)	55 (75.3%)	0.503	53 (73.6%)	55 (75.3%)	0.811
Wrong	25 (29.4%)	19 (26.4%)		25 (29.4%)	18 (24.7%)		19 (26.4%)	18 (24.7%)	
Situation 2) NP: ANVISA for BS, Mexican for MS, and OPAS for control									
Sugars									
Right	54 (63.5%)	47 (65.3%)	0.820	54 (63.5%)	60 (82.2%)	0.009*	47 (65.3%)	60 (82.2%)	0.021*
Wrong	31 (36.5%)	25 (34.7%)		31 (36.5%)	13 (17.8%)		25 (34.7%)	13 (17.8%)	
Saturated fats									
Right	41 (48.2%)	67 (93.1%)	<0.001*	41 (48.2%)	43 (58.9%)	0.180	67 (93.1%)	43 (58.9%)	<0.001*
Wrong	44 (51.8%)	5 (6.9%)		44 (51.8%)	30 (41.1%)		5 (6.9%)	30 (41.1%)	
Sodium									
Right	60 (70.6%)	58 (80.6%)	0.150	60 (70.6%)	55 (75.3%)	0.503	58 (80.6%)	55 (75.3%)	0.449
Wrong	25 (29.4%)	14 (19.4%)		25 (29.4%)	18 (24.7%)		14 (19.4%)	18 (24.7%)	

*P < 0.05—two-sided. NP, Nutritional profile; BS, Brazilian FoPNL System; MS, Mexican FoPNL System.
Pearson Chi-Square test.

not display any warning information. The general characteristics of the participants in RotulApp (n = 230) during the data collection period are described in Table 5.

When analyzing right and wrong answers about nutrients, in relation to the identification of excessive added sugars, in situation 1 (PAHO's nutritional profile model for the three arms), the Mexican FoPNL system outperformed the control (82.2% of right answers against 63.5%). In situation 2 (specific nutritional profile model for each arm), the Mexican FoPNL system outperformed both the Brazilian FoPNL system and control (82.2% of right answers against 65.3 and 63.5%, respectively).

As for the identification of excessive saturated fats, in situation 1, the Mexican FoPNL system outperformed the Brazilian FoPNL system (58.9% of right answers against 38.9%). In situation 2, the Brazilian FoPNL system stood out with 93.1% of correct answers against 58.9% of correct answers in the Mexican FoPNL system group and 48.2% in the control group (Table 6).

Analyzing the ability of the FoPNL systems to make the consumers identify only the excess of critical nutrients, the Mexican FoPNL system performed better than control and the Brazilian FoPNL system, in situation 1, and the Brazilian and Mexican FoPNL systems performed better than control in situation 2 (Table 7).

There was a statistically significant difference ($p \leq 0.05$) between the Mexican FoPNL system and both the control and the Brazilian FoPNL system, for the outcomes "facilitation of a quick purchase decision" (3.59 ± 1.31 against 3.11 ± 1.42 ($p = 0.029$) and 3.07 ± 1.53 ($p = 0.030$), respectively) and "decision of to buy or not to buy a product" (3.74 ± 1.34 against 3.28 ± 1.45 ($p = 0.043$) and 3.10 ± 1.59 ($p = 0.009$), respectively) (Table 8). Considering only products that were scanned and eligible for the Brazilian FoPNL ($n = 19$), this system outperformed both the control and Mexican FoPNL systems for the outcome of "perceived healthiness" (2.26 ± 1.45 against 3.24 ± 1.29 and 3.18 ± 1.25, respectively) (Supplementary Data 2).

Discussion

In the present study, there was a statistically significant difference between the Mexican FoPNL system and both the control and the Brazilian FoPNL system, all delivered by a smartphone app, for the outcome "decision of to buy or not to buy a product" amongst dairy foods by the sample of this

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TABLE 7 Right and wrong answers about excessive nutrients, by study arm, considering different nutritional profile models.

In your opinion, does the scanned product contain any excessive nutrients or any substance that could harm a healthy diet?

Situation 1) NP: OPAS for control, MS, and BS									
Sugars	Control ($n = 68$)	BS ($n = 59$)	*P*-value	Control ($n = 68$)	MS ($n = 56$)	*P*-value	BS ($n = 59$)	MS ($n = 56$)	*P*-value
Right	39 (57.4%)	37 (62.7%)	0.539	39 (57.4%)	44 (78.6%)	0.012*	37 (62.7%)	44 (78.6%)	0.062
Wrong	29 (42.6%)	22 (37.3%)		29 (42.6%)	12 (21.4%)		22 (37.3%)	12 (21.4%)	
Saturated fats	Control ($n = 45$)	BS ($n = 50$)	*P*-value	Control ($n = 45$)	MS ($n = 46$)	*P*-value	BS ($n = 50$)	MS ($n = 46$)	*P*-value
Right	6 (13.3%)	6 (12.0%)	0.845	6 (13.3%)	17 (37.0%)	0.010*	6 (12.0%)	17 (37.0%)	0.004*
Wrong	39 (86.7%)	44 (88.0%)		39 (86.7%)	29 (63.0%)		44 (88.0%)	29 (63.0%)	
Sodium	Control ($n = 14$)	BS ($n = 7$)	*P*-value	Control ($n = 14$)	MS ($n = 13$)	*P*-value	BS ($n = 7$)	MS ($n = 13$)	*P*-value
Right	7 (50.0%)	1 (14.3%)	0.112	7 (50.0%)	9 (69.2%)	0.310	1 (14.3%)	9 (69.2%)	0.019*
Wrong	7 (50.0%)	6 (85.7%)		7 (50.0%)	4 (30.8%)		6 (85.7%)	4 (30.8%)	
Situation 2) NP: ANVISA for BS, Mexican for MS, and OPAS for control									
Sugars	Control ($n = 68$)	BS ($n = 18$)	*P*-value	Control ($n = 68$)	MS ($n = 56$)	*P*-value	BS ($n = 18$)	MS ($n = 56$)	*P*-value
Right	39 (57.4%)	15 (83.3%)	0.043*	39 (57.4%)	44 (78.6%)	0.012*	15 (83.3%)	44 (78.6%)	0.662
Wrong	29 (42.6%)	3 (16.7%)		29 (42.6%)	12 (21.4%)		3 (16.7%)	12 (21.4%)	
Saturated fats	Control ($n = 45$)	BS ($n = 1$)	*P*-value	Control ($n = 45$)	MS ($n = 46$)	*P*-value	BS ($n = 1$)	MS ($n = 46$)	*P*-value
Right	6 (13.3%)	1 (100.0%)	0.152	6 (13.3%)	17 (37.0%)	0.010*	1 (100.0%)	17 (37.0%)	0.383
Wrong	39 (86.7%)	0 (0.0%)		39 (86.7%)	29 (63.0%)		0 (0.0%)	29 (63.0%)	
Sodium	Control ($n = 14$)	BS ($n = 0$)	*P*-value	Control ($n = 14$)	MS ($n = 13$)	*P*-value	BS ($n = 0$)	MS ($n = 13$)	*P*-value
Right	NA	NA	NA	7 (50.0%)	9 (69.2%)	0.310	NA	NA	NA
Wrong	NA	NA		7 (50.0%)	4 (30.8%)		NA	NA	

*P < 0.05—two-sided. NP, Nutritional profile; BS, Brazilian FoPNL System; MS, Mexican FoPNL System.
Pearson Chi-Square and Fisher's Exact Test.

TABLE 8 Mean, median, and SD of the scale values, according to the different models of the study, for perceived healthiness of selected products, facilitation of a quick purchase decision, and decision of to buy or not to buy a product, based on the results obtained with the RotulApp application.

	Control ($n = 85$)	BS ($n = 2$)	*P*-value	Control ($n = 85$)	MS ($n = 73$)	*P*-value	BS ($n = 72$)	MS ($n = 73$)	P–value
Is this product considered healthy?									
Mean ± standard deviation	3.24 ± 1.29	3.10 ± 1.47	0.531	3.24 ± 1.29	3.18 ± 1.25	0.778	3.10 ± 1.47	3.18 ± 1.25	0.721
Median (interquartile range)	4.00 (2.00–4.00)	3.50 (2.00–4.00)		4.00 (2.00–4.00)	4.00 (2.00–4.00)		3.50 (2.00–4.00)	4.00 (2.00–4.00)	
Does this nutritional labeling model help me quickly decide which products to buy?									
Mean ± standard deviation	3.11 ± 1.42	3.07 ± 1.53	0.878	3.11 ± 1.42[b]	3.59 ± 1.31[a]	0.029*	3.07 ± 1.53[b]	3.59 ± 1.31[a]	0.030*
Median (interquartile range)	3.00 (2.00–4.00)	3.00 (1.00–4.00)		3.00 (2.00–4.00)	4.00 (2.50–5.00)		3.00 (1.00–4.00)	4.00 (2.50–5.00)	
Does this nutritional labeling model help me decide when to buy or not buy a product?									
Mean ± standard deviation	3.28 ± 1.45	3.10 ± 1.59	0.447	3.28 ± 1.45[b]	3.74 ± 1.34[a]	0.043*	3.10 ± 1.59[b]	3.74 ± 1.34[a]	0.009*
Median (interquartile range)	4.00 (2.00–5.00)	3.00 (1.00–5.00)		4.00 (2.00–5.00)	4.00 (2.50–5.00)		3.00 (1.00–5.00)	4.00 (2.50–5.00)	

*P < 0.05—two-sided; different letters mean P < 0.05. B, Brazilian FoPNL System; MS, Mexican FoPNL System.
ANOVA (*post-hoc* Tukey test).

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study. The Mexican FoPNL system presented a significantly higher value than the control and the Brazilian FoPNL system. The closer to 5, the greater the agreement of consumers that the model assisted in the decision of whether to buy a product or not, but the worse performance of the Brazilian FoPNL system may be explained by the fact that in 73.6% of the scans of this arm, no additional warning information was displayed to the consumer, due to the relatively permissive nutritional profile model for this system. The same difference was indicated between the Mexican FoPNL system and both the control and the Brazilian FoPNL system, for the outcome "facilitation of a quick purchase decision."

Although the present study did not show a statistically significant difference between the models for the outcome of "perceived healthiness," results from an Uruguayan online study indicated that FoPNL favored healthier food choices compared to the control (21). However, a recent systematic review indicated that, based on a limited number of studies in a real purchase situation, the influence of FoPNL on the purchase of healthier products was small (14).

As noted above, although the number of scans was proportional for each arm of the study, the percentage of products that received warning information in the Brazilian FoPNL system arm was only 26.4% ($n = 19$) (Supplementary Data). This is due to the nutritional profile model recommended for this FoPNL, which is a more permissive profile compared to those used in other Latin American countries (22, 23) and models proposed by the Brazilian regulatory agency and PAHO, it is, in fact, a model that categorizes fewer foods as containing excessive nutrients (11, 24).

Considering only products that displayed the Brazilian FoPNL, there was a statistically significant difference for the outcome "perceived healthiness," where the perception of healthiness was substantially reduced when compared to the control and the Mexican FoPNL. This result suggests that the Brazilian FoPNL reduces the perception of healthiness of dairy products, among the selected sample in this study, with critical nutrients in excess, as long as the model is present on the food label (Supplementary Data).

In the regulatory implementation of the Brazilian FoPNL system with the nutritional profile model proposed by ANVISA, the possible absence of the magnifying glass symbol (due to a more permissive nutritional profile model) will mean that the consumer will only have access to information already provided by the nutritional table and ingredients list of the product and will potentially believe that products without FoPNL are healthier than before the implementation of the regulation. A Chilean study, with the first-year evaluation of FoPNL implementation, indicated increased consumption of products without FoPNL, even in the same category of products that normally received a labeling warning (25).

Regarding the identification of excessive nutrients, considering the nutritional profile models proposed for each FoPNL delivered by a smartphone app (situation 2), there was a statistically significant difference between the right answers of excess or not added sugars [the Mexican FoPNL system stood out with the highest percentage of correct answers (82.2% against 63.5% of the control and 65.3% of the Brazilian FoPNL system)] and saturated fats (the Brazilian FoPNL system stood out with the highest percentage of correct answers (93.1% against 48.2% of the control and 58.9% of the Mexican FoPNL system)]. The differences were also observed when just the ability to identify the excess of critical nutrients was evaluated. It is noteworthy that for saturated fats, in the Brazilian FoPNL system arm, only one product out of the 72 scanned products showed an excess of this nutrient.

These findings show that the presence of FoPNL favors the better interpretation of the nutritional content of the product, a finding also seen in other studies (9, 14, 17). An online study carried out in 2021 with 2400 Brazilian participants also indicated that the use of different FoPNL models, including the magnifying glass and the octagon, both increased the understanding of the nutritional content of products, but this studies evaluated the effectiveness of the design only and not the concomitant application of nutritional profile models (26).

In the case of added sugars in situation 1, no statistically significant difference was found between the two models of FoPNL in identifying or not this nutrient was in excess (difference was only found when comparing the Mexican FoPNL system with the control group (82.2% of right answers against 63.5%). When considering only the identification of excessive nutrients in selected dairy products, both FoPNL systems performed better than the control, in situation 2. A similar finding to the study by Deliza et al. (27), which pointed out that different FoPNL models, such as warnings and the magnifying glass, seem to be more appropriate for this purpose, but also without significant difference between the models. In that study, the models were different in design, but not the nutritional profile (27).

In both situations (applying the nutritional profile models proposed for each FoPNL model and considering PAHO's nutritional profile model as a reference for all arms), consumers exposed only to the nutritional table, and ingredients list demonstrated less understanding of the sugar content of the products, demonstrated by the lowest number of correct answers. In general, FoPNL effectively informs and indicates high levels of critical nutrients and encourages healthier behaviors, especially considering that supermarket purchases are usually made in a rush and limited time (28–30). A meta-analysis of experimental studies found that FoPNL warnings lowered the sodium and sugar content of consumer purchases compared with no labels (9).

We can mention as strengths of this work the remote intervention through an application, which allows changes to the study design without harming its progress and simulates the implementation of FoPNL delivered by a smartphone app in a real purchase situation. In Brazil, there are no previous studies that developed applications for smartphones within the scope of FoPNL and on the effect of this strategy in a real purchase situation, which makes this work novel. Fuchs et al. indicate that the development of a tailoring framework for the personalization of digital food labels represents a promising purchase-intervention even in the absence of FoPNL and the advantage of this label customization through mobile apps over standardized labels is the real-time presentation of individualized and customized labels based on different nutritional profiles (31).

In addition, discussions for the implementation of FoPNL must have a broad approach, with the active participation of all regulatory and public policy spheres, accompanied by education and dissemination measures, as well as surveillance and sanctions in case of non-compliance (32). In this study, we evaluated not only the FoPNL designs but also the closest to what the corresponding legislation describes for descriptors and nutritional profile models.

As limitations, we highlight that despite the performed randomization for the label's groups, the chi-square test indicated that for the characteristics "education" and "responsible for shopping," there was a significant difference between the study arms, with a predominance of participants with incomplete graduation in the Brazilian FoPNL system arm and with a postgraduate education in the Mexican FoPNL system arm, in addition to a smaller number of participants responsible for purchases also in the Brazilian FoPNL system arm. The use of two different randomization lists could be responsible for these imbalances. Also, the voluntary use of an application for FoPNL may have included participants motivated to find and use nutritional information. Although, we believe that the main motivation of the participants was related to the contribution to the research of the local university. We can not disregard the possibility of a social desirability bias with some of the questions used. Also, our study tests the use of the app in a specific aisle with predetermined products, the results may differ in other food groups.

The use of FoPNL through an application is also a weakness considering that this is not how shoppers usually encounter and use labels in-store. Testing understanding of FoPNL when used on a smartphone to scan food products, involves different cognitive processes than what is expected when using FoPNL under real-life conditions. The low number of participants could also be a limiting factor for general conclusions, as it was a convenience sample and this was a pilot study. However, considering the significance level of 5%, the study sample had a power of 83.2% to demonstrate the mean difference in the decision to buy or not to buy a product (our primary outcome) between the Mexican (3.74 ± 1.34) and the Brazilian (3.10 ± 1.59) FoPNL systems.

The obtained results reinforce the need to adopt a FoPNL model in food regulatory legislation since the current labeling makes it difficult for consumers to understand the information, and FoPNL is, therefore, an important modification strategy, given the benefits it provides to consumers (29, 33).

Conclusion

The Mexican FoPNL system delivered by a smartphone app supported consumer decision-making regarding whether to buy or not to buy a product amongst dairy foods and in helping to quickly decide which dairy products to buy, compared to the control and among the selected sample in this study. With regards to correctly identifying critical nutrients in excess or not, both models of FoPNL performed well, with the Mexican FoPNL system delivered by a smartphone app standing out for added sugars and saturated fats (only using PAHO's nutritional profile model for the three arms) and the Brazilian FoPNL system delivered by a smartphone app standing out for saturated fats (considering the nutritional profile models proposed for each FoPNL), also among the selected dairy samples in this study.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by Universidade Federal de Minas Gerais Ethics Committee (01919218.1.0000.5149). The patients/participants provided their written informed consent to participate in this study.

Author contributions

AS: data collection, project management, methodology, writing—preparation of the original manuscript, writing—proofreading and editing, and statistical analysis. LA: supervision, methodology, writing—proofreading and editing, and statistical analysis. CN: methodology—feedback on study design and writing—proofreading and editing. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fnut.2022.898021/full#supplementary-material

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ABSTRACTS

SPANISH

Comparación de dos etiquetados nutricionales frontales por consumidores brasileños utilizando una aplicación de celular en un mercado real: un estudio piloto aleatorizado controlado

Una de las sugerencias para mejorar la comprensión del etiquetado de alimentos es implementar el etiquetado nutricional frontal (ENF), donde la información nutricional está objetivamente disponible a los consumidores. Datos científicos del mejor modelo de ENF a ser adoptado por la población brasileña son todavía emergentes, especialmente en situaciones reales de compra. Este estudio tiene como objetivo evaluar/comparar los sistemas de ENF brasileños y mexicanos, propuestos en diferentes medidas de resultado, utilizando una aplicación, en productos lácteos disponibles en el pasillo de un supermercado. Este ensayo piloto aleatorizado controlado en una situación real de compra se llevó a cabo en junio/julio del 2021. Un total de 230 participantes fueron aleatoriamente asignados a uno de los tres brazos de estudio (los sistemas de ENF mexicano, brasileño o control—tabla de información nutricional y lista de ingredientes). Usando un celular, los participantes escanearon el código de barras de un producto y recibieron el ENF asignado (con la información sobre contenidos excesivos de azúcares añadidos, sodio y/o grasa saturada) o el control. Posteriormente, ellos respondieron preguntas relacionadas con nuestro resultado primario (decisión de comprar o no comprar un producto) y resultados secundarios (percepción de la salubridad, facilitación de una decisión de compra rápida e identificación de exceso de nutrientes). El sistema del ENF mexicano se mostró mejor en los resultados primarios (3,74 ± 1,34) y "facilitación de una decisión de compra rápida" (3,59 ± 1,31), comparado al control (3,28 ± 1,45; p = 0,043 y 3,11 ± 1,42; p = 0,029). El sistema de ENF mexicano también se mostró mejor en apoyar a los consumidores en identificar alimentos lácteos, entre la muestra seleccionada en este estudio, más altos en azúcares añadidos que el control (82,2% y 63,5% de respuestas correctas, respectivamente; p = 0,009). Para las grasas saturadas, el ENF brasileño resultó en 93,1% de respuestas correctas contra 48,2% para el control y 58,9% para el sistema mexicano (p ≤ 0.001). El sistema de ENF mexicano facilitó la capacidad de decisión de los consumidores sobre comprar o no comprar un determinado producto lácteo y en ayudar a decidir rápidamente qué productos lácteos comprar entre las muestras seleccionadas en este estudio, comparados al control. Considerando las respuestas correctas de nutrientes críticos en exceso o no, ambos modelos del ENF exhibidos por la aplicación del celular funcionaron bien.

Palabras clave: etiquetado de alimentos, etiquetado nutricional, aplicación de celular, etiquetado nutricional frontal, etiquetado de advertencia.

PORTUGUESE

Comparação de duas rotulagens nutricionais frontais para consumidores brasileiros utilizando um aplicativo de *smartphone* em situação real de compra: um estudo piloto randomizado controlado

Uma das sugestões para a melhoria da compreensão dos rótulos de alimentos é a implementação da rotulagem nutricional frontal (RNF), na qual a informação nutricional é disponibilizada de forma objetiva para o consumidor. Dados científicos sobre o melhor modelo de RNF a ser adotado para a população brasileira ainda vêm sendo levantados, especialmente considerando situações reais de compra. O presente estudo tem como objetivo avaliar/comparar os sistemas de RNF propostos para o Brasil e para o México, considerando diferentes desfechos, utilizando um aplicativo para *smartphone*, em produtos lácteos disponíveis em um corredor do supermercado. Esse estudo piloto randomizado controlado, em situação real de compra, foi conduzido em junho/julho de 2021. Um total de 230 participantes foi alocado aleatoriamente para um dos três braços do estudo (sistemas brasileiro e mexicano de RNF ou controle—tabela de informação nutricional e lista de ingredientes). Utilizando *smartphones*, os participantes escanearam o código de barras de um produto e receberam aleatoriamente um modelo de RNF (com informações sobre o conteúdo excessivo de açúcares adicionados, sódio e/ou gordura saturada) ou o controle. Após, os participantes responderam questões referentes ao desfecho primário do estudo (decisão de quando comprar ou não comprar um produto) e desfechos secundários (percepção de saudabilidade, decisão rápida de compra e identificação de nutriente em excesso). O sistema mexicano de RNF teve melhor desempenho no desfecho primário (3,74 ± 1,34) e no desfecho "decisão rápida de compra" (3,59 ± 1.31), ao ser comparado com o controle (3,28 ± 1,45; p = 0,043 e 3,11 ± 1,42; p = 0,029). O sistema mexicano de RNF teve um melhor desempenho em auxiliar os consumidores na identificação de alimentos lácteos, dentro das amostras selecionadas para o estudo, com altos teores de açúcares adicionados, quando comparado com o controle (82,2% e 63,5% das respostas corretas, respectivamente; p = 0,009). Para gorduras saturadas, o sistema brasileiro de RNF resultou em 93,1% de respostas corretas contra 48,2% do controle e 58,9% do sistema mexicano de RNF (p ≤ 0,001). O sistema mexicano de RNF facilitou a decisão de quando comprar ou não comprar um produto lácteo selecionado e auxiliou o consumidor a decidir rapidamente quais produtos lácteos comprar, considerando as amostras selecionadas para o presente estudo, quando comparado ao controle. Considerando as respostas corretas sobre a presença ou a ausência de nutrientes críticos em excesso, ambos os modelos de RNF, presentes no aplicativo para *smartphone*, tiveram um bom desempenho.

Palavras-chave: rotulagem de alimentos; rotulagem nutricional; aplicativos móveis; rotulagem nutricional frontal; rotulagem de advertência.

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Use of the term whole grain on the label of processed and ultra-processed foods based on cereals and pseudocereals in Brazil

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There has been an increasing consumption of processed and ultra-processed foods, accompanied by growing concerns about the relationship between diet quality and health. Whole-grain foods, composed of cereals and pseudocereals, are recommended as part of a healthy diet, and food labeling is an important tool for consumers to identify the presence of whole grains in packaged foods. This study aimed to analyze the use of the term whole grain on the label of processed and ultra-processed foods based on cereals and pseudocereals (amaranth, quinoa, and buckwheat) in Brazil. Data were collected by a census of all food labels in a Brazilian supermarket. Foods were classified into eight groups according to Brazilian legislation and according to the presence or absence of the term whole grain. The prevalence of foods displaying the term whole grain or related expressions on the front label was assessed, and differences between groups were analyzed using Pearson's chi-squared test. Comparisons were also made in relation to the position of whole-grain ingredients in the ingredients list, given that Brazilian food labeling regulations require that ingredients be listed in descending order of weight on packaged foods. The level of significance was defined as $p < 0.05$. The sample included 1,004 processed and ultra-processed foods based on cereals and pseudocereals, 156 (15.6%) of which displayed the term whole grain and/or similar expressions on the front label. Of these, 98 (9.8%) contained the term whole grain, 25 (2.5%) displayed analogous expressions, and 33 (3.3%) contained the term whole grain concomitantly with analogous terms, identified in foods of the groups Bakery goods, bread, cereals, and related products and Sugars, sugary foods, and snacks. Half of the food products displaying the term whole grain or related expressions on the front label did not have a whole-grain ingredient listed in the first position of the ingredients list. The frequency of whole grains was even lower when analyzing the second and third ingredients. These findings reveal the existence of inaccurate information regarding the term whole grain or analogous expressions on the front label of cereal- and pseudocereal-based packaged foods. It is expected that these results will contribute to stimulating the food industry and regulatory bodies to improve the use of the term whole grain and related expressions on packaged food labels, given that, up to the moment of data collection, there were no regulatory requirements for these statements. Furthermore, the findings might contribute to improving the clarity of information available on food labels, thereby preventing consumer deception at the time of purchase.

KEYWORDS

whole grain, whole foods, ingredients list, food labeling, packaged foods

Introduction

The NOVA classification system groups foods into four categories according to the degree and type of processing to which they are subjected: (i) fresh and minimally processed foods, (ii) processed culinary ingredients, (iii) processed foods, and (iv) ultra-processed foods (1). The replacement of fresh and minimally processed foods for ultra-processed foods with high energy density and low nutritional quality has been associated with a global increase in obesity and other chronic non-communicable diseases (2, 3).

The 2017–2018 Consumer Expenditure Survey (POF), conducted by the Brazilian Institute of Geography and Statistics (IBGE) and based on the NOVA classification, revealed that the purchase of fresh and minimally processed foods is decreasing, whereas the purchase of processed and, mainly, ultra-processed foods is increasing among the Brazilian population (4). Processed foods are defined as industrial products prepared by adding salt, sugar, oils, or fats and by using preservation methods, such as canning and bottling, to increase durability. Most processed foods have two or three ingredients. Ultra-processed foods are ready-to-eat industrial formulations that typically contain five or more ingredients and additives that intensify visual or sensory aspects, such as dyes, emulsifiers, and flavorings (1, 5).

The relationship between diet quality and health has been widely discussed in recent years. Whole foods have attracted great attention in this context because they are good sources of nutrients such as dietary fibers, vitamins, minerals, and phytochemicals (6–9). Of note, there is the notion that whole-grain foods have higher fiber and nutrient contents. However, this relationship should be analyzed with care. Analysis of fiber content is not a reliable method to assess whether a food product is whole grain, given that fibers from other sources may be added (10). For example, foods containing refined wheat flour and added fibers will not have the same levels of vitamins, minerals, or phytochemicals as similar foods prepared with whole grains because refinement may cause significant losses in nutrients (11–16).

Given that the consumption of whole grains is recommended as part of a healthy diet (8, 11, 17–19), government bodies and health promotion organizations worldwide have included this recommendation in their dietary guidelines (11, 18, 20). Definitions of whole grain are varied. Countries such as Australia, New Zealand, Singapore, Canada, Mexico, Denmark, Norway, and Sweden define whole grains as grains containing all major components in the same proportions as those found in the entire seed; however, countries differ in their requirements regarding the types of cereals or pseudocereals that qualify as grains and the processing methods that can be used to obtain whole grains (12, 13, 21–27). Likewise, production and labeling requirements for whole-grain foods differ greatly between countries. For instance, bread must contain 90% whole grains to be labeled as whole grain in Germany. In Canada, whole-grain bread must contain at least 60% whole wheat flour in relation to the total amount of flour used. In Scandinavian countries (Denmark, Norway, and Sweden), the requirement is a minimum of 50% whole grains on a dry weight basis (28–30).

In Brazil, there is no legal definition or quantitative or qualitative criteria to identify whole-grain products. Despite this gap, the Brazilian Health Regulatory Agency (ANVISA) expressed concern that many manufacturers misuse the term whole grain on food labels, perhaps in an attempt to convey the impression that the product is healthier (31). This inaccurate information can deceive consumers as to the true composition of food products, influencing food choices in a misleading way (10).

Regardless of the definition of whole grain, food labeling represents the primary means of informing consumers about the composition of packaged foods. Information displayed on food labels can guide consumers in selecting a food product, assessing its content, and understanding its proper use (32–35).

This study aimed to analyze the use of the term whole grain on the label of processed and ultra-processed foods based on cereals and pseudocereals in Brazil. To date, we identified five studies that analyzed claims, labels, and ingredients lists of food products formulated with whole grains, with special emphasis on whole-grain breads, cakes, cereal bars, and biscuits (36–40). Three of these studies were conducted in Brazil and analyzed consumer perceptions, nutrition information, and the ingredients list of whole breads and biscuits according to current regulatory requirements (37, 38, 40). However, no study was found to analyze all whole-grain foods available for sale at a given time and place. The present research collected data from a supermarket located in southern Brazil. Although limited, this method provided an overview of food items sold in a conventional supermarket and of products broadly available in the country.

Materials and methods

Study design

This cross-sectional study investigated all retail packaged food products available in a large Brazilian supermarket. The supermarket was chosen purposely and belongs to one of the 10 largest Brazilian supermarket chains, which has 27 stores throughout the country, according to the Brazilian Supermarket Association (41). Most of the food and beverage products sold in this supermarket are of broadly available brands and can be found in other large supermarkets throughout the country.

A survey was performed by mapping all aisles in the store. Data collectors were responsible for mapping every product in assigned aisles. All ready-for-sale products, regardless of their origin, that were packed in the absence of the consumer are subject to the Brazilian and Mercosur Regulation on Food Labeling (No. 360/2003) and were included in the audit (42). The supermarket manager gave written consent for the research.

Data collection

Data were gathered over a 3-month period (October to December 2013) in Florianópolis, Santa Catarina State, southern Brazil. Information on product name and type, nutritional values (energy, carbohydrate, protein, total fat, saturated fat, trans fat, fiber, and sodium contents per serving), and serving sizes were obtained in-store from product labels. These data were then fed into an electronic version of the data collection form developed by Kliemann et al. (43). The electronic form was created using Epi Collect Plus software and then installed on tablet computers. All food labels were photographed in-store to record their ingredients lists, which were later transcribed to the electronic form. This procedure was adopted so as not to disturb shoppers, given that transcribing requires a long time to be executed. For data collection, we recruited graduate and undergraduate Nutrition students ($n = 12$), who received practical-theoretical training and, 1 month before data collection, participated in a field test in a different supermarket.

To improve quality control of data, we evaluated, as in a previous study (44), the inter-rater agreement between photographs and data transcribed to the electronic forms for 5% of the products. Kappa test results showed a high degree of inter-rater agreement between the two databases (>99%, $p < 0.05$).

Data management

Collected data were transferred directly from tablet computers to an online database at the end of each collection day. The database was exported to a Microsoft Excel 2010 spreadsheet. Each food product was coded with a number, and, later, each image in the database was renamed to the corresponding food product number.

Identification and selection of cereal and pseudocereal foods labeled or not as whole grain

Brazilian legislation (45) classifies and numbers labeled foods into eight groups, as follows: (I) Baking goods, breads, cereals, legumes, roots, tubers, and related products; (II) Fresh and canned vegetables; (III) Fruits, juices, syrups, and drink mixes; (IV) Milk and dairy products; (V) Meat and eggs; (VI) Oils, fats, and nuts; (VII) Sugars and products in which carbohydrates and fats are the main energy sources; and (VIII) Gravies, sauces, ready-made seasonings, broths, soups, and ready-to-eat dishes.

We analyzed which groups contained foods based on cereals and pseudocereals. For the purposes of this study, cereals included canary grass, rice, wild rice, oat, rye, barley, fonio, adlay, common millet, pearl millet, corn, sorghum, teff, wheat, and triticale and pseudocereals included amaranth, quinoa, and buckwheat (6, 46–50).

We chose to assess processed and ultra-processed foods because they are generally formulated with various ingredients, and grains may not be used in their intact form. Groups containing only fresh and/or minimally processed foods and/or foods not based on cereals or pseudocereals were excluded from the analysis.

After defining food groups, we identified processed and ultra-processed foods based on cereals and pseudocereals, according to food census data ($n = 5{,}620$) (44). A decision flowchart was used to identify the degree of processing (51).

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Then, photographs of the front-of-pack of food items were analyzed for identification of whole grain or similar terms. Analogous terms were defined as any expression containing the term “whole” as part of the label statement (e.g., “with whole flour” and “made with whole grain”) but not as part of a claim or product name.

We developed a flowchart to assist in food identification (Supplementary material). This tool contains dichotomized questions to determine whether a food item should be included or excluded from the analysis. Food products were classified according to the presence of whole-grain-related terms: category 1, products containing the term whole grain; category 2, products containing analogous terms; category 3, products containing both whole grain and analogous terms; and category 4, conventional products that did not contain whole grain or analogous terms.

Similar foods were defined as those that were of the same group as whole-grain foods but lacked these terms, being possible to infer from the front label that these products contained refined cereals (for example, a sliced bread product containing the term traditional on the front-of-pack label). It is noteworthy that the process of regulating food products with traditional claims in the global market is still incipient. No regulatory mechanisms were found for the use of traditional claims. The United Kingdom Food Standards Agency published guidelines concerning commonly misused terms in food labels, including the descriptor traditional. The main objectives of the document were to help food manufacturers and producers decide when to use these marketing terms, help enforcement authorities identify inappropriate uses, and help consumers make informed choices (52). In Brazil, legislation states that food labels should not contain misleading information on the nature, composition, origin, or quality of the food product (53). Thus, it can be understood that packaged foods should not be described as traditional or contain related terms.

Assessment of the ingredients list

We identified ingredients derived from cereals and pseudocereals (e.g., whole cereal/pseudocereal or broken, cracked, and flaked derivatives) through qualitative analysis of food labels. Cereal and pseudocereal ingredients were classified as simple or compound (e.g., flour and mixture of flours, respectively). Subsequently, the ingredients were further classified as refined or whole grain. Whole grain items were identified as whole cereals, whole pseudocereals, or items containing the word “whole” in their name. It should be noted that compound ingredients were considered whole grain only when all ingredients were whole grain (e.g., mixture of whole flours).

Data analysis

Assessment of the use of whole-grain-related terms on the labels of processed and ultra-processed foods containing cereals and pseudocereals was carried out using two indicators: prevalence of whole grain and similar terms on the front-of-pack and frequency of whole cereals among the first three ingredients in the ingredients list of processed and ultra-processed foods containing whole-grain-related terms. For this purpose, descriptive statistical analyses were performed, and results are expressed as prevalence.

Pearson’s chi-squared test was used to assess differences in the prevalence of the use of whole grain or similar terms between food groups (45).

We carried out a descriptive analysis of the ingredients list of processed and ultra-processed foods to identify whether whole grains were the main ingredients. The order of cereal- and pseudocereal-based ingredients in ingredients lists was analyzed using Microsoft Excel 2019 spreadsheets. It should be clarified that, according to Brazilian and Mercosur legislation, ingredients must be listed in descending order of proportion by weight (53). Therefore, the relative amount of whole-grain ingredients in a food product can be deduced from their position in the ingredients list. Whole grains should be the first or second ingredient, preferably listed after water only; for foods containing several whole-grain ingredients, these ingredients should appear at the beginning of the list (54, 55). Therefore, we intentionally analyzed the presence of whole grains among the first three items of the ingredients list. Descriptive statistical analyses were performed, and results are expressed as prevalence.

Differences in the prevalence of whole grain or similar terms between food groups were assessed at the 5% significance level. Data analysis was performed using Stata version 13.0 (56).

Results

We analyzed the labels of 1,004 processed and ultra-processed foods based on cereals and pseudocereals. According to Brazilian legislation (45), these foods were categorized into two groups, namely group I, Bakery goods, bread, cereals, and related products ($n = 578$), and group VII, Sugars, sugary foods, and snacks ($n = 426$). Group VIII (Gravies, sauces, ready-made seasonings, broths, soups, and ready-to-eat dishes) was excluded from the analysis because whole-grain-related terms were only identified in fresh or minimally processed foods (e.g., almost ready-to-eat mixture of cereals and legumes). The other groups described by legislation were not included in the analysis because they did not contain foods based on cereals or pseudocereals (groups II, III, IV, V, and VI).

A total of 156 (15.5%) food products exhibited whole-grain-related terms, of which 98 (9.8%) displayed the term whole grain,

TABLE 1 Description and prevalence of processed and ultra-processed foods based on cereals and pseudocereals labeled or not as whole grain or related terms, stratified into food groups according to Brazilian Resolution No. 359/2003.

Category 1: Foods labeled as whole grain		Category 2: Foods labeled with related terms		Category 3: Foods labeled as whole grain plus related terms		Category 4: Similar conventional foods		Total *N* (%)
n **(%)**	**Examples**	***n*** **(%)**	**Examples**	***n*** **(%)**	**Examples**	***n*** **(%)**	**Examples**	
Group I - Bakery goods, bread, cereals, and related products								
87 (15.1)	Whole-grain biscuit, whole-grain noodles, whole-grain rye bread, whole-grain toast	25 (4.3)	Breakfast cereal with whole grains, granola with five whole grains, bread mix with whole flour	22 (3.8)	Salted whole-grain biscuits with rye and whole grains, whole-grain bread made with 100% whole-grain flour	444 (76.8)	Salted biscuits, cakes without filling, breakfast cereal, bread	578 (100)
Group VII - Sugars, sugary foods, and snacks								
11 (2.6)	Whole-grain cake, whole grain panettone, whole-grain cookies	–	–	11 (2.6)	Whole milk and honey biscuits made with whole grains, whole-grain cake with whole flour	404 (94,8)	Sweet cookies, cakes with filling, panettone	426 (100)
98 (9.8)	–	**25 (2.5)**	–	**33 (3.3)**	–	**848 (84.4)**	–	**1,004 (100)**

25 (2.5%) exhibited analogous terms, and 33 (3.3%) had whole grain and analogous terms on the front-of-pack (Table 1). In group I, 87 (15.1%) foods exhibited the term whole grain, 25 (4.3%) exhibited analogous terms, and 22 (3.8%) exhibited both whole grain and analogous terms. In group VII, 11 (2.6%) food products displayed the term whole grain and 11 (2.6%) displayed both whole grain and analogous terms.

Regarding group I, the food products that were most frequent in category 1 were salted biscuits (48.3%); in category 2, granola (48.0%); and, in category 3, salted biscuits and breads (40.9% each). The most frequent foods of group VII in category 1 were corn snacks (45.5%) and, in category 3, cookies (45.5%) (Table 2).

In group I, of the 87 food products containing the term whole grain (category 1), in 25 (28.7%), the term was used as a claim, in 12 (13.8%), the term was used as a product name, and, in 50 (57.5%), the term was used both as a claim and as a product name. In foods of category 3, whole grain was used as a product name in 15 products (68.2%) and as a claim and product name in seven foods (31.8%). Of category 3 foods that used whole grain as a claim and product name, only six products (27.3%), including breads, exhibited the percentage of whole-grain cereals on the front label (Table 3).

In group VII, of the 11 foods in category 1, 9 (81.8%) exhibited whole-grain claims and 2 (18.2%) used the term as a claim and product name. Of the 11 foods belonging to category 3, 9 (81.8%) used whole grain as a product name and 2 (18.2%) as both claim and product name (Table 3).

Table 4 shows the analogous expressions displayed on the front-of-pack labels of processed and ultra-processed foods. The most common terms in group I were "whole-grain cereal" (31.0%) and "made with whole grains" (24.1%). In group VII, the most frequent analogous terms were "4 whole-grain cereals" and "7 whole grains" (6.9% each).

The use of the term whole grain (category 1) on front-of-pack labels was significantly higher in group I than in group VII (Table 5).

Analysis of the ingredients list (Figure 1) showed that, in category 1 foods of group I, 47.1% ($n = 41$) of products had one type of whole grain as the major ingredient. For example, whole-wheat flour was the first ingredient of whole-wheat sesame biscuit. The frequency of products with whole grains as second (19.5%, $n = 17$) and third (5.8%, $n = 5$) ingredients was lower. None of the foods in category 2 had whole grains as the first ingredient, and only 12% ($n = 3$) had whole grains as the second or third ingredient. In category 3 foods, whole grains were the first ingredient in 50% ($n = 11$) of products, the second ingredient in 40.9% ($n = 9$), and the third ingredient in 4.5% ($n = 1$).

In group I, of the products that did not contain the term whole grain and/or analogous expressions ($n = 444$) on the front panel, 17 had a whole-grain cereal among the first three ingredients. In group VII, no product without the term whole

TABLE 2 Examples of processed and ultra-processed foods based on cereals or pseudocereals exhibiting whole grain and/or analogous terms on the front label, stratified into food groups according to Brazilian Resolution No. 359/2003.

Type of food	Category 1: Foods labeled as whole grain n (%)	Category 2: Foods labeled with related terms n (%)	Category 3: Foods labeled as whole grain plus related terms n (%)
Group I - Bakery goods, bread, cereals, and related products			
Salted biscuits	42 (48.3)	–	9 (40.9)
Bread	27 (31.0)	–	9 (40.9)
Granola	7 (8.0)	12 (48.0)	–
Empanada	3 (3.4)	–	–
Pasta	2 (2.3)	–	–
Cereal bars	2 (2.3)	2 (8.0)	–
Bread mix	1 (1.1)	1 (4.0)	–
Cake mix	1 (1.1)	–	–
Breakfast cereal	1 (1.1)	10 (40,10)	2 (9.1)
Waffle	1 (1.1)	–	–
Cake without filling	–	–	2 (9.1)
Group VII - Sugars, sugary foods, and snacks			
Corn snacks	5 (45.5)	–	1 (9.1)
Cookies	4 (36.4)	–	5 (45.5)
Panettone	1 (9.1)	–	–
Sweet popcorn	1 (9.1)	–	–
Sweet biscuits	–	–	4 (36.4)
Cake with filling	–	–	1 (9.1)

TABLE 3 Use of whole grain expressions on the front label of processed and ultra-processed foods based on cereals or pseudocereals, stratified into food groups according to Brazilian Resolution No. 359/2003.

Food group	Category	Whole-grain term used as claim n (%)	Whole-grain term used as product name n (%)	Whole-grain term used as claim and product name n (%)	Total N (%)
I[a]	Category 1: Foods labeled as whole grain	25 (28.7%)	12 (13.8)	50 (57.5)	87 (100)
	Category 3: Foods labeled as whole grain plus related Terms	–	15 (68.2)	7 (31.8)	22 (100)
VII[b]	Category 1: Foods labeled as whole grain	9 (81.8)	–	2 (18.2)	11 (100)
	Category 3: Foods labeled as whole grain plus related terms	–	9 (81.8)	2 (18.2)	11 (100)

[a]Group I: Bakery goods, bread, cereals, and related products.
[b]Group VII: Sugars, sugary foods, and snacks.

grain and/or analogous expressions had a whole-grain cereal as one of the first three ingredients.

In group VII, 45.5% ($n = 5$) of products in category 1 had whole grains as the primary ingredient and 27.3% ($n = 3$) had whole grains as the second ingredient. In category 3, whole grain was the main ingredient in 18.2% ($n = 2$) of products and the second ingredient in 9.1% ($n = 1$).

Discussion

The findings showed that 15.5% of processed and ultra-processed foods based on cereals and pseudocereals displayed the term whole grain or analogous expressions on front-of-pack labels. Furthermore, we observed a lack of standardization in the use of terms analogous to whole grains on front-of-pack labels. Studies analyzing food labels in Australia, Canada, and the United States of America (USA) found that 29, 21, and 20.7%, respectively, of breads, cereal products, and bakery products made reference to whole grains, displayed whole grain labels, or met the requirements to make whole-grain claims on the front-of-pack (36, 39, 57). The similarity between our results and those of the referred studies might be due to the lack of regulation on whole-grain foods in Australia, Brazil, and Canada (10, 39, 57, 58), which allows the food industry to use this type of information as a marketing tool. Studies have shown that, because consumers have little knowledge of whole grains, they might find it difficult to identify products containing these ingredients, thereby relying on food labels. In view of this, food labels that present clear information are useful to consumers at the time of purchase (39, 57, 58). It is worth noting that the presence of whole-grain ingredients does not necessarily imply good nutritional quality. Other nutrition information should be considered when assessing the healthiness of a product. For instance, in the study of Curtain and Grafenauer (59), it was found that grain-based muesli bars ($n = 165$) containing whole grains had higher energy, total fat, and dietary fiber values as well as lower sugar and sodium contents than bars with refined cereals. However, none of the muesli bars were considered

TABLE 4 Prevalence and examples of terms analogous to whole grain displayed on the front label of processed and ultra-processed foods based on cereals or pseudocereals, stratified into food groups according to Brazilian Resolution No. 359/2003.

Analogous term	Prevalence in group I foods[a] *n* (%)	Examples of group I foods containing analogous terms	Prevalence in group VII foods[b] *n* (%)	Examples of group VII foods containing analogous terms
Whole grain	18 (31.0)	Granola and breakfast cereal	–	–
Made with whole-grain cereals	14 (24.1)	Cereal bars, salted biscuits, and breakfast cereal	1 (1.7)	Sweet biscuits
100% whole-grain flour	4 (6.9)	Cake without filling and sliced bread	–	–
Produced with whole grains	3 (5.2)	Bread	–	–
With whole-grain flour	2 (3.4)	Cake without filling and bread mix	1 (1.7)	Cake with filling
Flour 100% whole-grain	2 (3.4)	Sliced bread	–	–
Five whole grains	2 (3.4)	Granola	–	–
With whole grains	1 (1.7)	Breakfast cereal	–	–
Produced entirely with whole-grain flour	1 (1.7)	Bread	–	–
With whole-grain rice	–	–	1 (1.7)	Corn snacks
Four whole-grain cereals	–	–	4 (6.9)	Cookies
Seven whole grains	–	–	4 (6.9)	Cookies
N	47 (81.0)	–	11 (19.0)	–
Total	58 (100)			

[a]Group I: Bakery goods, bread, cereals, and related products.
[b]Group VII: Sugars, sugary foods, and snacks.

low in sugar. Furthermore, in evaluating bars according to the classification of the Australian front-of-pack labeling system, whose objective is to help consumers make healthier choices within food categories, no significant difference was found between whole-grain and refined cereal bars.

In the current study, a higher prevalence of the term whole grain was found in the front panel of foods of group I than in the front panel of foods of group VII. This result was expected, given that foods of group VII had a lower amount of whole grains, as inferred by analysis of the ingredients list. The main characteristic of Sugars, sugary foods, and snacks (VII) is that they are ultra-processed, which, according to the literature, indicates a higher amount of refined flour.

According to the results obtained here, half of the food products labeled as whole grain did not contain a whole-grain cereal as the primary ingredient. Mozaffarian et al. (36), in analyzing the labels of cereal products sold in the USA, such as breads, cake, cereal bars, and cookies (n = 545), found that 40% of foods had whole grains as the first ingredient and 54.3% contained whole grains (regardless of the position in the ingredients list). In a Canadian survey assessing 436 labels of packaged breads, it was found that 65% of products contained at least one whole-grain ingredient and 24% contained one whole-grain ingredient in the first position of the ingredients list (39). Three studies conducted in Brazil assessing the labels of whole-wheat bread and biscuits ($n = 21$, $n = 30$, and $n = 24$) found that, among whole-wheat breads, 33.3 and 71.4% had whole wheat flour as the first ingredient, and 33.3% of whole-wheat biscuits declared whole-wheat flour as the first ingredient (37, 38, 40). Overall, the results of these studies are similar. Analysis of the ingredients list showed that products that displayed whole grain or similar terms on front-of-packs do not contain whole grains as the major ingredient, implying a lower amount of nutrients and phytochemicals. Thus, consumers might be being misled as to product composition.

A previous study in the USA aimed to determine criteria for identifying whole-grain products. The authors identified that information available on food labels could contribute to this end, including whole-grain claims and the presence of whole grains in the ingredients list, whether in the first or other positions. However, it was deemed that this information can confuse consumers and organizations, such as schools and cafeterias (36). The World Health Organization underscored, through the Global Strategy on Diet, Physical Activity, and Health, that

TABLE 5 Prevalence of the term whole grain combined or not with analogous expressions on the front-of-pack label of processed and ultra-processed foods based on cereals or pseudocereals, stratified by food groups according to Brazilian Resolution No. 359/2003.

Food group	Category 1: Foods labeled as whole grain		p	Category 3: Foods labeled as whole grain plus related terms		p
	Without analogous expressions n (%)	With analogous expressions n (%)		Without analogous expressions n (%)	With analogous expressions n (%)	
I[a]	491 (85.0)	87 (15.0)		557 (96.2)	22 (3.8)	
VII[b]	414 (97.4)	11 (2.6)	<0.001[c]	418 (97.4)	11 (2.6)	0.276
Total	905 (90.2)	98 (9.8)		975 (96.7)	33 (3.3)	

[a]Group I: Bakery goods, bread, cereals, and related products.
[b]Group VII: Sugars, sugary foods, and snacks.
[c]Significant difference (Pearson's chi-squared test, $p < 0.05$).

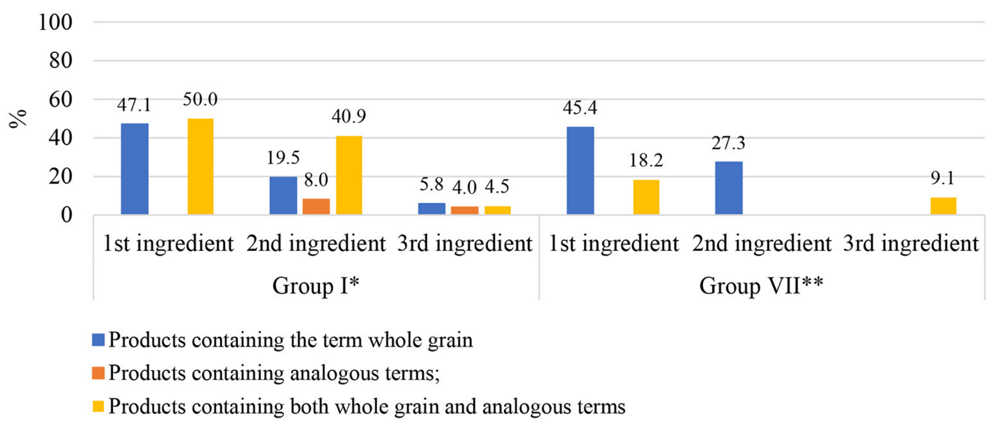

FIGURE 1
Position of whole-grain ingredients among the first three ingredients displayed in the ingredients list of processed and ultra-processed foods based on cereals or pseudocereals labeled as whole grain and/or related terms, stratified by food groups according to Brazilian Resolution No. 359/2003. *Group I: Bakery goods, bread, cereals, and related products. **Group VII: Sugars, sugary foods, and snacks.

consumers have the right to standardized, clear information on food composition for informed food choices (35).

Currently, for consumers to know whether a food product contains whole grains, it is necessary to consult the ingredients list, which is presented in descending order of weight (53). In Brazil, in view of the gap in whole-grain labeling legislation, the General Food Management (GGALI), together with ANVISA, conducted a study on the regulatory process of whole-grain foods (10). This investigation resulted in the publication of Resolution No. 493, April 2021, which came into force on April 22, 2022. The resolution determines the requirements of composition and labeling for cereal-based foods to be classified as whole grain and use whole-grain claims. According to the resolution, a food product is considered whole grain when at least 30% of ingredients are derived from whole cereals or pseudocereals and their amount is greater than that of refined ingredients. Foods may display the expression whole grain in their product name, provided that the total percentage of whole-grain ingredients be declared (47, 60). It should be noted that, in order to comply with the new legislation, food manufacturers must make changes to the way that information is presented on food labels, such as by disclosing the percentage of whole grains.

The limitations that arise from gathering data from one supermarket only must be considered. As the study was conducted in a large supermarket in southern Brazil, data may not reflect the profile of products sold throughout the country. Nevertheless, care was taken during supermarket selection to ensure that our database consisted of products of well-known brands that are found in other parts of the country.

To the best of our knowledge, this was the first study to analyze the use of whole grain and similar terms on the labels of processed and ultra-processed foods based on cereals and pseudocereals using a census database of food labels. The study is original and relevant within this field of research and may contribute to reducing the lack of publications in the area. Furthermore, our findings underscore the need to improve legislation and inspection, as well as to promote actions aimed at food and nutrition education to enable the population to understand and use food label information, thereby promoting informed food choices.

The results support the new changes in Brazil's label policy, such as the regulation proposed in 2021, which describes the composition requirements for labeling cereal-based foods as whole grain. These changes will help consumers to easily and quickly identify a whole-grain product during food purchase, allowing comparisons between products within the same food category. Such information may positively stimulate Brazilian consumers to minimize the consumption of products that do not meet their expectations or necessities with regard to whole-grain foods.

Conclusion

Our results showed that, of the 1,004 processed and ultra-processed food products based on cereals and pseudocereals analyzed, 9.8% had the term whole grain on the front-of-pack, 2.5% exhibited analogous terms, and 3.3% used both whole grain and analogous terms. This finding highlights the need to regulate whole-grain labeling to ensure clear and standardized information so as not to confuse consumers.

