Framing the Complex Interplay of Ultra-Processed Foods, Nutrition Labeling, and Consumer Response: A Systematic Review

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Abstract. *In recent decades, rising rates of obesity and diet-related chronic diseases have turned consumer food choices into a central public health issue. Increasing evidence identifies ultra-processed foods (UPFs) as a major driver of this trend, raising concerns about how consumers perceive, select, and integrate these products into their daily diets. In response, governments and international institutions have introduced a range of policy tools aiming to influence consumer decision-making-such as Front-of-Pack Nutritional Labels (FOPLs), food processing classification systems (such as NOVA), marketing restrictions, and product reformulations intended to steer choices toward healthier options. Despite recent expansion, research on consumer behavior within the UPF field remains fragmented. While many studies examine health effects or nutrient composition, fewer explore how consumers interpret food processing information, react to labelling systems, or internalize policy interventions that frame UPFs as problematic. This study conducts a systematic literature review spanning 2000–2026, leveraging PRISMA methodology. A total of 297 scientific articles were identified through Web-of-Science and Scopus and analyzed to map consumer-oriented research trends. Results reveal a substantial and accelerating increase in publications and identify major sequential research streams: (i) consumer perceptions of food processing and health risk; (ii) behavioral responses to FOPLs; (iii) public debates on NOVA and nutrient profiling systems; and (iv) policy interventions shaping everyday food environments. Finally, it outlines future research directions to strengthen the conceptual coherence and policy relevance of the UPF field.*

1. Framing of the research

In recent decades, obesity and diet-related chronic diseases have become major global public health concerns. Numerous studies link the consumption of ultra-processed foods to adverse health outcomes such as obesity, type 2 diabetes, cardiovascular disease and premature mortality (Monteiro et al., 2013; Elizabeth et al., 2020; Pagliai et al., 2021). This epidemiological shift reflects a broader nutritional transition driven by the global expansion of industrialized food systems, the restructuring of retail distribution, and the growing availability of packaged and UPFs. Within this context, the UPFs—formalized through the NOVA classification—have gained prominence by reframing dietary quality not solely in terms of nutrient intake, but as a function of the degree and purpose of industrial processing. UPF attributes confer convenience, affordability, and long shelf life, but at the cost of diminished nutritional integrity and potential impacts on appetite regulation, satiety, and metabolic health. As a consequence, increasing attention has been devoted to policy tools aimed at improving the food environment and guiding healthier and more informed consumer choices, particularly FOPL systems (Julia & Hercberg, 2017; Taillie et al., 2020, Mazzù et al., 2023). Food policies such as marketing restrictions and mandatory reformulation have emerged as complementary strategies to reduce the consumption of UPFs and facilitate informed decision-making. However, UPFs counter-measures rely on different conceptual foundations. For instance, the NOVA framework situates health outcomes within the industrial and sociotechnical processes that underpin modern food production, whereas nutrient-profiling models used in most FOPLs assess products based on their nutrient composition (e.g., salt, sugar, and fat content). This theoretical divergence raises practical and communicative challenges, as nutrient scores provide immediate, easily interpretable information, whereas they may not capture the broader implications of extensive food processing. Accordingly, the literature remains fragmented, with studies on UPFs, labeling systems, and consumer behavior often developing in parallel rather than in a unified framework centered on consumers' understanding and decision-making processes. From a consumer perspective, the coexistence of processing-based classifications (such as NOVA) and nutrient-profiling labels (such as Nutri-Score, NutrInform Battery or Warning Labels) introduces a potential interpretative tension. While nutrient-profiling labels summarize the nutritional composition of products, the UPF paradigm emphasizes industrial transformation and formulation practices. Understanding how these frameworks coexist is therefore essential to clarify how consumers interpret food quality signals. The present study therefore reconstructs the evolution of the scientific literature through a consumer-centered perspective, positioning ultra-processed foods as a conceptual lens through which behavioral, nutritional, and policy debates can be integrated. By distinguishing between core UPF research, policy instruments such as FOPLs, and adjacent streams addressing consumer perception and choice, the review aims to clarify how these debates have evolved over time and across geographical contexts, and to identify where consumers' role remains theoretically and empirically underrepresented. In doing so, this paper

