Dynamics of demand-side and supply-side responses to Front-of-Pack nutrition labels in Europe

ABSTRACT

The EU food market is characterized by the presence of several Front-of-Pack (FOP) nutrition labels, some of which have been very recently introduced. While the EU Commission proposed to harmonize and possibly mandate the use of FOP labels, agreement on which label to adopt is far from being achieved. This review explores the main issues related to the adoption of FOP nutrition labels from both the demand-side and the supply-side perspective with the aim of providing an updated evidence-based roadmap for the development of future studies on FOP labelling, that can contribute to extend scientific evidence and guide future EU food policies.

1 Introduction

Nutrition-related information provision to consumers has always been considered a key policy tool for enabling, supporting, and guiding consumer food choices toward healthier dietary patterns. Information-based demand-side policies involve various forms of information provision (Mazzocchi et al., 2009), among which nutritional labelling is the most relevant. Nutritional labelling provides consumers with information at the point of purchase and enables them to evaluate and compare the characteristics of different products so that they can make informed and, potentially, healthier choices (Banterle and Cavaliere, 2014; Cannoosamy et al., 2014; Cavaliere et al., 2017; Cecchini and Warin, 2016; Grunert and Wills, 2007; Loureiro et al., 2006; Kim et al., 2001; Ni Mhurchu et al., 2018; Post et al., 2010; Variyam, 2008). Hence, nutritional labelling is considered a viable tool for reducing consumer risk of incurring diet-related health issues such as overweight, obesity, and consequent non-communicable diseases. It is estimated that in the EU in 2017, over 950,000 deaths occurred (one out of five people) and over 16 million people lost healthy life years attributable to unhealthy diets and related cardiovascular diseases and cancers (GBD 2017

Diet Collaborators, 2019). Such diseases also generate considerable direct and indirect costs for society, which negatively affect the overall welfare of the population (Loureiro and Nayga, 2005).

Many countries worldwide began regulating the use of nutritional labelling on food products a long time ago, starting with the US in 1994. The EU aligned years later, with the Regulation 1169/2011 on information provision to consumers. The regulation established a list of mandatory information (i.e., nutritional declaration) and allowed producers to adopt various forms of additional voluntary indications[1]. The latter, commonly known as "Front-of-Pack" (FOP) labels, include a variety of nutrition labelling schemes mostly based on graphic symbols and/or colour coding that can be used in addition to the mandatory nutritional declaration.

FOP nutrition labels have been described by the World Health Organization as a combined initiative of governments, the food industry, and retailers that can eventually guide consumers toward healthier food choices (WHO, 2018). They are designed to facilitate consumers' understanding of the main nutritional characteristics of food products, making product comparison easier. The underlying idea is to help consumers see the most important nutrition information at the point of purchase in a simplified and time-saving manner (Van Camp et al., 2012). Moreover, FOP nutrition labels are expected to trigger a positive response from the food and beverage industry by encouraging a heathy reformulation of their products (Storcksdieck genannt Bonsmann et al., 2020).

Given these anticipated benefits, the voluntary adoption of different FOP schemes has grown significantly over the past 10 years. To date, several FOP schemes exist worldwide, that differ both in terms of type and amount of the information reported. The presence of so many different schemes pushed some governments towards harmonization and, in some cases, towards mandatory adoption at the national level. Chile was among the first countries to mandate the use of a harmonized FOP nutrition label in 2016, followed by the majority of South American countries (Global Food Research Program, 2020). Iran also harmonized and mandated the use FOP labelling,

[1] Voluntary nutrition and health claims represent a specific type of voluntary indications that do not fall under Reg. 1169/20011 and are, respectively disciplined by Reg. 1924/2006 and 432/2012)

while several other countries such as Australia, Argentina, and Nigeria adopted one FOP scheme for all food products while maintaining voluntary adoption by firms.

In contrast with the general trend, the EU context is still characterized by a highly heterogeneous presence of FOP schemes. The EU Commission recently proposed to harmonize, as explained in the Farm-to-Fork strategy (European Commission, 2020a), but agreement on which label to adopt and possibly mandate is far from being achieved. In fact, harmonization across member states and the EU Commission's proposal of mandating FOP labelling has become the core of a heated debate involving policy-makers, scholars at various levels, public opinion, and food industry stakeholders.

A few review papers have recently been published on the use of FOP nutrition labelling worldwide (see for instance Roberto et al., 2021; Song et al., 2021 or Temple, 2020). No other review paper, however, has focused on the European context. While nutritional labelling has been mandated and harmonized in the EU (i.e., Regulation 1169/2011) the adoption of FOP labels is still loosely regulated. As a result, the EU food market is characterized by the presence of several FOP schemes, some of which have been very recently introduced. No other review has also explored the main issues related to the adoption of FOP nutrition labels from a supply-side perspective. In previous studies, this aspect has been mainly analysed by investigating the extent FOP schemes are able to leverage firms' healthy reformulation of their products. However, there are also other dynamics that need to be taken into consideration, especially in the EU context where the food and beverage industry is characterized by a high presence of micro and small firms producing many high-quality products with Denomination of Origin. We attempt to fill this void in the literature.

After illustrating the EU regulatory framework and classification of existing EU FOP schemes, we will discuss consumers' cognitive response to different FOP labels in order to understand why some schemes can be more effective than others. We will also assess the effectiveness of the different FOP labels in terms of consumers' understanding, acceptability, and behavioural outcomes (i.e., purchasing intentions) based on a few recent studies. As for the supply

side, we will describe the main dynamics of firms' responses to voluntary FOP nutrition labels by exploring, among others, the role of firms' dimension and differentiation strategies. Our aim in this review article is to gather the most recent evidence on EU FOP schemes, especially newly and highly debated ones, and to provide an updated and comprehensive overview of their main pros and cons as well as their possible impacts on the EU food and beverage industry.

We find that there are main gaps that are yet to be filled in the literature concerning FOP nutrition labelling, especially in terms of identifying the most effective FOP scheme that is beneficial to consumers and not harmful to food firms or penalizing some markets. Our review provides an evidence-based roadmap for the development of future studies on FOP schemes, that can provide further scientific support to future EU food policies geared at harmonizing FOP nutrition labelling in the EU.

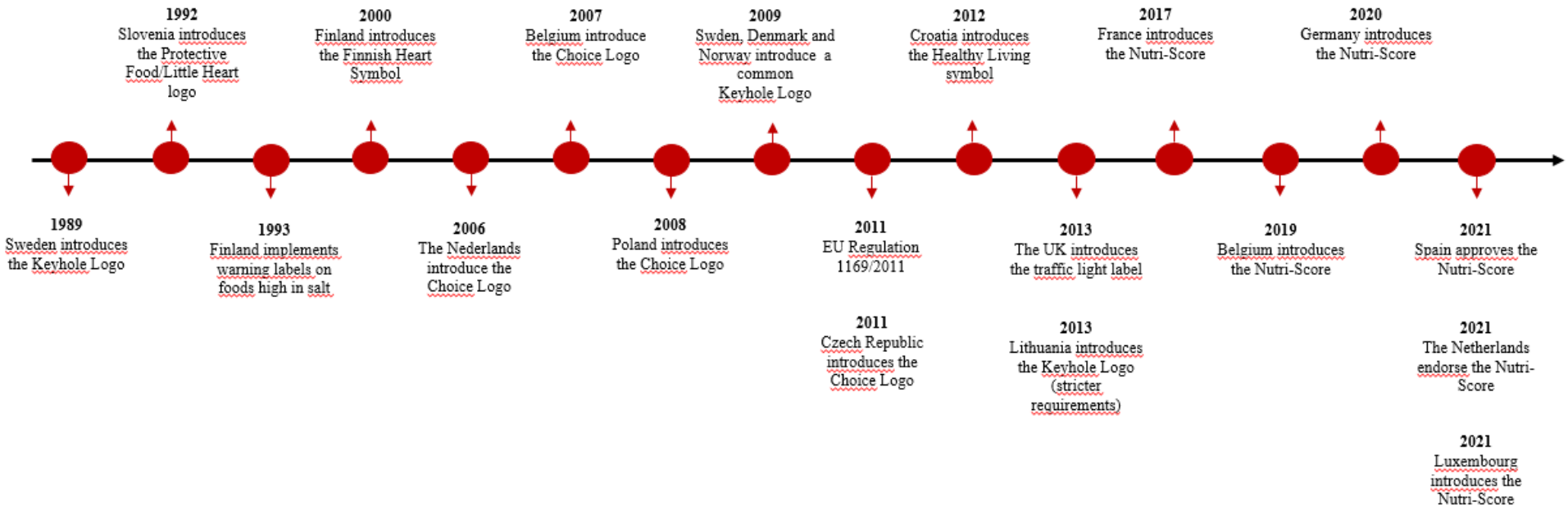
2 Current EU FOP nutrition labelling landscape and regulation

At the EU level, the use of FOP nutrition labelling is regulated by Regulation No. 1169/2011 on the provision of food information to consumers, which introduced the mandatory nutritional declaration on all prepacked food, while allowing producers to display additional indications on a voluntary basis. Specifically, Art. 35 of the regulation establishes that the same information presented in the nutritional declaration (all or only some of them) can be reported using alternative forms of expression and/or presented by means of graphical forms or symbols in addition to words or numbers. Art. 36 additionally admits other FOP labels that report information different from those reported in the nutritional declaration.