In assessing the position of whole-grain ingredients on the ingredients list, we found that about half of all food products analyzed did not have a whole-grain cereal as the primary ingredient. It can be said that cereal- and pseudocereal-based foods that display whole grain or similar terms on the front-of-pack contain inaccurate, unclear, or misleading information, which may prevent consumers from making informed food choices.

The results of this study may contribute to the strengthening of public policies aiming to improve food labeling legislation in Brazil. This research is relevant to show that, before implementation of regulatory requirements for whole-grain labeling, at least half of the foods containing cereals were inappropriately identified as whole grain. Thus, our results underscore the importance of this new regulation to improve the quality of information on whole foods available to consumers and its potential to improve the nutritional quality of cereal- and pseudocereal-based foods in Brazil. Future studies can be conducted to assess changes in the nutritional quality of cereal- and pseudocereal-based foods with different degrees of processing and investigate whether marketing strategies promote the consumption of healthier foods.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Author contributions

ÉB was responsible for planning the research, collecting, analyzing, interpreting the data, and drafting the manuscript. PU, AN, and AG were responsible for planning the research, collecting, analyzing, and interpreting the data, and revising the manuscript. AF and GB contributed to data interpretation and manuscript revision. RP was responsible for designing the original study, planning research and analysis, coordinating the research, supervising, revising the final manuscript. All authors approved the version submitted for publication.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fnut.2022.875913/full#supplementary-material

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ABSTRACTS

SPANISH

Uso del término "integral" en la etiqueta de alimentos procesados y ultraprocesados basados en cereales y pseudocereales en Brasil

Ha habido un aumento en el consumo de alimentos procesados y ultraprocesados, acompañado por preocupaciones crecientes acerca de la relación entre la calidad de la dieta y la salud. Alimentos integrales compuestos por cereales y pseudocereales son recomendados como parte de una dieta saludable y el etiquetado de alimentos es una importante herramienta para los consumidores identificar la presencia de cereales integrales en alimentos envasados. Este estudio tuvo por objetivo analizar el uso del término "integral" en la etiqueta de alimentos procesados y ultraprocesados basados en cereales y pseudocereales (amaranto, quinua y trigo sarraceno) en Brasil. Los datos fueron recolectados mediante un censo de todas las etiquetas de alimentos en un supermercado brasileño. Los alimentos fueron clasificados en ocho grupos de acuerdo con la legislación brasileña y de acuerdo con la presencia o ausencia del término "integral". La prevalencia de alimentos presentando el término "integral" o expresiones relacionadas en la etiqueta frontal fue evaluada y diferencias entre grupos fueron analizadas usando la prueba chi-cuadrado de Pearson. Comparaciones también fueron hechas con relación a la posición de ingredientes integrales en la lista de ingredientes, dado que el reglamento del etiquetado de alimentos brasileño exige que los ingredientes sean listados en orden decreciente del peso en los alimentos envasados. El nivel de significancia fue definido como $p < 0.05$. Las muestras incluyeron 1.004 alimentos procesados y ultraprocesados basados en cereales y pseudocereales, 156 (15,6%) de los cuales presentaron el término "integral" y/o expresiones similares en la etiqueta frontal. De estos, 98 (9,8%) contenían el término "integral", 25 (2,5%) presentaron expresiones análogas y 33 (3,3%) contenían término "integral" concomitantemente con términos análogos, identificado en alimentos de los grupos "productos de panadería, panes, cereales y productos relacionados" y "azúcares, alimentos azucarados y pasabocas". La mitad de los productos alimenticios presentando el término "integral" o expresiones relacionadas en la etiqueta frontal no tuvieron un ingrediente integral listado en la primera posición de la lista de ingredientes. La frecuencia de cereales integrales hasta fue menor cuando se analizaron los segundos y terceros ingredientes. Estos hallazgos revelan la existencia de información imprecisa con respecto al término "integral" o expresiones análogas en la etiqueta frontal de los alimentos envasados basados en cereales y pseudocereales. Se espera que estos resultados contribuyan al estímulo de la industria de alimentos y cuerpos reguladores para mejorar el uso del término "integral" y expresiones relacionadas en etiquetas de alimentos envasados, dado que, hasta el momento de la recolección de datos, no hubo requerimientos regulatorios para estas afirmaciones. Además, los hallazgos deben contribuir para mejorar la claridad de la información disponible en etiquetas de alimentos, de este modo se evita el engaño del consumidor en el momento de la compra.

Palabras clave: cereal integral, alimentos integrales, lista de ingredientes, etiquetado nutricional, alimentos envasados.

PORTUGUESE

Uso do termo "integral" nos rótulos de alimentos processados e ultraprocessados à base de cereais e pseudocereais no Brasil

Tem havido um aumento do consumo de alimentos processados e ultraprocessados, acompanhado de preocupações crescentes sobre a relação entre qualidade da dieta e saúde. Os alimentos integrais, compostos por cereais e pseudocereais, são recomendados como parte de uma dieta saudável e a rotulagem é uma ferramenta importante para o consumidor identificar a presença de cereais integrais em alimentos embalados. O estudo teve como objetivo analisar o uso do termo "integral" nos rótulos de alimentos processados e ultraprocessados à base de cereais e pseudocereais (amaranto, quinoa e trigo sarraceno) no Brasil. Os dados foram coletados a partir de um censo de todos os rótulos de alimentos de um supermercado brasileiro. Os alimentos foram classificados em oito grupos conforme a legislação brasileira e de acordo com a presença ou a ausência de menção ao termo "integral". Foi verificada a prevalência do uso do termo "integral" e expressões análogas no painel frontal, e as diferenças entre grupos foram analisadas por meio do teste qui-quadrado de Pearson. Comparações também foram feitas em relação à posição dos ingredientes integrais na lista de ingredientes, dado que a regulação brasileira de rotulagem de alimentos requer que os ingredientes sejam listados em ordem descendente de peso em alimentos embalados. O nível de significância foi definido pelo valor de $p < 0,05$. A amostra incluiu 1.004 alimentos processados e ultraprocessados à base de cereais e pseudocereais, sendo que 156 (15,6%) deles apresentaram o termo "integral" e/ou expressões análogas no painel frontal. Dentre esses, 98 (9,8%) apresentaram o termo "integral", 25 (2,5%) trouxeram expressões análogas e 33 (3,3%) continham o termo "integral" concomitante a expressões análogas, identificados em alimentos dos grupos de "produtos de panificação, pães, cereais e produtos relacionados" e "açúcares, alimentos açucarados e *snacks*". Metade dos alimentos que apresentaram o termo "integral" e/ou expressões análogas no painel frontal não apresentaram um cereal integral como primeiro ingrediente. A frequência foi ainda menor quando se avaliou o segundo e terceiro ingredientes. Estes achados revelam a existência de informações imprecisas sobre o termo "integral" ou expressões análogas no rótulo frontal de alimentos embalados à base de cereais e pseudocereais. Espera-se que estes resultados possam contribuir para auxiliar a indústria de alimentos e os órgãos reguladores para aprimorar o uso do termo "integral" e expressões relacionadas nos rótulos de alimentos embalados, dado que, até o momento da coleta de dados, não havia requerimentos regulatórios para estas declarações. Além disso, os achados podem contribuir para aprimorar a clareza da informação disponível nos rótulos de alimentos, prevenindo assim o engano do consumidor no momento da compra.

Palavras-chave: cereal integral, alimentos integrais, lista de ingredientes, rotulagem nutricional, alimentos embalados.

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From the most to the least flexible nutritional profile: Classification of foods marketed in Brazil according to the Brazilian and Mexican models

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Nutrient profiling is the science of classifying or ranking foods according to their nutritional composition, for reasons related to disease prevention and health promotion. To be effective, policies such as front-of-pack nutrition labeling (FoPNL) must have an adequate nutritional profile model, since it will determine which products will be eligible to receive a FoPNL. This study aimed to determine the percentage of packaged food and drink products available in Brazil that would be subject to FoPNL under two different legislations: Brazilian and Mexican. This is a cross-sectional study in which we collected information on food products (photos of the ingredients list, the front label, the barcode, and the nutrition facts table) from one of the largest stores of a supermarket chain in the city of Belo Horizonte-MG, Brazil, from March to May 2021 (~6 months after the publication of the Brazilian legislation about FoPNL and a year and a half before the legislation came into force). The products were classified in relation to the BNPM (added sugars, saturated fats, and sodium) and the MNPM (energy, free sugars, saturated fats, trans fats, sodium, non-sugar sweeteners, and caffeine). A total of 3384 products were collected and, after applying the exclusion criteria, 3,335 products were evaluated. Of these, 2,901 would be eligible to receive FoPNL in Brazil and 2,914 would be eligible to receive FoPNL in Mexico. According to the BNPM, 56.7% (95% CI 54.9; 58.5%) of the products were "high in" critical nutrients, 27.1% (95% CI 25.5; 28.7%) of the products in added sugars, 26.7% (95% CI 25.2; 28.4%) of the products in saturated fats, and 21.4% (95% CI 19.9; 22.9%) of the products in sodium. As for the MNPM, 96.8% (95% CI 96.1; 97.4%) of them were "high in" up to five critical nutrients and up to two warning rectangles (caffeine and non-sugar sweeteners), 45.8% (95% CI 44.0; 47.6%) of them in free sugars, 43.7% (95% CI 41.9; 45.5%) of them in saturated fats, and 47.9% (95% CI 46.1; 49.7%) of them in sodium. We concluded that the eligibility to receive FoPNL by

BNPM and MNPM was relatively similar between products; however, almost all products would have at least one FoPNL and/or warning rectangles according to Mexican legislation, and nearly half of them would have at least one FoPNL, considering BNPM. The MNPM is much more restrictive than the BNPM. The Nutrient Profile Model (NPM) that regulates FoPNL, and other health policies, must be carefully defined to ensure that foods are properly classified according to their healthiness.

KEYWORDS

food labeling, nutrient profile, front-of-pack nutrition, labeling policies, food legislation, sweetners

Introduction

Food labeling is considered an important tool for promoting healthy eating habits, allowing consumers to have access to information on the nutritional composition of foods and thus conscious choices (1, 2). However, such information is difficult to understand and limits the potential of labeling as an effective method of communication of the nutritional content of foods (1, 3).

Due to these difficulties and as a strategy to promote healthier diets, following recommendations by the World Health Organization (WHO) (4, 5), several countries have already adopted front-of-pack nutrition labeling (FoPNL) on food packages (6–9). This type of labeling consists of simple and quick information about the nutritional quality of foods and is displayed on the main panel of labels to complement the nutritional information detailed on the back of packages and facilitate consumers' understanding of the composition of the products (5, 10). Evidence suggests that FoPNL facilitates the interpretation of information by consumers and favors healthier choices and purchases, in addition to contributing to the reformulation of food by the industry (11–19).

Focused on the main objective of better informing consumers about the composition of foods, different models of FoPNL have been implemented all over the world (2), and warning labels such as the octagon have been recently implemented in some countries in Latin America (6–9). In Brazil, the chosen model for the implementation of FoPNL was the black magnifying glass model, which will inform, from October 2022, the high content of added sugars, saturated fats, and sodium (20, 21). Mexico has adopted, since 2020, the FoPNL model in the shape of a black octagon, warning about the excess of calories; free sugars; saturated fats; trans fats and sodium and the presence of caffeine and non-sugar sweeteners [with the warning rectangle "*contiene cafeína* (caffeine) *evitar en niños*" and "*contiene edulcorantes* (non-sugar sweeteners)—*no recomendable en niños*"] (6).

For the implementation of FoPNL, in addition to the label type and design, a Nutrient Profile Model (NPM) must also be defined (10). According to the WHO (4), nutrient profiling is the science of classifying or ranking foods according to their nutritional composition, for reasons related to disease prevention and health promotion. Such profiles use algorithms or cutoff points to convert the levels of nutrients and other food components into ratings or scores (22). The NPM also establishes eligibility criteria determining which foods will be able to be classified and will receive FoPNL and which nutrients will be considered, with their cutoff limits and the definition of food categories (23, 24). A careful definition of the NPM is essential to ensure that FoPNL helps consumers to differentiate less healthy foods from healthy foods and, consequently, to promote an improvement in the quality of diets (4, 25).

Currently, different NPMs are used around the world for different policy applications (4, 24, 25). The Pan American Health Organization (PAHO)'s NPM (26) was developed by experts in the field of nutrition, and it identifies processed and ultra-processed foods with excessive amounts of free sugars, sodium, total fats, saturated fats, and trans-fatty acids and informs about the presence of non-sugar sweeteners (26, 27). Ultra-processed foods are exclusive formulations of ingredients, resulting from a series of industrial processes (28). The PAHO's NPM was adapted in Mexico as the basis for defining the NPM of the current FoPNL regulation (Table 1) (6).

In Brazil, the NPM considered for the application of FoPNL (for added sugars, saturated fats, and sodium) was developed by the National Health Surveillance Agency (ANVISA) (Table 1). Before the publication of the new legislation on food nutrition labeling (20, 21), it was presented in a public consultation (20, 21, 29) that the NPM would be implemented in a staggered way to provide time for the food industry to adapt to these new labeling rules. However, in the new Brazilian legislation (20, 21), only the most flexible profile was considered. An estimate of the eligible products "high in" critical nutrients in Brazil was previously carried out, but either with stricter criteria and not officially implemented (27) or with a limited number of products

TABLE 1 Eligibility criteria and parameters of Brazilian and Mexican nutrient profile models.

	 **Brazilian nutrient Profile model (BNPM) (IN 75, 2020)**		 **Mexican nutrient Profile model (MNPM) (NOM-051, 2020)**	
FoPNL				
FoPNL eligible products	Pre-packaged foods whose amounts of added sugars, saturated fats, or sodium are equal to or greater than the defined limits		Pre-packaged products with added free sugars, fats, or sodium and with the energy value, amount of free sugars, saturated fat, trans fat, and sodium equal to or greater than the defined limits	
FoPNL exempt products	✓ Fruits, vegetables, leguminous, tubers, cereals, nuts, chestnuts, seeds and mushrooms* ✓ Flours* ✓ Packaged, chilled, or frozen meat and fish* ✓ Eggs* ✓ Fermented milk* ✓ Cheeses* ✓ Milk of all species of mammalian animals ✓ Powdered milk ✓ Olive oil and other vegetable oils, cold-pressed or refined ✓ Salt for human consumption ✓ Infant formulas ✓ Enteral nutrition formulas ✓ Weight control foods ✓ Food supplements ✓ Alcoholic beverages ✓ Products intended exclusively for industrial processing or food service ✓ Food additives and technology adjuvants		✓ Infant formulas and follow-on formula ✓ Non-alcoholic foods and beverages for infants and young children with nutritional specifications for fats, sugars, and sodium ✓ Vegetable oils, vegetable or animal fats, sugar, honey, iodized salt, and fluoridated iodized salt, as well as cereal flours	
	Solids/100 g	**Liquids/100 mL**	**Solids/100 g**	**Liquids/100 mL**
Sugars	≥15 g Added sugar	≥7.5g Added sugar[a]	≥10% of total energy from free sugars[b]	
Saturated fats	≥6 g	≥3 g	≥10% of total energy from saturated fats	
Sodium	≥600 mg	≥300 mg	≥1 mg of sodium per kcal or ≥300 mg **Calorie-free drinks:** ≥45 mg of sodium	
Energy	NA	NA	≥275 total kcal	≥70 total kcal or ≥8 kcal from free sugars
Trans fats	NA	NA	≥1% of total energy from trans fats	
Non-sugar sweeteners	NA	NA	Presence	
Caffeine	NA	NA	Presence	

*As long as no ingredients that increase the added sugars value or significant nutritional value of saturated fats or sodium are added to the product, according to the established limits.
NA, not applicable (nutrient/ingredient not considered).
[a]Added sugar considering Brazilian Legislation are all monosaccharides and disaccharides added during food processing, including fractions of monosaccharides and disaccharides from the addition of the ingredients such as cane sugar, beet sugar, sugars from other sources, honey, molasses, "rapadura," cane juice, extract malt, sucrose, glucose, fructose, lactose, dextrose, inverted sugar, syrups, maltodextrins, and other hydrolyzed carbohydrates and ingredients with the addition of any of the foregoing ingredients, with the exception of polyols, added sugars consumed by fermentation or non-enzymatic browning and sugars naturally present in milk and dairy products and sugars naturally present in vegetables, including fruits (whole, in pieces, in powder, dehydrated, in pulps, in purees, in whole juices, in reconstituted juices, and in concentrated juices) (21). In the present study, we could not consider maltodextrins as added sugar in the estimation of added sugars.
[b]Free sugars, considering Mexican Legislation, are available monosaccharides and disaccharides added (or added sugars) to foods and non-alcoholic beverages by the manufacturer, in addition to sugars that are naturally present in honey, syrups, and fruit or vegetable juices (6).

(10). Thus, it is unknown, so far, what percentage of food and drink products in a Brazilian market would be eligible to receive FoPNL at the time that precedes the implementation of FoPNL in Brazil. Moreover, the Brazilian Nutrient Profile Model (BNPM) is more flexible than the current NPM adopted in countries that had already implemented FoPNL, such as Chile (30), Peru (9), and Uruguay (7). As the NPM is the first step to other public health policies, such as FoPNL, a more recent evaluation (6 months after the publication of the new Brazilian Legislation) in a large dataset of products available in the Brazilian food supply would be interesting to evaluate the performance of BNPM and compare it to a more restrictive model, like the MNPM.

Considering that the established criteria in the NPM are fundamental for the success and credibility of FoPNL, and other health policies that are dependent on NPM, this study aimed to evaluate and compare (for the common critical nutrient between the profiles) eligible food and drink products that would receive FoPNL according to the parameters of the BNPM and the MNPM.

Materials and methods

Study design

This was a cross-sectional study, in which packaged foods and drinks sold in Brazil were evaluated using the nutrition facts table, list of ingredients, and nutritional claims and classified according to the criteria of the BNPM and the MNPM. The comparison between the two NPMs was performed based on the respective eligibility and exclusion criteria for applying the FoPNL and the nutrients/substances, as well as their respective cutoff points according to the legislation of both countries (6, 20, 21).

Data collection

Labeling information was collected at a supermarket in the city of Belo Horizonte-MG, between March and May 2021, by previously trained collectors, in one of the 10 largest chains in Brazil in 2020, and with prior authorization. The choice of the supermarket was based on the ranking published by the Brazilian Association of Supermarkets (ABRAS—Associação Brasileira de Supermercados). Data were collected from all foods and drinks that had a nutrition facts table according to the current Brazilian Regulation (RDC 360/2003) (31) and were available for sale during the collection period. If a product was available in multiple sizes or flavors, all flavors and all sizes would be collected. The products were categorized according to Normative Instruction n°75/2020 (20), a Brazilian regulation that divides foods into eight food groups: Group I–Bakery products, cereals, leguminous, roots, tubers, and their derivatives; Group II–Vegetables, greens, and pickled vegetables; Group III–Fruits, juices, nectars, and fruit refreshments; Group IV–Milk and dairy products; Group V–Meat and eggs; Group VI–Oils, fats, and oilseeds; Group VII–Sugars and products with energy from carbohydrates and fats; and Group VIII–Sauces, ready-to-eat seasonings, broths, soups, ready-to-eat dishes, and alcoholic beverages. The categories that make up the food groups are described in Supplementary Table 1.

Epicollect5 software (https://five.epicollect.net/), a free mobile and web application that generates questionnaires and freely hosts project websites for data collection, was used. The following information was collected from the packaging of the products: commercial name, sales denomination, flavor, net content, brand, barcode, nutritional information (energy and nutrients of concern), and ingredients list (added caffeine and non-sugar sweeteners). Concerning sugar content, this information was collected when it was available since the declaration of sugars is voluntary according to the Brazilian Legislation in force during data collection (31). For products without sugar content information but with sugars and/or foods that contain sugars in their ingredients list, an estimate of the content of free and added sugars was performed using an adapted method described by Scapin et al. (32) and the Pan American Health Organization (PAHO) (26).

To verify which products would receive the information "contains caffeine," according to MNPM, the terms "coffee" and "cola" were searched in the sales denomination of the products, and among the selected products, the presence of added caffeine was searched in the list of ingredients. According to current Brazilian legislation, RDC 259/2002 (33), if caffeine is an ingredient in the product, it must be included in its ingredient list. For the evaluation of the presence of non-sugar sweeteners, Resolution RDC 18/2008 (34), a regulation of non-sugar sweeteners in Brazil, was consulted. Based on this document, a search was made for the following terms in the ingredients list: sorbitol, sorbitol syrup, D-sorbite, mannitol, acesulfame potassium, aspartame, cyclamic acid and its calcium, potassium and sodium salts, isomalt, isomaltitol, saccharin and its calcium, potassium, and sodium salts, sucralose, thaumatin, steviol glycosides, neotame, maltitol, maltitol syrup, lactitol, xylitol, erythritol, and advantame. Variations in listed names were considered, such as "stevia."

Application of eligibility and NPM thresholds

The BNPM and the MNPM were applied to eligible food and drink products according to described criteria in Table 1. Foods and drinks are eligible for the application of the NPM according

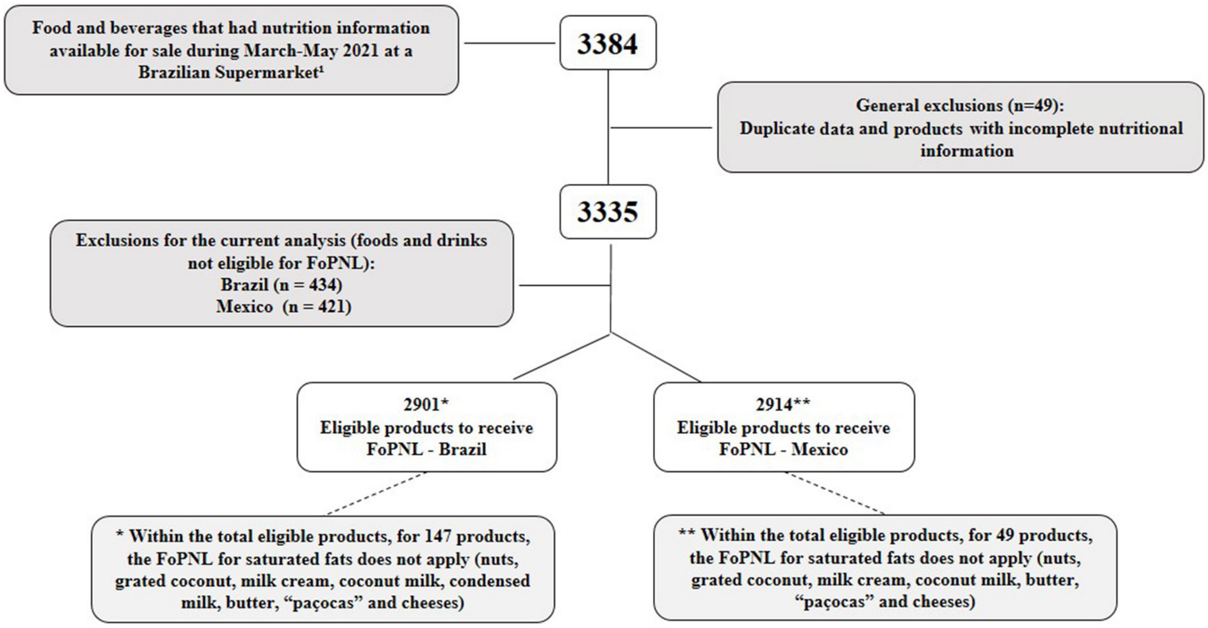

FIGURE 1
Number of initial and final products that were collected and used in the present study. [1]Information table is not currently required for alcoholic beverages, food additives, and technology adjuvants the spices; natural mineral waters ans other waters for human consumption; to vinegars; to salt (sodium chloride); coffee, yebra mate, tea, and other herbs without the addition of other ingredients; food prepared and packed in restaurants and establishments commercial, ready for consumption; Fractionated products at retail points of sale, marketed as pre-measured; fresh, chilled, and frozen fruits, vegetables, and meats; food with packaging whose visible surface for labeling is ≤100cm^2.

to BNPM if they are added by ingredients that add significant nutritional value to the product, referring to sugars, saturated fat, and sodium above certain values (21). For the MNPM, for foods with added sugar, fat, or sodium and foods with energy, free sugars, saturated fat, trans fat, and sodium, as well as for foods containing non-sugar sweeteners and added caffeine, the above reference values are the target of FoPNL (6). The criteria adopted for the nutrient cut-off point were according to stage three of MNPM.

It is important to note that the MNPM also considers free sugars present in foods, considering sugars that are naturally present in honey, syrups, and fruit or vegetable juices, besides added sugars (6). The BNPM considers only added sugars. According to the BNPM, all monosaccharides and disaccharides are added during food processing including fractions of monosaccharides and disaccharides from the addition of the ingredients such as cane sugar, beet sugar, sugars from other sources, honey, molasses, "rapadura," cane juice, extract malt, sucrose, glucose, fructose, lactose, dextrose, inverted sugar, syrups, maltodextrins, and other hydrolyzed carbohydrates and ingredients with the addition of any of the foregoing ingredients, with the exception of polyols, added sugars consumed by fermentation or non-enzymatic browning and sugars naturally present in milk and dairy products, and sugars naturally present in vegetables, including fruits (whole, in pieces, in powder, dehydrated, in pulps, in purees, in whole juices, in reconstituted juices, and in concentrated juices) (21). Although they are polysaccharides, maltodextrins were considered in the definition of added sugar of BNPM. In the present study, added sugar was estimated without considering the maltodextrins of BNPM. We assumed that the added sugar was equal to free sugar most of the time, except in the case of fruit juice addition (considered in the case of beverages).

According to MNPM, for products intended to be reconstituted or that require preparation before consumption, the declaration must be made following the directions for use indicated on the label. Therefore, chocolate powder, puddings, flans, ice cream powder, and cake mixes were calculated following its instructions (6). On the cotrary, BNPM, when referring to FoPNL, does not consider the nutritional value of the added ingredients to apply the NPM (20, 21).

After applying the eligibility criteria, the foods whose nutritional labeling was not applicable were removed, and a total of 2,901 eligible products for FoPNL according to BNPM and 2,914 eligible products for FoPNL according to MNPM were obtained. It is worth mentioning that, within the total number of products eligible for FoPNL, in which saturated fat is intrinsic to its composition, the parameters for FoPNL of this nutrient were not applied for 147 foods for BNPM and 49 for MNPM (Figure 1).

Statistical analysis

Data were compiled in an Excel spreadsheet (Microsoft Office). SPSS software (Statistical Package for Social Sciences) version 20.0 was used in the analyses. Numerical variables were presented as mean and standard deviation and also as median and interquartile range, given the non-normal distribution of the data (Kolmogorov–Smirnov test). The results of the eligibility and presence of FoPNL in the different food groups according to BNPM and MNPM were expressed in proportions and the 95% confidence interval was estimated using the binomial distribution as a reference. To compare the food and drink products "high in" values of sugars, saturated fats, and sodium, according to the BNPM and the MNPM, we used the McNemar test. To compare the values of sugars, saturated fat, and sodium among "high in" food and drink products according to the BNPM and the MNPM, we used the Mann–Whitney test. The adopted significance level was 5%.

Results

The largest number of evaluated products belonged to Groups VII ($n = 1269$) and I ($n = 679$). It is noteworthy that 87.4% (95% CI 86.2; 88.5%) of the total products would be eligible for FoPNL considering MNPM and 87.0% (95% CI 85.8; 88.1%) considering BNPM. In Groups III and VII, the number of eligible products is close to the total (99.4%; 95% CI 97.3; 100% and 98.0%; 95% CI 97.2; 98.7%, respectively), and in Groups I and VI, the number of eligible products is the lowest observed (BNPM: 65.4% 95% CI 61.8; 68.9% and 65.1% 95% CI 58.7; 71.3%, respectively, and MNPM: 65.5% 95% CI 61.9; 69.0% and 66.1% 95% CI 59.6; 72.1%, respectively) (Table 2). The results considering the sub-groups of each group are described in Supplementary Table 1.

Of the 2,901 evaluated products according to the BNPM, 1255 (43.3%) products were not "high in" any critical nutrient, 1110 (38.3%) were "high in" one critical nutrient, 535 (18.4%) were "high in" two critical nutrients, and only 1 (0.03%) product was "high in" three critical nutrients. The product "high in" three critical nutrients comes from the category of sweet cookies, with or without filling (360 kcal/100 g; 43.3 g of added sugars/100 g; 7.2 g of saturated fat/100 g; 958.3 mg of sodium/100 g). The most prevalent critical nutrient that exceeded the threshold of the BNPM was saturated fat, present in 776 products (26.7% 95% CI 25.2; 28.4%), followed by added sugar, present in 786 products (27.1%; 95% CI 25.5; 28.7%), and sodium, present in 621 products (21.4% 95% CI 19.9; 22.9%) (Table 2). As for the MNPM, of the 2,914 evaluated products, 93 (3.2%) would receive no FoPNL, 441 (15.1%) would receive one FoPNL, 1,065 (36.5%) would receive two FoPNL, 1,090 (37.4%) products would receive three FoPNL, 216 (7.4%) products would receive four FoPNL, 9 (0.3%) products would receive five FoPNL, and no product would receive six or seven FoPNL. For both models, some food categories would have 100% of the products "high in" at least one critical nutrient (Supplementary Table 1).

The percentages of products high in sugars, saturated fats, and sodium were high in the MNPM compared to the BNPM (Sugars: 45.8%; 95% CI 44.0; 47.6 vs. 27.1%; 95% CI 25.5; 28.7% | Saturated fats: 43.7%; 95% CI 41.9; 45.5 vs. 26.7%; 95% CI 25.2; 28.4% | Sodium: 47.9%; 95% CI 46.1; 49.7 vs. 21.4%; 95% CI 19.9; 22.9%) (Table 2). We highlight the discrepancy of products "high in" sugars between the two legislations for Group III (53.8%; 95% CI 46.0; 61.4% of products by the MNPM against 1.2%; 95% CI 0.2; 3.8% of products by the BNPM). It was also observed that 25.7% (95% CI 21.8; 29.9%) of products in Group I and 43.9% (95% CI 33.5; 54.7%) of products in Group II were "high in" sodium by the BNPM *vs.* 75.1% (95% CI 70.9; 78.9%) (Group I) and 90.2% (95% CI 82.6; 95.4%) (Group II) of products by the MNPM (Table 2). For products classified as "high in" sugar, the group with higher prevalence considering the BNPM was Group VII (54.3%; 95% CI 50.5; 57.0%). Considering MNPM, Group VII is the group with the highest percentage of products "high in" free sugars (68.6%; 95% CI 66.0; 71.2%), followed by Group III (53.8%; 95% CI 46.0; 61.5%) and Group IV (50.2%; 95% CI 45.6; 54.8%). The last two groups include juices and nectars and fruit refreshments (Group III) and milk and dairy products (Group IV). The prevalence of "high in" added sugars in these groups considering the BNPM was only 1.2% (95% CI 0.2; 3.8%) and 11.2% (95% CI 8.5; 14.3%), respectively.

Regarding non-sugar sweeteners, these were found in 15.8% (95% CI 14.5; 17.2%) of the 2,914 products eligible for MNPM. Considering all the evaluated products ($n = 3,335$), this percentage is 13.8%. Group VII was the group with a higher percentage of non-sugar sweeteners, in which 23.7% (95% CI 21.4; 26.1%) of the products had additives. In addition, it was found that, in some sub-groups of food categories, 100% of the products contained non-sugar sweeteners: cakes of all types, without filling ($n = 14$), powders to prepare flans and desserts ($n = 13$), and vegetables, fruits, and soy juices ($n = 5$) (Supplementary Table 1). For caffeine, the presence was less than 1% in general (0.6%; 95% CI 0.4; 0.9%) and 1.4% (95% CI 0.9; 2.2%) in all products from Group VII (Table 2), with the non-alcoholic non-carbonated beverages, such as tea and soft drinks with the highest percentage (1.6%, 18 items of 112 items) (Supplementary Table 1).

The amounts of the targeted nutrients by BNPM were higher in products "high in" considering BNPM than the amounts of these same nutrients in products "high in" the MNPM. Products "high in" the BNPM have 24.0% higher levels of saturated fat (considering mean values: 12.9 vs. 10.4 g); 45.6% higher levels of sugars (28.1 vs. 19.3 g); and 98.8% higher levels of sodium (3,832.7 vs. 1,928.4 mg) in relation to the average values of products "high in" by the MNPM (Table 3).

TABLE 2 Total number of collected food and drinks products, eligible for front-of-pack nutrition labeling (FoPNL), and receiving it according to Mexican and Brazilian Nutrient Profile Models.

Food groups			Group I	Group II	Group III	Group IV	Group V	Group VI	Group VII	Group VIII
	Total	**3,335[1]**	**679**	**84**	**161**	**505**	**135**	**218**	**1,269**	**284**
Eligible	Brazil	87.0 [85.8; 88.1]	65.4 [61.8; 68.9]	97.6 [92.8; 99.6]	99.4 [97.3; 100.0]	90.3 [87.5; 92.7]	96.3 [92.2; 98.7]	65.1 [58.7; 71.3]	98.0 [97.2; 98.7]	85.6 [81.2; 89.3]
	Mexico	87.4 [86.2; 88.5]	65.5 [61.9; 69.0]	97.6 [92.8; 99.6]	99.4 [97.3; 100.0]	90.3 [87.5; 92.7]	96.3 [92.2; 98.7]	66.1 [59.6; 72.1]	98.0 [97.2; 98.7]	89.1 [85.1; 92.4]
Presence FoPNL	Brazil	56.7 [54.9; 58.5]	40.5 [36.0; 45.2]	43.9 [33.5; 54.7]	1.9 [0.5; 3.8]	40.8 [36.3; 45.3]	60.0 [51.4; 68.2]	64.1 [56.0; 71.7]	70.6 [68.0; 73.1]	79.8 [74.5; 84.6]
	Mexico	96.8 [96.1; 97.4]	98.0 [96.4; 99.0]	95.1 [89.0; 98.5]	66.2 [58.7; 73.3]	99.1 [98.0; 99.7]	97.7 [94.1; 99.4]	100 [98.7; 100.0]	98.8 [98.1; 99.3]	98.4 [96.6; 99.5]
Added Sugars	Brazil	27.1 [25.5; 28.7]	9.2 [6.8; 12.2]	0.0 [0.0; 0.0]	1.2 [0.2; 3.8]	11.2 [8.5; 14.3]	0.0 [0.0; 0.0]	4.9 [2.1; 9.3]	54.3 [51.5; 57.0	4.12.9 [2.1; 7.1]
Free sugars	Mexico	45.8* [44.0; 47.6]	22.9* [19.2; 27.0; 28.6]	28.0 [19.1; 38.3]	53.8* [46.0; 61.4]	50.2* [45.6; 54.8]	0 [0.0; 0.0]	5.6 [2.6; 10.1]	68.6* [66.0; 71.2]	13.0* [9.3; 17.6]
Saturated fats	Brazil	26.7 [25.2; 28.4]	13.1 [10.1; 16.4]	3.7 [0.9; 9.2]	0.6 [0.0; 2.7]	27.9 [23.9; 32.1]	37.7 [29.7; 46.2]	16.2 [10.8; 22.8]	37.8 [35.1; 40.5]	18.5 [14.0; 23.7]
	Mexico	43.7* [41.9; 45.5]	31.0* [26.8; 35.4]	3.7 [0.9; 9.2]	1.2 [0.2; 3.8]	42.8* [38.3; 47.3]	81.5* [74.3; 87.6]	71.5* [63.8; 78.5]	52.5* [49.7; 55.3]	28.5* [23.1; 34.2]
Sodium	Brazil	21.4 [19.9; 22.9]	25.7 [21.8; 29.9]	43.9 [33.5; 54.7]	0.0 [0.0; 0.0]	11.0 [8.3; 14.0]	55.4 [46.8; 63.8]	48.6 [40.5; 56.8]	7.2 [5.9; 8.8]	78.2 [72.7; 83.1]
	Mexico	47.9* [46.1; 49.7]	75.1* [70.9; 78.9]	90.2* [82.6; 95.4]	5.0 [2.3; 9.1]	45.6* [41.1; 50.2]	94.6* [89.8; 97.6]	63.2* [55.1; 70.8]	26.1* [23.7; 28.6]	92.1* [88.3; 95.0]
Calories	Mexico	72.9 [71.3; 74.5]	74.4 [70.2; 78.3]	29.3 [20.2; 39.7]	53.8 [46.0; 61.4]	76.3 [72.3; 80.1]	28.5 [21.2; 36.6]	78.5 [71.3; 84.6]	87.1 [85.1; 88.8]	40.3 [34.4; 46.4]
Trans fat	Mexico	5.0 [4.2; 5.8]	8.3 [6.0; 11.1]	0.0 [0.0; 0.0]	0.6 [0.0; 2.7]	8.3 [6.0; 11.1]	4.6 [1.9; 9.1]	9.7 [5.6; 15.3]	3.2 [2.3; 4.3]	3.6 [1.7; 6.3]
Non-sugar sweeteners	Mexico	15.8 [14.5; 17.2]	10.8 [8.1; 13.9]	12.2 [6.3; 20.4]	21.2 [15.4; 28.0]	13.8 [10.9; 17.2]	0.0 [0.0; 0.0]	4.2 [1.7; 8.3]	23.7 [21.4; 26.1]	2.0 [0.7; 4.2]
Caffeine	Mexico	0.6 [0.4; 0.9]	0.0 [0.0; 0.0]	0.0 [0.0; 0.0]	0.0 [0.0; 0.0]	0.0 [0.0; 0.0]	0.0 [0.0; 0.0]	0.0 [0.0]	1.4 [0.9; 2.2]	0.0 [0.0; 0.0]

[1]The number of 3335 refers to the total products analyzed, however the percentages from the presence of FoPNL are based on the number of eligible products (BNPM=2901 BNPM and MNPM=2914).

Group I, Bakery products, cereals, leguminous, roots, tubers, and their derivatives; Group II, Vegetables, greens, and pickled vegetables; Group III, Fruits, juices, nectars, and fruit refreshments; Group IV, Milk and dairy products; Group V, Meat and eggs; Group VI, Oils, fats, and oilseeds; Group VII, Sugars and products with energy from carbohydrates and fats; Group VIII, Sauces, ready-to-eat seasonings, broths, soups, ready-to-eat dishes, and alcoholic beverages.

*$p < 0.01$ McNemar test for comparison of products "high in" according to Mexican and Brazilian Nutrient Profile Models for sugars, saturated fat, and sodium.

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TABLE 3 Mean and standard deviation, median, and interquartile intervale of nutrient contents for the food group with the presence and absence of front-of-pack nutrition labeling (FoPNL).

FoPNL	Mexico (n = 2,914)		FoPNL	Brazil (n = 2,901)		p value
	PRESENCE	ABSENCE		PRESENCE	ABSENCE	
Sugars			**Sugars**			
Percentage (number of products)[a]	45.8% (1,340)	44.2% (1,574)	Percentage (number of products)[a]	27.1% (786)	72.9% (2,115)	< 0.001
Mean (standard deviation)	19.3 g (±16.7)	0.6 g (±1.6)	Mean (standard deviation)	28.1 g (±16.6)	1.9 g (±3.5)	
Median (IQR)[b]	14.3 g (6.6–28.0 g)	0 g (0–0 g)	Median (IQR)[b]	21.0 g (16.5–40.0 g)	0 g (0.0–2.8 g)	< 0.001
Saturated fats			**Saturated fats**			
Percentage (number of products)[a]	43.7% (1,272)	56.3% (1,642)	Percentage (Number of products)[a]	26.7% (776)	73.3% (2,125)	<0.001
Mean (standard deviation)	10.4 g (±8.7)	0.8 g (±1.4)	Mean (standard deviation)	12.9 g (±6.9)	1.2 g (±6.9)	
Median (IQR)[b]	8.0 g (5.0–14.4 g)	0 g (0–1 g)	Median (IQR)[b]	11.3 g (8.0–16.7 g)	0 g (0.0–2.3 g)	< 0.001
Sodium			**Sodium**			
Percenta g e (number of products)[a]	47.9% (1,396)	52.1% (1,518)	Percentage (Number of products)[a]	21.4% (621)	78.6% (2,280)	<0.001
Mean (standard deviation)	1,928.4 mg (±4,114.7)	38.6 mg (±38.4 mg)	Mean (standard deviation)	3,832.7 mg (±4,132.6)	166.4 mg (±4,108.9)	
Median (IQR)[b]	531.0 mg (340.0–856.0 mg)	52.5 mg (10.8–128.5 mg)	Median (IQR)[b]	970.0 mg (684.1–1,809.1 mg)	86.7 mg (31.9–276.5 mg)	<0.001

IQR, Interquartile Range.
[a]Mc-Nemar test; [b]Mann–Whitney Test.

Discussion

This study compared the application of Mexican and Brazilian NPM on 3384 collected products in the Brazilian market, 6 months after the publication and one and a half years before Resolution n° 429 of 2020 came into force (21). Considering the MNPM, only 3.2% of the products would not receive FoPNL, while by the BNPM, almost half of the products (43.3%) would be classified as healthy. These results corroborate with the results of other studies that compared the BNPM with the PAHO's NPM and/or MNPM and found higher percentages of foods classified as healthy for the first profile (27, 35). Duran et al. (27) evaluated a preliminary and less rigorous BNPM than the one approved by the Brazilian Legislation, used in the present study, and observed that 38% and 55% of the foods were classified as healthy (without FoPNL) by the PAHO's NPM and BNPM, respectively. In the study conducted by Contreras-Manzano et al. (35), who evaluated foods available in the Mexican market, about 20% and almost half of the products were classified as healthy by the MNPM and the BNPM, respectively. Despite the methodological differences between the aforementioned and the present study, it is possible to notice an overestimation of the percentage of products classified as healthy by the BNPM.

Less strict NPMs, which fit a greater number of products with lower nutritional quality into healthy eating standards (36), are less capable of improving consumer eating behaviors (37) and cannot encourage product reformulation by the industry, maintaining the levels of harmful nutrients to health (38). In addition, NPMs can be used for various other purposes related to the prevention and control of obesity and overweight (26, 39) and also in addition to FoPNL, such as regulating the use of nutrition and health claims on foods, regulating the marketing of unhealthy foods to children, taxes on unhealthy foods, and restrictions on foods and beverages available or sold in and out of schools (40–42).

Although the eligibility criteria are different between the MNPM and the BNPM, especially regarding products that are exempted from FoPNL, there were no significant differences in the proportion of eligible foods for both NPMs. This result can be justified because, although the BNPM exempts a larger variety of foods from receiving FoPNL compared to the MNPM, most of these products become eligible for FoPNL when added to ingredients containing sugars, saturated fats, and sodium, bringing these results closer. This demonstrates that many of the products sold in a Brazilian supermarket and displaying the nutrition facts tables are ultra-processed or processed, aligned with other surveys of foods by the degree of processing and by NPM in supermarkets in Brazil (43) and other countries (44, 45). Eligibility criteria are important to protect some food categories that should be the main source of human food and nutrition—such as unprocessed or minimally processed foods, from the NPM and the consequent health policies, such as FoPNL. Also,

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applying eligibility criteria before the thresholds of NPM is important to predict a scenario assessment closer to reality.

The higher number of products "high in" sugars, saturated fat, and sodium by the MNPM compared to the BNPM is consistent with results from other studies comparing the PAHO's NPM with other NPMs (46–50), in which PAHO's is stricter and classifies a greater proportion of foods as "unhealthy." This result can be justified by the stricter cutoff points in the MNPM compared to the BNPM. Also, free sugars (considered in the MNPM and that includes the sugar of fruits and vegetable juices to the added sugars) are different from added sugars (considered in BNPM). The huge differences in the prevalence of products "high in" sugars in Group III (Fruits, juices, nectars, and fruit refreshments) are a consequence of the different definitions adopted between countries, besides the different cutoffs.

Some specific criteria for the application of FoPNL are also plausible justifications for the higher proportion of foods identified as "high in" by the MNPM. For example, in products that require preparation before consumption, the MNPM considers both the nutrients in the food itself and the nutrients in the added ingredients (6). On the contrary, BNPM, despite considering reconstitution, since the limits for the application of FoPNL are considered based on the ready-to-eat food, only considers the nutrients of the food itself, without the nutritional value of the added ingredients (20).

In the present study, only five products that would receive FoPNL according to the BNPM for saturated fat would not be "high in" for the same nutrient according to the MNPM: a 50% soluble cocoa chocolate powder, a corn snack, and three wheat snacks would receive FoPNL for saturated fat. The high energy density of the products is one possible explanation for this. If a food, not only has a high content of a certain nutrient, in this case, saturated fat, but also has a high energy content, the proportion is maintained and there is no extrapolation of the MNPM cutoff point, since, for these nutrients, the measure is relative (10% of the energy value) and not absolute. Although the number of products in this situation is small, this observation has been previously reported (10, 48). It is worth mentioning that the same products were "high in" for calories (all), one for free sugars (the 50% soluble cocoa chocolate powder), and the snacks for sodium according to the MNPM. Acording to MNPM, 5% of products would be "high in" trans fat.

In Brazil, trans fat was not considered in the NPM, since the legislation published in 2019 in the country foresees the limitation of the use of this component in foods (51). According to that regulation, partially hydrogenated fat will be banned as of 1 January 2023 (51).

The prevalence of caffeine in products was only 0.6% in the present study. Contreras-Manzano et al. (35) recently evaluated 38,872 packaged food products available in the Mexican supermarket and found a prevalence of 0.8% of products with added caffeine. We are not aware of other studies that identified the prevalence of added caffeine in food, probably due to the design of food labeling regulations, which make it difficult to identify them in food. We cannot discard the possibility of sub-estimation of added caffeine prevalence considering the way it has been researched in our products. However, the importance of including this information more clearly on labels has already been raised (52) since studies point to possible health harms through caffeine consumption, such as convulsions (53, 54), liver and kidney damage (55), cardiac arrhythmias (56), and headache (57). Furthermore, in children, caffeine consumption is associated with impaired growth and development, which justifies the inclusion of the warning retangle in MNPM (58).

The present study indicated that 13.8% of all evaluated products contained non-sugar sweeteners in their composition (15.8% considering eligibility criteria). Previous studies with data from 2013 (13.3%) (59) and 2017 (9.3%) (23) also reported the prevalence of non-sugar sweeteners in Brazil. However, considering the presence of non-sugar sweeteners in food categories, it was observed that some of them have different values from those previously found. While in this study, 100% of powders for preparing flans and desserts ($n = 13$) had at least one non-sugar sweetener, in the study by Figueiredo et al. (59), and the prevalence was 58.3% ($n = 24$). In addition, of the 63 evaluated soft drinks in this study, 71.4% contain one or more non-sugar sweeteners (data not shown), while in the study by Grilo et al. (23), of the 106 evaluated soft drinks, 44.3% had the additive. It should be noted that the higher prevalence of the use of non-sugar sweeteners in the group of soft drinks may be a consequence of the rules of the new Brazilian regulation of nutrition labeling (20, 21), since all soft drinks that do not have the addition of non-sugar sweeteners and were evaluated in this study would be "high in" added sugars by BNPM. Thus, the adoption of an NPM that has a warning rectangle for non-sugar sweeteners could avoid the reformulation of foods with the replacement of free sugars with non-sugar sweeteners. In Chile, whose NPM does not foresee the adoption of a warning for the presence of non-sugar sweeteners, the use of the additive increased from 37.9 to 43.6% after the initial implementation of the Chilean Labeling Law (60). It is important to notice that the use of other non-sugar sweeteners has emerged in countries that adopted the NPM—such as monk fruit and allulose—and the health effects of this kind of reformulation should be studied in future (35).

It is important to note that 45 of the 461 evaluated products with non-sugar sweeteners are products that have declared polyols in the ingredients list with a moistening, emulsifying, or stabilizing function. However, by the definition of the MNPM, non-sugar sweeteners are substances other than monosaccharides and disaccharides that impart a sweet flavor to products (6). Thus, even if they do not have the function of partially or completely replacing sugar, they are counted as products with non-sugar sweeteners and must carry the warning rectangle "*contiene edulcorantes (non-sugar* *sweeteners)—no recomendable en niños.*" We highlighted here the result found in the category "cakes, all types, without filling" ($n = 14$), where 100% of the products had a non-sugar sweetener substance but with another technological function described in its ingredients list.

For this study, to the best of our knowledge, data collection took place most recently in Brazil. Data collection happened between March and May 2021, when the changes provided by the new food labeling legislation, expected to be implemented in October of 2022, (20, 21), were already known. However, the present study has some limitations that deserve discussion. First, the collection was restricted to only one supermarket in the city of Belo Horizonte and may not reflect all the available packaged foods for sale in the country. Second, the assessment of the presence of FoPNL for sugars was performed based on estimates of free and added sugars (26, 32), since in Brazil, to date, the declaration of the total sugar content of foods is not mandatory. Also, BNPM considers maltodextrin as added sugar and it was not possible to estimate the amount of maltodextrin in some products. The research for added caffeine can be sub-estimated since we searched for caffeine in some products that, by sales denomination, probably had caffeine and not in all products of our database. Finally, the different ways of categorizing a database (22, 61) can make it difficult to compare the results from different studies, for example, in the categorization used in this study, soft drinks are included in the category of non-alcoholic beverages, carbonated, or non-carbonated (teas, soy-based drinks, and soft drinks). However, this was the categorization that best suited the database products and has also been used in other studies (59, 62).

Conclusions

Under both BNPM and MNPM, most of the evaluated products in this study were "high in" nutrients that are harmful to health. Although the percentage of products eligible to receive FoPNL was very close between the two profiles (87.4% under the MNPM and 87.0% under the BNPM), the total number of products "high in" critical nutrients varied greatly (96.8% under the MNPM and 56.7% under the BNPM). In addition, the application of the MNPM criteria resulted in higher proportions of products identified with an excess of each nutrient (sugars, saturated fats, and sodium) specifically, because it encompasses more nutrients than the BNPM, such as calories, trans fat, non-sugar sweeteners, and caffeine, but also because of the more restrictive cutoff points.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Author contributions

LA: study conception. ASi, LT, LB, ASo, and CP: data collection and transcription. LT, CP, and LB: data categorization. CP, LB, ASi, and LT: data on eligibility. LB, CP, ASi, and ASo: FoPNL application and tabulation. SP, LT, and ASo: discussion of data. SP, LT, CP, LB, and LA: writing. ASi: translation. NF: formatting and references. All authors: sugar estimation and final version of approval.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fnut.2022.919582/full#supplementary-material

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ABSTRACTS

SPANISH

Del perfil de nutrientes más flexible al menos flexible: clasificación de los alimentos comercializados en Brasil de acuerdo con los modelos brasileño y mexicano

El perfil de nutrientes es la ciencia de clasificar o categorizar alimentos de acuerdo con su composición nutricional, por razones relacionadas a la prevención de enfermedades y promoción de la salud. Para ser efectivo, políticas como el etiquetado nutricional frontal (ENF) deben tener un modelo de perfil nutricional adecuado, ya que determinará qué productos serán elegibles para recibir un ENF. Este estudio pretendió determinar el porcentaje de alimentos y bebidas envasados disponibles en Brasil que serían sujetos a un ENF bajo dos diferentes legislaciones: brasileña y mexicana. Este es un estudio transversal en el cual recolectamos información de productos alimenticios (fotos de la lista de ingredientes, la parte delantera de la etiqueta, el código de barras y la tabla de información nutricional) proveniente de una de las mayores tiendas de una cadena de supermercados en la ciudad de Belo Horizonte-MG, Brasil, desde marzo hasta mayo del 2021 (~6 meses después de la publicación de la legislación brasileña acerca del ENF y un año y medio antes de que la legislación comenzara a tomar fuerza). Los productos fueron clasificados con relación al modelo de perfil de nutrientes brasileño (MPNB) (azúcares añadidos, grasas saturadas y sodio) y el modelo de perfil de nutrientes mexicano (MPNM) (energía, azúcares libres, grasas saturadas, grasas trans, sodio, edulcorantes y cafeína). Un total de 3.384 productos fueron recolectados y después se aplicó un criterio de exclusión. Con eso, 3.335 productos fueron evaluados. De estos, 2.901 serían elegibles para recibir un ENF en Brasil y 2.914 serían elegibles para recibir un ENF en México. De acuerdo con el MPNB, 56,7% (95% IC 54,9; 58,5%) de los productos eran "altos en" nutrientes críticos, 27,1% (95% IC 25,5; 28,7%) de los productos en azúcares añadidos, 26,7% (95% IC 25,2; 28,4%) de los productos en grasas saturadas, y 21,4% (95% IC 19,9; 22,9%) de los productos en sodio. Así como el MPNM, 96,8% (95% IC 96,1; 97,4%) de ellos eran "altos en" hasta cinco nutrientes críticos y hasta dos rectángulos de advertencia (cafeína y edulcorantes), 45,8% (95% IC 44,0; 47,6%) de ellos en azúcares libres, 43,7% (95% IC 41,9; 45,5%) de ellos en grasas saturadas, y 47,9% (95% IC 46,1; 49,7%) de ellos en sodio. Concluimos que la elegibilidad de recibir un ENF por MPNB y MPNM fue relativamente similar entre los productos; sin embargo, casi todos los productos tendrían al menos un ENF y/o rectángulos de advertencia de acuerdo con la legislación mexicana, y casi la mitad de ellos tendría al menos un ENF, considerando el MPNB. El MPNM es mucho más restrictivo que el MPNB. El modelo de perfil de nutrientes (MPN) que regula el ENF y otras políticas de salud debe ser cuidadosamente definido para asegurar que los alimentos sean apropiadamente clasificados de acuerdo con su calidad para la salud.