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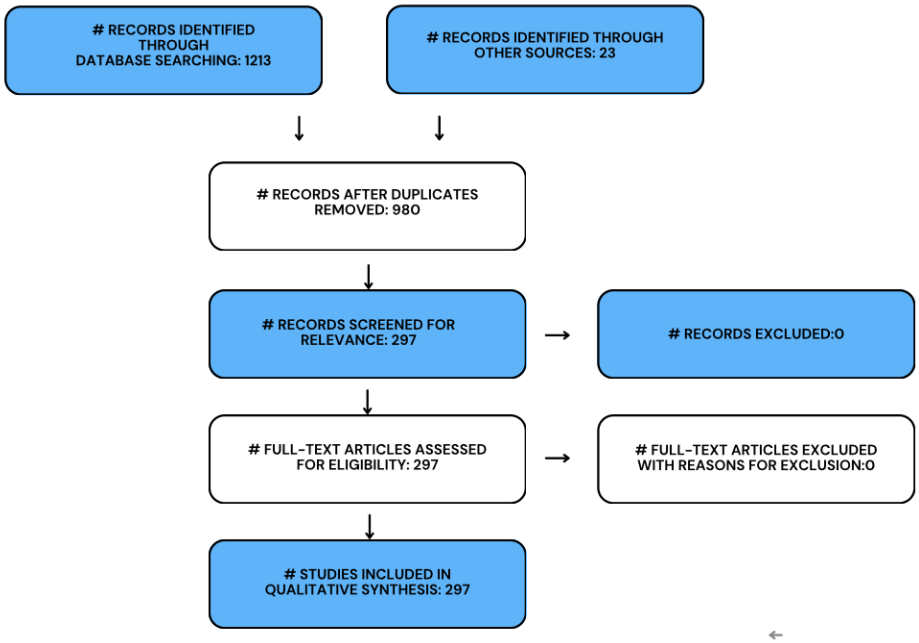
contributes to the literature in several ways. First, it offers a structured review of 297 scientific articles published between 2000 and 2026, systematically selected and analyzed following PRISMA guidelines. Second, it delineates four evolutionary phases in the development of research on UPFs and consumer-oriented food policy, tracing how conceptual and methodological orientations have shifted over time. Third, it synthesizes the main areas of debate and current research gaps, highlighting disconnections between processing-based classifications, labeling frameworks, and consumer behavior literature. Finally, it proposes a set of future research directions articulated from the findings, outlining how an integrated consumer perspective can strengthen the conceptual coherence and policy relevance of the UPF field. This review also provides relevant theoretical and managerial implications. Theoretically, it advances the literature by connecting health-oriented, policy-oriented, and consumer-centered approaches within a unified interpretative framework, thus highlighting the multidimensional evolution of the UPF debate.

2. Purpose of the paper. In recent years, several reviews have examined the relationship between ultra-processed food (UPF) consumption and health outcomes observed in consumers. For instance, Elizabeth et al. (2020), Pagliai et al. (2021), and Lane et al. (2021) consistently link UPF intake to adverse health outcomes—such as obesity, cardiovascular disease, diabetes, and higher mortality—consolidating the scientific basis of the UPF–health debate.
Beyond epidemiological associations, scholars have also examined how the industrial organization of food supply and retail affects consumption patterns and health disparities (Moodie et al., 2013; Baker et al., 2020). Studies on labeling policy—particularly those on FOPLs—have explored consumers' nutritional understanding and purchase behavior (Hawley et al., 2013; Cecchini & Warin, 2016; Egnell et al., 2020; Mazzù et al., 2024), but few have explicitly connected these behavioral insights to the structural diffusion of UPFs and the regulation of the food environment. As a result, three research domains—UPFs and processing, food policy instruments, and consumer behavior—have largely evolved in parallel. This review positions itself at the intersection of these three research domains. It analyzes and organizes existing work by adopting a consumer-centered perspective to bridge research on industrial food processing, nutrition policy, and behavioral responses. By systematically mapping these domains and reconstructing their temporal evolution, it clarifies how the UPF paradigm has interacted with labeling policies and consumer-oriented research. Through this lens, UPFs are examined as elements of consumers' food environments shaped by labeling, marketing and policy interventions.

