



Discovering Consumer Behavior Towards Back-of-Pack Nutrition Labels: A Systematic Literature Review

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Abstract

This systematic literature review aims to examine the impact of back-of-pack (BOP) labels on food manufacturers' practices in the field of consumer behaviour research. The review comprehensively analyses a wide range of articles spanning over two decades to provide an up-to-date and comprehensive analysis of the subject matter. It focuses specifically on how BOP labels affect consumers, food manufacturers' behaviors and practices. The findings highlight that BOP labels conveying intuitive information effectively prompt product reformulation, particularly in reducing unhealthy nutrients such as sodium, sugar, and calories. Voluntary BOP labeling has limited uptake and is often applied to already healthier products. Consumers and food producers' response varies based on label design and enforcement type, suggesting strategic labeling of healthier choices. The review provides valuable insights for future public health research and policymaking efforts, emphasizing the importance of mandatory policies and specific guidance in BOP labels. This research brings novelty by comprehensively examining the impact of back-of-pack (BOP) labeling on consumers and food manufacturers' practices. The findings contribute to the literature by highlighting the differential effects of mandatory and voluntary BOP labeling approaches and offering insights into label design and enforcement types. As per the researcher knowledge there is no available systematic literature review (SLR) specifically focusing on BOP labeling in recent years. Future research should explore the long-term impacts of mandatory versus voluntary BOP labeling on consumer dietary habits and food manufacturers' product reformulation strategies.



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Introduction

Obesity¹ is a global health concern with a BMI of 30 or higher, affecting approximately four million individuals annually.² Since 1980, the global obesity rate has nearly doubled, with projections indicating that by 2030, one in five women and one in seven men will be affected by obesity.³ Obesity is prevalent in all regions, except sub-Saharan Africa and Asia.⁴ The COVID-19 pandemic has exacerbated the obesity crisis worldwide, with a 3% increase between March 2021 and March 2022.⁵ Obesity is a risk factor for severe illness from COVID-19,^{6,7} tripling the likelihood of hospitalization. Research suggests that 30% to 53% of new cases of diabetes in the world wide attributed to obesity.⁸ Obesity also imposes significant economic burdens, with medical costs for individuals with obesity being 30% to 40% higher than those without obesity.⁹

BOP labels provide easily understandable information, enabling consumers to choose healthier options.¹⁰ Over thirty-five countries have adopted any one type of BOP label, ranging from voluntary to mandatory. The existing scientific literature emphasizes the impact of BOPNL on consumer understanding, perceptions, and food purchasing behavior.¹¹ Roberto *et al.*¹² also found that implementing BOP labels encouraged food producers to reformulate their products. However, there is currently a lack of systematic reviews specifically focusing on the responses of food manufacturers, especially those involved in producing pre-packaged foods with BOP labeling.

This systematic review helps to examine the influence of back-of-package (BOP) label designs and enforcement styles on food manufacturers' practices. Its primary goal is to enhance our understanding of how BOP labeling effectively reduces unhealthy food supply nutrients¹³ nutrition labels. Through this comprehensive analysis, the study aims to provide valuable insights into the specific effects of BOP label designs and enforcement strategies on food manufacturers. Ultimately, the findings will contribute to a more nuanced understanding of the effectiveness of BOP labeling in promoting healthier food choices for consumers.¹⁴

The research aims to investigate current strategies used by the global food industry in response to BOPNL. It seeks to understand how BOPNL

influences food manufacturers' decisions on reformulating products for better nutrition and to identify factors that either facilitate or hinder industry engagement with BOPNL and its regulations. Additionally, the study was assessed the effectiveness of BOPNL in promoting healthier consumer choices and propose recommendations to enhance its implementation and impact on food industry practices.

This research paper is organized into distinct sections. Section 2 comprehensively reviews the existing literature concerning the impact of BOP nutrition labeling on the practices of the food industry. In Section 3, the materials and methods employed for this study are meticulously detailed, encompassing the research design, data collection methodologies, and analytical techniques utilized. The subsequent Section 4 intricately presents the obtained results and engages in comprehensive discussions, wherein the implications of these findings are rigorously examined within the broader research context. In conjunction with the conclusion, the paper further delves into the implications of the study's outcomes and acknowledges its limitations, thereby paving the way for potential future research directions. This organizational framework ensures a meticulous exploration of the influence of BOP nutrition labeling on the intricate landscape of food industry practices.

Research Questions

RQ1

What are the current strategies employed by the global food industry in response to back-of-pack nutrition labeling (BOPNL)?

RQ2

How do consumers respond to back-of-pack (BOP) labels that convey intuitive information, specifically examining their impact on consumer choices and preferences in relation to product reformulation, particularly in reducing unhealthy nutrients such as sodium, sugar, and calories?

RQ3

How do mandatory policies for back-of-pack (BOP) labeling influence consumer behavior in terms of product preferences and choices compared to voluntary labeling approaches?

RQ4

What factors contribute to the effectiveness of mandatory policies in guiding consumer decisions in the food sector?

RQ5

How do consumers' responses vary based on design elements and enforcement types of back-of-pack (BOP) labels?

Review of Literature

Definition of Back of Pack Nutrition Label (BOPNL)
A Back-of-Pack (BOP) label refers to the nutritional and ingredient information displayed on the back or side of food packaging.¹⁵ This label typically includes details such as the product's nutritional content (e.g., calories, fat, sugar, and sodium), ingredient list, serving size, and sometimes additional information about allergens and dietary claims. BOP labels are designed to help consumers make informed choices about the products they purchase by providing essential health and nutritional information.^{15,16}

The field of nutrition labeling¹⁷ has gained immense significance in recent years, as consumers^{18,19} become more conscious about their dietary choices and the impact of food on their health.^{20,21} In particular, the nutrition facts label has emerged as a crucial tool in providing essential nutritional information to consumers at the point of purchase.¹³ Nutrition labels typically display important nutritional details, such as calorie content, fat content, sugar levels, and other key information,²² allowing consumers to make informed decisions^{23,24} about the products they purchase. While the nutrition facts panel label system has been widely adopted through many food manufacturers and retailers, there is a growing need to examine its effectiveness and impact on consumer behavior and health outcomes.²⁵ This has led to a substantial body of literature on the subject, but the information available is scattered across various studies and publications. A systematic review of the literature is essential to address this issue and provide a comprehensive understanding of the current state of knowledge. Motivating authors to engage in the systematic review of literature on BOPNL is crucial to advancing our understanding of this field. Conducting a rigorous analysis of existing research, authors contribute to consolidating the available evidence and identifying gaps in knowledge. This

systematic approach allows for a more objective assessment of the effectiveness of BOPNL and its potential implications for public health. Examining the findings from multiple studies, authors identified common themes, trends, and inconsistencies in the literature. This process enables the extraction of valuable insights and the formulation of evidence-based recommendations for policymakers,^{18,19} food manufacturers, and other stakeholders involved in implementing and improving BOPNL systems.