Palabras clave: etiquetado de alimentos, perfil de nutrientes, etiquetado nutricional frontal, políticas de etiquetado, legislación de alimentos, edulcorantes.

PORTUGUESE

Do perfil de nutrientes mais flexível ao menos flexível: classificação dos alimentos comercializados no Brasil de acordo com os modelos brasileiro e mexicano

Perfil de nutrientes é a ciência que classifica ou ranqueia os alimentos de acordo com sua composição nutricional, para fins de prevenção de doenças e promoção de saúde. Para serem eficazes, políticas como a de rotulagem nutricional frontal (RNF) devem ter um modelo de perfil de nutrientes adequado, já que irá determinar quais produtos serão elegíveis para receber a RNF. Este estudo teve como objetivo determinar a porcentagem de alimentos e bebidas disponíveis em um supermercado no Brasil que estariam sujeitos à RNF sob duas legislações diferentes: brasileira e mexicana. Trata-se de um estudo transversal no qual foram coletados informações de rótulos de produtos (fotos da lista de ingredientes, face frontal da embalagem, código de barras e tabela de informação nutricional) em uma das maiores lojas de uma rede de supermercados da cidade de Belo Horizonte-MG, Brasil, entre março e maio de 2021 (~6 meses após a publicação da legislação brasileira sobre RNF e um ano e meio antes da entrada em vigor

da legislação). Os produtos foram classificados segundo o modelo de perfil de nutrientes brasileiro (MPNB) (açúcares de adição, gorduras saturadas e sódio) e o modelo de perfil de nutrientes mexicano (MPNM) (energia, açúcares livres, gorduras saturadas, gorduras trans, sódio, edulcorantes e cafeína). Um total de 3.384 produtos foram coletados e após a aplicação dos critérios de exclusão, foram avaliados 3.335 produtos. Destes, 2.901 eram elegíveis para receber RNF no Brasil e 2.914 eram elegíveis para receber RNF no México. De acordo com o MPNB, 56,7% (IC 95% 54,9; 58,5%) dos produtos eram "altos em" nutrientes críticos, sendo 27,1% (95% CI 25,5; 28,7%) "altos em" em açúcares adicionados, 26,7% (IC 95% 25,2; 28,4%) "altos em" gorduras saturadas e 21,4% (IC 95% 19,9; 22,9%) "altos em" sódio. Quanto ao MPNM, 96,8% (IC 95% 96,1; 97,4%) dos produtos seriam "altos em" até cinco nutrientes críticos e receberiam até dois retângulos de advertência (cafeína e edulcorantes), sendo que 45,8% (IC 95% 44,0; 47,6%) dos produtos receberiam RNF referente a açúcares livres, 43,7% (IC 95% 41,9; 45,5%) receberiam RNF referente a gorduras saturadas e 47,9% (IC 95% 46,1; 49,7%) receberiam RNF referente a sódio. Concluiu-se que a elegibilidade para receber RNF pelos MPNB e MPNM foi relativamente similar entre os produtos; entretanto, quase todos produtos teriam pelo menos uma RNF e/ou retângulos de advertência de acordo com a legislação mexicana, e pouco mais da metade dos produtos avaliados receberia pelo menos uma RNF considerando o MPNB. O MPNM é muito mais restritivo do que o MPNB. O modelo de perfil de nutrientes (MPN) que regula a RNF e outras políticas de saúde deve ser cuidadosamente definido para garantir que os produtos sejam devidamente classificados conforme sua saudabilidade.

Palavras-chave: rotulagem de alimentos, perfil de nutrientes, rotulagem nutricional frontal, políticas de rotulagem, legislação, edulcorantes.

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Influence of nutrition claims on different models of front-of-package nutritional labeling in supposedly healthy foods: Impact on the understanding of nutritional information, healthfulness perception, and purchase intention of Brazilian consumers

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Nutrition claims are positive information about foods, which are widely used as a marketing strategy on labels. On the contrary, front-of-package nutritional labeling (FoPNL) aims to make it easier for consumers to understand the nutritional composition of foods and favor healthy food choices. However, the concomitant presence of nutrition claims and FoPNL may hinder the understanding, judgment, and choices of consumers at the moment of purchase. Therefore, the objective of this study was to evaluate the influence of nutrition claims on the efficacy of FoPNL models in the understanding of nutritional information, healthfulness perception, and purchase intention of Brazilian consumers. It was an experimental cross-sectional study carried out using an online questionnaire, with a total of 720 participants randomly divided into four FoPNL conditions: control, octagon, triangle, and magnifying glass. Each participant looked at 12 food packages, which were produced following the factorial design: (i) food category (cereal bar, whole grain cookies, and snacks); (ii) product type (containing one critical nutrient × containing two critical nutrients); and (iii) nutrition claims (present × absent). The comprehension of nutritional information was evaluated through the identification of excessive nutrients, and the healthfulness perception and purchase intention were evaluated using a seven-point scale. The results indicated that the presence of FoPNL increased the understanding of the information and reduced healthfulness perception and purchase intention. The presence of nutrition claims influenced the three outcomes, decreasing the probability of understanding information about food composition by 32% (OR 0.68, 95% confidence interval 0.58–0.78, $p < 0.01$) and significantly increasing ($p < 0.05$) average health scores (1.95–2.02) and purchase intention (2.00–2.05). Nonetheless, the interaction "FoPNL × claims" was not significant, which indicated that claims act independently. All FoPNL models were more effective than the control. For the least healthful type of product (two nutrients in excess), the octagon and triangle models were superior to the magnifying glass, regarding the outcome of healthfulness perception. The results prove the efficacy of FoPNL in consumer understanding and judgment. Despite the positive effects of FoPNL, it did not cancel the positivity bias generated by the claims.

KEYWORDS

food labeling, nutrition policy, FOP, warning labels, consumer research, consumer perception, health halo, positivity bias

Introduction

In general, nutrient declarations, especially those related to excessive nutrients considered critical (such as added sugars, saturated fat, and sodium), are hard to find and interpret and are therefore rarely used by consumers at the moment of purchase (1–3). For this reason, the front-of-package nutritional labeling (FoPNL) was proposed to make it easier for consumers to understand the nutritional information of foods (4, 5). Besides improving the comprehension of nutritional information, FoPNL encourages healthier food choices as well as product reformulations by the industry toward less nutritionally unbalanced options (6). Thus, it may aid in the reduction of obesity risk and non-communicable diseases (7).

As recommended by international health bodies (8–10), FoPNL has been implemented in different countries with differences in design, type of information provided, and the degree/level of guidance provided for consumers to communicate the nutritional content and relative healthfulness of the foods (11, 12). Among the different models of FoPNL, nutritional warning models, which provide direct information about the excessive content of harmful nutrients, using text-based seals (13), have performed better than other FoPNL models (11, 13–16). This happens because nutritional warning models better serve the purpose of FoPNL: to allow consumers to correctly, quickly, and easily identify products that contain excessive amounts of critical nutrients, promoting more informed choices (13).

Several Latin American countries already have mandatory frontal nutritional labeling with warning models (17). In Chile (18), Mexico (19), Peru (20), and Uruguay (21), for example, the black octagon is applied to the front panel of packages to inform consumers when a product contains excessive amounts of critical nutrients (13). In Brazil, the triangle model was proposed to the regulatory body as an option for FoPNL, by design and nutrition experts (22). However, the magnifying glass was the chosen model, which will be implemented on a mandatory basis in October 2022 (23, 24). Although the magnifying glass models can promote the identification of "high in" food products as other warning models, its graphic symbol does not refer to the idea of alert or risks like other symbols, such as the octagon and the triangle, but the idea of "magnifying information, making its visualization easier, and suggesting the search for and evaluation of other information" (25).

A series of factors influence the performance and efficacy of FoPNL models, both regarding design characteristics such as color, size, and position in the package (26), and personal characteristics of consumers, such as gender, age, socioeconomic status, and interest in health (12). For instance, studies have shown that individuals with greater interest in health and healthy eating tend to check the nutritional information available on labels more frequently to make their food choices (27–30). Nutrient declarations are not the only source of information that compete for the attention of consumers who read labels to choose foods (31–33). Nutrition claims, though regulated, are used by the food industry to attract attention, promote health associations/perceptions among consumers, and increase sales (31, 32, 34, 35). According to the taxonomy developed by the International Network for Food and Obesity/Non-communicable Diseases Research, Monitoring, and Action Support (INFORMAS), food claims are classified into three categories: nutritional, health, and other claims that include, for example, claims related to the environment, such as "organic" (36).

Some studies have shown that the presence of claims on foods positively influences consumer perceptions of products (32, 37–43). However, in the literature, results concerning the effects of claims on consumer perceptions and behavior are inconsistent (44, 45). A review on the topic, which evaluated different types of claims (nutrition, health, and risk reduction), concluded that specific consumer characteristics, such as nutrition knowledge and health motivation, as well as product characteristics such as perceived healthiness, are the factors responsible for this incongruity of results (45). Furthermore, the influences of these characteristics may be limited to the food categories tested in the studies, which makes it difficult to generalize the results (45).

This positive influence generated by the presence of the claims is defined as a positivity bias or a health halo effect (44). The positivity bias occurs when the presence of information leads to better evaluations of the products by the consumer (46). The halo effect occurs when the consumer uses more specific information, for example, claims, to evaluate the product instead of other available information (46). These positive effects can generate misjudgments about the healthiness of foods (47), especially nutritionally unbalanced foods (45).

For this reason, some studies have evaluated the effects of the concomitant presence of FoPNL with other resources from the label, such as nutrition claims (32, 39, 40, 48, 49). The results of the studies are contradictory; while some have observed that FoPNL can nullify the positivity bias generated by claims (32, 41, 50), others have observed that the positive effect of claims on consumer perceptions occurs even in the presence of FoPNL (39, 40), and claims concerning the nutrients targeted by FoPNL may hinder the effectiveness of the FoPNL itself (49).

In this type of experimental design, there is still a lack of research performed on the Brazilian population (32) and, so far, there have been no studies in the literature that evaluate the influence of nutrition claims on the magnifying glass model, which will be implemented in the country (23). Therefore, the objective of this study was to evaluate the influence of nutrition claims on the efficacy of octagon and triangle FoPNL models, as determined by the Chilean legislation, and of the magnifying glass model, according to Brazilian legislation, in the understanding of nutritional information, healthfulness perception, and purchase intention of Brazilian consumers.

Given the positivity bias generated by nutritional claims on consumer perceptions (15, 32, 39, 41), and the trend toward the better performance of warning labels compared to the magnifying glass model (12, 51, 52), reported in the literature, the following hypotheses were created: (i) The presence of claims will lead to a positivity bias (greater perceptions of healthiness and purchase intent), regardless of FoPNL; (ii) the positivity bias generated by the claims will be weaker in the presence of warning labels (octagon and triangle), intermediate in the presence of the magnifying glass, and higher in the control.

Materials and methods

Participants

The study was performed with 720 participants who were over 18 years of age, representing the Brazilian population regarding gender, geographical region, socioeconomic status, and education characteristics, using quotas defined according to the Brazilian Institute of Geography and Statistics (53). The inclusion criteria of the study were being over 18 years of age and answering the questionnaire with the use of a computer. This last criterion excluded the participation using cellphones and tablets to ensure label visualization was as close as possible to real-sized products. The exclusion criteria were working in the food and/or nutrition field. The participants were recruited from a panel of respondents obtained from a market research company. All participants consented to participate in the research through a free and informed consent form. The study was carried out between December 2021 and February 2022, as approved by the Research Ethics Committee of the Universidade Federal de Minas Gerais (Brazil Platform—CAAE 2395020.1.0000.5149).

Experimental design

This was an experimental, cross-sectional study, carried out through an online questionnaire, to evaluate the influence of nutrition claims on different FoPNL models. It was based on the studies by Deliza et al. (12) and Bandeira et al. (51), who evaluated the performance of different FoPNL models according to observations from Brazilian consumers, among which was a preliminary model of the magnifying glass model. The study was also based on the research by Nobrega et al. (32), who evaluated the effect of the presence of nutrition claims and warnings on the healthfulness perception of Brazilian consumers. In this study, the FoPNL models tested were black octagon, black magnifying glass, and black triangle (**Figure 1**). Data on three outcomes were collected: the understanding of nutritional information (correct or incorrect), healthfulness perception, and purchase intention (both measured using a seven-point scale).

The participants were randomized in one of the four experimental conditions: control (without FoPNL), octagon, magnifying glass, and triangle (**Figure 2**). For each condition, the combinations between the following three factors tested in the food labels were assessed: (i) product category (cereal bar, whole grain cookies, and snacks); (ii) product type (containing one critical nutrient × containing two critical nutrients); and (iii) nutrition claims (present × absent). The combination of

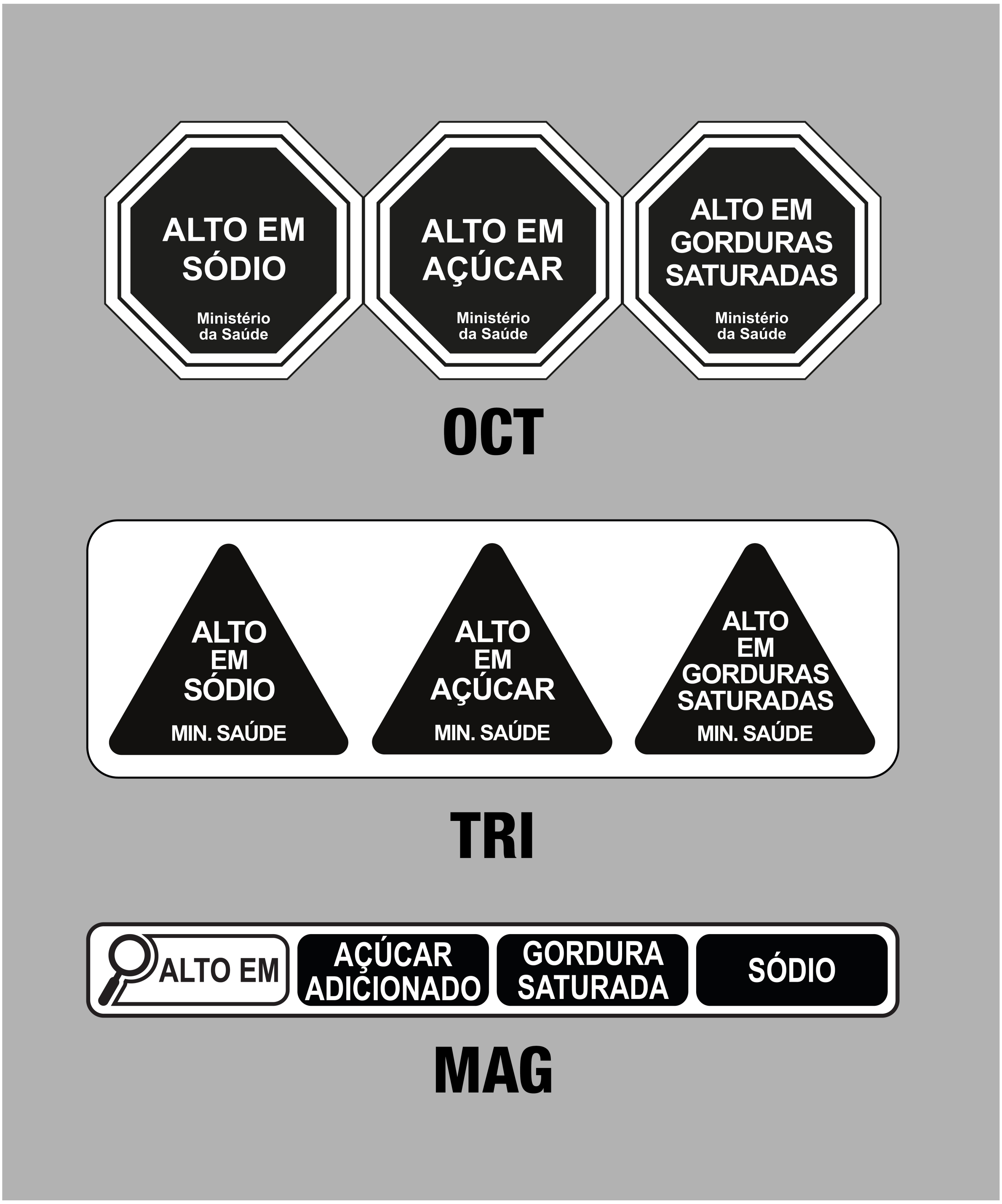

FIGURE 1
Models of front-of-package nutritional labeling tested in the study. OCT, octagon; TRI, triangle; MAG, magnifying glass.

these three factors (3 × 2 × 2) resulted in 12 front panels of food labels, by experimental condition, and the presentation of the images varied among the participants, following a Latin square experimental design (54). Considering operational issues regarding data collection that would make it impossible to obtain preliminary data to calculate the sample size, the calculations were done assuming a continuous response to be analyzed by an ANOVA applied to the data of an experiment

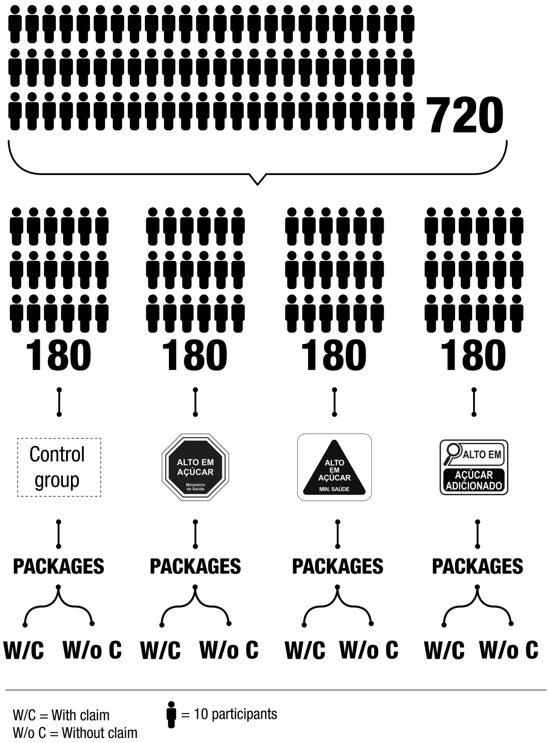

FIGURE 2
Allocation of participants in the intervention conditions of the study.

designed with blocks (participants) that evaluated 12 treatments (repeated measures). The number of participants in each one of the four experiments was limited to 180, resulting in a total of 720 participants (**Figure 2**). Since each Latin square required a minimum of 12 participants, it was replicated 180/12 = 15 times. Considering a probability of 5% of Type I Error and a test power of 90%, the number of 180 participants would be able to detect a size effect equal to or higher than 0.345 (a moderate one). All participants looked at the same food labels, with changes only in the presence/model of FoPNL.

Stimuli

The three food categories (cereal bars, whole grain cookies, and snacks) with a "healthy snack" visual appeal (**Figure 3**) were selected due to the potential of FoPNL to modify consumer healthfulness perception and purchase intention, especially for foods that are mistakenly regarded as healthy (55), such as cereal bars, breakfast cereals, among others, which traditionally use the healthfulness "appeal" as a marketing strategy (33, 56–58). For each category, two types of products with different nutritional compositions were selected, one with only one excessive critical nutrient and another with two excessive critical nutrients (**Figure 4**). The presence and absence of positive nutrition claims on food labels were controlled. Two nutrition claims were included in products that were supposed to carry such information: nutrient content claim and another nutrient claim related to health, according to the INFORMAS taxonomy (36) (**Figure 4**). The combination of the three mentioned factors, (i) product category, (ii) product type, and (iii) nutrition claims, resulted in 12 (3*2*2) package front panels with different food labels, for each experimental condition. **Table 1** shows the nutritional composition of the products used as a reference to elaborate the labels, with the respective information on FoPNL inclusion and nutrition claims.

The front panels of packages with labels were developed by an information designer, using Photoshop and Illustrator software (Adobe©), to combine graphic elements (colors, typography, photography, and illustrations) from different products that exist in the Brazilian market, fictitious brands, and at least one excessive critical nutrient (added sugars, saturated fat, and sodium). Although the Chilean legislation (18) encompasses a greater number of critical nutrients in FoPNL, only the three nutrients mentioned were considered, once that is how the Brazilian legislation (23) defines it. The added sugar, saturated fat, and sodium limits considered for the inclusion/declaration in the FoPNL were also defined according to the parameters of the Brazilian legislation (23), considering the nutritional composition of the used products as a reference. Once the total and added sugars were not available in the nutritional information of the products, an estimate of the added sugars was performed based on the method proposed by the Pan American Health Organization Nutrient Profile Model, considering the quantity of total sugars declared (59). Even though this method estimates the quantity of free sugars in the product, all the free sugar corresponding to the added sugars in the products are used as a reference (cereal bars and sweet whole grain cookies). The FoPNL models were applied to the top-right corner of the labels, as suggested by the Chilean legislation that regulates FoPNL (18), and the percentage of the main panel area of the packages they occupied followed the model guidelines. The octagon and triangle models followed the proportions established in the Chilean legislation and application manual (18), and the labels with magnifying glasses followed the proportions in the Brazilian legislation (23).

Experimental procedure

The research questionnaire consisted of four steps. In the first one, participants provided some personal information such as weight (kg), height (cm), whether they were responsible for the household grocery shopping, and the frequency of consumption of the evaluated products. Sociodemographic information such as gender, age, geographical region, socioeconomic status, and education was not requested, once the research company already had such data.

FIGURE 3
Food categories considered in the study with an example of the octagon symbol.

In the second step, the participants were introduced to the 12 food labels, one by one, following the Latin square design, and answered three questions:

(i) does this product contain any nutrient in a higher quantity than recommended for a healthy diet? With the following answer options: "No," "Yes, sugar," "Yes, saturated fat," and "Yes, sodium." The participant could choose more than one answer;
(ii) show how healthy you consider this product by choosing one of the options on a seven-point scale, ranging from 1—"not healthy" to 7—"very healthy";
(iii) show your intention to purchase this product by choosing one of the options on a seven-point scale, ranging from 1—"I would definitely not buy it" to 7—"I would definitely buy it."

The third step of the questionnaire was applied only to the groups that looked at FoPNL labels (octagon, magnifying glass, and triangle). The participants observed the respective FoPNL model and answered eight questions that assessed consumer opinions and perceptions regarding visibility, ease of understanding, and credibility of the information, among other aspects related to front-of-package labeling. Such questions were adapted from the study by Khandpur et al. (60) and answered according to a seven-point Likert scale, ranging from 1—"I strongly disagree" to 7—"I strongly agree."

In the fourth and last step of the questionnaire, the participants were asked to answer the General Health Interest questionnaire, a subscale of the Health and Taste Attitude Scales (61), translated to Portuguese (62) and validated. This questionnaire consists of eight questions designed to assess consumer interest in healthy eating, which were answered according to a seven-point Likert scale, ranging from 1—"I strongly disagree" to 7—"I strongly agree" (62).

Data analysis

All statistical analyses were performed using the *Statistical Package for the Social Sciences* (SPSS) software, versions 20.0 and 28.0, at a significance level of 5%. Differences in the frequency of participant sociodemographic characteristics were assessed using the chi-square test.

To evaluate the understanding of nutritional information, a binary variable was created for each label/product to identify the correct answers, using the answers to the question "Does this product contain any nutrient in a higher quantity than recommended for a healthy diet?" ("No;" "Yes, sugar;" "Yes, saturated fat;" "Yes, sodium"). Since the participant could choose more than one option, an answer to this question was considered correct only if the participant mentioned those nutrients that were excessive. Answers that considered the nutrients in excess, as well as others whose values were not above the ones recommended by the nutritional profile adopted (23), were not considered correct. The percentage of correct answers was calculated for each FoPNL condition. A generalized linear mixed model (GLM), through binary logistic regression, with random effects on the individuals was used to evaluate the influence of FoPNL conditions (control, octagon, magnifying glass, and triangle), nutrition claim condition (presence and absence), food category (cereal bar, cookie, and snack), and type of product (containing one or two excessive nutrients) and their two-way interactions in the probability of a correct understanding of the nutritional information. The model was adjusted for questions about interest in health in which significant differences between experimental groups were detected.

Healthfulness perception and purchase intention scores were evaluated using a mixed model analysis of variance (ANOVA). FoPNL, nutrition claims, food category, type of product, and their interactions were considered fixed effects, and participants were considered random effects. When interactions were significant, ANOVA was performed for each type of product separately. Sidak's test was used for a *post hoc* comparison of the average values. The models included, as adjustment variables, those questions about interest in health in which significant differences between experimental groups were detected.

The average and standard deviation of agreement regarding the Likert scale were calculated separately for each question of the opinion and perception questionnaire and the interest in health one. ANOVA was used to assess the existence of

FIGURE 4
Combination of factors considered for label development: food category (cereal bars, snacks, and crackers/cookies); type of product (containing 1 or 2 nutrients in excess); nutrition claim (present vs. absent).

TABLE 1 Nutritional composition of the products used as a reference for the study and their respective FoPNL and nutrition claim information.

Category	Type of product	Serving (g)	Nutrient content per serving					FoPNL			Nutrition claims
			Calories (kcal)	Total sugars (g)	Added sugars (g)*	Saturated fat (g)	Sodium (mg)	Added sugars	Saturated fat	Sodium	Nutrient claim related to health/Nutrient content claim
Cereal bar	1 nutrient	22	87	4.8	3.6	1.3	17	✓			With whole grains/Low in sodium
	2 nutrients	20	86	5.7	5.7	2.5	28	✓	✓		With whole grains/Low in sodium
Whole grain cookie	1 nutrient	21	88	2.4	2.4	0.4	130			✓	Whole grains/Low in saturated fat
	2 nutrients	20	92	6.4	4.8	1.7	40	✓	✓		Whole grains/Source of vitamins and minerals
Snack	1 nutrient	45	184	2.8	2.8	0.7	182			✓	Whole grains/Low in saturated fat
	2 nutrients	40	188	-	-	4.0	500		✓	✓	Whole grains/High in fiber

*Estimated according to the PAHO Nutrient Profile Model.

significant differences between the conditions of FoPNL, and Tukey's test was used for *post hoc* comparisons.

Results

Participants

The samples consisted of 51.7% women and 48.3% men, and the median age was 30 years, ranging from 18 to 73 years (Table 2). Significant differences were found between groups solely regarding the consumption frequency of cereal bars and snacks (Table 2).

Understanding of nutritional information

The understanding of nutritional information was significantly affected by FoPNL, food category, type of product, nutrition claims, and by "FoPNL × food category" and "Food category × type of product" interactions (Table 3).

The presence of nutritional claims reduced by 32% the chance of answering correctly in relation to the content of critical nutrients (Table 4). The inclusion of FoPNL increased the chance of correct answers in the three food categories (Table 4). For the cereal bar category, for instance, the chance of answering correctly was 63 times greater for the octagon group and 54 and 44 times greater for the triangle and magnifying glass, respectively, when compared to the control (Table 4).

Comparing the products with one and two critical nutrients in excess, it was possible to observe that the greater amount of critical nutrients (i.e., two nutrients) reduced the understanding of nutritional information by 49, 21, and 49% for the cereal bars, cookies, and snacks, respectively (Table 4).

Healthfulness perception

Healthfulness perception of products was significantly affected by all the main effects included in the model (FoPNL, food category, type of product, and nutrition claims) and by the interaction "FoPNL × type of product." The significance of this interaction suggested that the impact of FoPNL on healthfulness perception depends on the number of critical nutrients in the product (1 or 2 nutrients in excess) (Table 3).

Table 5 shows the average health scores for the evaluated products, considering the effects included in the model, and their interactions. It is possible to observe that cereal bars were perceived as least healthy than cookies and snacks and the presence of nutrition claims statistically increased health perceptions (Table 5).

TABLE 2 Sociodemographic characteristics of the study participants.

Characteristic	Participant percentage (%)				
	General ($n = 720$)	Control ($n = 180$)	Octagon ($n = 180$)	Triangle ($n = 180$)	Magnifying glass ($n = 180$)
Age (median/P25–p75)	30 (23–41)	30 (24–39)	31 (23–42)	30 (23–42)	31 (23–41)
18–24 years old	33.3	33.3[a]	33.3[a]	33.3[a]	33.3[a]
25–34 years old	30.0	30.0[a]	30.0[a]	30.0[a]	30.0[a]
35–44 years old	17.2	17.2[a]	17.2[a]	17.2[a]	17.2[a]
45–54 years old	12.2	12.2[a]	12.2[a]	12.0[a]	12.2[a]
55 years old or older	7.2	7.2[a]	7.2[a]	7.2[a]	7.2[a]
Gender					
Female	51.7	51.7[a]	51.7[a]	51.7[a]	51.7[a]
Male	48.3	48.3[a]	48.3[a]	48.3[a]	48.3[a]
BMI (median/P25–P75)	24.7 (21.9–27.8)	24.5 (21.5–28.0)	25.4 (21.8–28.2)	24.5 (22.0–27.2)	24.4 (21.9–27.7)
Underweight	4.2	3.9[a]	5.0[a]	4.4[a]	3.3[a]
Normal weight	48.2	49.4[a]	40.0[a]	51.1[a]	52.2[a]
Overweight	32.8	29.4[a]	40.6[a]	31.1[a]	30.0[a]
Class I obesity	10.0	10.6[a]	9.4[a]	8.9[a]	11.1[a]
Class II obesity	4.0	5.6[a]	3.9[a]	3.3[a]	3.3[a]
Class III obesity	0.8	1.1[a]	1.1[a]	1.1[a]	0.0[a]
Region					
Midwest	7.8	7.8[a]	7.8[a]	7.8[a]	7.8[a]
North	8.9	8.9[a]	8.9[a]	8.9[a]	8.9[a]
Northeast	27.2	27.2[a]	27.2[a]	27.2[a]	27.2[a]
South	13.9	13.9[a]	13.9[a]	13.9[a]	13.9[a]
Southeast	42.2	42.2[a]	42.2[a]	42.2[a]	42.2[a]
Education					
Incomplete middle school education	38.9	38.9[a]	38.9[a]	38.9[a]	38.9[a]
Complete middle school/Incomplete high school education	12.8	12.8[a]	12.8[a]	12.8[a]	12.8[a]
Complete high school/Incomplete higher education	31.1	31.1[a]	31.1[a]	31.1[a]	31.1[a]
Complete higher education	12.5	12.8[a]	14.4[a]	10.6[a]	12.2[a]
Post-graduation education	4.7	4.4[a]	2.8[a]	6.7[a]	5.0[a]
Socioeconomic status					
Up to 2 minimum wages	16.7	17.8[a]	14.4[a]	15.6[a]	18.9[a]
2–4 minimum wages	13.3	12.2[a]	15.6[a]	14.4[a]	11.1[a]
4–10 minimum wages	55.6	55.6[a]	55.6[a]	55.6[a]	55.6[a]
10–20 minimum wages	13.2	13.9[a]	12.2[a]	12.8[a]	13.9[a]
Over 20 minimum wages	1.2	0.6[a]	2.2[a]	1.7[a]	0.6[a]
Are you responsible for the grocery shopping?					
Yes	93.2	95.6[a]	97.8[a]	87.8[b]	91.7[a,b]
No	6.8	4.4[a]	2.2[a]	12.2[b]	8.3[a,b]
Frequency of cereal bar consumption					
Every day	10.4	9.4[a]	10.6[a]	8.9[a]	12.8[a]
2–3 times a week	30.3	41.1[a]	31.1[a,b]	23.3[b]	25.6[b]
Once a week	17.4	18.3[a]	17.2[a]	18.9[a]	15.0[a]
2–3 times a month	27.9	22.8[a]	25.6[a]	30.6[a]	32.8[a]
Never	14.0	8.3[a]	15.6[a,b]	18.3[b]	13.9[a,b]
Frequency of whole grain cookies consumption					
Every day	10.1	11.7[a]	13.3[a]	7.2[a]	8.3[a]
2–3 times a week	37.1	37.8[a]	34.4[a]	37.2[a]	38.9[a]

(Continued)

TABLE 2 (Continued)

Characteristic	Participant percentage (%)				
	General (n = 720)	Control (n = 180)	Octagon (n = 180)	Triangle (n = 180)	Magnifying glass (n = 180)
Once a week	20.8	22.2[a]	20.0[a]	20.6[a]	20.6[a]
2–3 times a month	19.2	17.8[a]	22.2[a]	18.3[a]	18.3[a]
Never	12.8	10.6[a]	10.0[a]	16.7[a]	13.9[a]
Frequency of snack consumption					
Every day	3.5	5.6[a]	4.4[a]	1.7[a]	2.2[a]
2–3 times a week	26.5	36.7[a]	23.3[b]	20.0[b]	26.1[a,b]
Once a week	30.0	26.1[a]	31.7[a]	30.0[a]	32.2[a]
2–3 times a month	28.3	21.7[a]	27.8[a,b]	35.6[b]	28.3[a,b]
Never	11.7	10.0[a]	12.8[a]	12.8[a]	11.1[a]

Different letters on the same line indicate a significant difference using the chi-square test ($p < 0.050$).

TABLE 3 *F* values and *p*-values of fixed effects and interactions of the GLM performed to the understanding of nutritional information and the ANOVA models used for healthfulness perception and purchase intention.

Effect	df	Understanding of nutritional information	Healthfulness perception	Purchase intention
		***F* (*p*-value)**	***F* (*p*-value)**	***F* (*p*-value)**
FoPNL	3	**205.66 (<0.001)**	**88.46 (<0.001)**	**70.00 (<0.001)**
Food category	2	**4.50 (0.011)**	**7.48 (0.001)**	**116.00 (<0.001)**
Type of product	1	**73.31 (<0.001)**	**327.85 (<0.001)**	**99.25 (<0.001)**
Nutrition claims	1	**24.90 (<0.001)**	**57.82 (<0.001)**	**31.21 (<0.001)**
FoPNL*food category	6	**3.61 (0.001)**	1.62 (0.138)	**3.79 (0.001)**
FoPNL*type of product	3	1.30 (0.271)	**15.92 (<0.001)**	**10.04 (<0.001)**
FoPNL*nutrition claims	3	0.50 (0.681)	0.40 (0.753)	0.71 (0.545)
Food category*type of product	2	**4.54 (0.011)**	2.93 (0.053)	**39.70 (<0.001)**
Food category*nutrition claim	2	0.07 (0.936)	0.99 (0.371)	**3.57 (0.028)**
Type of product*nutrition claims	1	0.70 (0.403)	2.02 (0.155)	0.08 (0.780)
FoPNL*food category*type of product	6	0.50 (0.806)	0.84 (0.536)	**2.66 (0.014)**
FoPNL*food category*nutrition claims	6	0.90 (0.495)	1.53 (0.165)	0.70 (0.648)
FoPNL*type of product*nutrition claims	3	0.14 (0.934)	2.05 (0.105)	0.41 (0.742)
Food category*Type of product*nutrition claims	2	0.45 (0.635)	0.45 (0.638)	0.24 (0.782)
FoPNL*food category*type of product*nutrition claims	6	0.70 (0.651)	0.48 (0.823)	0.16 (0.988)
ID Variance		**Estimate (standard error); *p*-value**		
		3.393 (0.254); $p < 0.001$	0.320612 (0.17628); $p < 0.001$	0.342764 (019059); $p < 0.001$

df, degree of freedom. Bold indicates statistically significant findings at $p < 0.05$ level. Models adjusted for the questions about interest in health with $p < 0.05$ and random effects on individuals.

FoPNL reduced the healthfulness perception in the two types of the evaluated products (1 or 2 nutrients in excess). However, it is important to note that for products with only one nutrient in excess, the FoPNL models did not differ from each other, all being more effective than the control. In products with two critical nutrients, the octagon and triangle significantly reduced the perception of healthfulness in relation to the magnifying glass and all models were superior to the control. The least healthy products (two excessive nutrients) received lower health scores than the products with one critical nutrient in excess, across all experimental arms.

Purchase intention

Purchase intention was significantly affected by all the main effects of the model and by the interactions "FoPNL*food

TABLE 4 Odds ratios (IC95%) of the significant effects and interactions of the model in the understanding of nutritional information.

Effect		Understanding of nutritional information correct answers
Nutrition claims		
Absence		1
Presence		0.68 (0.58–0.78)**
Food category × FoPNL		
Cereal bar	Control	1
	Octagon	63.28 (39.79–100.63)**
	Triangle	54.19 (34.13–86.03)**
	Magnifying glass	44.15 (28.12–69.31)**
Cookie	Control	1
	Octagon	91.25 (55.52–149.97)**
	Triangle	88.16 (53.44–145.44)**
	Magnifying glass	93.21 (56.70–153.24)**
Snack	Control	1
	Octagon	89.53 (54.01–148.40)**
	Triangle	85.91 (51.60–143.02)**
	Magnifying glass	108.85 (65.25–181.57)**
Food category × type of product		
Cereal bar	1 Excessive nutrient	1
	2 excessive Nutrients	0.51 (0.41–0.64)**
Cookie	1 Excessive nutrient	1
	2 Excessive nutrients	0.79 (0.63–0.99)*
Snack	1 Excessive nutrient	1
	2 Excessive nutrients	0.51 (0.41–0.65)**
Akaike information criteria		46,342.696

Model adjusted for the questions about interest in health with $P < 0.05$ and random effects on individuals. Significance was evaluated in relation to the reference category (1.00) at $^{*}p < 0.05$ and $^{**}p < 0.01$.

TABLE 5 Average healthfulness perception scores by FoPNL (control, octagon, triangle, and magnifying glass), food category (cereal bar, cookie, and snack), type of product (containing 1 and 2 excessive nutrients), nutrition claims (absence and presence), and their interactions.

Effect	Healthfulness perception Mean (95% Confidence interval)
Food category	
Cereal bar	1.96 (1.92–2.01)^{b}
Cookie	2.00 (1.96–2.05)^{a}
Snack	1.99 (1.95–2.03)^{a}
Nutrition claims	
Absence	1.95 (1.91–2.00)^{a}
Presence	2.02 (1.98–2.06)^{b}

FoPNL × type of product	1 excessive nutrient	2 excessive nutrients
Control	2.61 (2.52–2.07)$^{b\ A}$	2.55 (2.47–2.64)$^{c\ B}$
Octagon	1.82 (1.73–1.91)$^{a\ A}$	1.64 (1.56–1.73)$^{a\ B}$
Triangle	1.84 (1.75–1.93)$^{a\ A}$	1.63 (1.54–1.71)$^{a\ B}$
Magnifying glass	1.98 (1.89–2.07)$^{a\ A}$	1.82 (1.73–1.90)$^{b\ B}$

Different lowercase letters on the same column and uppercase letters on the same line indicate a significant difference using Sidak's test ($p < 0.050$). Model adjusted for the questions about interest in health with $p < 0.05$ and random effects on individuals.

category," "FoPNL*type of product," "Food category*type of product," "Food category*nutrition claim," and "FoPNL*food category*type of product" (Table 3).

In the presence of claims, purchase intention was higher in the cookies and snacks categories, but for cereal bars, the inclusion of this information did not change consumers' intentions (Table 6). The effect of FoPNL varied according to food category and type of product, reducing consumers' purchase intention. In the snacks category, no statistical difference was observed between the evaluated FoPNL models in either of the two types of products. This also happened in the most healthy version of the cookie. However, considering the least healthy version of the cookie, the purchase intentions of consumers who saw the octagon and the triangle were lower than the ones who saw the magnifying glass (Table 6).

In the cereal bar category, while in the most healthy version of the product, the octagon symbol reduced the purchase intention in relation to the magnifying glass and control, and in the least healthy version, only the triangle symbol had this effect. It is worth noting that in all experimental arms, participants had different purchase intentions among the most and least healthy versions of the evaluated products, except for the cereal bars without FoPNL (Table 6).

Consumer perceptions of front-of-package nutritional labeling models

The opinions and perceptions of participants regarding the evaluated FoPNL models are shown in Table 7. No significant difference between models was observed in any of the questions presented and, for all of them, the median answer was 7.0. Participant interest in health only varied between the experimental groups for three of the eight questions in the questionnaire (Table 8).

Discussion

Front-of-package nutritional labeling will be implemented in Brazil in October 2022 and will become mandatory for the vast majority of food and beverage producers in October 2023. However, so far, there has been little research on how Brazilian consumers understand and perceive different FoPNL models, especially the magnifying glass model, as it will be implemented in the country, as it will be implemented in the country. In this context, the present work compared the magnifying glass model with two FoPNL models in the warning format, in terms of understanding nutritional information, healthfulness perception, and purchase intention of Brazilian consumers.

TABLE 6 Average purchase intention scores by FoPNL (control, octagon, triangle, and magnifying glass), food category (cereal bar, cookie, and snack), type of product (containing 1 and 2 excessive nutrients), nutrition claims (absence and presence), and their interactions.

Effect	Purchase intention Mean (95% confidence interval)	
Food category × nutrition claims	**Absence**	**Presence**
Cereal bar	2.09 (2.01–2.14)$^{a\ A}$	2.12 (2.07–2.17)$^{a\ A}$
Cookie	2.03 (1.98–2.07)$^{b\ A}$	2.08 (2.03–2.12)$^{b\ B}$
Snack	1.88 (1.83–1.93)$^{c\ A}$	1.97 (1.92–2.02)$^{c\ B}$

FoPNL × food category × type of product	Cereal Bar		Cookie		Snack	
	1 excessive nutrient	2 excessive nutrients	1 excessive nutrient	2 excessive nutrients	1 excessive nutrient	2 excessive nutrients
Control	2.64 (2.55–2.74)$^{c\ A}$	2.64 (2.54–2.74)$^{c\ A}$	2.57 (2.47–2.67)$^{b\ A}$	2.65 (2.55–2.75)$^{c\ B}$	2.54 (2.44–2.63)$^{b\ A}$	2.42 (2.33–2.52)$^{b\ B}$
Octagon	1.94 (1.84–2.04)$^{a\ A}$	1.81 (1.71–1.90)$^{a,b\ B}$	1.84 (1.74–1.94)$^{a\ A}$	1.77 (1.67–1.87)$^{a\ B}$	1.82 (1.72–1.92)$^{a\ A}$	1.65 (1.55–1.75)$^{a\ B}$
Triangle	1.95 (1.85–2.05)$^{a,b\ A}$	1.72 (1.63–1.82)$^{a\ B}$	1.83 (1.73–1.93)$^{a\ A}$	1.81 (1.72–1.91)$^{a\ A}$	1.80 (1.70–1.90)$^{a\ A}$	1.56 (1.47–1.66)$^{a\ B}$
Magnifying glass	2.15 (2.05–2.24)$^{b\ A}$	1.99 (1.90–2.09)$^{b\ B}$	1.92 (1.82–2.02)$^{a\ A}$	2.01 (1.91–2.11)$^{b\ B}$	1.92 (1.82–2.02)$^{a\ A}$	1.68 (1.58–1.78)$^{a\ B}$

Different lowercase letters on the same column and uppercase letters on the same line indicate a significant difference using Sidak's test ($p < 0.050$). Model adjusted for the questions about interest in health with $p < 0.05$ and random effects on individuals.

TABLE 7 Participant perception of the FoPNL models evaluated.

Questions	FoPNL		
	Octagon	Triangle	Magnifying glass
	Average (SD)	Average (SD)	Average (SD)
(1) This front-of-package labeling model called my attention.	6.54 (1.02)[a]	6.55 (1.04)[a]	6.45 (1.06)[a]
(2) This front-of-package labeling model is visible.	6.57 (1.03)[a]	6.54 (0.97)[a]	6.52 (0.95)[a]
(3) This front-of-package labeling model is easy to understand.	6.68 (0.75)[a]	6.73 (0.74)[a]	6.73 (0.61)[a]
(4) This front-of-package labeling model will help me quickly decide which products to buy.	6.58 (0.86)[a]	6.49 (1.07)[a]	6.51 (0.86)[a]
(5) This front-of-package labeling model will help me identify healthier products.	6.52 (1.04)[a]	6.56 (1.09)[a]	6.55 (0.80)[a]
(6) This front-of-package labeling model will help me decide whether I should buy a product.	6.41 (1.13)[a]	6.36 (1.12)[a]	6.44 (0.74)[a]
(7) I consider the information of this front-of-package labeling model credible and truthful.	6.58 (0.89)[a]	6.45 (1.06)[a]	6.49 (0.81)[a]
(8) This front-of-package labeling model will change my decision of which products to buy.	6.34 (1.17)[a]	6.20 (1.32)[a]	6.29 (0.99)[a]

Different letters on the same line indicate a significant difference using Tukey's test ($p < 0.050$).

Effect on the understanding of nutritional information

The results found in the present study are aligned with the literature, which shows that FoPNL indeed favors the understanding of nutritional information (12, 14, 51, 60, 63). The presence of FoPNL, in the three evaluated models, increased the correct answers regarding the presence of critical nutrients in excess in the three evaluated food categories. Bandeira et al. (51) indicated a similar result, in which the octagon, the triangle, the circle, and magnifying glass symbols increased the understanding of the nutritional content, compared to the control, in an equal way.

On the contrary, the presence of claims and the greater quantity of excessive critical nutrients (i.e., the presence of two excessive nutrients) reduced the percentage of correct answers, in the three evaluated food categories, indicating that such information hinders consumer understanding. Some studies have reported that the overload of information in food labels may discourage consumers from seeking more nutritional information on packages as a way to minimize cognitive effort (33, 64), jeopardizing choices and, consequently, the change in consumer behavior (65).

Effect on healthfulness perception and purchase intention

As hypothesized, the presence of nutrition claims on the evaluated labels generated a positivity bias, as it increased the participants' healthfulness perceptions of food and purchase intentions. The results from the literature, concerning the influence of claims in foods with FoPNL on healthfulness perception and purchase intention, are mixed (32, 33, 39, 40, 50, 66), and some studies have observed a positivity bias of claims, as reported in the present study (39, 40). Such influence seems to be related to the type of claim presented on labels (39, 40, 67). For example, Mediano Stoltze et al. (39) observed, using breakfast cereal packages, that fiber-related claims led to more positive product ratings compared to having no claims or having fat-related claims. Furthermore, according to Talati et al. (44), claims may be less persuasive for foods considered "unhealthy," which justifies the observed effect in the present study, especially in relation to cereal bars, which received the lowest health scores and their purchase intentions were not affected by the inclusion of nutrition claims.

Although such claims refer to positive nutritional properties, they are frequently presented in products with unbalanced nutritional profiles (68–71). This is particularly worrisome, once, as in the present study, other studies have already shown that the presence of claims on food labels tends to increase their healthfulness perception (15, 39, 72–74). Thus, some countries, such as Australia, New Zealand (75), and Mexico (19), forbid claims on foods that contain excessive content of critical nutrients.

The inclusion of FoPNL statistically reduced healthfulness perceptions and purchase intentions of the evaluated foods. In products with two critical nutrients, the octagon and the triangle had a greater effect than the magnifying glass in reducing the perception of healthfulness. As for the outcome of purchase intention, although all FoPNL models were greater than the control, for the cereal bars category and for the least healthy version of cookies, there was a better performance of the octagon and the triangle symbols in relation to the magnifying glass. These findings can be explained by the number of seals applied to the labels in the different FoPNL conditions. In the condition of the warning symbols (octagon and triangle), for each nutrient in excess, one seal was applied to the label. While in the magnifying glass condition, regardless of the number of critical nutrients, only one magnifying glass symbol was present on food labels.

TABLE 8 Participant interest in health, evaluated through the General Health Interest Questionnaire, by experimental condition.

Questions	FoPNL			
	Control	Octagon	Triangle	Magnifying glass
	Average (SD)	Average (SD)	Average (SD)	Average (SD)
(1) I am very worried about how healthy foods are.	6.03 (1.06)[a]	6.06 (1.13)[a]	5.90 (1.28)[a,b]	5.68 (1.24)[b]
(2) I always follow a healthy and balanced diet.	5.21 (1.36)[b]	4.90 (1.52)[a,b]	4.67 (1.62)[a]	4.84 (1.45)[a,b]
(3) It is important for me that my diet is low in fat.	5.47 (1.55)[a]	5.17 (1.65)[a,b]	4.81 (1.76)[b]	4.87 (1.65)[b]
(4) It is important for me that my daily diet contain many vitamins and minerals.	6.28 (0.98)[a]	6.10 (1.24)[a,b]	5.97 (1.22)[b]	6.02 (1.03)[a,b]
(5) I eat what I like and I DO NOT worry about how healthy the food is.	3.13 (2.04)[a]	3.39 (1.96)[a]	3.26 (2.01)[a]	3.23 (1.72)[a]
(6) How healthy the food is has little impact on my choices.	3.26 (2.07)[a]	3.30 (2.04)[a]	3.51 (2.00)[a]	3.38 (1.87)[a]
(7) How healthy snacks are does not make any difference for me.	3.19 (1.99)[a]	3.09 (1.91)[a]	3.23 (1.97)[a]	3.18 (1.88)[a]
(8) I DO NOT avoid any food, even those that may elevate my cholesterol.	2.81 (1.98)[a]	3.25 (2.05)[a]	2.91 (1.84)[a]	2.89 (1.77)[a]

Different letters on the same line indicate a significant difference using the Tukey's test ($p < 0.050$).

This result can be discussed under the aspect of processing fluency, which concerns the ease or difficulty of processing new information (76). This fluency can be influenced by a large number of variables, such as the "figure-ground contrast, the clarity with which a stimulus is presented, the duration of its presentation, or the amount of previous exposure to the stimulus," and can be objectively measured, through processing speed and accuracy (76). According to Delivett et al. (77), easily processed images and texts provide feelings of processing fluency that can shape people's judgment of information. Some studies have already demonstrated this effect, where an increase in processing fluency has led to more positive product reviews (77–79).

In the present study, probably, the presence of two warning seals vs. a single magnifying glass, contemplating the same nutritional information, improving the processing fluency, and reducing the healthfulness perceptions and purchase intention (in the cereal bars category and for the less healthy version of cookies) of the consumers. Deliza et al. (12) observed that participants needed less time to identify the high nutrient content in the presence of the black octagon and triangle, compared to the magnifying glass, which may also reflect greater processing fluency in the presence of the warning symbols, since this fluency can be measured by processing speed and accuracy (76). Those authors (12) attribute this finding to the fact that warning symbols are more familiar and this has also been discussed by other authors (51, 52). However, the results of the present study demonstrate that not only the FoPNL design but also the number of seals applied to the labels influence consumers' perceptions. Furthermore, in the present study, FoPNL was applied according to the requirements of the legislation, so that the smallest labeling area for the magnifying glass could also contribute to the worst results of this symbol.

Hodgkins et al. (80) suggest that labels with a data approach (nutrient-specific) require greater cognitive effort from the consumer for understanding, while the criteria-based approach (synthesis) requires less cognitive effort from the consumer. In this way, the use of two warning symbols—as a visual synthesis of two nutrition warnings, could help the consumer to understand the message more than just one symbol with two warning texts. However, a specific study would need to be designed for this.

Combined effect of front-of-package nutritional labeling and claims

In the present study, no interaction between nutrition claims and FoPNL was observed in the evaluated outcomes, contradicting hypothesis 2. Despite the positive effects of FoPNL, as the increase in understanding of nutritional information and the reduction of healthfulness perception and purchase intention, this information could not cancel the positivity bias generated by the claims, which seems to happen independently. Other studies have evaluated the relative impact of FoPNL information and claims on consumers, obtaining diverse results, mainly in relation to the effect of the claims. However, while some studies observe the occurrence of the positivity bias (32, 39, 67), others do not find it (33, 34). In general, the results indicate a stronger effect of FoPNL information on consumers, compared to the claims (32, 39–41, 50, 67, 81). It was also observed in the present study since the F values for FoPNL were greater than the ones for claims in all the evaluated outcomes. Mediano Stoltze et al. (39) tested the co-occurrence of warning labels and nutrient content claims on consumers' perception of products and behavioral intentions using breakfast cereal labels. They found similar results to those obtained in the present study—although the claims generated a positivity bias, the FoPNL presented a stronger effect, with no interaction with the claims (39). On the contrary, in the study by Talati et al. (82), the authors concluded that FoPNLs are more effective in improving food choices by consumers when nutrition and health claims are not present. These differences seem to be justified both by factors that influence the effect of claims on consumers and by differences in experimental design, such as the evaluated categories and types of food. The similarity between the results of this study and those found by Mediano Stoltze et al. (39), for example, may be due to the similarities between foods (foods with a "healthy connotation") and the nutrition claims tested in both studies.

