



Interaction effects between food labels related to health and environmental aspects: A scoping review

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ABSTRACT

Front-of-pack labels are widely used to communicate sustainability dimensions of foods. However, the growing number of labels raises concerns about potential interaction effects when multiple sustainability dimensions are communicated simultaneously. A scoping review was conducted to systematically map and synthesise the existing literature on consumer responses to the simultaneous presence of health-related and environmental front-of-pack labels on food products. We retrieved 7901 studies from the initial search, of which 23 met our inclusion criteria and have been included for analysis. The majority of studies applied quantitative experimental designs, primarily from Western countries. While both health and environmental labels individually tend to promote healthier and more sustainable choices, evidence on their combined effects remains inconclusive. Most studies found that two positive labels reinforce sustainable choices, whereas conflicting labels can induce compensatory inferences or confusion, potentially reducing label effectiveness. Very few studies explicitly examined conflicting dual labelling, highlighting a significant research gap. As such, it is not possible to draw general conclusions about interaction effects between health and environmental labels on foods. Overall, the findings underscore the need for systematic experimental research on dual labelling to enable general conclusions about the direction of label interaction effects.

1. Introduction

The United Nations Sustainable Development Goals (SDGs) represent a comprehensive global policy framework aimed at eradicating poverty, safeguarding the environment, promoting universal prosperity, and eliminating hunger and malnutrition. This ambitious and integrative agenda incorporates objectives related to human health and environmental sustainability across the majority of its targets (United Nations, 2015).

As set out in SDG 12, one key approach in accelerating the sustainable development has been to foster sustainable consumption choices. This is particularly crucial in relation to food choices. Food production and, consequently, consumption are major contributors to greenhouse gas emissions (Clune, Crossin, & Verghese, 2017), water depletion (Mekonnen & Gerbens-Leenes, 2020), and biodiversity loss (IPBES,

2019). Consequently, the urgency of transitioning to a more sustainable food system is increasing. However, since consumers cannot verify sustainability attributes either before or after purchasing a product, additional information is required to support more sustainable food choices. Labels offer a promising approach to communicate sustainable product characteristics as credence attributes in an understandable and concise manner (Fernqvist & Ekelund, 2014).

Consumers often make food choices under time pressure and cognitive constraints, which reduces the amount of information processing during decision-making (Huseynov & Palma, 2021). Consequently, consumers frequently rely on simple decision heuristics when evaluating food options (Scheibehenne, Miesler, & Todd, 2007). Food labels can influence consumer decision-making by reducing information asymmetries and by providing simplified cues that facilitate product evaluation at the point of purchase.

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Behavioural research further suggests that such labels can influence choices through both deliberative and intuitive decision-making processes. According to dual-process theories of decision-making, consumer behaviour may be shaped by both fast, automatic, and unconscious (System 1) thinking and by slow, logical, and conscious (System 2) thinking (Kahneman, 2011). Simplified visual cues such as colours, symbols, or summary scores may therefore guide food choices at the point of purchase by triggering intuitive evaluations.

However, these simplified cues may also generate unintended cognitive biases. One relevant phenomenon is the so-called halo effect, whereby the presence of one positive attribute (e.g., a positive health-related label) leads consumers to infer broader product benefits that are not justified (Chandon & Wansink, 2012). Such halo effects become particularly relevant when several labels are displayed simultaneously on a product, as consumers may rely on one salient cue while overlooking potentially conflicting information.

Building on this, the European Commission launched the “Sustainable EU Food System” initiative in 2021, which aims to define rules for sustainability labelling of food (European Commission, 2021). The Commission also plans to introduce standardized, mandatory front-of-pack nutritional labelling (Jones, Maganja, Shahid, Neal, & Pettigrew, 2024). This reflects that front-of-pack labelling is increasingly adopted as a food policy intervention to help consumers make sustainable purchase decisions. Furthermore, the proliferation of labels has been driven by both governmental and industry initiatives. Labels are one policy instrument used worldwide to support sustainable food consumption (Ammann, Arbenz, Mack, Nemecek, & El Benni, 2023). As a result, an increasing number of labels addressing various sustainability dimensions - such as health, animal welfare, and environmental impact - are appearing on food products.

