

The rise of the ultra-processed foods paradigm: a systematic review of its expansion into nutritional labelling, consumer response and food policy

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Abstract

Purpose – This paper reviews how the ultra-processed foods (UPFs) paradigm has expanded into food quality evaluation, Front-of-Pack Nutritional Label (FOPLs), consumer response and food policy and develops and operationalises a cue-integration framework explaining how processing-based and nutrient-based signals jointly shape food evaluation.

Design/methodology/approach – A systematic literature review was conducted on 297 peer-reviewed articles indexed in Web of Science and Scopus between 2000 and 2026. The review combines bibliometric mapping and interpretive coding across four analytical pillars with a second-stage classification of 27 studies assigned to processing–nutrient interplay stream.

Findings – Processing-based and nutrient-based signals interact through four modes: complementarity, substitution, tension and sequential inference. These modes are differentiated by three operational dimensions: cue-valence alignment, relative cue diagnosticity and temporal order. Although recent research increasingly examines combined signals, it has not produced a fully integrated theoretical account, and signal effects remain contingent on consumer characteristics and decision context.

Practical implications – The review helps policymakers, food companies and retailers understand when processing-based and nutrient-based signals reinforce each other, when they conflict and when they may generate consumer confusion.

Originality/value – The paper integrates previously separate research streams on UPFs, FOPLs, consumer interpretation and food policy and operationalises processing–nutrient interplay.

Keywords Ultra-processed foods, NOVA, Food quality evaluation, Nutrient profiling, Front-of-pack labelling, Consumer perception, Food choice

Paper type Literature review

1. Introduction

Obesity and diet-related chronic diseases have increased scholarly and policy attention to the factors shaping everyday food choices. Within this debate, Ultra-Processed Foods (UPFs) have become central because they are widespread in contemporary diets and associated with adverse health outcomes, including obesity, cardiovascular disease, type 2 diabetes and premature mortality (Monteiro *et al.*, 2013; Elizabeth *et al.*, 2020; Pagliai *et al.*, 2021; Lane *et al.*, 2024). The NOVA classification shifted attention from nutrients alone to the extent and purpose of industrial processing (Monteiro, 2009; Monteiro *et al.*, 2010). This changed how



food quality is evaluated: nutrient composition remains important, but processing level, formulation, ingredient structure, packaging and perceived naturalness have also become relevant dimensions of food evaluation. Recent reviews have consolidated the evidence linking UPF consumption to adverse health outcomes and established the topic firmly within nutrition and public health research (Elizabeth *et al.*, 2020; Pagliai *et al.*, 2021; Lane *et al.*, 2021, 2024). This consolidation also made clear that health outcomes represent only one part of the debate.

Beyond health outcomes, the literature developed along two related streams. Consumer-response research examines how people interpret food cues, infer healthiness and quality, and make choices in environments shaped by packaging, convenience, communication and broader food meanings. Policy research examines how food quality is communicated and governed through Front-of-Pack labels (FOPLs), warning systems, marketing restrictions, taxes and reformulation measures (Moodie *et al.*, 2013; Hawley *et al.*, 2013; Julia and Hercberg, 2017; Taillie *et al.*, 2020; Baker *et al.*, 2020; Mazzù *et al.*, 2023). FOPLs were developed to make nutritional information easier to interpret and use at the point of choice, and substantial research has examined whether simplified formats improve comprehension and support healthier decisions (Hawley *et al.*, 2013; Cecchini and Warin, 2016; Egnell *et al.*, 2020; Mazzù *et al.*, 2024). However, processing-based and nutrient-based systems communicate different product properties. NOVA and explicit UPF information concern how food is formulated and produced, whereas most FOPLs summarize selected aspects of nutrient composition. The two systems may therefore produce convergent, competing or temporally ordered judgements. For example, a product may display a relatively favourable nutrient profile while remaining highly processed, whereas a less processed product may still present nutritional limitations.

1.1 A cue-integration framework for food quality evaluation

Consumers rarely evaluate foods through a single item of information. Consumer judgements are constructed from the cues available in a particular context, and the use of each cue depends on its accessibility, salience and perceived diagnosticity (Feldman and Lynch, 1988; Bettman *et al.*, 1998; Kardes *et al.*, 2004). Processing-related information and nutrient-related information can therefore be treated as distinct food-quality cues rather than as mutually exclusive classification systems.

The framework developed in this review differentiates their interaction along three dimensions. The first is cue-valence alignment: processing and nutrient information may support the same evaluative direction or imply different judgements. The second is relative cue diagnosticity: one signal may be regarded as more informative, credible or relevant than the other. The third is temporal order: one cue may shape the initial judgement, while another is consulted later to confirm, qualify or revise it.

These dimensions distinguish four interaction modes. Complementarity occurs when processing and nutrient cues support the same evaluation. Substitution occurs when one cue is treated as sufficient and the other is ignored or underweighted. Tension occurs when the two cues imply conflicting evaluations. Sequential inference occurs when the consumer uses one cue to form an initial judgement and a second cue to confirm or revise it. Table 1 operationalises the four modes by specifying their cue configurations, coding criteria, decision processes, expected outcomes and boundary conditions.

The four analytical pillars have not developed at the same pace. Research on UPFs and processing is most established in nutrition and public health, consumer-response studies focus mainly on comprehension, perceived healthiness and choice, and policy research examines the design and effects of labels and regulatory instruments. The processing–nutrient interplay has emerged more recently and remains less systematically theorized. The cue-integration framework is introduced to connect these streams without collapsing their distinct research questions.

Table 1. Four modes of interaction between processing-based and nutrient-based food evaluation

Mode	Definition	Typical situation	Operational cue configuration	Decision process	Expected outcome	Principal boundary conditions	Implication for food quality evaluation
Complementarity	Processing level and nutrient profile reinforce the same evaluation	A product is both ultra-processed and high in nutrients of concern	Processing and nutrient cues have aligned evaluative valence and both are attended to	Cues are integrated and mutually reinforce the judgement	Stronger evaluation and greater decision confidence	Cue visibility, perceived credibility and sufficient attention	Signals converge and may strengthen perceived risk or lower perceived quality
Substitution	One evaluative system is treated as sufficient, reducing attention to the other	A nutrient-based Front-of-Pack score is used as the main shortcut	One cue is perceived as more diagnostic than the other and displaces the alternative cue	The more diagnostic cue becomes a shortcut and the alternative cue is ignored or underweighted	Efficient but potentially incomplete evaluation	Time pressure, low literacy, familiarity, trust in the diagnostic label	Processing-related information may be ignored or underweighted
Tension	Processing level and nutrient profile imply different evaluations	A product has a favourable nutrient profile but is highly processed	Processing and nutrient cues have opposing evaluative valence and both are noticed	The consumer must resolve conflicting information	Ambiguity, lower confidence, further information search or reliance on prior beliefs	Nutrition literacy, health goals, product knowledge and institutional trust	Consumers may experience ambiguity or conflicting quality judgements
Sequential inference	One cue shapes an initial judgement and the other is consulted subsequently	A consumer first notices a FOPL and then checks ingredients or processing cues	Processing and nutrient cues are encountered or consulted in a discernible order	The first cue anchors the judgement; the second confirms, qualifies or overrides it	Reinforcement, adjustment or reversal of the initial evaluation	Cue order, prominence, shopping channel and attention availability	Cue order, salience, and attention shape final evaluation

The review addresses three questions: (1) how did processing become a distinct dimension of food evaluation; (2) how did UPF research expand into consumer-response and policy-instrument research; and (3) under which cue configurations do the four interaction modes emerge. The analysis covers 297 articles across four historical phases and four analytical pillars: UPFs and processing, consumer response, policy instruments and processing–nutrient interplay. The analysis reconstructs how these streams converged, identifies where the links between them remain partial and positions the review relative to earlier work focused mainly on health outcomes (Table 2).