Such findings help support regulations on FoPNL, providing evidence concerning the influence of claims on FoPNL. According to McLean et al. (41), nutrition claims are only useful when they are consistent with the nutritional profile of foods, which is hardly ever a reality (68–71). For instance, Duran et al. (69) evaluated a sample of 3,491 products available in the Brazilian market and observed that foods with nutrition claims were more likely to be high in critical nutrients when compared to those with low content of critical nutrients. The presence of claims in "unhealthy" foods has also been reported by other authors (71, 83).

Consumer perceptions of the front-of-package nutritional labeling models

With regards to participants' opinions and perceptions about the respective evaluated FoPNL models, the "high grades" found and the lack of significant difference in the results support the efficacy of FoPNL concerning visibility, ease of understanding, and credibility of the information assessed through the questionnaire. Nonetheless, it is noteworthy that the octagon and the triangle models, as applied in this study, indicated better results than the magnifying glass, and all showed better results compared to the control in relation to healthfulness perception and purchase intention. According to Khandpur et al. (60), who evaluated consumers' opinions about the triangle and the traffic light FoPNL models, although those opinions are important, label appeal may not mean that consumers will use labels in a better way. Likewise, their opinion about a piece of information may have a different impact on their behavior or behavior intention, which corroborates with the findings of the present study.

Strengths and limitations

It is worth mentioning that this research is the first to evaluate the influence of nutrition claims on FoPNL, including the magnifying glass model, in the Brazilian population. This study was also carefully designed by applying the FoPNL dimensions as defined in the Brazilian legislation for the magnifying glass model (23) and in the Chilean legislation for the octagon and triangle models (18), collecting results closer to reality. Besides, the sample was meticulously composed of age-diverse participants and represented the Brazilian population regarding gender, socioeconomic status, education, and country region.

However, the present research has some limitations. The experimental design performed online may not represent the reality of purchases in physical stores and actual product labels. Nonetheless, it is believed that this limitation was minimized by excluding mobile devices (cell phones and tablets) from the study, allowing the visualization of food labels and their constituents in dimensions close to real ones on computer/laptop screens. In addition, online shopping has increased considerably, which requires understanding how consumers behave in this environment. Another aspect to be highlighted refers to the nutrition claims on the labels. For the three models, they were applied near the center of the front panel of the packages to promote similarity with the way claims appear on actual products. Thus, their application did not follow the parameter established by the new Brazilian legislation, which states that nutrition claims should be placed on the lower half of the frontal panel, with smaller characters than those used in the magnifying glass FoPNL (24). Moreover, the effect of the different types of nutrition claims that were included on labels was not evaluated, to assess possible differences in participants' associations.

The question about participants' weight before the application of the questionnaire and the order in which the outcomes were evaluated in the questionnaire may have triggered a response bias. The question about nutrient content, presented first, may have influenced the perception of healthfulness and this, in turn, influenced the purchase intention. Another issue that should be mentioned as a limitation is that changing both the design and the size of the FoPNL, based on the application criteria of Brazilian and Chilean legislation, makes it difficult to conclude which factor was responsible for the differences found in results. It is also worth noting that the results may not be generalizable to a larger variety of foods, once only three food categories were evaluated.

Conclusion

In general, the presence of FoPNL favored the understanding of nutritional information and reduced healthfulness perception and purchase intention. On the contrary, nutrition claims reduced the percentage of correct answers regarding excessive nutrients and increased healthfulness perception and purchase intention. Despite the positive effects of FoPNL, it did not cancel the positivity bias generated by the claims, which occurred independently. However, the effect of FoPNL varied according to the food category and the amount of critical nutrients in the product, with those with two nutrients in excess receiving the lowest health and purchase intentions scores.

Regarding the FoPNL models, all were more effective than the control. However, for the least healthy type of product (2 nutrients in excess), the octagon and the triangle models were superior to the magnifying glass, regarding the outcome of healthfulness perception. Finally, we consider that the results of this study constitute evidence that proves and reinforces the efficacy and benefits of including FoPNL for consumer understanding and judgment of the healthfulness perception and purchase intention of products. Future research that evaluates FoPNL effectiveness on consumer behavior changes, as well as research that evaluates the effect of different types of claims on consumers' associations and specific research on the understanding of the symbols and attention to them, may be interesting to complement the body of evidence regarding FoPNL inclusion on food labels.

Data availability statement

The original contributions presented in this study are included in the article, further inquiries can be directed to the corresponding author/s.

Ethics statement

The studies involving human participants were reviewed and approved by Research Ethics Committee of the Universidade Federal de Minas Gerais (Brazil Platform–CAAE 2395020.1.0000.5149). The participants provided their written informed consent to participate in this study.

Author contributions

SP and LA: study conception and manuscript. CR and CS: label creation. SP, LA, and IR: statistical analysis. SP, IR, LA, and CR: data analysis and discussion. All authors reviewed and approved the final version submitted.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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ABSTRACTS

SPANISH

Influencia de las declaraciones nutricionales en diferentes modelos de etiquetado nutricional frontal de alimentos supuestamente saludables: impacto en la comprensión de la información nutricional, percepción de salubridad e intención de compra de los consumidores brasileños

Declaraciones nutricionales son informaciones positivas sobre los alimentos, las cuales son ampliamente usadas como una estrategia de *marketing* en las etiquetas. Al contrario, el etiquetado nutricional frontal (ENF) tiene por objetivo hacer que los consumidores comprendan más fácilmente la composición nutricional de los alimentos y favorecer la elección de alimentos saludables. Sin embargo, la presencia concomitante de las declaraciones nutricionales y el ENF puede dificultar el entendimiento, opinión y elecciones de los consumidores en el momento de la compra. Por lo tanto, el objetivo de este estudio fue evaluar la influencia de las declaraciones nutricionales en la eficiencia de los modelos del ENF en el entendimiento de la información nutricional, percepción de salubridad e intención de compra de los consumidores brasileños. Se trató de un estudio experimental transversal conducido por medio de un cuestionario en línea con un total de 720 participantes aleatoriamente divididos en cuatro condiciones del ENF: control, octágono, triángulo y lupa. Cada participante miró 12 envases de alimentos que fueron producidos siguiendo un diseño factorial: (i) categoría alimenticia (barra de cereal, galletas integrales y pasabocas); (ii) tipo de producto (conteniendo un nutriente crítico × conteniendo dos nutrientes críticos); y (iii) declaraciones nutricionales (presente × ausente). La comprensión de la información nutricional fue evaluada por la identificación de nutrientes excesivos, y la percepción de salubridad y la intención de compra fueron evaluados usando una escala de siete puntos. Los resultados indicaron que la presencia del ENF aumentó el entendimiento de la información y redujo la percepción de salubridad y la intención de compra. La presencia de las declaraciones nutricionales influenció los tres resultados, disminuyendo la probabilidad de comprensión de la información acerca de la composición de los alimentos en 32% (OR 0,68, 95% intervalo de confianza 0,58-0,78, $p < 0{,}01$) y aumentando significativamente ($p < 0{,}05$) los puntajes promedio de salud (1,95-2,02) y intención de compra (2,00-2,05). Sin embargo, la interacción "ENF × declaraciones" no fue significativa, indicando que las declaraciones actúan independientemente. Todos los modelos de ENF fueron más efectivos que el control. Para el tipo de producto menos saludable (dos nutrientes en exceso), los modelos de octágono y triángulo fueron superiores que la lupa, con respecto al resultado de percepción de salubridad. Los resultados prueban la eficacia del ENF en el entendimiento y opinión de los consumidores. A pesar de los efectos positivos del ENF, no se canceló el sesgo de positividad generado por las declaraciones.

Palabras clave: etiquetado de alimentos, política de nutrición, ENF, etiquetas de advertencia, investigación del consumidor, percepción del consumidor, aureola de salud, sesgo de positividad.

PORTUGUESE

Influência das alegações nutricionais em diferentes modelos de rotulagem nutricional frontal em alimentos supostamente saudáveis: impacto na compreensão das informações nutricionais, percepção de saudabilidade e intenção de compra de consumidores brasileiros

As alegações nutricionais são informações positivas sobre os alimentos, amplamente utilizadas como estratégia de publicidade nos rótulos. Por outro lado, a rotulagem nutricional frontal (RNF) visa facilitar a compreensão dos consumidores sobre a composição nutricional dos alimentos e favorecer escolhas alimentares saudáveis. No entanto, a presença concomitante de alegações nutricionais e RNF pode dificultar o entendimento, o julgamento e as escolhas dos consumidores no momento da compra. Portanto, o objetivo deste estudo foi avaliar a influência das alegações nutricionais na eficácia de modelos de RNF, na compreensão da informação nutricional, percepção de saudabilidade e intenção de compra de consumidores brasileiros. Tratou-se de um estudo transversal experimental realizado por meio de questionário *online*, com um total de 720 participantes divididos aleatoriamente em quatro condições de RNF: controle, octógono, triângulo e lupa. Cada participante visualizou 12 embalagens de alimentos, que foram produzidas seguindo o planejamento fatorial: (i) categoria de alimento (barras de cereal, biscoitos integrais e salgadinhos); (ii) tipo de produto (contendo um nutriente crítico em excesso × contendo dois nutrientes críticos em excesso); e (iii) alegações nutricionais (presente × ausente). A compreensão da informação nutricional foi avaliada por meio da identificação dos nutrientes em excesso, e a percepção de saudabilidade e intenção de compra foram avaliadas por meio de uma escala de sete pontos. Os resultados indicaram que a presença da RNF aumentou a compreensão das informações e reduziu a percepção de saudabilidade e a intenção de compra. A presença de alegações nutricionais influenciou os três desfechos, reduzindo a probabilidade de compreender as informações sobre a composição dos alimentos em 32% (OR 0,68, intervalo de confiança de 95% 0,58–0,78, $p < 0,01$) e aumentando significativamente ($p < 0,05$) os escores médios de saudabilidade (1,95– 2,02) e de intenção de compra (2,00–2,05). No entanto, a interação “RNF × alegações” não foi significativa, indicando que as alegações agem de forma independente. Todos os modelos de RNF foram mais eficazes do que o controle. Para o tipo de produto menos saudável (dois nutrientes em excesso), os modelos de octógono e de triângulo foram superiores à lupa quanto ao desfecho da percepção de saudabilidade. Os resultados comprovam a eficácia da RNF no entendimento e julgamento do consumidor. Apesar dos efeitos positivos da RNF, esta informação não anulou o viés de positividade gerado pelas alegações.

Palavras-chave: rotulagem de alimentos, política de nutrição, RNF, rótulos de advertência, pesquisa do consumidor, percepção do consumidor, auréola de saúde, viés de positividade.

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The challenges of front-of-package labeling in Brazil

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KEYWORDS

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The Brazilian legal system has plenty of mechanisms to ensure the public right to access clear information. The Federal Constitution (FC), enacted in 1988 and known as the "Citizen Constitution," has as its principle to guarantee the right to human dignity. Protection of consumers, as well as their inviolable right to life and safety, are guaranteed by the FC as basic rights. The FC limits the country's economic order when establishing that its goal is to provide dignity for all Brazilians. Therefore, economic development cannot put people at risk, and its processes must be aligned with principles of goodwill and balance between consumers and suppliers. Collectively, FC establishes that health, food, and youth protection are social rights; hence, the government is responsible for providing policies for its implementation (1).

Due to the increase of obesity and non-communicable diseases (NCD), the actions related to food regulation are crucial to tackle the raising of malnutrition in all its forms, including the consequences of overweight, undernutrition, and micronutrient deficiency. Food regulation could be understood as a set of actions, led by the state, to protect consumers. As regulation actions could be listed the food taxation, the food marketing restriction/prohibition and the food labeling, including front-of-package nutrition labeling (FoPNL).

Improvements of food labeling permeate the discussion of food and nutrition security (FNS), considering the need to support the population on their food choices, even helping them understand the confusing information in the packages. That is also a part of consumers' rights. A label of easy comprehension contributes to the enforcement of the basic right of clear information on the composition and the risks of food products, as stated by the Brazilian Consumer Defense Code (CPC) (2).

At an international level, there are countless recommendations for governments to promote practices that regulate food labeling and inform consumers about the risks of the consumption of some products to their health, and facilitate their food choices, as stated in many international documents by the World Health Organization (WHO) (3), Food and Agriculture Organization of the United Nations (FAO) (4), and Pan American Health Organization (PAHO) (5).

The urgency and priority given to these subjects due to the current situation of health and nutrition of the Brazilians, a scenario that combines high levels of obesity and NCD (6), could be associated with factors related to the national rules of food labeling that may allow association with deceptive marketing and non-clear information, impacting on the growth of unhealthy foods consumption. Besides that, reading and comprehending nutrition facts panels are intricate for consumers, especially the interpretation of numbers and technical information, the need for calculations, small font size, and package visual pollution (7).

Evidence from Brazil aligned with international experiences, and society mobilization triggered political discussions. In 2013, the National Council for Food and Nutrition Security (*Conselho Nacional de Segurança Alimentar e Nutricional* - Consea) manifested for the first time that the National Health Surveillance Agency (*Agência Nacional de Vigilância Sanitária* - Anvisa) should provide "efficiency of the update and qualification of regulatory ideas for food labels," as the entity is responsible for the food labeling standards in the country (8).

In 2014, Anvisa created a working group (WG) to discuss and elaborate regulatory proposals for the nutrition labeling of packaged food. The model of the FoPNL stood out as the main point of divergence among the proposals brought to light by Anvisa. Although the food industry, represented by the Brazilian Food Industry Association (*Associação Brasileira da Indústria de Alimentos* - ABIA), recommended the traffic-light labels, other proposals, aligned with the interests of public health, presented the model of warning labels with different formats. The civil society coalition "Alliance for Adequate and Healthy Diets" ("*Aliança pela Alimentação Adequada e Saudável*") favored the model with the triangle format (9).

The warning labels have as their premise that the products with high content of nutrients related with obesity and NCDs must be easily identified to facilitate the healthiest food choice. Recent meta-analyses has shown that warning labels work better than colorful models (such as traffic-light and Nutri-Score) to discourage the purchase of unhealthy products and lower the amount of calories and saturated fat purchased (10), and, when compared to no labels, warning labels reduced the calorie and sugar content of purchased products, while other systems had no effect on purchasing (11). Bearing in mind the eye-catching packages that emphasize the quality of the alleged products, contrasting symbols for the inadequate nutrients are needed (9, 12).

Since 2017, Anvisa has started elaborating revisions and technical reports that sometimes consulted civil society. An increase in corporate political activities (CPA) of ultra-processed food and beverage industries stood out together with an agribusiness incurs on this subject, including the establishment of the coalition "Labeling Network" (13), an organization of influential Brazilian ultra-processed food and beverages industries. This group did not publicly disagree with the label update; however, it presented itself as the solution, initially defending the traffic-light labels. Evidence shows that this model lacks the efficiency to inform and discourage the purchase of harmful products (14–18).

During this long regulatory process in Brazil, many other countries conducted regulatory processes for nutrition food labels where a FoPNL was chosen, especially in Latin American countries. Since 2016 in Chile, packaged products have exhibited front-of-package black octagons, indicating excess of amounts of calories, sugar, sodium, and/or saturated fat (19). In addition, this warning label is currently approved and/or implemented Peru (20), Uruguay (21), Mexico (22), and Argentina (23).

Considering that scientific evidence and international experiences are not always enough to balance the influence of industries on political affairs, the involvement of civil organizations in the protection of a healthy diet and general health has been essential to guarantee the population's interests. In Brazil, the Alliance for Adequate and Healthy Diets launched the campaign "You have the right to know what you eat" in 2017. Due to Anvisa's slowness to go through the regulatory process, the Alliance launched, at the end of 2018, a second campaign with testimonies of doctors, fathers, mothers, young people, and people with NCD about the need for adequate food labeling, aiming to pressure Anvisa to open the public consultation (PC) about the nutrition labeling regulation. In 2019, during the PC, the Alliance encouraged the participation of the population with the third communication campaign "When you open your mouth, do not shut your eyes," disclosing the civil society idea of the triangle warning labels on food packages.

In October 2020, Brazil approved the nutrition labeling of packaged foods, with an unprecedented FoPNL model in a magnifying glass format. Its design was modified and is smaller than the one presented in the PC with a considerable loss of graphic legibility and clarity. The design of the approved magnifying glass was never evaluated, with no scientific evidence that proves its efficiency. During the process of choosing, studies conducted under the ANVISA request tested the magnifying glass design presented in the PC and revealed that warning labels are more effective at being identified and facilitating the understanding of the nutrition composition, the perception of healthiness and shifting purchase intention (24, 25). Only one study showed a marginally better performance of the magnifying glass at improving purchase intentions when compared to triangles (26). Scientific evidence, published in 2021, after the approval of the Brazilian magnifying glass, showed that octagons

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FIGURE 1
The FoPNL design model approved by Anvisa. Brazil, 2020. Source: Anvisa.

were more effective in identifying the least harmful product, understanding the nutrient composition, and shifting purchase intentions (27).

The beginning of the implementation of the regulation is expected to October 2022 (28, 29). The approved model has a weaker nutrient profile than other countries (such as Chile) and the PAHO model, which means that unhealthy food products will not receive a magnifying glass, according to the Brazilian regulation. Added to this, the model defines that the product will receive just one magnifying glass independently of the number of critical nutrients (sugar, sodium, and/or saturated fat) present in the product. The nutrients will be listed beside or below the magnifying glass (Figure 1). The octagonal FoPNL, for example, determines one label for each nutrient.

Based on the presented information, allied to the lack of scientific evidence of the model efficacy, the approved regulation was insufficient to meet both public health recommendations (3, 5) as the guarantee that all unhealthy food will receive the magnifying glass identification. Due to the challenging political scenario (a neoliberal government, concerned about financial market aspirations instead of the public health, with an ultra-right-wing position) and considerable interference of the industry during the regulatory process, the model approved was below the expected.

It took more than 6 years for Anvisa to decide on this regulatory process. During this time, the Brazilian political scenario went through several moments of instability that resulted in the replacement of Anvisa board directors, Health Ministers, and three presidents of the Republic. Besides the changes in power that slowed the process, the current government has a declared liberal position and defends commercial interests above public health.

In this context, besides the insufficiency of the regulation, the result of the regulatory process represents progress and recognition of the civil society work during this period, considering that they were able to defend the scientific evidence and the public health interest as a priority. The regulation approved by Anvisa represents one of the few losses of the food industry in the current government since they were not able to prevent the warning FoPNL. The food industry used the act in a way to reduce its scope, therefore, the effects of regulation acts (30).

After concluding this regulatory process, Brazil enhanced its health protection affairs, albeit industry interests are still a priority to detriment of public health interests. That impacts its capacity to fulfill its obligation of fully guaranteeing the right to health and food access. We advanced a step on the way to the right to information about the health risks from food products, but there are lots of changes and improvements to implement, and we will continue working toward the implementation of this regulation until every Brazilian has fully granted the right to know what he or she is eating.

Author contributions

JG has designed and drafted the article. All of the others authors revised critically and approved the final version to be published.

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COMMENTARIES

SPANISH

Los desafíos del etiquetado frontal en Brasil

Palabras clave: política, regulación de alimentos, etiquetado de alimentos, derechos alimentarios, seguridad alimentaria y nutricional

El sistema legal brasileño tiene muchos mecanismos para asegurar el derecho público de acceder a la información clara. La Constitución Federal (CF), promulgada en 1988 y conocida como la "Constitución Ciudadana", tiene como su principio garantizar el derecho a la dignidad humana. La protección a los consumidores, como bien su inviolable derecho a la vida y la seguridad, son garantizados por la CF como derechos básicos. La CF limita el orden económico del país al establecer que su objetivo es promover la dignidad a todos los brasileños. Por lo tanto, el desarrollo económico no puede dejar a las personas en riesgo y sus procesos deben estar alineados con los principios de buena voluntad y equilibrio entre consumidores y proveedores. Colectivamente, la CF establece que la salud, alimentación y protección a los jóvenes son derechos sociales; entonces, el gobierno es responsable por proveer políticas para su implementación (1).

Debido al aumento de la obesidad y enfermedades no transmisibles (ENT), las acciones relacionadas con la regulación de alimentos son cruciales para frenar el crecimiento de la desnutrición en todas sus formas, incluyendo las consecuencias de sobrepeso, desnutrición, y deficiencia de micronutrientes. El reglamento alimentario puede ser entendido como un conjunto de acciones dirigidas por el estado para proteger a los consumidores. Como acciones de regulación pueden ser enumeradas los impuestos alimentarios, la restricción/prohibición de la comercialización de alimentos y el etiquetado de alimentos incluyendo el etiquetado nutricional frontal (ENF).

Mejoramientos del etiquetado de alimentos permean la discusión de la seguridad nutricional y alimentaria (SNA), considerando la necesidad de apoyar la población en sus elecciones alimentarias, incluso ayudándoles a entender la información confusa en los envases. Esto también es parte de los derechos de los consumidores. Una etiqueta fácil de comprender contribuye al refuerzo del derecho básico a la clara información acerca de la composición y los riesgos de los productos alimentarios, como afirmado por el Código de Defensa del Consumidor (CDC) brasileño (2).

A nivel internacional, hay incontables recomendaciones para que los gobiernos promuevan prácticas que regulen el etiquetado de alimentos e informen a los consumidores acerca de los riesgos del consumo de algunos productos para su salud y para facilitar sus elecciones alimentarias, como afirmado en diversos documentos internacionales por la Organización Mundial de la Salud (OMS) (3), la Organización de las Naciones Unidas para la Alimentación y la Agricultura (*Food and Agriculture Organization of the United Nations* - FAO) (4) y la Organización Panamericana de la Salud (OPS) (5).

La urgencia y prioridad dadas a estos temas son debido a la actual situación de salud y nutrición de los brasileños, un escenario que combina altos niveles de obesidad y ENT (6), puede estar asociada con factores relacionados a las normas del etiquetado de alimentos que deben permitir la asociación con publicidad engañosa e información confusa, impactando el crecimiento del consumo de alimentos poco saludables. Además de eso, leer y comprender las tablas de información nutricional es complicado para los consumidores, especialmente la interpretación de la información técnica y numérica, la necesidad de cálculos, el tamaño de letra pequeño y la polución visual en los envases (7). Evidencias provenientes de Brasil alineadas con experiencias internacionales y movilización social motivaron discusiones políticas. En el 2013, el Consejo Nacional de Seguridad Alimentaria y Nutricional (*Conselho Nacional de Segurança Alimentar e Nutricional* - Consea) manifestó por primera vez que la Agencia Nacional de Vigilancia Sanitaria (*Agência Nacional de Vigilância Sanitária* - Anvisa) debería proporcionar "eficiencia en la actualización y cualificación de ideas regulatorias para el etiquetado de alimentos", ya que la entidad es responsable por las normas de etiquetado de alimentos en el país (8).

En el 2014, Anvisa creó un grupo de trabajo (GT) para discutir y elaborar propuestas regulatorias para el etiquetado nutricional de alimentos. El modelo de ENF se destacó como el punto principal de divergencia entre las propuestas traídas a luz por la Anvisa. A pesar de que la industria de alimentos, representada por la Asociación Brasileña de la Industria de Alimentos (*Associação Brasileira da Indústria de Alimentos* - ABIA), haya recomendado las etiquetas de semáforo, otras propuestas, alineadas con los intereses de salud pública, presentaron el modelo de etiquetas de advertencia con diferentes formatos. La coalición de la sociedad civil "Alianza por la alimentación adecuada y saludable" ("*Aliança pela Alimentação Adequada e Saudável*", en portugués) favoreció el modelo con el formato de triángulo (9).

Las etiquetas de advertencia tienen como su premisa que los productos con alto contenido de nutrientes relacionados con obesidad y ENT deban ser fácilmente identificados para facilitar la elección de los alimentos más saludables. Un metaanálisis reciente ha mostrado que las etiquetas de advertencia funcionan mejor que los modelos coloridos (como el de semáforo y el Nutri-Score) para desalentar la compra de productos poco saludables y disminuir la cantidad de calorías y grasas saturadas compradas (10), y cuando comparados a la ausencia de etiquetas, las etiquetas de advertencia redujeron la compra de productos conteniendo calorías y azúcares, mientras otros sistemas no tuvieron ningún efecto en la compra (11). Teniendo en mente los envases llamativos que enfatiza la supuesta calidad de productos, símbolos contrastantes para nutrientes inadecuados son necesarios (9, 12).

Desde el 2017, la Anvisa comenzó a elaborar revisiones e informes técnicos que en ocasiones consultaron a la sociedad civil. El aumento en las actividades políticas corporativas (APC) de las industrias de alimentos ultraprocesados y bebidas se destacaron junto con una incursión del agronegocio en este tema, incluyendo el establecimiento de la coalición "Red Etiquetado" ("*Rede Rotulagem*", en portugués) (13), una organización de influyentes industrias brasileñas de alimentos y bebidas ultraprocesados. Este grupo no estuvo públicamente en desacuerdo con la actualización de etiquetas; sin embargo, se presentó así mismo como la solución, defendiendo inicialmente las etiquetas tipo semáforo. Evidencias muestran que este modelo pierde la eficiencia de informar y desalentar la compra de productos perjudiciales (14-18).

Durante este largo proceso regulatorio en Brasil, muchos otros países condujeron procesos regulatorios de etiquetado nutricional de alimentos donde el ENF fue elegido, especialmente en países latinoamericanos. Desde el 2016 en Chile, los productos envasados han exhibido octágonos negros en el frente del envase, indicando exceso de cantidades de calorías, azúcar, sodio y/o grasas saturadas (19). Adicionalmente, esta etiqueta de advertencia es actualmente aprobada y/o implementada en Perú (20), Uruguay (21), México (22) y Argentina (23).

Considerando que evidencias científicas y experiencias internacionales no son siempre suficientes para equilibrar la influencia de las industrias en asuntos políticos, la participación de organizaciones civiles en la protección de una alimentación saludable y salud general ha sido esencial para garantizar los intereses de la población. En Brasil, la Alianza para la Alimentación Adecuada y Saludable lanzó la campaña "Tienes el derecho de saber lo que comes" en el 2017. Debido a la demora de la Anvisa para someterse a los procesos regulatorios, la Alianza lanzó, a finales del 2018, una segunda campaña con testimonios de doctores, padres, madres, jóvenes y personas con ENT acerca de la necesidad de un etiquetado de alimentos adecuado, intentando presionar a la Anvisa para abrir la consulta pública (CP) acerca de la regulación del etiquetado nutricional. En el 2019, durante la CP, la Alianza incentivó la participación de la población con la tercera campaña de comunicación "Cuando abras tu boca, no cierres tus ojos", dando a conocer la idea en la sociedad civil del etiquetado de advertencia triangular en los envases de alimentos.

En octubre del 2020, Brasil aprobó el etiquetado nutricional de alimentos envasados, con un modelo ENF sin precedentes en un formato de lupa. Este diseño fue modificado y es más pequeño que el presentado en la CP con una pérdida considerable de legibilidad gráfica y claridad. El diseño en formato de lupa aprobado nunca fue evaluado, sin evidencia científica que demuestre su eficacia. Durante el proceso de elección, estudios conducidos bajo el pedido de la Anvisa probaron el diseño de formato de lupa presentado en la CP y revelaron que las etiquetas de advertencia son más efectivas para ser identificadas y facilitar la comprensión de la composición nutricional, la percepción del cuidado de la salud y cambios en la intención de compra (24, 25). Solo un estudio mostró una respuesta marginalmente mejor que el modelo de lupa en mejorar las intenciones de compra cuando comparada a los triángulos (26). La evidencia científica, publicada en el 2021, después de la aprobación del modelo de lupa brasileña, mostró que los octágonos fueron más efectivos en identificar los productos menos perjudiciales, en entender la composición nutricional y en cambiar la intención de compra (27).

El comienzo de la implementación de la regulación es esperado para octubre del 2022 (28, 29). El modelo aprobado tiene un perfil nutricional más débil que los otros países (como Chile) y el modelo de la OPS, que significa que productos alimenticios poco saludables no recibirán el modelo de lupa de acuerdo con el reglamento brasileño. Adicionalmente, el modelo define que los productos recibirán una sola lupa independientemente del número de nutrientes críticos (azúcar, sodio y/o grasas saturadas) presentes en el producto. Los nutrientes serán enumerados al lado o al bajo del modelo de lupa (Figura 1). El ENF octagonal, por ejemplo, determina una etiqueta por cada nutriente.

FIGURA 1

Basado en la información presentada, unido a la falta de evidencia científica de la eficiencia del modelo, el reglamento aprobado fue insuficiente para cumplir las recomendaciones de salud pública (3, 5) como una garantía de que todos los alimentos poco saludables recibirán la identificación del modelo de lupa. Debido al desafiante escenario político (un gobierno neoliberal, preocupado por las aspiraciones del mercado financiero en lugar de la salud pública y con una posición de ultraderecha) e interferencia considerable de la industria durante los procesos regulatorios, el modelo aprobado estuvo por debajo de lo esperado.

Pasaron más de 6 años para que la Anvisa decidiera este proceso regulatorio. Durante este periodo, el escenario político brasileño pasó por muchos momentos de inestabilidad que resultaron en el reemplazo de los directores de la Anvisa, ministros de salud y tres presidentes de la república. Además de los cambios de poder que retrasaron los procesos, el gobierno actual tiene una posición liberal declarada y defiende los intereses comerciales sobre la salud pública.
En ese contexto, además de la insuficiencia del reglamento, el resultado del proceso regulatorio representa un avance y un reconocimiento de la sociedad civil durante este periodo, considerando que fueron capaces de defender la evidencia científica y el interés de la salud pública como una prioridad. El reglamento aprobado por la Anvisa representa una de las pocas pérdidas de la industria de alimentos en el actual gobierno, ya que no pudieron evitar el ENF de advertencia. La industria de alimentos usó el acto para reducir su alcance y, por lo tanto, los efectos de las leyes de regulación (30).

Después de concluir este proceso regulatorio, Brasil mejoró sus asuntos de protección a la salud, aunque los intereses de la industria todavía son una prioridad para el detrimento de los intereses de la salud pública. Eso afecta su capacidad para cumplir con su obligación de garantizar completamente el derecho a la salud y el acceso a los alimentos. Avanzamos un paso en el camino hacia el derecho a la información sobre el riesgo a la salud proveniente de productos alimenticios, pero hay muchos cambios y mejoras por implementar y continuaremos trabajando hacia la implementación de esta regulación hasta que a cada brasileño se le conceda totalmente el derecho de saber que está comiendo.

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Nota del editor
Todas las afirmaciones expresadas en este artículo son únicamente de los autores y no representan necesariamente la de sus organizaciones afiliadas o de la editorial, los editores y los revisores. Cualquier producto que pueda ser evaluado en este artículo o la solicitud que pueda ser hecha por su fabricante, no está garantizado ni respaldado por el editor.

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PORTUGUESE

Os desafios da rotulagem frontal no Brasil

Palavras-clave: política, regulação de alimentos, rótulo de alimentos, direitos alimentares, segurança alimentar e nutricional

O sistema jurídico brasileiro possui diversos mecanismos para garantir o direito público ao acesso à informação clara. A Constituição Federal (CF), promulgada em 1988 e conhecida como "Constituição Cidadã", tem como princípio garantir o direito à dignidade da pessoa humana. A proteção do consumidor, bem como seu direito inviolável à vida e à segurança, são garantidos pela CF como direitos básicos. A CF limita a ordem econômica do país ao estabelecer que seu objetivo é proporcionar dignidade a todos os brasileiros. Portanto, o desenvolvimento econômico não pode colocar pessoas em risco e seus processos devem estar alinhados com princípios de boa vontade e equilíbrio entre consumidores e fornecedores. Coletivamente, a CF estabelece que saúde, alimentação e proteção da juventude são direitos sociais; portanto, o governo é responsável por fornecer políticas para sua implementação (1).

Devido ao aumento da obesidade e das doenças crônicas não transmissíveis (DCNT), as ações relacionadas à regulação dos alimentos são cruciais para enfrentar o aumento da desnutrição em todas as suas formas, incluindo as consequências do sobrepeso, da desnutrição e da deficiência de micronutrientes. A regulação de alimentos pode ser entendida como um conjunto de ações, lideradas pelo Estado, para proteger os consumidores. Como ações de regulação, poderiam ser listadas a tributação de alimentos, a restrição/proibição da publicidade de alimentos e a rotulagem de alimentos, incluindo a rotulagem nutricional frontal (RNF).

Aperfeiçoamentos na rotulagem de alimentos permeiam a discussão sobre segurança alimentar e nutricional (SAN), considerando a necessidade de apoiar a população em suas escolhas alimentares, auxiliando-a, inclusive, na compreensão das informações confusas das embalagens. Isso também faz parte dos direitos dos consumidores. Um rótulo de fácil compreensão contribui para a efetivação do direito básico à informação clara sobre a composição e os riscos dos produtos alimentícios, conforme determina o Código de Defesa do Consumidor (CDC) brasileiro (2).

A nível internacional, são inúmeras as recomendações aos governos para que promovam práticas que regulem a rotulagem dos alimentos e informem os consumidores sobre os riscos do consumo de alguns produtos para a sua saúde e facilitem as suas escolhas alimentares, como afirmam vários documentos internacionais da Organização Mundial da Saúde (OMS) (3), da Organização das Nações Unidas para Agricultura e Alimentação (*Food and Agriculture Organization of the United Nations* - FAO) (4) e da Organização Pan-Americana da Saúde (OPAS) (5).

A urgência e a prioridade dadas a esses assuntos devido à atual situação de saúde e nutrição dos brasileiros, cenário que combina altos índices de obesidade e DCNT (6), pode estar associada a fatores relacionados às normas nacionais de rotulagem de alimentos que podem permitir associação com publicidade enganosa e informações não claras, impactando no crescimento do consumo de alimentos não saudáveis. Além disso, a leitura e a compreensão das tabelas de informação nutricional são complexas para os consumidores, principalmente a interpretação de números e informações técnicas, a necessidade de cálculos, o tamanho pequeno da fonte e a poluição visual da embalagem (7).

Evidências do Brasil alinhadas com experiências internacionais e mobilização da sociedade desencadearam discussões políticas. Em 2013, o Conselho Nacional de Segurança Alimentar e Nutricional (Consea) manifestou pela primeira vez que a Agência Nacional de Vigilância Sanitária (Anvisa) deveria dar "agilidade aos processos de atualização e qualificação de propostas regulatórias de rotulagem de alimentos", já que a entidade é responsável pelas normas de rotulagem de alimentos no país (8).

Em 2014, a Anvisa criou um grupo de trabalho (GT) para discutir e elaborar propostas normativas para a rotulagem nutricional de alimentos embalados. O modelo da RNF se destacou como o principal ponto de divergência entre as propostas trazidas pela Anvisa. Embora a indústria de alimentos, representada pela Associação Brasileira da Indústria de Alimentos (ABIA), tenha recomendado o semáforo nutricional, outras propostas, alinhadas aos interesses da saúde pública, apresentavam o modelo de rótulos de advertência com diferentes formatos. A coalizão da sociedade civil "Aliança pela Alimentação Adequada e Saudável" favoreceu o modelo no formato de triângulo (9).

Os rótulos de advertência têm como premissa que os produtos com alto teor de nutrientes relacionados à obesidade e DCNT devem ser facilmente identificados para facilitar a escolha dos alimentos mais saudáveis. Metanálises recentes mostraram que rótulos de advertência funcionam melhor do que modelos coloridos (como semáforos e o Nutri-Score) para desencorajar a compra de produtos não saudáveis e diminuir a quantidade de calorias e gorduras saturadas compradas (10) e, quando comparados a produtos sem rótulos, os rótulos de advertência reduziram o teor de calorias e açúcar dos produtos adquiridos, enquanto outros sistemas não tiveram efeito sobre a compra (11). Tendo em vista as embalagens atraentes que enfatizam as qualidades alegadas nos produtos, são necessários símbolos contrastantes para os nutrientes inadequados (9, 12).

Desde 2017, a Anvisa passou a elaborar revisões e pareceres técnicos que por vezes consultavam a sociedade civil. O aumento das ações políticas corporativas (APC) das indústrias de alimentos e bebidas ultraprocessados se destacaram junto com o agronegócio neste tema, incluindo a criação da coalizão "Rede Rotulagem" (13), uma organização de indústrias brasileiras de alimentos e bebidas ultraprocessados. Este grupo não discordou publicamente da atualização do rótulo; porém, apresentou-se como a solução, inicialmente defendendo os rótulos do tipo semáforo. As evidências mostram que esse modelo carece de eficiência para informar e desencorajar a compra de produtos prejudiciais (14–18).

Durante esse longo processo regulatório no Brasil, muitos outros países conduziram processos regulatórios para rotulagem nutricional de alimentos onde um modelo de RNF foi escolhido, especialmente em países da América Latina. Desde 2016, no Chile, os produtos embalados exibem octógonos pretos na frente da embalagem, indicando quantidades excessivas de calorias, açúcar, sódio e/ou gordura saturada (19). Além disso, o modelo de advertência está atualmente aprovado e/ou implementado no Peru (20), Uruguai (21), México (22) e Argentina (23).

Considerando que as evidências científicas e as experiências internacionais nem sempre são suficientes para equilibrar a influência das indústrias nos assuntos políticos, o envolvimento das organizações civis na defesa da alimentação saudável e da saúde em geral tem sido fundamental para garantir os interesses da população. No Brasil, a Aliança pela Alimentação Adequada e Saudável lançou em 2017 a campanha "Você tem direito de saber o que come". Devido à demora da Anvisa em dar seguimento ao processo regulatório, no fim de 2018, a Aliança lançou uma segunda campanha, com depoimentos de médicos, pais, mães, jovens e pessoas com DCNT sobre a necessidade de uma rotulagem de alimentos adequada, com o objetivo de pressionar a Anvisa a abrir a consulta pública (CP) sobre a regulação da rotulagem nutricional. Em 2019, durante a CP, a Aliança estimulou a participação da população com a terceira campanha de comunicação "Quando abrir a boca, não feche os olhos", divulgando a ideia do triângulo de advertência nas embalagens de alimentos para a sociedade civil.
Em outubro de 2020, o Brasil aprovou a rotulagem nutricional de alimentos embalados, com modelo inédito de RNF em formato de lupa. Seu *design* foi modificado e é menor do que o apresentado na CP com uma perda considerável de legibilidade gráfica e clareza. O *design* da lupa aprovada nunca foi avaliado, não havendo evidência científica que comprove sua eficiência. Durante o processo de escolha, estudos realizados a pedido da Anvisa testaram o desenho da lupa apresentado na CP e revelaram que as advertências são mais eficazes na identificação e facilitam o entendimento da composição nutricional, a percepção de saudabilidade e a mudança na intenção de compra (24, 25). Apenas um estudo mostrou um desempenho marginalmente favorável da lupa para melhorar a intenção de compra quando comparado aos triângulos (26). Evidências científicas, publicadas em 2021, após a aprovação da lupa brasileira, mostraram que os octógonos foram mais eficazes para identificar o produto menos prejudicial, entender a composição de nutrientes e mudar a intenção de compra (27).

O início da implementação do regulamento está previsto para outubro de 2022 (28, 29). O modelo aprovado tem um perfil nutricional mais fraco do que outros países (como o Chile) e o modelo da OPAS, o que significa que alimentos não saudáveis não receberão lupa, segundo a norma brasileira. Somado a isso, o modelo define que o produto receberá apenas uma lupa independentemente da quantidade de nutrientes críticos (açúcar, sódio e/ou gordura saturada) presentes no produto. Os nutrientes serão listados ao lado ou abaixo da lupa (Figura 1). A RNF octogonal, por exemplo, determina uma advertência para cada nutriente.

FIGURA 1

Com base nas informações apresentadas, aliadas à ausência de evidência científica sobre a eficácia do modelo, a norma aprovada foi insuficiente para atender tanto as recomendações de saúde pública (3, 5) quanto a garantia de que todo alimento não saudável receberá uma lupa de identificação. Devido ao cenário político desafiador (um governo neoliberal, preocupado com as aspirações do mercado financeiro em detrimento à saúde pública, com uma posição de ultradireita) e considerável interferência da indústria durante o processo regulatório, o modelo aprovado ficou aquém do esperado.

Demorou mais de 6 anos para a Anvisa decidir sobre esse processo regulatório. Nesse período, o cenário político brasileiro passou por vários momentos de instabilidade que resultaram na substituição de diretores da Anvisa, ministros da Saúde e três presidentes da República. Além das mudanças de poder que prolongaram o processo, o atual governo tem uma posição liberal declarada e defende os interesses comerciais acima da saúde pública.

Nesse contexto, apesar da insuficiência da norma, o resultado do processo regulatório representa um avanço e o reconhecimento da atuação da sociedade civil nesse período, considerando que ela soube defender prioritariamente a evidência científica e o interesse da saúde pública. A norma aprovada pela Anvisa representa uma das poucas perdas da indústria de alimentos no atual governo, uma vez que não conseguiram impedir a advertência como RNF. A indústria alimentícia utilizou-se do ato de forma a reduzir seu alcance e, portanto, os efeitos dos atos regulatórios (30).

Após a conclusão desse processo regulatório, o Brasil aprimorou seus assuntos de proteção à saúde, embora os interesses da indústria ainda sejam prioritários em detrimento dos interesses da saúde pública. Isso impacta sua capacidade de cumprir sua obrigação de garantir integralmente o direito à saúde e o acesso à alimentação. Avançamos um passo no caminho do direito à informação sobre os riscos dos alimentos à saúde, mas há muitas mudanças e melhorias a serem implementadas, e continuaremos trabalhando para a implementação desta regulamentação até que todos os brasileiros tenham garantido o direito de saber o que ele ou ela está comendo.

Contribuições do autor

JG concebeu e redigiu o artigo. Todos os demais autores revisaram criticamente e aprovaram a versão final a ser publicada.

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O autor NR era funcionário da FIAN Brasil. O autor PJ era funcionário da ACT Promoção da Saúde. Os demais autores declaram que a pesquisa foi realizada na ausência de quaisquer relações comerciais ou financeiras que possam ser interpretadas como um potencial conflito de interesses.

Nota do autor

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Impact of textual warnings on emotional brain responses to ultra-processed food products

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Background and objectives: Ultra-processed food products (UPF) have been associated with numerous non-communicable diseases. Despite this, the addictive nature of UPF, and the aggressive marketing strategies used to promote them, has created a strong emotional connection between UPF and consumers, and supports their increasing UPF global consumption. In view of the emotional link that consumers often have with UPF, modulating emotional reactions to UPF (by using strategies such as textual warnings) is important in changing consumers' behavior. Since emotions are better understood by assessing individuals' implicit reactions, we conducted an electroencephalographic study applying the event-related potential technique to investigate whether textual warnings were able to modulate the brain responses to UPF stimuli.

Materials and methods: Twenty-six participants (19 women) viewed pictures of UPF preceded by a warning sentence about the health risks of consuming UPF or a control sentence while the electroencephalogram was recorded. In addition, the participants rated the picture in respect of pleasantness, arousal, and intention to consume. As emotions are associated with motivational circuits in the brain, we focused on a well-known event-related potential brain marker of the motivational relevance associated with emotional stimuli, namely late positive potential (LPP).

Results: The late positive potential amplitude was larger for pictures depicting UPF under the warning condition compared to the control condition, a result that was accompanied by lower pleasantness ratings during the warning condition (compared to the control).

Conclusion: Textual warnings about the negative health consequences of consuming UPF changed the emotional responses toward UPF, possibly increasing the motivation to avoid UPF. These results shed new light on the impact of textual warnings on UPF-evoked emotions.

KEYWORDS

food labeling, consumer behavior, event-related potentials (ERP), EEG, motivation, ultra-processed food, emotion, late positive potential (LPP)

Introduction

The relationship between food and emotions has always been of great interest because of the implications for understanding food choices, emotional eating, eating disorders, and marketing strategies of the food industry (1–3). From an evolutionary perspective, foods are emotional stimuli that promote approach behaviors through the activation of a motivational system in the brain named the appetitive motivational system (4). This system ensures that human beings will seize opportunities to obtain food (as for most of human history procuring enough food has been a challenge) and has shaped our approach to sweet, sour, salty, fatty, umami, and starchy foods (5).

However, in the last decades, food environments have changed dramatically, with ultra-processed food (UPF) becoming ubiquitous in the industrialized world (6). In general, UPF are industrial formulations excessive in fats, sodium/salt and/or sugar and depleted or low in micronutrients and other bioactive compounds (7, 8). The food industry designed UPF to be hyper-palatable, which enhances their hedonic value and the pleasure associated with their consumption (9). In addition, the aggressive marketing strategies used by the food industry to promote UPF have long associated UPF with positive emotional content to attract consumers (10, 11). In fact, it has already been observed that viewing pictures of UPF evoke strong emotional reactions in individuals, and may prompt approach behaviors toward UPF that are associated with the activation of the appetitive motivational system (12).

Concerns about UPF and efforts to reduce their consumption are based on a strong body of evidence that links them to the development of obesity and non-communicable diseases, such as cancer and cardiovascular diseases (13–15), and shows them to be socially, economically and environmentally harmful (16–18). Therefore, public policies and actions are essential to achieve an effective reduction in the demand for and offer of UPF. In this context, nutritional warnings, in the form of a front-of-package nutrition labeling scheme, may help consumers to identify products containing excessive amounts of "critical nutrients" (19). This study aims to contribute to the understanding about the brain mechanisms underlying how textual warnings depicting the possible negative health consequences of UPF consumption would discourage consumers from purchasing such food.

Consumers' purchase decisions are guided by food-evoked emotions (3), so it is vital that nutritional warnings are able to modulate these responses if such public health strategies are to be effective. David et al. (12) collected reports of emotional experiences evoked by pictures of UPF and showed that textual warnings were effective in reducing the strong appetitive motivation evoked by the images and the intention to consume them. Since it can be difficult to capture emotional reactions using words, and given that social desirability bias can be an important confounding factor in experiments that depend on participant's explicit responses (20), implicit emotional measures represent a valuable tool in food research (21). Indeed, it has been shown that non-verbal food-evoked emotions are better at predicting food choices than verbal food-evoked emotions (2). In this respect, event-related potentials derived from electroencephalographic signals can be used to assess consumers' implicit emotional motivators. Event-related potentials reflect rapid brain responses associated with food pictures in different experimental conditions (22). Thus, it is possible to obtain valid measures of emotions evoked by UPF pictures and to investigate their modulation by public health strategies such as textual warnings.

Using event-related potentials, it is possible to observe a waveform known as late positive potential (LPP) 300–400 ms after the onset of pictures or words with emotional content (i.e., food stimuli) (23, 24). Any increase in the LPP waveform indicates that the presented stimuli is motivationally relevant for the observer, that is, a larger LPP indicates sustained allocation of attention toward emotionally evocative stimuli (25). The LPP is typically larger for food pictures than objects, and larger for palatable food than less palatable food (22, 26, 27). LPP can also reflect experimental manipulations in food studies (28–31).

The event-related potential approach has already been used to study how cognitive strategies may change emotional responses toward foods (28, 29). However, to the best of our knowledge, no study has used the event-related potential technique to investigate whether textual warnings are able to modulate the powerful influence of UPF (as defined by the

NOVA classification system) (7), a food cue that highly activates the appetitive motivational system (12). The present study aimed to add to the findings of the study by David et al. (12), which only used questionnaires to investigate whether textual warnings were able to modulate the emotional brain responses, by also measuring the LPP waveform evoked by UPF. Based on the findings of previous studies that used cognitive strategies, such as inducing the participant into thinking about the long-term consequences of eating unhealthy foods (28, 29), we hypothesized that the LPP would be larger for UPF pictures when preceded by a textual warning compared to those preceded by a control text. In summary, we used the event-related potential technique to gain new insights into the brain mechanisms underlying the effects of textual warnings on emotional processes that drive consumer behaviors in respect of UPF.

Materials and methods

Participants

Thirty-three participants, all students at the Federal University of Rio de Janeiro, were recruited. Due to electroencephalogram (EEG) data acquisition problems (e.g., eye blinks, eye movements, muscle activity, and skin potentials), the final sample consisted of 26 volunteers, 19 women and 7 men, aged between 18 and 30 years old [mean (M) = 21.84 y.o., standard deviation (SD) = 2.41]. Sample characteristics are shown in **Table 1**. All the participants were naive to the purpose of the experiment, were omnivores, and Portuguese native speakers who reported normal or corrected-to-normal vision. The final sample reported no psychiatric or neurological problems. The experiment was reviewed and approved by the Federal University of Rio de Janeiro (*Campus* Macaé) Ethics Committee. The participants provided their written informed consent to participate in this study.

TABLE 1 Final sample characteristics.

	Mean	Standard deviation	Min-Max
Age (years old)	21.84	2.41	18–30
Waist circumference (cm)	70.12	9.56	55–94
Body mass index (kg/m^2)	21.87	3.94	16–33.4
		n (%)	
Gender–male		7 (27%)	
Gender–female		19 (73%)	
Monthly household income (up to US$149.80)		5 (19.23%)	
Monthly household income (up to US$374.54)		14 (53.85%)	
Monthly household income (up to US$749.09)		3 (11.54%)	
Monthly household income (up to US$1,123.64)		4 (15.38%)	

Household incomes values refers to Brazilian Real currency (BRL) converted into US dollars (USD) (currency conversion 5.54 BRL: 1 USD).

Procedure

The experiment was conducted in the mornings in a room with dim ambient light and sound attenuation. The participants sat in front of a computer monitor with their head resting on a forehead/chin supporter approximately 57 cm from the screen. A microcomputer running E-Prime 2.0 (Psychological Software Tools Inc.) timed the presentation of the stimuli (UPF pictures that were presented on the computer screen), delivered the event-markers (triggers) that indicated the onset of the UPF pictures in the electroencephalographic signal, and recorded the keyboard responses. Using the event-related potential technique, the electroencephalographic segments containing the event of interest (the onset of the UPF pictures) were extracted from the electroencephalographic signal and were averaged to produce the event-related potential waveforms (32; see **Figure 1A**).

Figure 1B describes the sequence of events in each trial. The test started with a black screen (100 ms) followed by a fixation cross shown for 1000–1100 ms (in order for subjects to keep their eyes fixed on screen). Then, a control text (in the first block of 32 trials) or a warning text (in the second block of 32 trials) appeared for 6000 ms. The sentence was replaced by a fixation cross for 2100–2300 ms. After the offset of the fixation cross, a UPF picture appeared in the center of the screen for 4000 ms. The picture was replaced by a fixation cross for 2100–2300 ms. After this, the participants performed a picture-rating task in which: (1) They rated the image according to the emotional dimensions of arousal and valence (pleasantness), by completing the computer version of the Self-Assessment Manikin (SAM) (33); (2) They also rated their intention to consume the UPF depicted in the picture. They used the right-side keyboard numbers to rate the pictures and each rating lasted on the screen for 5000 ms. The SAM arousal dimension indicates the level of emotional arousal, ranging from 1, low arousal, to 9, extremely high arousal. The SAM valence measures the degree of pleasantness of the figure, ranging from 1 for extremely unpleasant to 9 for extremely pleasant. In the intention to consume, the participant estimates how much he/she would like to eat that food shown in the picture, ranging from 1 (none) to 9 (maximum). The above sequence was repeated 32 times (32 trials) for each block (the first 32 trials for the control condition and the following 32 trials for the warning condition, with a short break between them).

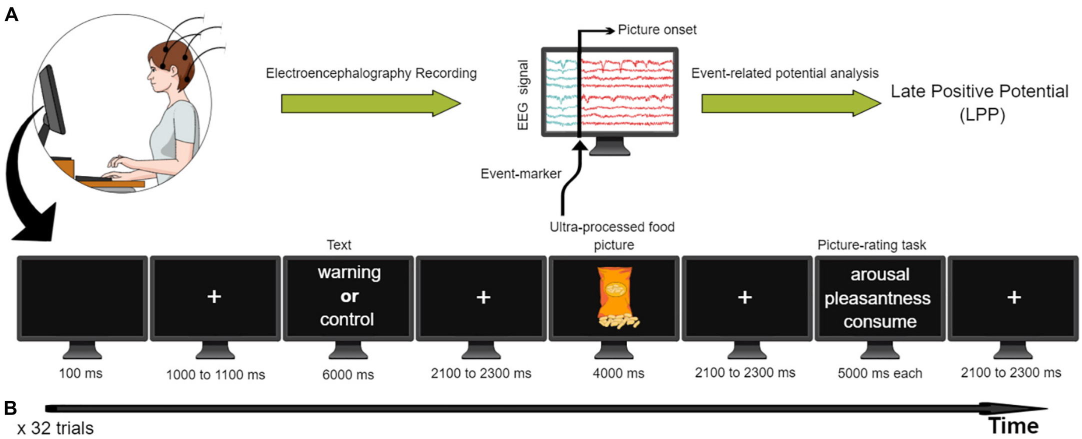

FIGURE 1
(A) The event-related potential waveform late positive potential (LPP) was extracted from the raw electroencephalographic signal. The event of interest (UPF picture) was presented to the participant on a computer screen while the electroencephalographic (EEG) signal was being recorded. Event-markers (i.e., triggers) in the EEG signal time-locked to the UPF picture onset defined the segments from the EEG signal to be analyzed. After conducting 32 trials containing different UPF pictures, the EEG signal was averaged across the segments, revealing the event-related potential waveform–late positive potential (LPP). **(B)** Experimental design showing the sequence of events during the experiment. Participants viewed pictures depicting UPF preceded by a control text (the first block comprising 32 trials, control condition) or a warning text (the second block comprising the 32 remaining trials, warning condition). After viewing the UPF picture, participants rated it in two basic dimensions of emotion: arousal and pleasantness. They also rated their intention to consume the foods depicted in the pictures. UPF, ultra-processed food; EEG, electroencephalographic; LPP, late positive potential.