Food Industry and Back of Pack Labelling

The food industry has implemented various practices and strategies in response to BOP nutrition labeling.¹⁴ One prominent approach is reformulation,²⁶ wherein food manufacturers modify the composition of their products to improve their nutritional profile.²⁷ This involves reducing levels of salt, sugar, saturated fats, or trans fats, aligning them with dietary guidelines and label claims.²⁸ Companies invest in research and development to find suitable alternatives that maintain taste, texture, and shelf life while enhancing the healthfulness of their offerings.²⁹ Reformulating products, the food industry aims to provide consumers with healthier options that meet their nutritional needs. Another strategy the food industry employs is portion control.³⁰ Recognizing the impact of portion size on calorie intake, manufacturers have provided clearer guidance on appropriate serving sizes.³¹ This involves adjusting package sizes, introducing portion-specific packaging, or incorporating visual cues on packaging to promote portion awareness. BOP labeling significantly influences food manufacturers' decisions regarding product reformulation to improve nutritional content.³² The presence of BOPNL serves as a visual and easily accessible tool for consumers to evaluate.¹⁴ As a result, food manufacturers recognize the impact of these labels on consumer perceptions and purchasing decisions. To meet the demands of informed consumers and align with evolving dietary guidelines, manufacturers are motivated to reformulate their products and improve their nutritional profiles. BOP labeling acts as a catalyst for food manufacturers to prioritize the reduction of ingredients such as salt,³³ sugar, saturated fats,³⁴ and trans fats³⁵ in their products. The visibility of nutritional information on packaging prompts manufacturers to reconsider their formulations and explore alternative ingredients and manufacturing

processes that reduce the levels of undesirable components.³⁶ Reformulating products to improve their nutritional content, manufacturers aim to align with consumer preferences for healthier options and enhance their brand reputation as providers of

nutritious choices.³² Therefore, the influence of BOP labeling on food manufacturers' decisions regarding reformulation is substantial and drives their efforts to create healthier food offerings.

Table 1: Comparative Analysis of Previous Studies and Novel Contributions of This Study on Consumer Behavior Towards Back-of-Pack Nutrition Labels

Aspect	Previous Studies	Gaps Identified	Novelty Offered by This Study
Scope of Research	Cowburn and Stockley (2005): General consumer understanding and use of BOP labels.	Limited focus on diverse demographic groups and specific purchasing contexts.	Comprehensive analysis covering diverse demographics and various purchasing contexts.
Methodology	Grunert and Wills (2007): Quantitative surveys and experimental designs.	Lack of qualitative insights and real-world observational studies.	Mixed-methods approach including qualitative interviews and real-world observational studies for a holistic understanding.
Consumer Behavior Analysis	Draper <i>et al.</i> (2013): Basic behavior patterns and general attitudes towards nutrition labels.	Insufficient exploration of psychological and social factors influencing label usage.	In-depth analysis of psychological and social factors affecting consumer interaction with nutrition labels.
Impact Assessment	Cecchini and Warin (2016): Impact of labels on consumer choice and health outcomes.	Limited longitudinal studies to assess long-term impact.	Longitudinal approach to evaluate the long-term impact of BOP nutrition labels on consumer behavior and health.
Technological Integration	Sundar and Kardes (2015): Traditional labels with minimal focus on digital or interactive labeling technologies.	Neglect of emerging technologies and their potential to enhance consumer engagement.	Exploration of digital and interactive labeling technologies and their potential to improve consumer engagement.
Policy Implications	Hawley <i>et al.</i> (2013): Recommendations for label design and policy based on limited consumer feedback.	Insufficient consideration of consumer feedback in policy recommendations.	Integration of extensive consumer feedback to inform more effective label design and policy recommendations.

Consumers' confidence in the nutritional information provided on the BOP label is affected by several factors, such as food labelling knowledge,³⁷ how trustworthy they perceive it to be, the level of

transparency, independent authentication, the reputation of the brand, personal experience, education and awareness, adherence to regulations, the layout and appearance of the label, and

consistent behavior. Consumers are more inclined to believe labeling when they are knowledgeable about it and comprehend it, especially if it originates from a credible source.³⁸ Furthermore, confidence can be further enhanced by the implementation of clear and succinct labeling, independent verification by third parties, and adherence to regulatory mandates. Through comprehending these variables, producers and regulators may collaborate to enhance consumer confidence in BOP nutrition labeling, ultimately enabling consumers to make well-informed decisions on their diet and well-being.

Navigating BOP Labeling and Regulatory Challenges in the Food Industry: Key Facilitating and Hindering Factors

The compliance of food products with nutritional regulations in the presence of BOP labeling varies depending on several factors.³⁹ There is a growing emphasis on compliance as food manufacturers recognize the importance of providing accurate and transparent information to consumers. With BOP labeling as a prominent means of conveying nutritional information, manufacturers have increasingly prioritized compliance with nutritional regulations.⁴⁰ However, it is important to note that achieving full compliance across all food products is challenging due to the complexity of regulations, variations in regional requirements, and the diverse nature of the food industry.⁴¹ Small- and medium-sized enterprises face financial constraints that hinder their engagement with BOP labeling, limiting their ability to meet regulatory requirements. Addressing these hindering factors requires regulatory harmonization, clear guidelines, and support mechanisms for smaller businesses to ensure wider industry engagement with BOP labeling and its associated regulations. Collaboration between regulatory bodies, industry stakeholders, and consumer advocacy groups can contribute to developing more effective and feasible labeling practices for the food industry. BOP labeling has shown effectiveness in promoting healthier food choices among consumers. Providing clear and accessible nutritional information, BOP labels enable consumers to make informed decisions about the products they purchase and consume. Research has indicated that individuals who regularly read and understand BOP labels are more likely to choose healthier food options and consider the nutritional content of their choices.

BOP Labels Increases Consumer Awareness

BOP labeling increases consumer awareness of the nutritional composition of food products, helping them identify excessive amounts of ingredients such as salt, sugar, and unhealthy fats.⁴² It serves as a visual cue⁴³ that influence consumer preferences,⁴⁴ encouraging them to select products that align with their dietary goals and preferences. Studies have also shown that BOP labeling contributes to healthier eating habits and improved dietary patterns, particularly when accompanied by educational campaigns⁴⁵ that enhance consumers' understanding of the information provided on the labels.