2. Methodology

The search was carried out in Web of Science and Scopus, which together cover the main disciplinary areas relevant to the review: nutrition, food science, food policy, consumer research and public health. The search strategy combined three sets of terms related to: (1) UPFs, NOVA and industrial food processing; (2) food labelling, nutrient profiling, Front-of-Pack labels, warning labels and nutrition information; and (3) consumer-related constructs, including perception, food choice, healthiness evaluation, attitudes, behaviour and purchase intention. The review covers the period 2000–2026 in order to capture both the pre-NOVA nutrient-centred literature and the later development of processing-based food evaluation. The pre-2020 literature was retained to reconstruct the emergence and consolidation of nutrient- and processing-based approaches, rather than to represent current packaging or regulatory conditions. Claims concerning contemporary labelling, marketing, regulation and consumer awareness were derived primarily from the 2020–2026 evidence. The corpus was divided into four phases reflecting the main shifts in the literature: an initial nutrient-centred stage, a second phase marked by the emergence of the processing perspective after 2009, a third phase of empirical consolidation from the mid-2010s, and a final phase in which processing, labelling, consumer response, and policy became more closely interconnected. The selection of articles followed the main steps of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) protocol (Figure 1).

Table 2. Positioning of the present review relative to previous UPF reviews

Study	Focus	Method	Period	Main contribution
Elizabeth <i>et al.</i> (2020)	Ultra-Processed Foods and health outcomes	Narrative review	Up to 2019	Epidemiological overview of UPF-related health outcomes
Pagliai <i>et al.</i> (2021)	UPF consumption and health status	Systematic review and meta-analysis	Up to 2020	Meta-analytic synthesis of UPF-health associations
Lane <i>et al.</i> (2021)	UPF and chronic disease risk	Systematic review and meta-analysis	Up to 2020	Systematic synthesis of associations between UPF consumption and chronic noncommunicable diseases
Lane <i>et al.</i> (2024)	UPF exposure and adverse health outcomes	Umbrella review of epidemiological meta-analyses	2009–June 2023	Comprehensive assessment of meta-analytic evidence across multiple adverse health outcomes
Present study	UPFs, nutrient profiling, consumer response, food policy and processing–nutrient interplay	Systematic literature review	2000–2026	Integrates four analytical pillars and operationalises processing–nutrient interplay through four cue-interaction modes

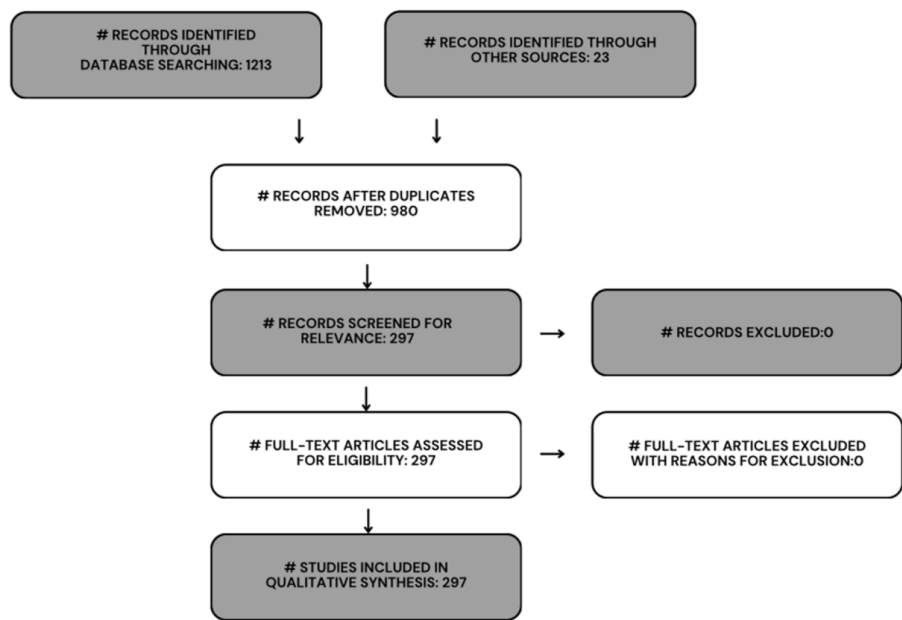


Figure 1. PRISMA flow diagram of the literature selection process

The search was conducted on 15 February 2026 in Web of Science and Scopus. In Web of Science, the following topic search was applied: TS=((“ultra-processed food*” OR “ultra processed food*” OR UPF OR NOVA OR “processed food*” OR “industrial food*”)) AND (label* OR labelling OR labelling OR “Front-of-Pack” OR “front of pack” OR FOP OR “warning label*” OR “nutrition label*” OR “food label*” OR “Nutri Score” OR NutriScore OR “traffic light” OR packaging OR “nutrition information” OR “nutrition claim*” OR “health claim*” OR “nutrition communication”) AND (consumer* OR perception* OR attitude* OR behavior* OR behaviour* OR “food choice*” OR “purchase intention” OR “decision making” OR preference* OR “risk perception”). A total of 1,213 records were identified. In Scopus, the same search logic was applied to the TITLE-ABS-KEY fields. The search included only peer-reviewed journal articles written in English and published between 2000 and 2026.

The screening was carried out in two steps. First, three reviewers checked titles and abstracts. In cases of disagreement, articles were discussed until a shared decision was reached. The same approach was then used during full-text screening. After selection, each article was coded according to the following criteria: year and phase, main focus of the paper, relevance for policy, presence of consumer-related issues, and use of UPF or NOVA. Articles were not included solely because they contained one of the search terms; they also had to be substantively relevant to the review topic. This was especially important for broad terms such as “processed food*” and “industrial food*”, which can also refer to food technology or processing methods in a narrow technical sense. Such studies were retained only when they contributed directly to the review’s focus on UPFs, NOVA, nutrient-based labelling, consumer evaluation, or the relationship between processing and nutritional assessment. Studies were excluded when they dealt with food labelling only in very general terms, without a clear link to UPFs, processing level, nutrient profiling, or food quality evaluation. They were also excluded when they treated food processing only as a technological operation, with no connection to diet quality, labelling, or consumer response. Editorials, commentaries, conference abstracts, non-

English publications, and non-peer-reviewed material were not included. After the full-text screening, articles with only a weak connection to the review topic were excluded. The final corpus included 297 articles published between 2000 and 2026. The review integrates systematic screening with interpretive coding in order not only to document publication growth, but also to reconstruct how the literature evolved and how adjacent research areas progressively intersected. The analysis distinguishes studies centred on NOVA and processing, studies focused on labelling and regulation, and related work on food communication, naturalness, heuristics and consumer behaviour. The 2026 results should be interpreted cautiously because the year was incomplete at the time of data collection.