Currently, a variety of FOP labels exist in the EU market (Figure 1). 'Keyhole Logo' is the oldest, first introduced in Sweden in 1989 and then later adopted in Norway, Denmark (2009), and Lithuania (2014) (Kanter et al., 2018). In 1992, Slovenia introduced the 'Protective Food' logo (also called 'Little Heart') (Miklavec et al., 2016). Finland launched the 'Finnish Heart Symbol' in 2000.

Six years later, the Netherlands introduced the ‘Healthy Choice’ logo but later dismissed it. The “Healthy Choice” logo however, was

Figure 1. Timeline of EU FOP labelling adoption



adopted in Poland in 2009 and in the Czech Republic in 2012 (Kanter et al., 2018). Another type of FOP label is the 'Reference Intakes' label (Reference Intake), developed in 2006 and introduced in 2014 in all EU countries to replace the older 'Guideline Daily Amounts'. In 2013, Multiple Traffic Lights, which probably represents one of the most popular and debated FOP labels, was adopted by the UK in 2013 and is currently in use in Ireland (Kanter et al., 2018). Croatia proposed and adopted 'Healthy Living' in 2012.

Based on the results of a large scale randomized controlled trial, the NutriScore label was selected in 2017 as the official nutritional FOP label in France (Ducrot et al., 2015a; Ducrot et al., 2016; Julia et al., 2016; Julia et al., 2017; Julia and Hercberg, 2017). The NutriScore scheme is based on the use of colours (green to red) associated with letters (A to E) that attribute an overall evaluation of the nutritional quality of the product[2]. The colour coding strongly resembles the principle of the Multiple Traffic Lights label, where the green colour is automatically associated with a "go/good" sign and the red colour with a "stop". However, unlike the Multiple Traffic Lights label, the NutriScore does not associate the colours with the nutritional values. Instead, it uses letters to further simplify the information.

The introduction of NutriScore is rapidly changing the EU FOP nutrition labelling landscape. Indeed, some EU countries have already followed France. For example, some (Belgium and Germany in 2019) have already substituted their FOP schemes with the NutriScore, while others (Spain, the Netherlands, and Luxembourg) have approved it for utilization.

On the opposite side, some countries such as Italy, Cyprus, the Czech Republic, Greece, Hungary, Latvia and Romania, have strongly opposed the French label (Council of the European Union, 2020). Italy never welcomed this FOP scheme, arguing that it is too simplistic and—above

[2] The algorithm gives points for each element in the nutrition table (per 100 g or ml). Components that have negative effect (energy, sugars, saturated fatty acids, salt) are given 0-10 points, whereas for components that have a positive effect (proteins, fibre, percentage of fruit, vegetables, nuts, grapeseed oil, walnut oil and olive oil) 0-5 points are subtracted. Then, the result is converted into the Nutri-Score table.

all—that it would strongly penalize high-quality products, especially those with denomination of origin (e.g., Parmesan), which would be in most cases be labelled “E”/red.

To counteract the adoption of the NutriScore, in 2019, the Italian Ministries of Economic Development, Agricultural Policies, Health and Foreign Affairs developed and presented to the EU Commission the Nutrinform Battery FOP label (https://www.nutrinformbattery.it/) (Ministero dello Sviluppo Economico, 2020). The Nutrinform Battery reports the nutrient content of energy, fat, saturated fat, sugar, and salt per portion size and it associates such information with the image of a battery load. The battery load is used to graphically express to what extent (in percentages) each nutrient in a portion contributes to the daily-recommended intake. In essence, this scheme strongly resembles the Reference Intake FOP label. The Nutrinform Battery can be voluntarily adopted by food firms on all pre-packaged food, with the exception of products that are under Denomination of Origin quality schemes. Protected designation of origin (PDO), protected geographical indications (PGI) and traditional specialties guaranteed (TSG) products are excluded from this decree due to the risk that FOP additional logos might prevent consumers from recognizing the quality mark that certifies the distinctiveness and uniqueness of these products.

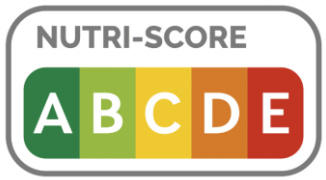
2.1 Classification of EU FOP nutrition labels

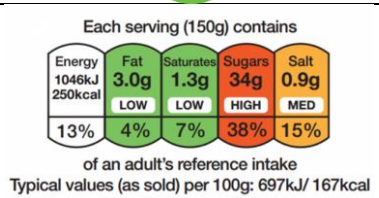
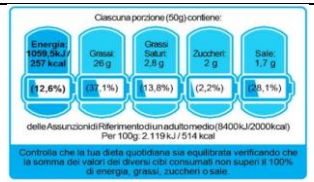
According to a recent report of the EU commission (Storcksdieck genannt Bonsmann et al., 2020), FOP labels can be classified in different ways. A first possible classification is based on two categories: the “reductive” schemes (representing a reduced version of the nutrition information reported in the nutritional declaration) and the “evaluative” schemes (reporting an evaluation of the product in terms of nutritional profile) (Newman et al., 2014). An alternative and more complex classification divides FOP labels into “nutrient-specific” schemes that provide information on specific nutrients and “summary indicator” schemes, which provide an overall and synthetic evaluation of the nutritional quality/healthiness of the food (Savoie et al., 2013). Table 1 illustrates the existing EU FOP nutritional labels by country with their related classification.

"Nutrient-specific" FOP can be of two types: "numerical" or "colour-coded". An example of nutrient-specific numerical labels is the monochrome Guideline Daily Amounts, which reports the same information as the nutrition declaration (content of energy, fat, saturates, sugars, and salt). The Multiple Traffic Lights label, on the other hand, is an example of a nutrient-specific colour-coded label. This label reports the information as the nutrition declaration; however, it adds colours to highlight the level (high, medium, low) of the specific nutrient.

"Summary indicator" schemes can be subdivided into two main types as well, specifically into "positive" indicators (applied exclusively to foods that respond to specific nutritional criteria) and "graded" indicators, which express global and graded information on the nutritional quality of the food (applicable to all food products). A popular example of a positive summary indicator is the Keyhole Logo, which expresses a positive evaluation of the overall nutritional quality of the product. The NutriScore, on the other hand, ranks the product into five categories according to their nutritional composition and healthiness (Julia et al., 2018).

Table 1. EU FOP labels and their classification

FOP name	Logo	Country	Type of FOP	Developer
Reference Intake (previously known as Guideline Daily Amounts)		EU-wide	Reductive or Nutrient-specific - Numerical	Industry
Keyhole Logo		Sweden, Denmark, Lithuania	Evaluative or Summary Indicator - Positive	Government
NutriScore		France, Belgium, Germany, Spain, the Netherlands, Luxembourg	Evaluative Or Summary Indicator – Graded	Government
Finnish Heart Symbol		Finland	Evaluative Or Summary Indicator - Positive	Government
Choice Logo		Czech Republic, Poland	Evaluative Or Summary Indicator - Positive	Industry

Slovenian 'Little Heart' logo		Slovenia	Evaluative Or Summary Indicator - Positive	Government
Croatian Healthy Living		Croatia	Evaluative Or Summary Indicator - Positive	Government
(Multiple) Traffic Lights scheme		Ireland	Evaluative Or Nutrient-specific - Colour-coded	Government + Industry
Nutrinform Battery		Italy	Reductive or Nutrient-specific - Numerical	Government

3. Demand-side response to FOP nutrition labelling

3.1 Consumer cognitive response to different nutrition labelling formats

Among all the different types of information on food labels, the mandatory nutritional declaration reports the most accurate information about the nutritional characteristics of food products. However, the effectiveness of this tool in guiding consumers toward healthy choices can be limited. One of the main reasons is that in the nutritional declaration, the information is dense, and consumers can find it difficult to understand. Hence, the cognitive effort needed to process all the information tends to be high and time consuming, which in turn increases the cost of using this information source. Consumers with scarce numeracy, literacy, and scarce nutrition knowledge are the most disadvantaged (Campos et al., 2011; Sinclair et al., 2013). Numeracy and literacy are required to translate the numeric information of the nutritional declaration into health-related concepts and is complementary to nutrition knowledge to allow consumers' understanding (Rothman et al., 2006). Previous evidence shows that high nutrition knowledge helps consumers process complex information and facilitates the memorization and reuse of such notions during food purchasing decisions (Miller and Cassady, 2015). Moreover, and importantly, while grocery-shopping, consumers are influenced by several exogenous factors such as time pressure and tiredness, which can limit their use of the nutritional declaration (Bialkova et al., 2013; Siegrist et al., 2015).

These issues have prompted private and public initiatives geared at designing complementary tools to make nutrition information more accessible to all consumers at the point of purchase and eventually more effective in leveraging healthy choices.

The aim of FOP schemes is to transform the high amount of information reported in the mandatory nutritional declaration into a concise format, using graphics, logos, and colours that can be easily and quickly translated into health-related judgements (Muller and Prevost, 2016). FOP labels allow consumers to rapidly infer which products have the healthiest option is because they

are designed to trigger a specific cognitive response, based on effortless and automatic reasoning. According to the psychological theory (Kahneman, 2011), this cognitive response is guided by the so-called System I, which mainly relies on associative memory (i.e., recalling familiar concepts in mind). It is effortless, fast, intuitive, and highly unconscious. System II on the other hand is slow, effortful, skilled, and deliberate, and comes into play only to solve difficult tasks.