Embracing BOP Labeling Regulations: Unleashing the Power of SLR in the Food Industry

The systematic review of literature in the field of BOPNL offers an exciting opportunity to contribute to the current knowledge base.⁴⁶ Critically evaluating and synthesizing existing research, authors can provide a comprehensive overview of the effectiveness and impact of BOPNL on consumer behavior and health outcomes. This research is vital in informing future policy decisions, enhancing the design and implementation of BOPNL systems, and ultimately promoting healthier food choices among consumers. The forthcoming systematic review aims to bridge the existing gaps in the literature and shed light on the key factors that influence the effectiveness of BOPNL. Exploring topics such as consumer understanding⁴⁷ and perception of nutrition label,⁴⁸ the impact of label design and format,⁴⁹ and the role of contextual factors, the review has offered valuable insights for both researchers and practitioners in the field. Through this comprehensive analysis, the systematic review will strive to provide evidence-based recommendations to improve the current state of BOPNL systems and contribute to the broader goal of promoting public health through informed dietary choices. The findings of this research was served as a valuable resource for policymakers, industry stakeholders, and consumers, fostering a better understanding of the impact of nutrition labeling and driving positive changes in the food industry.

Materials and Methods

The systematic literature⁵⁰ search followed PRISMA guidelines⁵¹ to identify relevant academic research

articles meeting inclusion criteria for this study. It provides a detailed protocol for the search, ensuring transparency and methodological rigor in the research process.⁵⁰ The protocol outlines specific steps for selecting appropriate studies for inclusion.

Inclusion and Exclusion Criteria for Study Selection in the Systematic Review

This systematic review examined publications on the exposure of BOP labeling, implemented through governmental or non-governmental organizations. It examined outcomes such as changes in product formulation, labeling practices adoption, and nutritional disparities between labelled and unlabelled products. The review included articles published in English and Spanish between January 1, 1984, and June 30, 2023, comparing results with a 2015 meta-analysis. Grey literature sources, such as working papers, were also included to cover a broader range of relevant studies. The systematic review excluded studies that did not align with the research focus,^{39,52,53} including non-nutrient-based BOP labels, product-specific industry claims, health or nutrition claims,⁵⁴ or non-nutritional information like alcohol content claims. Additionally, studies with inaccessible or unavailable abstracts or full texts were excluded. This allowed for a targeted analysis, focusing on relevant studies that specifically examined the impact of nutrient-based BOP labels on food manufacturers' practices.

Information Sources and Search Strategy for Study Identification

The study identification strategy involved a comprehensive search across multiple databases,⁵⁰ focusing on English-language databases like PubMed, Cochrane Library, SCOPUS and Google Scholar. The systematic search was conducted on June 20, 2023, with additional strategic searches on May 9 and May 28, 2023. Search updates were enabled on search engines to ensure ongoing access. Key terms like "Nutrition label," "Nutrition logo," "Back of Pack," "Food label," and "Warning Label" were used in the search query. Outcomes of interest were not included due to their diverse representation in the literature. PubMed:((((("Nutrition label"[Title/Abstract]) OR ("Nutrition logo"[Title/Abstract]))OR ("Back of Pack"[Title/ Abstract])) OR ("Food label"[Title/Abstract])) OR ("Warning Label"[Title/Abstract])). Comprehensive search approach identified relevant studies across multiple

databases, providing diverse literature for systematic review.

Article Review and Study Selection Process

The article screening and selection process involved one investigator searching and screening titles and abstracts of identified studies for relevance to the research topic. A second author conducted a secondary screening, analyzing full-text articles for relevance and eligibility. If discrepancies arose, they convened to resolve and reach a consensus on the inclusion or exclusion of specific studies. A thematic synthesis framework was used to summarize the literature, identify key findings components, and provide a comprehensive understanding of research outcomes.

Data Extraction Process

The reviewed studies examined various back-of-pack (BOP) labels on packaged food and beverage products, including nutrient-specific, traffic light, guideline daily amount (GDA), warning, and hybrid labels. Nutrient-specific labels provide information on specific nutrients, traffic light labels use color-coding, GDA labels display nutrient content, warning labels alert consumers about harmful ingredients, and hybrid labels combine multiple elements. It's crucial to note that BOP labels classification vary due to varying regulatory frameworks and requirements across regions and countries. The review faced limitations due to heterogeneity in outcomes and measurement methods across studies. A quantitative meta-analysis was not feasible, and the review focused on providing a narrative summary of the literature. Although not registered in the International Prospective Register of Systematic Reviews, it adhered to established guidelines and methodologies. The review did not involve research on human subjects, so Institutional Review Board (IRB) approval was not sought.

Results

The study selection process involves importing 12024 from Scopus and other resources for an initial review. After removing duplicates, a title/abstract review was conducted, resulting in 105 publications. Two reviewers independently screened the full text, and four articles were identified through manual searching and reference review. A final list of 84 articles met the review criteria was obtained.

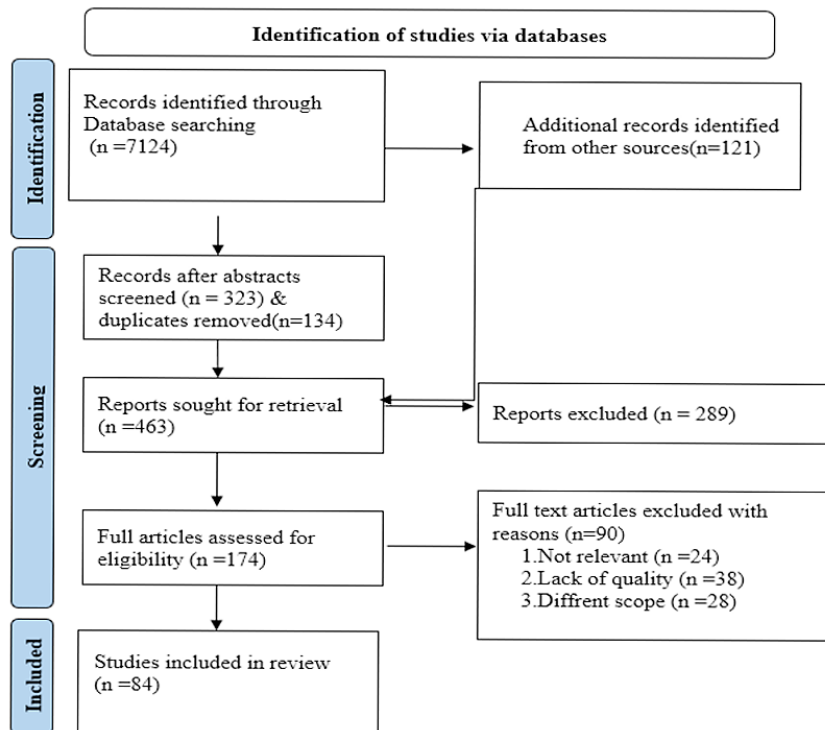


Fig.1: Mapping the SLR on BPO label.

A systematic search of databases yielded 7,124 records, and another 121 records were identified from other sources. After screening the abstracts and removing duplicates, 323 records remained. Out of these, 463 reports were sought for retrieval, but 289 were excluded during the review process. The exclusion reasons included 24 reports deemed irrelevant, 38 reports lacking quality, and 28 reports addressing a different scope. Ultimately, 84 studies were included in the review based on their relevance, quality, and alignment with its scope and research question.

