Turning FOP nutrition labels into action: A systematic review of label+ interventions

Eva-Maria Schruff-Lim [a,*], Ellen J. Van Loo [a], Ellen van Kleef [a], Hans C.M. van Trijp [a]

[a] *Marketing and Consumer Behaviour Group, Wageningen University & Research, Hollandseweg 1, 6706 KN Wageningen, the Netherlands*

ARTICLE INFO

ABSTRACT

The effectiveness of nutrition labels in modifying dietary choices remains limited. Information provision alone is a necessary yet insufficient condition for behavior change to occur. Individuals need to (1) turn information into knowledge and (2) turn knowledge into behavior. This article provides a theoretical framework that suggests that complementary interventions may be needed to target barriers that prevent individuals from processing and acting upon FOP nutrition labels. Evidence about which interventions can support nutrition labels for behavioral change is scattered. This article addresses this research gap through a systematic review of multicomponent nutrition label interventions (*label+ interventions*) and their effects on the actual healthfulness of dietary choices. From the 3519 records identified, 85 label+ interventions were included. The findings provide limited evidence for the effectiveness of supporting nutrition labels with educational material or reference information. The evidence for supporting nutrition labels with interactive digital interventions, such as basket feedback, or financial incentives is promising. Overall, the findings indicate that more intrusive interventions are required to give cause to act on nutrition labels. Implications and future research avenues for the various label+ categories are discussed.

Trial registration: PROSPERO systematic review registration number: CRD42020183141.

1. Introduction

Empowering consumers to make informed dietary choices has been an important strategy in reducing non-communicable diseases and obesity. However, the early attempts of providing nutrition information in the form of the nutrition facts panel on the back of products have been met with poor understanding by consumers (Campos, Doxey, & Hammond, 2011; Cowburn & Stockley, 2005). As a consequence, simpler front-of-pack (FOP) nutrition labels have gained increasing popularity in research, marketing, and public policy (Kanter, Vanderlee, & Vandevijvere, 2018) with the aim to improve the salience, understanding, and use of nutrition information (FDA, 2010). A variety of FOP nutrition labels (see Fig. 1) have been developed which vary in their level of aggregation (nutrient-specific vs. summary indicators) and interpretation (reductive/descriptive vs. interpretative/evaluative) (Ikonen, Sotgiu, Aydinli, & Verlegh, 2020; Kanter et al., 2018). However, when making food choices, consumers' attention to and use of FOP nutrition labels is often low (Grunert, Wills, & Fernández-Celemín, 2010). As such, the effect of FOP nutrition labels on actual behavior remains limited regardless of the design (e.g., Bauer & Reisch, 2019; Cadario & Chandon, 2020; Ikonen et al., 2020; Perez-Cueto, 2019).

Complementary interventions may be needed to target barriers that prevent individuals from processing and acting upon FOP nutrition labels (hereafter called *label+ interventions*). The aim of the current study is to provide a theoretical framework on barriers of FOP nutrition label use and how supporting interventions could address these barriers. A systematic search was used to identify existing research on label+ interventions and the evidence of their effectiveness in changing dietary choices is synthesized in a narrative form. To the authors' knowledge, this is the first review to focus on nutrition label+ interventions. The review provides insights about which interventions most effectively support nutrition labels and identifies future research recommendations.

2. Theoretical background

The challenge of purposive communication consists of two steps, (1) to turn information into knowledge and (2) to turn knowledge into behavior (Hornik, 1989). Individuals need to process nutrition information, understand it, and decide to act upon it in their decision (Grunert et al., 2010). Processing and acting upon nutrition information in food choices, like any behaviors, are driven by an individual's motivation, opportunity, and ability (MOA) (MacInnis & Jaworski, 1989; Rothschild, 1999). The MOA framework has been used to describe, understand, and predict when information is being processed (Grunert, 2011; MacInnis & Jaworski, 1989) and when a behavior is performed (Brug, 2008; Ölander & Thøgersen, 1995; Rothschild, 1999). In the current study these frameworks are integrated into an overall theoretical framework, explaining when and how nutrition information is turned into knowledge and ultimately into action (see Fig. 2). We suggest that turning information into knowledge (step 1) achieves transparency of nutrition information. Following the definition by Michener and Bersch (2013), transparency is achieved when individuals are able to detect (i.e., visibility) and understand nutrition information (i.e., inferability). Converting knowledge into action (step 2) achieves actionability of the information, defined in this article as giving individuals cause for action.

FOP nutrition labels provide individuals the opportunity to objectively process nutrition information (De Bauw, De La Revilla, Poppe, Matthys, & Vranken, 2022; Grunert, Hieke, & Wills, 2014; Hung, Grunert, Hoefkens, Hieke, & Verbeke, 2017). As the nutritional content of a food product cannot be observed (i.e., credence quality attribute), nutrition information needs to be explicitly communicated to reduce information asymmetry between manufacturers and individuals (van Trijp, 2009; Verbeke, 2005). However, providing opportunity to process nutrition information is a necessary but not sufficient condition for FOP nutrition labels to be processed when making food choices. To process the information various processing operations need to be undertaken which require an increasing amount of processing capacity, starting from noticing the cue (feature analysis), recognizing it is a nutrition label (basic categorization), understanding the absolute healthfulness of the individual product (meaning analysis), understanding the relative healthfulness across a set of products (information integration), and ultimately relating the healthfulness information to prior knowledge and to the self (constructive processes and role-taking operations) (MacInnis & Jaworski, 1989). According to the elaboration-likelihood model (Petty & Cacioppo, 1986), the depth of information search and processing depends on the individual's ability and motivation. However, even if individuals understand the nutrition information (i.e., have the ability to make a healthy choice), they might not turn this knowledge into behavior (knowledge-behavior gap, Hornik, 1989) because they lack motivation or opportunity to act upon the nutrition information (Rothschild, 1999).

2.1. Step 1: Turning information into knowledge

2.1.1. Barrier 1: Lack of ability to process nutrition information

Considering nutrition information requires individual's ability to search, process, and comprehend the information. The ability to process nutrition information can be constrained by personal and environmental barriers. The personal barrier and main aspect of ability relates to an individual's skills and knowledge to interpret the information (MacInnis, Moorman, & Jaworski, 1991). Prior research confirms that FOP nutrition labels are generally well understood and increase individuals' ability to rank products according to nutritional quality (e.g., Ikonen et al., 2020; Nohlen et al., 2022). However, individuals with lower educational level, income, self-reported nutritional knowledge, and higher age have more difficulties to understand FOP labels (Ducrot et al., 2015; Nohlen et al., 2022). Possible interventions that increase consumers' ability to use nutrition information by increasing the skills and knowledge to interpret the information could be providing education and trainings (Michie et al., 2011; Rothschild, 1999). Consumer education campaigns should support the introduction of FOP nutrition labels and could inform the public about FOP nutrition labels and how to correctly use them (Nohlen et al., 2022; Roberto et al., 2021).

The environmental barrier of ability to process nutrition information relates to the ease with which nutrition information can be considered in an information overloaded environment (Bauer & Reisch, 2019). Especially in supermarkets consumers are presented with a variety of competing information sources (e.g., regarding brand, flavor, price, nutrition information) across a large choice set which makes the choice process cognitively demanding (Ketron, Spears, & Dai, 2016). Rather than assessing all available information, as rational choice theory (Aleskerov, Bouyssou, & Monjardet, 2007) would suggest, consumers' limited time and cognitive capacities often lead to quick decisions without examining and weighting all information (Cohen & Babey, 2012; Schulte-Mecklenbeck, Sohn, de Bellis, Martin, & Hertwig, 2013; Simon, 1955). This highlights the need for supportive environments that facilitate using nutrition labels by reducing complexity of processing nutrition information during the shopping trip (De Bauw et al., 2022). Possible interventions that increase consumers ability to use nutrition information by making it easier to consider nutrition labels could be presentation alterations (e.g., benefit-based categorization, sorting, filtering).

2.1.2. Barrier 2: Lack of motivation to process nutrition information

Processing information requires a certain level of motivation and the lack of motivation presents a major barrier to the effectiveness of nutrition labels (Bialkova & van Trijp, 2011; Grunert et al., 2010; Van Loo et al., 2015). In the current study, motivation to process is defined as the individuals' desire or readiness to process the nutrition information in the food choice (MacInnis et al., 1991). Motivation to process nutrition information is driven by an interest in healthy eating (Hung et al.,
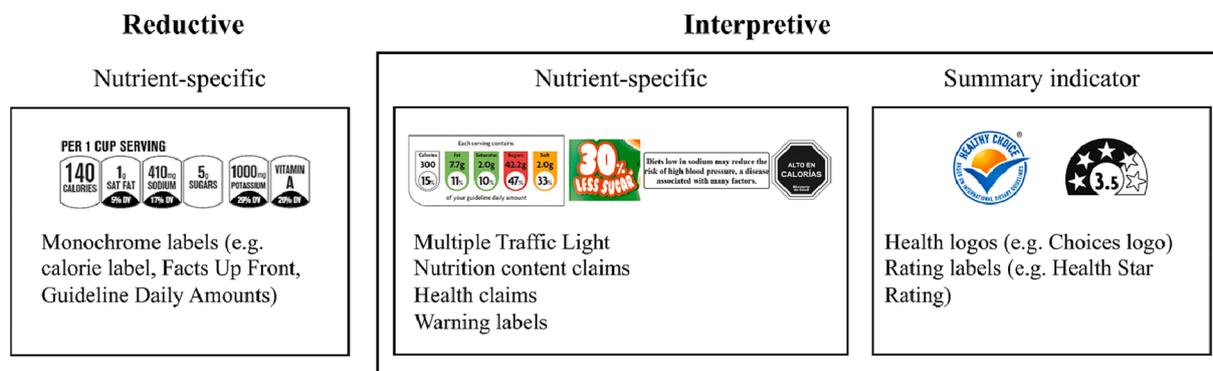

Fig. 1. Typology and selective examples of FOP nutrition labels (Reproduced from Ikonen et al. (2020), used under the terms of the Creative Commons Attribution 4.0 license).
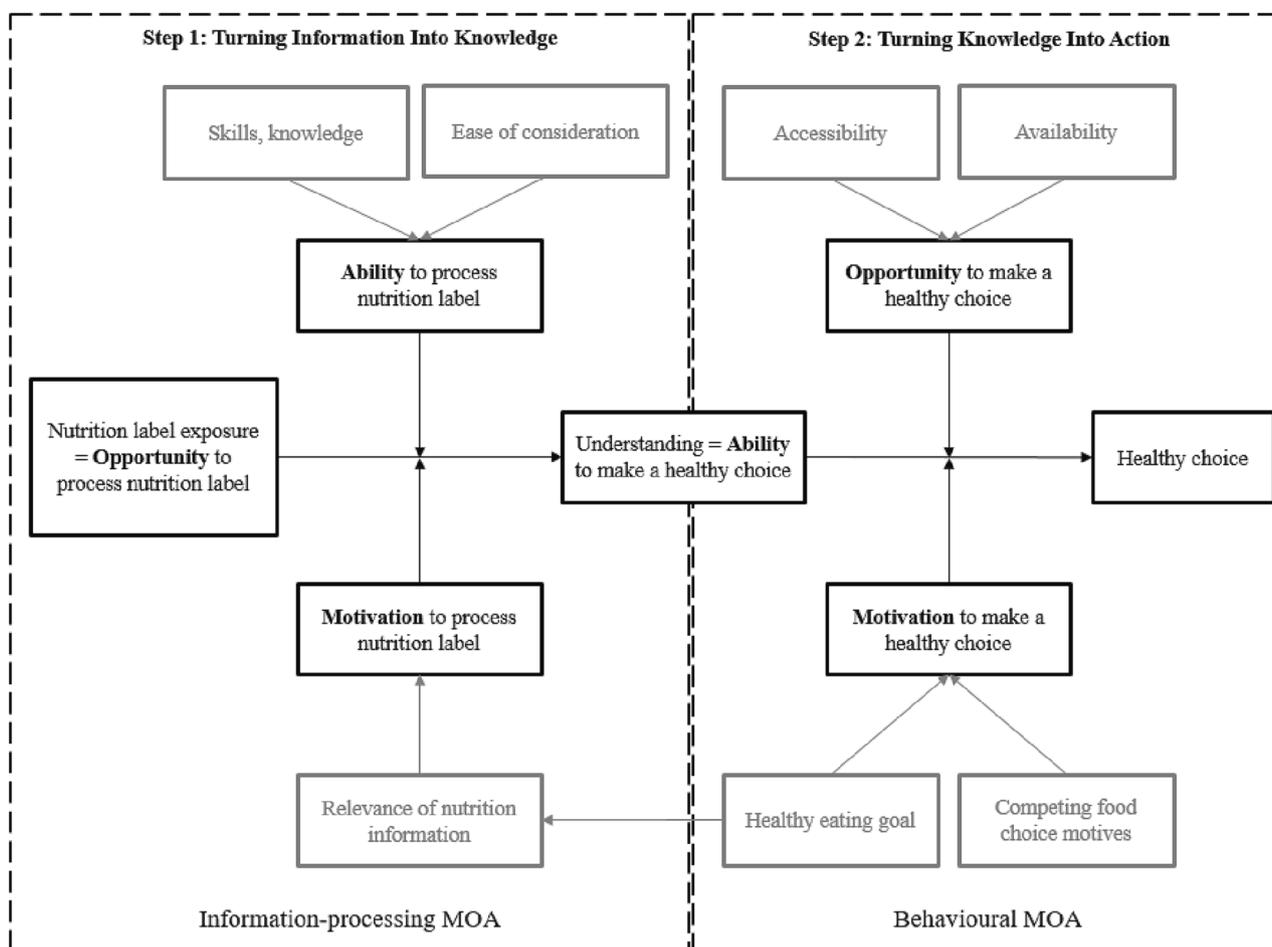
Fig. 2. Theoretical framework guiding the review.

2017). Individuals engage in a behavior when it serves their self-interest (Rothschild, 1999). As such increasing the personal relevance of the information (e.g., through personalization) could lead to higher motivation to process the information (De Bauw et al., 2022). Personalization has been shown to increase attention to the message and in turn to positively affect the attitude towards the message (Maslowska, Smit, & van den Putte, 2016). One example of personalizing the information is providing basket feedback during the shopping trip. Basket feedback integrates nutrition information of multiple food choices into an overall indicator which makes it easier for individuals to keep track of their basket healthfulness (De Bauw et al., 2022; Gustafson & Zeballos, 2019). Realizing that the food basket is becoming unhealthy might increase the relevance of nutrition information and in turn motivate individuals to search for nutrition labels to make healthier choices. Possible interventions that increase consumers motivation to process nutrition information by increasing the personal relevance of nutrition information in food choices could be highlighting consequences of unhealthy diets or using basket feedback.

2.2. Step 2: Turning knowledge into action

2.2.1. Barrier 3: Lack of motivation to make healthy choices

Acting upon nutrition information requires individual's motivation to make a healthy choice. Even though healthfulness is generally important to individuals based on a high level of abstraction (i.e., relevance), it is often not decisive in the concrete choice (i.e., determinance) (Myers & Alpert, 1977; van Dam & van Trijp, 2013; van Ittersum, Pennings, Wansink, & van Trijp, 2007). Benefits that have more proximate consequences (i.e., lower psychological distance), such as flavor

and price, receive more importance in actual food choices than benefits with more distant consequences (i.e., higher psychological distance), such as healthfulness (Fagerstrøm et al., 2019; Glanz, Basil, Maibach, Goldberg, & Snyder, 1998). However, when a product characteristic does not differ among choice options, it does not play a role in the decision (van Ittersum et al., 2007). As such, one possibility to increase the likelihood that knowledge is turned into action is to align benefits that have more proximate consequences with the healthy choice. Possible interventions that increase consumers motivation to act upon nutrition information by decreasing the influence of competing food choice motives could be discounts on healthy items, surcharges on unhealthy items, or taste cues.