The analysis combined descriptive bibliometric mapping and qualitative coding. Biblioshiny for R was used to examine publication trends, geographical distribution and journal outlets. Qualitative coding was then used to classify articles by year, geographical context, main topic, policy relevance, consumer-related focus and reference to UPFs or NOVA. For descriptive stream mapping, each article was assigned to one primary analytical area, while secondary relevance was retained for the qualitative synthesis. When articles addressed more than one stream, they were assigned according to their dominant analytical focus, while secondary themes were recorded during qualitative coding. To operationalize the four-mode framework, the 29 articles initially assigned to the processing–nutrient interplay stream were subjected to a second-stage coding procedure. Two articles did not provide sufficient evidence of processing–nutrient interplay and were excluded from mode classification, leaving 27 classifiable studies. Each retained article was coded for five dimensions: (1) the evaluative valence of the processing and nutrient cues; (2) their relative diagnosticity, assessed through the extent to which each cue was treated as informative, credible or relevant to the focal judgement; (3) whether the cues were presented or consulted simultaneously or sequentially; (4) the principal consumer or policy outcome; and (5) the primary interaction mode ([Supplementary Table J](#)). Complementarity was coded when both cues supported the same evaluation; substitution when one cue displaced or reduced the influence of the other; tension when the cues implied conflicting evaluations; and sequential inference when one cue shaped an initial judgement that was subsequently confirmed, qualified or revised by another. Because the literature includes both studies that directly compare the two cues and studies in which one cue is focal while the alternative remains implicit, the classifications represent an interpretive synthesis rather than evidence that every study experimentally manipulated both cues. Where a study could fit more than one mode, the mode corresponding to its focal mechanism was coded as primary. Two reviewers independently performed the coding and resolved differences through discussion.

3. Results

3.1 Main research streams on ultra-processed foods: a descriptive quantitative perspective

The analysis of the 297 selected articles identifies a set of interconnected analytical streams within the literature on Ultra-Processed Foods (UPFs), tracing how the field evolved over the past 2 decades ([Figure 2](#)) and how it progressively extended from a core focus on UPFs toward Front-of-Pack labelling, policy interventions, and consumer behaviour.

Publication output remained limited until the mid-2010s and subsequently increased sharply. The corpus grew from 15 articles in 2000–2008 to 37 in 2009–2014, 77 in 2015–2019 and 168 in 2020–2026. The recent phase therefore accounts for 56.6% of the full corpus. Sixteen of the 27 studies retained for second-stage coding were published between 2020 and 2026 (59.3%), indicating that explicit analysis of processing–nutrient interplay is concentrated in the recent phase.

Bibliometric mapping indicates an expansion from a health- and epidemiology-centred core toward research on labelling, consumer interpretation and policy instruments. The keyword network identifies three broad clusters: UPFs and health outcomes; nutrition labelling and warning systems; and consumer information, quality and choice. Additional

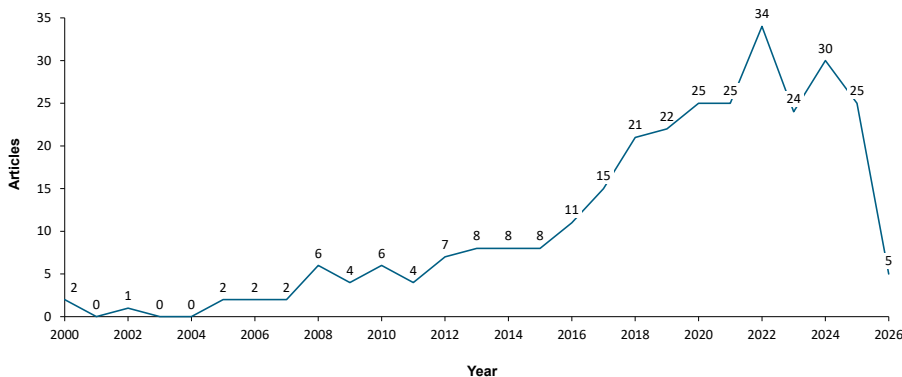


Figure 2. Annual scientific production related to ultra-processed foods, food labelling, and consumer behaviour (2000–2026). Note: The 2026 value includes only articles indexed up to February 2026

indicators concerning authorship, countries and citation patterns are reported in [Supplementary Table A](#) and [Supplementary Figures A–C](#).

[Table 3](#) summarizes the changing distribution of the four analytical streams. The historical phases are used to reconstruct how processing emerged as an evaluative dimension and how it subsequently entered consumer and policy research.

3.2 Historical evolution of processing-based and nutrient-based food evaluation

3.2.1 First phase: nutrient-based evaluation and information transparency (2000–2008). In the first phase, UPFs were not yet a central topic. The literature focused mainly on nutrients, nutrition information, label readability and consumers' ability to use food labels in everyday decision-making ([Legault et al., 2004](#); [Cowburn and Stockley, 2005](#); [Grunert and Wills, 2007](#)). Processing was not yet treated as an independent evaluative dimension, while simplified FOPLs began to attract attention because they appeared easier to use than detailed back-of-pack information ([Feunekes et al., 2008](#); [Supplementary Tables B and C](#)).

3.2.2 Second phase: emergence of the UPF/NOVA paradigm (2009–2014). Between 2009 and 2014, the nutrient-centred approach began to coexist with a processing-based view of food quality. Monteiro's work shifted attention from nutrient composition alone to the extent and purpose of industrial processing ([Monteiro, 2009](#)), while the NOVA classification provided the conceptual structure for this perspective ([Monteiro et al., 2010](#)). UPFs also began to be framed as part of broader food-system and public-health dynamics, including the influence of large food and beverage companies on dietary patterns ([Moodie et al., 2013](#)). Early empirical applications linked UPF consumption to poorer dietary patterns and potential adverse health effects in Canada ([Moubarac et al., 2013](#)) and to higher obesity levels in Brazilian households ([Canella et al., 2014](#)). Consumer research, however, remained mostly focused on nutrition information, FOPL comprehension and simplified label formats rather than on direct interpretation of UPFs ([Barreiro-Hurlé et al., 2010](#); [Campos et al., 2011](#)). Policy-related work also connected dietary change to food-system transformations and nutrition transitions in low- and middle-income countries ([Fanzo et al., 2014](#)). The phase established the conceptual basis for subsequent comparisons between processing- and nutrient-based evaluation ([Supplementary Tables D and E](#)).