3. Methodology. The study adopted a multi-step systematic review protocol to identify, select, and analyze scientific literature on UPF, food labeling systems, policies and consumer perceptions and behaviors. The selection process of the items followed the traditional phases provided for by the PRISMA protocol (Figure 1).

Figure 1. PRISMA Flow Diagram of the Literature Selection Process



First, all potentially relevant records were identified, considering the literature's interdisciplinary scope. The research was conducted in the Web-of-Science and Scopus databases. The search strategy was designed to identify literature situated at the intersection of three core dimensions: ultra-processed foods (industrial processing), nutrition labeling (regulatory tools), and consumer behavior (perceptions and choices). To this end, a search string was defined by combining terms related to UPF, food labeling, and consumer behavior. The string used was as follows: TS=((“ultra-processed food” OR “ultra processed food” OR UPF OR NOVA OR “processed food*” OR “industrial food*”) AND (label* OR labeling OR labelling OR “front-of-pack" OR “warning label*” OR “nutrition label*” OR “food label*” OR

NutriScore OR "traffic light") AND (consumer* OR perception* OR behavior* OR "food choice*" OR "purchase intention")). Duplicate records were then removed prior to screening. The remaining articles were subjected to an initial screening phase through the reading of titles and abstracts, with the aim of excluding contributions that were not relevant to the objectives of the review. In the next phase, the full reading of the articles considered potentially relevant was carried out. At this stage, studies were excluded when, despite containing relevant keywords, they lacked a substantive focus on ultra-processed foods or on the research areas under review. At the end of the selection process, 297 scientific papers were included, published between 2000 and 2026. Inclusion decisions were not based solely on keyword matching but were guided by an interpretative framework centered on ultra-processed foods. During screening, articles were assessed for relevance to UPFs and grouped into research on the NOVA classification, policy instruments (e.g., FOPLs), and broader food system components (e.g., packaging, claims, marketing). Studies were excluded if unrelated to UPFs or processing, non–peer-reviewed, non-English, or lacking conceptual relevance.

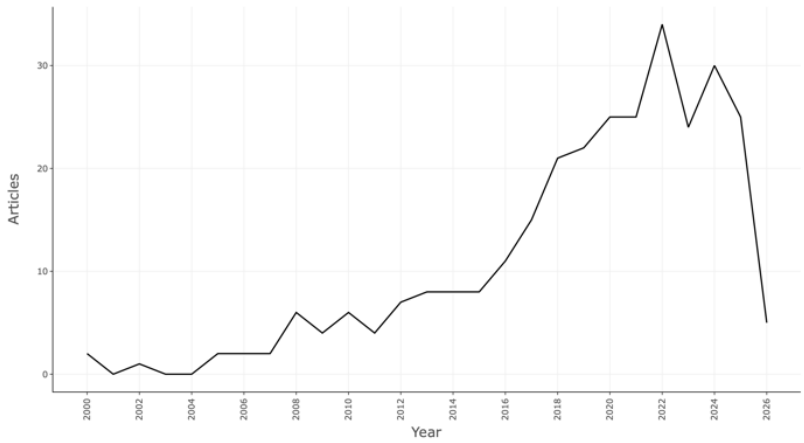
Data analysis. The selected articles were examined through a mixed analytical strategy that combined (i) descriptive quantitative analysis in R with (ii) in-depth qualitative examination of content. This dual approach made it possible to organize the literature into distinct evolutionary phases and to identify areas of convergence as well as persistent research gaps. From a quantitative perspective, the dataset was analyzed with Biblioshiny in R to map publication trends, geographical distribution, and main outlets, allowing the identification of four main historical phases in the development of the UPF literature between 2000 and 2026. These phases reflect shifts in the prominence of different themes and policy debates and provide the temporal scaffold for interpreting changes in how UPF, nutrition policy, and consumer behavior have been studied. In parallel, a qualitative thematic analysis was conducted to identify the primary research streams and reconstruct the evolution of the scientific debate. Articles were coded using an iterative thematic coding procedure. Each study was classified according to predefined analytical dimensions, including year of publication, geographical focus, main topic, conceptual orientation, policy relevance, and the presence or absence of explicit references to UPF or the NOVA classification. On this basis, contributions were iteratively grouped into thematic categories, which were refined throughout the analysis until a stable set of research streams and crosscutting themes emerged.