Individuals with stronger health motivation are more likely to act upon nutrition information in their food choice (Hess, Visschers, & Siegrist, 2012; van Herpen & van Trijp, 2011; Visschers, Hess, & Siegrist, 2010). Health motivation can be activated externally by goal reminders in the environment (i.e., goal priming) (Papies, 2016) or by priming a more abstract mindset, causing individuals to focus more on higher construal benefits (i.e., construal level priming) (Price, Higgs, & Lee, 2016). Basket feedback that signals that the food basket is becoming unhealthy might activate healthy eating goals to compensate previous unhealthy choices. Healthier food swap recommendations that automatically suggest alternative healthier products when an individual makes an unhealthy choice may shift individuals out of their routine food choices and remind individuals of their health goals (i.e., "stop and rethink"). Examples of these interactive digital interventions are provided in Fig. 3. Possible interventions that increase consumers motivation to act upon nutrition information by activating healthy eating goals could be health goal priming, construal level priming, food swap
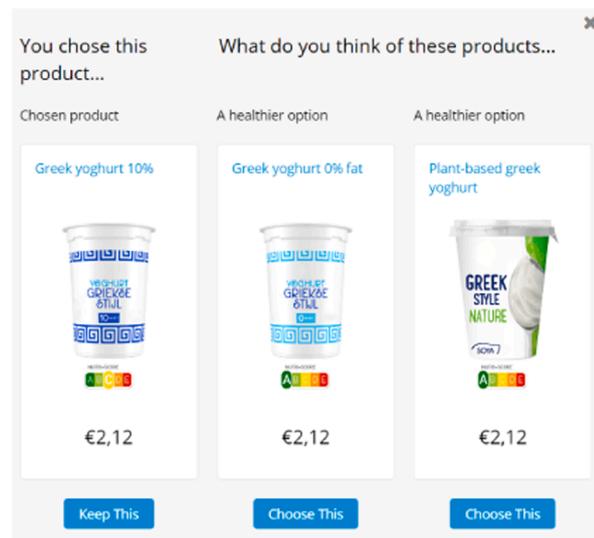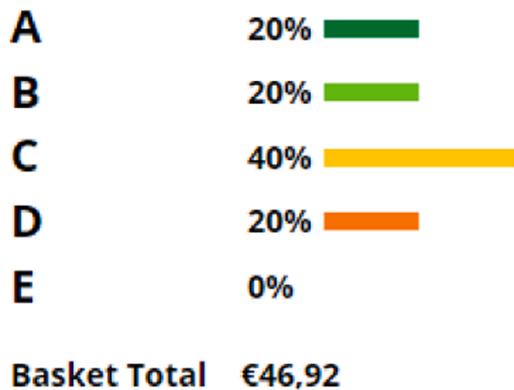
Fig. 3. Examples of interactive digital interventions: basket feedback (left) and food swap recommendations (right).

recommendations, or social norms (i.e., "Increasingly people choose healthy foods").

2.2.2. Barrier 4: Lack of opportunity to make healthy choices

Acting upon nutrition information requires individual's opportunity to make a healthy choice. The opportunity to make healthy choices can be constrained by personal and environmental barriers. We define accessibility of healthy choices as the extent to which individuals have the required resources to make a healthy choice (e.g., money, time). The price of food is a major determinant in food choice (Fagerstrøm et al., 2019). Since energy-dense foods high in sugar and saturated fat cost less on a per-calorie basis than energy-dilute foods, the price of food presents both a real and perceived barrier to healthy diets, especially among low-income individuals (Drewnowski, 2004; Herforth, Bai, Venkat, Mahrt, Ebel, & Masters, 2020). Individuals with lower income purchase foods with a lower per-calorie cost and as such purchase food higher in fat and lower in nutrients (Appelhans et al., 2012). In addition, unhealthy foods are heavily promoted (Coates, Hardman, Halford, Christiansen, & Boyland, 2019; Qutteina, Hallez, Mennes, De Backer, & Smits, 2019; Story & French, 2004) and are more frequently discounted than healthier products (Ravensbergen, Waterlander, Kroeze, & Steenhuis, 2015). A possible intervention that increases consumers opportunity to act upon nutrition information by increasing accessibility is to reduce the price of healthier foods.

Availability of healthy choices refers to the extent to which the environment offers and facilitates healthy choices. Today's food environment is often referred to as an obesogenic environment (Swinburn, Egger, & Raza, 1999). Developments in the food industry have led to an increase in the supply of ultra-processed energy-dense (ED) foods (Zobel, Hansen, Rossing, & von Scholten, 2016). As a result, the availability of unhealthy ultra-processed foods has dramatically increased and exceeds the availability of healthier less-processed foods in supermarkets (Luiten, Steenhuis, Eyles, Mhurchu, & Waterlander, 2016). Possible interventions that increase consumers opportunity to act upon nutrition information by increasing availability are to introduce new healthy foods, to increase the facings of healthier foods, or to reformulate existing unhealthier foods.

2.3. Removing barriers with supportive interventions

Targeting barriers of behaviors by means of interventions is a standard practice in intervention research (Michie et al., 2011; Rothschild, 1999). Since previous reviews (e.g., Bauer & Reisch, 2019; Cadario &

Chandon, 2020; Ikonen et al., 2020; Perez-Cueto, 2019) have pointed out that nutrition labels on their own have limited effectiveness to change dietary choices, complementary interventions may be needed to target barriers that prevent individuals from processing and acting upon nutrition labels. Multicomponent interventions have been suggested as a promising strategy to improve the healthfulness of consumers' choices as information provision alone seems not sufficient (Adam & Jensen, 2016; Kahn-Marshall & Gallant, 2012; Perez-Cueto, 2019). However, since a combination of interventions can have synergistic, additive, or even harmful effects, it is important to understand how intervention components interact (Capewell & Capewell, 2018; Mazza, Dynan, Siegel, & Tucker, 2018). So far little research has focused specifically on how complementary interventions can support nutrition labels and how these intervention components interact.

Previous reviews on nutrition labels have focused on assessing which label is most effective and as a result have identified which design characteristics are most promising. The use of interpretative summary labels that use color, symbols, a range of all possible score, and are displayed on both healthy and unhealthy products have been suggested to be most promising (e.g., the Nutri-Score label) (e.g., Ikonen et al., 2020; Nohlen et al., 2022; Roberto et al., 2021). However, these reviews focused on the nutrition label itself and ignored how complementary interventions can increase the effectiveness of nutrition labels. Past reviews on nudging (Adam & Jensen, 2016; Cadario & Chandon, 2020; Harbers et al., 2020; Liberato, Bailie, & Brimblecombe, 2014) included studies with label+ interventions but grouped these together with other multicomponent interventions that did not include nutrition labels (e.g., nudge + nudge). Thus, conclusions are limited to the effectiveness of multicomponent interventions in general, but not for label+ interventions specifically. As such, a review about label+ interventions that assesses how nutrition labels can be supported is lacking. To fill this research gap, this review will focus on multicomponent interventions that include a nutrition label and a complementary intervention component that supports the nutrition label (i.e., label+ interventions). In the following we refer to the term intervention as the whole (multicomponent) treatment a group receives and to intervention components as the individual parts a multicomponent intervention contains. Following this definition, label+ interventions are a specific type of multicomponent interventions that contain a nutrition label and a plus (i.e., complementary) intervention component.

3. Methods

In order to identify studies, a review protocol was developed and preregistered on Prospero (ID: CRD42020183141). The guidelines of the preferred reporting items for systematic reviews and *meta*-analyses (PRISMA) were followed during the review process (Moher et al., 2009) (Appendix A: PRISMA checklist).

3.1. Search strategy

The Boolean search query was developed using the PICOS framework and is reported in Table 1. Since the plus intervention components were not known a priori, the search terms for the intervention only referred to the label component to maximize the yield of the search. The search was conducted without date restrictions on both general databases (Web of Science, Scopus) and specific consumer behavior and psychology databases (APA PsycInfo, APA PsycArticles, Psychology and Behavioral Sciences Collection, SocINDEX). The search query was restricted to the title, abstract, and article keywords. Alerts were established to identify new publications following the initial database search in April 2020 and were screened with the same criteria until July 2022.

3.2. Selection of studies and inclusion criteria

The review was restricted to studies that satisfied the following inclusion criteria: (a) were written in English, (b) used an empirical study design (i.e., no reviews), (c) included a nutrition label+ intervention, (d) measured food and/or beverage choices or purchases directly (i.e., hypothetical choices or real purchases), and e) compared a nutrition label+ intervention to an eligible comparator (i.e., a control group, a label only, or a plus only group). We excluded studies that used dietary recall measures to reduce heterogeneity of the included studies and as dietary recall measures can be influenced by social desirability bias (Hebert, Clemow, Pbert, Ockene, & Ockene, 1995). Eligible nutrition label+ interventions consisted of any nutrition label on the front-of-pack, shelf, or menu in combination with any behavior change intervention component that is separate from the nutrition label component and supported the label. Thus, we excluded studies that included back-of-pack nutrition labels (i.e., Nutrition Facts Panel), compared different labels (e.g., calorie label vs. calorie label+ exercise equivalent), or studies in which the plus component targeted only non-labelled products (e.g., calorie labels for soup but accessibility improvements for bread). Two changes to the preregistered inclusion criteria were made. In the process of the review it became clear that many studies combined nutrition labels with multiple plus components (e.g., label+ nudge + discount). Due to the large number of different combinations and their heterogeneity, it was impossible to provide clear conclusions of the findings for these studies. Thus, we decided to exclude interventions that combined nutrition labels with multiple plus components (n = 15). In addition, studies that used children or individuals with chronical diseases as participants were excluded in order to reduce heterogeneity of the included studies and provide more generalizable conclusions (n = 8).

After deleting the duplicates in Endnote the titles and abstracts of the

Table 1
Search query for Web of Science.

PICOS	Search terms
Population	None
Intervention	TOPIC: (label*)
Comparison	AND TOPIC: (intervention* OR condition*)
Outcome	AND TOPIC: (choice* OR choos* OR chos* OR decision* OR basket* OR sales OR sold OR spend* OR spent OR select* OR purchas* OR order* OR behav* OR prefer*)
Setting	AND TOPIC: (nutrition* OR health* OR obes* OR diet*)AND TOPIC: (food* OR snack* OR drink* OR beverage* OR meal*)

remaining records were screened. For all potentially relevant records full-text articles were acquired and screened. All studies about nutrition labels were included for the full-text screening in order to avoid excluding any label+ interventions. The first author (ESL) was responsible for the screening procedure and the second author (EVL) screened a randomly selected subsample of the articles eligible for full text screening (n = 25, 13%). Disagreements or uncertainties were resolved through discussion within the review team. The Cohen's kappa was 0.80 which reflects substantial agreement (McHugh, 2012).

3.3. Quality assessment

The quality of the studies was assessed using the Quality Assessment Tool for Quantitative Studies developed for the Effective Public Health Practice Project (Thomas, Ciliska, Dobbins, & Micucci, 2004). This tool was used as it was established for public health interventions and can be used for a range of study designs. It assesses the risk of bias for six individual criteria: (A) selection bias, (B) study design, (C) confounders, (D) blinding, (E) data collection method, and (F) withdrawals and dropouts. Each of the six criteria is assigned a weak, moderate, or strong rating (see Table 2). In line with the recommendation by the Cochrane Handbook for Systematic Reviews of Interventions (Higgins et al., 2022), we report the ratings for the individual criteria in Appendix B rather than the overall quality score which is difficult to interpret and does not provide guidance for future research. In addition, we further assessed whether studies were incentive-compatible, pre-registered, and provide open access to their data.

3.4. Data extraction and synthesis

Data extraction was performed by the first author (ESL) using a standardized data extraction form. Data was extracted from each included study regarding the study context, study design, intervention characteristics, outcomes, and results. If studies contained multiple conditions, we included all conditions that represented a label+ intervention. The study design was coded as randomized control trial (RCT), controlled trial (CT), and pre-post design. The setting was coded as either (online) lab or field. Lab experiments are defined as those studies that are conducted in an artificial and controlled environment. In contrast, natural field experiments are conducted in the real-world setting where the subjects naturally undertake the task (Levitt & List, 2007).[1] Field experiments were further differentiated in the specific environment the study took place (e.g., supermarkets, canteens). Following the Quality Assessment Tool for Quantitative Studies developed for the Effective Public Health Practice Project (Thomas et al., 2004), a randomized controlled trial (RCT) is defined as a design in which researchers randomly allocate participants to an intervention or control group. For an appropriate method of randomization, each participant needs to have the same chance of receiving each intervention and the researcher could not predict which intervention was next. A controlled trial is an experimental study design where the method of allocating study subjects to intervention or control groups is not random, but transparent before assignment and open to the researchers (e.g., allocation by alternation). In a pre-post design with control group the exposure to the intervention is not under the control of the investigators (i.e., allocation of stores decided by the retailer). The groups are assembled according to whether exposure to the intervention has occurred and as such might be nonequivalent or not comparable on some feature that affects the outcome. In a pre-post design without control group, the same group is pretested, given an intervention, and

---

[1] Note that our dichotomous distinction does not depend on the subject pool (student vs. non-student samples) nor the framing (hypothetical vs. incentive-compatible choice). Hence, artefactual and framed field experiments are coded as lab experiments.

Table 2
Assessment criteria for the risk of bias in the individual studies.

Risk of bias	Explanation	Coding
Selection Bias	How representative is the sample? What percentage of selected individuals agreed to participate (i.e., risk of self-selection)?	Strong: representative sample Moderate: customers of field study, non-representative panel sample Weak: convenience sample, university sample
Study Design	What is the likelihood of bias due to the allocation process in an experimental study?	Strong: RCT, CT Moderate: Pre-post with control Weak: Pre-post without control
Confounders	Were there important differences between groups prior to the intervention? If yes, were these differences controlled for (in the design or analysis)?	Strong: no baseline differences Moderate: matched control sites, baseline difference which are controlled for Weak: Unclear risk of confounders (e. g., maturation and history in pre-post designs without control group) Unclear: not reported
Blinding	To which extent does detection bias (i.e., non-blind assessors) and reporting bias (i.e., non-blind subjects) play a role?	Strong: blinded assessors and subjects (e.g., customers unaware of experiment and data is collected electronically) Moderate: one is not blinded (e.g., unclear whether participant are blinded, but data is collected electronically) Weak: both are not blinded Unclear: not reported
Data collection method	To which extent are the data collection methods valid and reliable?	Strong: electronic sales data, electronically recorded choices Moderate: manual recording of choices Weak: non-reliable and non-valid data collection Unclear: not reported
Withdrawal, Drop-outs	To which extent is the study affected by attrition bias?	Strong: attrition max 20% Moderate: attrition max 40% Weak: attrition more than 40% Unclear: not reported
Incentive-compatible	To which extent is the participant incentivized to make real choices?	Yes: choice has consequences (monetary or food) No: hypothetical choice
Pre-registered	Was the study pre-registered?	Yes: pre-registered protocol, published protocol No: none available
Open access data	Is open access to the data provided?	Yes: open access database, e.g., OSF No: data available upon request

Table 3
Overview of plus intervention components in the included studies.

Plus component	Barrier	MOA component	n
Reference information	Skills, knowledge	Ability to process nutrition labels	12
Education material	Skills, knowledge		24
Training to use labels	Skills, knowledge		1
Presentation order	Ease of consideration		5
Information about health risks	Relevance	Motivation to process nutrition labels	1
Basket feedback	Relevance	Motivation to process nutrition labels	13
	Health goals	Motivation to make a healthy choice	
Social norm message	Health goals	Motivation to make a healthy choice	1
Healthy eating prompts	Health goals		4
Food swap recommendation	Health goals		4
Financial incentive	Accessibility	Opportunity to make a healthy choice	19
	Competing food choice motives	Motivation to make a healthy choice	
Introduction of healthy foods	Availability	Opportunity to make a healthy choice	1

and harvest plots comprehensible and to avoid overreporting some studies. If possible, we always used overall measures such as healthfulness scores or total calories of the whole basket. If this was not possible, we used the sales of healthy and unhealthy choices. If this was not reported either, we used specific nutrients (e.g., fat, sodium). If outcomes relating to both the whole basket and specific food groups (e. g., both total calories and snack and beverage calories) were reported, we always used the basket measures. If outcomes from multiple time points were reported, we always used the longest intervention duration. Some studies reported multiple outcomes that were independent (i.e., sales of green and red products). In these cases more than one outcome was included. Since we were interested in how label+ interventions compare to the individual components of the intervention, all reported pairwise comparisons of the label + intervention to a control, label only, and plus only condition were included.