The reduced version of hunger scale (34) was used to assess the participants' subjective hunger before the experimental session, after the control condition, and after the warning condition (see **Supplementary Table**). The scale consists of reported subjective hunger at the time, and participants were asked to rate first how hungry they were, using a 7-point scale, and then how much of their favorite food they could eat right at the moment using a 6-point scale, with total scores varying from 0 to 11.

Stimuli

The food depicted in the pictures were classified as ultra-processed based on the NOVA system that considers the extent and purpose of industrial food processing (35). Sixty-four pictures of UPF that are easily found in the Brazilian market were used. "Sugary" product types were represented by 16 pictures of carbonated soft drinks, chocolate bars, chocolate discs and gums; "salty" product types by 16 pictures of corn chips, potato chips, tortilla chips and instant noodles; "saturated fatty" product types by 16 pictures of sausages, salami, nuggets and hot dogs; and "trans-fatty" products by 16 pictures of margarines, filled cookies, wafer cookies, and ice creams. The pictures, as well as the warning and control texts, are the same as those used in David et al. (12), another study by our group, and are shown in detail there (12). The pictures did not include the extrinsic properties of the products, such as the product's name, brand or package. The set of 32 UPF pictures presented in block 1 (control) in one session for one participant was presented to another participant in block 2 (warning), and vice-versa.

The textual warnings and the control texts were sentences in Portuguese language presented before each UPF in the warning condition and in the control condition, respectively. The warning condition contained sentences addressing the health risk of products, namely the high content of one of the following "components": sugar, sodium, saturated fat, or trans-fat. For example, a textual warning used for "sugar" pictures was: "*This product contains excessive sugar and, if consumed in large amounts, increases the risk of obesity and dental cavities.*" The control condition contained sized match sentences that also included information about the nutritional contents, for example: "*This product contains sugar and must be kept under refrigeration and be consumed before the expiration date.*" That is, in the control condition, the health risks associated with overconsumption were replaced by the information about the product's conservation and expiration date (see David et al. (12) for detailed information about the control and warning texts). The control and warning texts were presented in the center of the screen in white font on a black background and occupied approximately 75% of the screen dimensions.

Electroencephalogram recording and analysis

The EEG signal was recorded using a TiEEG (EMSA Equipamentos Médicos Ltd., Rio de Janeiro, Brazil) recording

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system with 23 electrodes positioned according to the electrode sites from the 10–20 system: Fpz, Fp1, Fp2, Fz, F7, F3, F4, F8, Cz, C3, C4, T7, T8, Pz, P3, P7, P4, P8, Oz, O1, O2, M1, and M2. All of the electrodes were referenced to Cz during the recording session and re-referenced to the averaged mastoids offline. The sample rate was 600 Hz during data acquisition, and the impedance was kept below 5 kΩ for all of the electrodes. The data were filtered offline using 0.1 Hz high-pass and 30 Hz low-pass digital filters. The offline analysis of the data was performed using the EEGLAB toolbox 14 (36) with MatLab R2016b (MathWorks, Natick, MA, USA). Eye blink artifacts were removed from the data using an independent component analysis (ICA) available in EEGLAB. These components were excluded from the data only after a visual inspection of the topographical maps demonstrated their proximity to the ocular area and established waveform characteristics. The EEG data were epoched from a 200 ms pre-picture onset (baseline period) to a 1000 ms post-UPF picture onset. The event-related potentials waveforms associated with "control" and "warning" conditions were averaged. Epochs containing deviations larger than 100 μV relative to the baseline for any of the electrodes were rejected. The epoch rejection rate did not exceed 20% per subject. The LPP values correspond to mean peak in the window of 400–800 ms after UPF picture onset, which has been usually described for LPP (23).

Statistical analysis

Mean values of arousal, pleasantness, and intention to consume were analyzed by Student's paired *t*-tests for comparisons between the control and warning conditions. The effect sizes of the differences were estimated using Cohen's d values. All data had a normal distribution as assessed by the Shapiro–Wilk W-test ($p > 0.05$ for all variables).

Electroencephalogram data were identified by an analysis of repeated measures ANOVA (using a Greenhouse–Geisser correction when pertinent) with the factors: anterior/posterior (3 levels: central, parietal and occipital electrodes); left/right (3 levels: left, midline and right electrodes), and condition (2 levels: warning and control). Regarding the anterior/posterior factor, central corresponds to the electrodes C3, Cz, and C4, parietal corresponds to the electrodes P3, Pz, and P4, and occipital corresponds to the electrodes O1, Oz, and O2. Although the focus here was on the difference between the LPP for the control and warning conditions (condition factor), it is important to include the other factors to ensure that the waveform included in the analysis presented the pattern expected for LPP. When applicable, Tukey *post-hoc* analyses were performed.

Spearman correlations were performed between LPP measures (LPP warning condition minus LPP control condition) and hunger scores in order to verify if the observed effects were influenced by hunger. The significance level adopted in all analyses was $\alpha = 0.05$.

Results

The analysis of participant's keyboard responses revealed that textual warnings significantly reduced the pleasantness ratings [$t_{(25)} = -2.83$, $p < 0.01$, Cohen's $d = 0.37$] evoked by the UPF pictures in the warning condition compared with the control condition, in which these pictures were preceded by control texts. That is, subjects judged UPF pictures in the warning condition less pleasant than in the control condition [$M_{(warning)} = 5.23$, SD = 1.29, $M_{(control)} = 5.67$, SD = 1.01]. Neither the subjective measures of arousal ratings [$t_{(25)} = -1.75$, $p = 0.09$, $M_{(warning)} = 5.44$, SD = 1.11, $M_{(control)} = 5.65$, SD = 0.98, Cohen's $d = 0.20$], or the measures of the intention to consume [$t_{(25)} = -1.94$, $p = 0.06$, $M_{(warning)} = 4.59$, SD = 1.29, $M_{(control)} = 4.97$, SD = 0.92, Cohen's $d = 0.34$] differed between the warning and control conditions.

In order to illustrate the brain effects related to warning sentences, the grand average waveforms of EEG data for each condition and the topographical scalp maps are presented in **Figures 2A,B**, respectively. It is possible to observe a remarkably increased amplitude at the posterior electrodes for the warning condition (waves in red) compared to the control condition (waves in blue) (**Figure 2A**). In fact, the ANOVA showed a main effect of condition [$F_{(1,25)} = 11.84$, $p < 0.01$], with LPP amplitudes being larger in the warning condition compared to the control condition [$M_{(warning)} = 3.55$ μV; $M_{(control)} = 1.51$ μV], which means a greater emotional reaction in the warning condition than in the control condition (**Figure 2C**). Compatible with what is expected for the LPP (23), there was also a main effect of anterior/posterior electrodes [$F_{(2,50)} = 5.65$, $p < 0.05$, $\varepsilon = 0.67$], but this effect did not interact with condition ($p = 0.17$). *Post-hoc* analysis showed that, regardless of warning and control conditions, LPP amplitudes were larger at parietal sites ($M = 3.74$ μV) compared with central sites ($M = 1.53$ μV), and occipital sites ($M = 2.33$ μV) did not differ in LPP amplitude from parietal and central sites. Left/Right factor also reached significance [$F_{(2,50)} = 7.81$, $p < 0.01$, $\varepsilon = 0.96$] but did not interact with condition ($p = 0.28$). *Post-hoc* analysis showed that, regardless of warning and control conditions, LPP amplitudes were larger at left sites ($M = 3.02$ μV) and right sites ($M = 2.95$ μV) compared to midline sites ($M = 1.64$ μV), with no difference between left and right sites. There were no significant interactions between anterior/posterior and left/right, as well as no triple interaction between factors (all *p*'s > 0.05).

Furthermore, hunger did not affect the observed results since correlation analysis showed no significant results between the EEG data (LPP for Warning—Control across sites) and hunger scores (all *p*'s > 0.05).

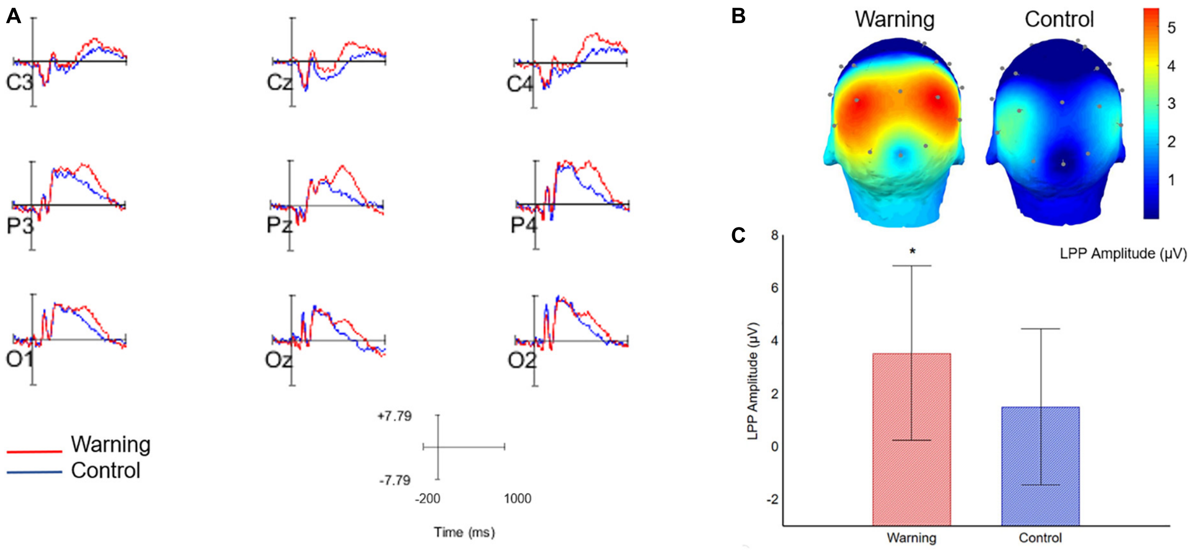

FIGURE 2
(A) Grand averages showing event-related potential waveforms during the warning (red line) and control conditions (blue line) across posterior electrodes (C3, Cz, C4, P3, Pz, P4, O1, Oz, O2). The grand-average ERP plots included the segment during 200 ms pre-UPF picture onset (baseline period) to a 1000 ms post-UPF picture onset. Positive voltages are plotted upward. **(B)** Topographical maps of the scalp (3D head, posterior view) showing the voltage distribution across the posterior electrodes during the warning (left) and control (right) conditions in the time window of 400–800 ms after UPF picture onset. The colormap changes from blue to red, the more positive-going are the waveform deflections over the scalp, measured in micro voltages (μV). Since the LPP is a waveform with positive deflection, it can be observed that it is greater during the warning condition (warm color) than during the control condition. LPP was observed at the posterior electrodes, in agreement with the literature (25). **(C)** Bar chart showing LPP amplitudes during the 400–800 ms time window analysis in the posterior electrodes (voltages were averaged across electrodes) in warning condition (red bar) and control condition (blue bar). *$p < 0.05$.

Discussion

The current study used event-related brain potentials to investigate whether textual warnings modulated the emotional brain responses evoked by pictures of UPF. We found a greater brain emotional reaction in the warning condition than in the control condition, manifested as an increase in the LPP waveform. Subjects also rated UPF pictures in the warning condition to be less pleasant than in the control condition. LPP is a well-known brain marker of stimuli motivational significance (25), and the more pronounced LPP combined with the lower feeling of pleasantness evoked by UPF pictures during the warning condition indicate that the textual warnings promoted changes in the participants' motivational state. Taken together, these results suggest that thinking about the long-term consequences of eating UPF (which was achieved here by applying textual warnings) increases the motivation to avoid them.

A possible explanation to the LPP increase (along with the decrease in the pleasantness ratings) in the warning condition (relative to control) is that textual warnings trigger cognitive strategies that change the perceptions about UPF, modulating the brain emotional responses they evoke. Our results corroborate the study by Meule et al. (28) in which subjects presented a greater LPP when instructed to think about the long-term consequences of eating high caloric food than when they were asked to think about the short-term effects of eating these foods. Similarly, a study by Ma et al. (29) also observed a larger LPP in response to food words when they were paired with names of chronic diseases. It is possible that the LPP increase during the warning condition reflects an increase in emotional states that motivates the individuals to withdraw from stimuli. This interpretation is in line with previous studies that have found an LPP increase in conditions in which food stimuli were not appealing to the participants, such as when food was decomposing (compared with responses to fresh food) (37) or when vegetarians viewed images containing meat (compared to the responses of omnivores) (38). To the best of our knowledge, this is the first study which focused on the LPP evoked specifically by UPF pictures, according to the NOVA classification (7). Most of the previous event-related potential studies used pictures of unhealthy foods, or caloric foods, but those foods were not classified according to the extent and purpose of industrial processing (22, 30). The studies of Lemos et al. (39) and Coricelli et al. (40) did consider UPF, but did not focus on LPP. Currently, the consumption of UPF is a major worldwide public health concern because they are becoming dominant in food environments as they are hyperpalatable, increasingly cheaper, aggressively marketed (16, 41–43) and contain ingredients that drive addictive behavior (9).

It is also important to mention that UPF evokes strong emotional responses that prompt their consumption (12). Our findings are in line with those of David et al. (12) who suggested that textual warnings are able to reduce the appetitive emotional responses evoked by UPF. In the present study, we offer a better understanding on how textual warnings are able to counteract the strong capacity of UPF to attract consumers through the emotions they evoke. In order to develop nutritional warnings that help consumers to resist the appeal of UPF, it is important to consider not only the evidence about *whether* warnings affect consumers' emotional responses toward UPF but also about *how* and *why* they do this. One advantage of the current study compared to the study by David et al. (12) is that we studied consumer behavior from a brain perspective using EEG, and did not rely solely on applying questionnaires to assess UPF-evoked emotions. Thus, we were able to uncover the brain processes involved in motivational states evoked by UPF and how they are affected by textual warnings. Another advantage is that by applying the event-related potential technique, we provided insights into the brain mechanisms affecting consumers behavior that occur implicitly and are not reported by the participants (44).

The results of the scales showed that there was a reduction in pleasantness in the warning condition compared to the control condition, but no significant changes in the arousal ratings, or intention to consume. Although LPP was previously associated with arousal in the literature (45), more recent studies suggest that LPP represents motivational significance, a phenomenon that is beyond the arousal measured by SAM (25). This is illustrated, for example, in the reactions to pictures with erotic content and exciting sports pictures, both of which are generally rated high in arousal (33). However, erotic pictures evoke a significant LPP, while exciting sports pictures do not (46). Therefore, the larger LPP in the warning condition is reflecting brain processes that cannot be understood simply in the terms of arousal. The absence of a significant effect in intention to consume and arousal is probably due the small sample size for these measures. The mean values for intention to consume (warning = 4.59; control = 4.97) showed a tendency toward a reduction in intention to consume in the warning condition, although the p value did not reach significance level ($p = 0.06$). Furthermore, a reduction in the intention to consume had already been observed in a previous study by our group with the same UPF pictures and same texts, but with a larger sample (12).

Although the block of pictures relating to the warning condition were always shown after those related to the control condition and, consequently, toward the end of the morning, the effect of increased hunger was not able to explain the modulation of LPP in the data. This reveals that the effect of textual warnings can occur regardless of hunger status. This lack of effect in respect of increased hunger may not completely exclude the possibility of an association between the factors, as in other studies LPP has been seen to be greater in response to food cues when participants were hungry compared to satiated (26); however, other studies have not found a direct relationship between hunger and LPP (27, 47).

Some limitations of this study should be highlighted. First, all participants were undergraduate or graduate students, as is common in other studies in this field (28, 29). For this reason, they cannot be considered to be a fully representative sample of the population, as they have a high level of education (incomplete or complete higher education). Second, although the sample size is not small for studies applying the event-related potential technique (48), it is possible that the small size made it difficult to properly observe the effects of individual variability in the sample. There is a final limitation in respect of the control texts, namely that it is possible that the sentences in the control condition were not completely neutral, because the control texts included the name of the macronutrient (i.e., "sugar"). Although the focus in the control condition was to control the health risks associated with overconsumption, the observed differences between conditions may have been even greater if the macronutrient had not been included in the control condition. Further studies should investigate the impact of naming the macronutrients.

In conclusion, textual warnings were able to modulate brain responses related to the motivational significance of ultra-processed food. It is likely that textual warnings increase the activation of motivational brain circuits that facilitate behaviors related to avoiding UPF. These findings build new bridges between the fields of neuroscience and public health, and provide further evidence in respect of the effectiveness of nutritional warnings that we hope will help in respect of public policy efforts to protect the population from the risks of consuming UPF.

Data availability statement

The datasets analyzed for this study can be found at http://data.mendeley.com/library (49).

Ethics statement

The studies involving human participants were reviewed and approved by Comitê de Ética em Pesquisa–UFRJ Macaé, Universidade Federal do Rio de Janeiro. The patients/participants provided their written informed consent to participate in this study.

Author contributions

IL, ID, and FB conceptualized and designed the experiments. TF, NF, and IL collected the data. TF, IL, and ID drafted the manuscript. FG was a staff member of the Pan American Health Organization. All authors contributed to analysis and interpretation, reviewed draft versions of the manuscript for salient intellectual content, provided suggestions and critical feedback, and read and approved the final manuscript.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fnut.2022.895317/full#supplementary-material

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ABSTRACTS

SPANISH

Impacto de las advertencias textuales en las respuestas cerebrales emocionales a productos alimenticios ultraprocesados

Justificación y objetivos: Productos alimenticios ultraprocesados (PUP) han sido asociados con numerosas enfermedades no transmisibles. A pesar de esto, la naturaleza adictiva de los PUP y las estrategias de marketing agresivo usadas para promoverlos, han creado una fuerte conexión emocional entre los PUP y los consumidores y apoya el creciente consumo global de los PUP. En vista del enlace emocional que los consumidores con frecuencia tienen con los PUP, la modulación de las reacciones emocionales a los PUP (mediante el uso de estrategias como las advertencias textuales) son importantes para cambiar el comportamiento de los consumidores. Dado que las emociones son mejor entendidas evaluando las reacciones implícitas de los individuos, conducimos un estudio electroencefalográfico aplicando la técnica del potencial relacionado con eventos para investigar si las advertencias textuales podrían modular las respuestas cerebrales a los estímulos de los PUP.
Materiales y métodos: Veintiséis participantes (19 mujeres) miraron imágenes de PUP precedidas por una afirmación de advertencia sobre los riesgos para la salud de consumir los PUP o una afirmación control mientras el electroencefalograma fue grabado. Adicionalmente, los participantes calificaron la imagen con respecto al agrado, excitación e intención de consumo. Como las emociones están relacionadas con los circuitos motivacionales en el cerebro, nos enfocamos en un bien conocido marcador cerebral potencial de eventos de relevancia motivacional asociado a los estímulos emocionales, a saber, el potencial positivo tardío (del inglés, *Late Positive Potential* - LPP).
Resultados: La amplitud del LPP fue mayor para las imágenes que mostraban los PUP bajo la condición de advertencia comparados con la condición de control, un resultado que fue acompañado por clasificaciones más bajas de agrado durante la condición de advertencia (comparada con el control).
Conclusión: Las advertencias textuales sobre las consecuencias negativas para la salud del consumo de los PUP cambiaron las respuestas emocionales hacia estos productos, posiblemente aumentando la motivación para evitar los PUP. Estos resultados arrojan una nueva luz en el impacto de las advertencias textuales en emociones evocadas por los PUP.

Palabras clave: etiquetado de alimentos, comportamiento del consumidor, potenciales relacionados a eventos (ERP), EEG, motivación, productos alimenticios ultraprocesados, emoción, potencial positivo tardío (LPP).

PORTUGUESE

Impacto de advertências textuais nas respostas emocionais cerebrais para produtos alimentícios ultraprocessados

Justificativa e objetivos: Os produtos alimentícios ultraprocessados (PUP) têm sido associados a inúmeras doenças crônicas não transmissíveis. Apesar disso, a natureza viciante dos PUP e as estratégias agressivas de publicidade utilizadas para promovê-los criaram uma forte conexão emocional dos PUP com os consumidores, apoiando o seu crescente consumo global. Tendo em vista esse vínculo emocional que os consumidores costumam ter com os PUP, modular as reações emocionais aos PUP (usando estratégias como advertências textuais) é importante para mudar o comportamento dos consumidores. Como as emoções são melhor compreendidas avaliando as reações implícitas dos indivíduos, realizamos um estudo eletroencefalográfico aplicando a técnica de potenciais relacionados a eventos para investigar se advertências textuais seriam capazes de modular as respostas cerebrais a imagens de PUP.
Materiais e métodos: Vinte e seis participantes (19 mulheres) visualizaram imagens de PUP precedidas por uma frase de advertência sobre os riscos à saúde do consumo destes produtos ou por uma frase controle enquanto o sinal eletroencefalográfico era registrado. Além disso, os participantes avaliaram essas imagens em relação à valência hedônica, ao alerta emocional e à intenção de consumo. Como as emoções estão associadas a circuitos motivacionais no

encéfalo, nos concentramos em um conhecido marcador cerebral da relevância motivacional associada a estímulos emocionais, conhecido como potencial positivo tardio (do inglês, *Late Positive Potential* - LPP).

Resultados: A amplitude da LPP foi maior para as imagens de PUP na condição advertência em comparação com a condição de controle, resultado que foi acompanhado por redução na classificação de valência hedônica durante a condição de advertência (comparado ao controle).
Conclusão: Advertências textuais sobre as consequências negativas para a saúde do consumo de PUP alteraram as respostas emocionais a eles, possivelmente aumentando a motivação para se evitar PUP. Esses resultados lançam uma nova luz sobre o impacto das advertências textuais nas emoções evocadas por PUP.

Palavras-chave: rotulagem de alimentos, comportamento do consumidor, potenciais relacionados a eventos (ERP), EEG, motivação, produtos alimentícios ultraprocessados, emoção, potencial positivo tardio (LPP).

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Brazil's nutrition labeling regulation: Challenges ahead on the path to guaranteeing consumer's right to adequate information

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KEYWORDS

front-of-package nutrition labeling, nutrition labeling, food regulation, nutrient profile model, warning label

Introduction

Latin America and the Caribbean (LAC) face rising rates of multiple forms of malnutrition (1). Between 2019 and 2020, the prevalence of undernutrition increased in the region, with the COVID-19 pandemic aggravating pre-existing drivers of food and nutrition insecurity (2). At the same time, adult and childhood obesity rates remain alarming, with prevalences of almost 25 and 5%, respectively (3).

National governments have approved laws to improve the food environment and promote healthy diets, including the implementation of warning labels (WLs) as their front-of-package nutrition labels (FoPNL) to support healthier food choices. Over the last decade, in LAC countries, mandatory FoPNL using WLs have been implemented in Chile (4), Peru (5), Uruguay (6), Mexico (7) and Argentina (8). This type of mandatory FoPNL has been shown to lead to greater shifts in consumer food purchase intentions as compared with other FoPNL systems such as "traffic lights" (9–13).

In Brazil, the regulatory process to change the nutrition food labeling regulation and include a FoPNL, was started in 2014 by the National Health Surveillance Agency (*Agência Nacional de Vigilância Sanitária*–Anvisa). Anvisa is linked to the Ministry of Health (Executive power) and responsible for regulating the food labeling in the country *via* resolutions (14, 15). The regulatory process had the active participation of the government, the academia, civil society organizations and food and beverage industry representatives. After technical discussions in a working group, submission of proposals to support improvements in the current regulation, revision of international experiences and scientific evidence, and public consultations, the regulatory process was concluded in October 2020. The final regulation aimed to help consumers make more informed food purchase choices by: (i) including a mandatory FoPNL in the format of a magnifying glass to highlight excess added sugar, saturated fat and sodium in products where these nutrients were added; (ii) establishing new guidelines for the format, content, and legibility of the nutrition facts panel; and (iii) restricting nutrition claims on foods and beverages that would receive a FoPNL. According to Anvisa's resolution about nutrition labeling on packaged foods, nutrition labeling is "any statement intended to inform the consumer of the nutritional properties of the food, including the nutrition facts panel, FoPNL and nutrition claims"; and FoPNL is a "simplified standardized statement of high content of specific nutrients on the main panel of the food label" (14).

The regulatory process, however, was influenced by the food and beverage industry and their attempts to delay Anvisa's decision, derail the process, influence consumer opinion, and weaken the approved regulation (16). In this commentary, we present an overview of the changes incorporated to the nutrition labeling regulation in Brazil and highlight the strengths, limitations and potential challenges of the approved regulation.

Changes to the FoPNL during the regulatory process

Despite several changes made to the FoPNL design and nutrient profile model (NPM) during the regulatory process (2014–2020), the available scientific evidence, that was free from conflict of interest and presented consistent and compelling evidence from Brazil and other LAC countries, was not fully incorporated, resulting in a final nutrition labeling regulation that could have done more to safeguard public health. This is likely because of the food industry's corporate political activities used throughout the process to weaken the technical discussions and to delay the approval of the regulation. Some examples of the discursive strategy are related to the loss of jobs and damage to the economy, the need for nutrition education with the focus on individual responsibility, the multifactorial cause of obesity promoting physical activity, balanced diets, smaller food portions and food reformulation, and against the Nanny-State (16). Regarding instrumental strategies, the food and beverage industry built the *Rede Rotulagem* (Labeling Network, in English) coalition, lobbied several decision makers, financed polls and research, and used legal action when it was opportune (17).

From 2014 to 2016, Anvisa coordinated a working group with government, academia, civil society and food industry representatives to discuss possible solutions to strengthen nutrition food labeling for packaged foods (18). In 2017, Anvisa received proposals for improving nutrition food labeling and, at the end of the same year, the official regulatory process was opened (19), based on the regulatory impact analysis (*análise de impacto regulatório*–AIR). The AIR is "a systematic evidence-based regulatory management process that seeks to assess, based on the definition of a regulatory problem, the possible impacts of the options available to achieve the intended objectives" (20). The AIR is run by Anvisa's technical team and incorporates two online public consultations: a preliminary technical consultation, which was aimed to base Anvisa's decisions and the draft of the regulation, and a final consultation, which invited general public feedback on the draft regulation.

Anvisa's first technical proposal was presented in the "Preliminary Regulatory Impact Analysis Report on Nutrition Food Labeling" in 2018 (21). The report defined the regulatory objectives and identified that the best option for the FoPNL was a "high in" model that focused on excessive amounts of nutrients of concern that increase the risk of obesity and non-communicable diseases (NCDs). The NPM developed by Anvisa was based on the World Health Organization (WHO) (22) and the Codex Alimentarius (23) recommendations, with two gradual thresholds, starting with the less restrictive one. A variety of "high in" design options were presented for the FoPNL model (Figure 1A).

Anvisa's second technical proposal in 2019 presented the draft of the nutrition labeling regulation for public consultation. It included a FoPNL model in the format of a magnifying glass that would indicate high amounts of only three nutrients: added sugar, saturated fat and sodium (Figure 1B) (24, 25). The NPM would be implemented in two phases: less restrictive in the first year, and more restrictive after 2 years of implementation.

The final nutrition labeling regulation, which was approved by Anvisa's directors in 2020 based on the work of the technical team, presented a FoPNL with a revised magnifying glass design (14, 15) (Figure 1C), and a NPM with nutrient thresholds that had been previously proposed by Anvisa as an intermediate step, as follows: added sugar: $\geq$15/100 g; $\geq$7.5/100 ml; saturated fat: $\geq$6/100 g; $\geq$3/100 ml; sodium: $\geq$600 mg/100g; $\geq$300 mg/100 ml (thresholds for solid and semi-solid/liquid, respectively).

Strengths and limitations of the Brazilian nutrition labeling regulation

The approved nutrition labeling regulation coherently targets the various nutrition information features available on food packages sold in Brazil, and has positive aspects worth highlighting. The nutrition facts panel had three main improvements. The first is the inclusion of mandatory information on total and added sugars, a recommendation by the WHO (26) to help consumers make more informed decisions as regards to nutrients that are associated with the development of obesity and diet-related NCDs. Second,

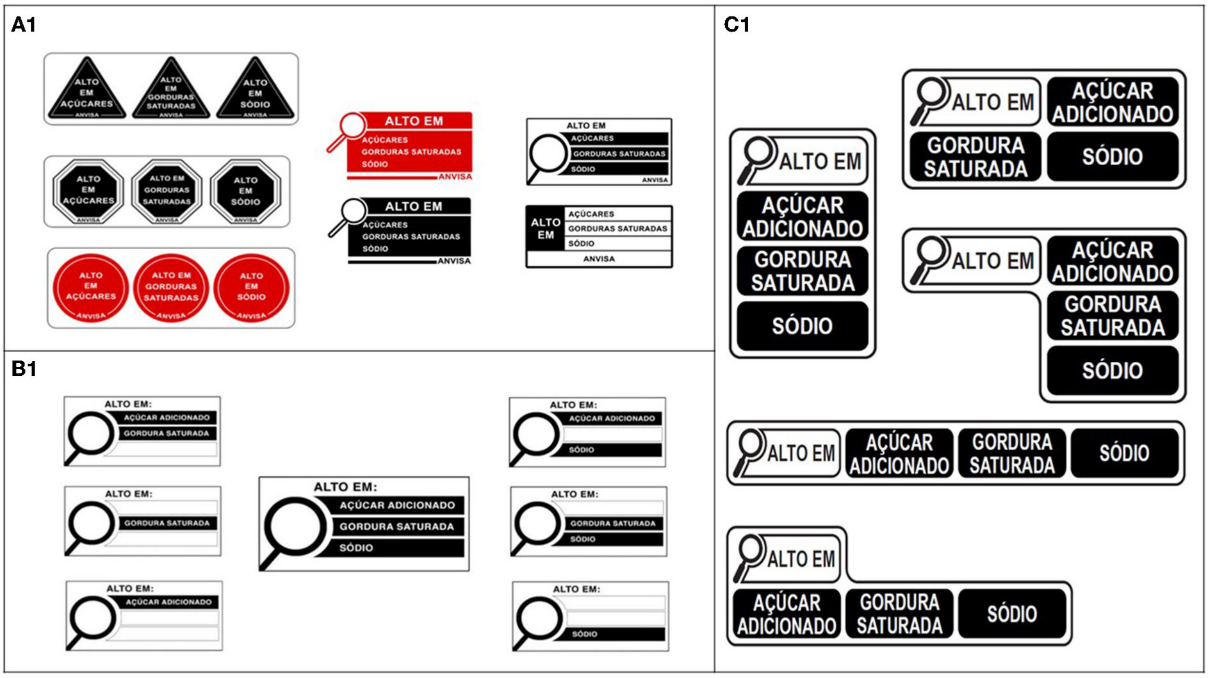

FIGURE 1
(A1) Design options of the FoPNL presented by Anvisa in the Preliminary Regulatory Impact Analysis Report on Nutrition Food Labeling in 2018. **(B1)** Design options of the FoPNL presented by Anvisa in the final public consultation in 2019. **(C1)** Final design of the FoPNL approved by Anvisa in 2020.

food and beverage packages will be required to carry information on the content of nutrients by 100 g/ml. The same numerical base allows consumers to better compare between products. Nutrition content, currently presented by portion and percentage of daily value (%DV), are not necessarily based on each individual's consumption patterns and do not allow comparison between products from different food groups (27). The %DV is calculated for a pre-established 2,000-calorie diet for a healthy individual, which does not account for various nutritional requirements (28). Finally, the regulation proposes several design changes to improve legibility, optimizing color contrast with black writing on a white background, setting a minimum font size, standardizing the type of the font, as well as the placement of the nutrition facts panel on the food package.

The regulation also establishes strong and clear criteria for products to be targeted by the FoPNL and excludes unprocessed and minimally processed foods, selected processed foods (fresh fruits and vegetables, yogurt and other fermented milk beverages without added sugars, processed cheeses) with a low content of added sugars, sodium and saturated fat, breastmilk substitutes, nutrition supplements, and alcoholic beverages. These criteria align with the Brazilian Dietary Guidelines (29), as foods that are recommended for a healthy diet will not receive a "high in" label (30–32).

All products that exceed nutrient thresholds will have to mandatorily display a black and white "high in" FoPNL model, placed on the top half of the front panel of the food package. The color contrast and the position in the package improves label saliency, drawing consumer attention to the most important information (33, 34) and follows best practices of information design (35). The regulation forbids the use of other FoPNL models on the label. Nutrition claims on the package will also be restricted, but only for added sugars, fats and sodium if the product carries a FoPNL for these nutrients.

The regulation, however, falls short on several fronts. The design of the FoPNL–the magnifying glass–has not been implemented in any country so far. This model was first proposed in Canada, but was shown to be less effective than other tested options (36). In fact, the magnifying glass design incorporated in the Brazilian regulation had not even been tested prior to publication of the regulation in 2020. To our knowledge, only one study tested this design, published in 2021, and showed that the WLs (in the format of an octagon) were more effective than the magnifying glass in identifying the least harmful option, understanding the nutrient content, and shifting purchase intentions (37). The available evidence on the magnifying glass design presented during the public consultation showed better results for warning labels, such as octagons and triangles, on outcomes like time to detect the label, objective understanding of the nutritional content, perception of healthiness and purchase intention (38, 39). One study showed that the magnifying glass performed marginally better at improving purchase intentions than the triangles, despite having scored worse for objective understanding (40).

Regardless of the number of nutrients of concern in excess in the product, there will be only one magnifying glass printed on the package. This may be a better use of space in the package; however, the design does not benefit from having individual labels like the WLs, that catch the attention of the consumers and repeatedly alert them to excess nutrients (41). Also, the size specifications of the FoPNL may not be adequate relative to the size of the food packages, with smaller labels occupying less space on food labels, which may hinder the consumer's ability to notice them (42, 43).

The NPM and nutrients thresholds adopted in the approved nutrition labeling regulation have not been previously validated and have been shown to capture a lower proportion of unhealthy foods (as defined by the Nova classification system) (44) compared to currently implemented NPMs, such as the Pan-American Health Organization (PAHO) NPM and the Chilean NPM. The PAHO NPM identifies more foods high in nutrients of concern (62%) such as sweetened dairy and non-dairy beverages, canned vegetables, and convenience foods (45). Not to mention that with the adoption of the nutrient thresholds proposed by Anvisa, many ultra-processed foods and beverages will not receive a FoPNL, and will not contribute to help consumers overcome information barriers to follow the Brazilian Dietary Guidelines that recommends this type of food to be avoided (29).

The FoPNL in the approved nutrition labeling regulation only targets added sugar, saturated fat and sodium, leaving out other ingredients and nutrients of concern, such as low-calorie sweeteners (LCSs), trans fatty acids and caffeine. Recent, yet growing evidence, shows that LCSs are associated with higher risk of dysbiosis (46), abdominal obesity (47), non-communicable diseases (48) and metabolic abnormalities (49) and type 2 diabetes (50) in adults. For children, available evidence on the safety and effectiveness of consuming foods and beverages with LCSs is inconclusive (51). In fact, the consumption of foods and beverages with LCSs has been shown to increase their risk of developing NCDs as adults (48, 52). Consuming foods and beverages with LCSs may also lead to long-term and heightening of sweet taste preferences (53, 54). LCSs were found as an additive in 9% of all packaged foods and beverages sold in Brazil, in 15% of ultra-processed products, including in those foods and beverages with advertising on the FoPNL that targets children (55). In the case of trans fatty acids, their consumption has no known "safe level" and is related to increased risk of cardiovascular diseases, especially coronary heart disease (56–58), and mortality. WHO recommends the elimination of industrially produced trans fat. Limited data on the safety of consuming caffeine in sensitive population such as children and adolescents are available (59, 60). In the Mexican FoPNL regulation, all products with caffeine need to display a precautionary warning highlighting the presence of caffeine and that the product should be avoided by children (7).

The regulation also fails to ban all claims on products that will receive FoPNL, other than those related to the nutrients of the FoPNL. This may still leave consumers vulnerable to being misled by a potential "halo effect" of the presence of nutrition claims for other nutrients such as 'high in fiber, vitamins and minerals' (61–64). In Brazil, claims are found in 41% of packaged products. Almost a third (28%) of packaged foods and beverages sold in the country carry a nutrition claim (e.g., source of calcium, 25% less sodium) and 22% carry a health claim (e.g., gluten free, natural). Importantly, foods with nutrition claims were more likely to be high in added sugar, sodium and/or saturated fat than those that would not receive a FoPNL (61).

The Brazilian approved nutrition labeling regulation does not include any restrictions on marketing targeted to children (like children's characters, cartoons, games, collectible gifts etc.) in foods high in nutrients of concern, as adopted in Chile and Mexico. Such marketing strategies are found in 20% of packaged foods and beverages sold in Brazil (55) and are known to increase children's desire for the product (65), brand loyalty (66) and demand for purchasing the product (67).

It took 6 years for Anvisa to reach a decision and approve the nutrition labeling regulation (Figure 2), due to the organization of the regulatory process, food industry interference and the COVID-19 pandemic. However, its *vacatio legis*[1] time will take 2 years plus the time of adaptation. Selected products will be allowed a longer implementation period, including foods with returnable packaging such as sugar sweetened beverages, which is among the top most consumed ultra-processed products in Brazil (68) and is associated with increased risk of diabetes and obesity (69). A total of 5 years until the nutrition labeling regulation is fully implemented is a long wait for a policy that is a public health priority. Latin American countries that have approved similar regulations required or will require less time for the new regulations to be implemented than in Brazil (4–8).

Conclusion

The recently approved nutrition labeling regulation of packaged foods in Brazil reflects a regulatory process that invited technical and scientific contributions from inside and outside Brazil and incorporated evidence-based elements of nutrition disclosure tools. The conflict of interest free scientific evidence

1 Latin expression that means the period between the publication date of a legal norm and the beginning of its validity. In general, the *vacatio legis* is expressed in an article in the end of the law with the following text: "The present law enters into force after (the number of) days of its official publication".

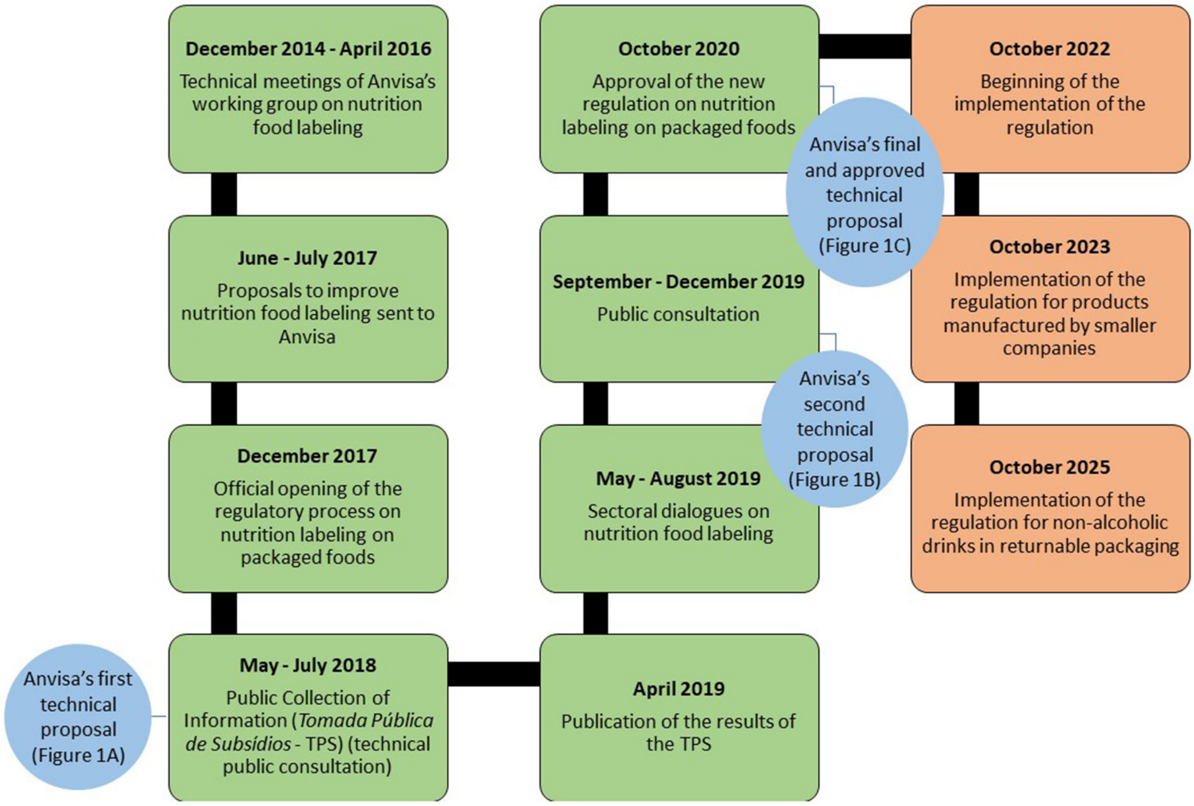

FIGURE 2
Timeline of the regulatory process of nutrition labeling on packaged foods and its implementation. Brazil, 2014–2025. Boxes in green contemplate events of the regulatory process that have already happened. Boxes in red contemplate events predicted to happen in the next years. Circles in blue represent Anvisa's technical proposals throughout the regulatory process.

that was provided during the regulatory process was not always sufficient to reach public health policy decisions and not all of the recommendations were included in the approved regulation.

An evaluation process is likely to be conducted by Anvisa, which may result in technical improvements of the norm. Despite this government-led evaluation, independent impact evaluation and monitoring shall be conducted by researchers. Impact evaluation studies should target changes in knowledge and purchase behavior of consumers, and product reformulation by the food industry. Evidence from independent and government-led evaluations should be considered in future improvements of the nutrition labeling regulations in Brazil so the effectiveness of the regulation to protect public health and correct unintended setbacks are enhanced.

The newly approved and soon-to-be implemented nutrition labeling regulation in Brazil is certainly good news for the Brazilian population despite the limitations outlined in this commentary. Robust scientific evidence, free of industry influence, and the active participation of civil society and academia in the regulatory process have contributed to also improving the information available on the nutrition facts panel and ensures that relatively unhealthy foods mandatorily display a "high in" FoPNL to highlight nutrients in excess. In doing so, Brazil joins a growing list of countries, especially those in the LAC region, which are implementing a suite of public policies to tackle the burden of malnutrition. This is a step in the right direction, that builds the foundation for continued improvements to the labeling regulations and for the introduction of complementary food policies that restrict marketing to children, ban sales of these unhealthy foods in schools, and increase taxes for the products that receive a FoPNL. Strengthening the collaboration between civil society, the government and academia will be crucial for improving what has already been achieved.

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LAM, CAB, NK, and APBM have been involved in drafting the manuscript and revising it critically for important intellectual content. All authors have made substantial contributions to the conception of the paper and gave final approval of the version to be published.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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COMMENTARIES

SPANISH

Regulación del etiquetado nutricional de Brasil: desafíos por delante en el camino de garantizar el derecho del consumidor a la información adecuada

Palabras clave: etiquetado nutricional frontal, etiquetado nutricional, regulación de alimentos, modelo de perfil nutricional, etiqueta de advertência

Introducción

Latinoamérica y el Caribe (LAC) enfrentan el aumento de las tasas de múltiples formas de desnutrición (1). Entre el 2019 y 2020, la prevalencia de la desnutrición aumentó en la región, con la pandemia del COVID-19 agravando los agentes preexistentes de inseguridad alimentaria y nutricional (2). Al mismo tiempo, las tasas de obesidad en adultos y niños permanecen alarmantes con prevalencia de al menos 25% y 5%, respectivamente (3).

Los gobiernos nacionales han aprobado leyes para mejorar el ambiente alimentario y promover dietas saludables, incluyendo la implementación de etiquetas de advertencia (EA) así como su etiquetado nutricional frontal (ENF) para apoyar la elección de alimentos más saludables. Durante la última década, en los países de LAC, el ENF obligatorio utilizando EA ha sido implementado en Chile (4), Perú (5), Uruguay (6), México (7) y Argentina (8). Se demostró que este tipo de ENF obligatorio conduce a grandes cambios en las intenciones de compra de alimentos por parte del consumidor cuando comparado con otros sistemas de ENF como el del "semáforo" (9-13).

En Brasil, los procesos regulatorios para cambiar el reglamento del etiquetado nutricional de alimentos e incluir un ENF se iniciaron en el 2014 por la Agencia Nacional de Vigilancia Sanitaria (*Agência Nacional de Vigilância Sanitária* - Anvisa). La Anvisa está unida al Ministerio de la Salud (poder Ejecutivo) y es responsable por la regulación del etiquetado de alimentos en el país vía resoluciones (14, 15). El proceso regulatorio contó con la participación activa del gobierno, la academia, organizaciones de la sociedad civil y representantes de la industria de alimentos y bebidas. Después de las discusiones técnicas en un grupo de trabajo, la entrega de propuestas para mejorar el actual reglamento, revisión de experiencias internacionales y evidencia científica y consultas públicas, los procesos regulatorios fueron concluidos en octubre del 2020. El reglamento final pretendía ayudar a los consumidores a estar más informados para elegir y comprar alimentos por: (i) incluir el ENF obligatorio en el formato de una lupa para resaltar el exceso de azúcar añadido, grasa saturada y sodio en productos dónde estos nutrientes fueron añadidos; (ii) establecer nuevas guías para el formato, contenido y legibilidad de la tabla de información nutricional; y (iii) restringir las declaraciones de propiedades nutricionales en alimentos y bebidas que recibirían un ENF. De acuerdo con la resolución de la Anvisa acerca del etiquetado nutricional en alimentos envasados, etiquetado nutricional es "cualquier afirmación que intenta informar al consumidor acerca de las propiedades nutricionales de los alimentos, incluyendo la tabla de información nutricional, el ENF y las declaraciones de propiedades nutricionales"; y el ENF es "una afirmación estándar simplificada del alto contenido de nutrientes específicos en el panel principal de la etiqueta de alimentos" (14).

El proceso regulatorio, sin embargo, fue influenciado por la industria de alimentos y bebidas y sus intentos de retrasar la decisión de la Anvisa, descarrilar el proceso, influenciar la opinión del consumidor, y debilitar el reglamento aprobado (16). En este comentario, presentamos una perspectiva general acerca de los cambios incorporados a la regulación del etiquetado nutricional en Brasil y resaltar las ventajas, limitaciones y desafíos potenciales de la regulación aprobada.

Cambios en el ENF durante el proceso regulatorio

A pesar de los múltiples cambios hechos al diseño del ENF y al modelo de perfil nutricional (MPN) durante el proceso regulatorio (2014-2020), la evidencia científica disponible, que estaba libre de conflicto de intereses y consistentemente presentada y con evidencia convincente desde Brasil y otros países de LAC, no fue completamente incorporada. Esto resultó en un reglamento final del etiquetado nutricional que podría haber hecho más para salvaguardar la salud pública. Esto es probable debido a las actividades políticas corporativas de la industria de alimentos utilizadas a lo largo del proceso para debilitar las discusiones técnicas y retrasar la aprobación de la regulación. Algunos ejemplos de la estrategia discursiva son relacionados a la pérdida de empleos y daños a la economía, la necesidad de educación nutricional con el enfoque de responsabilidad individual, las causas multifactoriales de la obesidad promoviendo la actividad física, dietas balanceadas, porciones más pequeñas de alimentos y reformulación alimentaria, y contra el Estado-Niñera (16). Con respecto a las estrategias instrumentales, la industria de alimentos y bebidas construyó la coalición *Rede Rotulagem* (Red Etiquetado, en español), presionó a varios tomadores de decisión, financió encuestas e investigaciones y utilizó acciones legales cuando fue oportuno (17).

Desde el 2014 hasta el 2016, la Anvisa coordinó un grupo de trabajo con el gobierno, la academia, la sociedad civil y los representantes de la industria de alimentos para discutir posibles soluciones para fortalecer el etiquetado nutricional de alimentos envasados (18). En el 2017, la Anvisa recibió propuestas para mejorar el etiquetado nutricional de alimentos y al final del mismo año, el proceso regulatorio oficial fue abierto (19), basado en el análisis del impacto regulatorio (*análise de impacto regulatório* - AIR). El AIR es "el proceso de gestión regulatoria basado en evidencia sistemática que busca evaluar, con base en la definición de un problema regulatorio, los posibles impactos de las opciones disponibles para lograr los objetivos previstos" (20). El AIR está dirigido por el equipo técnico de la Anvisa e incorpora dos consultas públicas en línea: la consulta técnica preliminar, que tuvo como objetivo fundamentar las decisiones de la Anvisa y el reglamento preliminar, y una consulta final, que invitó al público en general a opinar sobre el reglamento preliminar.

La primera propuesta técnica de la Anvisa fue presentada en el "Reporte Preliminar del Análisis de Impacto Regulatorio en el Etiquetado Nutricional de Alimentos" en el 2018 (21). El reporte definió los objetivos regulatorios e identificó que la mejor opción para el ENF fue el modelo "alto en" que se enfocó en cantidades excesivas de nutrientes perjudiciales que aumentan el riesgo de obesidad y enfermedades no transmisibles (ENT). El MPN desarrollado por la Anvisa está basado en las recomendaciones de la Organización Mundial de la Salud (OMS) (22) y el Codex Alimentarius (23) con dos límites graduales, empezando con el menos restrictivo. Una variedad de opciones de diseños "alto en" fueron presentados por el modelo de ENF (Figura 1A).

FIGURA 1

La segunda propuesta técnica de la Anvisa en el 2019 presentó la versión preliminar de la regulación del etiquetado nutricional para la consulta pública. Se incluyó el modelo de ENF en el formato de una lupa que indicaría altas cantidades de solo tres nutrientes: azúcar añadido, grasa saturada y sodio (Figura 1B) (24, 25). El MPN sería implementado en dos fases: la menos restrictiva en el primer año y la más restrictiva después de 2 años de implementación.

La regulación final del etiquetado nutricional que fue aprobada por los directores de la Anvisa en el 2020, basada en el trabajo del equipo técnico, presentó un ENF con un diseño de lupa revisado (14, 15) (Figura 1C) y una MPN con límites de nutrientes que han sido previamente propuestos por la Anvisa como un paso intermediario, de acuerdo con lo siguiente: azúcar añadido: ≥ 15/100 g; ≥ 7,5/100 ml; grasa saturada: ≥ 6/100 g; ≥ 3/100 ml; sodio: ≥ 600 mg/100 g; ≥ 300 mg/100 ml (límites para sólido y semisólido/líquido, respectivamente).

Ventajas y limitaciones de la regulación del etiquetado nutricional brasileño

El reglamento del etiquetado nutricional aprobado se enfoca coherentemente en las diversas características de información nutricional disponibles en los envases de alimentos vendidos en Brasil y tiene aspectos positivos que merecen ser destacados. La tabla de información nutricional tuvo tres mejoras importantes. La primera es la inclusión de la información obligatoria de los azúcares totales y añadidos, una recomendación de la OMS (26) para ayudar a los consumidores a tomar decisiones mejor informadas considerando los nutrientes que están asociados con el desarrollo de la obesidad y la dieta relacionada con las ENT. Segundo, se exigirá que los envases de alimentos y bebidas lleven información sobre el contenido de nutrientes por 100 g/mL. La misma base numérica permite a los consumidores una mejor comparación entre productos. Contenidos nutricionales actualmente presentados por porciones y porcentajes de valores diarios (%VD) no son necesariamente basados en los patrones de consumo de cada individuo y no permiten comparaciones entre productos con diferentes grupos de alimentos (27). Los %VD son calculados por una dieta de 2.000 calorías preestablecida para un individuo saludable, que no considera los varios requerimientos nutricionales (28). Finalmente, el reglamento propone varios cambios de diseño para mejorar la legibilidad, optimizando el contraste de colores con letras negras en un fondo blanco, colocando un tamaño mínimo de letra, estandarizando el tipo de letra, como bien la ubicación de la tabla de información nutricional en el envase del alimento.

La regulación también establece criterios fuertes y claros para los productos objeto del ENF y excluye alimentos no procesados y mínimamente procesados, alimentos procesados seleccionados (frutas frescas y vegetales, yogurt y otras bebidas lácteas fermentadas sin adición de azúcares, quesos procesados) con un bajo contenido de azúcares añadidos, sodio y grasas saturadas, sustitutos de la leche materna, suplementos nutricionales y bebidas alcohólicas. Estos criterios se alinean con las Guías Alimentarias Brasileñas (29), ya que los alimentos que se recomiendan para una dieta saludable no recibirán una etiqueta de "alto en" (30-32).