Eight experiments/surveys were conducted, focusing on the inclusion of nutrition facts and serving size labeling on the back of food packaging.^{42,55-60} These studies specifically examined the impact of such labeling on consumer behavior or perception. Additionally, six experiments, surveys included FOP and BOP nutrition facts and serving size labeling.⁶¹⁻⁶³ These studies considered the effects of having nutrition information displayed both on the front and back of the food packaging. It is worth noting that without further context or specific details about the experiments or surveys mentioned, providing more

specific elaboration or insights is challenging. Each study likely had its objectives, methodologies, and findings, which could provide valuable information on how the presentation of nutrition facts and serving size labeling influences consumer choices and understanding.

Three studies^{58,62,63} were conducted to examine consumer perception and interpretation of nutrition facts and serving sizes of labels, specifically emphasising the impact of health framing on consumer perception. These studies aimed to investigate "how serving size influences the nutritional information provided and the resulting anticipated guilt after consuming the product. Furthermore, seven additional studies explored consumer comprehension of proposed or revised nutrition facts labels and serving size details in comparison to the existing ones.^{55,62-65} One study⁶⁶ specifically examined how customers interpreted nutrition facts based on the amount of servings per pack and size".

Five articles examined consumer behaviors about proposed or improved nutrition facts

labeling and serving sizes.^{55,59,62,63,67} These studies investigated the impact of health enclosing on buying intention.⁶¹ They also explored purchasing behaviors before and after introducing recommended serving sizes on nutrition labels. Furthermore, they analyzed

the impact of different levels of detail (fine-grained vs. gross-grained labels) in serving size information on intended and actual consumption, as well as portion size perception.⁶⁸

Table 2 The studies included in the analysis were summarized based on their geographic location, back-of-pack (BOP) label design, and enforcement style

Countries	Number of Research Studies	Type of Back-of-Pack Label	Enforcement Style
Australia	14	Nutrition facts panel table, Guideline Daily Amount and energy icon, Health Star Rating, Pick the Tick	Mandatory
New Zealand	12	Nutrition label with serving size, Guideline Daily Amount and energy icon, Health Star Rating, Pick the Tick	Voluntary
Europe	8	BOP nutrition specific label, Guideline Daily Amount, and energy icon, Nutrient-specific, Traffic Light, Warning Labels	Mandatory and Voluntary
Canada	9	Guideline Daily Amount and energy icon, Nutrient-specific	Voluntary
Iran	4	Nutrient-specific	Mandatory
Indonesia	5	Health choice logo, The information displayed on product labels must be written or printed using the Indonesian language, Arabic numerals, and Latin alphabet.	Voluntary
Malaysia	5	Nutrition Claim, Dater Marking, Nutrition information	Mandatory
Philippines	7	Principle Display Panel.	Mandatory
Singapore	6	Nutrition Information Panel, ingredient listing, food additives labeling, and halal labeling.	Mandatory
Vietnam	3	Nutrition Facts, Ingredient Listing, Food Additives Labeling, and Genetically modified organic food labeling,	Mandatory and voluntary
Thailand	4	Thai Quality Mark, Organic Labeling, Halal Labeling, and Low-Sodium or Low-Sugar Labels	Voluntary
South America	3	Nutrient-specific	Mandatory
Other Countries	3	Guideline Daily Amount and energy icon, Nutrient-specific BOP labels.	Varies (Mandatory and Voluntary)

Table 2 provides an overview of different countries, their respective approaches to back-of-pack labeling on food products, and the number of research studies conducted in each country. It also includes information on the back-of-pack label types and the enforcement style adopted in the respective countries. Table 1 displays the study sample's geographic distribution and label designs. Most

studies focused on industry responses in Australia (n=14) and New Zealand (12), followed via South America (3) and Europe (8). However, there is a lack of literature on industry practices in other regions. The study sample included ten countries and 6 different label designs, with these countries and labels being the primary focus of analysis.

Table 3: Types of BOP nutrition labels

Type of BOP Label	Label Image	Country	Enforcement Style	Enforcement Institution																											
Guideline Daily Amount	<p>Each 40g serving contains Calories 112 6% Sugars 7g 8% Fat 1.5g 2% Saturates 0.3g 1% Salt 0.5g 8% of an adult's guideline daily amount</p>	Australia	Voluntary	Food Standards Australia New Zealand																											
Health Star Rating	<p>HEALTH STAR RATING 4.5 ENERGY 1540kJ SAT FAT 0.6g LOW SUGARS 2.5g LOW SODIUM 230mg FIBRE 8.1g PER 100g</p>	New Zealand	Voluntary	Ministry for Primary Industries																											
Pick the Tick		Australia	Voluntary	National Heart Foundation																											
Nutrient-specific	<p>Nutrition information</p> <table border="1"> <thead> <tr> <th></th> <th>Per 100 g</th> <th>%Reference Intake, (n)</th> </tr> </thead> <tbody> <tr> <td>Energy</td> <td>469.2 kJ / 112 kcal</td> <td>9%</td> </tr> <tr> <td>Fat</td> <td>1.5 g</td> <td>3%</td> </tr> <tr> <td>Of which Saturates</td> <td>0.3 g</td> <td>1%</td> </tr> <tr> <td>Carbohydrate</td> <td>7.0 g</td> <td>14%</td> </tr> <tr> <td>Of which Sugars</td> <td>2.5 g</td> <td>5%</td> </tr> <tr> <td>Protein</td> <td>1.2 g</td> <td>2%</td> </tr> <tr> <td>Salt</td> <td>0.5 g</td> <td>10%</td> </tr> <tr> <td>Vitamin C</td> <td>1.4 mg</td> <td>3%</td> </tr> </tbody> </table> <p><small>Small text: Salt content is representative due to the presence of naturally occurring sodium. Reference value of an average adult (8400 kJ / 2000 kcal). NUTRIENT INTAKE: Reference Intake (RI) 100%. Energy Intake: 112 kcal (469 kJ). Fat: 1.5g (3%). Saturates: 0.3g (1%). Carbohydrate: 7.0g (14%). Sugars: 2.5g (5%). Protein: 1.2g (2%). Salt: 0.5g (10%). Vitamin C: 1.4mg (3%).</small></p>		Per 100 g	%Reference Intake, (n)	Energy	469.2 kJ / 112 kcal	9%	Fat	1.5 g	3%	Of which Saturates	0.3 g	1%	Carbohydrate	7.0 g	14%	Of which Sugars	2.5 g	5%	Protein	1.2 g	2%	Salt	0.5 g	10%	Vitamin C	1.4 mg	3%	Europe	Mandatory	European Union institutions
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Energy Icon	<p>THE MORE STARS THE BETTER ENERGY RATING 458 kJ / 109 kcal</p>	Australia	Voluntary	Food Standards Australia New Zealand																											
Nutrition fact label	<p>Nutrition Facts</p> <p>Check: Energy, Fat, Sugar, Protein</p>	India	Mandatory	Food safety and standards authority of India.																											
Traffic Light	<p>per 30g cereal: 16 ENERGY 460kJ / 110kcal / 6% 0.7g FAT LOW 2% 0.1g SATURATES LOW 1% 5.1g SUGARS HIGH 6% 0.2g SALT MED 4% % of an adult's reference intake. Typical values per 100g: Energy 1530kJ/360kcal</p>	Europe	Mandatory	European Union institutions																											
Warning Labels	<p>EXCESO CALORIAS EXCESO AZÚCARES SECRETARÍA DE SALUD CONTIENE EDULCORANTES NO NUTRICIONALES E HIGIENIZANTES CONTIENE CAJ EN LA VITAN ESTERIL</p>	Europe	Mandatory	European Union institutions																											
Nutrient-specific	<p>Nutrition Facts</p> <p>Energy: 441 kcal Fat: 2.5g Sugars: 1.5g Sodium: 1.5g</p>	Iran	Mandatory	Ministry of Health and Medical Education																											
Nutrient-specific	<p>NUTRIÇÃO ENERGÉTICA</p> <p>Energy: 441 kcal Fat: 2.5g Sugars: 1.5g Sodium: 1.5g</p>	South America	Mandatory	Varies by country																											