Harvestplots allow to visualize the distribution of the evidence from a diverse set of studies. Studies are grouped in a matrix according to the significance and direction of the intervention effect (i.e., column). Similar to Chan, McMahon, and Brimblecombe (2021), findings were rated as benefit (i.e., beneficial effects as intended), promising (i.e., potentially beneficial effects with change in power, dose, exposure, or analysis), mixed (beneficial effects for some outcomes, while no effect or negative effect for other outcomes), no effect, or harm (i.e., harmful effects in opposite direction as intended). Different pairwise comparisons are reported in separate rows (i.e., control, label only, or plus only). Not only the evidence, but also the study characteristics can be visualized in harvest plots (Ogilvie et al., 2008). The height of each bar represents the study design (i.e., higher bars represent RCTs and CTs) and the width of the bar visualizes the intervention duration (i.e., wider bars represent longer durations). The letter above the bar indicates the setting of the study (e.g., restaurant) while the number below the bar refers to the study ID in Appendix B. The color of the bar illustrates the outcome measure used (i.e., overall nutritional quality, healthy, or unhealthy choices).

4. Results

The study selection process is displayed in the PRISMA flowchart (see Fig. 4). The database search produced 3519 records. After 1341 duplicates were removed, the title and abstract of 2178 records were screened. 192 reports were eligible for full-text screening. 35 reports met the inclusion criteria and were included in the review along with 19 additional reports that were identified from the search alerts after the database search in April 2020 until July 2022, resulting in a total of 54

tested immediately after the intervention. The nutrition labels were classified as reductive nutrient-specific labels (e.g., numeric calorie labels), interpretative nutrient-specific labels (e.g., multiple traffic light), and interpretative summary labels (e.g., Nutri-Score). The plus intervention components were tabulated and classified according to the barriers in the theoretical framework (see Table 3).[2] Through discussion and testing examples and counter-examples we arrived at the final plus coding.

The data was synthesized using tabulation of main study characteristics and findings. For label+ categories with many observations (n > 5) findings were visualized in harvest plots. Since many studies reported multiple outcomes, we followed an outcome hierarchy to keep the tables

---

[2] Change from registered protocol: Initially it was planned to categorize label+ interventions according to the intervention typology of the behavior change wheel (Michie et al., 2011). However, it was decided to use a taxonomy that emerges from the included studies and to integrate it to the guiding theoretical framework instead of imposing an existing taxonomy ex-ante.
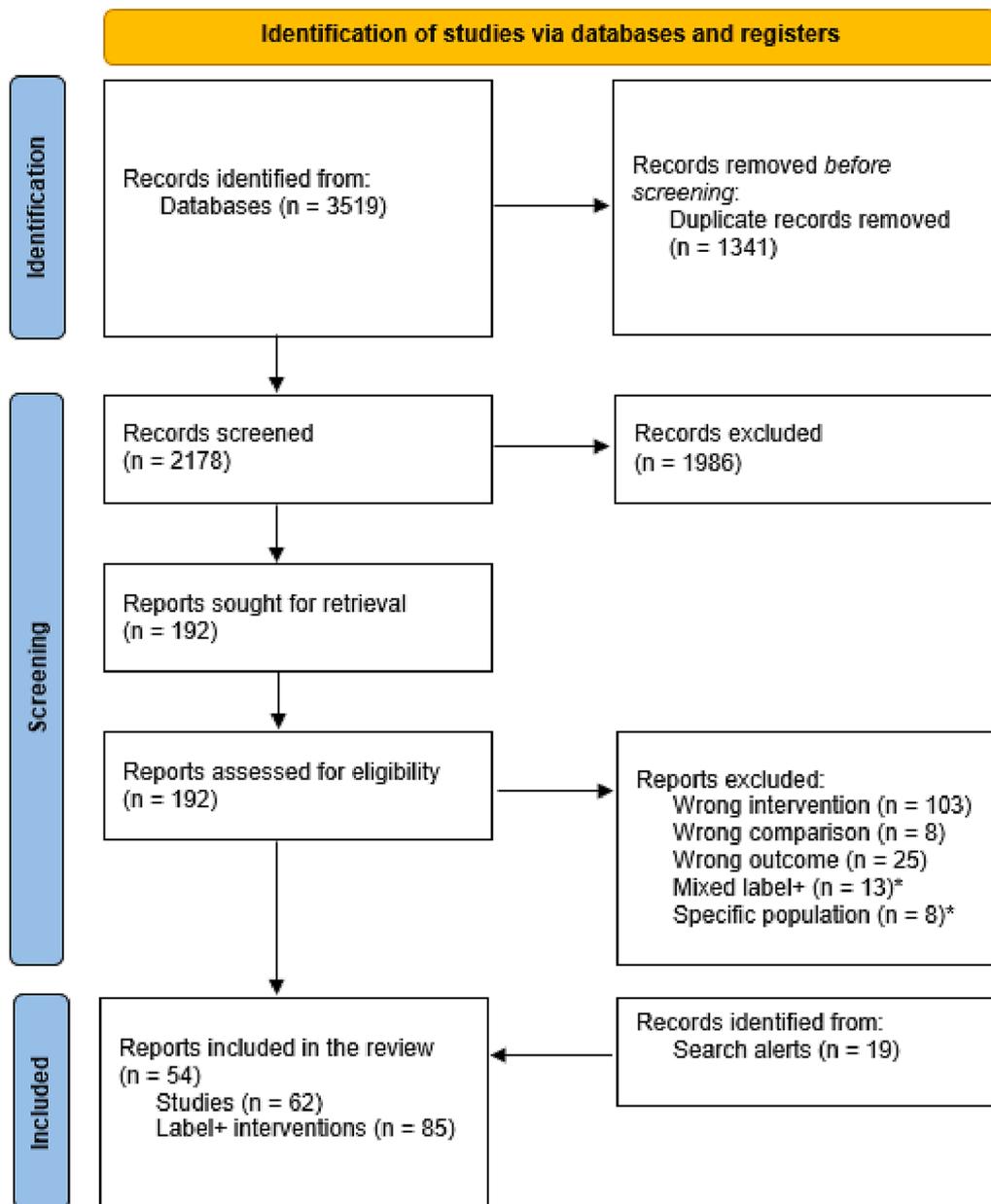
Fig. 4. PRISMA flow diagram.
Note: * Change from preregistered protocol.

reports included in the review. The reports describe 85 label+ interventions in 62 studies. An overview of the included label+ interventions and their findings is provided in Appendix B.

4.1. Characteristics of included studies (n = 62)

The review includes both lab (n = 33) and field studies (n = 29). The setting of the field studies ranges from canteens (n = 12), (online) supermarkets and small food stores (n = 10), restaurants (n = 5), to vending machines (n = 2). The included studies are evenly distributed between randomized controlled trials (n = 21), controlled trials (n = 23), before-after designs with control group (n = 8), and before-after designs without control group (n = 10). The majority of included studies (n = 55) was published after 2010 and took place in the United States (n = 33). Only three studies compared the effectiveness of a label+ intervention across different levels of socio-economic status (SES) (Acton, Kirkpatrick, & Hammond, 2021; Marty, Jones, &

Robinson, 2020b; Thorndike, Riis, Sonnenberg, & Levy, 2014). The quality assessment indicates that the most common risk of bias relates to selection bias from using convenience sampling methods or a university sample (n = 18), followed by risk of confounding (n = 11) and study design (n = 10). Especially pre-post designs without control group should be treated with caution as these studies cannot account for effects that might arise due to time (e.g., maturation and history). All field studies (n = 29), yet only nine lab studies (n = 9 / 33) were incentive-compatible. As such, the majority of lab studies measured hypothetical choices. Twelve studies were pre-registered (n = 12) and only three studies provide open access to the data (n = 3).

4.2. Characteristics of included label+ interventions (n = 85)

4.2.1. Types of nutrition labels

Our dataset suggests that most label+ interventions include a reductive nutrient-specific label (n = 32), specifically numeric calorie

labels (n = 25). This can be explained by the high number of US based studies included in the review and the strong research interest in calorie labels following the 2010 Affordable Care Act which mandated menu labels in US food chain establishments (FDA, 2014). The other label+ interventions include an interpretative summary (n = 33) and interpretative nutrient-specific labels (n = 20).

4.2.2. Types of plus intervention components

The majority of label+ interventions combined nutrition labels with further information (n = 24 educational material about the nutrition labels, n = 12 reference information about the recommended daily calorie intake), followed by financial incentives based on the nutrition information (n = 19), and real-time feedback on the basket healthfulness (n = 13).

4.3. Effectiveness of label+ interventions

4.3.1. Label+ reference information

The review included 12 interventions that supported nutrition labels with reference information about the nutrition labels (e.g., daily calorie intake reference statement) (Downs, Wisdom, & Loewenstein, 2015; Finkelstein, Doble, Ang, Wong, & van Dam, 2021; Harnack et al., 2008; Liu, Roberto, Liu, & Brownell, 2012; Marty et al., 2020b; Oh, Huh, & Mukhopadhyay, 2020; Oliveira, De Steur, Lagast, Gellynck, & Schouteten, 2020; Pang & Hammond, 2013; Roberto, Larsen, Agnew, Baik, & Brownell, 2010). The harvest plot in Fig. 5 visualizes the evidence from the label+ reference information interventions for all outcomes and

pairwise comparisons (n = 20 bars). All the evidence in this subcategory stems from lab experiments that measure decisions at a single time point (n = 20/20). Most studies use reductive nutrient-specific labels (predominantly numeric calorie labels) (n = 18/20). Effects were most often measured using overall nutritional outcomes (i.e., the calorie content of the choices, n = 16/20) and compared to control (n = 12/20).

Compared to a control condition (n = 12), label+ reference information interventions predominantly do not show an effect (n = 9/12), while 3 studies report beneficial or promising findings (n = 3/12). Compared to a label only condition (n = 7), all the evidence indicates no additional benefit of providing reference information to nutrition labels. Compared to a plus only condition (n = 1), the evidence indicates no additional benefit of providing nutrition labels to reference information.

4.3.2. Label+ Education material

The review included 24 interventions that supported nutrition labels with educational material about the nutrition labels (e.g., flyers, signage) (Albright, Flora, & Fortmann, 1990; Dingman, Schulz, Wyrick, Bibeau, & Gupta, 2015; Dubois et al., 2020; Freedman & Connors, 2010; Hobin et al., 2017; Hoenink et al., 2021; Julia et al., 2021; Julia et al., 2016; Marty, Cook, Piernas, Jebb, & Robinson, 2020a; Montagni et al., 2020; Mora-Garcia, Tobar, & Young, 2019; Olstad, Vermeer, McCargar, Prowse, & Raine, 2015; Osman & Thornton, 2019; Rodgers et al., 1994; Roy & Alassadi, 2021; Sacks, Tikellis, Millar, & Swinburn, 2011; Sproul, Canter, & Schmidt, 2003; Sutherland, Kaley, & Fischer, 2010; Thorndike et al., 2014; Thorndike, Sonnenberg, Riis, Barraclough, & Levy, 2012; Vyth et al., 2011). The harvest plot in Fig. 6 visualizes the evidence from
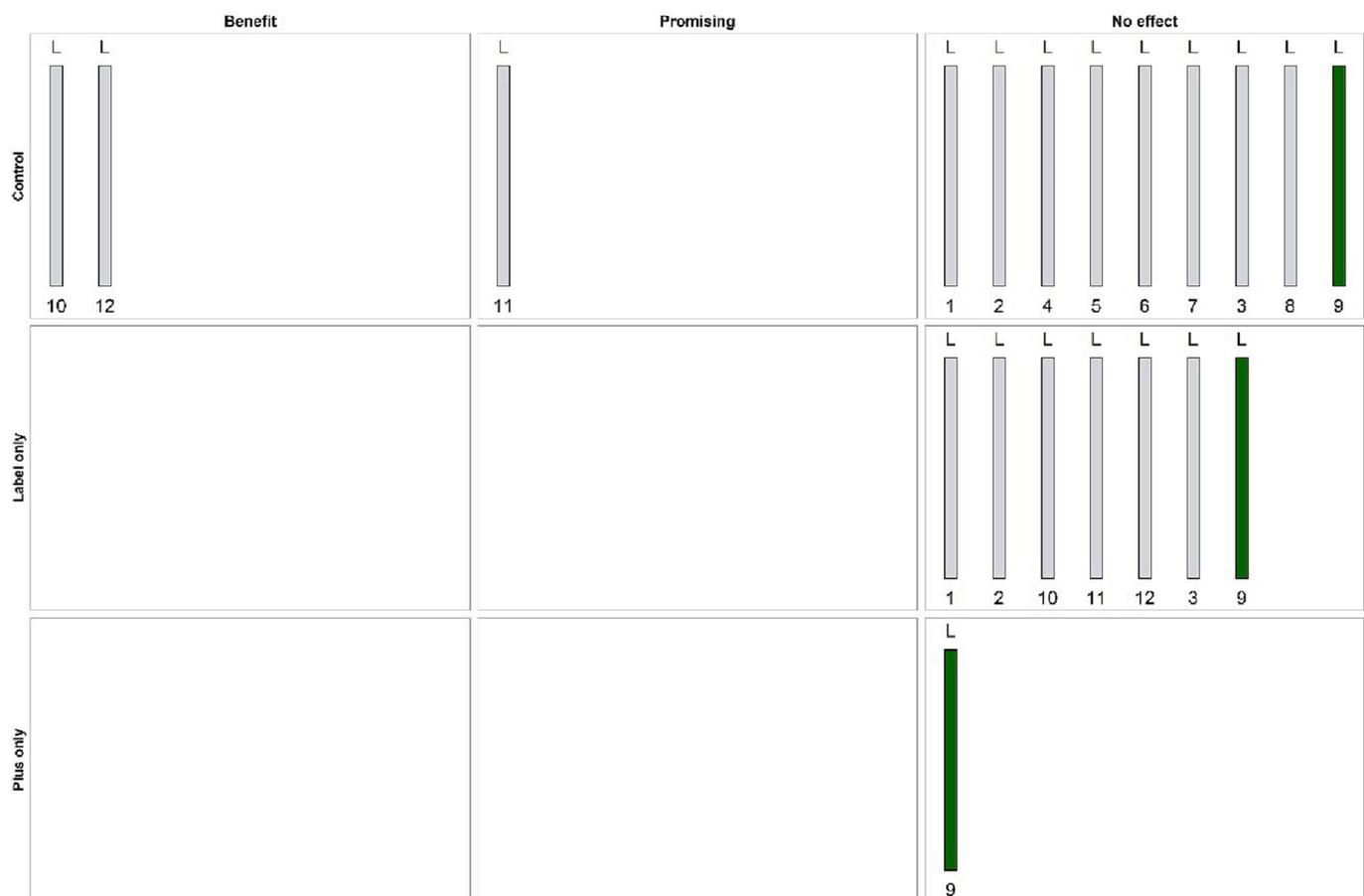

Fig. 5. Harvest plot for label+ reference information interventions for each pairwise comparison. *Figure key:* The color of the bar represents the outcome type (green = healthy, red = unhealthy, grey = overall nutritional quality); the bar length indicates the study design (RCT + CT = high, pre-post = low); the bar width indicates the intervention duration (the wider, the longer); the letter above the bars describes the setting (L = lab; C = canteen; R = restaurant; S = supermarket and convenience store; V = vending machine); the number below the bar refers to the study ID. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