These labels differ in the type of information they convey and the way the information is communicated to consumers. As the market for nutrition labelling is already highly differentiated, this is used as an example. For nutrition labelling, four distinct categories of front-of-package labels can be identified.

First are endorsement labels, which may only be used if specific, predefined criteria are met. A well-known example is the Keyhole label in Denmark. Second are summary indicator systems, which provide an overall assessment of a product's relative healthfulness by combining multiple nutrient criteria into a single score. Examples include the Nutri-Score and Australia's Health Star Rating. Third are nutrient-specific warning labels, which signal when a product exceeds established thresholds for certain nutrients (e.g., sugar, salt, saturated fats). The Chilean warning label is a prominent example. Finally, nutrient-specific interpretive labels present individual nutrient information separately, often using colour-coded systems for easy interpretation. The UK's multiple traffic light label is a widely recognized instance of this approach (Ferrand, 2021). The ever-growing number of labels means that consumers are increasingly confronted with multiple labels appearing simultaneously on a product. In addition, the increasing use of summary indicator labels has created situations where consumers encounter conflicting labels on a product. For instance, a packaged muesli may carry a Nutri-Score D suggesting an unhealthy choice, while at the same time displaying a green eco-score, indicating a low environmental impact.

So far, it remains unclear how consumers process and evaluate different and potentially conflicting food labels. Recent studies have begun to investigate intra-sustainability label trade-offs (de Bauw, Matthys, Poppe, Franssens, & Vranken, 2021; Jürkenbeck, 2023; Jürkenbeck et al., 2024; Sonntag, Lemken, Spiller, & Schulze, 2023). Among the potential trade-offs, the simultaneous presence of nutritional and environmental labels is of particular relevance. Both dimensions (health and environment) have the potential to support informed consumer choices and were classified as very significant (Cecchini & Warin, 2016; Potter et al., 2021). When health and environmental labels are placed simultaneously on the same foods, interaction effects may occur.

Thus, if several labels are placed on a food product, the individual labels can no longer be considered in isolation. Potential interaction effects can affect label effectiveness and may lead to unintended, even adverse, outcomes. However, these interactions and their implications for consumer decision-making have not yet been fully elucidated. A better understanding of these potential trade-offs is therefore supporting evidence-informed food label policies.

A common label, representing the health dimension of sustainable nutrition, in Europe is the Nutri-Score. Several initiatives are currently developing environmental labels for food, both from the public and private sectors. Examples are Denmark's national initiative (Lebensmittelpraxis, 2024), Foundation Earth (Foundation Earth, 2022), Ecoscore by Beelong (Beelong, 2025), and Planet-Score (L'Institut de l'agriculture et de l'alimentation biologiques, 2022). Besides, studies suggest that a relevant fraction of consumers in the EU are also interested in the environmental impacts of their food choices (Potter et al., 2021). Accordingly, environmental labels are an effective way of enabling consumers to take this information into account in their behaviour and thus help to protect the environment (Dihl, Berthold, & Sütterlin, 2021; Thøgersen, 2021). In addition, such labels may also appeal to less interested consumers and foster more informed public debates (Lemken, Zühlsdorf, & Spiller, 2021). At the same time, challenges might arise if consumers are confronted with multiple, sometimes even conflicting labels on the same product. If multiple labels are perceived as confusing, inconsistent or overwhelming (Fitzgerald, Russo Donovan, Kees, & Kozup, 2019; Garaus, Wagner, & Kummer, 2015), they may lead to less environmentally friendly or less healthy choices.

To date, a comprehensive overview of how consumers perceive and respond to health and environmental labels presented simultaneously on a product is lacking.

Therefore, this scoping review aims to systematically map and synthesise the existing literature on consumer responses to the simultaneous presence of health-related and environmental front-of-pack labels on food products.