When it comes to food purchasing, the information in the nutritional declaration involves System II since it requires high cognitive workload due to the need to manipulate numeric information and compare such information across products (Muller and Prevost, 2016; Crosetto et al., 2016). FOP schemes on the other hand trigger automatic thinking under System I and simplify decision-making. However, not all FOP labels are the same and consumer cognitive response varies depending on the label format. Reductive FOP schemes typically involve numbers, while evaluative schemes are mostly based on colours and logos. They provide different stimuli and, therefore, are processed differently and produce variation in understanding and food choice behaviours (Crosetto et al., 2016; Muller and Prevost, 2016).

Siegrist et al. (2015) conducted an eye tracking study involving three different labels, namely the nutritional declaration, the Guideline Daily Amount, and the Multiple Traffic Lights. The results demonstrated that participants needed more time to process the information of the Guideline Daily Amount compared to the nutritional declaration and the Multiple Traffic Lights, respectively. Overall, the Multiple Traffic Lights was the better in terms of information processing.

Overall, evidence suggests that evaluative FOP labels, as compared to reductive FOP schemes, are more effective in catching consumer attention, in facilitating the understanding of nutrition-related information, and in enabling consumers to understand the healthiness of different product alternatives (Bialkova et al., 2013; Hersey et al., 2013; Boztug et al., 2015; Chalamon and Nabec, 2015; Crosetto et al., 2016).

3.2 Effectiveness of FOP nutrition labels

Over the past decade, the effectiveness of FOP nutrition labels in guiding consumers toward healthier food choices has been extensively investigated. The main evidence indicates that FOP schemes are effective in guiding consumers towards more healthful food choices, especially for consumer segments with low socio-economic status and scarce nutritional knowledge. However, significant differences exist across different FOP schemes. Overall, more detailed FOP labels such as the Guideline Daily Amount or the Reference Intake, which use numbers and require computation, seem to be less effective compared to easier schemes based on the use of colour coding and logos (see Roberto et al. 2021 and Song et al. 2020 for a comprehensive and updated state-of-the-art of FOP labelling worldwide).

Studies on FOP labelling effectiveness further proliferated after the introduction of the NutriScore label, both within and outside the EU. In these studies, the effectiveness of FOP labels has been analysed from different perspectives, especially in terms of understanding and acceptability. The latter represents an umbrella term that covers different aspects, such as liking, perception, and perceived usefulness of the FOP scheme. Several studies have also explored the effectiveness of FOP schemes on consumer behaviour, mainly in terms of purchasing intentions. The following subsections explore all these areas with a focus on European studies.

3.2.1 Understanding of FOP labels

Consumer understanding of labelled nutrition-related information is one of the most critical issues in assessing the overall effectiveness of a label (Cavaliere et al., 2020). Evaluating objective understanding requires determining if consumers' understanding of a FOP label is consistent with the meaning that the FOP label aims to communicate (Grunert and Wills, 2007). In most studies, understanding was assessed in terms of consumers' ability to correctly evaluate the nutritional quality of different products; i.e., the ability to rank products based on their healthiness.

Crosetto et al. (2016) used an incentivized laboratory experiment to explore whether the Guideline Daily Amount and Multiple Traffic Lights labels are able to guide consumers select

healthy items. They found that the Guideline Daily Amount is more effective when consumers are not under time constraints. However, under time pressure, they found that the Multiple Traffic Lights performs better. They also tested a combined version of Guideline Daily Amount and Multiple Traffic Lights and showed that this experimentally designed label outperformed the others.

When comparing the performances of the Guideline Daily Amount and the Multiple Traffic Lights, Siegrist et al. (2015) found that consumer's perceived healthiness of food products did not change significantly depending on the label. Ducrot et al. (2015a) analysed consumer understanding of four FOP labels through online questionnaires on a large sample of French consumers. Specifically, participants were asked to rank different food products (pizza, prepared fish dishes, dairy products, breakfast cereals, and appetizers) based on the information provided through four different labels: Reference Intake (at the time known as "Guideline Daily Amount"), Multiple Traffic Lights, NutriScore (at the time known as Five-Colour Nutrition Label), and Green Tick (in use in New Zealand). Overall, the researchers found that the presence of a FOP label helped consumers rank products correctly with respect to their healthiness, relative to when no label was shown. Among all the FOPs considered in Ducrot et al. (2015a), the NutriScore performed better. The authors suggested that this was likely due to the combination of both colours and text that, as demonstrated in past studies, is able to catch consumer attention more than other forms of communication (Hersey et al., 2013). The second highest percentage of correct answers was observed for Multiple Traffic Lights. The authors also found that the NutriScore performed better than the other FOP labels in terms of increasing the number of correct answers across participants with lower education levels. In another study involving the same sample and experimental design, Ducrot et al. (2015b) explored how individual characteristics of the respondents and the presence of FOP labels were associated with the ability to rank products based on their healthiness. They found that the NutriScore was most effective among individuals with no nutritional knowledge.

Egnell et al. (2018a) investigated the objective understanding of four different FOP labels (namely, NutriScore, Multiple Traffic Lights, the simplified nutrition labelling system -i.e., the

French SENS-, and modified Reference Intakes). A total of 3751 French consumers were invited to participate in an online questionnaire and were asked to rank products (breakfast cereals, pre-prepared dishes, sandwiches, canned fish, and sweet biscuits) from the lowest to the highest nutritional quality. Participants were presented with three pictures of different products belonging to the same food category (one among breakfast cereals, pre-prepared dishes, sandwiches, canned fish, and sweet biscuits) and later asked to rate the products from the lowest to highest nutritional quality according to the nutritional information provided (with an FOP label or in a no-label condition). Their findings highlighted that all FOP labels increased the ability of participants to rank foods according to their nutritional quality compared to the no-label condition. They found that the NutriScore performed better than the other FOP schemes.

Consumer understanding was also investigated in two large cross-country studies involving both EU and extra-EU countries. The first, by Egnell et al., published in 2018b, involved Argentina, Australia, Bulgaria, Canada, Denmark, France, Germany, Mexico, Singapore, Spain, the USA, and the UK. The second by Egnell et al. (2020a) involved partly the same sample as in Egnell et al. (2018b) (i.e., Bulgaria, Denmark, France, Germany, Spain, and the UK) and extended the study to Belgium, Italy, the Netherlands, Poland, Portugal, and Switzerland. These studies shared the same experimental design based on the comparison of five different FOP labels, namely, three reductive labels (i.e., the Health Star Rating system[3], the Multiple Traffic Lights, and the Reference Intake) and two evaluative labels (i.e., the NutriScore and the Warning Symbol). They focused on three different product categories (i.e., pizza, cake, and breakfast cereals). Respondents in both studies (approximately 1000 per country) were invited to voluntarily participate in an online survey and complete some tasks. First, in a no-label condition, they were asked to rank one set of three pizzas, one set of three cakes, and one set of three breakfast cereals based on their nutritional quality (i.e., low, medium and high). In the second task, respondents were assigned to one of the five FOP label

[3] Used in Australia and New Zealand.

conditions and asked to perform the same task. Understanding the different FOP labels was assessed by analysing consumers' ability to correctly rank the products based on their nutritional quality from the lowest to the highest. The main findings of these two cross-country studies were consistent overall. The results from both studies indicated that the presence of an FOP label increased the ability of respondents to correctly assess the nutritional quality of food products compared to when no label was present. However, in both studies, large disparities emerged both across different FOP labels and across product categories.

The results of Egnell et al. (2018b) indicated that when considering all countries, the NutriScore was the FOP scheme that led to the highest number of correct answers (i.e., the FOP label with the highest elicited understanding) compared with the no-label condition. Multiple Traffic Lights was the second best, while the Reference Intake label was the least effective. The strongest effects were elicited for cakes and breakfast cereals, while the results were less remarkable for pizza. Overall, compared to the Reference Intake, all FOP labels performed better. These results are consistent with those of Egnell et al. (2020a), perhaps since the two samples partly overlapped.

The same pattern of results was observed in several single country studies (Andreeva et al., 2020; Egnell et al., 2019a; Egnell et al., 2019b; Egnell et al., 2020b; Fialon et al., 2020; Galan et al., 2020; Vandevijvere et al., 2020) derived from Egnell et al. (2018b) and Egnell et al. (2020a) large-scale trials. While these single country studies share the same design and samples, their results highlight specific population-based differences. For instance, in the study by Galan et al. (2020) on the Spanish population, the results show that the effect of the NutriScore on consumer understanding is generally higher than for the other FOP labels, except for pizza. In the latter case, the Multiple Traffic Lights performed better. In the Bulgarian sample, however, the NutriScore performed better than other FOP labels in the pizza choice set, but it was outperformed by the Health Star Rating in the cake category. No significant differences in terms of product ranking ability across FOP labels were found for the breakfast cereals (Andreeva et al., 2020). Egnell et al.

(2019a) reported results for the German sample, and indicated that the NutriScore provided the greatest increase in the number of correct ranking responses compared to the no-label condition for both pizza and breakfast cereals, while for cakes, the Multiple Traffic Lights performed better.

In a recent study, De Temmermann et al. (2021) also explored the impact of the NutriScore on consumers' perceived healthiness of food products. They recruited 303 participants in Flanders to take part in two online experiments. Respondents were asked to rank different products with or without the NutriScore based on their perceived healthiness. Their results suggested that the presence of the NutriScore enabled participants to better assess the healthiness of the products.