Table 4. Review of consumer behavior towards back of pack nutrition label information: key findings and implications

Author and Year	Food Type	Label Type	Perception and Interpretation	Behavior	Implication
55	Chocolate chip, cookies, crackers, Lasagne	BOP nutrition label with SS	Consumers may perceive larger serving sizes as a recommendation or norm, leading to increased consumption.	As compared to the current label, the introduction of a modified (larger amount) label had notable effects on consumer behavior. In the case of cookies, participants served themselves 41% more cookies when presented with the modified label. Similarly, regarding cheese crackers, the modified label led participants to serve 27% more to another person. Furthermore, the modified label influenced consumers to purchase 43% more lasagne for others and divided the lasagne into 22% larger slices. These findings suggest that the presentation of serving size information on food labels can significantly impact consumer choices and portion sizes, potentially leading to increased consumption or larger portions when a larger amount is indicated on the label.	Larger serving sizes on labels can lead to increased consumption and portion sizes. Consumers may misinterpret larger serving sizes as a recommendation or norm. Food manufacturers may use larger serving sizes to influence consumer behavior. Regulators should consider standardizing serving sizes and labeling to promote healthier choices. Public health campaigns should educate consumers about proper portion sizes and label interpretation.
69	Processed Snacks	Nutrition Facts	Consumers perceived the snacks as unhealthy	Decreased snack consumption	Clear nutrition information can influence healthier choices

63	Chili, Cheese, Rice Snacks, Sweet, Macroni, pizza, pasta, Soup and Frozen Fish.	FOP and BOP nutrition facts including SS	Including larger serving sizes resulted in lower health perc -ptions in consumers, but it was more representative of the depicted serving size. When larger serving sizes were presented, consumers perceived the foods as less healthy and estimated that their portion contained approximately 18% more calories. Additionally, they anticipated experiencing more guilt associated with consumption.*	Consumers exposed to larger serving size ate less confectionery compared to those presented with current serving size.	"Potential Solution to Overeating and Improving Public Health. Offering consumers easily comprehensible and precise information on all foods consumed in various settings, the likelihood of overeating could be diminished. This reduced caloric intake, facilitated by altering health perceptions or fostering a sense of guilt, can potentially enhance public health. Updating serving sizes on nutrition labels emerges as a viable strategy to promote healthier dietary selections and contribute to mitigating the obesity epidemic in the United States".
70	Cereals, Yogurt and Beverages	Traffic Light	Consumers easily interpreted healthiness	Increased purchase of "green" options	Traffic light labels aid in making informed beverage choices
65	Cakes and Chocolate milk	BOP nutrition label with SS	Per container nutrition labels are more effective in accurately identifying energy content than per serving labels**. The display format of serving size showed no association with correct energy estimation. Most (62%) preferred serving size formats that included servings per package.	NA	"Per container and dual-column formats improved comprehension of energy content compared to per serving labels, potentially impacting individuals' perceptions of food health and reducing consumption of discretionary foods. However, the same information's font size and display order did not influence accurate energy estimation".
5757	Crisps and Frozen meals	BOP nutrition facts	The single-serving per container format consistently achieved higher	NA	"Using a single-serving or dual-column labeling approach is recommended for products that contain 2 servings but are

<p>typically consumed in a single eating occasion”.</p>	<p>scores on most outcome measures.</p>	<p>Minimal change in behavior</p>
<p>Improved education needed for GDAs to impact behavior</p>	<p>Consumers struggled to understand</p>	<p>Guideline Daily</p>
<p>“The limited accuracy is primarily due to a lack of consideration for multiple servings rather than an overwhelming number of columns to evaluate or inadequate numeracy skills”.</p>	<p>Across all age groups, accuracy in identifying the healthiest product was relatively low, ranging from 50% to 55%. Numeracy, nutrition knowledge, and self-reported food label use supported accuracy but did not affect the differences in accuracy observed across age groups. Accuracy was improved when detailed instructions were provided, even in challenging situations where the information provided on a per serving and package basis was inconsistent. However, accuracy was compromised in individuals with lower numeracy skills, regardless of age, and older adults with poorer attention skills and when fewer instructions were given.</p>	<p>BOP nutrition</p>
<p>71</p>	<p>Frozen Meals, cereal, milk products, confectionery’s</p>	<p>72</p>
<p>Frozen Pizza and Snacks</p>	<p>Frozen Pizza and Snacks</p>	<p>Frozen Pizza and Snacks</p>

73	Cereal	Multiple Claims	Consumers were more likely to perceive as healthy	Increased purchase intention	Multiple claims can influence perception and purchase intent
74	Dairy Products	Front-of-Pack	Consumers focused on prominent claims	Shift towards healthier options	Prominent claims can drive healthier product choices
61	Veg soup and frozen pizza	FOP and BOP nutrition facts labels	The manipulation of health framing effectively decreased feelings of guilt regarding consumption for consumers with a higher level of concern about their diet. Individuals with a greater focus on their dietary choices were more influenced through the health framing technique.	The dietary concern influenced both purchase intention and guilt, with guilt as a mediator between health framing and purchase intention for participants with a high level of dietary concern.	“Prevention-focused health communication led participants to choose health-framed products, while emphasizing calorie consumption influenced their preference for products with listed calorie counts. When participants were encouraged to be diligent about their diet and cautious of health framing, they adjusted for serving sizes and selected products with the lowest negative nutrients”.
58	Ice cream container bulk	Nutrition facts panel label with one serve	Participants demonstrated a poor understanding of nutrition fact information, often miscalculating calorie content in assuming it applied to the entire container rather than per serving. However, participants with healthier dietary habits exhibited better comprehension and accuracy in interpreting the information.	NA	“To enhance consumers' comprehension of serving sizes, implementing dual column labels, which provide nutritional information per serving and for the entire pack, can be beneficial. Additionally, schools are important in educating students about the necessary skills to understand food labels and make informed dietary choices.