2. Method

2.1. Protocol registration

Scoping reviews are well-suited for studying areas that have not been comprehensively reviewed before. They provide detailed and structured overviews of the literature and identify research gaps (Arksey & O'Malley, 2007). The review was registered with the Open Science Framework (https://osf.io/6j5ay/?view_only=d3d45e0c3aab46f1b9dd ee9b02485987). The methods are based on standard scoping review methodology as recommended by the Joanna Briggs Institute (JBI) Handbook (JBI Manual for Evidence Synthesis, 2020) and the reporting follows the PRISMA extension for Scoping Reviews (PRISMA-ScR) (Pollock et al., 2023). The detailed checklist is provided in the Supplementary Material, Table 1.

2.2. Search strategy, screening and data extraction

Studies were included in the review based on a set of predefined eligibility criteria (Supplementary material, Table 2) based on the PPC framework (population, concept, and context) (Pollock et al., 2023). It is recommended for constructing clear and meaningful objectives and eligibility criteria for scoping reviews. The population of interest encompasses any kind of consumers, without restrictions regarding demographic characteristics such as age, gender, or socioeconomic status. The intervention under consideration is the simultaneous use of food labels that relate to both health aspects (such as nutritional value) and environmental aspects (such as carbon footprint).

With regard to the types of labels, the review focuses on quantifiable environmental labels, such as CO₂ labels, as well as the organic label. The latter is included due to its widespread perception among

consumers as an environmental label, despite ongoing debates regarding the actual environmental merits of organic agriculture (Clark & Tilman, 2017). However, labels indicating regional production were excluded, as these are typically not regulated by law. For example, in case of labelling as ‘from my region’, there is no legal regulation specifying the radius in kilometers of the point of sale that counts as ‘from my region’. Additionally, those labels may appeal to motives unrelated to environmental or health concerns, such as ethnocentrism or support for the local economy. For health labels, only those that relate to the nutritional value of food products were considered.

There were no restrictions based on country or geographic location. Studies that do not employ an empirical research design, such as commentaries or opinion pieces, were excluded from the review. The review considered any form of academic literature, including peer-reviewed journal articles and non-peer-reviewed articles such as preprints. Studies published in English and German were included. However, literature searches were conducted in English only. The search strategy was pre-tested and was based on four search concepts: i) food, diets and nutrition; ii) labelling; iii) health; and iv) environmental sustainability. To increase sensitivity, a variety of different search terms was included