Contrasting results were found in Hagman and Siegrist (2020). They randomly assigned more than one thousand Swiss consumers to one of the following five conditions: the FOP presented with (1) the nutrition facts table, (2) the Multiple Traffic Lights (3) the NutriScore, (4) the NutriScore on half of the products, or (5) the no-label control condition. They found that respondents' evaluation of the healthiness of the snacks was fairly accurate, even in the control condition. However, their results also showed that although the NutriScore led to the highest accuracy in identifying the healthiest options, it had only a minimal effect on the evaluation when it was displayed on half of the products. This result suggests that for maximum effectiveness, the label should be available on all products.

The results of Feteira-Santos et al. (2019) are also mixed. In their study, 357 participants from Portugal were presented with a food choice scenario composed of three alternative products of the same food type that differed in terms of their perceived nutritional quality (either yogurts, cereals, canned tuna, lasagne, or cookies). Each choice scenario was associated with one FOP label (Multiple Traffic Lights, Reference Intake, NutriScore, or Health Star Rating system) or a no-label control condition. Participants were asked to select the healthiest food product from this set of product alternatives. The highest proportion of correct choices was obtained with the Multiple Traffic Lights (72.3%), and the lowest with the NutriScore (62.2%).

Finally, only two empirical studies investigated consumer understanding for the Italian Nutrinform Battery. Mazzù et al. (2020) involved a sample of Italian consumers to explore subjective understanding of the Nutrinform Battery relative to the NutriScore. Consumers' subjective understanding was assessed using (a) comprehensibility design, (b) help-to-shop, and (c) complexity as sub-measures. The main findings highlighted that the Nutrinform Battery consistently outperformed the Nutri-Score in terms of subjective understanding. In a subsequent study, Mazzù et al. (2021) conducted a cross-country online survey in France, Germany, Greece, Italy, Portugal, Romania and Spain. They compared the Nutrinform and the NutriScore schemes exploring consumers' subjective understanding using the same sub-measures adopted in Mazzù et al. (2020). Their results show that the Nutrinfom battery reached higher mean values in each country in all sub-measures. However, differences exist across countries.

3.2.2 Acceptability of FOP labels

Some studies evaluated the effectiveness of FOP labels in terms of acceptability. This issue has been approached from different angles in past studies because acceptability is an umbrella term that involves several indicators, such as liking, perception, attractiveness, etc. Ducrot et al. (2015a) assessed acceptability through several indicators, specifically liking, attractiveness, and perceived cognitive workload. To assess liking, participants were shown the four FOP labels (Reference Intake, Multiple Traffic Lights, NutriScore, Green Tick) and were asked to choose (*i)* their preferred label, (*ii)* their least preferred label, (*iii)* the label that they wanted to see on the front of packages, and (*iv)* the one that they found the most useful for choosing healthy products. The results showed that Reference Intake was the preferred FOP label and the most useful in choosing healthy products, followed by the Multiple Traffic Lights, the NutriScore, and the Green Tick. Participants wanted to see the Reference Intake label the most in front of packages, followed by the NutriScore, the Multiple Traffic Lights label, and the Green Tick. The least appreciated FOP label was the Green Tick, followed by Reference Intake, the NutriScore, and the Multiple Traffic Lights

label. Attractiveness was investigated considering (i) the perceived contribution to needed information, (ii) ease of identification, and (iii) reliability. The Reference Intake label was considered the label that contributed to information the most and provided the most reliable information. However, it was also ranked as the hardest to identify. According to the participants, the NutriScore was the easiest FOP label to identify. Finally, perceived cognitive workload was assessed by means of three indicators: (i) complexity of understanding, (ii) perceived time needed for interpreting the label, (iii) discomfort caused by the label. The results showed that the highest cognitive workload was associated with the Guideline Daily Amount, whereas the NutriScore was the easiest and quickest to understand.

Another study published by Talati et al. (2019) involved the same cross-country sample and experimental design as Egnell et al. (2018b) to assess the acceptability of the different FOP labels in terms of liking, trust, comprehensibility, salience, and desire for the label to be compulsory. To this purpose, participants were presented with images of products carrying a FOP label (one among the Health Star rating, the Multiple Traffic Lights, the NutriScore, the Reference Intake, and the Warning Label) and were asked to score nine statements about the FOP (e.g., "I like this label", "I trust this label", "This label is easy to understand", "This label provides me with the information I need", and "It should be compulsory for this label to be shown on packaged food products") on a scale from "Strongly Disagree" to "Strongly agree". The results showed that, overall, the Multiple Traffic Lights label obtained the highest acceptability score on all considered indicators.

These results are in line with those of Feteira-Santos et al. (2019) highlighting that acceptability of the Multiple Traffic Lights (in terms of liking and appreciation) was higher than that of the Guideline daily amount, the Health Star Rating and the NutriScore, which was the one obtaining the lowest preference. Feteira-Santos et al. (2019) also explored perceived "Usefulness and trustworthiness" and "Perceived cognitive workload". In both cases, the Multiple Traffic Lights was ranked first. Interestingly, the authors also found that the NutriScore was associated with the heaviest cognitive workload, in terms of complexity and processing time. Liking of different FOP

schemes was also explored by Mazzù et al., 2020 and Mazzù et al. 2021 where they compared the Italian Nutrinform Battery with the French NutriScore. In the former study involving the Italian population, liking was higher for the Nutrinform than for the French label. However, it must be acknowledged that this result could be affected by the ongoing strong opposition to the NutriScore scheme of Italian politicians. In the second study, involving seven EU countries, significant differences were found across countries. On average, the Nutrinform seemed to outperform the Nutriscore, except for France where this label is widespread and already well known by consumers.

Hagman and Siegrist (2020) analysed the perceived usefulness and public support of mandatory implementation for different FOP schemes and found that both were higher for the Multiple Traffic Lights label than for the French NutriScore. The latter, however, ranked first both in terms of perceived usefulness and public acceptance among those respondents who became familiar with this label during the experiment.

Folkvold et al. (2021) examined the effects of the NutriScore label on consumer attitudes toward food products (measured on a semantic scale comprised of four items, such as attractive/unattractive and bad/good) and on taste, perception (measured using five items, such as "I think this product looks tasty"). In both cases, they did not find significant results. Similarly, De Temmermann et al. (2021) did not find significant effects of the NutriScore on taste perception.

3.2.3 FOP nutrition labels and consumer purchasing intentions

Some studies have specifically focused on the effectiveness FOP labels in changing consumer-purchasing intentions.

Vyth et al., (2010a) conducted one of the very few studies exploring the role of the Choices logo in the Netherlands in guiding food purchasing behaviour in a real supermarket settings. They invited participants to stop after they had done their shopping and counted the products in their shopping cart which were displaying the Choices logo. These data, combined with participants' responses to

a brief questionnaire, suggested that the choices logo was able to leverage healthy choices especially among health-conscious consumers.

Ducrot et al. (2016) aimed to assess the influence that five different label conditions (Reference Intake, NutriScore, Multiple Traffic Lights label, Green Tick, no label) had on consumers' purchasing behaviour through a randomized controlled trial on almost 12,000 French participants. In this study, the participants were asked for one week to grocery shop on a virtual web-based supermarket. The authors estimated the nutritional quality of the participants' shopping cart and compared the results across the different label conditions. They found that the NutriScore was the most effective in leading consumers toward healthier food choices. However, the authors acknowledged that the nutritional content of virtual grocery shopping did not correspond to real food consumption, as many food categories, such as fresh products and meat, were not included in the available alternatives.

Crosetto et al. (2020) conducted an online experiment with 691 French consumers adopting a similar approach. Participants were asked to purchase food products from a wide catalogue of food alternatives, the first time without labels, and a second time (unannounced) with different FOP labels displayed depending on the treatment (i.e., Multiple Traffic Lights, Reference Intake, Health Star Rating, NutriScore and SENS – a French frequency-based recommendation label). Their results indicated that the nutritional quality of respondents' shopping baskets increased in all label conditions compared to the control group and that among all labels, the NutriScore performed best. Interestingly, they highlighted that respondents showed a clear tendency to oversimplify the (already essential) information conveyed by the NutriScore label and behaved as the scale only has three values instead of five.

Three different studies by Egnell et al. (2019c, 2021a, and 2021b) investigated the effect of the NutriScore label (compared to the Reference Intake and the no-label condition) on purchasing intention respectively (i) among students aged 18 to 25 years old, (ii) among low-income consumers (i.e., max household income 1200 euro/month) and (iii) on purchasing intention for unprocessed vs.

processed foods. These studies derived their samples from three consecutive randomized controlled trials conducted in France between 2016 and 2017. Such trials, involving different consumer segments, shared the same experimental design in which participants were asked to perform an online shopping task in one of three label conditions, namely, the NutriScore, the Reference Intake, or the no-label condition. For the students' population, the results of Egnell et al. (2019c) showed that the NutriScore positively affected their purchasing intentions (i.e., increased nutritional quality of the shopping cart) compared to the Reference Intake. However, remarkably, no significant difference was found when comparing the NutriScore with the no-label condition. The same pattern of results is reported in Egnell et al. (2021c) involving low-income consumers. For the effects of the different FOP labels on purchasing intentions for processed and unprocessed foods, Egnell et al. (2021b) reported that the NutriScore was associated with fewer purchases of processed and ultra-processed foods compared with the Reference Intake and the no-label condition, even though the difference was not large.