3.2.3 Third phase: empirical consolidation of UPFs and consumer-oriented expansion (2015–2019). From 2015 to 2019, the UPF approach became more firmly established and empirically convergent. Highly processed foods were increasingly linked to poorer nutritional quality, higher sugar intake and less healthy food environments ([Poti et al., 2015](#); [Luiten et al.,](#)

Table 3. Analytical streams across the four historical phases

Stream	Phase 2000–2008	2009–2014	2015–2019	2020–2026	Total
UPF/ processing core	Absent or embryonic	Emerging and conceptually central through NOVA; first epidemiological applications appear	Strong empirical consolidation through studies on diet quality, food environments, and chronic disease risk	Fully consolidated and broadened toward additives, food supply, and multidimensional health concerns	
<i>Number</i>	9	8	18	32	67
Consumer response	Emerging, but limited to nutrition- information comprehension	Still limited and mainly connected to Front-of-Pack comprehension rather than direct UPF understanding	Clearly expanding through studies on conceptualization, understanding, and behavioural use of the UPF category	Strong and diversified, especially around heuristics, naturalness, perceived processing, and social interpretation	
<i>Number</i>	4	17	15	34	70
Policy instruments	Present, mainly as labelling transparency and sodium-related public health measures	Present and expanding, especially through food labelling and nutrition- transition concerns	Stronger and more visible through traffic-light labels, warning labels, and comparative FOP evaluations	Strong and internationalized, with growing comparison among warning- label and FOP architectures	
<i>Number</i>	2	12	40	77	131
Processing– nutrient interplay	Very weak; no real NOVA-versus- labelling tension because processing is not yet central	Emerging but still limited; nutrient-based systems remain dominant in consumer-facing applications	Increasingly visible; processing-based and nutrient- based systems begin to coexist more explicitly	More frequent but uneven; direct combined-cue evidence remains limited, while other studies provide structural or indirect evidence of processing–nutrient interplay	
<i>Number</i>	0	2	10	17	29
Total papers	15	37	77	168	297

2016; Martínez Steele *et al.*, 2016). Evidence also connected higher UPF consumption with lower diet quality in Canada and with mortality and cardiovascular disease risk in France (Moubarac *et al.*, 2017; Schnabel *et al.*, 2019; Srouf *et al.*, 2019). At the same time, consumer-response research began to examine UPFs not only as an expert classification, but also as a consumer-facing cue. Consumers were increasingly able to recognize the term, although not always clearly or consistently, and simple health reminders were found to reduce UPF selection in supermarket settings (Ares *et al.*, 2016; Aguirre *et al.*, 2019; Botelho *et al.*, 2019). Policy research also expanded through studies of traffic-light labels, warning labels and comparative FOPL systems, showing that simpler labels can improve understanding of nutritional risks and help identify less healthy products (Freire *et al.*, 2017; Olivares-Cortés *et al.*, 2017; Egnell *et al.*, 2019). Nutrient- and processing-based cues consequently became more visible within the same decision environments (Supplementary Tables F and G).

3.2.4 Fourth phase: expansion into consumer research and policy integration (2020–2026). In the most recent phase, the literature became broader, more international and more closely connected to policy and consumer-related questions. Reviews, meta-analyses and umbrella reviews consolidated evidence linking UPF consumption to multiple health outcomes (Elizabeth *et al.*, 2020; Lane *et al.*, 2021, 2024), while comparative studies on Front-of-Pack labels showed that different formats generate different levels of understanding and choice effects, confirming the policy relevance of label design (Fialon *et al.*, 2020; Egnell *et al.*, 2020; Mazzù *et al.*, 2021, 2022). Processing increasingly appeared alongside nutrient composition as a distinct dimension of food quality (Romero Ferreiro *et al.*, 2021). The field also became more geographically and substantively diverse, including studies on warning-label developments in Latin America (Nieto *et al.*, 2021) and social interpretations of processed foods in India (Venkateshmurthy *et al.*, 2021). Consumer research showed that UPFs are evaluated through naturalness, artificiality and perceived processing, which often function as heuristics for healthiness and quality judgements (Machin *et al.*, 2020; Sanchez-Siles *et al.*, 2022; Hässig *et al.*, 2023), although their use varies across socioeconomic groups and decision contexts (Sapio *et al.*, 2025). Recent work further connects policy and communication, showing that UPF information can affect risk perception and food judgements (Gough *et al.*, 2025), that explicit UPF labels may be more effective when combined with nutrient warnings (D'Angelo Campos *et al.*, 2024), and that multidimensional labels may integrate nutrients, processing and related information (Muzzioli *et al.*, 2025). However, consumption remains shaped by convenience and habits (Calvo-Porrall and Rivaroli, 2025), and consumers still associate UPFs with unhealthiness, industrial production and artificiality without always classifying them accurately (McCausland *et al.*, 2026). This phase therefore provides most of the contemporary evidence used in Section 3.3, while showing that NOVA and nutrient profiling remain more often compared than theoretically integrated (Supplementary Tables H and I).

3.3 Cross-phase evidence for the four interaction modes

The second-stage assessment retained 27 of the 29 candidate articles for interaction-mode coding. Complementarity was identified in 11 studies (40.7%), substitution in 10 (37.0%), tension in five (18.5%) and sequential inference in one (3.7%) (Supplementary Table J). The classifications reflected the three operational dimensions of the framework: complementarity was associated primarily with aligned cue valence, tension with conflicting valence, substitution with asymmetric cue diagnosticity and sequential inference with an identifiable order of cue consultation.

Complementarity was clearest when processing and nutrient signals reinforced the same evaluation, as in the combination of an explicit UPF label and nutrient warnings (D'Angelo Campos *et al.*, 2024) and in multidimensional Front-of-Pack architectures integrating processing and nutritional information (Muzzioli *et al.*, 2025). Substitution occurred when processing information operated as a shortcut for broader healthiness judgements (Machin

et al., 2020; Hässig *et al.*, 2023). Tension emerged when processing and nutrient assessments pointed in different evaluative directions (Romero Ferreiro *et al.*, 2021; Gough *et al.*, 2025). Sequential inference was identified only in Botelho *et al.* (2019), where a health reminder preceded and influenced subsequent UPF choice.

Sixteen of the 27 classifiable studies (59.3%) were published between 2020 and 2026. Evidence was uneven in both distribution and form: complementarity and tension included direct comparisons or combined-label designs, whereas several substitution classifications were based on studies in which one cue operated as a heuristic and the alternative cue remained implicit. Sequential inference was represented by a single study. This pattern indicates growing attention to combined signals without full theoretical or empirical integration.

4. Discussion

4.1 Contributions across the four analytical pillars

This review shows that UPF research expanded from a processing-centred core to include consumer response, policy instruments, and nutrient-based evaluation, without producing a correspondingly integrated theoretical structure. NOVA and related approaches draw attention to industrial formulation, additives, changes to the food matrix and the structure of the packaged food supply. For consumers, processing also functions as a food-quality cue through ingredient lists and sensory expectations. These elements broaden the meaning of processing beyond formal classification and help explain why otherwise similar products may be interpreted differently.

This review makes three main contributions. First, it clarifies how processing became central to the UPF debate and gradually entered consumer food evaluation. UPFs are relevant not only because of their association with health risks, but also because processing functions as a consumer-facing signal through which people infer healthiness, naturalness, artificiality and product quality. These judgements are not based on processing alone, but on combinations of cues, including nutrient labels, packaging and broader food meanings (Ares *et al.*, 2016; Aguirre *et al.*, 2019; Botelho *et al.*, 2019; Sanchez-Siles *et al.*, 2022; Hässig *et al.*, 2023; McCausland *et al.*, 2026). Second, the review shows how policy research expanded from the simplification of nutrient information toward a broader set of instruments, including warning labels, processing-related information and reformulation measures. This development shifts the policy question from the effectiveness of individual labels to the design and coordination of consumer-facing food-quality signals (Fialon *et al.*, 2020; Egnell *et al.*, 2020; Mazzù *et al.*, 2022). Third, the review identifies signs of conceptual saturation in parts of the consumer literature. Although the field has expanded across journals, countries and methods, several studies reproduce similar conclusions regarding perceived processing and food healthiness. The co-citation analysis further indicates that these streams developed around relatively stable and only partially connected intellectual clusters (Supplementary Figure D).