Fig. 6. Harvest plot for label+ educational material interventions for each pairwise comparison. *Figure key:* The color of the bar represents the outcome type (green = healthy, red = unhealthy, grey = overall nutritional quality); the bar length indicates the study design (RCT + CT = high, pre-post = low); the bar width indicates the intervention duration (the wider, the longer); the letter above the bars describes the setting (L = lab; C = canteen; R = restaurant; S = supermarket and convenience store; V = vending machine); the number below the bar refers to the study ID. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)
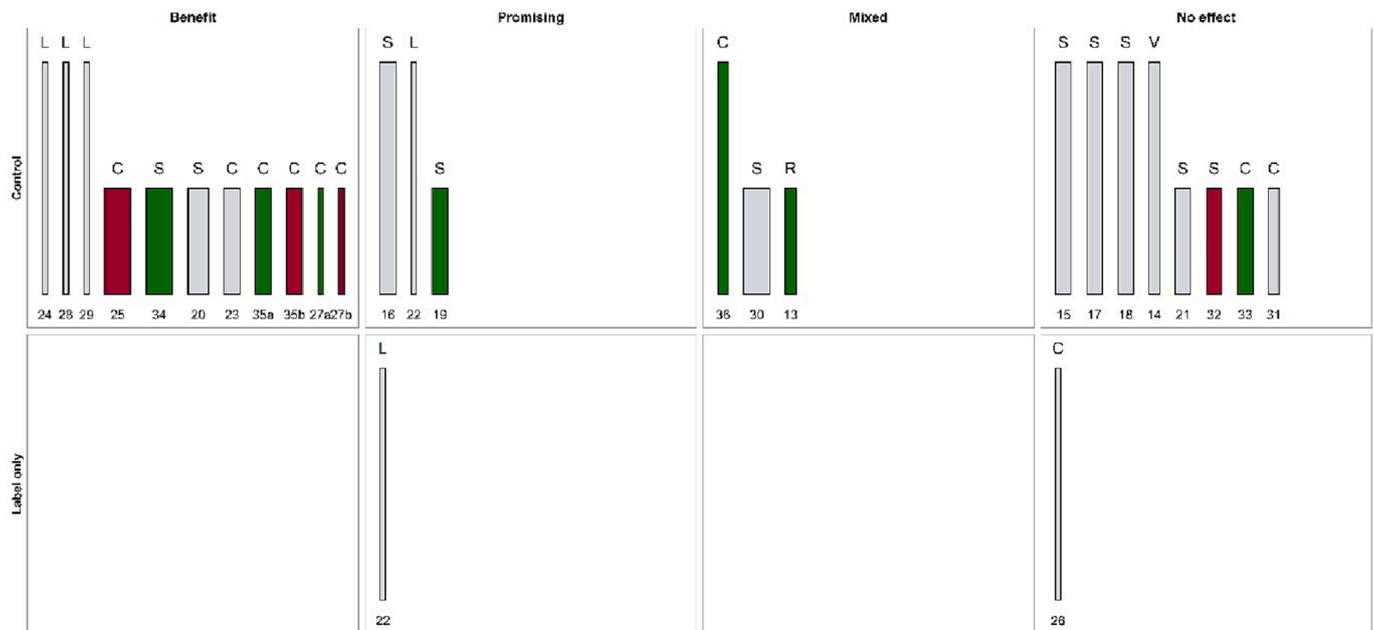
the label+ educational material interventions for all outcomes and pairwise comparisons (n = 27 bars)[3]. The majority of the evidence in this subcategory stems from field studies (n = 22/27) and relates to the introduction of an interpretative summary labels (e.g., Nutri-Score) (n = 21/27). Effects were most often measured using overall nutritional outcomes (n = 16/27), medium durations (1 < month(s) ≤ 6, n = 11/27), and compared to control (n = 25/27).

Compared to a control condition (n = 25), the evidence of the effectiveness of label educational material interventions is mixed and remains inconclusive. The evidence is rated as benefit (n = 11/25), promising (n = 3/25), mixed (n = 3/25), and no effect (n = 8/25). All the included studies that report beneficial or promising findings used an interpretative summary label. 71% (n = 12/17) of the studies with an interpretative summary label report beneficial or promising findings. The effectiveness of studies varies based on the outcome measure used. Improvements are sometimes restricted to specific product categories (Dubois et al., 2020; Julia et al., 2016; Rodgers et al., 1994; Vyth et al., 2011). Some studies suggest that the label+ information intervention had stronger effects in categories with greater variability in nutritional content (Dubois et al., 2020; Hobin et al., 2017) and in categories that are perceived as more healthy (Hobin et al., 2017). Some studies report that the intervention only increased the purchasing likelihood of healthier products without reducing the purchasing likelihood of less healthy products, resulting in no changes in the overall healthfulness of the basket (Dubois et al., 2020; Mora-Garcia et al., 2019). Whereas other studies report that sales of healthier products increased and sales of less healthy products decreased (Olstad et al., 2015; Sutherland et al., 2010; Thorndike et al., 2012). Some studies observe that the number of products purchased per transaction and the price per product increases (Hobin et al., 2017; Julia et al., 2016) while others find no change in the number of products and total costs of the basket (Marty et al., 2020a; Osman & Thornton, 2019; Sacks et al., 2011). Overall, this highlights that the measured effects of label + education material are small and not robust.

Two studies examine the additional benefit of providing educational material to nutrition labels. In the study by Julia et al. (2016) label+ educational material only marginally improved the healthfulness of the overall choices, but significantly improved the healthfulness of choices in the sweet biscuits category. In the study by Mora-Garcia et al. (2019) label+ educational material did not affect the calorie content of purchases, but significantly increased the likelihood of healthy choices. Even though the effect on behavior is modest, both studies demonstrate that combining nutrition labels with educational materials can improve important mediating outcomes, such as awareness (Julia et al., 2016; Mora-Garcia et al., 2019) and understanding of nutrition labels compared to only providing nutrition labels (Julia et al., 2016). However, these effects may be lower in information overloaded settings such as supermarkets and when not all products are labeled. Hobin et al. (2017) reported that less than 10% of survey respondents were aware of nutrition labels in a supermarket study that showed a Guiding Stars label on 48% of the products. In contrast, awareness of nutrition labels was between 39 and 85% among participants in canteens, restaurants, and vending machines (Albright et al., 1990; Dingman et al., 2015; Mora-Garcia et al., 2019; Olstad et al., 2015; Roy & Alassadi, 2021; Sproul et al., 2003).

4.3.3. Label+ Training

Only one study included a label+ training intervention. Specifically, Adams, Hart, Gilmer, Lloyd-Richardson, and Burton (2014) trained participants how to convert abstract numeric sugar content labels into more concrete images of sugar cubes. The label+ training treatment significantly reduced the likelihood of selecting sugar-sweetened beverages (SSBs) compared to the label only treatment.

4.3.4. Label+ Presentation order

Of the five studies changing the product placement in addition to nutrition labels, four studies sorted products according to their healthfulness to facilitate the use of the label (Allan, Johnston, & Campbell, 2015; Downs et al., 2015; Grandi, Burt, & Cardinali, 2021; Shah et al.,

---

[3] Some studies report multiple outcome measures and pairwise comparisons.

2016) and one study grouped healthier products together in a separate promotional shelf (Närhinen, Nissinen, & Puska, 2000). Providing nutrition labels and grouping healthier products in a separate promotional shelf did not increase the sales of promoted products (Närhinen et al., 2000). However, a short intervention duration was used that might have been unable to capture any changes. Sorting products according to their healthfulness resulted in significant improvements in the measured outcomes in three studies (Allan et al., 2015; Downs et al., 2015; Grandi et al., 2021) and no changes in one study (Shah et al., 2016). However, in the study by Allan et al. (2015) and Grandi et al. (2021) the improvements were limited to specific product categories. Downs et al. (2015) report that when nutrition labels are present, both systematic orderings (i.e., from low to high vs. from high to low calories) led to a reduction in calories compared to a random order. However, when nutrition labels were absent, individuals selected earlier listed products (i.e., convenience effect), resulting in lower calorie choices in ascending assortments and higher calorie choices in descending assortments.

4.3.5. Label+ Information about health risks

Only one study (Adams et al., 2014) combined nutrition labels with information of health risks. (Adams et al., 2014) supported numeric sugar content labels with information about health risks from sugar consumption. The label+ health risk treatment did not have a significant effect on the selection of SSBs compared to the label only treatment.

4.3.6. Label+ Basket feedback

The review included 13 interventions that supported nutrition labels with basket feedback (De Bauw et al., 2022; Gustafson & Zeballos, 2019; Shin, Chakraborty, Yan, van Dam, & Finkelstein, 2022; VanEpps, Molnar, Downs, & Loewenstein, 2021). Basket feedback summarizes the healthfulness of the items in the basket into an overall score and thus eases interpretation of the overall healthfulness of the basket. The harvest plot in Fig. 7 visualizes the evidence from the label+ basket feedback interventions for all outcomes and pairwise comparisons (n = 15 bars). All the evidence in this subcategory stems from lab experiments that measure one-time decisions using overall nutritional outcomes (n = 15/15). Most studies used reductive nutrient-specific labels (predominantly numeric calorie labels) (n = 13/15) and compared the effects to a label only condition (n = 11/15).

Compared to a control condition (n = 4), label+ basket feedback interventions predominantly are effective (n = 3/4), while one study by De Bauw et al. (2022) does not find a significant improvement in the basket healthfulness. However, in this study participants first made their choices (with or without nutrition labels) and only afterwards received the label+ basket feedback intervention in the overview screen of their baskets at checkout. The subset of participants that received nutrition labels (without additional interventions) during their initial choices had significantly healthier baskets than participants that did not receive nutrition labels, but basket feedback did not lead to additional improvements in the basket healthfulness (De Bauw et al., 2022). Compared to a label only condition (n = 11), the majority of evidence (n = 8/11) indicates additional benefit of providing basket feedback to
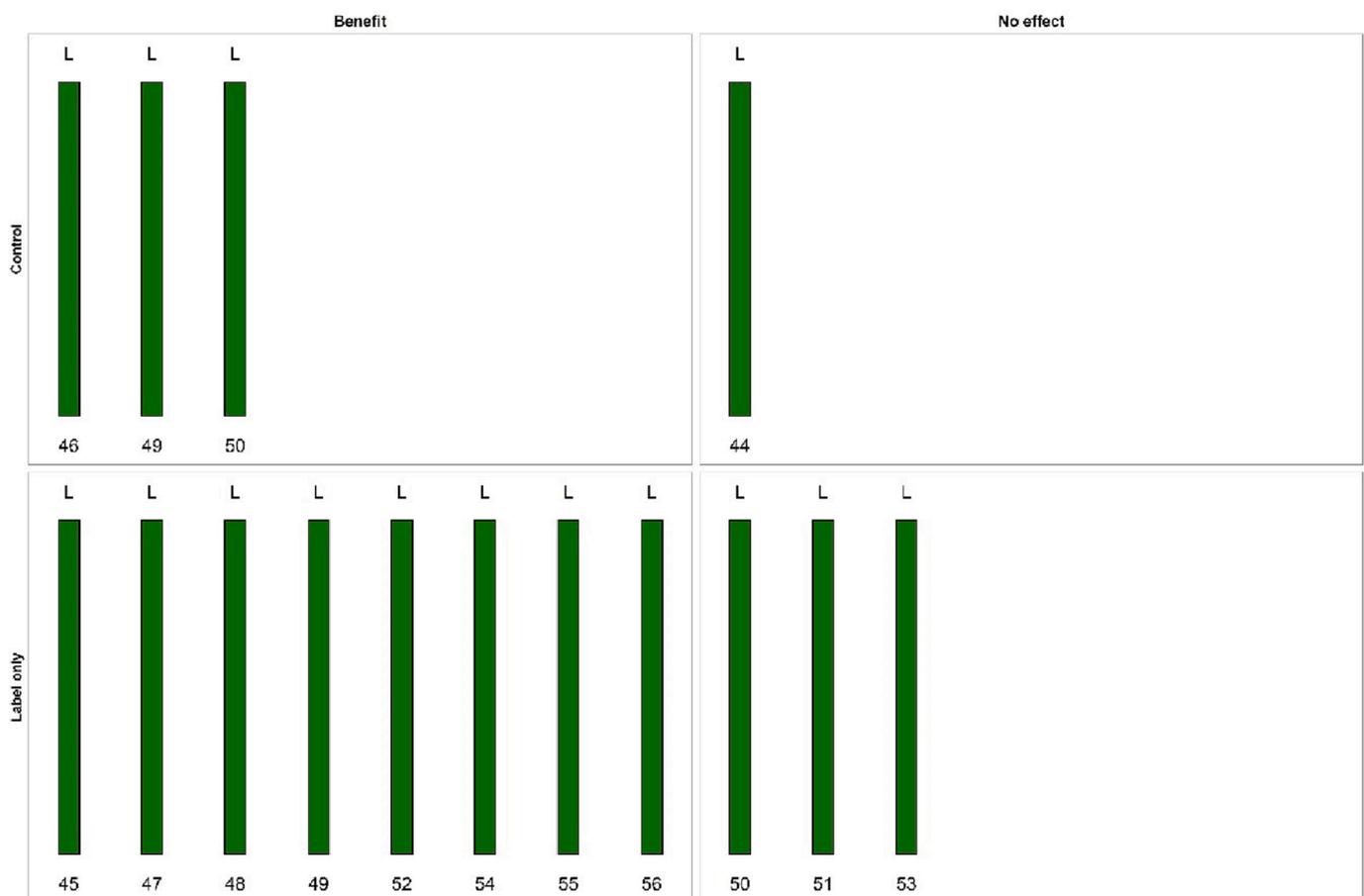

Fig. 7. Harvest plot for label+ basket feedback interventions for each pairwise comparison. *Figure key:* The color of the bar represents the outcome type (green = healthy, red = unhealthy, grey = overall nutritional quality); the bar length indicates the study design (RCT + CT = high, pre-post = low); the bar width indicates the intervention duration (the wider, the longer); the letter above the bars describes the setting (L = lab; C = canteen; R = restaurant; S = supermarket and convenience store; V = vending machine); the number below the bar refers to the study ID. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

nutrition labels.

The studies provide promising evidence that combining nutrition labels with real-time basket feedback can significantly reduce total calories ordered (Gustafson & Zeballos, 2019; VanEpps et al., 2021) and improve the basket healthfulness (Shin et al., 2022). Participants initially make similar choices but significant differences in total calorie ordered are caused by differences in calories from later choices (Gustafson & Zeballos, 2019). When baskets become relatively unhealthy, participants with basket feedback revised high-calorie orders more frequently and chose fewer and less high-calorie items (VanEpps et al., 2021). Participants without basket feedback significantly underestimated the calories of their order (Gustafson & Zeballos, 2019). Even though different formats of basket feedback were successful in reducing total calories ordered, the most effective format was an intuitive traffic-light basket feedback (VanEpps et al., 2021). More evidence is required from studies with higher external validity (e.g., field studies or using incentive-compatible designs) and longer intervention durations.

4.3.7. Label+ Social norm message

Only one study (Jansen, van Kleef, & Van Loo, 2021) supported nutrition labels with information about health eating social norms ("Dutch consumers more often choose healthy products."). Nutrition labels had a main effect on the nutritional quality of the shopping basket, while the main effect of social norms and their interaction was not significant.

4.3.8. Label+ Healthy eating prompts

Four studies (Bergen & Yeh, 2006; Lee-Kwan, Bleich, Kim, Colantuoni, & Gittelsohn, 2015; Levin, 1996; Scourboutakos et al., 2017) supported nutrition labels with healthy eating prompts. Bergen and Yeh (2006) randomly assigned eight vending machines in a college to either control, label only, or label+ motivational posters that encouraged the purchase of water and diet sodas. The growth rate of SSBs was significantly lower in the label+ motivational poster vending machines compared to the control vending machines. However, baseline sales were much lower in control vending machines (58 SSBs sold per week, SD = 16.97) compared to label+ vending machines (153.67 SSBs sold per week, SD = 58.74). No effect was found for water or diet sodas. Lee-Kwan et al. (2015) supported the introduction of menu nutrition labels with menu revisions that promoted the healthier menu items, but did not find a significant increase in the choice likelihood of healthier items compared to control restaurants. Levin (1996) supported the introduction of menu nutrition labels with signage that prompted to the label ("Look for the [heart symbol] for your low-fat entree selection"). The proportion of labelled food items sold increased significantly at the treatment canteen during the intervention period compared to the control canteen. Scourboutakos et al. (2017) supported the introduction of beverage nutrition labels with signage that encouraged the purchase of water ("Drink water when you are thirsty"). The calories of beverage choices did not differ between the control and intervention period, but the proportion of student who selected water (SSBs) increased (decreased).

4.3.9. Label+ Food swap recommendation

Three studies supported nutrition labels with healthier food swap recommendations in the lab (De Bauw et al., 2022; Jansen et al., 2021) and in the field (van der Laan & Orcholska, 2022). Food swap recommendations automatically suggest alternative healthier products when an individual makes an unhealthy choice. The recommendation can either pop up directly after the individual makes an unhealthy choice (Jansen et al., 2021; van der Laan & Orcholska, 2022) or at the basket overview before checkout (De Bauw et al., 2022).