Mixed results were found in other studies. For instance, in Finkelstein et al. (2019) 154 participants were asked to shop in an online experimental grocery store, knowing there was a one out of three possibility to buy the products. Participants were presented with the Multiple Traffic Lights label, NutriScore or no nutritional label. The authors found that the NutriScore was preferred when the aim is to improve overall diet quality, but the Traffic Lights label is more effective in reducing total energy intake. Folkvord et al. (2021) found no significant difference between consumer purchases of products with and without the NutriScore FOP label. Other studies examined how the quality of consumers' food choices varied depending on the presence of different FOP labels (De Temmerman et al., 2021, Ares et al., 2018; Dubois et al., 2021). The results of these studies suggested that while the NutriScore label increased the choice and purchase of healthy foods, it did not discourage the choice and purchase of unhealthy products.

In a recent study, Carlsson et al. (2021), conducted a Choice Experiment with sample of Swedish respondents in which the product attributes were displayed respectively through (i) a

traffic-light label, (ii) greyscale circles (with varying colour intensity), and (iii) using text only, without any graphic. In their study, they did not exclusively consider nutrition-related attributes, but their results are still significant as they provide indication on how labelling formats influence food choices. Specifically, they found that consumers preferred to have one label compared to plain text and that the traffic-light type was the most preferred. Furthermore, they highlighted that the red colour of the traffic lights strengthened consumer preferences for avoiding the worst level for non-nutritional attributes, while the green colour was more important for the more important for healthiness. They estimated that average price premiums for a green label on the healthiness attribute was 52 per cent higher compared to a red label.

4. Supply-side responses to FOP nutrition labelling

While consumer response to FOP nutrition labels has been extensively investigated from different angles, the studies examining firms' responses to such voluntary schemes are far fewer, especially in the European context.

Firms' decision to adopt a FOP nutrition label can have three interrelated reasons. The first is to respond to consumer demand-pull, increasingly oriented towards health and healthy nutrition. FOP labels represent an easy tool to communicate to consumers the healthy features of their products, thus reaching specific consumer segments and increasing market shares. A second reason relates to transparency. Firms that are more transparent in providing nutrition-related information can be perceived as caring more about their consumers and this may be translated into a more favourable judgement of the firms itself or its brand(s). The third motivation can be strategic, mainly aimed at differentiating products from the competitors (Storcksdieck genannt Bonsmann et al., 2020; European Commission, 2020b).

Overall, firms are incentivized to adopt voluntary FOP schemes as long as these labels are effective in changing consumer behaviour. However, firms' responses can vary significantly based on the dimension and type of the firm, the competitive strategies that they adopt, as well as on the

type of food products involved (Storcksdieck genannt Bonsmann et al., 2020; European Commission, 2020b).

The next sub-sections illustrate the main dynamics of firms' responses to FOP schemes, in terms of food products' reformulation and the different response that manufacturers and retailers may have to FOP labels.

4.1 Adoption of FOP schemes and firms' reformulation of food products

An expected positive impact of FOP labelling relates to food reformulation; i.e., firms' innovation of the product aimed at achieving a healthier nutritional profile. Indeed, the use of evaluative-positive FOP labels (such as the Keyhole) and the green colour of evaluative-graded FOP schemes (such as the NutriScore) is possible only if the product meets specific nutritional requirements. Firms can be incentivized to reformulate their products to obtain (more) favourable ratings of their products and brands. To date, evidence demonstrating the causal relationship between FOP labels adoption and healthy reformulation of products are sparse, especially within the EU context.

Between 2007 and 2009, Vyth et al. (2010b) investigated whether the adoption of the Choices logo in the Netherlands was associated with reformulation of existing products or with the development of new products with healthy nutritional features. The study involved 47 food firms (including one retailer and two caterer) participating in the Choices program who were asked to complete an online questionnaire providing several details of their products carrying the Choices logo. They found that out of 821 products, 417 were already compliant with the Choices logo requirements, 168 were reformulated to improve the nutritional profile and 236 were newly developed to meet the Choices logo criteria. Reformulation or development of new products was more frequent in the soups and snack categories. Furthermore, sodium was the nutrient reformulated in most of the product categories. They also observed an increase in fiber in newly developed Choices product.

More recently, Vermote et al. (2020) investigated changes in nutrient content and reformulation of breakfast cereals in anticipation of the implementation of the NutriScore label in Belgium. Their findings highlighted small differences in the nutritional content between 2017 and 2018, with regard to total sugar, salt, fibre and protein content. While these results seem to suggest that reformulation was pushed by the imminent introduction of the NutriScore, the authors acknowledged that it was not possible to derive robust conclusions. In fact, they clearly stated that Belgian firms may have improved the healthiness of their products due to other ongoing events of that period.

In a subsequent study, Vandevijvere (2020) explored the uptake and effects of the NutriScore label in Belgium during the first year of implementation. The study showed that the NutriScore appeared on roughly 10% of the total food supply. The majority of products displayed A and B scores, while about one quarter of products displayed D or E scores.

These studies provide some evidence that FOP labels can leverage firms' reformulation of products, which is in line with previous findings of extra-EU studies of his type (see Roberto et al., 2021 for a comprehensive overview). However, EU-specific evidence is very limited.

4.2 Manufacturers vs retailers' response to FOP labels

As anticipated, firms' responses to FOP labelling can vary considerably depending on the type of firms involved and their dimensions. The study by Van Camp et al. (2010) represents one of the very few studies conducted in the European context that examined the role of firms' characteristics in shaping their response to FOP schemes. The authors used data from the Global New Products Database on food products released in the UK between 2002 and 2008 to explore whether the adoption of different FOP labels (i.e., Multiple Traffic Lights and Guideline daily amount) was related to the characteristics of the firms (i.e., retailer vs manufacturer). Overall, they highlighted that both food retailers and food manufacturers responded quickly to the proposed FOP schemes, but their strategies remarkably differed. Indeed, the adoption of FOP labels was selective across

companies and food categories. Retailers dominated the use of FOP labelling, mainly adopting the Multiple Traffic Lights (especially in meat products, pastry dishes, pizzas, and prepared meals and sandwiches categories). In contrast, none of the food manufacturers adopted the Multiple Traffic Lights labelling, preferring the Guideline Daily Amount instead regardless of the food category.

In a follow-up study, Van Camp et al. (2012) used the same dataset of food innovation (i.e. Global New Products Database) to investigate, among others, if the adoption of a specific FOP nutrition label was related to the type of firm that launches the product, namely a retailer or a manufacturer. Their findings overall were in line with those of Van Camp et al. (2010) and confirmed that FOP labelling adoption was remarkably higher among retailers' private labels compared to private food firms. Furthermore, FOP labels were more frequently used in highly processed product categories than in fresh products.

The same evidence emerged in the recent study of Vandevijvere (2020) examining the NutriScore uptake in Belgium during the first year of implementation. The author reported that roughly 90% of the food products carrying the NutriScore label belonged to the private labels of the two major retailers in the country. Furthermore, the author reported that five of the most important retailers in Belgium already committed to adopting the NutriScore on their products, while the number of food and beverage manufacturers that committed to use the FOP labels remained low.

Such difference may depend on the fact that retailers' brands, namely private labels, are generally perceived to have lower quality than well-known brands (DelVecchio, 2001). This implies that retailers may have higher interest in adopting FOP schemes to improve their private label image and increase the perceived quality of their products (Golan et al., 2009). Furthermore, as highlighted in Van Camp et al. (2012), retailers' proximity to consumers represents a key advantage in that it allows them to quickly understand consumers' reaction to the introduction of FOP labels. It also allows them to respond faster to changes in demand.

5 Discussion

5.1 Demand-side considerations

The studies analysed in this review provided consistent evidence that evaluative FOP labels are more effective than reductive labels in enabling consumers to more accurately evaluate the healthiness of products, which is in line with previous evidence. With the exception of two studies by Mazzù et al., (2020, 2021), evaluative FOP labels performed better than reductive schemes, especially when the labels contained colour coding, as already demonstrated in previous reviews on FOP nutrition labelling (Feteira-Santos et al., 2020; Volkova and Ni Mhurchu, 2015; Roberto et al., 2021; Song et al., 2021). In this regard, the current interest of several EU countries in the French NutriScore seems to be well motivated. In fact, evaluative FOP schemes are able to activate fast cognitive responses under System I without requiring a high cognitive load, thus facilitating the overall understanding of nutrition information.

On the other hand, the decision by Italy to develop and propose an alternative FOP scheme based strictly on the Reference Intake model (which is a summary FOP label) may be questioned. Almost all studies in this review report that this format is the least effective in enabling consumers to correctly rank foods based on their nutritional characteristics, and consumers tend to consider such labels difficult to understand (Ducrot et al., 2015a; Egnell et al., 2018b; Feteira-Santos et al., 2020; Volkova and Ni Mhurchu, 2015).

In regard to evaluative colour-coded labels, some considerations are necessary. As explained, evaluative FOP schemes are processed via System I, which acts quickly and simplifies decisions. However, according to psychological theory, simplified reasoning (i.e., heuristic reasoning) does not always lead to optimal decisions (Khaneman, 2011; Muller and Prevost, 2016; Chalamon and Nabec, 2015). Heuristics often lead people to decide very quickly without considering important attributes or alternatives, and this might negatively affect the final decision (Khaneman 2011; Muller and Prevost, 2016; Chalamon and Nabec, 2015). Furthermore, given that System I reasoning is mainly based on associative memory, it may lead consumers to automatically judge some products as “bad” (because they are red and associated with a “stop” sign) and

consequently, exclude them from their shopping cart. On the other hand, the green colour may trigger a sort of a halo effect because consumers may erroneously transfer the positive meaning of the label to non-nutritional attributes (for instance in terms of sustainability) even though it is not so (Van Kleef and Dagevos, 2015).