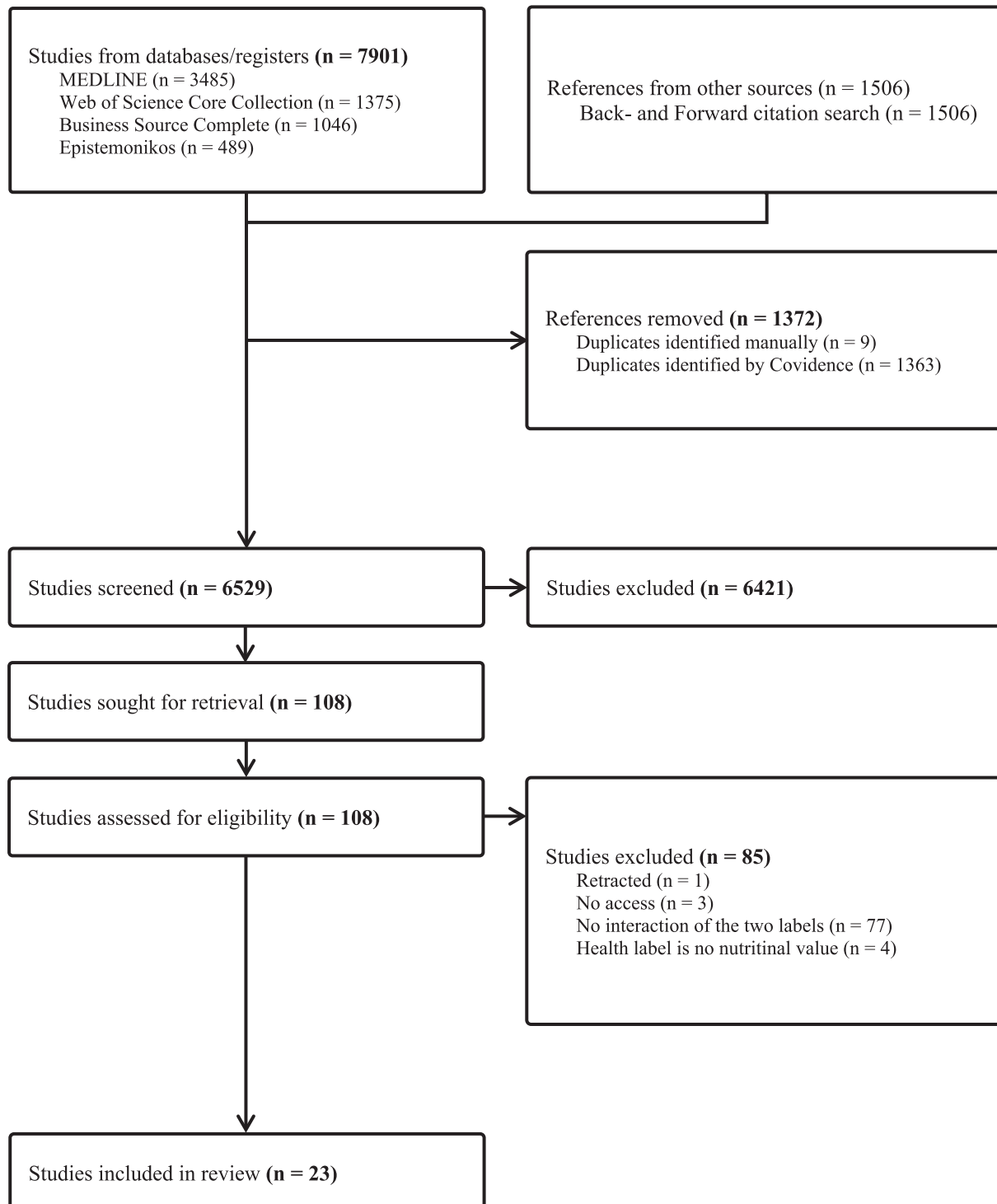


Fig. 1. PRISMA flow chart.

for each search concept. The search strategy was developed for Web of Science Core Collection (Supplementary material, Table 3) and adapted for each database. The databases MEDLINE, Business Source Complete, Web of Science Core Collection, and Epistemonikos were chosen to capture research from different disciplines. The search was restricted by publication dates after 2000 up to 11 July 2024. To manage the review process, we used Covidence. After the removal of duplicates, titles and abstracts of all identified studies ($n = 6395$) were independently screened by two of the four review authors (K.J., R.E., M.S., P.v.P.). If there were any disagreements, these were resolved by a third review author. Subsequently, full texts were screened by two review authors (K. J., R.E.). A back- and forward citation search was carried out for each of the 22 identified studies. This identified a further 1506 studies eligible for title and abstract screening. In total we carried out two rounds. A total of 7901 studies were screened independently by two review authors. One study from the back- and forward citation search was classified as relevant. Thus, a total of 23 studies were identified.

A standardized data extraction form was created in accordance with the research aims (Supplementary material, Table 4). A pilot test of the data extraction form was conducted using two studies (von Elm, Schreiber, & Haupt, 2019). Data extraction was conducted by one review author (R.E.) using a predefined extraction sheet. A second review author (K.J.) checked the data extraction. The results were synthesized narratively. The included studies were summarized according to the authors, publication year, country, aim of the study, research question, research design, sample, method of participants' recruitment, health label, environmental label, product example, results, future research, and limitations mentioned by the authors.

3. Results

3.1. Results of the search

We retrieved 7901 studies from the initial search and assessed 108 full texts for eligibility, of which 23 met our inclusion criteria and have been included for analysis (Fig. 1). Details on the search and screening process are shown in the PRISMA flow chart in Fig. 1.