4.2 The cue-integration framework and propositions

The principal theoretical contribution of this review is to shift the unit of analysis from individual classification or labelling systems to the cue configuration encountered by the consumer. Processing-based and nutrient-based signals do not have fixed effects independently of context. Their joint effect depends on whether they have aligned or conflicting valence, whether one is perceived as more diagnostic than the other and whether they are encountered simultaneously or sequentially. By conceptualizing this relationship as a multi-cue evaluation process, the framework moves beyond a simple opposition between processing and nutrients. The modes are analytically distinguishable but not necessarily mutually exclusive. Complementarity, substitution and tension describe relational outcomes between cues, whereas sequential inference describes the temporal process through which one of those outcomes may emerge. Sequential inference is coded as the primary mode only when cue order constitutes the focal

mechanism; otherwise, the study is classified according to the relational outcome between the cues.

Complementarity represents an integrative configuration. When both cues point toward the same evaluation, the second cue provides confirmatory information and should strengthen the judgement and increase confidence. This leads to the first proposition:

- P1.* When processing-based and nutrient-based cues have aligned evaluative valence, their joint presentation will produce more extreme judgements in the shared direction and greater judgement confidence than either cue presented alone.

Substitution arises when one cue is perceived as more diagnostic than the other. A cue regarded as more informative, credible or relevant can become a sufficient shortcut and reduce the influence of alternative information. Substitution is therefore especially likely under time pressure or limited nutrition literacy:

- P2.* A cue perceived as more diagnostic will reduce the influence of the alternative cue, particularly when limited attention, knowledge or motivation restrict consumers' processing of multiple signals.

Tension represents a conflict configuration. When a product has a favourable nutrient profile but is classified or perceived as highly processed, consumers must decide which signal is more informative. The outcome is therefore unlikely to be uniform:

- P3.* Conflicting processing- and nutrient-based cues will reduce judgement confidence and, when motivation and ability are sufficient, increase information search; otherwise, consumers will rely more on the cue perceived as more diagnostic.

Sequential inference represents an order-dependent configuration. The first cue can establish an anchor that is confirmed, adjusted or overridden by subsequently encountered information:

- P4.* The influence of processing- and nutrient-based cues will depend on their order of presentation, with later cues producing confirmation, adjustment or reversal of the initial evaluation.

The four modes vary across consumers and decision environments rather than constituting stable attributes of products or labelling systems. This explains why previous studies can report different effects for similar labels and why processing and nutrient information cannot be evaluated independently of salience, knowledge, trust and choice context.

4.3 Research, policy and managerial implications

For research, the framework provides explicit variables that can be manipulated: cue-valence alignment, relative cue diagnosticity and temporal order. Future experiments should therefore compare aligned and conflicting signals, manipulate their perceived informativeness or credibility and test whether consumers encounter them simultaneously or sequentially. Outcomes should include perceived healthiness and choice alongside confidence, information search, recall and cue comprehension. For policymakers, the framework suggests that adding more information does not necessarily improve decisions. A favourable nutrient score may substitute for processing information, while conflicting signals may increase uncertainty. Combined labelling systems should therefore be evaluated as cue configurations rather than as collections of independent elements. Pre-testing should assess whether signals reinforce, mask or contradict one another across consumer groups. For food companies and retailers, packaging, shelf design and digital interfaces determine the salience and order of food-quality cues. These actors can reduce ambiguity by ensuring that nutrient, ingredient and processing information are hierarchically coherent and by avoiding claims that create unresolved conflict with mandatory or voluntary labels. Digital shopping environments are particularly relevant because they allow the order and prominence of cues to be designed and experimentally tested.

4.4 Limitations and future research

This review has several limitations. First, the search focuses on UPFs, labelling, and consumer-related terms. As a result, some related areas, such as sensory science, food formulation, food matrix effects, and food technology, are only partially captured. Second, the division into historical phases and the assignment of studies to analytical streams involve interpretive judgement and should therefore be understood as an analytical reconstruction rather than a purely mechanical classification. Third, 2026 was still an incomplete publication year when the data were collected, so results for the most recent period should be read with some caution.

Consumer heterogeneity represents a further boundary condition. Precision-nutrition research shows that responses to the same foods vary across clinical, metabolic and microbiome profiles (Zeevi *et al.*, 2015; Leshem *et al.*, 2020; Rein *et al.*, 2022). Future studies should examine whether health status, dietary constraints, nutrition literacy and socioeconomic context alter the relative diagnosticity of processing and nutrient cues (Table 4).

Table 4. Future research agenda for integrated UPF, labelling, and food quality evaluation research

Macro-area of research	Future research questions
Consumer understanding of UPFs	How do consumers interpret UPFs in everyday shopping? Can they distinguish nutritional quality from level of processing?
Healthiness heuristics and perceived processing	How do naturalness, artificiality, packaging and sensory expectations shape perceived healthiness and product quality?
Effectiveness of FOPLs	Which FOPL systems are most effective in reducing purchases of unhealthy or ultra-processed products? Do warning labels produce different effects from nutrient-score systems such as Nutri-Score?
Processing–nutrient integration	How can nutrient-based labels and NOVA-like processing information be coordinated without generating confusion, redundancy or conflicting judgements?
Food marketing and claims	How do health claims, nutrition claims and packaging cues interact with warning labels and UPF-related information?
Retail and food environment	How do shelf placement, price, promotions and store context affect the visibility, evaluation and choice of UPFs?
Socioeconomic and consumer heterogeneity	How do income, education, age, nutrition literacy, health status and dietary constraints influence the use of nutrient-based and processing-based cues?
Policy evaluation and longitudinal effects	Do labelling policies and UPF-related communication produce durable changes in perception, purchasing, consumption and reformulation?
Industry response	How do food manufacturers and retailers adapt formulation, claims, category strategies and communication in response to labelling regulation?
Digital and contextual decision environments	How do online platforms, apps, time pressure, shopping goals and family roles affect the interpretation of UPF, nutrient and ingredient information?
Cue-valence alignment	When do convergent signals strengthen judgements, and when do conflicting signals reduce confidence?
Relative diagnosticity	Under which conditions does a FOPL substitute for processing or ingredient information? When and why does one cue become more diagnostic than the other, leading to substitution?
Temporal order	Does processing information confirm, qualify or reverse an initial nutrient-based judgement? How does cue order shape confirmation, adjustment or reversal of an initial food-quality judgement?
Consumer heterogeneity and conflict-resolution strategies	Which consumers resolve cue tension through additional search and which rely on a single shortcut?
Decision environment	How do shelf position, screen architecture, time pressure and shopping goals alter cue use?

5. Conclusion

This review shows that UPF research expanded across four analytical pillars—processing, consumer response, policy instruments and processing–nutrient interplay—without yet producing a fully integrated theoretical account. Within the fourth pillar, cue-valence alignment, relative cue diagnosticity and temporal order distinguish complementarity, substitution, tension and sequential inference. Future research should examine how consumer heterogeneity and decision context shape these modes and how combined processing- and nutrient-related signals influence understanding, confidence and choice. For policymakers and market actors, the framework provides a basis for designing and testing food-quality information as a coordinated cue configuration rather than as a collection of independent labels.