Although the results favour evaluative schemes, there is no clear evidence to establish which scheme works best. Although the NutriScore has gained increasing success across EU countries, there is insufficient evidence to establish the superiority of the French label over other alternatives. In fact, in many of the studies considered in this review, the NutriScore label and the Multiple Traffic Lights obtained similar results in terms of understanding (i.e., respondents' ability to rank products based on their healthiness) (Egnell et al., 2019b; Galan et al., 2020; Feteira-Santos et al., 2019). Moreover, a thorough analysis of the available evidence highlighted several critical issues that require careful evaluation and call for further research.

First, the number of existing studies that involve the NutriScore might seem high, given that its introduction is relatively more recent. However, as explained in detail in the previous sections, many of the available country-specific studies derive their data from two large-scale cross-country studies (Egnell et al., 2018b; Egnell et al., 2020a). This approach emphasizes some country-specific differences that could not be extensively discussed in large-scale cross-country studies. Nevertheless, this means that the main findings are based on similar methodologies (e.g., the same experimental design and products) and data; therefore, findings could lead to analogous conclusions.

Second, in some cases, the samples were remarkably unbalanced in terms of gender distribution. In Egnell et al. (2019a), Egnell et al. (2021a), and Egnell et al. (2021b), more than 70% of the respondents were female. Women are typically in charge of grocery shopping, and for this reason, they represent a key target in studies of this type. However, it is well known that females tend to be remarkably more attentive to food-related issues than men, and it is reasonable to expect that this affected the findings (i.e., it is likely that women are more prone to choose healthy

alternatives than men, independent of the type of label). A similar issue has been observed about education in Egnell et al., (2019a), Egnell et al., (2019b), Egnell et al., (2021a), Egnell et al., (2021b), and Fialon et al., (2020), where most of the respondents stated that they had intermediate to high nutritional knowledge.

A third critical aspect that demands further investigation is the effect of different FOP schemes on food choices. The vast majority of the studies in this review analysed food choices in terms of purchasing intentions (i.e., asking consumers to state which product they would be most likely to buy under different labelling conditions) or asking consumers to choose across different product alternatives before and after displaying different types of FOP labels. These approaches may provide biased results since they are not based on revealed preference measures. Among the reviewed studies, Crosetto et al. (2020) is the only one that adopted an incentive-compatible experiment to assess both the nutritional and economic impact of different FOP labels, including the NutriScore. As highlighted by Crosetto et al. (2020), the implementation of an FOP scheme should not come at the cost of the consumers. In other words, from a policy standpoint, the ideal FOP label should be able to bring dietary improvements with the lowest adjustment cost.

5.2 Supply-side considerations

Regarding the supply-side response to FOP nutrition labels, the review highlighted several gaps in the literature that call for further research and some critical points that European policy makers should take into account in light of the upcoming proposed introduction of a harmonized, possibly mandatory, FOP scheme. A key point is in regards to product reformulation. Available evidence suggests that FOP nutrition labelling may encourage firms to reformulate their products by improving their nutritional quality, which is one of the expected outcomes of such policy. However, EU-specific findings are very scant in this regard. As such, it is not possible to derive robust conclusions regarding the effectiveness of FOP schemes in leveraging firms' reformulation of their products, at least in relation to newly introduced FOP labels in Europe.

While EU evidence is limited, previous studies conducted outside the EU context highlighted controversial issues regarding firms' reformulation of food products that are of relevance for this discussion. First, previous studies demonstrated that firms' response to FOP labels in terms of reformulation varies depending on the type of FOP scheme adopted. For instance, Louie et al. (2012) investigated whether the introduction of the Daily Intake Guide (similar to the Reference Intake) in Australia in 2006 improved the nutritional quality of breakfast cereals. They found that the presence of the Daily Intake Guide did not enhance product reformulation. In fact, they found a few years later that a higher proportion of breakfast cereals carrying the label was 'high' in sugar.

Second, regardless of the type of FOP scheme, it is not obvious that firms have sufficient incentives to reformulate their products to make them healthier. As highlighted in Van Camp et al. (2010), modifying products' composition is a non-trivial task. The process requires technological competences and financial investments that are likely to affect production costs (Traill et al., 2012; Cao and Yan, 2021) and such costs may not be offset by sales. One reason is that certain consumer segments have an implicit belief that healthiness comes at the detriment of taste, which they consider more important (Haws et al., 2017; Moorman et al., 2012). Therefore, consumers' demand for nutritionally improved foods might decrease (Haws et al., 2017; Van Camp et al., 2010). In fact, the effect of FOP labels (especially evaluative-positive logos or the green colour of evaluative-graded FOP labels) is expected to be more pronounced in healthier than in unhealthier categories because they reach a consumer segment that is more interested in health than taste, as highlighted in (Vyth et al., 2010a; Maesen et al., 2021). Another reason why production costs may not be offset by sales is the higher costs of healthy foods compared to less healthy alternatives. It is well demonstrated in the literature that healthier foods are more costly (see Rao et al., 2013 for a comprehensive overview), which implies higher food expenses for consumers. Even if they are genuinely interested in health and nutrition, they may have budget constraints that would limit their

willingness to pay. Hence, reformulation intended to adopt FOP schemes may not always be profitable for firms (Traill et al., 2012; Cao and Yan, 2021).

Third, previous evidence showed that when reformulation is aimed at meeting FOP label requirements, it may be done strategically by mainly substituting ingredients without improving the overall products' nutritional quality (Van Camp et al., 2010; Vyth et al., 2010). One example is the addition of non-caloric sweeteners to low-fat products to maintain product tastiness (Capacci et al., 2012).

There is a fourth aspect to consider. As previously mentioned, food reformulation requires innovation capacity and investments, which may not be within the reach of small and very small firms (Cao and Yan, 2021; Lim et al., 2020). In such situation, big firms that already hold greater market shares can gain competitive advantage, while micro and small firms can be penalized. In fact, existing evidence shows that firms with more resources get more strategic advantages from the adoption of FOP labels (Moorman et al., 2005; Van Camp et al., 2012). This aspect is of primary importance in the European context, where micro and small firms represent the majority of the EU food and drink industry (Food and Drink Europe, 2020).

This review also highlighted remarkable differences in the adoption of FOP schemes between EU food manufacturers and food retailers. The latter tend to be more incentivized to adopt FOP schemes to boost the perceived quality of their products (Van Camp et al., 2010; Van Camp et al., 2012). Potentially, strategic behaviours are also likely to be adopted by big manufacturers. Indeed, compared to small and micro firms, big firms have higher innovation capacity and financial resources to adapt their products to FOP label requirements. Furthermore, big firms typically own more than one brand, which means that they can decide to display FOP labels only on some products, without involving their whole portfolio of products. Moreover, given that healthy products tend to be more costly and sometimes less appealing for consumers, they can strategically adopt different price strategies. For instance, they can lower the price of their less healthy foods to increase the demand and offset the reduction of sales of the healthy alternatives (Allais et al., 2015).

All these mechanisms are unlikely to suit the dynamics that characterize micro and small firms that respectively represent 79.8% and 15.6% of the EU food and drink industry (Food and Drink Europe, 2020).

6 Conclusions

The use of FOP nutrition labels is now at the core of a heated debate across EU countries. While FOP nutrition labelling represents an important policy tool to guide consumers towards healthful food choices, agreement on which FOP label type is more effective in this regard is still far from being achieved. This review confirmed past evidence showing that evaluative FOP schemes are superior than reductive ones. However, there is no clear evidence about which FOP scheme is better. In fact, available evidence on newly developed labels such as the NutriScore and above all the Nutrinform battery is still relatively scant. Hence, their effectiveness in leading consumers towards healthier dietary choices needs to be further investigated, especially with experimental studies involving incentive compatible methodologies and real-world settings. There is also a lack of studies that assess the possible impact of FOP labelling on diet costs. This is an essential aspect to consider to ensure that FOP labelling-based policy intervention will generate the greatest positive behavioural change (i.e., increased healthy choices) without imposing unsustainable costs for the consumers.

This review also highlighted some critical gaps in the literature regarding the supply-side responses to FOP labelling. Understanding firms' response to FOP schemes is crucial from a policy standpoint to assess how and why the food and beverage industry uses such labels, their incentives to adopt them, the impact of their adoption on the firm's performances as well as on consumers' food choices. To date, evidence in this regard is also very scant.

There is need to investigate the impact of a harmonized label (especially if this is to be mandated) on micro and small firms that could be exposed to significant risks due to their limited capacity to adapt and compete on the market. Future studies should also explore the effects of FOP

labels on high quality products, including those carrying Geographical Indications (PDO, PGI, and TSG). Many of these products (especially those in the processed meat and dairy categories) can hardly meet the nutritional requirements necessary to carry evaluative-positive FOP schemes or green evaluative-graded FOP. So, there is a need to examine the impact of mandating FOP label on these products. There is also a need to identify the FOP labels that can be beneficial to consumers without significantly harming food firms or penalizing some markets.

References

Allais, O., Etilé, F. and Lecocq, S. (2015). Mandatory labels, taxes and market forces: An empirical evaluation of fat policies. *Journal of health economics 43*: 27–44.