The retrieved literature represents 11 countries. The vast majority (20) of the studies come from Western countries. Half of these come from the US (5) and the UK (5). Two studies were conducted in China and one study in Chile (Fig. 2). Between 2017 and 2020, three studies

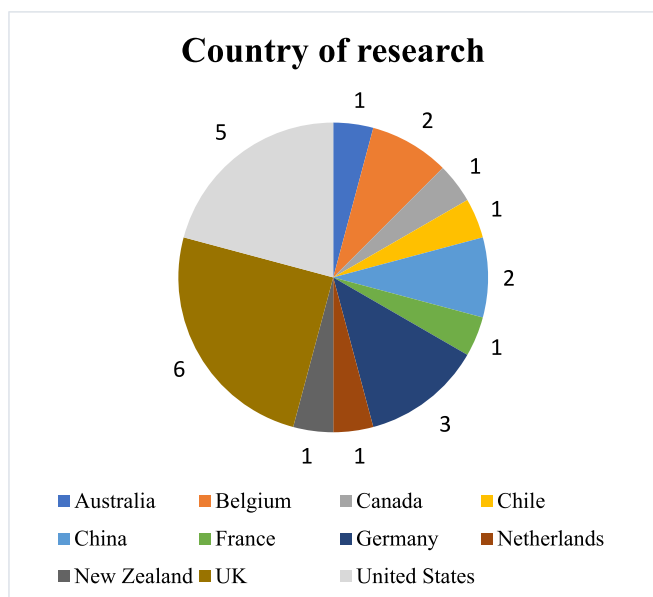


Fig. 2. Countries in which the included studies were conducted.

were conducted. The remaining 20 studies were published between 2021 and 2024.

The included studies used a variety of different study designs. The majority (22 out of 23) of the studies identified were quantitative in nature. Only one study can be categorised as qualitative research. The quantitative methods included online experiments (e.g. choice experiments) and real-world experiments in a canteen. The qualitative research employed focus group discussions as a method (Supplementary material 2).

The health and environmental labels that were investigated in the studies vary, both in terms of the number of the five label types (endorsement label, warning label, summary indicator label, traffic-light, label and others) and the specific labels within the five label types varied (Fig. 3).

Some studies have examined existing labels, while others have invented their own labels. As existing health labels, the Nutri-Score ($n = 6$), health star rating ($n = 1$), nutrition warning label ($n = 1$), and the nutrition fact label ($n = 1$) were studied. The carbon footprint label ($n = 6$), Eco-Score (renamed in November 2024 to Green-Score; $n = 4$), and greenhouse gas emissions ($n = 2$) were used as existing environmental labels.

As a consequence of the variety of utilized labels, the type and quantity of information provided by the labels varies. Some labels belong to the category endorsement labels and are one-dimensional (e.g. a green sustainability tick or a heart) while others are summary indicator labels, which combine several dimensions into a single, easily interpretable overall assessment (e.g. Nutri-Score, Eco-Score).

3.2. Interaction effects between health and environmental labels

Depending on the research design of the included studies, they examined different types of front-of-pack labels. In case of dual labelling, positive-positive, negative-negative and conflicting label combinations (positive-negative and vice versa) were examined. The large majority of studies conclude that health- and environmental labels promote a sustainable food choice.

However, the results for the dual labelling situation are very complex. In most cases, having two positive scores leads to a shift towards a more sustainable choice (Asioli & Grasso, 2021; Pink, Stylianou, Lee, Jolliet, & Cheon, 2022; Sleboda, de Bruin, Gutsche, & Arvai, 2024; Sonntag et al., 2023; Wolstenholme, Poortinga, & Whitmarsh, 2020). Sometimes the effect is driven by a single label (de Bauw et al., 2021), though a study by Yang et al. (2021) suggests that two positive labels can encourage a less sustainable choice. In contrast, Sigurdsson et al. (2023) and Weinand (2023) found no such effect. The study by Jürkenbeck et al. (2024) show that consumers rate French fries as healthier when the green environmental label (Eco-Score) is displayed alongside the green Nutri-Score than when only the green Nutri-Score is displayed. Research by Hoek, Pearson, James, Lawrence, and Friel (2017) included two positive labels, and the results showed that the environmental label was considered more important than the health label. However, it should be noted that, although both labels indicated a positive value, the colouring of the health label indicated the opposite, as it was red.