Note: FOP-Front of pack label; BOP -Back of pack label; SS-Serving size;* The mean values showed significant differences compared to comparator/control condition (p < 0.05);**,***p<0.01.

In Australia, there have been 14 research studies conducted in the field of back-of-pack labeling. The country uses three labels: Guideline Daily Amount, Energy icon, Health Star Rating and Pick the Tick. These labels provide consumers with information about the nutritional content and healthiness of the products. Importantly, these labels are mandatory, indicating that food manufacturers are legally required to include them on their packaging. This enforcement style ensures that consumers have consistent and standardized information to make informed choices about the products they purchase.

In contrast, New Zealand has conducted twelve research studies in back-of-pack labeling. Like Australia, they employ the Guideline Daily Amount and energy icon, Health Star Rating, and Pick the Tick labels. However, in New Zealand, the use of these labels is voluntary, meaning that food manufacturers have the option to include them on their packaging. While this approach provides flexibility to manufacturers, it also creates a potential inconsistency in providing nutritional information to consumers. Consumers in New Zealand need to be aware of this voluntary nature and carefully evaluate the products they purchase.

Moving on to Europe, eight research studies have been conducted, and the region adopts a more diverse approach to back-of-pack labeling. In addition to the Guideline Daily Amount and energy icon, Europe utilizes nutrient-specific, traffic light, and warning labels. Nutrient-specific labels provide information about specific nutrients such as fat, sugar, and salt content. While some European countries have made these labeling types mandatory, others have made them voluntary. This variation in enforcement style within the region might lead to differing consistency levels in providing nutritional information across different European countries. The remaining countries in the table, including Canada, Iran, South America, and Other Countries, have conducted fewer research studies. They employ a combination of Guideline Daily Amount and energy icon, nutrient-specific labels, and sometimes additional label types. The enforcement styles vary among these countries, with some opting for mandatory labeling and others adopting a voluntary approach.

Table 3 summarises nutrition labelling schemes implemented and enforced in different countries, focusing on the country and specific labeling designs. The analysis includes four label designs in Australia: Guideline Daily Amount, Health Star Rating, and Pick the Tick. Voluntary labeling schemes were evaluated in studies conducted in Australia, New Zealand, Europe, and Canada. On the other

hand, mandatory nutrient-specific labelling was examined in Iran and South American countries. It is worth noting that positive endorsement labels were predominantly proposed through non-governmental organizations (NGOs) or food companies rather than governmental institutions. Table 2 presents an overview of nutrition labelling initiatives across various countries, highlighting the diverse approaches taken regarding labeling designs and enforcement. The inclusion of voluntary and mandatory schemes and the distinction between governmental and non-governmental endorsements provide a comprehensive view of the different strategies adopted to promote healthier food choices through nutrition labeling. The literature on BOP labeling primarily focuses on product reformulation and uptake, with a smaller number investigating nutritional comparisons between labelled and unlabelled products. Since 2011, there has been a growing interest in measuring the effect of BOP labeling on food manufacturers' practices, with a significant increase in studies exploring its impact on the food environment. This highlights the growing emphasis on understanding the effects of BOP labeling and its implications.

Table 4 provides valuable insights into the effects of food labeling on consumer perception, behavior, and implications. It highlights the significance of serving size information and its impact on portion sizes,⁷⁵ consumption,⁷⁶ and guilt associated with food choices. Larger serving sizes indicated on labels increased portion sizes and consumption, while smaller serving sizes improved comprehension and reduced confectionery intake.^{42,77} Additionally, clear nutrition information and health framing techniques influenced consumer perceptions of healthiness,⁷⁸ purchase intentions,⁷³ and healthier options. These findings emphasize the importance of accurate and easily understandable food labeling in promoting healthier dietary choices and mitigating the obesity epidemic.⁷⁹ The studies also underscore the role of education, particularly in schools, in improving consumer understanding of nutrition facts^{63,66,80-82} and serving sizes.^{55,59,61,67} Dual column labels, providing information per serving and for the entire pack, were found to enhance comprehension and help consumers better understand appropriate serving sizes. The research suggests that updating serving sizes on nutrition labels, adopting clear labeling formats, and promoting nutritional education can contribute to healthier dietary selections and improve public health outcomes. These findings have implications for policymakers, food manufacturers, and educators in shaping effective food labeling strategies and fostering informed decision-making among consumers.

Table 5. Comparative Analysis of Back-of-Pack Nutrition Labeling Studies: Food Types, Label Types, Methodologies, and Variables Examined

Study	Food Type	Label Type	Methodology	Data Source	Variables Examined	Strengths
Dallas et al., 2015	Chocolate chip, cookies, etc.	BOP label with serving size	Experimental study	Laboratory setting	Consumer behavior, portion sizes, food choices	Notable effects on consumer behavior
Cooper et al., 2022	Processed snacks	Nutrition Facts	Perception study	Online survey	Consumer perceptions, snack consumption	Clear influence of nutrition information on healthier choices
Hydock et al., 2016	Various	FOP and BOP labels with serving sizes	Experimental study	Laboratory setting	Health perceptions, calorie estimation, guilt, food consumption	Offered potential solution to overeating and public health improvement
Riesenberget al., 2022	Cereals, yogurt, beverages	Traffic Light	Perception study	Online survey	Consumer interpretation, purchase behavior	Easily interpretable traffic light labels
Jones et al., 2016	Cakes, chocolate milk	BOP label with serving size	Experimental study	Laboratory setting	Energy content estimation, label preferences	Improved comprehension with per container and dual-column formats
Lando and Lo, 2013	Crisps, frozen meals	BOP nutrition facts	Experimental study	Laboratory setting	Outcome measures related to labeling formats	Recommended labeling approach for 2-serving products
Grunert, 2012	Frozen meals, cereal, etc.	Guideline Daily Allowances	Perception study	Online survey	Consumer understanding, behavior change	Highlighted the need for improved education on GDAs