In the study by Jansen et al. (2021) both nutrition labels and food swap recommendations had an independent main effect on the nutritional quality of the shopping basket which was not qualified by an interaction. In the study by van der Laan and Orcholska (2022) food

swap recommendation increased the proportion of labelled products sold compared to the control condition, but adding nutrition labels to food swap recommendations reduced the proportion of labelled products sold compared to label+ food swap recommendations. As such the proportion of labelled products sold was not significantly higher in the label+ food swap recommendation condition compared to the control condition. De Bauw et al. (2022) finds that nutrition labels significantly improved the nutritional content of the basket, but food swap recommendations at checkout did not further improve the nutritional content of the basket. As such, the evidence on label+ food swap recommendation interventions is mixed.

4.3.10. Label+ Financial incentive

The review includes 19 interventions that supported nutrition labels with a financial incentive for healthy choices (Acton & Hammond, 2018; Acton, Jones, Kirkpatrick, Roberto, & Hammond, 2019; Acton et al., 2021; Elbel, Taksler, Mijanovich, Abrams, & Dixon, 2013; Ellison, Lusk, & Davis, 2014; Giesen, Payne, Havermans, & Jansen, 2011; Mazza et al., 2018; Shah, Bettman, Ubel, Keller, & Edell, 2014). The majority combined a nutrition label with a tax on unhealthy products (n = 17/19). Two interventions used a subsidy on healthy products and a tax on unhealthy products (n = 2/19). The price changes ranged from 10% to 50%. Most interventions (n = 13/19) did not explicitly communicate the price change (i.e., non-itemized), while six interventions explicitly indicated the price change (i.e., itemized).

The harvest plot in Fig. 8 visualizes the evidence from all label+ financial incentive interventions (n = 33 bars[4]). Effects were most often measured using overall outcomes (n = 18/33), short durations ($\leq$1 week, n = 24/33), and compared to control (n = 20/33). Compared to a control condition (n = 20), the evidence of the effectiveness of label+ financial incentive interventions is largely promising. Studies most often report beneficial (n = 10/20) or promising findings (n = 7/20). Few studies report no effect (n = 2/20) or mixed effects (n = 1/20). Label+ itemized price changes (i.e., explicitly communicated) are consistently resulting in improvements (n = 6/6) whereas non-itemized price changes are only showing beneficial or promising effects in 75% of studies (n = 11/14). Findings from factorial designs indicate that significant improvements compared to a control condition are often driven by the tax while nutrition labels only have a small or no effect (Acton & Hammond, 2018; Acton et al., 2019; Giesen et al., 2011). Although most studies with a factorial design do not find an interaction effect between nutrition labels and price changes (Acton & Hammond, 2018; Acton et al., 2019; Ellison et al., 2014), one study reports that combining nutrition labels and taxes can have negative effects (Giesen et al., 2011). For high-restrained eaters nutrition labels improved dietary choices only when taxes were absent and taxes improved dietary choices only when nutrition labels were absent. For low-restrained eaters nutrition labels did not have an effect, but taxes improved dietary choices regardless of the presence of nutrition labels.

Compared to only providing a label (n = 5), the evidence is unclear whether the addition of price changes provides benefit (n = 2/5) or no effect (n = 3/5). Compared to only changing prices (n = 8), the evidence indicates a tendency that the addition of price changes provides benefit (n = 6/8) as opposed to no effect (n = 2/8). However, this comparison might be biased to comparing a label+ itemized tax to a non-itemized tax only condition. Across four studies, Shah et al. (2014) report that a label+ itemized tax led to a significantly greater reduction in unhealthy choices compared to control, label only, and non-itemized tax only. Label+ itemized taxes explicitly communicate that an item is unhealthy and that it is taxed. Since no itemized tax only condition (i.e., explicitly communicating that a product is taxed without giving a health reason) was used, it remains unclear whether the increased effectiveness compared to label only and non-itemized tax only is due to drawing

---

[4] Some studies report multiple outcome measures and pairwise comparisons.
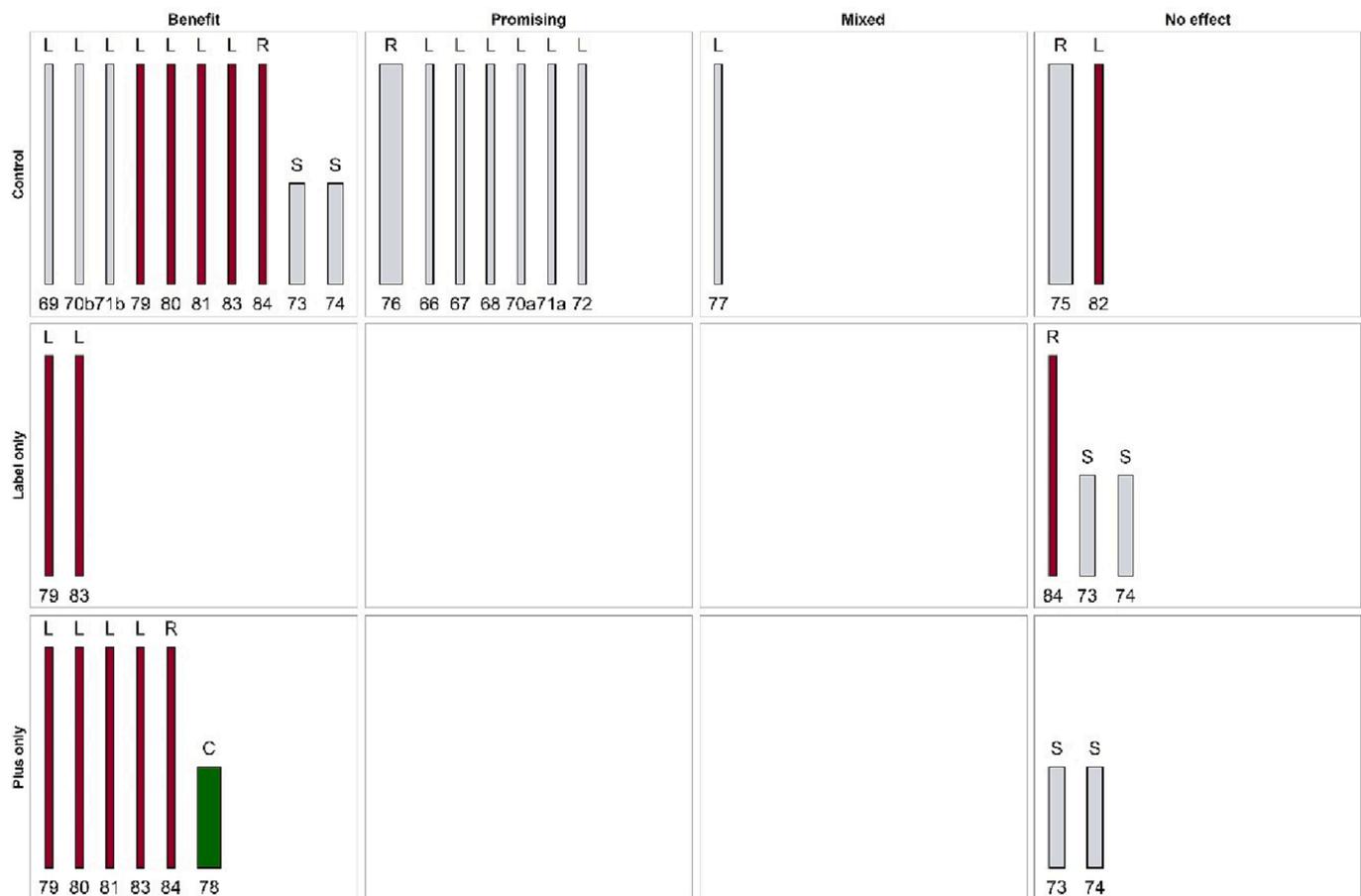
Fig. 8. Harvest plot for label+ financial incentive interventions for each pairwise comparison. *Figure key:* The color of the bar represents the outcome type (green = healthy, red = unhealthy, grey = overall nutritional quality); the bar length indicates the study design (RCT + CT = high, pre-post = low); the bar width indicates the intervention duration (the wider, the longer); the letter above the bars describes the setting (L = lab; C = canteen; R = restaurant; S = supermarket and convenience store; V = vending machine); the number below the bar refers to the study ID. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

attention to the tax (i.e., salience of the tax) or the interaction between the salience of the tax and the highlighted reason for the tax (i.e., tax and health salience).

4.3.11. Label+ Introduction of healthy foods

Only one study (Lowe et al., 2010) supported nutrition labels with increasing the availability of healthy choices by introducing ten new low-energy-dense foods. The calories of lunch meal choices in the canteen did not significantly change in the intervention period compared to the baseline period.

5. Discussion

5.1. Main findings and directions for future research

The aim of the current study was to provide a theoretical framework on barriers of FOP nutrition label use and how supporting interventions could address these barriers. The theoretical framework integrates existing information-processing and behavioral MOA frameworks into one overall theoretical framework. Nutrition label provision alone is a necessary yet insufficient condition for behavior change to occur. Individuals need to (1) turn the information into knowledge and (2) turn the knowledge into behavior (Hornik, 1989).

A systematic search was used to identify existing research on label+ interventions and the evidence of their effectiveness in changing dietary choices was synthesized in a narrative form. In total 85 label+ interventions were included. Most interventions (n = 24) supported

nutrition labels with educational material about the nutrition labels, followed by financial incentives (n = 19), basket feedback (n = 13), and reference information (n = 12). Other label+ categories had too little observations (n ≤ 5) to draw solid conclusions and generalize about their effectiveness. Two label+ categories are situated in the first step of the model (turning information into knowledge). Both reference information and educational material increase individuals' skills and knowledge to interpret the nutrition labels and as such target the ability to process nutrition labels. One label+ category is situated both in the first and second step of the model. Basket feedback summarizes the healthfulness of food choices in the basket in real-time and as such can highlight when the basket becomes unhealthy. This can highlight the personal relevance of nutrition information and as such target the motivation to process nutrition labels. In addition, it can activate healthy eating goals and the motivation to make healthy choices to balance previous unhealthy choices. One label+ category is situated in the second step of the model (turning knowledge into action). Financial incentives can reduce the price difference between unhealthy and healthy foods and as such increase the influence of other food choice motives, such as healthfulness. Making healthier foods cheaper can also provide individuals with the required resources to make a healthy choice. The study characteristics and evidence were tabulated and visualized in harvest plots. Table 4 summarizes the main findings of this review and provides recommendations for future research.

The evidence for label+ *reference information* interventions indicates no effect in improving the healthfulness of dietary choices. Reasons could be the strong reliance on reductive nutrient-specific labels (e.g.,

Table 4
Key findings of the review.

Step	Category	n	Key finding	Future research
(1) Turn information into knowledge	Label+ reference information	12	No robust effect on behavior change	More research is required to understand whether reference guidelines can be useful for more habitual shopping situations
	Label+ educational material	24	No robust effect on behavior change, but improvements in awareness and understanding	More research on how label+ information campaigns can build support for more upstream policy measures
(1) + (2)	Label+ basket feedback	13	Generally effective, but only studies with short timeframes	More research with longer intervention durations in real-world settings is needed
(2) Turn knowledge into action	Label+ financial incentive	19	Generally effective, but driven by the strong effect of the tax	More research on the underlying psychological mechanism of label+ itemized taxes is needed to understand why label+ itemized taxes are more effective

numeric calorie labels) and unhealthy product categories (e.g., fast food meals, snacks). Previous reviews indicate that nutrition labels that use numeric information are more difficult to understand, especially for individuals with lower educational level (Campos et al., 2011; Hersey, Wohlgenant, Arsenault, Kosa, & Muth, 2013; Roberto et al., 2021). In addition, individuals are less interested in nutrition information on product categories that are perceived as a treat (Grunert & Wills, 2007) and as such might have been more likely to ignore the information. More research is required to understand whether reference guidelines can be useful for more habitual shopping situations (e.g., supermarket food choices).

The evidence about the effectiveness of label+ *educational material* interventions in improving the healthfulness of dietary choices is not very convincing. Most studies report no significant improvements in dietary choices and small effect sizes. Effects were not robust across nutrition label, product category, and outcome measure used. Studies were more often effective when using an interpretative summary nutrition label. Prior research suggests that design characteristics of interpretative summary labels, such as the use of a single summary indicator on both healthier and unhealthier products, showing a range of possible scores, and utilizing symbols and colors that leverage automatic associations, are most promising for attention, understanding, and use of FOP nutrition labels (e.g., Dubois et al., 2020; Ikonen et al., 2020; Nohlen et al., 2022; Roberto et al., 2021). Especially the five-colored summary FOP nutrition label Nutri-Score has been shown to better increase individuals' ability to rank products according to nutritional quality compared to other interpretative labels (Dubois et al., 2020; Hagmann & Siegrist, 2020), particularly among individuals with low self-reported nutritional knowledge (Ducrot et al., 2015). In line with previous *meta*-analyses on nutrition labels (Cecchini & Warin, 2016; Ikonen et al., 2020), there is some evidence that label+ educational material interventions are effective in encouraging purchases of healthier products to a small extent but unable to discourage purchases of less healthy products. This might explain the null effect on the overall nutritional content of the shopping basket (Dubois et al., 2020; Mora-

Garcia et al., 2019). However, combining nutrition labels with educational materials can improve important prerequisites for informed nutrition label use, such as awareness (Julia et al., 2016; Mora-Garcia et al., 2019) and understanding of nutrition labels compared to solely providing nutrition labels (Julia et al., 2016). Due to the limited details on the education material used in some studies, an in-depth analyses on the medium and the message type was not possible. Further research is needed to conclude whether the type of medium (e.g., flyers, aisle signage) and message (e.g., gain vs. loss frame) can influence effectiveness.

The evidence for label+ *basket feedback* interventions is promising but limited due to the short timeframes and strong reliance on lab-based studies. Label+ basket feedback interventions significantly increased revisions of high-calorie choices and in turn improved the nutritional quality of the basket (Gustafson & Zeballos, 2019; Shin et al., 2022; VanEpps et al., 2021). Combining nutrition labels with real-time basket feedback enables consumers to keep a more accurate overview of their basket healthfulness (Gustafson & Zeballos, 2019) and eases consideration of nutrition information as it does not require consumers to integrate nutrition information from multiple product choices (VanEpps et al., 2021). More research is needed how these effects develop over longer intervention durations and in real-world settings.

Another example of an interactive digital intervention is a recommender system that can be used to react to unhealthy choices by automatically recommending healthier alternative products (i.e., food swap recommendation). Only one of the three included label+ *food swap recommendation* interventions provides evidence that nutrition labels and food swap recommendations have an independent main effect on the basket healthfulness (Jansen et al., 2021). In combination with nutrition labels, healthier food swap recommendations may be able to inform inattentive consumers that they made an unhealthy choice just-in-time and draw their attention to nutrition labels. However, the findings from van der Laan and Orcholska (2022) suggest that adding nutrition labels to food swap recommendation may be harmful. A possible explanation is that the nutrition label activated a healthy = untasty intuition (Raghunathan, Naylor, & Hoyer, 2006) and as such reduced the effectiveness of food swap recommendations. Another reason could be that the study by van der Laan and Orcholska (2022) only labelled the healthier alternative, while Jansen et al. (2021) used a graded label design that highlights the relative health gain of the recommendation. The lack of effect in the study by De Bauw et al. (2022) might be explained by the timing of the food swap recommendations. Providing food swap recommendations at checkout is less effective than providing food swap recommendation directly after an unhealthy choice is made (Forwood, Ahern, Marteau, & Jebb, 2015). More research is required to understand when and why food swap recommendations are accepted.