Data availability statement

The bibliographic dataset and thematic coding underlying this systematic literature review are available on request.

Supplementary material

The supplementary material for this article can be found online.

References

- Aguirre, A., Borneo, M.T., El Khori, S. and Borneo, R. (2019), “Exploring the understanding of the term ultra-processed foods by young consumers”, *Food Research International*, Vol. 115, pp. 535-540, doi: [10.1016/j.foodres.2018.09.059](https://doi.org/10.1016/j.foodres.2018.09.059).
- Ares, G., Vidal, L., Allegue, G., Giménez, A., Bandeira, E., Moratorio, X., Molina, V. and Curutchet, M.R. (2016), “Consumers’ conceptualization of ultra-processed foods”, *Appetite*, Vol. 105, pp. 611-617, doi: [10.1016/j.appet.2016.06.028](https://doi.org/10.1016/j.appet.2016.06.028).
- Baker, P., Machado, P., Santos, T., Sievert, K., Backholer, K., Hadjikakou, M., Russell, C., Huse, O., Bell, C., Scrinis, G., Worsley, A., Friel, S. and Lawrence, M. (2020), “Ultra-processed foods and the nutrition transition: global, regional and national trends, food systems transformations and political economy drivers”, *Obesity Reviews*, Vol. 21 No. 12, e13126, doi: [10.1111/obr.13126](https://doi.org/10.1111/obr.13126).
- Barreiro-Hurlé, J., Gracia, A. and de-Magistris, T. (2010), “Does nutrition information on food products lead to healthier food choices?”, *Food Policy*, Vol. 35 No. 3, pp. 221-229, doi: [10.1016/j.foodpol.2009.12.006](https://doi.org/10.1016/j.foodpol.2009.12.006).
- Bettman, J.R., Luce, M.F. and Payne, J.W. (1998), “Constructive consumer choice processes”, *Journal of Consumer Research*, Vol. 25 No. 3, pp. 187-217, doi: [10.1086/209535](https://doi.org/10.1086/209535).
- Botelho, A.M., de Camargo, A.M., Dean, M. and Fiates, G.M.R. (2019), “Effect of a health reminder on consumers’ selection of ultra-processed foods in a supermarket”, *Food Quality and Preference*, Vol. 71, pp. 431-437, doi: [10.1016/j.foodqual.2018.08.017](https://doi.org/10.1016/j.foodqual.2018.08.017).
- Calvo-Porrall, C. and Rivaroli, S. (2025), “Examining the consumer behaviour of ultra-processed food products: evidence from the Spanish market”, *British Food Journal*, Vol. 127 No. 3, pp. 821-841, doi: [10.1108/bfj-06-2024-0606](https://doi.org/10.1108/bfj-06-2024-0606).
- Campos, S., Doxey, J. and Hammond, D. (2011), “Nutrition labels on pre-packaged foods: a systematic review”, *Public Health Nutrition*, Vol. 14 No. 8, pp. 1496-1506, doi: [10.1017/s1368980010003290](https://doi.org/10.1017/s1368980010003290).
- Canella, D.S., Levy, R.B., Martins, A.P.B., Claro, R.M., Moubarac, J.-C., Baraldi, L.G., Cannon, G. and Monteiro, C.A. (2014), “Ultra-processed food products and obesity in Brazilian households (2008-2009)”, *PLOS One*, Vol. 9 No. 3, e92752, doi: [10.1371/journal.pone.0092752](https://doi.org/10.1371/journal.pone.0092752).
- Cecchini, M. and Warin, L. (2016), “Impact of food labelling systems on food choices and eating behaviours: a systematic review and meta-analysis of randomized studies”, *Obesity Reviews*, Vol. 17 No. 3, pp. 201-210, doi: [10.1111/obr.12364](https://doi.org/10.1111/obr.12364).

- Cowburn, G. and Stockley, L. (2005), "Consumer understanding and use of nutrition labelling: a systematic review", *Public Health Nutrition*, Vol. 8 No. 1, pp. 21-28, doi: [10.1079/phn2005666](https://doi.org/10.1079/phn2005666).
- D'Angelo Campos, A., Ng, S.W., McNeel, K. and Hall, M.G. (2024), "How promising are ultra-processed front-of-package labels? A formative study with US adults", *Nutrients*, Vol. 16 No. 7, 1072, doi: [10.3390/nu16071072](https://doi.org/10.3390/nu16071072).
- Egnell, M., Talati, Z., Galan, P., Hercberg, S., Pettigrew, S. and Julia, C. (2019), "Comparison of front-of-pack labels to help German consumers understand the nutritional quality of food products", *Ernährungs Umschau*, Vol. 66 No. 5, pp. 76-78.
- Egnell, M., Talati, Z., Galan, P., Andreeva, V.A., Vandevijvere, S., Gombaud, M., Dréano-Trécant, L., Hercberg, S., Pettigrew, S. and Julia, C. (2020), "Objective understanding of the nutri-score front-of-pack label by European consumers and its effect on food choices: an online experimental study", *International Journal of Behavioral Nutrition and Physical Activity*, Vol. 17, 146.
- Elizabeth, L., Machado, P., Zinöcker, M., Baker, P. and Lawrence, M. (2020), "Ultra-processed foods and health outcomes: a narrative review", *Nutrients*, Vol. 12 No. 7, 1955, doi: [10.3390/nu12071955](https://doi.org/10.3390/nu12071955).
- Fanzo, J., Hawkes, C., Udomkesmalee, E., Afshin, A., Allemandi, L., Assery, O., *et al.* (2014), "Nutrition, agriculture and the global food system in low and middle income countries", *Food Policy*, Vol. 47, pp. 91-96.
- Feldman, J.M. and Lynch, J.G. Jr (1988), "Self-generated validity and other effects of measurement on belief, attitude, intention, and behavior", *Journal of Applied Psychology*, Vol. 73 No. 3, pp. 421-435, doi: [10.1037/0021-9010.73.3.421](https://doi.org/10.1037/0021-9010.73.3.421).
- Feunekes, G.I.J., Gortemaker, I.A., Willems, A.A., Lion, R. and van den Kommer, M. (2008), "Front-of-Pack nutrition labelling: testing effectiveness of different nutrition labelling formats front-of-pack in four European countries", *Appetite*, Vol. 50 No. 1, pp. 57-70, doi: [10.1016/j.appet.2007.05.009](https://doi.org/10.1016/j.appet.2007.05.009).
- Fialon, M., Egnell, M., Talati, Z., Galan, P., Dréano-Trécant, L., Touvier, M., Pettigrew, S., Hercberg, S. and Julia, C. (2020), "Effectiveness of different front-of-pack nutrition labels among Italian consumers: results from an online randomized controlled trial", *Nutrients*, Vol. 12 No. 8, p. 2307, doi: [10.3390/nu12082307](https://doi.org/10.3390/nu12082307).
- Freire, W.B., Waters, W.F., Rivas-Mariño, G., Nguyen, T. and Rivas, P. (2017), "A qualitative study of consumer perceptions and use of traffic light food labelling in Ecuador", *Public Health Nutrition*, Vol. 20 No. 5, pp. 805-813, doi: [10.1017/s1368980016002457](https://doi.org/10.1017/s1368980016002457).
- Gough, T., Cummings, J.R., Evans, R., Hill, S., Jones, A. and Robinson, E. (2025), "Food in the news: effects of exposure to information about ultra-processed vs high in nutrients of concern foods on consumer perceptions and intake", *Appetite*, Vol. 214, 108217, doi: [10.1016/j.appet.2025.108217](https://doi.org/10.1016/j.appet.2025.108217).
- Grunert, K.G. and Wills, J.M. (2007), "A review of European research on consumer response to nutrition information on food labels", *Journal of Public Health*, Vol. 15 No. 5, pp. 385-399, doi: [10.1007/s10389-007-0101-9](https://doi.org/10.1007/s10389-007-0101-9).
- Hässig, A., Hartmann, C., Sanchez-Siles, L.M. and Siegrist, M. (2023), "Perceived degree of food processing as a cue for perceived healthiness", *Food Quality and Preference*, Vol. 110, 104944.
- Hawley, K.L., Robert, C.A., Bragg, M.A., Liu, P.J., Schwartz, M.B. and Brownell, K.D. (2013), "The science on front-of-package food labels", *Public Health Nutrition*, Vol. 16 No. 3, pp. 430-439, doi: [10.1017/s1368980012000754](https://doi.org/10.1017/s1368980012000754).
- Julia, C. and Hercberg, S. (2017), "Nutri-score: evidence of the effectiveness of the French front-of-pack nutrition label", *Ernährungs Umschau*, Vol. 64 No. 12, pp. 181-187.
- Kardes, F.R., Posavac, S.S. and Cronley, M.L. (2004), "Consumer inference: a review of processes, bases, and judgment contexts", *Journal of Consumer Psychology*, Vol. 14 No. 3, pp. 230-256, doi: [10.1207/s15327663jcp1403_6](https://doi.org/10.1207/s15327663jcp1403_6).
- Lane, M.M., Davis, J.A., Beattie, S., Gómez-Donoso, C., Loughman, A., O'Neil, A., Jacka, F., Berk, M., Page, R., Marx, W. and Rocks, T. (2021), "Ultra-processed food and chronic