4. Results. This combined process highlighted four dominant strands: (i) the relationship between UPF consumption and health outcomes; (ii) the role of industrial food processing in shaping diet quality and food systems; (iii) the conceptual interplay between the NOVA classification and nutrient profiling models; and (iv) the impact of policy tools—particularly FOPLs—on consumer understanding and food choice. By examining how these strands evolve across the four phases, the review identifies points of convergence between health, policy, and consumer research, as well as domains where conceptual or methodological integration remains limited. A temporal perspective was therefore central to the analysis, enabling the reconstruction of key milestones in the UPF debate and clarifying how attention progressively shifted from nutrient based framings to broader discussions encompassing processing, food environments, and consumer facing nutrition policies. Additionally, the geographical distribution of scientific production was analyzed to highlight the territorial and political contexts in which different research strands are most concentrated, and to explore how regulatory and institutional dynamics—such as the adoption of Warning Labels in Latin America or FOPL debates in Europe—have influenced the configuration of the literature.

4.1 Main research streams on ultra-processed foods, from a descriptive quantitative perspective

The analysis of 297 scientific articles identifies several interconnected research streams on ultra-processed foods (UPF), showing how the literature has developed over the last two decades (Figure 2). In the early 2000s, output was very low, with only a few articles per year. From 2012 onwards, publications increased more sharply, accelerating after 2016 and peaking around 2022.

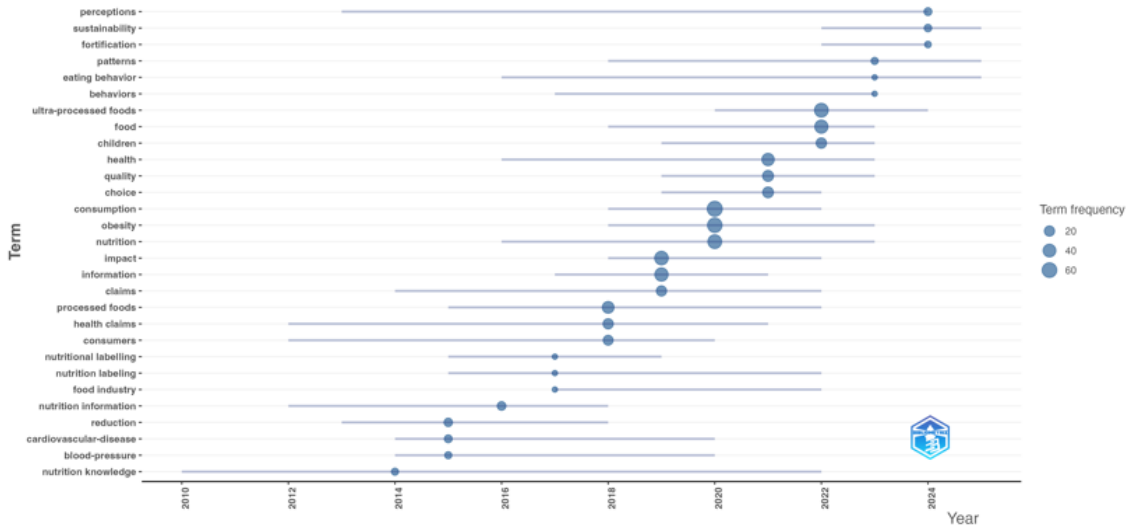
Figure 2. Annual scientific production related to ultra-processed foods, food labeling, and consumer behaviour (2000-2026).



4.1.2. Temporal evolution of literature, from a qualitative perspective

Additionally, the analysis of the corpus shows a significant growth in the number of publications over time and allows us to identify different evolutionary phases of scientific debate. The temporal analysis further reveals that the evolution of the literature does not follow a linear trajectory, but is divided into four distinct phases, each characterized by a different combination of nutrient-based approach, increasing attention to industrial processing, development of front-of-pack labeling systems and progressive integration with the policy debate (Figure 3). In the corpus analyzed, publications increased from 19 articles in 2000–2008 to 164 in 2020–2026, showing a strong acceleration in the most recent phases. This dynamic suggests that the issue of UPF and related policies is consolidated, especially after the formalization of the NOVA paradigm and, subsequently, with the international spread of regulatory tools such as FOPLs as NutrInform Battery, Warning Labels, Traffic-Light and the Nutri-Score. This acceleration reflects the growing institutionalization of the UPF paradigm within both public health research and food policy debates.