When two negative labels discourage the less sustainable option, then a sustainable choice is encouraged (Jürkenbeck et al., 2024; Pink et al., 2022; Sonntag et al., 2023). The study by Jürkenbeck et al. (2024), tested various dependent variables and found that, when evaluating the attractiveness of a product, it is the product with two negative labels that was perceived as the least attractive. The results of Weinand (2023) support this, showing that quality perception is lower with two negative labels than with a single label. Sonntag et al. (2023) found no significant interaction effect in a choice experiment. Furthermore, Pink et al. (2022) concluded that there is no additive effect of two negative labels.

Out of the 23 included studies, only five studies analysed consumer behaviour in terms of conflicting label ratings. When a positive and negative label are combined, the positive label cancels out the negative

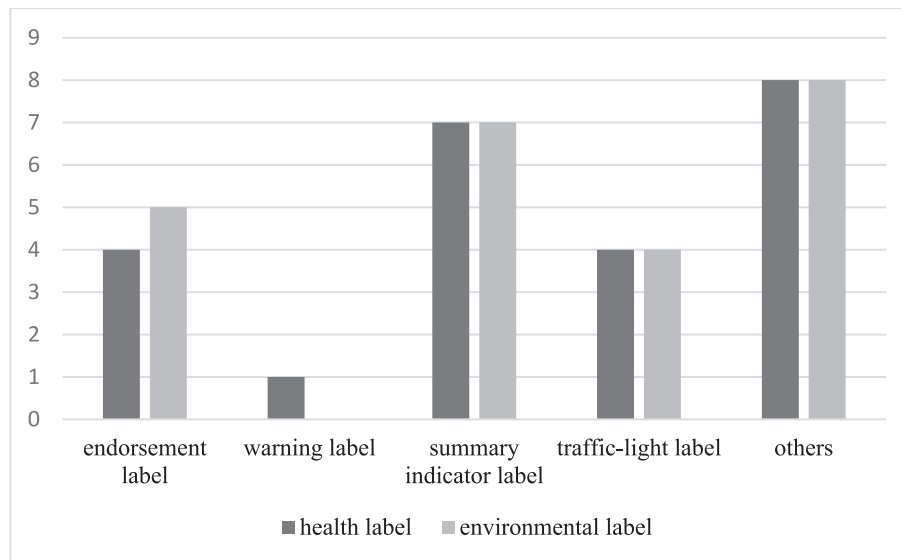


Fig. 3. Number of investigated labels of the five label categories.

one (Lebensmittelpraxis, 2024). Weinand (2023) found similar results. Once again, it is evident that positive nutritional information can compensate negative information about a product's carbon footprint. For instance, Pink et al. (2022) demonstrated that a positive health label outweighs the environmental label. However, Marette (2022) showed the opposite, demonstrating that a red environmental label had a stronger influence than a green health label. If the environmental label shows a positive characteristic and the health label shows a negative characteristic, the product is classified by study participants as healthier due to a spillover effect of the green environmental label (Jürkenbeck et al., 2024).

In general, due to the inconclusive results of the few existing studies that focus specifically on interaction effects, only cautious conclusions can be drawn regarding the interaction effects of labels.