- noncommunicable diseases: a systematic review and meta-analysis”, *Obesity Reviews*, Vol. 22 No. 3, e13146, doi: [10.1111/obr.13146](https://doi.org/10.1111/obr.13146).
- Lane, M.M., Gamage, E., Du, S., Ashtree, D.N., McGuinness, A.J., Gauci, S. and Marx, W. (2024), “Ultra-processed food exposure and adverse health outcomes: umbrella review of epidemiological meta-analyses”, *BMJ*, Vol. 384.
- Legault, L., Brandt, M.B., McCabe, N., Adler, C., Brown, A.M. and Brecher, S. (2004), “2000-2001 food label and package survey: an update on prevalence of nutrition labelling and claims on processed, packaged foods”, *Journal of the American Dietetic Association*, Vol. 104 No. 6, pp. 952-958, doi: [10.1016/j.jada.2004.03.024](https://doi.org/10.1016/j.jada.2004.03.024).
- Leshem, A., Segal, E. and Elinav, E. (2020), “The gut microbiome and individual-specific responses to diet”, *mSystems*, Vol. 5 No. 5, e00665-20, [10.1128/msystems.00665-20](https://doi.org/10.1128/msystems.00665-20).
- Luiten, C.M., Steenhuis, I.H.M., Eyles, H., Ni Mhurchu, C. and Waterlander, W.E. (2016), “Ultra-processed foods have the worst nutrient profile, yet they are the Most available packaged products in a sample of New Zealand supermarkets”, *Public Health Nutrition*, Vol. 19 No. 3, pp. 530-538, doi: [10.1017/s1368980015002177](https://doi.org/10.1017/s1368980015002177).
- Machín, L., Antúnez, L., Curutchet, M.R. and Ares, G. (2020), “The heuristics that guide healthiness perception of ultra-processed foods: a qualitative exploration”, *Public Health Nutrition*, Vol. 23 No. 16, pp. 2932-2940, doi: [10.1017/s1368980020003158](https://doi.org/10.1017/s1368980020003158).
- Martínez Steele, E., Baraldi, L.G., Louzada, M.L.C., Moubarac, J.-C., Mozaffarian, D. and Monteiro, C.A. (2016), “Ultra-processed foods and added sugars in the US diet: evidence from a nationally representative cross-sectional study”, *BMJ Open*, Vol. 6 No. 3, e009892, doi: [10.1136/bmjopen-2015-009892](https://doi.org/10.1136/bmjopen-2015-009892).
- Mazzù, M.F., Romani, S., Baccelloni, A. and Simonetti, E. (2021), “In search of superiority: exploring the effectiveness gap of front-of-pack nutritional labels. An assessment of consumer’s decision-making process toward healthier food choices”, *Hsoa Journal of Food Science and Nutrition*, Vol. 7 No. 3, pp. 1-5.
- Mazzù, M.F., Baccelloni, A., Romani, S. and Andria, A. (2022), “The role of trust and algorithms in consumers’ front-of-pack labels acceptance: a cross-country investigation”, *European Journal of Marketing*, Vol. 56 No. 11, pp. 3107-3137, doi: [10.1108/ejm-10-2021-0764](https://doi.org/10.1108/ejm-10-2021-0764).
- Mazzù, M.F., Romani, S., Marozzo, V., Giambarresi, A. and Baccelloni, A. (2023), “Improving the understanding of key nutritional elements to support healthier and more informed food choices: the effect of front-of-pack label bundles”, *Nutrition*, Vol. 105, 111849, doi: [10.1016/j.nut.2022.111849](https://doi.org/10.1016/j.nut.2022.111849).
- Mazzù, M.F., He, J. and Baccelloni, A. (2024), “Unveiling the impact of front-of-pack nutritional labels in conflicting nutrition information—a congruity perspective on olive oil”, *Food Quality and Preference*, Vol. 118, 105202, doi: [10.1016/j.foodqual.2024.105202](https://doi.org/10.1016/j.foodqual.2024.105202).
- McCausland, H.C., Nasser, J.A. and LaFata, E.M. (2026), “A narrative review of public and expert perceptions of ultra-processed foods: knowledge, opinions, and educational directions”, *Appetite*, Vol. 216, 108273, doi: [10.1016/j.appet.2025.108273](https://doi.org/10.1016/j.appet.2025.108273).
- Monteiro, C.A. (2009), “Nutrition and health. The issue is not food, nor nutrients, so much as processing”, *Public Health Nutrition*, Vol. 12 No. 5, pp. 729-731, doi: [10.1017/s1368980009005291](https://doi.org/10.1017/s1368980009005291).
- Monteiro, C.A., Levy, R.B., Claro, R.M., Castro, I.R.R. and Cannon, G. (2010), “A new classification of foods based on the extent and purpose of their processing”, *Cadernos de Saúde Pública*, Vol. 26 No. 11, pp. 2039-2049, doi: [10.1590/s0102-311x2010001100005](https://doi.org/10.1590/s0102-311x2010001100005).
- Monteiro, C.A., Moubarac, J.-C., Cannon, G., Ng, S.W. and Popkin, B. (2013), “Ultra-processed products are becoming dominant in the global food system”, *Obesity Reviews*, Vol. 14, pp. 21-28, doi: [10.1111/obr.12107](https://doi.org/10.1111/obr.12107).
- Moodie, R., Stuckler, D., Monteiro, C., Sheron, N., Neal, B., Thamarangsi, T., Lincoln, P. and Casswell, S. (2013), “Profits and pandemics: prevention of harmful effects of tobacco, alcohol, and ultra-processed food and drink industries”, *The Lancet*, Vol. 381 No. 9867, pp. 670-679, doi: [10.1016/s0140-6736\(12\)62089-3](https://doi.org/10.1016/s0140-6736(12)62089-3).