Todos los productos que exceden los límites nutricionales tendrán que obligatoriamente exhibir un modelo de ENF "alto en" blanco y negro, situado en la mitad superior de la parte delantera del envase de los alimentos. El contraste de color y la posición en el envase mejora la prominencia de la etiqueta, llamando la atención del consumidor a la información más importante (33, 34) y sigue las mejores prácticas de diseño de la información (35). El reglamento prohíbe el uso de otros modelos de ENF en la etiqueta. Las declaraciones nutricionales en el envase también serán restringidas, pero solo para azúcares añadidos, grasas y sodio si el producto lleva una ENF para estos nutrientes.

El reglamento, sin embargo, se queda corto en varios frentes. El diseño del ENF - modelo de la lupa - no ha sido implementado en ningún país hasta el momento. Este modelo fue primeramente propuesto en Canadá pero se mostró menos efectivo que otras opciones probadas (36). De hecho, el diseño de la lupa incorporado en el reglamento brasileño ni había sido probado antes de la publicación del reglamento en el 2020. A nuestro conocimiento, apenas un estudio probó este diseño, publicado en el 2021, y mostró que las EA (en el formato de octágono) fueron más efectivas que las lupas para identificar la opción menos perjudicial, entender el contenido de nutrientes y cambiar las intenciones de compra (37). La evidencia disponible del diseño de la lupa presentado durante la consulta pública mostró mejores resultados para EA, como los octágonos y triángulos, en resultados como el tiempo para detectar la etiqueta, entender el objetivo del contenido nutricional, percepción del cuidado de la salud e intención de compra (38, 39). Un estudio mostró que el modelo de la lupa se desempeñó marginalmente superior en mejorar las intenciones de compra que los triángulos, aunque tenga un puntaje peor para la comprensión objetiva (40).

Independientemente del número de nutrientes perjudiciales en exceso del producto, habrá solamente una lupa impresa en el envase. Esto puede ser un mejor uso del espacio en el envase; sin embargo, el diseño no se beneficia de tener etiquetas individuales como las EA, que llaman la atención del consumidor y repetidamente lo alerta del exceso de nutrientes (41). También, las especificaciones de tamaño del ENF pueden no ser adecuadas con relación al tamaño del envase del alimento, con etiquetas más pequeñas ocupando menos espacio en el etiquetado de los alimentos, que pueden dificultar la habilidad del consumidor para percibirlos (42, 43).

El MPN y los límites nutricionales adoptados en el reglamento del etiquetado nutricional aprobado no han sido previamente validados y se mostró que engloban una proporción menor de alimentos no saludables (como definido por el sistema de clasificación Nova) (44) comparado a los MPN actualmente implementados, como la MPN de la Organización Panamericana de Salud (OPS) y la MPN chilena. La MPN de la OPS identifica más alimentos con alto contenido de nutrientes perjudiciales (62%) como las bebidas lácteas y no lácteas azucaradas, los vegetales enlatados y las comidas rápidas (45). Además, con la adopción de los nutrientes perjudiciales propuestos por la Anvisa, muchos alimentos y bebidas ultraprocesados no recibirán un ENF y no contribuirán para ayudar al consumidor a superar las barreras de información para seguir las Guías Alimentarias Brasileñas que recomiendan evitar estos tipos de alimentos (29).

El ENF en el reglamento del etiquetado nutricional aprobado solo señala azúcar añadido, grasa saturada y sodio, sin incluir otros ingredientes y nutrientes perjudiciales como los edulcorantes bajos en calorías (EBC), ácidos grasos trans y cafeína. Evidencia reciente, pero creciente, muestra que los EBC están asociados con riesgos más altos de disbiosis (46), obesidad abdominal (47), enfermedades no transmisibles (48), anormalidades metabólicas (49) y diabetes tipo 2 (50) en adultos. Para niños, la evidencia disponible de la seguridad y efectividad del consumo de alimentos y bebidas con EBC no es conclusiva (51). De hecho, ha sido demostrado que el consumo de alimentos y bebidas con EBC aumentan el riesgo de desarrollar ENT cuando adultos (48, 52). El consumo de alimentos y bebidas con EBC también pueden conducir a un aumento a largo plazo de preferencias por el sabor dulce (53, 54). Los EBC fueron encontrados como un aditivo en 9% de todos los envases de alimentos y bebidas vendidos en Brasil, en 15% de productos ultraprocesados, incluso en aquellos alimentos y bebidas con publicidad en la cara frontal dirigida a niños (55). En el caso de los ácidos grasos trans, su consumo no tiene un "nivel seguro" conocido y está relacionado con el riesgo creciente de enfermedades cardiovasculares, especialmente enfermedades coronarias (56-58), y la muerte. La OMS recomienda la eliminación de las grasas trans producidas industrialmente. Datos limitados acerca de la seguridad del consumo de cafeína en población vulnerable como niños y adolescentes están disponibles (59, 60). En el reglamento del ENF mexicano, todos los productos con cafeína necesitan exhibir una alerta de precaución resaltando la presencia de cafeína y que el producto debe ser evitado por niños (7).

El reglamento tampoco prohíbe todas las declaraciones en productos que recibirán el ENF, distintos de los relacionados con los nutrientes del ENF. Esto todavía puede dejar a los consumidores vulnerables a ser engañados por un posible "efecto halo" por la presencia de declaraciones nutricionales para otros nutrientes como "alto contenido de fibra, vitaminas y minerales" (61-64). En Brasil, las declaraciones son encontradas en 41% de los productos envasados. Casi un tercio (28%) de los alimentos y bebidas envasados vendidos en el país llevan una declaración nutricional (ej.: fuente de calcio, 25% menos de sodio) y 22% llevan una declaración de salud (ej.: libre de gluten, natural). Es importante destacar que los alimentos con declaraciones nutricionales tenían más probabilidad de tener un alto contenido de azúcar añadido, sodio, y/o grasa saturada que aquellos que no recibirían un ENF (61).

El reglamento del etiquetado nutricional aprobado en Brasil no incluye ninguna restricción de publicidad dirigida a niños (como los personajes infantiles, dibujos animados, juegos, regalos coleccionables etc.) en alimentos con alto contenido de nutrientes perjudiciales, como adoptado en Chile y México. Esas estrategias de publicidad son encontradas en 20% de los envases de alimentos y bebidas vendidos en Brasil (55) y son conocidas por aumentar el deseo de los niños por el producto (65), la lealtad a la marca (66) y la demanda por la compra del producto (67).

Llevó 6 años para la Anvisa llegar a una decisión y aprobar el reglamento del etiquetado nutricional (Figura 2), debido a la organización del proceso regulatorio, a la interferencia de la industria de alimentos y a la pandemia del COVID-19. Sin embargo, su tiempo de *vacatio* legis[1] llevará 2 años más el tiempo de adaptación. A los productos seleccionados se les permitirá un periodo de implementación más largo, incluyendo alimentos con envases retornables como las bebidas azucaradas, que están entre los productos ultraprocesados más consumidos en Brasil (68) y están asociados con el riesgo creciente de diabetes y obesidad (69). Un total de 5 años hasta que la regulación del etiquetado nutricional se implemente por completo es una larga espera para una política que es una prioridad de salud pública. Los países latinoamericanos que han aprobado reglamentos similares requieren o requerirán menos tiempo para implementar los nuevos reglamentos que en Brasil (4-8).

[1]Expresión latina que significa el período comprendido entre la fecha de publicación de una norma jurídica y el comienzo de su vigencia. En general, el *vacatio legis* es expresado en un artículo al final de la ley con el siguiente texto: "La presente ley entra en vigor después (el número de) días de su publicación oficial".

FIGURA 2

Conclusión

El reglamento del etiquetado nutricional de alimentos envasados recientemente aprobado en Brasil refleja un proceso regulatorio que invitó a las contribuciones científicas y técnicas desde adentro y afuera de Brasil e incorporó elementos basados en evidencia de las herramientas de información nutricional. El conflicto de interés libre de evidencia científica que fue proporcionado durante el proceso regulatorio no fue siempre suficiente para alcanzar las decisiones de políticas de salud pública y no todas las recomendaciones fueron incluidas en el reglamento aprobado.

Es probable que la Anvisa realice un proceso de evaluación, que puede resultar en mejoras técnicas de la norma. A pesar de esta evaluación dirigida por el gobierno, evaluaciones de impacto independientes y vigilancia deben ser conducidas por investigadores. Estudios de evaluación de impacto deben traer cambios en el conocimiento, en el comportamiento de compra de los consumidores y en la reformulación de productos por la industria de alimentos. Evidencias provenientes de evaluaciones independientes y de las conducidas por el gobierno deben ser consideradas en futuros mejoramientos de los reglamentos del etiquetado nutricional en Brasil. Con eso, se potencia la eficiencia del reglamento para proteger la salud pública y corregir contratiempos no deseados.

El reglamento de etiquetado nutricional recientemente aprobado y que pronto se implementará en Brasil es ciertamente una buena noticia para la población brasileña, a pesar de las limitaciones descritas en este comentario. Evidencias científicas robustas, libres de la influencia de la industria y la participación activa de la sociedad civil y la academia en el proceso regulatorio han contribuido también al mejoramiento de la información disponible en la tabla de información nutricional y asegura que alimentos relativamente no saludables obligatoriamente exhiban un ENF “alto en” para resaltar nutrientes en exceso. Al hacerlo, Brasil se une a una creciente lista de países, especialmente aquellos de la región de LAC, que están implementando un conjunto de políticas públicas para hacer frente al peso de la desnutrición. Este es un paso en la dirección correcta, que construye la base para mejoramientos continuos en los reglamentos del etiquetado y a la introducción de políticas alimentarias complementarias que restringen la publicidad a niños, prohíben la venta de estos alimentos no saludables en las escuelas, y aumentan los impuestos para los productos que reciben un ENF. Fortalecer la colaboración entre la sociedad civil, el gobierno y la academia será crucial para mejorar lo que ya se ha logrado.

Contribuciones de los autores

LAM, CAB, NK y APBM han participado en la redacción del manuscrito y en la revisión crítica del contenido intelectual importante. Todos los autores hicieron contribuciones significativas en la concepción del artículo y aprobaron la versión final a ser publicada.

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Conflictos de interés

Los autores declaran que la investigación fue conducida en ausencia de cualquier relación comercial o financiera que pudiera resultar en un potencial conflicto de interés.

Nota del editor

Todas las afirmaciones expresadas en este artículo son únicamente de los autores y no representan necesariamente las de sus organizaciones afiliadas o de la editorial, los editores y los revisores. Cualquier producto que pueda ser evaluado en este artículo o la solicitud que pueda ser hecha por su fabricante, no está garantizado ni respaldado por el editor.

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PORTUGUESE

A regulamentação da rotulagem nutricional no Brasil: desafios para garantir o direito do consumidor à informação adequada

Palavras-chave: rotulagem nutricional frontal, rotulagem nutricional, regulação de alimentos, modelo de perfil nutricional, rótulo de advertência

Introdução

A América Latina e o Caribe (ALC) enfrentam taxas crescentes de múltiplas formas de desnutrição (1). Entre 2019 e 2020, a prevalência de desnutrição aumentou na região, com a pandemia de COVID-19 agravando os fatores preexistentes de insegurança alimentar e nutricional (2). Ao mesmo tempo, as taxas de obesidade infantil e adulta permanecem alarmantes, com prevalências de quase 25% e 5%, respectivamente (3).

Os governos nacionais aprovaram leis para melhorar o ambiente alimentar e promover dietas saudáveis, incluindo a implementação de rótulos de advertência (RA) como rotulagem nutricional frontal (RNF) para apoiar escolhas alimentares mais saudáveis. Na última década, nos países da ALC, a RNF obrigatória usando RA foi implementada no Chile (4), no Peru (5), no Uruguai (6), no México (7) e na Argentina (8). Esse tipo de RNF obrigatória demonstrou levar a maiores mudanças nas intenções de compra de alimentos do consumidor em comparação com outros sistemas de RNF, como os "semáforos" (9–13).

No Brasil, o processo regulatório para alterar o regulamento de rotulagem nutricional de alimentos e incluir uma RNF foi iniciado em 2014 pela Agência Nacional de Vigilância Sanitária (Anvisa). A Anvisa é vinculada ao Ministério da Saúde (Poder Executivo) e responsável por regulamentar a rotulagem de alimentos no país por meio de resoluções (14, 15). O processo regulatório contou com a participação ativa do governo, da academia, de organizações da sociedade civil e de representantes da indústria de alimentos e bebidas. Após discussões técnicas em um grupo de trabalho, apresentação de propostas para apoiar melhorias na regulamentação atual, revisão de experiências e evidências científicas internacionais e consultas públicas, o processo regulatório foi concluído em outubro de 2020. O regulamento final visou ajudar os consumidores a fazer escolhas de alimentos mais informadas: (i) incluindo uma RNF obrigatória em formato de lupa para destacar o excesso de açúcar adicionado, gordura saturada e sódio em produtos onde esses nutrientes foram adicionados; (ii) estabelecendo novas diretrizes para o formato, conteúdo e legibilidade da tabela de informação nutricional; e (iii) restringindo alegações nutricionais em alimentos e bebidas que receberiam uma RNF. De acordo com a resolução da Anvisa sobre rotulagem nutricional em alimentos embalados, rotulagem nutricional é "qualquer declaração destinada a informar o consumidor sobre as propriedades nutricionais do alimento, incluindo a tabela de informação nutricional, a RNF e as alegações nutricionais"; e RNF é uma "declaração padronizada simplificada de alto teor de nutrientes específicos no painel principal do rótulo do alimento" (14).

O processo regulatório, no entanto, foi influenciado pela indústria de alimentos e bebidas e suas tentativas de atrasar a decisão da Anvisa, inviabilizar o processo, influenciar a opinião do consumidor e enfraquecer a regulamentação aprovada (16). Neste comentário, apresentamos uma visão geral das mudanças incorporadas à regulamentação de rotulagem nutricional no Brasil e destacamos os pontos fortes, limitações e potenciais desafios da regulamentação aprovada.

Alterações na RNF durante o processo regulatório

Apesar de várias alterações feitas no *design* da RNF e no modelo de perfil nutricional (MPN) durante o processo regulatório (2014–2020), as evidências científicas disponíveis, livres de conflitos de interesse e que apresentavam evidências consistentes e convincentes do Brasil e de outros países da ALC, não foram totalmentes incorporadas, resultando em um regulamento final de rotulagem nutricional que poderia ter feito mais para proteger a saúde pública. Provavelmente, isso se deve às atividades políticas corporativas da indústria de alimentos utilizadas ao longo do processo para enfraquecer as discussões técnicas e atrasar a aprovação da regulamentação. Alguns exemplos da estratégia discursiva estão relacionados à perda de empregos e prejuízos à economia, necessidade de educação nutricional com foco na responsabilidade individual, causa multifatorial da obesidade promovendo a atividade física, dietas balanceadas, porções menores de alimentos e a reformulação de alimentos, e contra o Estado-Babá (16). Em relação às estratégias instrumentais, a indústria de alimentos e bebidas construiu a coalizão Rede Rotulagem, pressionou diversos tomadores de decisão, financiou pesquisas e acionou a Justiça quando oportuno (17).

De 2014 a 2016, a Anvisa coordenou um grupo de trabalho com representantes do governo, da academia, da sociedade civil e da indústria de alimentos para discutir possíveis soluções para fortalecer a rotulagem nutricional de alimentos embalados (18). Em 2017, a Anvisa recebeu propostas para melhorar a rotulagem nutricional de alimentos e, no final do mesmo ano, foi aberto o processo regulatório oficial (19), baseado na análise de impacto regulatório (análise de impacto regulatório - AIR). A AIR é "um processo sistemático de gestão regulatória, baseado em evidências, que busca avaliar, a partir da definição de um problema regulatório, os possíveis impactos das opções regulatórias disponíveis para o alcance dos objetivos pretendidos" (20). A AIR é conduzida pela equipe técnica da Anvisa e incorpora duas consultas públicas *online*: uma consulta técnica preliminar, que teve como objetivo embasar as decisões da Anvisa e a minuta do regulamento, e uma consulta final, que convidou o público em geral a comentar o projeto de regulamento.

A primeira proposta técnica da Anvisa foi apresentada no "Relatório Preliminar de Análise de Impacto Regulatório sobre Rotulagem Nutricional de Alimentos" em 2018 (21). O relatório definiu os objetivos regulatórios e identificou que a melhor opção para a RNF era um modelo "alto em" que focava em quantidades excessivas de nutrientes críticos que aumentam o risco de obesidade e doenças crônicas não transmissíveis (DCNTs). O MPN desenvolvido pela Anvisa foi baseado nas recomendações da Organização Mundial da Saúde (OMS) (22) e do Codex Alimentarius (23), com dois pontos de corte graduais, iniciando pelo menos restritivo. Uma variedade de opções de *design* "alto em" foi apresentada para o modelo de RNF (Figura 1A).

FIGURA 1

A segunda proposta técnica da Anvisa em 2019 apresentou a minuta do regulamento de rotulagem nutricional para consulta pública. Ele incluía um modelo de RNF no formato de uma lupa que indicaria altas quantidades de apenas três nutrientes: açúcar adicionado, gordura saturada e sódio (Figura 1B) (24, 25). O MPN seria implementado em duas fases: o menos restritivo no primeiro ano e o mais restritivo após 2 anos de implementação.

O regulamento final de rotulagem nutricional, aprovado pela diretoria da Anvisa em 2020 com base no trabalho da equipe técnica, apresentava uma RNF com *design* de lupa revisado (14, 15) (Figura 1C) e um MPN com pontos de corte de nutrientes que já tinham sido propostos anteriormente pela Anvisa como etapa intermediária, sendo: açúcar adicionado: ≥ 15 g/100 g; ≥ 7,5 g/100 ml; gordura saturada: ≥ 6 g/100 g; ≥ 3 g/100 ml; sódio: ≥ 600 mg/100 g; ≥ 300 mg/100 ml (pontos de corte para sólidos e semissólidos/líquidos, respectivamente).

Pontos fortes e limitações da regulamentação brasileira de rotulagem nutricional

O regulamento de rotulagem nutricional aprovado visa, de forma coerente, os diversos recursos de informação nutricional disponíveis nas embalagens de alimentos comercializados no Brasil e apresenta aspectos positivos que merecem destaque. A tabela de informação nutricional teve três melhorias principais. A primeira é a inclusão de informações obrigatórias sobre açúcares totais e adicionados, uma recomendação da OMS (26) para ajudar os consumidores a tomar decisões mais informadas em relação aos nutrientes associados ao desenvolvimento de obesidade e DCNTs relacionadas à dieta. Em segundo lugar, as embalagens de alimentos e bebidas serão obrigadas a apresentar informações sobre o conteúdo de nutrientes por 100 g/ml. A mesma base numérica permite que os consumidores comparem melhor entre os produtos. Os conteúdos nutricionais, atualmente apresentados por porção e percentual do valor diário (%VD), não são necessariamente baseados no padrão de consumo de cada indivíduo e não permitem a comparação entre produtos de diferentes grupos de alimentos (27). O %VD é calculado para uma dieta pré-estabelecida de 2.000 calorias para um indivíduo saudável, que não leva em conta várias necessidades nutricionais (28). Por fim, o regulamento propõe diversas alterações de *design* para melhorar a legibilidade, otimizando o contraste de cores com a letra preta sobre fundo branco, estabelecendo um tamanho mínimo de fonte, padronizando o tipo de fonte, bem como a colocação da tabela de informação nutricional na embalagem do alimento.

O regulamento também estabelece critérios fortes e claros para os produtos a serem alvo da RNF e exclui alimentos não processados e minimamente processados, alimentos processados selecionados (frutas e vegetais frescos, iogurte e outras bebidas lácteas fermentadas sem adição de açúcares, queijos processados) com baixo teor de açúcares adicionados, sódio e gordura saturada, substitutos do leite materno, suplementos nutricionais e bebidas alcoólicas. Esses critérios estão alinhados com o Guia Alimentar para a População Brasileira (29), pois os alimentos que são recomendados para uma dieta saudável não receberão o rótulo "alto em" (30–32).

Todos os produtos que excedam os pontos de corte de nutrientes terão obrigatoriamente de exibir um modelo de RNF "alto em" em preto e branco, inserido na metade superior do painel frontal da embalagem do alimento. O contraste de cores e a posição na embalagem melhoram o destaque do rótulo, chamando a atenção do consumidor para as informações mais importantes (33, 34) e seguem as melhores práticas de *design* da informação (35). O regulamento proíbe o uso de outros modelos de RNF no rótulo. As alegações nutricionais na embalagem também serão restritas, mas apenas para açúcares adicionados, gorduras e sódio se o produto contiver uma RNF para esses nutrientes.

A regulamentação, no entanto, falha em várias frentes. O *design* da RNF – a lupa – ainda não foi implementado em nenhum país. Este modelo foi proposto pela primeira vez no Canadá, mas mostrou-se menos eficaz do que outras opções testadas (36). De fato, o *design* da lupa incorporado ao regulamento brasileiro sequer havia sido testado antes da publicação do regulamento em 2020. Ao nosso conhecimento, apenas um estudo, publicado em 2021, testou esse *design* e mostrou que os RA (no formato de octógono) foram mais eficazes do que a lupa na identificação da opção menos prejudicial, na compreensão do conteúdo de nutrientes e na mudança das intenções de compra (37). As evidências disponíveis sobre o *design* da lupa apresentadas durante a consulta pública mostraram resultados melhores para RA, como octógonos e triângulos, em resultados como tempo para detectar o rótulo, compreensão objetiva do conteúdo nutricional, percepção de saudabilidade e intenção de compra (38, 39). Um estudo mostrou que a lupa teve um desempenho marginalmente melhor em melhorar as intenções de compra do que os triângulos, apesar de ter pontuado pior para a compreensão objetiva (40).

Independentemente da quantidade de nutrientes críticos em excesso no produto, haverá apenas uma lupa impressa na embalagem. Isso pode ser um melhor aproveitamento de espaço na embalagem; no entanto, o *design* não se beneficia de ter rótulos individuais como os RA, que chamam a atenção dos consumidores e os alertam repetidamente sobre o excesso de nutrientes (41). Além disso, as especificações de tamanho da RNF podem não ser adequadas em relação ao tamanho das embalagens dos alimentos, com rótulos menores ocupando menos espaço nos rótulos dos alimentos, o que pode prejudicar a capacidade do consumidor de percebê-los (42, 43).

O MPN e os pontos de corte de nutrientes adotados no regulamento de rotulagem nutricional aprovado não foram validados anteriormente e demonstraram capturar uma proporção menor de alimentos não saudáveis (conforme definido pelo sistema de classificação Nova) (44) em comparação com os MPN atualmente implementados, como o MPN da Organização Pan-Americana da Saúde (OPAS) e o MPN chileno. O MPN da OPAS identifica mais alimentos altos em nutrientes críticos (62%), como produtos lácteos adoçados e bebidas não lácteas, vegetais enlatados e alimentos de conveniência (45). Sem contar que, com a adoção dos pontos de corte de nutrientes propostos pela Anvisa, muitos alimentos e bebidas ultraprocessados não receberão RNF e não contribuirão para que os consumidores superem as barreiras de informação para seguir o Guia Alimentar para a População Brasileira que recomenda que esse tipo de alimento seja evitado (29).

A RNF no regulamento de rotulagem nutricional aprovado inclui apenas açúcar adicionado, gordura saturada e sódio, deixando de fora outros ingredientes e nutrientes críticos, como edulcorantes de baixa caloria (EBCs), ácidos graxos trans e cafeína. Evidências recentes, mas crescentes, mostram que EBCs estão associados a maior risco de disbiose (46), obesidade abdominal (47), DCNTs (48) e anormalidades metabólicas (49) e diabetes tipo 2 (50) em adultos. Para crianças, as evidências disponíveis sobre a segurança e a eficácia de se consumir alimentos e bebidas com EBCs são inconclusivas (51). De fato, foi demonstrado que o consumo de alimentos e bebidas com EBCs aumenta o risco de desenvolver DCNTs na idade adulta (48, 52). Consumir alimentos e bebidas com EBCs também pode levar e aumentar as preferências de sabor doce em longo prazo (53, 54). EBCs foram encontrados como aditivo em 9% de todos os alimentos e bebidas embalados vendidos no Brasil, em 15% dos produtos ultraprocessados, inclusive naqueles alimentos e bebidas com publicidade voltada para crianças na parte da frente da embalagem (55). No caso dos ácidos graxos trans, seu consumo não tem "nível seguro" conhecido e está relacionado ao aumento do risco de doenças cardiovasculares, principalmente coronarianas (56–58), e mortalidade. A OMS recomenda a eliminação da gordura trans produzida industrialmente. Dados limitados sobre a segurança do consumo de cafeína em populações sensíveis, como crianças e adolescentes, estão disponíveis (59, 60). No regulamento mexicano de RNF, todos os produtos com cafeína precisam exibir um aviso de precaução destacando a presença de cafeína e que o produto deve ser evitado por crianças (7).

O regulamento também falha em proibir todas as alegações em produtos que receberão RNF, exceto aquelas relacionadas aos nutrientes da RNF. Isso ainda pode deixar os consumidores vulneráveis a serem enganados por um potencial "efeito halo" da presença de alegações nutricionais para outros nutrientes, como "rico em fibras, vitaminas e minerais" (61-64). No Brasil, as alegações são encontradas em 41% dos produtos embalados. Quase um terço (28%) dos alimentos e bebidas embalados vendidos no país apresentam uma alegação nutricional (por exemplo, fonte de cálcio, 25% menos sódio) e 22% apresentam uma alegação de saúde (por exemplo, sem glúten, natural). É importante ressaltar que os alimentos com alegações nutricionais eram mais propensos a ter alto teor de açúcar adicionado, sódio e/ou gordura saturada do que aqueles que não receberiam uma RNF (61).

O regulamento de rotulagem nutricional aprovado no Brasil não inclui nenhuma restrição à publicidade direcionada a crianças (como personagens infantis, desenhos animados, jogos, brindes colecionáveis etc.) em alimentos altos em nutrientes críticos, conforme adotado no Chile e no México. Tais estratégias de publicidade são encontradas em 20% dos alimentos e bebidas embalados vendidos no Brasil (55) e são conhecidas por aumentar o desejo das crianças pelo produto (65), a fidelidade à marca (66) e a demanda de compra do produto (67).

A Anvisa levou 6 anos para tomar uma decisão e aprovar o regulamento de rotulagem nutricional (Figura 2), devido à organização do processo regulatório, à interferência da indústria de alimentos e à pandemia de COVID-19. No entanto, seu tempo de *vacatio legis*[2] levará 2 anos a mais de adaptação. Produtos selecionados terão um período de implementação mais longo, incluindo alimentos com embalagens retornáveis, como bebidas adoçadas com açúcar, que está entre os produtos ultraprocessados mais consumidos no Brasil (68) e está associado ao aumento do risco de diabetes e obesidade (69). Um total de 5 anos até que o regulamento de rotulagem nutricional seja totalmente implementado é uma longa espera para uma política que é uma prioridade de saúde pública. Os países latino-americanos que aprovaram regulamentos semelhantes exigiram ou exigirão menos tempo para que os novos regulamentos sejam implementados do que no Brasil (4-8).

FIGURA 2

Conclusão

A recém-aprovada regulamentação da rotulagem nutricional de alimentos embalados no Brasil reflete um processo regulatório que incluiu contribuições técnicas e científicas de dentro e de fora do Brasil e incorporou elementos baseados em evidências de ferramentas de divulgação nutricional. A evidência científica livre de conflito de interesses que foi fornecida durante o processo regulatório nem sempre foi suficiente para chegar às decisões de políticas de saúde pública e nem todas as recomendações foram incluídas na regulamentação aprovada.

É provável que um processo de avaliação seja conduzido pela Anvisa, o que pode resultar em melhorias técnicas da norma. Além desta avaliação liderada pelo governo, a avaliação e o monitoramento de impacto independentes devem ser conduzidos por pesquisadores. Estudos de avaliação de impacto devem visar mudanças no conhecimento e no comportamento de compra dos consumidores e na reformulação de produtos pela indústria de alimentos. Evidências de avaliações independentes e lideradas pelo governo devem ser consideradas em melhorias futuras das regulamentações de rotulagem nutricional no Brasil, de modo que a eficácia da regulamentação para proteger a saúde pública e a correção de contratempos não intencionais seja aprimorada.

O regulamento de rotulagem nutricional recém-aprovado e prestes a ser implementado no Brasil é certamente uma boa notícia para a população brasileira, apesar das limitações descritas neste comentário. Evidências científicas robustas, livres da influência da indústria, e a participação ativa da sociedade civil e da academia no processo regulatório também contribuíram para melhorar as informações disponíveis na tabela de informação nutricional e garantir que alimentos relativamente não saudáveis apresentem obrigatoriamente uma RNF "alto em" para destacar os nutrientes em excesso. Ao fazer isso, o Brasil se junta a uma lista crescente de países, especialmente os da região da ALC, que estão implementando um conjunto de políticas públicas para combater o peso da desnutrição. Este é um passo na direção correta, que constrói as bases para melhorias contínuas nos regulamentos de rotulagem e para a introdução de políticas de alimentação complementares que restringem a publicidade para crianças, proíbem a venda de alimentos não saudáveis nas escolas e aumentam os impostos para os produtos que recebem RNF. Fortalecer a colaboração entre sociedade civil, governo e academia será fundamental para melhorar o que já foi alcançado.

Contribuições do autor

LAM, CAB, NK e APBM participaram da redação do manuscrito e da revisão crítica do conteúdo intelectual importante. Todos os autores fizeram contribuições substanciais para a concepção do artigo e deram a aprovação final da versão a ser publicada.

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[2]Expressão latina que significa o período compreendido entre a data de publicação de uma norma jurídica e o começo da sua vigência. Em geral, o *vacatio legis* é expresso em um artigo ao final da lei com o seguinte texto: "A presente lei entra em vigor após (o número de) dias da sua publicação".

Conflito de interesse

Os autores declaram que a pesquisa foi conduzida na ausência de quaisquer relações comerciais ou financeiras que possam ser interpretadas como um potencial conflito de interesses.

Notas do autor

Todas as reivindicações expressas neste artigo são exclusivamente dos autores e não representam necessariamente as de suas organizações afiliadas, ou as do editor, dos editores e dos revisores. Qualquer produto que possa ser avaliado neste artigo, ou reclamação que possa ser feita por seu fabricante, não é garantido ou endossado pelo editor.

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Comparing Latin American nutrient profile models using data from packaged foods with child-directed marketing within the Brazilian food supply

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Objectives: This study aimed to examine and compare the extent to which different nutrient profile models (NPMs) from Latin America (LA) identify packaged foods and beverages with child-directed marketing sold in Brazil as being high in nutrients associated to the risk of non-communicable diseases (NCDs).

Materials and methods: In this cross-sectional study, we evaluated 3,464 foods found in the five largest Brazilian supermarkets. Child-directed marketing was coded using the International Network for Food and Obesity/NCDs Research, Monitoring and Action Support (INFORMAS) protocol. Differences in medians of sugar, saturated fats, and sodium per 100 kcal in foods, with the presence and absence of child-directed marketing, were tested using the Mann–Whitney test. We compared six NPMs in LA and examined to what extent they targeted these products using prevalence ratios. Analyses were performed overall and by the degree of food processing according to the Nova food classification.

Results: We found 1,054 packages with child-directed marketing. Among these, candies, cakes and pies, sauces and creams, and sugar-sweetened beverages were significantly higher in sugar, saturated fat, and sodium per 100 kcal than products that are not targeted at children ($p < 0.05$). Compared with PAHO and the Mexico models, the Brazilian NPMs would allow three times more ultra-processed foods to omit warnings for sodium ($p < 0.05$). The Uruguayan NPM also flagged fewer ultra-processed foods high in sodium ($p < 0.05$). The Brazilian model also allows four times more sugar-sweetened beverages and six times more dairy drinks to omit warnings for sugar than the Mexico and PAHO models. In comparison to all other NPMs, the Brazilian model showed the worst performance in identifying baked goods as high in sodium. Chile, Uruguay, and Peru models would also target significantly less sugar-sweetened beverages and high in at least one critical nutrient than PAHO and Mexico models.

Conclusion: Compared with other NPMs in LA, the NPM criteria adopted in Brazil are more permissive and less likely to inform consumers of the poor nutritional quality of ultra-processed foods and beverages with child-directed marketing.

KEYWORDS

nutrient profile model, food labeling, food policies, child-directed marketing, marketing, marketing to children, unhealthy food marketing

Introduction

Childhood obesity has become a global epidemic and carries significant long-term consequences to physical and mental health (1), including an increased risk of the development of diet-related chronic diseases and worse psychological health and socioeconomic outcomes (2, 3). Moreover, excessive weight gain in childhood increases the risk of being overweight and obese in adulthood (4). According to the World Health Organization (WHO), in 2019, an estimated 38.2 million children were overweight or obese worldwide (5). The prevalence of obesity among children and adolescents (ages 2–19 years) in Latin America (LA) is among the highest in the world, with one in five individuals either overweight or obese (6).

Ultra-processed food consumption (7–10) and exposure to the marketing of unhealthy foods and beverages (11–16) are linked to growing overweight and obese in childhood. Ultra-processed foods are defined as formulations of ingredients, mostly of industrial use, which results from a series of industrial processes (hence "ultra-processed") with added sugars, salt, fat, and additives. Some examples of these foods are salty snacks, sugar-sweetened beverages (SSBs), biscuits, candies, and breakfast cereals (17).

Persuasive marketing strategies influence children's and adolescents' food intake, preferences, attitudes, and eating behavior (18–20). They are particularly harmful at this stage of life because their cognitive development is relatively limited, making it harder for them to recognize the persuasive intent of marketing used by the food industry (21, 22). Food marketing may also affect children's purchasing preferences for foods and influence long-term norms related to food consumption (23, 24). Despite that marketing on food packaging is less studied than televised food marketing in addressing childhood obesity (19, 25), current evidence suggests that cartoon characters and other endorsers including brand mascots, celebrities, sports figures comprise the most prevalent type of marketing targeted at children on food packages (19, 22). As the sales of packaged foods in LA rise, particularly that of ultra-processed foods (26), this evidence gap may constrain effective policymaking to prevent childhood overweight and obesity.

Some LA countries have implemented strategies and policies to curb rising obesity rates including taxation of SSBs; front-of-package (FoP) nutritional labeling for nutrients like sugar, saturated fat, and sodium; and marketing and food procurement restrictions (27–30). Evidence from Chile, where a combination of these policies was implemented in 2016, showed that the volume of SSB purchases with FoP nutritional labeling decreased by 22.8 ml/capita/day post regulation (31). Other studies from Chile showed a decrease in hours of children's exposure to TV programs with advertisements using cartoon characters for foods high in energy, saturated fats, added sugars, or sodium (32), and a decline in the proportion of advertisements for foods high in these nutrients of concern after the restrictions were implemented. The sharpest declines were seen for carbonated beverages, desserts, breakfast cereals, and fruit-flavored drinks (33).

Nutritional labeling regulations have recently been revised in Brazil, resulting in new FoP nutritional labeling policies to assist with consumers' food purchase decisions (34). Like in Chile, the updated Brazilian labeling regulation includes a nutrient profile model (NPM) to identify excessive amounts of sugar, saturated fat, and sodium (35, 36). NPMs set eligibility criteria and nutrient thresholds to determine which foods and beverages should be targeted by food policies (28, 30, 37). The NPM adopted in Brazil differs from the models used in other LA countries, including the one endorsed by the Pan American Health Organization (PAHO) (38, 39). The Brazilian model has been reported to be more permissive in limiting nutrients of concern, which could lead to a lower proportion of foods and beverages receiving FoP labels, even though they may have high contents of sodium, saturated fat, and sugar as identified by using other NPMs (39).

Nutrient profile models can also be used to target foods that should have marketing restrictions for children (28, 33, 37, 40–42). Based on the key role that NPMs play in flagging unhealthy products that could face marketing restrictions, the aim of this study is to examine and compare the extent to which different NPMs from Latin America (LA) identify packaged foods and beverages with child-directed marketing sold in Brazil as being high in nutrients associated to the risk of non-communicable diseases (NCDs).

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Materials and methods

Brazilian food labeling database

In this cross-sectional study, we used data from a sample of packaged foods sold in five Brazilian food retailers with the largest market share in the country (43). The five retailers account for 70% of the sales of branded products, who were identified using the annual food retail sales report generated by Euromonitor International in 2016 (44). Supermarkets were selected as the source of data collection because they account for a large share (59%) of the energy consumed by Brazilians (45). São Paulo, located in the southeast region of the country, was chosen as the primary study area because it is the largest city in Brazil (46). As one of the food retail chains only had stores in the northeast region of the country, data collection at this chain was conducted in Salvador, their largest market.

Data on the geographic location of the five retail chains in São Paulo and Salvador in Brazil were collected from the websites of each company, and the addresses were geocoded. The neighborhood of each store was defined as a 1 km buffer (using Euclidean distance) around the store. The stores were stratified by tertiles of neighborhood income. Information on income from the household top earner was obtained from the 2010 Brazilian Census (46). The largest store of each retail chain in the first and third tertiles was selected to ensure socioeconomic representativeness in the sample, except for one chain that only allowed data collection in its distribution center, where all products sold in the chain were available. Formal permission was obtained from all the supermarkets included in this study.

The sampling of the five food retailers and 128 food groups investigated was based on the sampling recommendations of the International Network for Food and Obesity/Non-communicable Diseases (NCDs) Research, Monitoring and Action Support (INFORMAS) (48). Details about the food groups are available in Supplementary Table 1. The INFORMAS sampling approach was deemed appropriate for this study when factors like potential researcher burden, time, and data collection costs were considered. The approach focuses on food categories clearly related to reducing or increasing the rates of obesity and diet-related NCDs (relevant to INFORMAS objectives), for example, fruits and vegetable products (canned, frozen, etc.).

Data were collected between April and July 2017 by trained fieldworkers using previously employed protocols (47). Packaged foods and beverages were included, and ∼13,000 different items distributed in 128 categories of food products had all sides of their package photographed. Information on the product brand and flavor, package size, nutrition facts panel, ingredients list, and reconstitution instructions, when applied, was entered between July and November 2017 by trained nutritionists. For data on composition information (nutrition facts panel, ingredient list), 10% of the sample was double-entered by the same person and 10% of the sample was repeated by a second person for intra- and inter-rater reliability analyses. After the exclusion of items available in more than one package size, products without nutrition information, multipacks with different items, products without a list of ingredients, and products with missing values for portion size and/or calories, 11,434 records were maintained in the database (Figure 1). More details about the procedures for data collection can be found in a previous study (39).

Identifying marketing strategies

Data related to marketing strategies were collected from the food labels in a random subsample of the aforementioned packaged foods and beverages. Marketing strategies included nutrition and health claims, food promotion, premium offers, and promotional characters. These data were originally collected to estimate the prevalence of packaged foods and beverages containing marketing strategies in the Brazilian food supply and to estimate the proportion of products that would receive FoP nutritional labeling under the approved Brazilian food labeling regulation.

We used the information on marketing strategies from this random subsample of 30% of all the 128 categories of food products (11,434 foods and beverages), resulting in 3,491 products. We did not find statistically significant differences in food composition when we compared this random sample with the universe of photographed food packages (Figure 1). For this stage of data collection, four researchers with a degree in nutrition science were trained according to protocols developed by INFORMAS (48). The *"Food Labeling Module"* protocol was used, which aims to monitor health-related labeling components and promotional characters and premium offers on packaged foods and non-alcoholic beverages sold in major food outlets (Figure 1). It provides guidance for the data collection on ingredient lists, nutrient declarations, and nutrition and health claims to monitor the components of food labeling offered in food retail outlets in different countries (48). The monitoring of labeling on packaged foods proposed in the protocol captures the presence/absence and other aspects of the list of ingredients (e.g., whether quantitative or not), nutrient declarations, supplementary nutrition information, and all claims (nutrition claims, health claims, and other claims), except for other non-health-related labeling information, for example, date marking and country of origin. Premium offers and promotional characters on food packages are also considered in this protocol (48).

Trained research assistants evaluated the images of all sides of the packages. They identified the presence of claims and

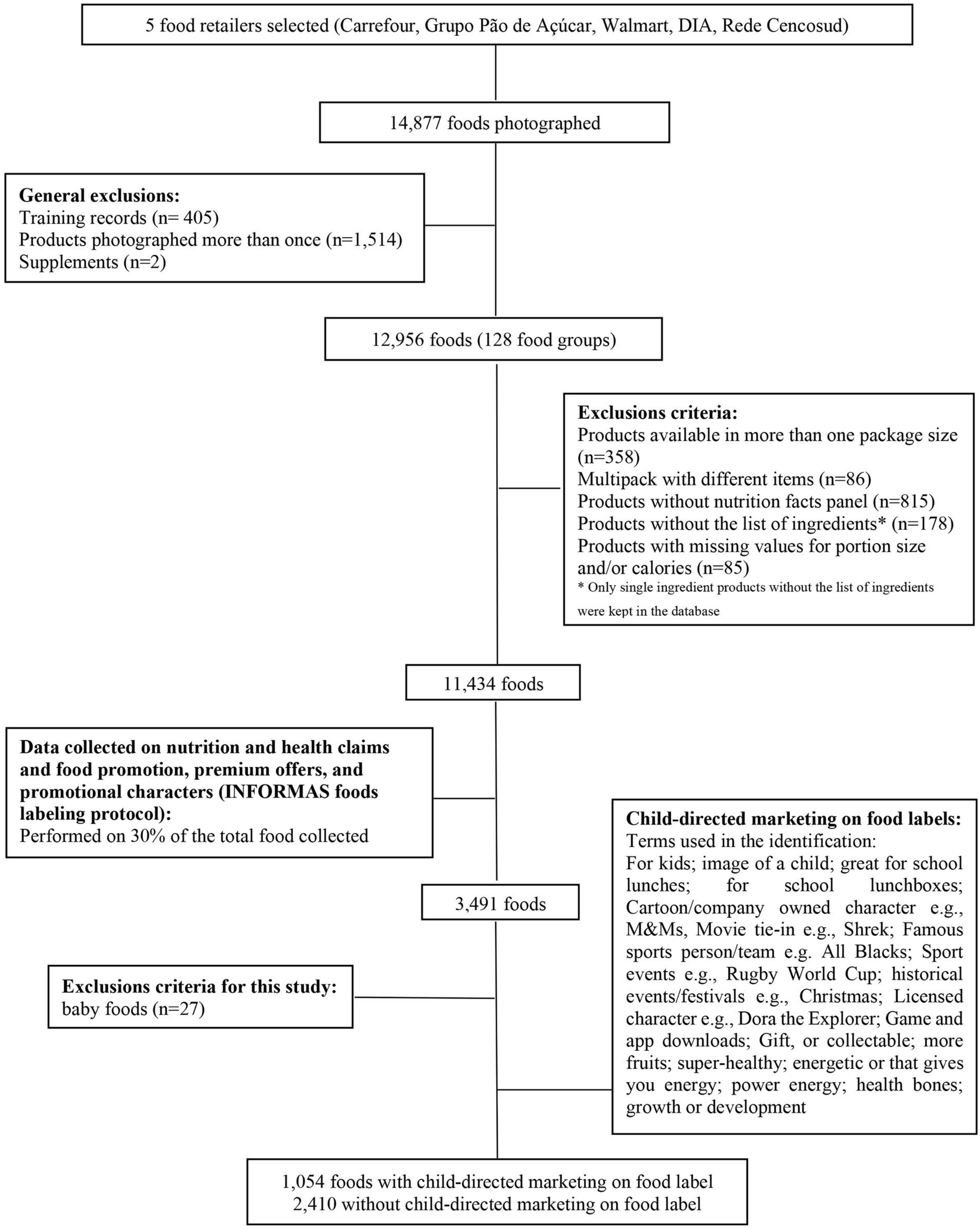

FIGURE 1
Flowchart of data collection and exclusion process.

categorized the types of terms and content of food labels that could be classified as health-related claims, promotional characters, and premium offers using the taxonomy provided by the INFORMAS protocol (Supplementary Table 2). All visible text on the label could be coded as a claim, including brand names and slogans. For this study, we only considered claims on the front of the package. We neither considered the mention of substances in the list of ingredients as a claim nor considered the mention of nutrients as a mandatory part of nutrition labeling in Brazil.

Data entry was performed between April and June 2017 in Epi Info^{TM} version 7. Baby foods were excluded (n = 27 items) because these are regulated by the Brazilian Norm for the Commercialization of Foods for Infants and Young Children, Bottles, Pacifiers, and Breast Protectors (NBCAL), which restricts child-directed marketing (49). Our final sample consisted of 3,464 foods and beverages (Figure 1).

Identifying child-directed marketing on food labels

Any content shown in all visible text of the label that could be characterized as child-directed marketing was assessed. A report made by the WHO (50) highlights the importance of considering in the definition of what is "child-directed marketing" the unintentional exposure of children, for example, in marketing "directed at adults." Even if children are not the primary target audience, this exposure can have negative health impacts. In this study, we sought to cover both marketing strategies directed to children and those that can persuade children and their parents or caregivers to purchase and/or consume the product.

To help decide what constitutes child-directed marketing, we combined three categories proposed by INFORMAS' *Food Labeling Module* along with insights from the scientific literature. A search for the scientific literature was conducted using the following terms: childhood/infant/child/adolescent obesity or overweight; marketing; unhealthy foods; child-target; child-directed appeals; child-appeal advertising; child-directed marketing strategies; child-directed marketing; food marketing; advertising to children. From the literature (12–14, 18–22, 30, 51, 52), we verified the following terms and elements: cartoons and mascots, images of children, images of fruits and vegetables, sports and athletes, school elements, growth and development references, energy references, "healthy bones" "super healthy," among others claims (Supplementary Table 1). These elements, along with health and nutrition claims, promotional characters, and prizes, helped identify a total of 1,054 foods with at least one child-directed marketing strategy on their packages. Details of the variables and terms used to characterize child-directed marketing from the INFORMAS codebook are provided in Supplementary Table 1.

Nutrient profile models

Given the importance of NPMs in the implementation of further government policies regulating unhealthy food marketing to children (30, 33, 37), we compared the Brazilian NPM with five NPMs proposed or adopted in the LA context. We chose NPMs that are relevant to FoP nutritional labeling and restrictions to unhealthy food marketing to children in LA, given the similarities in the epidemiological, nutritional, economic, and demographic contexts of the region (35, 53). The six NPMs were as follows:

1. NPMs proposed in Brazil (34),
2. NPMs proposed by the Pan-American Healthy Organization (PAHO) (35),
3. NPMs proposed in Chile (36),
4. NPMs proposed in Mexico (54),
5. NPMs proposed in Uruguay (55), and
6. NPMs proposed in Peru (56).

Table 1 shows in detail the characteristics of each of these NPMs, including nutrient thresholds for solids (in grams (g)) and liquids (in milliliters (ml)) and the eligibility criteria. Targeted nutrients of concern differ across NPMs and include energy, saturated fat, total fat, trans fat, sodium, free sugars, total sugar, caffeine, and/or non-nutritive sweeteners. In Brazil, all packaged foods and beverages are eligible to receive an FoP nutritional label (or warning labels), except for fresh fruits and vegetables, tubers, cereals, nuts, seeds and mushrooms, flours, meat, fish and eggs, fermented milk without added sugar, cheese, fluid milk, powdered milk, olive oil and vegetable oils, salt, infant formulas, enteral formulas, weight control foods, supplements, and alcoholic beverages (34). Since the nutrient criteria may differ among the NPMs evaluated, we analyzed and compared those in common among all of them (free sugar, saturated fat, and sodium).

The term "free sugars" was adopted in this article to refer to both free and added sugars (57). Although Chile and Peru consider total sugar in their NPM, all the sugar present in the foods analyzed was interpreted as free sugars since the labels of foods and beverages sold in Brazil do not have on the nutrition facts panel the information on total sugar or added sugar, but include only carbohydrates. We estimated the content of free sugars using a validated and curated eight-step protocol that uses information available on the list of ingredients and on the carbohydrate content of packaged foods and beverages displayed on the nutrition facts panel (57). This method uses information readily available on most food labels and allows for the estimation of the added sugar content of packaged foods and beverages in countries where both added and total sugar

TABLE 1 Characteristics of the six nutrient profiling models used in this study.

Nutrient profiling models	Nutrients of concern	Eligibility
Brazil	Sugar (free sugars): ≥15 g/100 g; ≥7.5 g/100 m Sodium: ≥600 mg/100 g; ≥300 mg/100 ml Saturated fat: ≥6 g/100 g; ≥3 g/100 ml	All foods and beverages. Except: fresh fruits and vegetables; tubers; cereals; nuts and seeds; mushrooms; flours; meat; fish and eggs; fermented milk without added sugar; cheese; fluid milk; powdered milk; vegetable oils; salt; infant formulas; enteral formulas; food for weight control diets; nutritional supplements; alcoholic beverages
PAHO	Sugar (free sugars): ≥10% of total energy Sodium: ≥1 mg per 1 kcal Saturated fat: ≥10% of total energy Trans fat: ≥1% of total energy Presence of non-nutritive sweeteners	Processed and ultra- processed foods and beverage, according to NOVA food classification
Chile (phase three)	Sugar (total sugar): ≥10 /100 g; ≥5 g/100 ml Sodium: ≥400 mg/100 g; ≥100 mg/100 ml Saturated fat: ≥4 g/100 g; ≥3 g/100 ml Energies: ≥1,150 kJ (275 kcal); ≥233 kJ (70 kcal)	Food and beverages with added sugar, sodium, or fat
Mexico (phase three)	Sugar (free sugars): ≥10% of total energy Sodium: ≥1 mg of sodium per 1 kcal or ≥300 mg; ≥45 mg for non-caloric beverages Saturated fat: ≥10% of total energy Trans fat: ≥1% of total energy Energies: ≥275 kcal/100 g; ≥70 kcal/100 ml or ≥8 kcal/100 ml from free sugars Presence of added caffeine Presence of non-nutritive sweeteners	Foods and beverages with free sugars, fat, or sodium
Uruguay	Sugar (free sugars): ≥13 g/100 g; ≥3 g/100 ml or 5 g/100 ml for products without other sweeteners; ≥7 g/100 ml in products with up to 80% of total calories from sugars and no added other sweeteners Sodium: ≥500 mg/100 g; ≥200 mg/100 ml Saturated fat: ≥6 g/100 g; ≥3 g/100 ml Total fat: ≥13 g/100 g; ≥4 g/100 ml	All food and beverages. Except: enteral nutrition; foods for weight control diets; nutritional supplements; infant formulas up to 36 months and table-top sweeteners.
Peru (phase two)	Sugar (total sugar): ≥10 g/100 g; ≥5 g/100 ml Sodium: ≥400 mg/100 g; ≥100 mg/100 ml Saturated fat: ≥4 g/100 g; ≥3 g/100 ml Presence of trans fat	All processed and ultra-processed foods that exceed the targeted nutrients of concern

information are not mandated on food labels, which is the case in Brazil (57). These eight-step included objective and subjective estimation procedures for different food groups. Intrinsic sugar found in milk and 100% fruit juices was excluded from the estimates. In addition, one of the steps uses the total sugar content of the product when producers voluntarily make it available in the nutrition facts panel (57).

Food classification

Food and beverages were classified by the degree of processing using the Nova classification (17), a system that divides foods and beverages into four groups according to the extent and purpose of the industrial processing they undergo. It considers all physical, biological, and chemical methods used during the food manufacturing process, including the use of food additives (17). Nova group 1 includes *unprocessed foods* (composed of fresh fruits and vegetables, and eggs) and *minimally processed foods* (composed of frozen meat, frozen fish, 100% fruit juice, coffee powder, tea herbs, dried cereals and pulses, cocoa powder, plain yogurts, fluid or powdered milk, frozen vegetables, and dried herbs). The remaining three Nova food groups include *culinary ingredients* (sugar, honey, olive oils, oils, cooking fats, salt, and vinegars), *processed foods* (bread, jerky, bacon, canned and dried fish, cheese, canned and dried fruit, and vegetables), and *ultra-processed foods* (soft drinks, sugar-sweetened beverages, dairy drinks, baked goods, breakfast cereals, salty snacks, candies, cakes and pies, dairy desserts, ultra-processed meat, ready-to-eat food, and sauces and creams).

Statistical analyses

First, we defined whether a food or beverage had any child-directed marketing. We observed the presence of caffeine and non-nutritive sweeteners using the list of ingredients available on food packages. The following components of the list of ingredients were identified as non-nutritive sweeteners: sorbitol, mannitol, acesulfame, aspartame, cyclamate, isomaltose, saccharin, sucralose, thaumatin, stevia, neotame, maltitol, lactitol, xylitol, and erythritol. We then calculated the proportion of foods and beverages with child-directed marketing. Third, using the nutrition information collected from the nutrition facts panel of the products, we calculated the content of free sugars (g), saturated fat (g), and sodium (mg) per 100 Kcal. To classify a food or beverage as high in any nutrient of concern, we used the cutoff points and eligibility criteria defined in each of the NPMs studied (Table 1).