4. Discussion

4.1. Pattern of interaction effects

This scoping review aimed to synthesise the existing literature on consumer responses to the simultaneous presence of health and environmental labels. Overall, only 23 studies examining such interaction effects of food labels were identified, and the results remain heterogeneous and inconclusive. In most cases, the presence of two positive labels leads to a more sustainable choice. Sometimes, however, the effect is driven by a single label (de Bauw et al., 2021), but there is also a study indicating that the presence of two positive labels can actually reduce sustainable choices (Yang et al., 2021). One explanation could be that consumers may think that a product cannot be good in both dimensions, a phenomenon known as compensatory inferences (Wänke, 2009). This can lead to skepticism and weaken the impact of both labels, thereby hindering sustainable choices. These heterogeneous findings highlight that interaction effects between health and environmental labels cannot be assumed to follow a simple additive logic. Instead, the observed behavioural responses suggest that consumers may rely on cognitive shortcuts when confronted with multiple labels. Understanding the mechanisms underlying these responses is therefore essential for interpreting the patterns observed in the existing literature.

4.2. Underlying behavioural mechanisms

Several behavioural mechanisms may help to explain the

heterogeneous interaction effects observed in different studies. One important mechanism is the halo effect, whereby the presence of a positive attribute in one area causes consumers to assume that the product has additional benefits that are not explicitly stated (Chandon & Wansink, 2012). In the context of dual labelling, a positive environmental label may lead consumers to perceive a product as healthier than it actually is, or vice versa. Evidence of such spillover effects has been observed in experimental studies where environmental labels have influenced perceptions of nutritional quality (Jürkenbeck et al., 2024).

Conversely, compensatory inferences may occur when consumers find it implausible that a product can perform well across multiple sustainability dimensions simultaneously (Wänke, 2009). In such cases, the presence of two positive signals may reduce credibility and trigger skepticism, potentially weakening the influence of both labels. This mechanism may explain why some studies have found that presenting two favourable signals does not necessarily lead to more sustainable product choices, and in rare cases can even result in fewer of them.

In addition to these inferential processes, simple visual cues may also influence consumer behaviour. Research in contexts with a single label has shown that colour signals can play a significant role in guiding consumer decisions, with red labels typically having stronger behavioural effects than green ones (Carlsson, Kataria, Lampi, Nyberg, & Sterner, 2021; Vasiljevic et al., 2024). When multiple labels are presented simultaneously, such visual salience may influence which label receives the greatest attention and ultimately drives the decision-making process. Taken together, these mechanisms suggest that consumers do not necessarily process multiple sustainability signals in an analytically integrated manner.

4.3. Positioning the findings within the broader front-of-pack labelling literature

Within the broader literature on nutrition labelling, nutrient-specific warning labels have emerged as effective policy instruments for encouraging healthier food choices (Clarke et al., 2021; Nobrega, Ares, & Deliza, 2020). Evidence from countries that have implemented such systems, most notably Chile, indicates that warning labels highlighting high levels of nutrients of concern (e.g. sugar) can significantly influence purchasing behaviour (Da Silva, Bento, & Guaraldo, 2022).

Despite this strong evidence base, warning labels are largely absent from the dual labelling literature identified in this review. Most of the studies examined summary indicator systems, such as Nutri-Score or

Eco-Score, while experimental designs investigating the simultaneous presentation of health and environmental information rarely included nutrient-specific warning labels. Consequently, the current evidence provides little insight into how warning labels interact.

Another important factor is the effect of colour. Research on the colour effect of single labelling clearly shows that red has a stronger effect than green (Carlsson et al., 2021). In some cases, this effect was also found with dual labelling. However, other studies showed the opposite effect. Thus, no consistent conclusions can be drawn regarding the colour effect in dual labelling.

These gaps are particularly relevant in situations where products receive conflicting evaluations across sustainability dimensions. For instance, a product may have a favourable environmental label and simultaneously display a nutritional warning for high sugar or fat content. As warning labels are designed to indicate risk rather than relative performance, they may overshadow other label information and influence how consumers make decisions regarding such trade-offs. However, the existing literature does not yet permit robust conclusions to be drawn about these potential interaction effects.