Figure 3. Evolution of Research Streams in Ultra-Processed Food Literature.



4.2.1 First phase: centrality of the nutrient-based approach and information transparency (2000–2008). In the first phase, the literature was primarily shaped by a nutrient-based perspective, with strong attention to transparency, consumer information, and the growing use of labels on packaged foods. Early studies focused on monitoring the spread of nutrition labeling and claims in the food market, showing that these instruments were becoming increasingly relevant in consumers' interactions with packaged products (Legault et al., 2004). At the same time, scholars began to examine whether consumers were actually able to understand and use this information effectively. Evidence suggested that many consumers found detailed nutritional information difficult to interpret, especially when labels were complex or overloaded with technical data (Cowburn & Stockley, 2005). Research then explored the value of nutritional information in food choice, showing that labels were effective only when simple, familiar, and easy to interpret (Loureiro et al., 2006; Grunert & Wills, 2007). This explains the growing attention to simplified FOPL systems, while food processing had not yet become central to the debate (Feunekes et al., 2008). Overall, this phase remained firmly centered on nutrients, readability, and information clarity.

4.2.2 Second phase: emergence of the UPF/NOVA paradigm and conceptual transition phase (2009–2014). Between 2009 and 2014, the literature entered a phase of conceptual transition, in which the traditional nutrient-based framework began to be challenged by a new way of understanding diet quality. A major turning point was Monteiro's argument that the key issue was not only food composition in terms of nutrients, but also the degree and purpose of industrial processing (Monteiro, 2009). This marked the beginning of a broader shift in the literature, which moved from asking whether foods were high or low in specific nutrients to questioning how foods were produced, transformed, and incorporated into daily diets. This transition became more structured with the introduction of the NOVA classification, which proposed a new categorization of foods based on the extent and purpose of processing (Monteiro et al., 2010). NOVA provided the conceptual basis for later work on ultra-processed foods and helped reframe the debate beyond the nutrient profile alone. However, during this phase, research on FOPL and consumer understanding did not disappear. On the contrary, studies continued to show that consumers responded favorably to simplified labeling systems and that front-of-pack information could support better understanding under certain conditions (Kim & Kim, 2009; Barreiro-Hurlé et al., 2010; Campos et al., 2011). At the same time, the literature increasingly linked dietary change to broader structural transformations in food systems (Fanzo et al., 2014). Overall, this phase represented the bridge between a purely informational view of nutrition and the emergence of the processing paradigm.

4.2.3 Third Phase: Empirical Consolidation of UPFs and Policy Shift (2015–2019). From 2015 to 2019, the literature moved from conceptual discussion to empirical consolidation of the UPF/NOVA framework. Research increasingly documented the concrete dietary and environmental implications of ultra-processed foods, showing that higher levels of processing were associated with poorer nutritional quality in household food purchases and food environments (Poti et al., 2015; Luiten et al., 2016). In addition, studies on the composition of national diets demonstrated that ultra-processed foods contributed substantially to excessive sugar intake and to broader patterns of nutritional imbalance, reinforcing concerns about their public health significance (Martínez Steele et al., 2016). This phase was also characterized by stronger evidence linking ultra-processed food consumption to diet quality and health outcomes (Moubarac et al., 2017; Schnabel et al., 2019; Srour et al., 2019). At the same time, the literature became more policy-oriented. Research on traffic-light systems and warning labels demonstrated that simplified FOPL tools could improve understanding of nutritional risk and raise awareness of unhealthy foods (Freire et al., 2017; Olivares-Cortés et al., 2017). Comparative work on different FOPL schemes also showed that the format of the label mattered significantly for consumer interpretation and use (Egnell et al., 2019; Mazzù et al., 2022). Overall, this phase marked the transformation of the UPF paradigm into an empirically grounded and policy-relevant field, supported by evidence from dietary studies, supermarket environments and regulatory experiments.