Andreeva, V. A., Egnell, M., Handjieva-Darlenska, T., Talati, Z., Touvier, M., Galan, P., Hercberg, S., Pettigrew, S. and Julia, C. (2020). Bulgarian consumers' objective understanding of front-of-package nutrition labels: a comparative, randomized study. *Archives of Public Health* 78(1).

Ares, G., Varela, F., Machin, L., Antúnez, L., Giménez, A., Curutchet, M. R. and Aschemann-Witzel, J. (2018). Comparative performance of three interpretative front-of-pack nutrition labelling schemes: Insights for policy making. *Food Quality and Preference* 68: 215-225.

Banterle, A. and Cavaliere, A. (2014). Is there a relationship between product attributes, nutrition labels and excess weight? Evidence from an Italian region. *Food Policy* 49: 241–249.

Bialkova, S., Grunert, K. G. and van Trijp, H. (2013). Standing out in the crowd: The effect of information clutter on consumer attention for front-of-pack nutrition labels. *Food policy* 41: 65-74.

Boztuğ, Y., Juhl, H. J., Elshiewy, O. and Jensen, M. B., (2015). Consumer response to monochrome Guideline Daily Amount nutrition labels. *Food Policy* 53: 1-8.

Campos, S., Doxey, J. and Hammond, D. (2011). Nutrition labels on pre-packaged foods: a systematic review. *Public health nutrition*, 14(8): 1496–1506.

Cannoosamy, K., Pugo-Gunsam, P. and Jeewon, R. (2014). Consumer Knowledge and Attitudes Toward Nutritional Labels. *Journal of Nutrition Education and Behavior* 46(5): 334–340.

Cao, Z. and Yan, R. (2021). Product nutrition, innovation, advertising, and firm's financial gains. *Journal of Business Research, 133*: 13-22.

Capacci, S., Mazzocchi, M., Shankar, B., Macias, J. B., Verbeke, W., Pérez-Cueto, F. J., Kozioł-Kozakowska, A., Piórecka, B., Niedzwiedzka, B., D'Addesa, D., Saba, A., Turrini, A., Aschemann-Witzel, J., Bech-Larsen, T., Strand, M., Smillie, L., Wills, J. and Traill, W. B. (2012). Policies to promote healthy eating in Europe: a structured review of policies and their effectiveness. *Nutrition reviews 70*(3): 188–200.

Carlsson, F., Kataria, M., Lampi, E., Nyberg, E. and Sterner, T., (2021). Red, yellow, or green? Do consumers' choices of food products depend on the label design?. *European Review of Agricultural Economics*, jbab036.

Cavaliere, A., De Marchi, E. and Banterle, A. (2017). Investigation on the role of consumer health orientation in the use of food labels. *Public Health* 147: 119–127.

Cavaliere, A., Siletti, E. and Banterle, A. (2020). Nutrition information, Mediterranean diet, and weight: A structural equation approach. *Agricultural Economics (Zemědělská Ekonomika)* 66(1): 10–18.

Cecchini, M. and Warin, L. (2016). Impact of food labelling systems on food choices and eating behaviours: a systematic review and meta-analysis of randomized studies. *Obesity reviews: an official journal of the International Association for the Study of Obesity* 17(3): 201–210.

Chalamon, I. and Nabec, L. (2015). Why Do We Read On-Pack Nutrition Information so Differently? A Typology of Reading Heuristics Based on Food Consumption Goals. *Journal of Consumer Affairs* 50(2): 403–429.

Council of the European Union (2020). Front of Pack Nutrition Labeling – Information from the Italian and the Czech delegations, on behalf of the Cyprus, Czech, Greek, Hungarian, Italian, Latvian and Romanian delegations.

Crosetto, P., Muller, L. and Ruffieux, B. (2016). Helping consumers with a front-of-pack label: Numbers or colors? *Journal of Economic Psychology* 55: 30–50.

Crosetto, P., Lacroix, A., Muller, L. and Ruffieux, B. (2020). Nutritional and economic impact of five alternative front-of-pack nutritional labels: experimental evidence. *European Review of Agricultural Economics* 47(2): 785–818.

De Temmerman, J., Heeremans, E., Slabbinck, H. and Vermeir, I. (2021). The impact of the Nutri-Score nutrition label on perceived healthiness and purchase intentions. *Appetite 157*, 104995.

DelVecchio, D. (2001). Consumer perceptions of private label quality: the role of product category characteristics and consumer use of heuristics. *Journal of Retailing and Consumer Services 8*: 239-249.

Dubois, P., Albuquerque, P., Allais, O., Bonnet, C., Bertail, P., Combris, P., Lahlou, S., Rigal, N., Ruffieux, B. and Chandon, P. (2021). 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**:** 119–138.

Ducrot, P., Méjean, C., Julia, C., Kesse-Guyot, E., Touvier, M., Fezeu, L., Hercberg, S., and Péneau, S. (2015a). Effectiveness of Front-Of-Pack Nutrition Labels in French Adults: Results from the NutriNet-Santé Cohort Study. *PLoS ONE* 10(10): e0140898.

Ducrot, P., Méjean, C., Julia, C., Kesse-Guyot, E., Touvier, M., Fezeu, L.K., Hercberg, S. and Péneau, S. (2015b). Objective Understanding of Front-of-Package Nutrition Labels among Nutritionally At-Risk Individuals. *Nutrients* 7(8): 7106-7125.

Ducrot, P., Julia, C., Méjean, C., Kesse-Guyot, E., Touvier, M., Fezeu, L. K., Hercberg, S. and Péneau, S., (2016). Impact of Different Front-of-Pack Nutrition Labels on Consumer Purchasing Intentions: A Randomized Controlled Trial. *American Journal of Preventive Medicine* 50, 5: 627-636.

Egnell, M., Ducrot, P., Touvier, M., Allès, B., Hercberg, S., Kesse-Guyot, E. and Julia, C. (2018a). Objective understanding of Nutri-Score Front-Of-Package nutrition label according to individual characteristics of subjects: Comparisons with other format labels. *PLoS ONE* 13(8): e0202095.

Egnell, M., Talati, Z., Hercberg, S., Pettigrew, S. and Julia, C. (2018b). Objective Understanding of Front-of-Package Nutrition Labels: An International Comparative Experimental Study across 12 Countries. *Nutrients* 10(10):1542.

Egnell, M., Talati, Z., Pettigrew, S., Galan, P., Hercberg, S. and Julia, C. (2019a). Comparison of front-of-pack labels to help German consumers understand the nutritional quality of food products. Color-coded labels outperform all other systems. *Ernahrungs Umschau* 66(5): 76–84.

Egnell, M., Talati, Z., Gombaud M., Galan, P., Hercberg, S., Pettigrew, S. and Julia C. (2019b). Consumers' Responses to Front-of-Pack Nutrition Labelling: Results from a Sample from The Netherlands. *Nutrients* 11(8): 1817.

Egnell, M., Boutron, I., Péneau, S., Ducrot, P., Touvier, M., Galan, P., Buscail, C., Porcher, R., Ravaud, P., Hercberg, S., Kesse-Guyot, E. and Julia C. (2019c). Front-of-Pack Labeling and the Nutritional Quality of Students' Food Purchases: A 3-Arm Randomized Controlled Trial. *American Journal of Public Health* 109(8): 1122-1129.

Egnell, M., Talati, Z., Galan, P., Andreeva, V.A., Vandevijvere, S., Gombaud, M., Dréano-Trécant, L., Hercberg, S., Pettigrew, S. and Julia, C. (2020a). Objective understanding of the Nutri-score front-of-pack label by European consumers and its effect on food choices: an online experimental study. Behavioral Nutrition and Physical Activity 17, 146.

Egnell, M., Galan, P., Farpour-Lambert, N.J., Talati, Z., Pettigrew, S., Hercberg, S. and Julia, C. (2020b). Compared to other front-of-pack nutrition labels, the Nutri-Score emerged as the most efficient to inform Swiss consumers on the nutritional quality of food products. PLoS ONE 15(2): e0228179.

Egnell, M., Boutron, I., Péneau, S., Ducrot, P., Touvier, M., Galan, P., Buscail, C., Porcher, R., Ravaud, P., Hercberg, S., Kesse-Guyot, E. and Julia, C. (2021a). Randomised controlled trial in an experimental online supermarket testing the effects of front-of-pack nutrition labelling on food purchasing intentions in a low-income population. *BMJ open 11*(2): e041196.

Egnell, M., Galan, P., Fialon, M., Touvier, M., Péneau, S., Kesse-Guyot, E., Hercberg, S. and Julia, C. (2021b). The impact of the Nutri-Score front-of-pack nutrition label on purchasing intentions of unprocessed and processed foods: post-hoc analyses from three randomized controlled trials. *International Journal of Behavioral Nutrition and Physical Activity* 18**:** 38.

European Commission (2020a). Farm to Fork Strategy. For a fair, healthy and environmentally friendly food system.

European Commission (2020b). Report from the Commission to the European Parliament and the Council regarding the use of additional forms of expression and presentation of the nutrition declaration.

European Community (2006). Regulation (EC) No 1924/2006 of the European Parliament and of the Council of 20 December 2006 on nutrition and health claims made on foods. Official Journal of the European Union.