The findings for label+ *financial incentive* interventions indicate support for combining nutrition labels with price changes to improve dietary choices. Especially combining nutrition labels with itemized price changes that explicitly indicate the presence and reason for the price change showed promising results compared to price changes that are included in the price without highlighting their presence (i.e., non-itemized taxes) (Shah et al., 2014). This difference may be explained by the salience of the tax. When price changes are included in the price without highlighting their presence (i.e., non-itemized taxes), smaller price changes are often not noticed by consumers as they often do not remember the original price (Claudy, Doyle, Marriott, Campbell, & O'Malley, 2021). Highlighting the presence of a tax increases the awareness of the tax. Salience of a tax has been shown to improve effectiveness of a tax (Chetty, Looney, & Kroft, 2009; Zizzo, Parravano, Nakamura, Forwood, & Suhrcke, 2021). The salience of the tax might further avoid misconceptions about quality perceptions of more expensive foods (Shah et al., 2014). Highlighting the reason of a tax may signal in addition that unhealthy choices are penalized, increase awareness of negative health consequences, and remind consumers of

their health goals, which in turn might encourage the purchase of healthy products even if they can afford unhealthy products (Claudy et al., 2021). However, the fact that in all included label+ itemized tax studies the presence and reason for the tax were highlighted simultaneously, prevents from solid conclusions on whether highlighting the health reason for the tax provides additional benefit to highlighting the presence of a tax. More research on the underlying psychological mechanism of label+ itemized taxes is needed to understand whether label+ itemized taxes operate only through the price mechanism (i.e., avoiding more expensive products) or also through activating health awareness.

Overall, the evidence for the label+ categories situated in the first step of the model, ensuring that information translates into knowledge, is not promising, whereas label+ categories that are situated in both steps or the second step, ensuring that knowledge translates into action, provide evidence of effectiveness. This suggest that activating interventions are required to ensure that information translates into behavior.

5.2. Implications for public policy

The policy objectives of FOP nutrition labelling are twofold: to improve the salience, understanding, and use of nutrition information among consumers and to encourage manufacturers to develop healthier products, either by reformulating existing products or by introducing new healthy products (FDA, 2010; Kanter et al., 2018; Nohlen et al., 2022). Previous reviews have warned that FOP nutrition labels achieve their goal to improve awareness and understanding of nutrition information, but are less impactful in stimulating healthier choices (e.g., Bauer & Reisch, 2019; Cadario & Chandon, 2020; Ikonen et al., 2020; Perez-Cueto, 2019). Our theoretical framework and systematic review allow a better understanding of the aspects affecting the effectiveness of FOP nutrition labels. To achieve maximum possible health gains, complementary interventions may be needed to target barriers that prevent individuals from processing and acting upon FOP nutrition labels. A multifaceted policy program rather than relying on a single intervention is required to achieve this goal (Capewell & Capewell, 2018; Claudy et al., 2021; Lee et al., 2017; Rutter et al., 2017; van Kleef & Dagevos, 2015). More intrusive interventions may be required to give cause for action when individuals are unmotivated to engage in the suggested behavior (Capewell & Capewell, 2018). In line with this, we found that supporting nutrition labels with more intrusive interventions such as interactive digital interventions and financial incentives were more effective than purely information-based interventions (i.e., label+ reference information and label+ education material).

Policymakers need to determine whether to rely on voluntary compliance by retailers or impose mandatory interventions. The decision to impose mandatory interventions on retailers should be based on a careful assessment of the feasibility of implementation, their potential impact, and the need of governmental interference in the market. For interactive digital interventions, this assessment likely differs between online and physical environments. Current evidence of effectiveness of digital interventions is based mainly on online lab experiments. As online shopping environments can closely mimic lab experiments, implementation of interactive digital interventions, such as basket feedback or food swap recommendations, is feasible and relevant. However, in physical shopping environments the effectiveness of interactive digital interventions is still largely unknown. If interventions require effort, such as downloading an app or manually replacing unhealthy choices, the effectiveness is likely lower as this targets health-motivated individuals who are already sensitive to nutrition information (Van Loo et al., 2015). Consumers might also be less willing to manually put back unhealthy choices in physical stores as touch can increase perceived ownership and valuation of the product (Peck & Shu, 2009). The necessity to impose mandatory intervention can be subject to scrutiny, as several companies are already implementing digital interventions

voluntarily as part of their corporate social responsibility efforts (Albert Heijn, n.d.; Jumbo, 2022; Stuber, Lakerveld, Kievitsbosch, Mackenbach, & Beulens, 2022; van der Laan & Orcholska, 2022). However, public policies are needed to address ethical and legal concerns surrounding these emerging digital technologies. Among others it is imperative that interactive digital interventions are based on an official source (e.g., the Nutri-Score) to avoid harmful recommendations. In addition, vulnerable groups (e.g., individuals suffering from eating disorders) should be able to opt out of such health-promoting interactive digital interventions (for a more detailed discussion, see Calvaresi et al., 2022).

Providing financial disincentives for consumers to purchase unhealthy food is likely not implemented voluntarily by retailers. Unhealthy products are generally less expensive (Herforth et al., 2020) and perceived as more tasty (Raghunathan et al., 2006). This creates demand for low-cost unhealthy products. In order to stay competitive, retailers offer unhealthy products to fulfil consumer demand and even promote unhealthy products more than healthy products (Hendriksen et al., 2021; Ravensbergen et al., 2015). These interdependencies in the food system create a lock-in effect of supply and demand for unhealthy products that requires policy interventions (van Rijnsoever, van Lente, & van Trijp, 2011). To correct relative price differences subsidies on healthier foods and/or taxes on unhealthier foods can be considered. Combined fiscal policies have larger effects on dietary choices as greater relative price differences can be achieved which incentivizes consumers to switch from taxed unhealthy to subsidized healthy foods (Caro, Valizadeh, Correa, Silva, & Ng, 2020; Claudy et al., 2021; Niebylski, Redburn, Duhaney, & Campbell, 2015; Pearson-Stuttard et al., 2017). Taxes lead to a larger tax burden and welfare loss for low-income consumers, whereas combined fiscal policies reduces health disparities and results in welfare gains for low-income consumers (Caro et al., 2020; Claudy et al., 2021). Research has suggested that fiscal policies are most effective when they are at least 10–20% (Claudy et al., 2021; Niebylski et al., 2015), when they are directly passed into the price tag (Zheng, Huang, & Ross, 2019), and when their presence is signposted (Chetty et al., 2009; Zizzo et al., 2021). A recent successful example of an unhealthy food tax is the UK Soft Drinks Industry Levy. After overcoming industry opposition, the policy was implemented and has led to product reformulations (Scarborough et al., 2020) and healthier consumer choices (Pell et al., 2021). Previous research has found that taxes receive more public support when the tax revenue is used for other policy measures to reduce obesity, such as information campaigns or subsidies for healthier foods (Brownell & Frieden, 2009). Health communication campaigns have been used across a range of health-risk behaviors (e.g., smoking, binge drinking, unhealthy eating) to influence public awareness of health risks, concern over such health risks, social acceptability of the behavior, and ultimately support for more restrictive policies (Durkin, Brennan, & Wakefield, 2012; Murukutla et al., 2020). Policymakers might benefit from building public support for bolder policies to accelerate food consumer behavior change.

6. Conclusion

Our theoretical framework and systematic review allow a better understanding of the aspects affecting the effectiveness of FOP labels. Complementary interventions may be needed to target barriers that prevent individuals from processing and acting upon FOP nutrition labels. The findings provide limited evidence for the effectiveness of supporting nutrition labels with reference information. Even though label+ educational material interventions have beneficiary effects on important requirements of nutrition label use (awareness and understanding), effects on consumer behavior were small and not robust across studies. Interactive digital interventions, such as basket feedback, and financial incentives provide promising evidence in supporting nutrition labels. If the goal of FOP nutrition labelling is not only transparency but also the use of nutrition information in dietary choices, it is unlikely sufficient to support nutrition labels with further information

about nutrition labels. More intrusive interventions may be required when individuals are not motivated to engage in the behavior.

CRediT authorship contribution statement

Eva-Maria Schruff-Lim: Conceptualization, Methodology, Software, Data Curation, Validation, Formal analysis, Writing - Original Draft. **Ellen J. Van Loo:** Conceptualization, Methodology, Validation, Formal analysis, Writing - Review & Editing. **Ellen van Kleef:** Conceptualization, Methodology, Validation, Formal analysis, Writing - Review & Editing. **Hans C. M. van Trijp:** Conceptualization, Methodology, Formal analysis, Writing - Review & Editing.

Ethics approval and consent to participate: Not applicable.

Consent for publication: Not applicable.

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.

Acknowledgment

Appendix A:. Prisma checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, *meta*-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	1
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	1
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	1
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	4
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	5
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	4
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	5: Table 1
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the *meta*-analysis).	5
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	5-6
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	5-6
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	5
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	6
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each *meta*-analysis.	6

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	NA[1]
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, *meta*-regression), if done, indicating which were pre-specified.	NA[2]
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	6-7
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	Appendix B
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	Appendix B
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	Appendix B

(continued)

Section/topic	#	Checklist item	Reported on page #
Synthesis of results	21	Present results of each *meta*-analysis done, including confidence intervals and measures of consistency.	NA[4]
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	NA[1]
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, *meta*-regression [see Item 16]).	NA[2]
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	11-14
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	7, 11-14
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	14
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	14

[1] Given our inability to perform a meta-analysis, the risk of bias could not be assessed across studies, but only within individual studies.

[2] In the present review, we did not perform any additional analyses.

[3] In line with the qualitative synthesis, we described the main findings qualitatively and did not provide effect estimates and confidence intervals.

[4] Given our inability to perform a meta-analysis, we have synthesized the findings narratively (pp. 17–31) and visualized the findings in harvest plots (Figs. 5–8).

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(6): e1000097. https://doi.org/10.1371/journal.pmed1000097

Appendix B:. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.foodpol.2023.102479.

References

Acton, R.B., Hammond, D., 2018. The impact of price and nutrition labelling on sugary drink purchases: Results from an experimental marketplace study. Appetite 121, 129–137. https://doi.org/10.1016/j.appet.2017.11.089.

Acton, R.B., Jones, A.C., Kirkpatrick, S.I., Roberto, C.A., Hammond, D., 2019. Taxes and front-of-package labels improve the healthiness of beverage and snack purchases: A randomized experimental marketplace. International Journal of Behavioral Nutrition and Physical Activity 16, 46. https://doi.org/10.1186/s12966-019-0799-0.

Acton, R.B., Kirkpatrick, S.I., Hammond, D., 2021. Exploring the main and moderating effects of individual-level characteristics on consumer responses to sugar taxes and front-of-pack nutrition labels in an experimental marketplace. Canadian Journal of Public Health 112, 647–662. https://doi.org/10.17269/s41997-021-00475-x.

Adam, A., Jensen, J.D., 2016. What is the effectiveness of obesity related interventions at retail grocery stores and supermarkets? A systematic review. BMC Public Health 16, 1247. https://doi.org/10.1186/s12889-016-3985-x.

Adams, J.M., Hart, W., Gilmer, L., Lloyd-Richardson, E.E., Burton, K.A., 2014. Concrete images of the sugar content in sugar-sweetened beverages reduces attraction to and selection of these beverages. Appetite 83, 10–18. https://doi.org/10.1016/j.appet.2014.07.027.

Albert Heijn. (n.d.). NutriCheck. Retrieved from https://labs.ah.nl/nutricheck.

Albright, C.L., Flora, J.A., Fortmann, S.P., 1990. Restaurant menu labeling: Impact of nutrition information on entree sales and patron attitudes. Health Education & Behavior 17 (2), 157–167. https://doi.org/10.1177/109019819001700203.

Aleskerov, F., Bouyssou, D., Monjardet, B., 2007. Utility maximization, choice and preference, Vol. 16. Springer Science & Business Media, Berlin.

Allan, J.L., Johnston, M., Campbell, N., 2015. Snack purchasing is healthier when the cognitive demands of choice are reduced: A randomized controlled trial. Health Psychology 34 (7), 750–755. https://doi.org/10.1037/hea0000173.

Appelhans, B.M., Milliron, B.-J., Woolf, K., Johnson, T.J., Pagoto, S.L., Schneider, K.L., Ventrelle, J.C., 2012. Socioeconomic status, energy cost, and nutrient content of supermarket food purchases. American Journal of Preventive Medicine 42 (4), 398–402. https://doi.org/10.1016/j.amepre.2011.02.007.

Bauer, J.M., Reisch, L.A., 2019. Behavioural insights and (un)healthy dietary choices: A review of current evidence. Journal of Consumer Policy 42 (1), 3–45. https://doi.org/10.1007/s10603-018-9387-y.

Bergen, D., Yeh, M.C., 2006. Effects of energy-content labels and motivational posters on sales of sugar-sweetened beverages: Stimulating sales of diet drinks among adults study. Journal of the American Dietetic Association 106 (11), 1866–1869. https://doi.org/10.1016/j.jada.2006.08.002.

Bialkova, S., van Trijp, H.C.M., 2011. An efficient methodology for assessing attention to and effect of nutrition information displayed front-of-pack. Food Quality and Preference 22 (6), 592–601. https://doi.org/10.1016/j.foodqual.2011.03.010.

Brownell, K.D., Frieden, T.R., 2009. Ounces of prevention — The public policy case for taxes on sugared beverages. New England Journal of Medicine 360 (18), 1805–1808. https://doi.org/10.1056/NEJMp0902392.

Brug, J., 2008. Determinants of healthy eating: Motivation, abilities and environmental opportunities. Family Practice 25 (suppl_1), i50–i55. https://doi.org/10.1093/fampra/cmn063.

Cadario, R., Chandon, P., 2020. Which healthy eating nudges work best? A meta-analysis of field experiments. Marketing Science 39 (3), 465–486. https://doi.org/10.1287/mksc.2018.1128.

Calvaresi, D., Carli, R., Piguet, J.-G., Contreras, V.H., Luzzani, G., Najjar, A., Schumacher, M., 2022. Ethical and legal considerations for nutrition virtual coaches. AI and Ethics 1–28.

Campos, S., Doxey, J., Hammond, D., 2011. Nutrition labels on pre-packaged foods: A systematic review. Public Health Nutrition 14 (8), 1496–1506. https://doi.org/10.1017/S1368980010003290.

Capewell, S., Capewell, A., 2018. An effectiveness hierarchy of preventive interventions: Neglected paradigm or self-evident truth? Journal of Public Health 40 (2), 350–358. https://doi.org/10.1093/pubmed/fdx055.

Caro, J.C., Valizadeh, P., Correa, A., Silva, A., Ng, S.W., 2020. Combined fiscal policies to promote healthier diets: Effects on purchases and consumer welfare. PloS One 15 (1), e0226731.

Cecchini, M., 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 17 (3), 201–210. https://doi.org/10.1111/obr.12364.

Chan, J., McMahon, E., Brimblecombe, J., 2021. Point-of-sale nutrition information interventions in food retail stores to promote healthier food purchase and intake: A systematic review. Obesity Reviews e13311.

Chetty, R., Looney, A., Kroft, K., 2009. Salience and taxation: Theory and evidence. American Economic Review 99 (4), 1145–1177. https://doi.org/10.1257/aer.99.4.1145.

Claudy, M., Doyle, G., Marriott, L., Campbell, N., O'Malley, G., 2021. Are sugar-sweetened beverage taxes effective? Reviewing the evidence through a marketing systems lens. Journal of Public Policy & Marketing 40 (3), 403–418. https://doi.org/10.1177/0743915620965153.

Coates, A.E., Hardman, C.A., Halford, J.C., Christiansen, P., Boyland, E.J., 2019. Food and beverage cues featured in YouTube videos of social media influencers popular with children: An exploratory study. Frontiers in Psychology 10, 2142. https://doi.org/10.3389/fpsyg.2019.02142.

Cohen, D.A., Babey, S.H., 2012. Contextual influences on eating behaviours: Heuristic processing and dietary choices. Obesity Reviews 13 (9), 766–779. https://doi.org/10.1111/j.1467-789X.2012.01001.x.

Cowburn, G., Stockley, L., 2005. Consumer understanding and use of nutrition labelling: A systematic review. Public Health Nutrition 8 (1), 21–28. https://doi.org/10.1079/PHN2004666.

De Bauw, M., De La Revilla, L.S., Poppe, V., Matthys, C., Vranken, L., 2022. Digital nudges to stimulate healthy and pro-environmental food choices in E-groceries. Appetite 172, 105971. https://doi.org/10.1016/j.appet.2022.105971.

Dingman, D.A., Schulz, M.R., Wyrick, D.L., Bibeau, D.L., Gupta, S.N., 2015. Does providing nutrition information at vending machines reduce calories per item sold? Journal of Public Health Policy 36 (1), 110–122. https://doi.org/10.1057/jphp.2014.38.