4.2.4 Fourth phase: globalization of the debate, comparison of schemas and integration of nutrients and processing (2020-2026). In the most recent phase, the literature became broader, more international, and more explicitly connected to regulatory and policy debates. Reviews, meta-analyses and umbrella reviews played an important role in consolidating the evidence linking ultra-processed food consumption with multiple adverse health outcomes, thereby strengthening the epidemiological basis of the field (Elizabeth et al., 2020; Lane et al., 2021; Lane et al., 2024). Compared with earlier phases, the debate was no longer limited to defining ultra-processed foods or documenting their spread; it increasingly focused on how this evidence should inform consumer policy, dietary guidelines and public health action. At the same time, comparative research on FOPL systems became more central. Studies showed that different schemes, such as interpretive summary labels and other front-of-pack formats, influence consumer understanding and food choices in different ways, suggesting that the design of the label is crucial for policy effectiveness (Egnell et al., 2020). Another important development was the growing recognition that food evaluation should not rely only on nutrient profiles but should also incorporate the degree of processing. This perspective is well reflected in work arguing that nutritional value and processing represent two distinct yet complementary dimensions of food quality (Romero Ferreiro et al., 2021). In parallel, the literature expanded to include the ways in which consumers interpret ultra-processed foods in everyday life. Studies showed that consumers often rely on heuristics and simplified judgments when assessing the healthiness of packaged foods, which helps explain why labels, packaging cues, and cultural meanings matter so much in food choice (Machín et al., 2020). The field also became more geographically diverse, with research highlighting the policy dynamism of Latin America in the development of warning labels and stronger regulatory tools (Reyes & Corvalán, 2020; Nieto et al., 2021), as well as the social and symbolic meanings attached to highly processed foods (Venkateshmurthy et al., 2021), also expanding to the broader structure of food supply (Sylvetsky et al., 2020). Overall, this phase reflects the global maturation of the field, where health evidence, consumer behavior, labeling policies and food system transformation are increasingly integrated. This phase highlights the growing importance of consumer perception as the interface between scientific evidence, regulation, and market practices.

5. Managerial implications. The paper highlights several implications for policymakers, food producers, and retailers operating in markets increasingly shaped by nutrition policies and consumer health concerns. These findings suggest that policy design benefits from maintaining analytical clarity between process-based classifications and nutrient-based labeling systems, while remaining open to their complementary application in public health interventions. For food companies, the coexistence of nutrient-profiling labels and processing-based classifications implies that product reformulation strategies must consider multiple dimensions of food evaluation. For policymakers, the results suggest that communication strategies addressing ultra-processed foods should acknowledge how consumers interpret both nutrient-based and processing-based signals when making food choices.

6. Originality of the paper. The review shows that research on ultra-processed foods has rapidly expanded from a relatively narrow topic into a broad and multidimensional field, driven by growing evidence on health outcomes and by increasing attention to the role of industrial processing in diet quality. First, a key finding concerns the conceptual tension between the UPF paradigm and FOPL systems. While FOPL summarizes nutritional composition and NOVA focuses on the degree and purpose of industrial processing, the literature increasingly suggests that these frameworks, though conceptually distinct, may be deployed in complementary ways within integrated food policies. Second, the analysis highlights the strong link between scientific research and policy development. The literature increasingly interacts with debates on how to regulate food environments and address the rise of obesity, with different regions experimenting with various strategies such as labeling systems, warning labels, taxes, or marketing restrictions. Geographical differences also play an important role, as research trajectories often reflect national policy priorities and transformations in local food systems. Lastly, the historical perspective reveals that this paradigm shift - from nutrient-based to processing-based frameworks - has not been linear or uncontested. Debates on NOVA's operationalization, comparisons with alternative

profiling systems, and the practical constraints of food policy implementation suggest that both frameworks coexist and interact in shaping contemporary regulatory and consumer information strategies.

7. Research limitations. This review has some limitations. Its future research agenda remains conceptual rather than empirically tested, and the breadth of topics covered means that several important areas—such as digital food environments, industry responses, and sustainability—are identified as promising directions but not examined in depth.

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