Miller <i>et al.</i> , 2017	Frozen pizza, snacks	BOP nutrition label	Perception and behavior study	Online survey, experimental study	Accuracy in identifying healthiest product, factors affecting accuracy	Provided insights into and factors accuracy influencing it
Chopra <i>et al.</i> , 2021	Cereal	Multiple claims	Perception and purchase intent study	Online survey	Consumer perception, purchase intention	Influence of multiple claims on perception and purchase intent
Dominick <i>et al.</i> , 2018	Dairy products	Front-of-Pack (FOP)	Experimental study	Laboratory setting	Consumer focus, product choices	Impact of prominent claims on healthier choices
Mohr <i>et al.</i> , 2012	Vegetable soup, frozen pizza	FOP and BOP nutrition facts	Experimental study	Laboratory setting	Health framing, guilt, dietary concern, purchase intention	Influence of health framing and calorie information on product choices
Persoskie <i>et al.</i> , 2017	Ice cream container bulk	Nutrition Facts panel label	Perception study	Online survey	Comprehension of serving sizes, education	

Table 5 provides an overview of relevant studies on back-of-pack (BOP) nutrition labeling. The studies employ various research methodologies, including experimental studies, perception studies, and online surveys. The sample sizes and data sources used vary across the studies, indicating a range of participant populations and data collection methods. The variables examined in the studies include consumer behavior,⁸³ portion sizes, food choices, health perceptions, calorie estimation, guilt, purchase behavior, energy content estimation, label preferences, comprehension, accuracy, perception, and purchase intention. The strengths identified in the studies include the notable effects of modified labels on consumer behavior, the clear influence of nutrition information on healthier choices, the potential solution to overeating and public health improvement through serving size adjustments, easily interpretable traffic light labels, improved comprehension with per container and dual-column label formats, and insights into accuracy and factors influencing it. The table offers a comprehensive overview of the research conducted on BOP nutrition labeling, highlighting the diverse range of topics, methodologies, and findings. Researchers can refer to this table to gain insights into the existing literature, identify gaps, and inform future studies in this field.

Discussions

Table 2 and 3 provides a comprehensive overview of various types of back-of-pack (BOP) labels, their corresponding images, countries of implementation, enforcement styles, and the institutions responsible for their enforcement. This discussion will delve into key points raised from the results section, emphasizing the significance of BOP labels in promoting consumer awareness and healthy food choices. In the same way, Der Horst *et al.*⁴² says that Australia and New Zealand employ voluntary BOP labels such as the "Guideline Daily Amount," "Health Star Rating," and "Pick the Tick." These labels allow food manufacturers to voluntarily provide information about their products' nutritional content and healthiness. The voluntary nature of these labels reflects a cooperative approach between regulatory bodies and food industry stakeholders. It encourages companies to proactively engage in promoting healthier options and assists consumers in making informed choices.

The involvement of organizations like the National Heart Foundation (in the case of "Pick the Tick") further reinforces the credibility and trustworthiness of these voluntary labels. European countries adopt a mandatory approach to BOP labelling, as exemplified via labels such as "Nutrient-specific," "Traffic Light," and "Warning Labels." European Union institutions enforce these labels to ensure consistency and standardized information across member states. Mandatory BOP labels are powerful tools to educate consumers about the nutritional composition and potential health risks associated with specific products. The "Nutrient-specific" label provides comprehensive information about various nutrients.

In contrast, the "Traffic Light" and "Warning Labels" employ colour-coding and symbols to indicate the healthiness or potential health concerns of a product. Such mandatory labelling systems enhance public health by enabling consumers to make informed choices and encouraging the food industry to reformulate products to meet healthier standards. Table 2 highlights variations in BOP labeling practices outside Europe and Australia/New Zealand. For instance, Iran and South America enforce mandatory nutrient-specific labeling, with the Ministry of Health and Medical Education overseeing enforcement in Iran. In contrast, enforcement in South America varies by country. These variations indicate that different regions and countries adapt BOP labeling strategies to suit their cultural, dietary, and regulatory contexts. Despite the differences, the underlying goal remains to provide consumers with essential nutritional information and foster healthier food choices.

Jones *et al.*, explored that serving size about BOP label not focused on individual behaviour. Table 2 identifies the institutions responsible for enforcing BOP labels in each country. For example, Food Standards Australia New Zealand and the Ministry for Primary Industries oversee enforcement in Australia and New Zealand. Similarly, the European Union institutions enforce BOP labels across member states. The presence of dedicated enforcement institutions ensures compliance with labeling regulations, monitors adherence to established standards, and facilitates the consistency and accuracy of information provided on BOP labels.

The comprehensive overview presented in Table 4 sheds light on the extensive research conducted on back-of-pack (BOP) nutrition labeling. The studies included in the table employ diverse research methodologies, such as experimental studies, perception studies, and online surveys. This variety of approaches reflects the researchers' efforts to explore different aspects of BOP nutrition labeling and its impact on consumer behavior.

One of the notable strengths identified in these studies is the significant influence of modified labels on consumer behavior. These findings underscore the importance of providing clear and easily interpretable nutrition information to empower consumers in making healthier choices. The potential for overeating reduction and improvement in public health outcomes through serving size adjustments is another promising aspect highlighted in the literature. By raising awareness about appropriate portion sizes, BOP nutrition labeling can contribute to addressing the issue of excessive food consumption. The inclusion of traffic light labels in some studies is another positive development. These labels offer a simple and intuitive way for consumers to assess the nutritional quality of a food item.

The findings suggest that traffic light labels can effectively guide consumers towards healthier options, supporting public health initiatives aimed at reducing the prevalence of diet-related diseases. Additionally, the research reveals valuable insights into label comprehension. The use of per container and dual-column label formats enhances consumers' understanding of the nutritional content, promoting more informed food choices. This finding suggests that such label formats should be encouraged in BOP nutrition labeling regulations or guidelines. The research also sheds light on the accuracy of consumers' calorie estimation. Understanding the factors that influence calorie estimation can help inform strategies to improve the effectiveness of BOP nutrition labels. By addressing the gaps in consumer knowledge and providing accurate information, these labels can contribute to more informed decision-making.

While Table 5 provides a comprehensive overview of the existing literature, it also reveals some gaps in research. For instance, certain variables related to BOP nutrition labeling, such as socio-

economic factors, cultural influences, and the impact on vulnerable populations, may require further investigation. Future studies could focus on these areas to provide a more nuanced understanding of the impact of BOP nutrition labeling across different demographics. In conclusion, the diverse range of topics, methodologies, and findings presented in Table 5 demonstrate the considerable research conducted on BOP nutrition labeling. The strengths identified in the studies highlight the potential of modified labels, appropriate portion sizes, traffic light labels, and label formats to positively influence consumer behavior and improve public health outcomes. The insights gained from these studies can inform policymakers, health professionals, and researchers in developing effective strategies to enhance the impact of BOP nutrition labeling and contribute to healthier food choices.