Downs, J.S., Wisdom, J., Loewenstein, G., 2015. Helping consumers use nutrition information: Effects of format and presentation. American Journal of Health Economics 1 (3), 326–344. https://doi.org/10.1162/ajhe_a_00020.

Drewnowski, A., 2004. Obesity and the food environment: Dietary energy density and diet costs. American Journal of Preventive Medicine 27 (3), 154–162. https://doi.org/10.1016/j.amepre.2004.06.011.

Dubois, P., Albuquerque, P., Allais, O., Bonnet, C., Bertail, P., Combris, P., Chandon, P., 2020. Effects of front-of-pack labels on the nutritional quality of supermarket food purchases: Evidence from a large-scale randomized controlled trial. Journal of the Academy of Marketing Science 49 (1), 119–138. https://doi.org/10.1007/s11747-020-00723-5.

Ducrot, P., Méjean, C., Julia, C., Kesse-Guyot, E., Touvier, M., Fezeu, L.K., Péneau, S., 2015. Objective understanding of front-of-package nutrition labels among nutritionally at-risk individuals. Nutrients 7 (8), 7106–7125. https://doi.org/10.3390/nu7085325.

Durkin, S., Brennan, E., Wakefield, M., 2012. Mass media campaigns to promote smoking cessation among adults: An integrative review. Tobacco Control 21 (2), 127–138.

Elbel, B., Taksler, G.B., Mijanovich, T., Abrams, C.B., Dixon, L.B., 2013. Promotion of healthy eating through public policy: A controlled experiment. American Journal of Preventive Medicine 45 (1), 49–55. https://doi.org/10.1016/j.amepre.2013.02.023.

Ellison, B., Lusk, J.L., Davis, D., 2014. The impact of restaurant calorie labels on food choice: Results from a field experiment. Economic Inquiry 52 (2), 666–681. https://doi.org/10.1111/ecin.12069.

Fagerstrøm, A., Richartz, P., Pawar, S., Larsen, N.M., Sigurdsson, V., Eriksson, N., 2019. The relative importance of healthy food labels when shopping for groceries online. Procedia Computer Science 164, 538–545. https://doi.org/10.1016/j.procs.2019.12.217.

FDA. (2014). *Food labeling; Nutrition labeling of standard menu items in restaurants and similar retail food establishments*. Washington: Office of the Federal Register, National Archives and Records Administration Retrieved from https://www.federalregister.gov/documents/2014/12/01/2014-27833/food-labeling-nutrition-labeling-of-standard-menu-items-in-restaurants-and-similar-retail-food.

FDA. (2010). *Federal Register Volume 75, Issue 82 (April 29, 2010)*. Washington: Office of the Federal Register, National Archives and Records Administration Retrieved from https://www.govinfo.gov/content/pkg/FR-2010-04-29/pdf/2010-9939.pdf.

Finkelstein, E.A., Doble, B., Ang, F.J.L., Wong, W.H.M., van Dam, R.M., 2021. A randomized controlled trial testing the effects of a positive front-of-pack label with or without a physical activity equivalent label on food purchases. Appetite 158, 104997. https://doi.org/10.1016/j.appet.2020.104997.

Forwood, S.E., Ahern, A.L., Marteau, T.M., Jebb, S.A., 2015. Offering within-category food swaps to reduce energy density of food purchases: A study using an experimental online supermarket. International Journal of Behavioral Nutrition and Physical Activity 12 (1), 85. https://doi.org/10.1186/s12966-015-0241-1.

Freedman, M.R., Connors, R., 2010. Point-of-purchase nutrition information influences food-purchasing behaviors of college students: A pilot study. Journal of the American Dietetic Association 110 (8), 1222–1226. https://doi.org/10.1016/j.jada.2010.05.002.

Giesen, J.C., Payne, C.R., Havermans, R.C., Jansen, A., 2011. Exploring how calorie information and taxes on high-calorie foods influence lunch decisions. The American Journal of Clinical Nutrition 93 (4), 689–694. https://doi.org/10.3945/ajcn.110.008193.

Glanz, K., Basil, M., Maibach, E., Goldberg, J., Snyder, D., 1998. Why Americans eat what they do: Taste, nutrition, cost, convenience, and weight control concerns as influences on food consumption. Journal of the American Dietetic Association 98 (10), 1118–1126. https://doi.org/10.1016/s0002-8223(98)00260-0.

Grandi, B., Burt, S., Cardinali, M.G., 2021. Encouraging healthy choices in the retail store environment: Combing product information and shelf allocation. Journal of Retailing and Consumer Services 61, 102522. https://doi.org/10.1016/j.jretconser.2021.102522.

Grunert, K.G., 2011. Sustainability in the food sector: A consumer behaviour perspective. International Journal on Food System Dynamics 2 (3), 207–218. https://doi.org/10.18461/ijfsd.v2i3.232.

Grunert, K.G., Hieke, S., Wills, J., 2014. Sustainability labels on food products: Consumer motivation, understanding and use. Food Policy 44, 177–189. https://doi.org/10.1016/j.foodpol.2013.12.001.

Grunert, K.G., Wills, J.M., 2007. A review of European research on consumer response to nutrition information on food labels. Journal of Public Health 15 (5), 385–399. https://doi.org/10.1007/s10389-007-0101-9.

Grunert, K.G., Wills, J.M., Fernández-Celemín, L., 2010. Nutrition knowledge, and use and understanding of nutrition information on food labels among consumers in the UK. Appetite 55 (2), 177–189. https://doi.org/10.1016/j.appet.2010.05.045.

Gustafson, C.R., Zeballos, E., 2019. Cognitive aids and food choice: Real-time calorie counters reduce calories ordered and correct biases in calorie estimates. Appetite 141, 104320. https://doi.org/10.1016/j.appet.2019.104320.

Hagmann, D., Siegrist, M., 2020. Nutri-Score, multiple traffic light and incomplete nutrition labelling on food packages: Effects on consumers' accuracy in identifying healthier snack options. Food Quality and Preference 83, 103894. https://doi.org/10.1016/j.foodqual.2020.103894.

Harbers, M.C., Beulens, J.W., Rutters, F., de Boer, F., Gillebaart, M., Sluijs, I., van der Schouw, Y.T., 2020. The effects of nudges on purchases, food choice, and energy intake or content of purchases in real-life food purchasing environments: A systematic review and evidence synthesis. Nutrition Journal 19, 103. https://doi.org/10.1186/s12937-020-00623-y.

Harnack, L.J., French, S.A., Oakes, J.M., Story, M.T., Jeffery, R.W., Rydell, S.A., 2008. Effects of calorie labeling and value size pricing on fast food meal choices: Results from an experimental trial. International Journal of Behavioral Nutrition and Physical Activity 5, 63. https://doi.org/10.1186/1479-5868-5-63.

Hebert, J.R., Clemow, L., Pbert, L., Ockene, I.S., Ockene, J.K., 1995. Social desirability bias in dietary self-report may compromise the validity of dietary intake measures. International Journal of Epidemiology 24 (2), 389–398. https://doi.org/10.1093/ije/24.2.389.

Hendriksen, A., Jansen, R., Dijkstra, S.C., Huitink, M., Seidell, J.C., Poelman, M.P., 2021. How healthy and processed are foods and drinks promoted in supermarket sales flyers? A cross-sectional study in the Netherlands. Public Health Nutrition 24 (10), 3000–3008.

Herforth, A., Bai, Y., Venkat, A., Mahrt, K., Ebel, A., & Masters, W. A. (2020). *Cost and affordability of healthy diets across and within countries: Background paper for the state of food security and nutrition in the world 2020. FAO agricultural development economics technical study no. 9* (Vol. 9): Food & Agriculture Org.

Hersey, J.C., Wohlgenant, K.C., Arsenault, J.E., Kosa, K.M., Muth, M.K., 2013. Effects of front-of-package and shelf nutrition labeling systems on consumers. Nutrition Reviews 71 (1), 1–14. https://doi.org/10.1111/nure.12000.

Hess, R., Visschers, V.H., Siegrist, M., 2012. The role of health-related, motivational and sociodemographic aspects in predicting food label use: A comprehensive study. Public Health Nutrition 15 (3), 407–414. https://doi.org/10.1017/S136898001100156X.

Higgins, J., Thomas, J., Chandler, J., Cumpston, M., Li, T., Page, M., Welch, V., 2022. Cochrane Handbook for Systematic Reviews of Interventions. Retrieved from www.training.cochrane.org/handbook.

Hobin, E., Bollinger, B., Sacco, J., Liebman, E., Vanderlee, L., Zuo, F., Hammond, D., 2017. Consumers' response to an on-shelf nutrition labelling system in supermarkets: Evidence to inform policy and practice. Milbank Quarterly 95 (3), 494–534. https://doi.org/10.1111/1468-0009.12277.

Hoenink, J.C., Stuber, J.M., Lakerveld, J., Waterlander, W., Beulens, J.W., Mackenbach, J.D., 2021. The effect of on-shelf sugar labeling on beverage sales in the supermarket: A comparative interrupted time series analysis of a natural experiment. International Journal of Behavioral Nutrition and Physical Activity 18, 49. https://doi.org/10.1186/s12966-021-01114-x.

Hornik, R., 1989. The knowledge-behavior gap in public information campaigns: A development communication view. In: Information campaigns: Balancing social values and social change, Vol. 18. SAGE Publications, Newbury Park, pp. 113–138.

Hung, Y., Grunert, K.G., Hoefkens, C., Hieke, S., Verbeke, W., 2017. Motivation outweighs ability in explaining European consumers' use of health claims. Food Quality and Preference 58, 34–44. https://doi.org/10.1016/j.foodqual.2017.01.001.

Ikonen, I., Sotgiu, F., Aydinli, A., Verlegh, P.W.J., 2020. Consumer effects of front-of-package nutrition labeling: An interdisciplinary meta-analysis. Journal of the Academy of Marketing Science 48 (3), 360–383. https://doi.org/10.1007/s11747-019-00663-9.

Jansen, L., van Kleef, E., Van Loo, E.J., 2021. The use of food swaps to encourage healthier online food choices: A randomized controlled trial. International Journal of Behavioral Nutrition and Physical Activity 18, 156. https://doi.org/10.1186/s12966-021-01222-8.

Julia, C., Blanchet, O., Mejean, C., Peneau, S., Ducrot, P., Alles, B., Hercberg, S., 2016. Impact of the front-of-pack 5-colour nutrition label (5-CNL) on the nutritional quality of purchases: An experimental study. International Journal of Behavioral Nutrition and Physical Activity 13, 101. https://doi.org/10.1186/s12966-016-0416-4.

Julia, C., Arnault, N., Agaësse, C., Fialon, M., Deschasaux-Tanguy, M., Andreeva, V.A., Galan, P., 2021. Impact of the front-of-pack label Nutri-Score on the nutritional quality of food choices in a quasi-experimental trial in catering. Nutrients 13 (12), 4530. https://doi.org/10.3390/nu13124530.

Jumbo, 2022. Een tikkie gezonder? Dat doe je zo!. https://www.jumbo.com/inspiratie/eentikkiegezonder.

Kahn-Marshall, J.L., Gallant, M.P., 2012. Making healthy behaviors the easy choice for employees: A review of the literature on environmental and policy changes in worksite health promotion. Health Education & Behavior 39 (6), 752–776. https://doi.org/10.1177/1090198111434153.

Kanter, R., Vanderlee, L., Vandevijvere, S., 2018. Front-of-package nutrition labelling policy: Global progress and future directions. Public Health Nutrition 21 (8), 1399–1408. https://doi.org/10.1017/S1368980018000010.

Ketron, S., Spears, N., Dai, B., 2016. Overcoming information overload in retail environments: Imagination and sales promotion in a wine context. Journal of Retailing and Consumer Services 33, 23–32. https://doi.org/10.1016/j.jretconser.2016.07.017.

Lee, B.Y., Bartsch, S.M., Mui, Y., Haidari, L.A., Spiker, M.L., Gittelsohn, J., 2017. A systems approach to obesity. Nutrition Reviews 75 (suppl_1), 94–106. https://doi.org/10.1093/nutrit/nuw049.

Lee-Kwan, S.H., Bleich, S.N., Kim, H., Colantuoni, E., Gittelsohn, J., 2015. Environmental intervention in carryout restaurants increases sales of healthy menu items in a low-income urban setting. American Journal of Health Promotion 29 (6), 357–364. https://doi.org/10.4278/ajhp.130805-QUAN-408.

Levin, S., 1996. Pilot study of a cafeteria program relying primarily on symbols to promote healthy choices. Journal of Nutrition Education 28 (5), 282–285. https://doi.org/10.1016/S0022-3182(96)70102-4.

Levitt, S.D., List, J.A., 2007. What do laboratory experiments measuring social preferences reveal about the real world? Journal of Economic Perspectives 21 (2), 153–174.

Liberato, S., Bailie, R., Brimblecombe, J., 2014. Nutrition interventions at point-of-sale to encourage healthier food purchasing: A systematic review. BMC Public Health 14, 919. https://doi.org/10.1186/1471-2458-14-919.

Liu, P.J., Roberto, C.A., Liu, L.J., Brownell, K.D., 2012. A test of different menu labeling presentations. Appetite 59 (3), 770–777. https://doi.org/10.1016/j.appet.2012.08.011.

Lowe, M.R., Tappe, K.A., Butryn, M.L., Annunziato, R.A., Coletta, M.C., Ochner, C.N., Rolls, B.J., 2010. An intervention study targeting energy and nutrient intake in worksite cafeterias. Eating Behaviors 11 (3), 144–151. https://doi.org/10.1016/j.eatbeh.2010.01.002.

Luiten, C.M., Steenhuis, I.H., Eyles, H., Mhurchu, C.N., 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 19 (3), 530–538. https://doi.org/10.1017/S1368980015002177.

MacInnis, D.J., Jaworski, B.J., 1989. Information processing from advertisements: Toward an integrative framework. Journal of Marketing 53 (4), 1–23. https://doi.org/10.1177/002224298905300401.

MacInnis, D.J., Moorman, C., Jaworski, B.J., 1991. Enhancing and measuring consumers' motivation, opportunity, and ability to process brand information from ads. Journal of Marketing 55 (4), 32–53. https://doi.org/10.2307/1251955.

Marty, L., Cook, B., Piernas, C., Jebb, S.A., Robinson, E., 2020a. Effects of labelling and increasing the proportion of lower-energy density products on online food shopping: A randomised control trial in high-and low-socioeconomic position participants. Nutrients 12 (12), 3618. https://doi.org/10.3390/nu12123618.

Marty, L., Jones, A., Robinson, E., 2020b. Socioeconomic position and the impact of increasing availability of lower energy meals vs. menu energy labelling on food choice: Two randomized controlled trials in a virtual fast-food restaurant. International Journal of Behavioral Nutrition and Physical Activity 17, 10. https://doi.org/10.1186/s12966-020-0922-2.

Maslowska, E., Smit, E.G., van den Putte, B., 2016. It is all in the name: A study of consumers' responses to personalized communication. Journal of Interactive Advertising 16 (1), 74–85. https://doi.org/10.1080/15252019.2016.1161568.

Mazza, M.C., Dynan, L., Siegel, R.M., Tucker, A.L., 2018. Nudging healthier choices in a hospital cafeteria: Results from a field study. Health Promotion Practice 19 (6), 925–934. https://doi.org/10.1177/1524839917740119.

McHugh, M.L., 2012. Interrater reliability: The kappa statistic. Retrieved from Biochemia Medica 22 (3), 276–282. https://www.ncbi.nlm.nih.gov/pubmed/23092060.

Michener, G., Bersch, K., 2013. Identifying transparency. Information Polity 18 (3), 233. https://doi.org/10.3233/IP-130299.

Michie, S., Ashford, S., Sniehotta, F.F., Dombrowski, S.U., Bishop, A., French, D.P., 2011. A refined taxonomy of behaviour change techniques to help people change their physical activity and healthy eating behaviours: The CALO-RE taxonomy. Psychology & Health 26 (11), 1479–1498. https://doi.org/10.1080/08870446.2010.540664.

Moher, D., Liberati, A., Tetzlaff, J., Altman, D.G., Prisma Group, 2009. Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. PLoS Medicine 6 (7), e1000097. https://doi.org/10.1371/journal.pmed1000097.