For the descriptive analyses, we first tested the normality of the continuous variables (free sugar, sodium, and saturated fat) through the Shapiro–Wilk test. Once non-normal distributions were confirmed, we then performed the Mann–Whitney test to assess differences in the median of free sugar, sodium, and saturated fat per 100 kcal of the foods and beverages with the presence and absence of child-directed advertising, with significance levels set at a p-value of < 0.05. The variables were expressed through descriptive statistics using medians and interquartile ranges (p25; p75).

To estimate the proportion of foods with child-directed marketing that should receive at least one FoP nutritional labeling, we used all the nutrients of concern adopted in each NPM. We also estimated the proportion of foods with child-directed marketing that should receive FoP nutritional labeling for free sugar, sodium, and saturated fat, separately. We compared the differences in the proportion of foods and beverages labeled as high in critical nutrients using prevalence ratios and the 95% confidence interval (when the confidence interval of the prevalence ratio did not pass 1, the differences were considered statistically significant). Comparisons were made between Brazil and other models, Mexico and other models, and PAHO and other models, analyses were performed overall and by Nova food groups. All analyses were run in Stata SE version 16.

Results

From a total of 3,464 foods and beverages, 1,054 (30%) had at least one child-directed marketing strategy. The remaining 70% of the foods and beverages had other types of claims and marketing strategies. Most with child-directed marketing were classified as ultra-processed foods (n=654, 61%). The sugar-sweetened beverages subgroup had significantly higher proportions of child-directed marketing, 57.5% (95% CI: 50.8–64.0), than other subgroups of ultra-processed foods. We found differences in the proportion of foods with and without child-directed marketing in all food subgroups, except for dairy beverages (Figure 2).

Table 2 shows the comparison of nutrients (free sugars, saturated fat, and sodium) according to the presence or absence of child-directed marketing. Among products with the presence of child-directed marketing, we found higher concentrations of free sugars (g per 100 kcal) in candies (median [IQR] 33.0 g [20.4; 83.0]) ($p < 0.05$), higher concentrations of saturated fat (g per 100 kcal) in cakes and pies (median [IQR] 11.1 g [8.8; 14.0 g]) ($p < 0.001$) and in sauces and creams (median [IQR] 13.7 g [0.0; 42.2 g]) ($p < 0.05$), and higher concentrations of sodium (mg per 100 kcal) in the sugar-sweetened beverages (median [IQR] 32.6 mg [9.1; 161.1 mg]) ($p < 0.05$) and in candies (median [IQR] 37.8 mg [14.5; 76.3 mg]) ($p < 0.001$).

Table 3 shows the proportion of foods with child-directed marketing that contain a high content of at least one of the nutrients in each NPM. A total of 87% of foods with child-directed marketing were high in at least one nutrient when the PAHO and Mexican NPMs were applied, whereas, only 54% when the Brazilian NPM was applied. Compared with the PAHO NPM, the Brazilian NPM allowed eight times more soft drinks and four times more sugar-sweetened beverages and dairy drinks targeted at children to omit warnings on at least one critical nutrient ($p < 0.05$); when compared to the Mexican NPM, the Brazilian NPM allowed 2.6 times more processed foods, eight times more carbonated soft drinks, 4.7 times more sugar-sweetened beverages, 4.3 times more dairy drinks, and two times more ready-to-eat foods and baked goods to omit warnings on at least one critical nutrient ($p < 0.05$). Compared with the PAHO and Mexican models, the NPMs employed by Chile, Uruguay, and Peru also omitted significantly more warnings on at least one critical nutrient in soft drinks and sugar-sweetened beverages ($p < 0.05$).

Table 4 shows the proportion of foods with child-directed marketing and high in sodium across different NPMs. The Brazilian NPM allowed three times more foods and beverages to omit warnings for sodium ($p < 0.05$) than the PAHO NPM and 2.5 times more than the Mexican NPM. The Chilean and Uruguayan NPMs also allowed approximately two times more foods and beverages to omit warnings for sodium ($p < 0.05$) than the PAHO model. Analyzing the performance of the NPMs in labeling ultra-processed foods that are high in sodium, we found that the Brazilian NPM flagged three times fewer products than the PAHO and Mexican models, and the Uruguayan NPM labeled two times fewer ultra-processed foods than the PAHO model ($p < 0.05$). The Brazilian model also showed the lowest performance in labeling baked goods as high in sodium compared with all NPMs, except the Uruguayan NPM. The models from Uruguay and Chile allowed a significantly higher proportion of candies to omit warnings for sodium than the PAHO

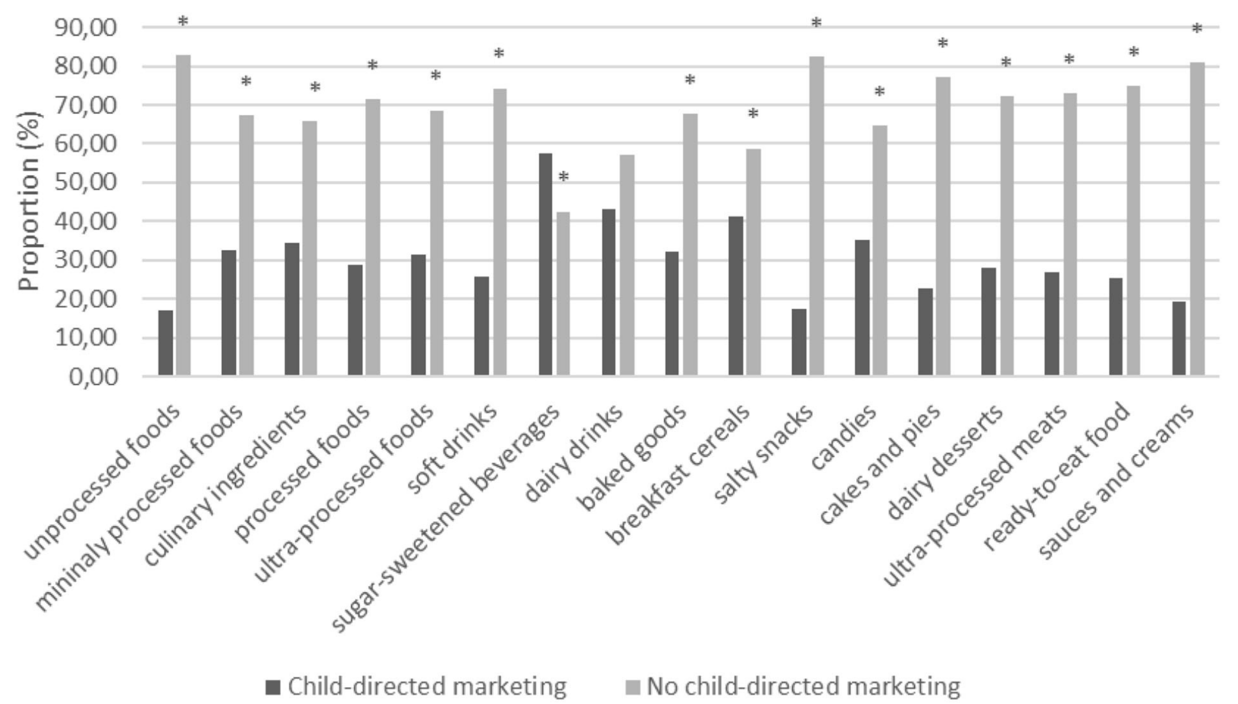

FIGURE 2
Proportion of Brazilian packaged foods and beverages with the presence or absence of child-directed marketing sold in Brazilian top five food retailers, 2017.

model. However, the Brazilian NPM identified a higher percentage of culinary ingredients high in sodium than the Mexican NPM ($p < 0.05$).

Table 5 shows the proportion of foods with child-directed marketing and high in saturated fat across different NPMs. The Chilean NPM allowed 2.2 times more foods and beverages to omit warnings for saturated fat ($p < 0.05$) than the PAHO NPM. The Brazilian NPM allowed up to 15 times more processed foods to omit warnings for saturated fat ($p < 0.05$) than other models. Also, the Brazilian NPM allowed approximately five times more cakes and pies to omit warnings for saturated fat ($p < 0.05$) than PAHO, Mexican, Chilean, and Peru models. The models from Uruguay and Peru labeled eight times more processed foods high in saturated fat than the Mexican model ($p < 0.05$).

Table 6 shows the proportion of foods with child-directed marketing and high in free sugar by applying different NPMs. The Brazilian NPM allows around four times more sugar-sweetened beverages and six times more dairy drinks to omit warnings for free sugar ($p < 0.05$) than the PAHO and Mexican NPMs. The Peru NPM allows around three times more sugar-sweetened beverages to omit warnings for free sugar ($p < 0.05$) than the Mexican model.

Discussion

This study applied different NPMs from LA to a sample of 1,054 foods and beverages with the presence of child-directed marketing sold in Brazil. Sugar-sweetened beverages had the highest prevalence of child-directed marketing strategies. A higher content of free sugars (g), saturated fat (g), and sodium (mg) per 100 kcal was observed among subgroups of ultra-processed foods including candies, cakes and pies, sauces and creams, and sugar sweetened-beverages with child-directed marketing when compared with the same food groups without child-directed marketing. In addition, the proportion and types of foods and beverages with child-directed marketing high in nutrients of concern varied across NPMs. The PAHO and Mexican NPMs were the most effective profiling schemes in labeling foods high in nutrients of concern with the presence of child-directed marketing among all. The differences observed were more remarkable when comparing these two models with the Brazilian model, which allowed more foods targeted at children, especially ultra-processed foods, to omit warning labels for free sugar, sodium, and saturated fat. The models of Chile, Uruguay, and Peru would also target significantly fewer sugar-sweetened beverages with child-directed marketing and high in at least one critical nutrient than PAHO and Mexican ones.

TABLE 2 Median and interquartile range for the content of free sugars, saturated fat, and sodium per 100 kcal in processed and ultra-processed foods by the presence and absence of child-directed marketing (Brazil, 2017).

Food groups	Free sugars (g)				Saturated Fat (g)				Sodium (mg)			
	Child-direct marketing				Child-direct marketing				Child-direct marketing			
	No		Yes		No		Yes		No		Yes	
	n	Median (IQR)	*n*	Median (IQR)	*n*	Median (IQR)	*n*	Median (IQR)	*n*	Median (IQR)	*n*	Median (IQR)
Processed foods	227	0.0 (0.0; 11.11)	94	0.0 (0.0; 0.0)	226	7.5 (0.0; 39.1)	94	39.4 (12.0; 48.5)	227	247.8 (115.0; 520.0)	94	188.4 (112.0; 294.1)
Ultra-processed foods (total)	1,429	9.9 (0.6; 29.9)	657	8.1 (0.5; 32.2)	1,425	9.4 (0.0; 19.5)	653	5.7 (0.0; 16.1)	1,424	97.34 (25.2; 318.4)	654	70.5 (20.6; 205.9)
Soft drinks	26	12.5 (7.8; 13.3)	9	0.0 (0.0; 0.0)	26	0.0 (0.0; 0.0)	9	0.0 (0.0; 0.0)	26	25.3 (13.8; 50.0)	9	1.1 (1.1; 2.3)
Sugar-sweetened beverages	91	3.1 (2.7; 12.5)	123	3.1 (0.6; 10.6)	91	0.0 (0.0; 0.0)	123	0.0 (0.0; 0.0)	91	16.2 (0.0; 54.5)	123	32.6 (9.1; 161.1)[a]
Dairy drinks	57	6.28 (3.2; 11.9)	43	5.19 (3.2; 9.6)	57	7.0 (3.1; 11.2)	43	7.0 (0.0; 12.8)	57	66.7 (40.0; 156.2)	43	48.5 (8.2; 69.9)
Baked goods	65	5.3 (3.1; 25.8)	31	5.8 (3.1; 35.6)	65	2.2 (0.0; 3.9)	31	3.1 (1.4; 8.5)[a]	65	153.3 (126.2; 185.3)	31	157.7 (127.1; 190.4)
Breakfast cereals	47	33.0 (14.3; 56.6)	33	34.2 (24.2; 58.6)	47	7.2 (1.9; 11.6)	33	7.4 (2.3; 13.7)	47	25.5 (10.0; 47.5)	33	33.7 (16.4; 54.4)
Salty snacks	149	9.4 (1.65; 53.3)	33	7.4 (0.0; 45.8)	147	9.8 (2.9; 18.0)	32	7.9 (3.2; 19.3)	148	101.1 (24.6; 165.8)	33	114.4 (43.8; 144.5)
Candies	262	28.1 (23.7; 36.4)	144	33.0 (20.4; 83.0)[a]	262	15.6 (5.7; 26.5)	143	8.9 (0.0; 21.6)	260	29.6 (11.1; 56.5)	143	37.8 (14.5; 76.3)[a]
Cakes and pies	54	21.9 (16.8; 27.8)	16	23.2 (17.7; 28.9)	54	7.3 (4.5; 10.8)	16	11.1 (8.8; 14.0)[a]	54	81.7 (51.8; 115.6)	16	60.6 (53.6; 72.0)
Dairy desserts	106	19.3 (15.9; 50.7)	41	19.0 (11.3; 36.4)	105	15.3 (2.4; 23.7)	40	9.0 (0.0; 16.1)	105	23.1 (11.8; 33.6)	41	29.7 (4.0; 55.5)
Ultra-processed meat	154	0.3 (0.0; 0.8)	57	0.1 (0.0; 1.2)	153	22.5 (15.0; 30.0)	56	20.8 (14.7; 26.7)	153	442.4 (278.9; 571.4)	56	234.2 (66.1; 430.1)
Ready-to-eat food	187	0.3 (0.0; 3.3)	63	0.6 (0.1; 11.2)	187	11.2 (4.5; 16.1)	63	9.5 (2.8; 16.3)	187	261.1 (189.6; 380.1)	62	239.3 (143.3; 383.6)
Sauces and creams	230	3.2 (0.0; 55.8)	56	2.4 (0.0; 16.5)	230	0.0 (0.0; 14.3)	56	13.7 (0.0; 42.2)[a]	230	773.5 (237.4; 2,030.4)	56	392.4 (171.0; 1108.6)

[a]Median values significantly higher for free sugars (g), saturated fat (g), and sodium (mg) by the presence of child-directed marketing. Differences in medians was observed by the Mann–Whitney test ($p < 0.05$).

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TABLE 3 Proportion (%) of foods and beverages with child-directed marketing and a high content of at least one nutrient of concern according to different nutrient profile models (NPMs), overall, and by food category (Brazil, 2017).

	PAHO	Brazil	Chile	Mexico	Uruguay	Peru
Food groups	**% (95% CI)**	**% (95% CI)**	**% (95% CI)**	**% (95% CI)**	**% (95% CI)**	**% (95% CI)**
Unprocessed and minimally processed foods	0.00	0.00	0.00	0.00	0.00	0.00
Culinary ingredients	0.00	82.35 (57.23; 94.21)	0.00	6.25 (2.03; 17.70)	75.00 (60.93; 85.23)[b]	83.33 (70.04; 91.45)
Processed foods	91.30 (83.55; 95.60)	35.00 (17.66; 57.48)	61.96 (51.65; 71.30)	93.48 (86.22; 97.04)[a]	73.91 (64.00; 81.87)	75.00 (65.16; 82.80)
Ultra-processed foods (total)	86.39 (83.54; 88.81)	53.54 (49.51; 57.34)	70.03 (66.40; 73.42)	91.59 (89.20; 93.49)	63.76 (60.00; 67.36)	65.44 (61.71; 69.00)
Soft drinks	88.89 (49.93; 98.47)[a]	11.11 (1.53; 50.08)	11.11 (1.53; 50.10)[b c]	88.89 (49.94; 98.47)[a]	11.11 (1.53; 50.06)[c]	11.11 (1.53; 50.06)[bc]
Sugar-sweetened beverages	73.98 (65.51; 80.98)[a]	17.89 (12.07; 25.69)	31.71 (24.09; 40.40)[b c]	83.74 (76.12; 89.27)[a]	34.15 (26.31; 42.96)[b]	22.76 (16.20; 31.01)[b c]
Dairy drinks	76.74 (61.90; 87.02)[a]	18.60 (9.57; 33.04)	34.88 (22.23; 50.10)	81.40 (66.97; 90.42)[a]	39.53 (26.17; 54.67)[a]	32.56 (20.31; 47.77)
Baked goods	96.77 (80.31; 99.55)	48.39 (31.64; 65.50)	80.65 (63.06; 91.00)	100.00[a]	64.52 (46.53; 79.16)	83.87 (66.60; 93.13)
Breakfast cereals	87.88 (71.79; 95.38)	87.88 (71.78; 95.38)	84.85 (68.34; 93.60)	100.00	87.88 (71.79; 95.38)	87.88 (71.79; 95.38)
Salty snacks	84.38 (67.49; 93.35)	66.67 (48.32; 81.06)	84.38 (67.49; 93.40)	90.63 (74.62; 96.95)	75.00 (57.38; 86.99)	84.38 (67.50; 93.35)
Candies	95.10 (90.08; 97.65)	70.99 (62.64; 78.13)	93.01 (87.48; 96.20)	99.30 (95.19; 99.90)	71.33 (63.38; 78.15)	76.92 (69.30; 83.11)
Cakes and pies	100.00	100.00	100.00	100.00	100.00	100.00
Dairy desserts	95.12 (82.45; 98.78)	78.95 (63.19; 89.12)	85.37 (71.02; 93.30)	100.00	73.17 (57.72; 84.49)	87.80 (73.83; 94.84)
Ultra-processed meat	68.42 (55.32; 79.13)	54.39 (41.43; 66.78)	64.91 (51.76; 76.10)	70.18 (57.13; 80.60)	68.42 (55.33; 79.13)	68.42 (55.33; 79.13)
Ready-to-eat food	95.24 (86.23; 98.46)	47.62 (35.65; 59.87)	80.95 (69.36; 88.90)	96.83 (88.15; 99.21)[a]	73.02 (60.78; 82.53)	79.37 (67.61; 87.63)
Sauces and creams	94.55 (84.38; 98.23)	80.49 (65.55; 89.94)	83.64 (71.42; 91.30)	94.55 (84.38; 98.23)	83.64 (71.42; 91.27)	85.45 (73.50; 92.56)
Total	87.10 (84.50; 89.32)	54.05 (50.25; 57.81)	69.28 (65.88; 72.48)	86.75 (84.21; 88.93)	65.87 (62.51; 69.08)	67.87 (64.55; 71.03)

Total sample size of foods and beverages with child-directed marketing = 1,054 products. In this table, we use all the nutrients of concern adopted in each NPM. [a] Statistically significant differences between Brazil NPM and other NPMs; [b] statistically significant differences between Mexico NPM and other NPMs; [c] statistically significant differences between PAHO NPM and other NPMs; differences between pairs were tested using the prevalence ratio and 95% CI.

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TABLE 4 Proportion (%) of foods and beverages with child-directed marketing and a high content of sodium according to different nutrient profile models (NPM), overall, and by food category (Brazil, 2017).

	PAHO	Brazil	Chile	Mexico	Uruguay	Peru
Food groups	**% (95% CI)**	**% (95% CI)**	**% (95% CI)**	**% (95% CI)**	**% (95% CI)**	**% (95% CI)**
Unprocessed and minimally processed foods	0.00	0.00	0.00	18.61 (14.10; 24.17)	5.63 (3.29; 9.45)	0.00
Culinary ingredients	0.00	11.76 (2.95; 36.89)[b]	4.26 (1.06; 15.51)	4.26 (1.06; 15.51)	4.26 (1.06; 15.51)	4.26 (1.06; 15.51)
Processed foods	79.35 (69.86; 86.43)	25.00 (10.79; 47.88)	52.13 (42.07; 62.02)	79.35 (69.86; 86.43)	44.57 (34.75; 54.82)	54.35 (44.11; 64.23)
Ultra-processed foods (total)	41.01 (37.29; 44.84)[a]	14.35 (11.80; 17.35)	24.00 (20.88; 27.43)	41.17 (37.44; 44.99)[a]	19.05 (16.21; 22.25)[c]	24.27 (21.12; 27.72)
Soft drinks	77.78 (42.04; 94.41)	0.00	0.00	77.78 (42.06; 94.41)	0.00	0.00
Sugar-sweetened beverages	39.02 (30.81; 47.92)	0.00	0.00	39.02 (30.81; 47.91)	0.00	0.00
Dairy drinks	18.60 (9.58; 33.03)	0.00	0.00	18.6 (9.58; 33.03)	0.00	2.33 (0.33; 14.79)[c]
Baked goods	87.1 (70.22; 95.08)[a]	12.9 (4.91; 29.78)	58.06 (40.40; 73.88)[a]	87.1 (70.23; 95.08)[a]	32.26 (18.30; 50.30)	58.06 (40.39; 73.88)[a]
Breakfast cereals	6.06 (1.52; 21.27)	0.00	3.03 (0.42; 18.65)	6.06 (1.52; 21.26)	0.00	3.03 (0.42; 18.66)
Salty snacks	56.25 (38.98; 72.13)	40 (24.28; 58.09)	69.7 (52.24; 82.87)	56.25 (38.99; 72.12)	50.00 (33.32; 66.68)	68.75 (51.00; 82.30)
Candies	14.79 (9.84; 21.63)	0.00	2.1 (0.68; 6.31)[c]	14.79 (9.84; 21.63)	1.41 (0.35; 5.46)[c]	2.11 (0.68; 6.35)[c]
Cakes and pies	0.00	0.00	0.00	0.00	0.00	0.00
Dairy desserts	7.32 (2.37; 20.40)	0.00	0.00	7.32 (2.38; 20.39)	0.00	2.44 (0.34; 15.43)
Ultra-processed meat	67.86 (54.63; 78.73)	50.00 (37.17; 62.83)	64.29 (51.01; 75.68)	69.64 (56.47; 80.23)	57.14 (43.98; 69.37)	64.29 (51.01; 75.68)
Ready-to-eat food	80.65 (68.91; 88.68)[a]	27.42 (17.76; 39.78)	59.68 (47.10; 71.10)	80.65 (68.92; 88.67)[a]	48.39 (36.28; 60.69)	59.68 (47.10; 71.10)
Sauces and creams	81.82 (69.38; 89.94)	68.29 (52.70; 80.63)	69.64 (56.47; 80.23)	81.82 (69.38; 89.94)	61.82 (48.43; 73.62)	70.91 (57.64; 81.36)
Porridge flour	0.00	0.00	0.00	0.00	0.00	0.00
Total	42.96 (39.56; 46.47)[a]	14.48 (12.00; 17.37)	20.43 (18.11; 22.96)[c]	36.35 (33.50; 39.29)[a]	16.94 (14.81; 19.33)[c]	26.38 (23.43; 29.56)

Total sample size of foods and beverages with child-directed marketing = 1,054 products; [a]statistically significant differences between Brazil NPM and other NPMs; [b]statistically significant differences between Mexico NPM and other NPMs.; [b]statistically significant differences between PAHO NPM and other NPMs; differences between pairs were tested using the prevalence ratio and 95% CI.

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TABLE 5 Proportion (%) of foods and beverages with child-directed marketing and a high content of saturated fat according to different nutrient profile models (NPM), overall, and by food category (Brazil, 2017).

	PAHO	Brazil	Chile	Mexico	Uruguay	Peru
Food groups	**% (95% CI)**	**% (95% CI)**	**% (95% CI)**	**% (95% CI)**	**% (95% CI)**	**% (95% CI)**
Unprocessed and minimally processed foods	0.00	0.00	0.00	0.00	0.00	0.00
Culinary ingredients	0.00	52.94 (30.23; 74.50)	4.17 (1.04; 15.21)	8.33 (3.16; 20.21)	72.92 (58.74; 83.59)[b]	72.92 (58.73; 83.59) [b]
Processed foods	77.17 (67.49; 84.63)[a]	5.00 (0.70; 28.30)	13.04 (7.55; 21.59)[ac]	78.26 (68.67; 85.53)[a]	60.87 (50.57; 70.29)[a]	67.39 (57.18; 76.18)[a]
Ultra-processed foods (total)	36.77 (33.14; 40.55)	20.48 (17.48; 23.85)	25.38 (22.18; 28.88)	37.08 (33.44; 40.86)	22.61 (19.56; 25.99)	31.23 (27.78; 34.90)
Soft drinks	0.00	0.00	0.00	0.00	0.00	0.00
Sugar-sweetened beverages	0.81 (0.11; 5.56)	0.00	0.00	0.81 (0.11; 5.55)	0.00	0.00
Dairy drinks	32.56 (20.31; 47.77)	0.00	0.00	34.88 (22.24; 50.09)	0.00	2.33 (0.33; 14.79)[c]
Baked goods	16.13 (6.87; 33.40)	3.23 (0.45; 19.70)	3.23 (0.45; 19.68)	16.13 (6.87; 33.39)	3.23 (0.45; 19.68)	9.68 (3.15; 26.09)
Breakfast cereals	36.36 (21.93; 53.76)	30.3 (17.13; 47.77)	39.39 (24.42; 56.67)	36.36 (21.93; 53.75)	30.30 (17.13; 47.76)	45.45 (29.55; 62.34)
Salty snacks	45.16 (28.85; 62.58)	44.83 (28.07; 62.84)	48.39 (31.65; 65.49)	45.16 (28.86; 62.57)	41.94 (26.12; 59.60)	48.39 (31.65; 65.50)
Candies	45.77 (37.75; 54.02)	35.38 (27.64; 43.98)	49.3 (41.16; 57.47)	45.77 (37.76; 54.02)	36.62 (29.10; 44.85)	50.00 (41.84; 58.16)
Cakes and pies	62.5 (37.69; 82.12)[a]	12.5 (3.14; 38.66)	68.75 (43.29; 86.38)[a]	62.50 (37.70; 82.11 a)	12.50 (3.14; 38.64)[c]	68.75 (43.28; 86.38)[a]
Dairy desserts	47.5 (32.70; 62.75)	18.42 (9.03; 33.93)	12.5 (5.29; 26.74)[c]	47.50 (32.71; 62.74)	17.50 (8.57; 32.43)	35.00 (21.93; 50.79)
Ultra-processed meat	60.71 (47.46; 72.56)	39.29 (27.44; 52.55)	17.86 (9.88; 30.12)[c]	62.50 (49.23; 74.12)	39.29 (27.44; 52.54)	51.79 (38.85; 64.48)
Ready-to-eat food	47.62 (35.65; 59.87)	19.05 (11.14; 30.64)	20.63 (12.37; 32.38)	47.62 (35.66; 59.86)	19.05 (11.14; 30.63)	25.40 (16.17; 37.53)
Sauces and creams	61.82 (48.43; 73.63)	34.15 (21.36; 49.75)	49.09 (36.22; 62.08)	61.82 (48.43; 73.62)	50.91 (37.92; 63.78)	50.91 (37.92; 63.78)
Total	40.33 (36.96; 43.78)	20.66 (17.74; 23.92)	17.73 (15.59; 20.16)[c]	34.72 (31.90; 37.64)	23.49 (21.03; 26.14)	37.69 (34.38; 41.15)

Notes: Total sample size of foods and beverages with child-directed marketing = 1,054 products; [a] statistically significant differences between Brazil NPM and other NPMs; [b] statistically significant differences between Mexico NPM and other NPMs.; [c] statistically significant differences between PAHO NPM and other NPMs; differences between pairs were tested using prevalence ratio and 95% CI.

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TABLE 6 Proportion (%) of foods and beverages with child-directed marketing and high content of free sugar according to different nutrient profile models (NPMs), overall, and by food category (Brazil, 2017).

	PAHO	Brazil	Chile	Mexico	Uruguay	Peru
Food groups	**% (95% CI)**	**% (95% CI)**	**% (95% CI)**	**% (95% CI)**	**% (95% CI)**	**% (95% CI)**
Unprocessed and minimally processed foods	0.00	0.00	0.00	0.00	0.00	0.00
Culinary ingredients	0.00	29.41 (12.78; 54.23)	0.00	10.42 (4.40; 22.72)	12.50 (5.72; 25.18)	10.42 (4.40; 22.72)
Processed foods	7.61 (3.67; 15.13)	5.00 (0.69; 28.30)	6.52 (2.95; 13.78)	13.04 (7.55; 21.59)	5.43 (2.28; 12.41)	6.52 (2.96; 13.78)
Ultra-processed foods (total)	56.27 (52.43; 60.00)	38.36 (34.62; 42.25)	48.93 (45.11; 52.77)	57.64 (53.81; 61.39)	42.97 (39.21; 46.80)	43.12 (39.36; 46.95)
Soft drinks	11.11 (1.53; 50.07)	11.11 (1.53; 50.08)	11.11 (1.53; 50.07)	11.11 (1.53; 50.06)	11.11 (1.53; 50.06)	11.11 (1.53; 50.06)
Sugar-sweetened beverages	51.22 (42.43; 59.94)[a]	17.89 (12.07; 25.69)	31.71 (24.09; 40.45)	55.28 (46.41; 63.83)[a]	32.52 (28.43; 41.29)	22.76 (16.20; 31.01)[b]
Dairy drinks	72.09 (56.99; 83.43)[a]	18.60 (9.57; 33.04)	34.88 (22.23; 50.10)	81.40 (66.97; 90.42)[a]	30.23 (18.42; 45.40)	32.56 (20.31; 47.77)
Baked goods	58.06 (40.39; 73.88)	41.94 (26.11; 59.61)	48.39 (31.64; 65.50)	58.06 (40.39; 73.88)	41.94 (26.12; 59.61)	48.39 (31.65; 65.50)
Breakfast cereals	84.85 (68.34; 93.56)	84.85 (68.34; 93.56)	84.85 (68.34; 93.56)	84.85 (68.35; 93.56)	84.85 (68.35; 93.56)	84.85 (68.35; 93.56)
Salty snacks	46.88 (30.56; 63.88)	33.33 (18.94; 51.68)	43.75 (27.87; 61.02)	46.87 (30.57; 63.88)	34.38 (20.15; 52.10)	43.75 (27.87; 61.02)
Candies	84.64 (77.73; 89.66)	69.47 (61.05; 76.75)	87.41 (80.89; 91.93)	84.62 (77.73; 89.66)	68.53 (60.46; 75.62)	70.63 (62.65; 77.52)
Cakes and pies	100.00	100.00	100.00	100.00	100.00	100.00
Dairy desserts	90.24 (76.70; 96.30)	68.42 (5.20; 81.13)	82.93 (68.25; 91.65)	90.24 (76.70; 96.30)	68.29 (52.71; 80.63)	82.93 (68.26; 91.65)
Ultra-processed meat	0.00	0.00	0.00	0.00	0.00	0.00
Ready-to-eat food	36.51 (25.60; 49.01)	19.05 (11.14; 30.64)	31.75 (21.47; 44.17)	36.51 (25.60; 49.01)	26.98 (17.47; 39.22)	28.57 (18.79; 40.88)
Sauces and creams	18.18 (10.06; 30.62)	17.07 (8.35; 31.75)	14.55 (7.44; 26.50)	18.18 (10.06; 30.62)	20.00 (11.43; 32.64)	14.55 (7.44; 26.50)
Total	50.66 (47.09; 54.23)	37.69 (34.08; 41.44)	44.15 (40.63; 47.72)	50.00 (46.53; 53.46)	37.25 (33.96; 40.66)	37.37 (34.08; 40.79)

Total sample size of foods and beverages with child-directed marketing = 1,054 products; [1]statistically significant differences between Brazil NPM and other NPMs; [b]statistically significant differences between Mexico NPM and other NPMs.

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Previous studies conducted in Brazil (39), Canada (58), Mexico (40), Peru (59), England (60, 61), Chile (31), South Africa (37), and Australia (41) have shown that the choice of the NPM can have a substantial impact on different food policies. The NPM adopted by governments can affect the proportion of foods and beverages that receive an FoP warning label for nutrients linked to an increased risk of NCD and also could be used as a criterion to define foods and beverages subject to marketing and sales restrictions in all types of media and in schools' food environment (30, 31, 62). Regarding the use of the NPM for regulations on unhealthy food marketing to children, a study showed that 16 countries have adopted regulations addressing this issue, and in 10 of these countries, the NPM was used to identify which products should qualify for restrictions (30). Currently, four countries apply an NPM to all foods and beverages that exceed critical values for the nutrients included in the model (United Kingdom, Ireland [except cheese products], Taiwan, and Chile), while six countries apply an NPM for specific food and beverage categories (South Korea, Mexico, Ecuador, Poland, Uruguay, and Turkey) (30). Unlike the policies implemented in Chile (38) and Mexico (40), the Brazilian NPM will not be used to restrict child-directed marketing on food packages as part of its public health policy.

The nutrient profile models proposed in South Africa were adapted from the Chilean NPM and found to be suitable for food labeling regulation in that context (37). However, our results showed that the Chilean model compared with the PAHO and Mexican models was not effective in identifying foods and beverages with the presence of child-direct marketing as high in sugar. The Chilean model overall also identifies lower proportions of foods and beverages targeted at children and high in sodium and saturated fat than the PAHO model. However, the implementation of the NPM in Chile has led to a decline in the proportion of advertisements for foods high in nutrients of concern, especially soft drinks, desserts, breakfast cereals, and fruit-flavored drinks (33). This may be partly because of the NPM cutoff point and eligibility criteria adopted but could also be attributed to a range of other regulatory measures (e.g., taxes) implemented in that context (28).

We found that ultra-processed foods and beverages with child-directed marketing such as candies, cakes and pies, sauces and creams, and sugar-sweetened beverages had a higher content of free sugar, saturated fat, and sodium per 100 kcal than those same food items without child-directed marketing. A great proportion of these products would not receive warning labels for high sodium, saturated fat, and sugar by NPMs from Brazil, Uruguay, Chile, and Peru. Previous studies have also found poorer nutrient compositions for products with child-directed marketing in Brazil and Canada (58, 63). Studies conducted in Mexico (40), Brazil (63), Colombia (64), and Peru (59) found that packaged foods with child-directed marketing are often high in sugar, fat, and sodium and low in fiber. By applying the Peruvian NPM, ~88% of breakfast cereals with the presence of child-directed marketing would receive the FoP nutritional labeling for being high in at least one nutrient of concern. However, compared with stronger models (PAHO and Mexico), like the Peruvian NPM, a significantly lower proportion of carbonated soft drinks and sugar-sweetened beverages targeted at children would be eligible to receive warning labels for at least one critical nutrient. Corroborating our findings, another study showed significant discrepancies between the PAHO and Brazilian NPMs in labeling products with child-directed marketing and high levels of critical nutrients, especially for fruit drinks, dairy beverages, sandwich cookies, cakes, breakfast cereals, jellies, corn snacks, and yogurts (65).

In our study, the most effective models for labeling sugar-sweetened beverages high in free sugar and/or sodium targeted at children were the Mexican and PAHO models not only because the cutoff points of their nutrient profile models were higher than the others but also because the eligibility criteria that take the food processing dimension into account, as is the case with the PAHO model (35). The NPMs adopted in LA were less likely to identify foods high in sugar, saturated fat, and sodium or high in at least one nutrient of concern with the presence of child-directed marketing than the PAHO and Mexican NPMs. Our study highlights the need to review the thresholds of the Brazilian NPM for free sugar, saturated fat, and sodium and the eligibility criteria, especially for ultra-processed foods and beverages, should the Brazilian government intend to regulate child-directed marketing on packages. SSBs and other ultra-processed beverages with the presence of child-directed marketing on the package were less likely to be targeted by the Brazilian NPM than the other NPMs adopted in LA, and these products are frequently consumed by Brazilian children and are related to an increase in the risk for obesity, type 2 diabetes mellitus, and cardiovascular diseases (9, 63).

This study is not free of limitations. First, the subsample of products used in the analyses may not represent children's food intake in Brazil; however, several groups of ultra-processed foods associated with obesity and other NCDs in this age group were considered, such as carbonated soft drinks, sugar-sweetened beverages, dairy beverages, candies, and salty snacks (7–10, 59). Second, the sample might not be representative of the wider universe of products with marketing. Third, the estimated proportion of foods and beverages with child-directed marketing may have been misclassified, given our difficulty to discriminate marketing strategies geared toward children from other types of marketing strategies (50). Finally, because the Brazilian legislation does not require foods and beverages sold in the country to display the content of free sugars on the nutrition facts panel, our estimates for free sugar may be biased (57). The sensitivity analyses conducted however did not show the direction of the error since, for some food groups, the estimate increased the amount of free sugar per 100 g and in others decreased it compared to that reported on the package

(Supplementary Table 3). We tested the inter-rater agreement for free sugar values estimated by using this method for two senior researchers independently and found a 90% of agreement (kappa value = 0.75) (data not shown).

Strengths of our study include the use of a sample of foods from the largest Brazilian food retailers, the careful characterization of food packages with child-directed marketing using internationally recommended protocols for monitoring public food policies, and the comparison between NPMs adopted in Latin American countries. Our findings provide evidence of how the choice of NPM is a key part of food policy design and planning when the policy target is the promotion of healthy eating and the fight against childhood obesity.

In conclusion, we identified greater proportions of ultra-processed foods with child-directed marketing high in sugar, sodium, and/or saturated fat using the NPM suggested by PAHO and adopted in Mexico were better than the regulations adopted in Brazil to identify which foods should receive FOP nutrition labeling. Our findings suggest that the NPM criteria adopted in Brazil are also limited to support marketing restriction policies to protect children.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Author contributions

CB contributed to the design of the study and leaded the data analysis and writing of this manuscript. NK contributed to the writing of this manuscript and reviewed the data analysis. DN contributed to the writing of this manuscript. AD contributed to the design of the study and reviewed the data analysis. All authors read and approved the final manuscript.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

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ABSTRACTS

SPANISH

Comparación de modelos de perfil de nutrientes en Latinoamérica utilizando datos de alimentos envasados con *marketing* dirigido a niños del suministro brasileño de alimentos

Objetivos: Este estudio tuvo como objetivo examinar y comparar hasta qué punto los diferentes modelos de perfil de nutrientes (MPN) de Latinoamérica (LA) identifican alimentos y bebidas envasados con *marketing* dirigido a niños vendidos en Brasil, como siendo altos en nutrientes relacionados al riesgo de enfermedades no transmisibles (ENT).

Materiales y métodos: En este estudio transversal evaluamos 3.464 alimentos encontrados en los cinco mayores supermercados brasileños. El *marketing* dirigido a niños se codificó usando el protocolo de la Red Internacional para la Investigación de Alimentos y Obesidad/ENT, Seguimiento y Apoyo a la Acción (INFORMAS). Diferencias en medianas de azúcares, grasas saturadas y sodio por 100 kcal en alimentos con la presencia y ausencia del *marketing* dirigido a los niños fueron probadas usando la prueba *Mann-Whitney*. Comparamos seis MPN en LA y examinamos hasta qué punto se dirigieron a estos productos usando índices de prevalencia. Los análisis se realizaron de forma global y por el grado de procesamiento de los alimentos según la clasificación Nova de alimentos.

Resultados: Encontramos 1.054 envases con *marketing* dirigido a niños. Entre ellos, dulces, tortas y pasteles, salsas y cremas, y bebidas azucaradas fueron significativamente más altos en azúcares, grasas saturadas y sodio por 100 kcal que productos no dirigidos a niños ($p < 0.05$). Comparado con los modelos de México y de la OPS, el MPN brasileño permitiría tres veces más alimentos ultraprocesados que omiten las advertencias de sodio ($p < 0.05$). El MPN uruguayo también marcó menos alimentos ultraprocesados altos en sodio. El modelo brasileño también permite cuatro veces más bebidas azucaradas y seis veces más bebidas lácteas que omiten advertencias para azúcares que los modelos de México y de la OPS. En comparación con otras MPN, el modelo brasileño mostró el peor rendimiento en identificar productos horneados como altos en sodio. Los modelos de Chile, Uruguay y Perú también apuntarían significativamente menos bebidas azucaradas altas en al menos un nutriente crítico, que los modelos de OPS y de México.

Conclusión: Comparado con otros MPN en LA, el criterio del MPN adoptado en Brasil es más permisivo y menos probable de informar a los consumidores la baja calidad nutricional de los alimentos y bebidas ultraprocesados con *marketing* dirigido a niños.

Palabras clave: modelo de perfil de nutrientes, etiquetado de alimentos, políticas de alimentos, marketing dirigido a niños, marketing, marketing a niños, marketing de alimentos no saludables.

PORTUGUESE

Comparação de modelos de perfis de nutrientes latino-americanos utilizando dados de alimentos embalados com publicidade dirigida a crianças do varejo brasileiro de alimentos

Objetivos: Este estudo teve como objetivo examinar e comparar a medida em que diferentes modelos de perfis de nutrientes (MPN) da América Latina (AL) identificam alimentos e bebidas embalados com publicidade dirigida a crianças, vendidos no Brasil, como sendo altos em nutrientes associados ao risco de doenças crônicas não transmissíveis (DCNT).
Materiais e métodos: Neste estudo de corte transversal, nós avaliamos 3.464 alimentos encontrados nos cinco maiores supermercados brasileiros. A publicidade dirigida a crianças foi codificada utilizando o protocolo da Rede Internacional de Pesquisa, Monitoramento e Apoio à Ação para Alimentos e Obesidade/DCNT (INFORMAS). Diferenças nas medianas de açúcar adicionado, gorduras saturadas e sódio por 100 kcal foram verificadas para alimentos com ou sem publicidade dirigida a crianças usando o teste *Mann-Whitney*. Comparamos seis MPN na AL e examinamos em que medida eles identificavam esses alimentos usando razões de prevalência. As análises foram realizadas por grupos de alimentos e pelo seu grau de processamento de acordo com a classificação Nova de alimentos.

Resultados: Nós encontramos 1.054 alimentos com publicidade dirigida a crianças. Entre estes, guloseimas, bolos e tortas, molhos e cremes, e bebidas açucaradas tinham significativamente maior quantidade de açúcar adicionado, gordura saturada e sódio por 100 kcal do que produtos que não são dirigidos a crianças ($p < 0,05$). Em comparação com os modelos da OPAS e do México, o MPN brasileiro permitiu que três vezes mais alimentos ultraprocessados omitissem as advertências para alto em sódio ($p < 0.05$). O MPN uruguaio também identificou menos alimentos ultraprocessados altos em sódio ($p < 0,05$). O modelo brasileiro também permitiu que quatro vezes mais bebidas açucaradas e seis vezes mais bebidas lácteas omitissem as advertências para alto em açúcar do que os modelos do México e da OPAS. Em comparação a todos os outros MPNs, o modelo brasileiro também mostrou o pior desempenho na identificação de panificados altos em sódio. Os modelos adotados pelo Chile, Uruguai e Peru também identificaram significativamente menos bebidas açucaradas altas em pelo menos um nutriente crítico comparados aos modelos da OPAS e do México.

Conclusão: Em comparação com outros MPN utilizados na AL, os critérios do MPN do Brasil são mais permissivos e menos propensos a informar os consumidores sobre a baixa qualidade nutricional de alimentos e bebidas ultraprocessados com publicidade dirigida a crianças.

Palavras-chave: modelo de perfil de nutrientes, rotulagem de alimentos, políticas alimentares, marketing dirigido para crianças.

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Do they really support "your freedom of choice"? FoPNL and the food industry in Brazil

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Introduction: In 2020, Brazil approved the introduction of a new front-of-package nutrition labeling (FoPNL) in the format of a magnifying glass (MG) after years of discussion. There is currently a lack of understanding of the role of the food industry in that process. This study aimed to describe the corporate political activity (CPA) of the food industry and conflicts of interest situations, as they happened during the development and approval of a new FoPNL system in Brazil.

Materials and methods: We undertook bibliographical and documentary searches using material from food companies, trade associations and front groups involved in the regulatory process. We (1) collected information about the case study context, (2) collected data from documentary sources, and (3) prepared a synthesis of the results and a timeline of key events.

Results/Discussion: During the FoPNL regulatory process in Brazil, the food industry opposed the introduction of warning labels, a model supported by health authorities and implemented with success in other countries in Latin America. The food industry rather promoted a traffic-light labeling system, known to be less effective at guiding individuals to make healthier food choices. Later in the process, when it was evident that its preferred model would not be used, and a MG would rather be introduced, the food industry argued for the use of a different version of this FoPNL model. We found that the food industry, all along the process, was directly involved in and influenced the development of the FoPNL, by providing technical support, advising and lobbying policymakers. The food industry also established relationships with a consumer non-governmental organization and nutrition professional societies. The food industry also produced and disseminated information supporting its position in order to influence public opinion and high-level decision makers, and used the legal system to delay the process.

Conclusion: The FoPNL in Brazil is neither aligned with the recommendations of international health organizations nor with existing independent scientific evidence. The new FoPNL, as adopted in Brazil, reflects some of the preferences of the industry; it is likely that the influence of that sector during the legislative process was pivotal, even if its initial proposal was not adopted.

KEYWORDS

front-of-package labeling, nutrition labeling, corporate political activity, conflict of interest, food regulation

Introduction

The implementation of a front-of-packageprotect nutrition labeling (FoPNL) on food products is a key element that could help promote and protect health and health-related rights (1), and is recommended by the World Health Organization (WHO) (2) and the United Nations (UN) Special Rapporteur on the right to health (3). Clearer nutrition labels, as proposed with the introduction of FoPNL, have the potential to increase people's understanding of the healthiness of food products, thus helping them shift to healthier options (4–6). Clearer FoPNL, therefore, contributes to the reduction in the consumption of foods that contain too much sugar, fats and sodium, particularly ultra-processed food products, and is a cost-effective option for the control and reduction of non-communicable diseases (NCDs) (7). FoPNL is considered a cost-effective "stepping stone" for other measures that promote healthy diets, such as taxation, school environment regulation, and marketing restrictions (1, 3).

Several countries around the world have adopted FoPNL systems (8). Warning labels (WLs) of a geometric form, such as an octagon, on products with an excessive amount of nutrients of concern, are now used in Latin American countries (Chile, Peru, Uruguay, and Mexico; and in the process to be implemented in Argentina and Colombia). Comparative studies have shown that WLs are the most effective FoPNL system for the identification of unhealthy food products (9–12). Indeed, 1 year after the implementation of the Chilean FoPNL, a study showed a significant decrease in the consumption of food products that contain too much added sugar and sodium (13). In Uruguay, 58% of individuals surveyed reported modifying their purchasing decisions for healthier products after having seen WLs, only 1 month after the implementation of a FoPNL system (14).

Brazil was the first Latin American country to implement a nutrition food labeling regulation in 2003 (15). Since 2014, the Brazilian Health Surveillance Agency (*Agência Nacional de Vigilância Sanitária*–Anvisa) has led a discussion for the update of that regulation, in light of new scientific evidence and international recommendations. The process was carried out with representatives of civil society organizations, academia, the government and the food and beverage industry. In October 2020, a new regulation on nutrition labeling of packaged foods was approved (16, 17), with the inclusion of a mandatory FoPNL, using a magnifying glass (MG) for those products exceeding sets levels of added sugar, saturated fat and/or sodium. The implementation of the norm will go into effect in October 2022.

That process was not necessarily a smooth one. Large food manufacturers make a huge profit from the sales of their products, and the industry's profits are higher for unhealthy products, such as those high in salt, sugar and fat (18). A FoPNL that would limit the sales of those unhealthy products would direct individuals to healthier, but usually less profitable, choices. In Brazil, trade associations and the food industry therefore tried to influence the regulatory process and public opinion during the early development of the new FoPNL in the country (19). The industry used arguments that delegitimized Anvisa's role in the process, justified the involvement of the food industry, and shifted the blame away from the role of unhealthy food products for ill-health at the population level, and instead focused on individuals as responsible for their choices. These arguments from the industry were mostly based on an inconsistent set of non-academic and non-peer-reviewed evidence (20). Other countries in Latin America also faced strong opposition from the food industry to the introduction of new FoPNL systems (21–23). In Brazil, beyond these arguments used in the early stages of the regulatory process, the specific actions of the food industry to influence the entire process have not yet been explored.

The aim of the present study was therefore to identify the main events during the regulatory process for a new FoPNL in Brazil, and to map the actions used by the food industry, also known as corporate political activity (CPA), and the conflicts of interest (CoI) involved in that process (21, 24). The CPA of the food industry refers to action-based strategies (coalition management, information management, direct involvement and influence in public policy, legal action) and argument-based strategies (e.g., questioning the governance of a process; promoting solutions to health-related issues that have no evidence of their effectiveness, etc.) (21). CPA occurs through an action or argument used between two parties: the food industry and a third party (e.g., a policymaker, or a researcher). A CoI, as per the law in Brazil, refers to the case where a person, in a position or employment at the federal Executive Branch: (a) disclose or make use of privileged information, for one's own benefit or that of a third party; (b) carry out activities that imply the provision of services or the maintenance of a business relationship with an individual or legal entity that has an interest in a decision of the public agent or of a collegiate in which he participates; (c) carry out an activity that is incompatible with the attributions of the position or job; (d) act, even if informally, as attorney, consultant, advisor or intermediary of private interests in the bodies or entities of any of the Branches of the Union, the states, the Federal District and the municipalities; (e) perform an act for the benefit of the interest of a legal entity in which the public agent, his/her spouse, partner or relatives, by blood or related, in a direct or collateral line, up to the third degree, and which may benefit or influence in its management acts; (f) receive gifts from those who are interested in a decision by the public agent or collegiate in which he or she participates outside the limits and conditions; (g) provide services, even if occasional, to the company whose activity is controlled, inspected or regulated by the entity to which the public agent is linked (25).

Materials and methods

This study was of a qualitative nature. We undertook bibliographical and documentary searches, based on a combination of a case study design with a constructivist approach to the policy analysis methodology (26). Data collection and analysis were conducted between July and December 2021 by LAM with support from the other authors. All the authors contributed to the review and analysis of the data collected. The research team has expertise in public health nutrition, food policy and in industry interference in Brazil, from academia, civil society and the media. All but one author (MM) of the present study, through their work in academia, civil society and the media, were directly involved in the regulatory process under study. While our collective experience can provide crucial knowledge on the subject, it also meant that we took a critical approach to the actions described below. This work was therefore aligned with a critical social science perspective (27).

The searches conducted involved three main steps. First, we searched for information about the context of the case study (Brazil, Federal level). Second, we collected data from documentary sources. Finally, a synthesis of the results and a timeline of important CPA of the food industry during the regulatory process of the nutrition labeling of packaged foods regulation were elaborated.

The time period under study started in 2011, when Brazil officially requested the Southern Common Market (MERCOSUR) a review of the general and nutrition labeling on food products, until April 2022, when this article was finished. This represents the entire period of technical discussions and Anvisa's regulatory process of nutrition labeling of packaged foods, including the approval of the new regulation, but not the beginning of its implementation, which is planned to happen in October 2022.

The food industry included, for our analysis: food companies and trade associations directly involved in the regulatory process and the Labeling Network (*Rede Rotulagem*, in Portuguese), a group founded by several of these actors from the industry during this period (28).

Documentary searches were conducted using multiple sources. Documents from industries involved in the process were searched on the websites and social media profiles of the industry actors that were members of *Rede Rotulagem* (28), Your Freedom of Choice (*Sua Liberdade de Escolha*, in Portuguese) (29) and Eye on the MG (*Olho na Lupa*, in Portuguese) (30), such as the Brazilian Association of the Food Industry (*Associação Brasileira da Indústria de Alimentos*–ABIA) (31), the Brazilian Association of Soft Drinks and Non-Alcoholic Beverage Industries (*Associação Brasileira das Indústrias de Refrigerantes e de Bebidas não Alcoólicas*–ABIR) (32) and the Brazilian Dairy Association (*Associação Brasileira de Laticínios–Viva Lácteos*) (33). Official publications from Anvisa on the regulatory process, such as technical reports, presentations, regulations and standards were identified on its official website (34), as well as Brazilian Federal laws (35). Press and media articles were identified using Google searches. Google Scholar was used for identifying publications that have discussed the role of the food industry in the regulatory process in Brazil. A copy of some files of the regulatory process and other documents were obtained via the Access to Information Law (*Lei de Acesso à Informação*–LAI). Requests were made directly to Anvisa, on different occasions between 2017 and 2021. The requests focused on minutes of meetings of Anvisa working groups on labeling from 2011 to 2016; minutes of meetings between directors and corporations or trade associations; minutes of meetings between directors and researchers or research associations with potential CoI; access to documents submitted by corporations or trade associations to the General-Management of Foods (*Gerência-Geral de Alimentos*–GGALI) of Anvisa. Searches were also based on our collective expert knowledge of the case under study.

A distinction was made between independent sources and those from the food industry (as per the affiliations of authors, or as declared in the funding or CoI sections of publications, for example), in order to identify any CoI which may have led to bias.

Data was triangulated amongst those sources and we continued with our searches until no new data was identified.

The analysis and report of the material gathered included: (i) a description of the context under study and a timeline of key events; (ii) a reporting of the CPA of the food industry, with a particular focus on key events, identified as moments that had relevant importance in the regulatory process that were emphasized and mentioned by the food industry actors or by other representatives involved in the process. For that analysis, we used a deductive approach, using the existing classification of CPA described by Mialon et al. (21). Findings were synthesized narratively, using illustrative examples of the practices used by the industry in Brazil.