- Moubarac, J.-C., Batal, M., Martins, A.P.B., Claro, R., Levy, R.B., Cannon, G. and Monteiro, C.A. (2013), "Consumption of ultra-processed products and likely impact on human health: evidence from Canada", *Public Health Nutrition*, Vol. 16 No. 12, pp. 2240-2248.
- Moubarac, J.-C., Batal, M., Louzada, M.L.C., Martinez Steele, E. and Monteiro, C.A. (2017), "Consumption of ultra-processed foods predicts diet quality in Canada", *Appetite*, Vol. 108, pp. 512-520, doi: [10.1016/j.appet.2016.11.006](https://doi.org/10.1016/j.appet.2016.11.006).
- Muzzioli, L., Maddaloni, L., Pintavalle, M., Poggiogalle, E., Di Vincenzo, O., Migliaccio, S., Vinci, G. and Donini, L.M. (2025), "Toward multidimensional front-of-pack labels: integrating nutritional, environmental, and processing information", *Nutrients*, Vol. 17 No. 14, 2258, doi: [10.3390/nu17142258](https://doi.org/10.3390/nu17142258).
- Nieto, C., Tolentino-Mayo, L., Monterrubio-Flores, E., Medina, C. and Barquera, S. (2021), "Analysis of the impact on Mexican consumers of the new precautionary legends in processed foods with excessive nutrients", *Salud Pública de México*, Vol. 63 No. 4, pp. 542-549.
- Olivares-Cortés, S., Araneda-Flores, J., Morales-Illanes, G., Leyton-Dinamarca, B., Bustos-Zapata, N. and Hernández-Moreno, M. (2017), "Attitudes of Chilean students from different socioeconomic levels at the beginning of the implementation of the law governing the sale and advertising of foods high in critical nutrients", *Nutricion Hospitalaria*, Vol. 34 No. 2, pp. 431-438.
- Pagliai, G., Dinu, M., Madarena, M.P., Bonaccio, M., Iacoviello, L. and Sofi, F. (2021), "Consumption of ultra-processed foods and health status: a systematic review and meta-analysis", *British Journal of Nutrition*, Vol. 125 No. 3, pp. 308-318, doi: [10.1017/s0007114520002688](https://doi.org/10.1017/s0007114520002688).
- Poti, J.M., Mendez, M.A., Ng, S.W. and Popkin, B.M. (2015), "Is the degree of food processing and convenience linked with the nutritional quality of foods purchased by US households?", *The American Journal of Clinical Nutrition*, Vol. 101 No. 6, pp. 1251-1262, doi: [10.3945/ajcn.114.100925](https://doi.org/10.3945/ajcn.114.100925).
- Rein, M., Ben-Yacov, O., Godneva, A., Shilo, S., Zmora, N., Kolobkov, D., Cohen-Dolev, N., Wolf, B.-C., Kosower, N., Lotan-Pompan, M., Weinberger, A., Halpern, Z., Zelber-Sagi, S., Elinav, E. and Segal, E. (2022), "Effects of personalized diets by prediction of glycemic responses on glycemic control and metabolic health in newly diagnosed T2DM: a randomized dietary intervention pilot trial", *BMC Medicine*, Vol. 20 No. 1, 56, doi: [10.1186/s12916-022-02254-y](https://doi.org/10.1186/s12916-022-02254-y).
- Romero Ferreira, C., Lora Pablos, D. and Gómez de la Cámara, A. (2021), "Two dimensions of nutritional value: nutri-score and NOVA", *Nutrients*, Vol. 13 No. 8, 2783, doi: [10.3390/nu13082783](https://doi.org/10.3390/nu13082783).
- Sanchez-Siles, L.M., Domínguez-Torreiro, M., López-Nicolás, R. and Román, S. (2022), "Naturalness and healthiness in ultra-processed foods", *Food Quality and Preference*, Vol. 100, 104591.
- Sapio, S., Caso, G., Annunziata, A. and Vecchio, R. (2025), "Low-income consumers' perceptions of ultra-processed foods", *Food Quality and Preference*, Vol. 127, 105457, doi: [10.1016/j.foodqual.2025.105457](https://doi.org/10.1016/j.foodqual.2025.105457).
- Schnabel, L., Kesse-Guyot, E., Allès, B., Touvier, M., Srour, B., Hercberg, S., Buscail, C. and Julia, C. (2019), "Association of ultra-processed food consumption with risk of mortality among middle-aged adults in France", *JAMA Internal Medicine*, Vol. 179 No. 4, pp. 490-498, doi: [10.1001/jamainternmed.2018.7289](https://doi.org/10.1001/jamainternmed.2018.7289).
- Srour, B., Fezeu, L.K., Kesse-Guyot, E., Allès, B., Méjean, C., Andrianasolo, R.M., Chazelas, E., Deschasaux, M., Hercberg, S., Galan, P., Monteiro, C.A., Julia, C. and Touvier, M. (2019), "Ultra-processed food intake and risk of cardiovascular disease: prospective cohort study (NutriNet-Santé)", *BMJ*, Vol. 365, 11451, doi: [10.1136/bmj.11451](https://doi.org/10.1136/bmj.11451).
- Taillie, L.S., Hall, M.G., Popkin, B.M., Ng, S.W. and Murukutla, N. (2020), "Experimental studies of front-of-package nutrient warning labels on sugar-sweetened beverages and ultra-processed foods: a scoping review", *Nutrients*, Vol. 12 No. 2, 569, doi: [10.3390/nu12020569](https://doi.org/10.3390/nu12020569).
- Venkateshmurthy, N.S., Sharma, P., Ganpule-Rao, A., Prabhakaran, D., Mohan, S., Knai, C. and Knai, C. (2021), "A photovoice study to reveal community perceptions of highly processed packaged foods in India", *Ecology of Food and Nutrition*, Vol. 60 No. 6, pp. 810-825, doi: [10.1080/03670244.2021.1968853](https://doi.org/10.1080/03670244.2021.1968853).

Zeevi, D., Korem, T., Zmora, N., Israeli, D., Rothschild, D., Weinberger, A., Ben-Yacov, O., Lador, D., Avnit-Sagi, T., Lotan-Pompan, M., Suez, J., Mahdi, J.A., Matot, E., Malka, G., Kosower, N., Rein, M., Zilberman-Schapira, G., Dohnalová, L., Pevsner-Fischer, M., Bikovsky, R., Halpern, Z., Elinav, E. and Segal, E. (2015), "Personalized nutrition by prediction of glycemic responses", *Cell*, Vol. 163 No. 5, pp. 1079-1094, doi: [10.1016/j.cell.2015.11.001](https://doi.org/10.1016/j.cell.2015.11.001).

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