Montagni, I., Prevot, F., Castro, Z., Goubel, B., Perrin, L., Oppert, J.-M., Fontvieille, A.-M., 2020. Using positive nudge to promote healthy eating at worksite: A food labeling intervention. Journal of Occupational and Environmental Medicine 62 (6), e260–e266. https://doi.org/10.1097/JOM.0000000000001861.

Mora-Garcia, C.A., Tobar, L.F., Young, J.C., 2019. The effect of randomly providing nutri-score information on actual purchases in Colombia. Nutrients 11 (3), 491. https://doi.org/10.3390/nu11030491.

Murukutla, N., Cotter, T., Wang, S., Cullinan, K., Gaston, F., Kotov, A., Mullin, S., 2020. Results of a mass media campaign in South Africa to promote a sugary drinks tax. Nutrients 12 (6), 1878. https://doi.org/10.3390/nu12061878.

Myers, J.H., Alpert, M.I., 1977. Semantic confusion in attitude research: Salience vs. importance vs. determinance. ACR North American Advances 4, 106–110.

Närhinen, M., Nissinen, A., Puska, P., 2000. Changes in supermarket sales during and after a staged health promotion campaign. British Food Journal 102 (4), 308–319. https://doi.org/10.1108/00070700010327733.

Niebylski, M.L., Redburn, K.A., Duhaney, T., Campbell, N.R., 2015. Healthy food subsidies and unhealthy food taxation: A systematic review of the evidence. Nutrition 31 (6), 787–795. https://doi.org/10.1016/j.nut.2014.12.010.

Nohlen, H., Bakogianni, I., Grammatikaki, E., Ciriolo, E., Pantazi, M., Dias, J., Van Bavel, R., 2022. Front-of-pack nutrition labelling schemes: An update of the evidence (JRC130125). Publications Office of the European Union, Luxembourg.

Ogilvie, D., Fayter, D., Petticrew, M., Sowden, A., Thomas, S., Whitehead, M., Worthy, G., 2008. The harvest plot: A method for synthesising evidence about the differential effects of interventions. BMC Medical Research Methodology 8, 8. https://doi.org/10.1186/1471-2288-8-8.

Oh, G.-E., Huh, Y.E., Mukhopadhyay, A., 2020. Informed indulgence: The effects of nutrition information provision and dietary restraint on consecutive food consumption decisions. Psychology & Health 36 (11), 1–22. https://doi.org/10.1080/08870446.2020.1841764.

Ölander, F., Thøgersen, J., 1995. Understanding of consumer behaviour as a prerequisite for environmental protection. Journal of Consumer Policy 18 (4), 345–385. https://doi.org/10.1007/BF01024160.

Oliveira, D., De Steur, H., Lagast, S., Gellynck, X., Schouteten, J.J., 2020. The impact of calorie and physical activity labelling on consumer's emo-sensory perceptions and food choices. Food Research International 133, 109166. https://doi.org/10.1016/j.foodres.2020.109166.

Olstad, D.L., Vermeer, J., McCargar, L.J., Prowse, R.J.L., Raine, K.D., 2015. Using traffic light labels to improve food selection in recreation and sport facility eating environments. Appetite 91, 329–335. https://doi.org/10.1016/j.appet.2015.04.057.

Osman, M., Thornton, K., 2019. Traffic light labelling of meals to promote sustainable consumption and healthy eating. Appetite 138, 60–71. https://doi.org/10.1016/j.appet.2019.03.015.

Pang, J., Hammond, D., 2013. Efficacy and consumer preferences for different approaches to calorie labeling on menus. Journal of Nutrition Education and Behavior 45 (6), 669–675. https://doi.org/10.1016/j.jneb.2013.06.005.

Papies, E.K., 2016. Health goal priming as a situated intervention tool: how to benefit from nonconscious motivational routes to health behaviour. Health Psychology Review 10 (4), 408–424. https://doi.org/10.1080/17437199.2016.1183506.

Pearson-Stuttard, J., Bandosz, P., Rehm, C.D., Penalvo, J., Whitsel, L., Gaziano, T., Lloyd-Williams, F., 2017. Reducing US cardiovascular disease burden and disparities through national and targeted dietary policies: A modelling study. PLoS Medicine 14 (6), e1002311.

Peck, J., Shu, S.B., 2009. The effect of mere touch on perceived ownership. Journal of Consumer Research 36 (3), 434–447.

Pell, D., Mytton, O., Penney, T.L., Briggs, A., Cummins, S., Penn-Jones, C., Sharp, S.J., 2021. Changes in soft drinks purchased by British households associated with the UK soft drinks industry levy: Controlled interrupted time series analysis. BMJ 372. https://doi.org/10.1136/bmj.n254.

Perez-Cueto, F.J., 2019. An umbrella review of systematic reviews on food choice and nutrition published between 2017 and 2019. Nutrients 11 (10), 2398. https://doi.org/10.3390/nu11102398.

Petty, R.E., Cacioppo, J.T., 1986. In: The elaboration likelihood model of persuasion. Springer, pp. 1–24.

Price, M., Higgs, S., Lee, M., 2016. Snack intake is reduced using an implicit, high-level construal cue. Health Psychology 35 (8), 923. https://doi.org/10.1037/hea0000322.

Qutteina, Y., Hallez, L., Mennes, N., De Backer, C., Smits, T., 2019. What do adolescents see on social media? A diary study of food marketing images on social media. Frontiers in Psychology 10, 2637. https://doi.org/10.3389/fpsyg.2019.02637.

Raghunathan, R., Naylor, R.W., Hoyer, W.D., 2006. The unhealthy = tasty intuition and its effects on taste inferences, enjoyment, and choice of food products. Journal of Marketing 70 (4), 170–184. https://doi.org/10.1509/jmkg.70.4.170.

Ravensbergen, E.A., Waterlander, W.E., Kroeze, W., Steenhuis, I.H., 2015. Healthy or unhealthy on sale? A cross-sectional study on the proportion of healthy and unhealthy foods promoted through flyer advertising by supermarkets in the Netherlands. BMC Public Health 15 (1), 470. https://doi.org/10.1186/s12889-015-1748-8.

Roberto, C.A., Larsen, P.D., Agnew, H., Baik, J., Brownell, K.D., 2010. Evaluating the impact of menu labeling on food choices and intake. American Journal of Public Health 100 (2), 312–318. https://doi.org/10.2105/ajph.2009.160226.

Roberto, C.A., Ng, S.W., Ganderats-Fuentes, M., Hammond, D., Barquera, S., Jauregui, A., Taillie, L.S., 2021. The influence of front-of-package nutrition labeling on consumer behavior and product reformulation. Annual Review of Nutrition 41, 529–550. https://doi.org/10.1146/annurev-nutr-111120-094932.

Rodgers, A.B., Kessler, L.G., Portnoy, B., Potosky, A.L., Patterson, B., Tenney, J., Kahle, L.L., 1994. 'Eat for Health': A supermarket intervention for nutrition and cancer risk reduction. American Journal of Public Health 84 (1), 72–76. https://doi.org/10.2105/ajph.84.1.72.

Rothschild, M.L., 1999. Carrots, sticks, and promises: A conceptual framework for the management of public health and social issue behaviors. Journal of Marketing 63 (4), 24–37. https://doi.org/10.2307/1251972.

Roy, R., Alassadi, D., 2021. Does labelling of healthy foods on menus using symbols promote better choices at the point-of-purchase? Public Health Nutrition 24 (4), 746–754. https://doi.org/10.1017/S1368980020002840.

Rutter, H., Savona, N., Glonti, K., Bibby, J., Cummins, S., Finegood, D.T., Moore, L., 2017. The need for a complex systems model of evidence for public health. The Lancet 390 (10112), 2602–2604. https://doi.org/10.1016/S0140-6736(17)31267-9.

Sacks, G., Tikellis, K., Millar, L., Swinburn, B., 2011. Impact of 'traffic-light' nutrition information on online food purchases in Australia. Australian and New Zealand Journal of Public Health 35 (2), 122–126. https://doi.org/10.1111/j.1753-6405.2011.00684.x.

Scarborough, P., Adhikari, V., Harrington, R.A., Elhussein, A., Briggs, A., Rayner, M., White, M., 2020. Impact of the announcement and implementation of the UK soft drinks industry levy on sugar content, price, product size and number of available soft drinks in the UK, 2015–19: A controlled interrupted time series analysis. PLoS Medicine 17 (2), e1003025.

Schulte-Mecklenbeck, M., Sohn, M., de Bellis, E., Martin, N., Hertwig, R., 2013. A lack of appetite for information and computation. Simple heuristics in food choice. Appetite 71, 242–251. https://doi.org/10.1016/j.appet.2013.08.008.

Scourboutakos, M.J., Mah, C.L., Murphy, S.A., Mazza, F.N., Barrett, N., McFadden, B., L'Abbé, M.R., 2017. Testing a beverage and fruit/vegetable education intervention in a university dining hall. Journal of Nutrition Education and Behavior 49 (6), 457–465. https://doi.org/10.1016/j.jneb.2017.02.003.

Shah, A.M., Bettman, J.R., Ubel, P.A., Keller, P.A., Edell, J.A., 2014. Surcharges plus unhealthy labels reduce demand for unhealthy menu items. Journal of Marketing Research 51 (6), 773–789. https://doi.org/10.1509/jmr.13.0434.

Shah, M., Bouza, B., Adams-Huet, B., Jaffery, M., Esposito, P., Dart, L., 2016. Effect of calorie or exercise labels on menus on calories and macronutrients ordered and calories from specific foods in Hispanic participants: A randomized study. Journal of Investigative Medicine 64 (8), 1261–1268. https://doi.org/10.1136/jim-2016-000227.

Shin, S., Chakraborty, B., Yan, X., van Dam, R.M., Finkelstein, E.A., 2022. Evaluation of combinations of nudging, pricing, and labeling strategies to improve diet quality: A virtual grocery store experiment employing a multiphase optimization strategy. Annals of Behavioral Medicine kaab115. https://doi.org/10.1093/abm/kaab115.

Simon, H.A., 1955. A behavioral model of rational choice. The quarterly journal of economics 69 (1), 99–118. https://doi.org/10.2307/1884852.

Sproul, A.D., Canter, D.D., Schmidt, J.B., 2003. Does point-of-purchase nutrition labeling influence meal selections? A test in an army cafeteria. Military Medicine 168 (7), 556–560. https://doi.org/10.1093/milmed/168.7.556.

Story, M., French, S., 2004. Food advertising and marketing directed at children and adolescents in the US. International Journal of Behavioral Nutrition and Physical Activity 1, 3. https://doi.org/10.1186/1479-5868-1-3.

Stuber, J.M., Lakerveld, J., Kievitsbosch, L.W., Mackenbach, J.D., Beulens, J.W., 2022. Nudging customers towards healthier food and beverage purchases in a real-life online supermarket: A multi-arm randomized controlled trial. BMC Medicine 20 (1), 1–13. https://doi.org/10.1186/s12916-021-02205-z.

Sutherland, L.A., Kaley, L.A., Fischer, L., 2010. Guiding Stars: The effect of a nutrition navigation program on consumer purchases at the supermarket. American Journal of Clinical Nutrition 91 (4), 1090S–1094S. https://doi.org/10.3945/ajcn.2010.28450C.

Swinburn, B., Egger, G., Raza, F., 1999. Dissecting obesogenic environments: The development and application of a framework for identifying and prioritizing environmental interventions for obesity. Preventive Medicine 29 (6), 563–570. https://doi.org/10.1006/pmed.1999.0585.

Thomas, B., Ciliska, D., Dobbins, M., Micucci, S., 2004. A process for systematically reviewing the literature: Providing the research evidence for public health nursing interventions. Worldviews on Evidence-Based Nursing 1 (3), 176–184. https://doi.org/10.1111/j.1524-475X.2004.04006.x.

Thorndike, A.N., Sonnenberg, L., Riis, J., Barraclough, S., Levy, D.E., 2012. A 2-phase labeling and choice architecture intervention to improve healthy food and beverage choices. American Journal of Public Health 102 (3), 527–533. https://doi.org/10.2105/ajph.2011.300391.

Thorndike, A.N., Riis, J., Sonnenberg, L.M., Levy, D.E., 2014. Traffic-light labels and choice architecture: Promoting healthy food choices. American Journal of Preventive Medicine 46 (2), 143–149. https://doi.org/10.1016/j.amepre.2013.10.002.

van Dam, Y.K., van Trijp, H.C.M., 2013. Relevant or determinant: Importance in certified sustainable food consumption. Food Quality and Preference 30 (2), 93–101. https://doi.org/10.1016/j.foodqual.2013.05.001.

van der Laan, L.N., Orcholska, O., 2022. Effects of digital just-in-time nudges on healthy food choice – A field experiment. Food Quality and Preference 104535. https://doi.org/10.1016/j.foodqual.2022.104535.

van Herpen, E., van Trijp, H.C.M., 2011. Front-of-pack nutrition labels. Their effect on attention and choices when consumers have varying goals and time constraints. Appetite 57 (1), 148–160. https://doi.org/10.1016/j.appet.2011.04.011.

van Ittersum, K., Pennings, J.M., Wansink, B., van Trijp, H.C., 2007. The validity of attribute-importance measurement: A review. Journal of Business Research 60 (11), 1177–1190. https://doi.org/10.1016/j.jbusres.2007.04.001.

van Kleef, E., Dagevos, H., 2015. The growing role of front-of-pack nutrition profile labeling: A consumer perspective on key issues and controversies. Critical Reviews in Food Science and Nutrition 55 (3), 291–303. https://doi.org/10.1080/10408398.2011.653018.

Van Loo, E.J., Caputo, V., Nayga, R.M., Seo, H.-S., Zhang, B., Verbeke, W., 2015. Sustainability labels on coffee: Consumer preferences, willingness-to-pay and visual attention to attributes. Ecological Economics 118, 215–225. https://doi.org/10.1016/j.ecolecon.2015.07.011.

van Rijnsoever, F.J., van Lente, H., van Trijp, H.C., 2011. Systemic policies towards a healthier and more responsible food system. Journal of Epidemiology & Community Health 65 (9), 737–739.

van Trijp, H.C.M., 2009. Consumer understanding and nutritional communication: Key issues in the context of the new EU legislation. European Journal of Nutrition 48, S41–S48. https://doi.org/10.1007/s00394-009-0075-1.

VanEpps, E.M., Molnar, A., Downs, J.S., Loewenstein, G., 2021. Choosing the light meal: Real-time aggregation of calorie information reduces meal calories. Journal of Marketing Research 58 (5), 948–967. https://doi.org/10.1177/00222437211022367.

Verbeke, W., 2005. Agriculture and the food industry in the information age. European Review of Agricultural Economics 32 (3), 347–368. https://doi.org/10.1093/eurrag/jbi017.

Visschers, V.H., Hess, R., Siegrist, M., 2010. Health motivation and product design determine consumers' visual attention to nutrition information on food products. Public Health Nutrition 13 (7), 1099–1106. https://doi.org/10.1017/S1368980009993235.

Vyth, E.L., Steenhuis, I.H.M., Heymans, M.W., Roodenburg, A.J.C., Brug, J., Seidell, J.C., 2011. Influence of placement of a nutrition logo on cafeteria menu items on lunchtime food choices at Dutch work sites. Journal of the American Dietetic Association 111 (1), 131–136. https://doi.org/10.1016/j.jada.2010.10.003.

Zheng, H., Huang, L., Ross Jr, W., 2019. Reducing obesity by taxing soft drinks: Tax salience and firms' strategic responses. Journal of Public Policy & Marketing 38 (3), 297–315. https://doi.org/10.1177/0743915619845424.

Zizzo, D.J., Parravano, M., Nakamura, R., Forwood, S., Suhrcke, M., 2021. The impact of taxation and signposting on diet: An online field study with breakfast cereals and soft drinks. Experimental Economics 24, 1294–1324. https://doi.org/10.1007/s10683-020-09698-0.

Zobel, E.H., Hansen, T.W., Rossing, P., von Scholten, B.J., 2016. Global changes in food supply and the obesity epidemic. Current Obesity Reports 5 (4), 449–455. https://doi.org/10.1007/s13679-016-0233-8.