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The study did not require ethics approval, since only secondary and publicly available data was used.

Results

Table 1 is a timeline of key CPA strategies and CoI situations that we have documented for the regulatory process during the development of a new FoPNL in Brazil. **Table 2** presents the main actors from the industry, academia, civil society and government involved in that process.

A revision of the Brazilian regulation for nutrition food labeling of packaged foods was motivated by two events. First, in 2011, Brazil made a request to MERCOSUR for the revision of nutrition and general food labeling regulations in the region (36). It was accepted by other member countries (Paraguay, Uruguay, and Argentina) and marked the advancement of the international agreements on this theme (37). Furthermore, in 2013, the National Food and Nutrition Security Council (*Conselho Nacional de Segurança Alimentar e Nutricional*–Consea) of Brazil, an entity responsible for monitoring food and nutrition security public policies, published its Resolution no 007/2013, where the Council recommended that Anvisa would need to be moving with "the processes for updating and qualifying regulatory proposals for food labeling" (38). In response to these events, Anvisa created a working group (WG) on nutrition food labeling, with the participation of representatives from the government, civil society, academia and food industry (39). The meetings of the WG occurred from December 2014 to April 2016, and focused on the existing legislation and the possible solutions regarding a new nutrition facts panel, as well as nutrition claims and a FoPNL system (19). At the end of this period, members of the WG were invited to send their proposals about nutrition labeling regulation to Anvisa. We have not encountered any document or activity that could be classified as CPA or CoI for that period.

In 2017, four proposals from WG members were presented to Anvisa: one by the trade association ABIA, two from government bodies, and one from a civil society organization together with a research group from academia. The main disagreement between the proposals was about the FoPNL model (40). While ABIA recommended a traffic-light labeling (TLL) system based on a nutrient profile model (NPM) adapted from the United Kingdom (UK) and supported by the results of an opinion poll about Brazilians' preference for this model (40, 41) (**Figure 1A**), the other organizations recommended a WL with a NPM adapted from Pan American Health Organization (PAHO) (42), based on the scientific evidence of its efficacy (10, 43, 44).

In the same period, a group of 21 food industry trade associations, including ABIA, ABIR, *Viva Lácteos*, the Brazilian Supermarket Association (*Associação Brasileira de Supermercados*–ABRAS), the Brazilian Association of Animal Protein (*Associação Brasileira de Proteína Animal*–ABPA), the National Industry Confederation (*Confederação Nacional da Indústria*–CNI), among others, formed a coalition called *Rede Rotulagem* (**Tables 1**, **2**). *Rede Rotulagem* had an official website (28), a newsletter (that started with a weekly periodicity (45, 46), and from May 2019 was then issued on a monthly basis (47, 48) and social media profiles under the name of Your Freedom of Choice (*Sua Liberdade de Escolha*, in Portuguese) (49). This was the CPA strategy that we documented, where the food industry built an internal coalition, for the industry to speak as one, powerful voice, and reached out to key opinion leaders and the media, for building an external coalition that would support and disseminate its position (**Table 1**).

Rede Rotulagem used classic CPA arguments, where it called for free and autonomous food choices, and for the use of the TLL as the clearest and most objective model to inform consumers about nutrition information. *Rede Rotulagem* also rejected the WLs, which were qualified as alarmist and too restrictive compared to the TLL model, which was considered as informative and educational (28, 29, 50). The idea of "fear" and "alarmism" of WLs was further used by ABIA and the food industry.

In November 2017, ABIA commissioned an opinion poll to the Brazilian Institute of Public Opinion and Statistics (*Instituto Brasileiro de Opinião Pública e Estatística*–IBOPE), an example of CPA that could bias the information on which decisions were based. Participants were asked their opinion about WLs in the form of triangles and TLLs. The main result was that the Brazilian population preferred the TLL system over WLs, which were considered as illegible, with incomplete information and associated with fear and guilt (41). ABIA stressed that "everything indicates that this type of alert (WLs) scares more than informs or mobilizes the population." The results of the poll were disseminated by the food industry (51), especially through *Rede Rotulagem*'s platforms (48) (**Table 1**).

In December, Anvisa officially launched the regulatory process (52), and a new regulatory impact analysis (*análise de impacto regulatório*–AIR), "a systematic evidence-based

TABLE 1 Timeline and classification of the main corporate political activities and conflicts of interest situations during the regulatory process of nutrition labeling of packaged foods.

Date	Event	Classification of the CPA and CoI events			
		Strategies		Practices/Domain	Mechanisms/Arguments
June 2017	Creation of the *Rede Rotulagem*	Instrumental	Coalition management	Establish relationships with key opinion leaders and health organizations	–Promote public-private interactions with health organizations –Establish informal relationships with key opinion leaders
				Establish relationships with the media	–Establish close relationships with media organizations, journalists and bloggers to facilitate media advocacy
November 2017	Publication of the opinion poll "Population disposition for change in labeling of foods and non-alcoholic beverages categories" by IBOPE, commissioned by ABIA	Instrumental	Information management	Production	–Fund research, including through academics, ghost writers, own research institutions and front groups
				Amplification	–Cherry pick data that favors the industry, including use of non-peer reviewed or unpublished evidence
			Direct involvement and influence in policy	Actor in government decision making	–Provide technical support and advice to policymakers (including consultation)
		Discursive		Frame the debate on diet- and public health-related issues	–Shift the blame away from the food industry and its products, e.g., focus on individual responsibility, role of parents, physical inactivity
July 2018	Presentation of a lawsuit by ABIA requesting the extension of the TPS	Instrumental	Legal action	Use legal action (or the threat thereof) against public policies or opponents	–Litigate or threaten to litigate against governments, organizations or individuals
July 2018	Publication of the economic study "Socioeconomic impacts of the implementation of nutrition labeling models on the front panels of foods and beverages" by GO Associados, commissioned by the *Rede Rotulagem*	Instrumental	Information management	Production	–Fund research, including through academics, ghost writers, own research institutions and front groups
				Amplification	–Cherry pick data that favors the industry, including use of non-peer reviewed or unpublished evidence
		Discursive		The economy	–Stress the number of jobs supported and the money generated for the economy
				Expected food industry costs	–Policy will lead to reduced sales/jobs –Cost of compliance will be high
September 2018	Lobby with the former President of the Republic, Michel Temer, for the nomination of the former Director-President of Anvisa, William Dib	Instrumental	Direct involvement and influence in policy	Indirect access	–Lobby directly and indirectly (through third parties) to influence legislation and regulation so that it is favorable to the industry
November 2019	Request of ABPA to Anvisa for the extension of the PCs	Instrumental	Direct involvement and influence in policy	Indirect access	–Lobby directly and indirectly (through third parties) to influence legislation and regulation so that it is favorable to the industry
January–December 2019	Meetings of the leaders of Anvisa with the private food sector	Instrumental	Direct involvement and influence in policy	Indirect access	–Lobby directly and indirectly (through third parties) to influence legislation and regulation so that it is favorable to the industry
				Actor in government decision making	–Provide technical support and advice to policymakers (including consultation)
June 2020	Presentation of a letter of the Embassy of Italy in Brazil to the	Instrumental	Coalition management	Constituency fabrication	–Procure the support of community and business groups to oppose public health

(Continued)

TABLE 1 (Continued)

Date	Event	Classification of the CPA and CoI events			
		Strategies		Practices/Domain	Mechanisms/Arguments
	Presidency of the Republic and to Anvisa about the concerns of the agri-food sector Italian companies about the approval and implementation of a FoPNL in warning format			Constituency fabrication	– measures
		Discursive		Expected food industry costs	–Policy will lead to reduced sales/jobs –Cost of compliance will be high
				Frame the debate on diet- and public health-related issues	–Promote industry is preferred solutions: education, balanced diets, information, public private initiatives, self-regulation (reformulation)
December 2020	Interview of the former General-Manager of Foods of GGALI/Anvisa, Thalita Lima, to *ILSI em foco*	Instrumental	Coalition management	Establish relationships with key opinion leaders and health organizations	–Establish informal relationships with key opinion leaders
			Direct involvement and influence in policy	Indirect access	–Lobby directly and indirectly (through third parties) to influence legislation and regulation so that it is favorable to the industry
		Discursive		Frame the debate on diet- and public health-related issues	–Stress the good traits of the food industry
July 2021	Revolving doors of the former Director of Anvisa and rapporteur of the regulatory process of nutrition labeling of packaged foods, Alessandra Soares	Instrumental	Direct involvement and influence in policy	Indirect access	–Use the "revolving door," i.e., ex-food industry staff work in government organizations and vice versa
September 2021	Publication of the paper "Comparison of the efficacy of five front-of-pack nutrition labels in helping the Brazilian consumer make a healthier choice" by Unilever employees	Instrumental	Information management	Production	–Fund research, including through academics, ghost writers, own research institutions and front groups
				Amplification	–Cherry pick data that favors the industry, including use of non-peer reviewed or unpublished evidence
March 2022	Creation of *Olho na Lupa*	Instrumental	Coalition management	Establish relationships with the media	–Establish close relationships with media organizations, journalists and bloggers to facilitate media advocacy
			Information management	Amplification	–Cherry pick data that favors the industry, including use of non-peer reviewed or unpublished evidence
		Discursive		Frame the debate on diet- and public health-related issues	–Promote industry is preferred solutions: education, balanced diets, information, public private initiatives, self-regulation (reformulation)
Throughout the regulatory process	Participation of Anvisa's employees in events sponsored by the food industry	Instrumental	Coalition management	Establish relationships with key opinion leaders and health organizations	–Establish informal relationships with key opinion leaders
				Establish relationships with the media	–Establish close relationships with media organizations, journalists and bloggers to facilitate media advocacy
			Direct involvement and influence in policy	Indirect access	–Lobby directly and indirectly (through third parties) to influence legislation and regulation so that it is favorable to the industry

Brazil, 2011–2022. Lines in gray refers to conflicts of interest situations. ABIA, Brazilian Association of the Food Industry; ABPA, Brazilian Association of Animal Protein; Anvisa, Brazilian Health Surveillance Agency; CoI, conflicts of interest; PC, public consultation; CPA, corporate political activity; FoPNL, front-of-package nutrition labeling; GGALI, Food General Management; IBOPE, Brazilian Institute of Public Opinion and Statistics; ILSI, International Life Sciences Institute; TPS, Public Collection of Information.

TABLE 2 Actors involved in the regulatory process of nutrition labeling of packaged foods.

Name (in Portuguese)	Name (in English)	Abbreviation	Sector*	Description
Agência Nacional de Vigilância Sanitária	Brazilian Health Surveillance Agency	Anvisa	Government	Regulatory agency linked to the Ministry of Health and responsible for the elaboration of rules on food labeling.
Alessandra Bastos Soares	–	–	Government	Director of Anvisa from 2018 to 2020 (final period of the regulatory process) and rapporteur of the regulatory process on nutrition labeling on packaged foods.
Aliança pela Alimentação Adequada e Saudável	Alliance for Adequate and Healthy Diets	–	Civil society	Coalition that brings together 72 collectives, including civil society organizations, social movements, and professional entities, and is currently composed of 350 individual members in defense of the public interest of the defense of the Human Right to Adequate Food.
Associação Brasileira da Indústria de Alimentos	Brazilian Association of the Food Industry	ABIA	Industry	Founded in 1963, it is the majorst association of representatives of the food industry in the country. It brings together small, medium and large industries throughout the national territory, including Brazilian and multinational companies. It is also a member of the Labeling Network.
Associação Brasileira das Indústrias de Refrigerantes e de Bebidas não Alcoólicas	Brazilian Association of Soft Drinks and Non-Alcoholic Beverage Industries	ABIR	Industry	Founded in 1950, it brings together companies that manufacture various non-alcoholic beverages, such as soft drinks, juices, nectars, soft drinks, chocolate drinks, teas, isotonic drinks, energy drinks and mineral waters. It is also a member of the Labeling Network.
Associação Brasileira de Defesa do Consumidor	Brazilian Association for Consumer Defense	PROTESTE	Civil society	Founded in 2001, it is a non-profit association that works with suppliers and authorities to defend the interests of consumers.
Associação Brasileira de Laticínios	Brazilian Dairy Association	Viva Lácteos	Industry	Association that represents the dairy industry and brings together 38 of the main manufacturers and associations of the sector in Brazil. Together, Viva Lácteos associates are responsible for 70% of the production of milk and dairy products in the country. It is also a member of the Labeling Network.
Associação Brasileira de Nutrologia	Brazilian Association of Nutrology	ABRAN	Civil society	Founded in 1973, it is an association that brings together doctors working in the field of nutrology.
Associação Brasileira de Proteína Animal	Brazilian Association of Animal Protein	ABPA	Industry	National association that represents the poultry and pork meats sectors in Brazil. It is also a member of the Labeling Network.
Associação Brasileira de Supermercados	Brazilian Supermarket Association	ABRAS	Industry	Founded in 1968, it brings together representatives of the supermarket sector in the country. It is also a member of the Labeling Network.
Confederação Nacional da Indústria	National Industry Confederation	CNI	Industry	Created in 1938, it is the highest organization of the Brazilian industrial sector. It coordinates a system made up of 27 industry federations from the states and the Federal District–to which more than a thousand employers' unions are affiliated. It is also a member of the Labeling Network.
Conselho Nacional de Segurança Alimentar e Nutricional	National Food and Nutrition Security Council	Consea	Government	Council for the articulation between government and civil society in proposing guidelines for actions in the area of food and nutrition. The Council has an advisory role and advises the President of the Republic in formulating policies and defining guidelines for the country to guarantee the human right to food. Consea was dissolved in 2019 by President Bolsonaro.
–	Embassy of Italy in Brazil	–	Government	The main Italian diplomatic representation in Brazil.
Empresa Brasileira de Pesquisa Agropecuária	Brazilian Agricultural Research Corporation	Embrapa	Government	Created in 1973, it is a public research company linked to MAPA of Brazil.
Instituto Brasileiro de Defesa do Consumidor	Brazilian Institute for Consumer Defense	Idec	Civil society	Founded in 1987, it is a non-profit consumer association, independent of companies, parties or

(Continued)

TABLE 2 (Continued)

Name (in Portuguese)	Name (in English)	Abbreviation	Sector*	Description
				governments. In 2017, Idec presented a proposal to Anvisa to update and improve the nutrition labeling norm in the country. The proposal, based on the PAHO nutrient profile, included adherence to a front-of-package warning labeling model.
–	International Life Sciences Institute Brazil	ILSI Brasil	Industry	Created in 1990, it brings together scientists in the areas of nutrition, biotechnology and risk assessment. In Brazil, the members are companies in the food, agricultural, pharmaceutical and biotechnology sectors.
Jarbas Barbosa	–	–	Government	Director of Anvisa between 2015 and 2018 (period of progress of the regulatory process).
Michel Temer	–	–	Government	Vice President of Brazil from 2011 to 2016. After the impeachment of Dilma Roussef, he took over as president from 2016 to 2019.
Núcleo de Pesquisas Epidemiológicas em Nutrição e Saúde/Universidade de São Paulo	Center for Epidemiological Research in Nutrition and Health/University of São Paulo	Nupens/USP	Academia	It is an integration body of the USP created in 1990 with the purpose of stimulating and developing population research in nutrition and health. The group is composed of professors and researchers, masters, doctoral students and scholarship interns.
Olho na Lupa	Eye on the Magnifying Glass	–	Industry	An initiative of 11 associations representing the food and beverage industry and retail, with the aim to explain how to read and understand the information on food labels to consumers.
Rede Rotulagem	Labeling Network	–	Industry	It is an initiative of the food and beverage production sector that works on the subject of food labeling. It comprises 21 entities, including the industrial and commercial sectors.
Sociedade Brasileira de Alimentação e Nutrição	Brazilian Society of Food and Nutrition	SBAN	Civil society	Founded in 1985, it is a non-profit, scientific civil society whose objective is to stimulate and disseminate knowledge in the field of food and nutrition.
Thalita Lima	–	–	Government	General-Manager of Food at Anvisa between 2015 and 2022 (period of progress of the regulatory process).
Unilever	Unilever	–	Industry	British multinational consumer goods company founded in 1929 and based in London, UK. Its products include food, beverages, cleaning products and personal care products.
Universidade de Brasília	University of Brasília	UnB	Academia	Brazilian public higher education institution located in Brasília, in the Federal District, being one of the most important universities in the country.
William Dib	–	–	Government	Director President of Directors of Anvisa between 2016 and 2019 (period of progress of the regulatory process).
Wilson Mello	–	–	Government	Chairman of the Board of Directors of ABIA between 2018 and 2019.

Brazil, 2011–2022. *The industry classification includes all the industries and front groups represented by and related to food and nutrition. MAPA, Ministry of Agriculture, Livestock and Supply; PAHO, Pan American Health Organization.

regulatory management process that seeks to assess, based on the definition of a regulatory problem, the possible impacts of the options available to achieve the intended objectives" (53).

The first official step in the regulatory process was the Public Collection of Information (*Tomada Pública de Subsídios*–TPS) (54), an online technical consultation based on the Preliminary Regulatory Impact Analysis Report on Nutrition Food Labeling (54, 55), that took place between May and July 2018. The report was developed by Anvisa using the different proposals received, the scientific evidence available and international experiences on FoPNL. Anvisa's preliminary proposal indicated WLs as the most adequate FoPNL for Brazil (**Figure 2A**).

Three days before the end of the TPS, ABIA presented a writ of mandamus (56) against Anvisa, asking for an extension of the consultation, so that the trade association could present its studies and tests in favor of the TLL. This strategy was used after Anvisa denied a request from *Rede Rotulagem* to extend the TPS until 24 July (57, 58). On that occasion, Anvisa appealed the decision and declared that there was "perplexity" regarding ABIA's position (59). On July 11, 2017, the Federal Judge decided

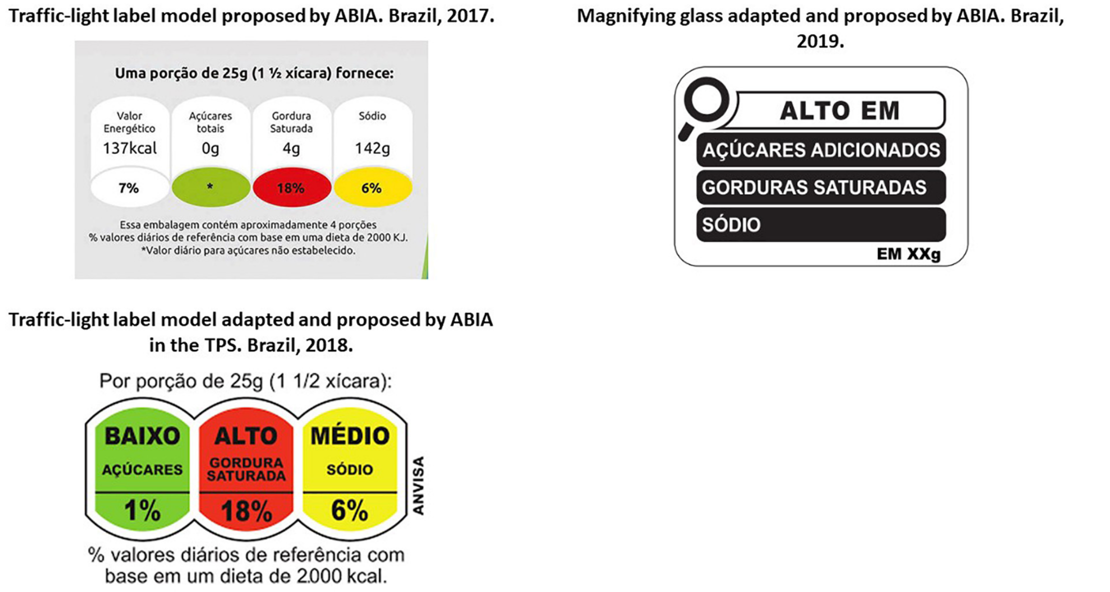

FIGURE 1
Different FoPNL models proposed by ABIA during the regulatory process. **(A)** Traffic-light label model proposed by ABIA. Brazil. 2017. **(B)** Traffic-light label model adapted and proposed by ABIA in the TPS. Brazil. 2018. **(C)** Magnifying glass adapted and proposed by ABIA. Brazil, 2019. Sources: Anvisa and ABIA. ABIA, Brazilian Association of the Food Industry; TPS, Public Collection of Information.

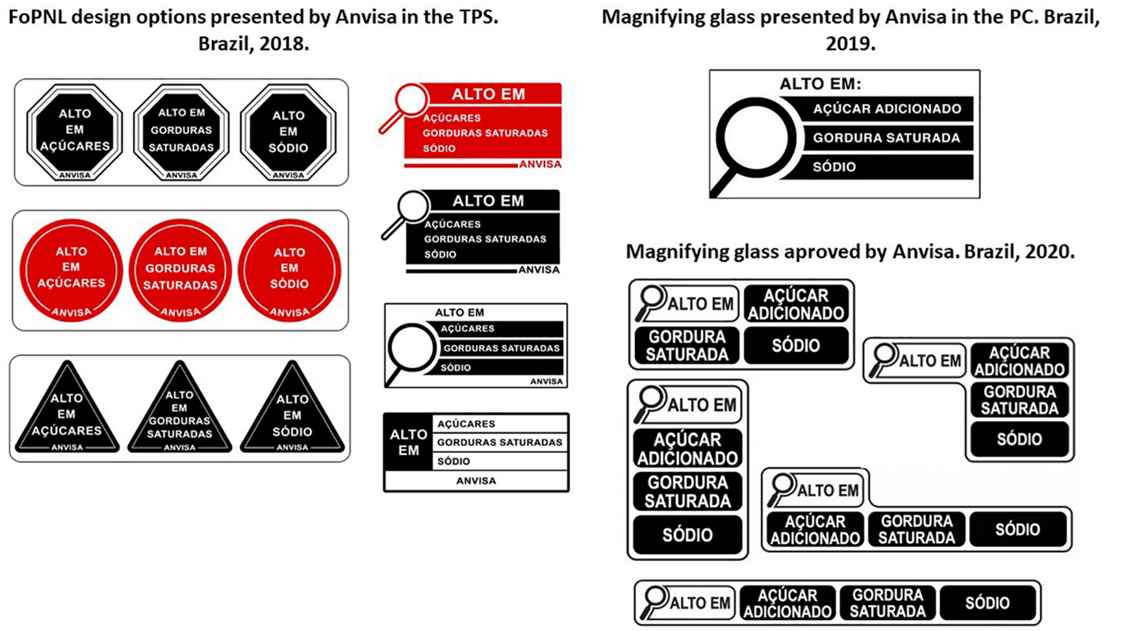

FIGURE 2
Different FoPNL models proposed by Anvisa during the regulatory process. **(A)** FoPNL design options presented by Anvisa in the TPS. Brazil, 2018. **(B)** Magnifying glass presented by Anvisa in the CP. Brazil, 2019. **(C)** Magnifying glass approved by Anvisa. Brazil. 2020. Source: Anvisa. FoPNL, front-of-package nutrition labeling; Anvisa, Brazilian Health Surveillance Agency; TPS, Public Collection of Information; PC, public consultation.

to defer ABIA's request, which prolonged the TPS for 15 more days (for a process of a total of 60 days)–a decision justified by the soccer World Cup, an event during which Brazilian life gets disrupted, and a truck drivers' strike, which also caused political challenges (56). The lawsuit of ABIA is a known CPA strategy that served to delay the process (Table 1).

In the TPS, ABIA called for the use of a modified design for the proposed TLL (**Figure 1B**), which was based on its work with external consultants hired by the trade association: nutrition researchers; companies undertaking research, design and communication, packaging, and economic analyses; and a law firm (60). The contributions of several food industry actors in the TPS were very similar to each other (even identical in some instances), signaling, at a minimum, some work in collaboration (a coalition management strategy) (20).

In July 2018, the consulting firm *GO Associados* published a non-peer-reviewed report entitled "Socioeconomic impacts of the implementation of nutrition labeling models on the front panels of foods and beverages," commissioned by *Rede Rotulagem* (an information management strategy). The aim of the study was to estimate the socioeconomic impacts of the implementation of the TLL and the WL models. The results showed that there would be job and economic losses with the implementation of WLs: R$ 7.0 billion in production, more than 130,000 jobs, R$ 1.0 billion in payroll and R$ 617 million in taxes (61). These results were presented to Anvisa and disseminated in the media (62). The overestimations in the calculations and the lack of considerations about the potential positive impacts on population health of the adoption of WLs were ignored in that report (63).

Over the next few months, Anvisa changed its position regarding the appropriate FoPNL system, following a series of events. The former Director-President of Anvisa, Jarbas Barbosa, who was a supporter of the regulatory process on nutrition food labeling, left his office in July 2018. William Dib, one of Anvisa's directors at that time, was nominated as Jarbas' substitute by the former President of the Republic (2016–2018), Michel Temer (64) (**Table 2**). During a public lunch event of the Federation of Industries of the State of São Paulo (*Federação das Indústrias do Estado de São Paulo*–Fiesp), Temer indicated he was against WLs, arguing that this model was a "danger sign" that could "harm the (industry) sector." At the same event, the former president of ABIA talked about the need to nominate a new Director-President of Anvisa who would be open to dialog with the industry (65). This is a key CPA strategy, a direct access and influence on the government. After Dib's nomination as Anvisa's Director-President in September 2018, he spoke in favor of the TLL, contradicting Anvisa's own conclusions in its Preliminary Regulatory Impact Analysis Report on Nutrition Food Labeling (66).

In December 2018, Dib participated in the seminar "Right to information in food labeling," hosted by *Valor Econômico*, an economics, business and finance newspaper. The event was supported by *Rede Rotulagem* and had speakers from ABIR, ABIA, CNI, the Brazilian Association of Nutrology (*Associação Brasileira de Nutrologia*–ABRAN), the Brazilian Society of Food and Nutrition (*Sociedade Brasileira de Alimentação e Nutrição*–SBAN) and PROTESTE, a non-profit consumers' association (67).

In March 2019, Dib participated in another event of the food industry: the AnuFood 2019, the biggest food and beverage fair in Brazil. During a speech shared with the former president of ABIA, Wilson Mello (**Table 2**), Dib described the fair as "an opportunity for Anvisa to strengthen dialogs and issues and find interfaces," meaning that the industry must be heard by the agency (a CPA strategy, with a direct contact and potential influence of the industry on government agencies). Dib also said that "social participation in the construction of the regulatory agenda is fundamental. It is essential for us at the agency that not only the consumer, but the regulated sector, participate in this process." Dib was praised by Mello "for (his) always open, collaborative attitude" (68, 69).

A year after the launch of the TPS, in April 2019, Anvisa held a meeting to present the results of the contributions and the calendar with the next steps of the regulatory process. Next, in May (70), July (71), and August (72) 2019, Anvisa held three sectoral dialogs, technical meetings with the presentation of the official proposal of the agency for different aspects of the new nutrition food labeling regulation, based on the TPS contributions, international experiences and scientific evidence. Academia, civil society, food industry and government representatives participated in the discussions. The design and the NPM that would be chosen for the FoPNL were not presented or discussed on these occasions. A study developed by University of Brasília (*Universidade de Brasília*–UnB) on the performance and perception of five FoPNL systems was published in April 2020 and used by Anvisa. The study showed a better performance of the WLs when compared to the MG (the model presented in the PCs, not the one approved in 2020) and the TLL.

With the end of the sectoral dialogs at Anvisa, in September 2019, the agency published the Regulatory Impact Analysis Report on Nutrition Food Labeling (73) and opened the public consultations (PCs) no 707 (74) and no 708 (75), with a proposal for the new nutrition labeling regulation. Anvisa's chosen FoPNL model was a MG that would indicate high amounts of added sugar, saturated fat and sodium, based on a two-step NPM developed by the agency (**Figure 2B**).

The PCs were supposed to last 45 days. However, after a request of ABPA, an entity that represents the poultry and pork meats sectors in Brazil and member of *Rede Rotulagem*, Anvisa extended the PCs for 30 more days, until December 9, 2019 (76). ABPA justification for the request was the need for more time to develop studies about the animal products' labels, especially regarding their readability, considering that these products are under both Anvisa' and the Ministry of Agriculture, Livestock and Supply (*Ministério da Agricultura, Pecuária e Abastecimento*–MAPA)'s regulation and that many of these products have common label for both national and international markets (77). This request represented another CPA strategy to delay the regulatory process, once more postponing the official timelines (**Table 1**).

The researchers from UnB (78) submitted a comment in the PC, arguing that the results of their study were not conclusive about the MG model, and said they were supportive of WLs instead (79). ABIA's contribution to the PCs included another modification on its proposal for the FoPNL, with the reduction of the size of the MG proposed by Anvisa (**Figure 1C**).

Anvisa then proposed a new MG, since the WLs generate "fear," a point which was noted in the study from UnB, and claimed in a speech of the former General-Manager of Foods at Anvisa, Thalita Lima (**Table 2**).

In 2019, it was reported by an investigative journalism platform that 90% of the meetings and events between Anvisa and outside organizations during that year were with companies and trade associations. The food industry was in second place in terms of numbers of meetings and events, behind the pharmaceutical industry (80). Lobbying activities are key CPA strategies used by the food industry to influence political decisions (**Table 1**).

In March 2020, a scientific paper led by the Brazilian Agricultural Research Corporation (*Empresa Brasileira de Pesquisa Agropecuária*–Embrapa) (81) (**Table 2**) compared the efficacy of different WLs, the MG (presented by Anvisa during the PCs), the TLL and the Guideline Daily Amounts (GDA). The study showed that WLs were the model with the best performance on all the evaluated aspects, and the use of familiar warning signs and the black color improved the efficacy of the FoPNL.

Anvisa soon had to face the COVID-19 pandemic from March 2020. This resulted in a delay to publish its decision about the new nutrition food labeling regulation. The food industry therefore asked for more *vacatio legis*[1] time, from 12 to 24 months (82).

In June 2020, Italian food companies shared their criticism of the proposed FoPNL, through the Embassy of Italy in Brazil in a letter sent to the Presidency of the Republic and to Anvisa. A key argument was that WLs "look like symbols of danger" and "generate fear in consumers, demonizing entire food categories as they disregard the importance of recommended portions for each." The letter mentioned that the Italian manufacturing sector had a great cultural importance in Brazil and that the food and beverage sector represented 9.6% of the gross domestic product (GDP) in the country, hence implying that any impact on the Italian food industry would have repercussions in Brazil. The letter also made it clear that WLs "attack the freedom of the consumers" (83) (**Tables 1**, **2**). Those are arguments described in the CPA literature, when the food industry promotes its economic importance, which could refrain government from adopting too restrictive measures, even if at a cost in terms of population health.

Moreover, in 2020 Anvisa canceled its Collegiate Board (*Diretoria Colegiada*–Dicol) meetings and ran out of quorum of directors to vote for the approval and publication of its norms (84). After almost a year since the launch of the PCs, with no further advances with the FoPNL process, the Brazilian Institute for Consumer Defense (*Instituto Brasileiro de Defesa do Consumidor*–Idec), a non-profit organization and the main civil society organization involved in the nutrition labeling regulatory process (**Table 2**), presented a writ of mandamus to the Federal Supreme Court (*Supremo Tribunal Federal*–STF) against Anvisa's Dicol, its President and the Presidency of the Republic. Idec requested for the appointment of new directors at Anvisa, and the inclusion of the regulatory process of the nutrition labeling of packaged foods on the agenda of the next Dicol meeting (85).

Anvisa's new directors were later on appointed and, on October 8, 2020, the new regulation on nutrition labeling of packaged foods was approved unanimously. The approved Resolution of the Collegiate Board (*Resolução da Diretoria Colegiada*–RDC) no 429/2020 (16) and Normative Instruction (*Instrução Normativa*–IN) no 75/2020 (17) had yet a different version of the FoPNL (**Figure 2C**). The MG was reduced in size, occupying less space on food packages, thus being less easily readable, less clear and simple (86). This new model was never evaluated before and was not based on any scientific evidence of its effectiveness, but was closer to the design advocated for by the food industry. The NPM was also weakened, with a larger proportion of food products being exempt from carrying the MG, because their cut offs for nutrients of concern were increased. The use of nutrition claims was only limited to those nutrients present on the FoPNL; claims for other nutrients, such as vitamins, minerals and fiber, being therefore allowed. Finally, the *vacatio legis* time was extended for another 24 months, at the request of the food industry, and the norm will be implemented from October 2022, with an extension of three more years for reusable packaging such as soft drinks. The food industry was therefore, on numerous occasions, able to delay the process.

Right after the approval of the regulation by Anvisa, *Rede Rotulagem* published its position about the new norm: "Although the productive sector has defended a more informative model, having even suggested, in the PCs process, the TLL design (colorful GDA), we are confident that the model approved by Anvisa meets the proposed objectives since the beginning of the regulatory process." The food industry also committed to undertake educational actions with consumers to guide them about the reading and understanding of the labels (87). This is a discursive strategy of the food industry, where it wants to be seen as a key actor in nutrition, and supports education so that individuals would be blamed if they continue to be sick, instead of the industry being questioned about the healthiness of its products.

1 Latin expression that means the period between the date of publication of a legal norm and the beginning of its validity. Generally, the vacatio legis is expressed in an article at the end of the law with the following text: "This law enters into force after (the number of) days of its official publication."

In December 2020 (88), the General-Manager of Foods at Anvisa at that time, Thalita Lima, gave an interview to "ILSI in Focus" (*ILSI em Foco*, in Portuguese) (89), a *newsletter* of ILSI Brasil (International Life Sciences Institute), a well-known front group funded by and close to the food industry (89) (**Table 2**). When asked about the way that Anvisa had been contributing to the advances of ILSI Brasil, Thalita answered: "I understand that there is a symbiotic relationship between the agency and ILSI Brasil, in which both institutions benefit from working together. Anvisa, with its agenda of priorities, signals to the society which themes need to be the object of research and studies. On the other hand, organizations such as ILSI help to fill this gap, providing the agency with important scientific information for decision-making." Lima also highlighted that "ILSI has historically contributed to various processes and activities of the agency. I would like to highlight the Institute's participation in the meetings of the Codex Alimentarius Working Group on Nutrition and Food for Special Purposes and in the regulatory process for Food Supplements, which represented an important advance for the productive sector and for the citizen, with improved quality, safety and product effectiveness" (**Table 1**). This is an information management strategy, discussed in other studies of the CPA of the food industry (23).

Anvisa's director and the rapporteur of the regulatory process on nutrition labeling of packaged foods, Alessandra Soares (**Table 2**), left its board in July 2021, and in the same month took up a position at Tavares Intellectual Property (Tavares Propriedade Intelectual, in Portuguese), which "advise clients on all matters related to the updated regulatory of foods and medicines, including, in particular, the acquisition of rights related to the registration of products before the main regulatory bodies" (90) (**Table 1**), a CPA practice known as the "revolving door," with a former employee goes with its knowledge and relationships from the government to the industry.

In the second semester of 2021, Anvisa launched a series of actions, with the publication of "Questions and answers about nutrition labeling of packaged foods" (91), and, in December, two webinars to present the new regulation and to answer questions about the FoPNL (92) and the nutrition facts panel (93).

In September 2021, a scientific paper written by Unilever's employees (**Table 2**) about the comparison of the Nutri-Score, another hybrid label, ABIA's model, Idec's model and Anvisa's model (the MG proposed in the PCs and not the one approved in 2020). The paper discussed the potential of each model to help individuals make healthier food choices. Nutri-Score is a color-coded nutrient profiling system (21), adopted voluntarily by the food industry in some European countries (94), and supported by WHO Europe and some European Union (EU) countries to be mandatorily adopted in the EU. Nutri-Score was subject to intense criticism and lobbying from the food industry, as described elsewhere (21, 95, 96). It is however now accepted and even supported by food companies, and preferred to the WLs. When compared to the control regarding the usefulness of each model to make healthier choices, the hybrid label and the ABIA's model performed best, followed by Nutri-Score. Idec's and Anvisa's models performed worse (97). The conclusion of the paper, based only on subjective measures about the perception of consumers, favored the model supported by ABIA and its members, including Unilever (**Table 1**).

In March 2022, the platform *Olho na Lupa*, described as "an initiative of 11 associations linked to the food and beverage industry and retail that aims to inform and educate Brazilian consumers about the new food labeling," was launched. The initiative has an official website (30) and social media profiles (98–101) and has ABIR, ABIA, ABPA, ABRAS, *Viva Lácteos* and CNI among its members (**Table 2**). The content of *Olho na Lupa* is based on the new regulation of nutrition labeling on packaged food. Regarding the FoPNL's NPM, the initiative explains that "Any food can be part of a healthy diet. With the indications of the nutrition label, you have more information to make your choices and compose a diet that is most appropriate to your needs and preferences," thus once again arguing that individuals are responsible for their own choices, and being silent on the fact that the consumption of certain products lead to ill-health (**Table 1**).

In April 2022, a scientific paper comparing the effectiveness of the FoPNL designs in the format of triangles, as proposed by civil society organizations, and the MG, as proposed by Anvisa in the PCs in 2019, was published. According to the participants of the study, the triangular model communicated important information, was a useful tool and was easier to understand. However, both models performed similarly in communicating nutrient information and the MG model performed marginally better at improving purchase intentions (102). This study was developed by researchers from the Center for Epidemiological Research in Nutrition and Health/University of São Paulo (*Núcleo de Pesquisas Epidemiológicas em Nutrição e Saúde/Universidade de São Paulo*–Nupens/USP) (**Table 2**) and Idec and used the MG presented in the PCs by Anvisa and not the one approved in 2020, which was not tested yet.

Throughout the entire period of the regulatory process in Brazil, food labeling was also being discussed in MERCOSUR and in Codex Alimentarius. In both spaces there is the active participation of Brazilian food industry's and civil society's representatives in the internal meetings with Anvisa to discuss the Brazilian position, and as observers in the international meetings when each country defends its position. This might have led to influence from the food industry at the regional level.

Discussion

Throughout the regulatory process for the adoption of a new nutrition labeling of packaged foods in Brazil, the food industry used various CPA strategies, and different situations of CoI situations were identified. The results of this study add evidence to the existing literature in that space (21, 24) and, particularly, on the efforts of industry actors to negatively influence the development of new FoPNLs (20, 22, 23, 103).

The food industry used "discursive" strategies in its presentation of commissioned reports and studies. Other organizations and individuals close to the industry also used arguments similar to the food industry such as ABRAN, the Embassy of Italy in Brazil and even a former leader of Anvisa. The main tactic of the food industry consisted in framing the debate, specially shifting the blame away from the food industry and its products in the ill-health of the population, and promoting industry's preferred solutions such as balanced diets and education, instead of a label that would be too restrictive for their products. The economy and the expected food industry costs were also mentioned, specially the potential losses in jobs and sales (20), argument also used against a proposal to reduce tax incentives for producers of sugary drinks in Brazil (104). These arguments were used before and during other regulatory processes on food labeling in Latin America (22, 23, 105, 106).

The main CPA action used by the food industry in addition to these arguments was its "direct involvement and influence in policy." Through the provision of technical support and advice to policymakers and lobbying, the food industry participated in technical discussions, PCs and meetings with decision makers, with no questioning about its conflict in defending commercial interests. Industry participation was also reported during the Mexican discussions about FoPNL, with a mandatory, biased and disproportional presence of the food industry representatives (105). Food industry representatives had access to Anvisa's technical and political leaders, with much more opportunities than civil society and academia. This helped the food industry present its arguments, lobby and influence the decisions regarding the nutrition labeling regulation, a situation that was observed in other contexts in Brazil (104). Even when the decision for a new FoPNL system was reached, high ranking individuals in Anvisa used the revolving door, which may be a strategic practice for the food industry in the future.

The "coalition management" was used to establish relationships with key opinion leaders, such as influencers, health organizations, and Anvisa's leaders. The establishment of relationships with the media also occurred in order to disseminate the food industry's narrative among journalists and, consequently, to the general population, a strategy that was already reported in previous analysis of the influence of the food industry in Brazil (104). Through the creation of *Rede Rotulagem*, the food industry managed to reach different audiences and to strengthen its voice in the regulatory process, a well-known strategy for corporations to avoid being in the spotlight. This strategy was also used in Colombia, while the FoPNL policy was being discussed in Congress (23). Eleven of the same organizations that were members of *Rede Rotulagem* created another initiative, *Olho na Lupa*, six months before the beginning of the implementation of the regulation, for helping consumers read and understand the food labels, reinforcing the idea that individuals are responsible for their own health. In this way, the food industry puts itself as part of the regulatory process and as defender of Anvisa's regulatory decision.

The "information management" strategy was mainly observed through the studies commissioned by the food industry, with the production and amplification of information that supported its narrative. These studies were not peer-reviewed and were produced by hired consultants or companies related to research, nutrition, design and law. Using that information, the food industry managed to disseminate its arguments related to its support for the free will of individuals, the need for more education and information, the risks of economic losses, the discrediting of WLs, and the superiority of TLLs. That last point was particularly stressed during the beginning of the FoPNL discussions.

Finally, "legal actions" were used once in the beginning of the regulatory process, when an informal request by the food industry to Anvisa was not sufficient to extend the TPS. It was a strategic move since Anvisa had first discussed its preference for WLs. In order to postpone the advance of the regulatory process, the food industry presented a lawsuit and then earned more time. ABPA's request later during the could have turned into another lawsuit against Anvisa if the agency did not agree with the extension of the deadline to present the contributions. A lawsuit was previously used by the food industry to prevent the implementation of a policy focused on childhood marketing restriction in Brazil (23).

It is important to highlight that the FoPNL process was not only influenced by the actions and discourse of the food industry itself, but also by other actors, some of which have closer ties to the companies, and others less so. ABRAN is one example. In February 2018, this association, which had not been part of the WG on nutrition food labeling, sent an adapted version of the Nutri-Score FoPNL as a proposal to Anvisa (**Figure 3**). After the publication of the Anvisa's Preliminary Regulatory Impact Analysis Report, which indicated WLs as the most adequate FoPNL for Brazil, in June 2018, ABRAN requested the agency to reconsider its model, and use instead an adaptation of the Nutri-Score (107). This request was made after the former Ministry of Health, Gilberto Occhi, praised the Nutri-Score model after a trip to Europe, also citing the TLL, both models already discarded by Anvisa at that time. ABRAN is an association that maintains partnerships with the private sector both in the organization of the Brazilian Congress of Nutrology (108) and in the production of scientific materials and that has already been criticized for its CoI situations related to food manufacturers (109). The researcher responsible for the adaptation of the Nutri-Score had CoI: he was lead author of a Danone-funded article, and participated in a Nestlé event for the promotion of growing-up milks (110). He also coordinated a webinar of ILSI

Brasil and is a member of its Scientific Committee–the webinar was focused on the Danone-funded article (111).

Another example of action not taken by the industry itself, but by other organizations and institutions using similar arguments and apparently converging interests, was the case of the Embassy of Italy in Brazil. The connection between the country's official representatives and food companies, especially Ferrero, the Italian transnational manufacturer of confectionery products, are not new. A former advisor of the Ferrero group was a member of Italy's Foreign Relations delegation and responsible for Italy's position against recommendations of WHO on sugar intake in 2015 (112, 113).

Our results are similar to the existing evidence about the use of CPA strategies by the food industry during FoPNL discussions in other countries of the region, such as Uruguay, Colombia, Mexico, Argentina, and the Caribbean (22, 23, 105, 106). This could be explained by the fact that many of the actors included in this study are transnationals (or associations representing the transnational companies) or belong to international organizations, such as ILSI. Considering regional economic blocs, like MERCOSUR, the argument that a county needs harmonization before a country could introduce a FoPNL national policy was used in Argentina to try to delay internal discussions. In Jamaica, as the Caribbean Community (*Comunidad del Caribe*, in Spanish) was debating the adoption of a FoPNL, a local lobby organization representing the manufacturing and ultra-processed food products sectors argued that WLs do not align with the realities of Jamaica's major trade partners, which, together with the use of other CPA strategies, resulted in the rejection of the proposed WLs (106).

Civil society and academia have actively participated in the Brazilian regulatory process on nutrition labeling since its inception with strategic actions that strengthened the process for approval of the FoPNL such as: mobilization campaigns in social media, mass media campaigns and petitions, propositions and participation in public hearings, carrying out FoPNL activities at events with medical societies, at universities, in schools, and communities. Those actors took part in the entire regulatory process, including the TPS, the PCs and meetings with Anvisa's technical and political leaders. These actions were led by Idec and the Alliance for Adequate and Healthy Diets (*Aliança pela Alimentação Adequada e Saudável*, in Portuguese) (114) (**Table 2**). The collaboration of academia was crucial to provide the scientific bases for the process.

The process analyzed here, led by Anvisa, allowed for the participation of civil society, academic and food industry representatives. This is also the case for other instances. Codex Alimentarius and MERCOSUR, for example, are spaces with stimulated and permitted participation of the food industry together with other actors. However, it is important to highlight that this participation is not balanced, with more representatives from the food industry than civil society, which could lead to a bias in the voices heard and influence the final position of countries. This situation is especially worrying because of the importance of these international spaces and their influence on countries. Codex is a program of the Food and Agriculture Organization of the United Nations (FAO) and WHO to set standards and guidelines for food regulation (115). Despite being a recommendation, Codex is usually used by the food industry as an attempt to delay national or regional discussions (23). MERCOSUR is a regional integration space to facilitate trade and investment between its country members (116). Some of the country's representatives are from the economy and trade sector of the government, and not all the countries have civil society representatives actively participating in the process, which means that public health and consumers' rights might not be prioritized during the discussions. Codex and MERCOSUR are both platforms through which the industry gains access to decision-making, which could be at the detriment of public health by establishing weak and corporate-friendly standards and agreements (117).

It is worth mentioning our study's limitations and strengths. We did not use interviews as a way to collect or triangulate information about the policy process. To overcome this gap,

FIGURE 3
Front-of-package nutrition labeling (FoPNL) model proposed by ABRAN. Source: ABRAN.

the data collection included the use of the LAI, besides publicly available information. Furthermore, many of this article's authors have direct involvement in the topic under study as representatives of civil society and investigative journalists, which represent a bias toward public health, rather than economic interests.

This is an original work that brings together the analysis of the CPA and CoI situations and the record of the regulatory process of the approval of a new FoPNL in Brazil. Since Latin America and the Caribbean countries are advancing in FoPNL regulation, this work is especially important to inspire them, document and share learnings and experiences about the food industry interference and possible ways to overcome these barriers. This paper was only possible to be developed because of the existing evidence and documentation of the regulatory process produced and disclosed by the civil society, the academia and the media in Brazil.

The analysis of the regulatory process for the adoption of the new nutrition labeling of packaged foods in Brazil demonstrated various CPA and CoI situations involving the food industry, which had a negative impact in the regulatory process, leading it to an approved FoPNL regulation which was neither aligned with the recommendations of international health organizations, nor with existing independent scientific evidence, nor the region's most recent experiences. The approval of a MG with a flexible NPM and a long adaptation period reflects the requests of the food industry.

In order to have the most adequate FoPNL regulation as possible, it is important to protect the process of the food industry interference by having mechanisms to avoid CoI. In this regard, PAHO recently launched a CoI prevention tool entitled "Prevention and management of CoI in nutrition programs at the national level" is promising (118). It presents a step by step of how governments and health ministries should proceed before establishing a relationship with non-state actors, investigating the actor's alignment, the profile of the interaction, and also the assessment of risks and benefits of the interaction. The implementation of this type of tool would allow greater protection of the political process, so that the primary interest of the policies prevails. It should be used to inspire other countries that are still in the process of formulating and discussing nutrition labeling standards.

Even so, from October 2022 Brazilian consumers will have more explicit information about the high amounts of nutrients of concern for health in food labels, which may help them make healthier food choices and improve health and prevent obesity and NCDs.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Author contributions

LAM, MM, and CMPC: conceptualization. LAM, MM, BKH, and CMPC: methodology. LAM, BKH, JMDP, MGS, and CMPC: writing—original draft preparation. LAM, MM, BKH, JMDP, MGS, APBM, JGC, and CMPC: writing—review and editing. LAM and CMPC: project administration. APBM and JGC: funding acquisition. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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ABSTRACTS

SPANISH

¿Ellos realmente apoyan "tu libertad de elección"? El etiquetado nutricional frontal y la industria de alimentos en Brasil

En el 2020, Brasil aprobó la introducción de un nuevo etiquetado nutricional frontal (ENF) en el formato de lupa después de años de discusión. Actualmente hay una falta de entendimiento de la influencia de la industria de alimentos en ese proceso. Este estudio tuo por objetivo describir la actividad política corporativa (APC) de la industria de alimentos y las situaciones de conflictos de interés, como ocurrido durante el desarrollo y aprobación de un nuevo sistema de ENF en Brasil. Realizamos búsquedas bibliográficas y documentales usando materiales provenientes de las empresas de alimentos, asociaciones de comercio y los grupos frontales involucrados en el proceso regulatorio. Nosotros (1) Colectamos informaciones acerca del contexto de los estudios de caso, (2) colectamos datos de fuentes documentales, y (3) preparamos una síntesis de los resultados y una línea de tiempo de los eventos claves. Durante el proceso regulatorio del ENF en Brasil, la industria de alimentos se opuso a la introducción de las etiquetas de advertencia, un modelo que tuvo apoyo de las autoridades de la salud y fue implementado con suceso en otros países de Latinoamérica. Sin embargo, la industria de alimentos promovió un sistema de etiquetado tipo "semáforo", conocido por ser menos efectivo en guiar a las personas a elegir los alimentos más saludables. Más tarde en el proceso, cuando quedó evidente que su modelo favorito no sería utilizado y que una lupa sería introducida en su lugar, la industria de alimentos discutió acerca del uso de una versión diferente de este modelo de ENF. Descubrimos que la industria de alimentos, durante todo el proceso, estuvo directamente involucrada e influenció el desarrollo del ENF, brindando apoyo técnico, orientando y presionando a los formuladores de políticas. La industria de alimentos también estableció relaciones con una organización no gubernamental de consumidores y sociedades de profesionales en nutrición. La industria de alimentos igualmente produjo y diseminó información apoyando su posición para influir en la opinión pública y en los tomadores de decisiones de alto nivel, y utilizó el sistema legal para retrasar el proceso. El ENF en Brasil no está alineado con las recomendaciones de las organizaciones de salud internacionales ni con las evidencias científicas independientes existentes. El nuevo ENF, tal como se adoptó en Brasil, refleja algunas de las preferencias de la industria; es probable que la influencia de este sector durante el proceso legislativo haya sido fundamental, incluso si su propuesta inicial no fuera adoptada.

Palabras clave: etiquetado frontal, etiquetado nutricional, actividad política corporativa, conflicto de interés, regulación de alimentos.

PORTUGUESE

Eles realmente apoiam "sua liberdade de escolha"? A rotulagem nutricional frontal e a indústria de alimentos no Brasil

Em 2020, o Brasil aprovou a inclusão de uma nova rotulagem nutricional frontal (RNF) no formato de lupa depois de anos de discussão. Atualmente, há pouco entendimento sobre o papel da indústria de alimentos neste processo. Este estudo teve como objetivo descrever a ação política corporativa (APC) da indústria de alimentos e as situações de conflitos de interesse que aconteceram durante o desenvolvimento e a aprovação do novo sistema de RNF no Brasil. Nós realizamos buscas bibliográficas e documentais usando material das indústrias de alimentos, associações comerciais e grupos de fachada envolvidos no processo regulatório. Nós (1) coletamos informações sobre o contexto do estudo de caso, (2) coletamos dados de fontes documentais, e (3) preparamos uma síntese dos resultados e uma linha do tempo com eventos-chave. Durante o processo regulatório de RNF no Brasil, a indústria de alimentos se opôs à introdução de rótulos de advertência, modelo apoiado por autoridades de saúde e implementado com sucesso em outros países da América Latina. A indústria de alimentos promoveu o sistema de semáforo nutricional, conhecido por ser menos efetivo em orientar indivíduos a fazerem escolhas alimentares mais saudáveis. Mais tarde no processo, quando estava evidente que o modelo escolhido pela indústria não seria utilizado, e que a lupa seria selecionada, a indústria de alimentos argumentou pelo uso de uma versão diferente deste modelo de

RNF. Nós encontramos que a indústria de alimentos , durante todo o processo, esteve diretamente envolvida e influenciou o desenvolvimento da RNF, fornecendo apoio técnico, aconselhando e fazendo lobby com formuladores de políticas. A indústria de alimentos também estabeleceu relações com organizações não governamentais de consumidores e sociedades profissionais de nutrição. A indústria de alimentos também produziu e disseminou informações apoiando sua posição a fim de influenciar a opinião pública e tomadores de decisão de alto nível, e usaram o sistema legal para atrasar o processo. A RNF do Brasil não está alinhada com as recomendações de organizações internacionais de saúde ou com alguma evidência científica independente existente. A nova RNF, como adotada no Brasil, reflete algumas das preferências da indústria; é provável que a influência deste setor durante o processo regulatório tenha sido fundamental, mesmo que sua proposta inicial não tenha sido adotada.

Palavras-chave: rotulagem nutricional frontal, rotulagem nutricional, atividade política corporativa, conflito de interesse, regulação de alimentos.

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