4.4. Relation to recent reviews

After we had completed our literature search, two reviews were published in 2025 which, at first glance, appeared to deal with a similar topic. However, on closer inspection, they differed significantly. Andreani, Sogari, Wongprawmas, Menozzi, and Mora (2025), published a review of the Eco-Score and Nutri-Score. However, they did not focus on interaction effects when both labels are placed on foods. Instead, they emphasised labels in isolation on consumer understanding, attitudes and behaviours.

Additionally, Muzzioli et al. (2025) examined three labelling dimensions in their review: food processing, nutrition, and the environment. Only in a small subsection do the authors address the literature on dual labelling. They concluded that the process of incorporating various aspects of healthy and sustainable diets into food labelling is still in its early stages. Our review confirms these conclusions: of the 23 studies investigating dual labelling, only five of these studies consider conflicting dual labelling situations, which may carry the highest risk of hindering a sustainable food choice.

4.5. Strengths, limitations and future work

Overall, the results of this review indicate that the growing variety of sustainability-related labels on food products creates a complexity that should not be underestimated. This complexity is reflected in the diversity of studies investigating interaction effects. On the one hand, different categories of labels (e.g. warning label, summary indicator label) were examined. On the other hand, both existing and fictitious labels were considered. Furthermore, the empirical approaches varied considerably, ranging from qualitative explorations to quantitative experiments. This methodological heterogeneity illustrates that considerable research effort is necessary to draw robust conclusions about consumer behaviour when dual labelling applies.

First, with regard to non-conflicting dual labelling (green/green and red/red), important questions remain. For example, it is still unclear whether the effects of each label can simply be added up or if the effects are mutually discounted. Second, with regard to conflicting dual labelling, many open questions remain unanswered. In particular, it remains unclear how consumers behave, for example, whether they might compensate labels for each other in some situations. So far, only fragments have been found in the literature, which allows only cautious conclusions.

This scoping review also has limitations that should be acknowledged. In this scoping review, the analysis was restricted to health and environmental labels. However, social and animal welfare labels were not included but these dimensions are also considered important

components of a sustainable diet. Therefore, future research should extend the analysis to interactions between labels representing different sustainability pillars. As far as the authors are aware, no studies have yet systematically investigated interaction effects for labels related to the four pillars of a sustainable diet (Spiller et al., 2020). Another limitation is the potential for publication bias, whereby non-significant interaction terms may not have been published among the included studies or in the wider literature.

From a policy perspective, the relevance of understanding dual labelling interactions is likely to increase in the coming years. Within the EU's Farm-to-Fork strategy, the European Commission plans to introduce mandatory front-of-pack nutritional labelling on food products (European Commission, 2021). Mandatory labelling on food products even further increases the likelihood that consumers will encounter dual labelling when purchasing food, which may display conflicting information.

Consequently, further empirical research on dual labelling is required. In particular, future studies should focus more on situations involving conflicting dual labelling, as only five studies analyzing this phenomenon were identified in the present scoping review. Therefore, understanding how consumers process and prioritize conflicting sustainability signals will be essential for designing effective and coherent food labelling policies.

5. Conclusion

Overall, further a substantial amount of research is needed to improve the understanding of the interaction effects between health and environmental labels. As the number of labels on the market continues to grow, the resulting abundance of information may confuse consumers. In most cases, labels are introduced without any accompanying communication measures, so it is unclear whether consumers interpret them correctly. To ensure correct understanding and informed decision-making, it is essential that label introducers such as policymakers and retailers - implement targeted communication strategies alongside labelling initiatives.

CRediT authorship contribution statement

Kristin Jürkenbeck: Writing – review & editing, Writing – original draft, Supervision, Project administration, Methodology, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Rebecca Elsner:** Methodology, Formal analysis, Data curation. **Peter von Phillipsborn:** Writing – review & editing, Funding acquisition, Data curation, Conceptualization. **Dominic Lemken:** Writing – review & editing, Funding acquisition. **Maureen Schulze:** Writing – review & editing, Methodology, Formal analysis, Data curation.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.foodqual.2026.105967>.

Data availability

Data will be made available on request.

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