Conclusion

This comprehensive systematic review evaluated the influence of back-of-pack (BOP) nutrition labeling on food industry practices. The findings of this study shed light on the impact of BOP labels on product reformulation, compliance with nutritional regulations, and food manufacturers' response to labeling initiatives. The review encompassed 84 relevant articles published between 1997 and 2023, providing a broad and diverse range of perspectives on BOP labeling. The results indicate that BOP labels conveying intuitive information effectively encourage product reformulation, particularly in reducing unhealthy nutrients such as sodium, sugar, and calories. These labels provide consumers with easily understandable information, enabling them to make informed decisions and choose healthier options. On the other hand, labels with numerical information lacking specific guidance had minimal impact, suggesting the importance of clear and intuitive labeling formats.

Mandatory policies demonstrated more consistent effects on product reformulation than voluntary approaches. Voluntary BOP labeling saw limited uptake and tended to be applied to already healthier products, potentially limiting its impact on overall dietary patterns. Therefore, the study highlights the importance of mandatory regulations to ensure widespread implementation and consistency across the food industry. Food manufacturers' responses to BOP labeling varied depending on the design

and enforcement type. While some manufacturers embraced the labeling initiatives and proactively reformulated their products, others strategically labelled healthier choices to portray their products more favourably. This underscores the need for ongoing monitoring and enforcement to ensure accurate and transparent labeling practices.

This systematic review highlights the potential of BOP label implementation in reducing nutrients of concern, but food manufacturers employ strategic practices to navigate labeling requirements and maintain market share. It calls for continuous evaluation and refinement of labeling policies to address potential loopholes and promote healthier food choices. The review's limitations include heterogeneity in outcomes and measurement methods, and its focus on studies conducted in Australia, New Zealand, Europe, Canada, Iran, and South America. Future research should explore additional aspects of BOP labeling, such as consumer understanding, perceptions, and food purchasing behavior. Further investigation into factors influencing food industry engagement with BOP labeling and its regulations is warranted. Continuous evaluation of the effectiveness of BOP labeling in promoting healthier food choices among consumers is essential for refining and improving labeling strategies. The recommendations derived from this review can guide future public health research and inform policymaking efforts to optimize the benefits of BOP labels for obesity prevention and improved public health outcomes.

In conclusion, the findings from these studies collectively underscore the significant impact of food labeling on consumer perception, behavior, and implications. Clear and accurate serving size information, transparent nutrition facts, and health framing techniques can positively influence consumer choices and promote healthier dietary decisions. Education and informative labeling are pivotal in empowering consumers to make informed choices and contribute to public health improvement. Our systematic literature review sheds light on several key aspects of back-of-pack nutrition labeling (BOPNL) within the global food industry. The current strategies employed by the industry (RQ1) include a mix of voluntary and mandatory labeling, with a significant focus on intuitive and easily interpretable information to guide consumer choices. Consumers

generally respond positively to intuitive BOP labels (RQ2), which have been shown to influence their preferences and drive product reformulation efforts aimed at reducing unhealthy nutrients such as sodium, sugar, and calories. Comparing mandatory and voluntary labeling approaches (RQ3), our findings indicate that mandatory policies have a more pronounced impact on consumer behavior, leading to healthier product choices. The effectiveness of these mandatory policies (RQ4) is largely attributed to factors such as clear label design, consistent enforcement, and comprehensive public education campaigns. Furthermore, consumer responses vary significantly based on the design elements and enforcement types of BOP labels (RQ5), highlighting the importance of user-centered design and robust regulatory frameworks to enhance the efficacy of nutrition labeling in promoting healthier eating habits.

Implications for Policy Makers, Academician and Marketers

Policy makers should consider the findings of this review when developing and implementing BOP labeling regulations. The study suggests that mandatory labeling policies are more effective than voluntary approaches in driving product reformulation. Therefore, policymakers should consider enacting mandatory regulations to ensure widespread compliance and consistent implementation across the food industry. Clear and intuitive labeling formats are crucial for maximizing the impact of BOP labels. Policy makers should prioritize the development of standardized labeling formats that convey intuitive information to consumers. Labels with numerical information alone do not significantly affect consumer behavior, emphasizing the need for labels that provide specific guidance and are easy to understand. Continuous evaluation and refinement of labeling policies are necessary. Policy makers should establish mechanisms for monitoring and enforcing compliance with BOP labeling regulations. This includes addressing potential loopholes and strategic practices employed by food manufacturers to ensure accurate and transparent labeling practices.

Academicians enhance their understanding of BOP labeling via conducting diverse studies on consumer perceptions, food purchasing behavior, and industry engagement factors. This review includes studies from various countries but has

limited generalizability. Academic research can also evaluate the effectiveness of BOP labeling over time in continuously assessing its impact on product reformulation and consumer choices, enabling refinement and improvement of labeling strategies. Food marketers prioritize BOP labeling to influence consumer choices and preferences. Clear, intuitive BOP labels provide easily understandable information, making them more appealing to health-conscious consumers. Transparency and accuracy are crucial for building consumer trust. Marketers should align their practices with regulatory requirements and provide accurate information. Avoid strategic labeling practices that erode consumer trust and undermine BOP labeling effectiveness. Staying informed about evolving regulations and requirements allows marketers to adapt their product formulations and labeling strategies to meet consumer demands for healthier choices and maintain a competitive edge in the market.

Practical Implications

Our research provides actionable insights for the food industry, policymakers, and public health practitioners. It highlights the importance of intuitive and clear BOP label designs to enhance consumer understanding and inform healthier purchasing decisions. The comparison of mandatory versus voluntary labeling underscores the need for robust regulatory frameworks to ensure consistent and reliable nutritional information. Additionally, the study offers guidelines for effective label design and enforcement strategies, as well as the potential of digital and interactive labeling technologies to engage consumers. These findings support the development of policies and industry practices that promote healthier dietary choices, ultimately contributing to better public health outcomes. We believe these practical contributions will facilitate the implementation of more effective BOP nutrition labeling strategies.

Limitations and Future Directions

The review's limitations include its focus on English and Spanish articles, potentially excluding relevant studies in other languages, and its time up to 2023. The heterogeneity in study designs, methodologies, and outcomes limited the ability

to conduct a quantitative meta-analysis, and the narrative summary approach used may have resulted in a less rigorous synthesis of literature. Additionally, the review primarily focused on food manufacturers' responses to BOP labeling, overlooking the perspectives of other stakeholders like retailers, policymakers, and consumers. Future research should include studies in languages other than English and Spanish to provide a global representation of the influence of BOP labeling on food industry practices. Updating the review with recent studies can capture emerging trends and developments in BOP labeling and its impact on food manufacturers. Meta-analysis provides robust evidence on BOP labelling's influence. Investigating stakeholders like retailers, policymakers, and consumers can offer a holistic understanding of challenges and opportunities associated with BOP labeling. Exploring the long-term effects of BOP labeling on consumer behavior, health outcomes, and the food environment can help better understand its sustainability and effectiveness in promoting healthier food choices.

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