European Community (2011). Regulation (EU) no 1169/2011 of the European Parliament and of the Council of 25 October 2011 on the provision of food information to consumers, amending Regulations (EC) No 1924/2006 and (EC) No 1925/2006 of the European Parliament and of the Council, and repealing Commission Directive 87/250/EEC, Council Directive 90/496/EEC, Commission Directive 1999/10/EC, Directive 2000/13/EC of the European Parliament and of the Council, Commission Directives 2002/67/EC and 2008/5/EC and Commission Regulation (EC) No 608/2004. Official Journal of the European Union.

Fialon, M., Egnell, M., Talati, Z., Galan, P., Dréano-Trécant, L., Touvier, M., Pettigrew, S., Hercberg, S. and Julia, C. (2020). Effectiveness of Different Front-of-Pack Nutrition Labels among Italian Consumers: Results from an Online Randomized Controlled Trial. *Nutrients* 12(8): 2307.

Feteira-Santos, R., Fernandes, J., Virgolino, A., Alarcão, V., Sena, C., Vieira, C. P., Gregório, M.J., Nogueira, P., Costa, A., Graça, P. and Santos, O. (2019). Effectiveness of interpretive front-of-pack nutritional labelling schemes on the promotion of healthier food choices. *International Journal of Evidence-Based Healthcare*, 1.

Feteira-Santos, R., Fernandes, J., Virgolino, A., Alarcão, V., Sena, C., Vieira, C. P., Gregório, M. J., Nogueira, P., Costa, A., Graça, P. and Santos, O. (2020). Effectiveness of interpretive front-of-pack nutritional labelling schemes on the promotion of healthier food choices: a systematic review. *International journal of evidence-based healthcare* 18(1): 24–37.

Finkelstein, E.A., Ang, F.J.L., Doble, B., Wong, W.H.M. and van Dam, R.M. (2019). A Randomized Controlled Trial Evaluating the Relative Effectiveness of the Multiple Traffic Light and Nutri-Score Front of Package Nutrition Labels. *Nutrients* 11(9): 2236.

Folkvord, F., Bergmans, N. and Pabian, S. (2021). The effect of the Nutri-Score label on consumer's attitudes, taste perception and purchase intention: An experimental pilot study. *Food Quality and Preference* 94,104303.

Food and Drink Europe (2020). Data & trends of the European food and drink industry 2020.

Galan, P., Egnell, M., Salas-Salvadó, J., Babio, N., Pettigrew, S., Hercberg, S. and Julia, C. (2020). Comprensión de diferentes etique-tados frontales de los envases en población espanola: resultados de un estudio comparativo. *Endocrinología, Diabetes y Nutrición* 67: 122-129.

Global Food Research Program. Front-of-Package Labeling around the World. 2020. Available from: http://globalfoodresearchprogram.web.unc.edu/resources

GBD 2017 Diet Collaborators (2019). Health effects of dietary risks in 195 countries, 1990-2017: a systematic analysis for the Global Burden of Disease Study 2017. *Lancet* 393(10184): 1958–1972.

Golan, E., Mancino, L. and Unnevehr, L. (2009). Food Policy Check the List of Ingredients, *Amber Waves* 7 (2): 16-21.

Grunert, K.G. and Wills, J.M. (2007). A review of European research on consumer response to nutrition information on food labels. *Journal of Public Health* 15: 385–399.

Hagmann, D. and 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.

Haws, K. L., Reczek, R. W. and Sample, K. L. (2017). Healthy diets make empty wallets: The healthy = expensive intuition. *Journal of Consumer Research* 43(6): 992–1007.

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

Julia, C., Blanchet, O., Méjean, C., Péneau, S., Ducrot, P., Allès, B., Fezeu, L.K., Touvier, M., Kesse-Guyot, E., Singler, E. and 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.

Julia, C., Hercberg, S. and World Health Organization. Regional Office for Europe (2017). Development of a new front-of-pack nutrition label in France: the five-colour Nutri-Score. *Public Health Panorama 03* (04): 712 - 725. World Health Organization. Regional Office for Europe.

Julia, C. and Hercberg, S. (2017). Development of a new front-of-pack nutrition label in France: the five-colour Nutri-Score. Public Health Panorama 3(4): 712-725.

Julia, C., Etilé, F. and Hercberg, S. (2018). Front-of-pack Nutri-Score labelling in France: an evidence-based theory. *Lancet Public Health* 3(4): 164.

Kahneman, D. (2011). Thinking, fast and slow. *Farrar, Straus and Giroux.*

Kanter, R., Vanderlee, L. and Vandevijvere, S. (2018). Front-of-package nutrition labelling policy: global progress and future directions. *Public Health Nutrition 21(8): 1399–1408.*

Kim, S.Y., Nayga, R.M. and Capps, O. (2001). Food label use, self-selectivity, and diet quality. Journal of Consumer Affairs 35: 346-363.

Lim, J.H., Rishika, R., Janakiraman, R. and Kannan, P.K. (2020). Competitive Effects of Front-of-Package Nutrition Labeling Adoption on Nutritional Quality: Evidence from Facts Up Front–Style Labels. *Journal of Marketing* 84(6): 3-21.

Louie, J. Chun Yu., Dunford, E. K., Walker, K. Z. and Gill, T. P. (2012). Nutritional quality of Australian breakfast cereals - are they improving? *Appetite* 59 (2): 464-470.

Loureiro, M. L. and Nayga, R. M. (2005). International Dimensions of Obesity and Overweight Related Problems: An Economics Perspective. *American Journal of Agricultural Economics* 87(5): 1147–1153.

Loureiro, M. L., Garcia, A. and Nayga, R.M. (2006). Do consumers value nutritional labels? *European Review of Agricultural Economics* 33(2): 249–268.

Maesen, S., Lamey, L., ter Braak, A. and Jansen, L. (2021). Going healthy: how product characteristics influence the sales impact of front-of-pack health symbols. Journal of the Academy of Marketing Science.

Mazzocchi, M., Traill, W.B. and Shogren, J.F. (2009). Fat Economics. Oxford University Press, New York.

Mazzù, M. F., Romani, S. and Gambicorti, A. (2020). Effects on consumers' subjective understanding of a new front-of-pack nutritional label: a study on Italian consumers. *International journal of food sciences and nutrition* 72(3): 357–366.

Mazzù, M. F., Romani, S., Baccelloni, A., & Gambicorti, A. (2021). A cross-country experimental study on consumers' subjective understanding and liking on front-of-pack nutrition labels. *International journal of food sciences and nutrition* 72(6): 833–847.

Miklavec, K., Pravst, I., Raats, M.M. and Pohar, J. (2016). Front of package symbols as a tool to promote healthier food choices in Slovenia: Accompanying explanatory claim can considerably influence the consumer's preferences. *Food Research International* 90: 235–243.

Miller, L. M. and Cassady, D. L. (2015). The effects of nutrition knowledge on food label use. A review of the literature. *Appetite* 92: 207–216.

Ministero dello Sviluppo Economico. DECRETO 19 novembre 2020. Forma di presentazione e condizioni di utilizzo del logo nutrizionale facoltativo complementare alla dichiarazione nutrizionale in applicazione dell'articolo 35 del regolamento (UE) 1169/2011.

Moorman, C., Rex, D. and Mela, C. (2005). The effect of standardized information on firm survival and marketing strategies. *Marketing Science* 24(2): 263–274.

Moorman, C., Ferraro, R., Smith, R. H., and Huber, J. (2012). From Consumer Information Regulation to Nutrition Competition: A Response. *Marketing Science* 31(5): 747–755.

Muller, L. and Prevost, M. (2016). What cognitive sciences have to say about the impacts of nutritional labelling formats. *Journal of Economic Psychology* 55: 17–29.

Newman, C. L., Howlett, E. and Burton, S. (2014). Shopper Response to Front-of-Package Nutrition Labeling Programs: Potential Consumer and Retail Store Benefits. *Journal of Retailing* 90 (1): 13-26.

Ni Mhurchu, C., Eyles, H., Jiang, Y. and Blakely, T. (2018). Do nutrition labels influence healthier food choices? Analysis of label viewing behaviour and subsequent food purchases in a labelling intervention trial. *Appetite* 121: 360–365.

Post, R. E, Mainous, A. G., Diaz, V. A., Matheson, E. M. and Everett, C. J. (2010). Use of the Nutrition Facts Label in Chronic Disease Management: Results from the National Health and Nutrition Examination Survey. *Journal of the American Dietetic Association* 110(4): 628-632.

Rao, M., Afshin, A., Singh, G. and Mozaffarian, D. (2013). Do healthier foods and diet patterns cost more than less healthy options? A systematic review and meta-analysis. *BMJ open* 3(12): e004277.

Roberto, C. A., Ng, S. W., Ganderats-Fuentes, M., Hammond, D., Barquera, S., Jauregui, A. and 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.

Rothman, R. L., Housam, R., Weiss, H., Davis, D., Gregory, R., Gebretsadik, T., Shintani, A. and Elasy, T. A. (2006). Patient understanding of food labels: the role of literacy and numeracy. *American journal of preventive medicine* 31(5): 391–398.

Savoie, N., Barlow, K., Harvey, K. L. L., Binnie, M. A. A. and Pasut, L. (2013). Consumer Perceptions of Frontof-package Labelling Systems and Healthiness of Foods. Canadian *Journal of Public Health-Revue Canadienne De Sante Publique* 104(5): 359–363.

Siegrist, M., Leins-Hess, R. and Keller, C. (2015). Which front-of-pack nutrition label is the most efficient one? The results of an eye-tracker study. *Food Quality and Preference* 39: 183–190.

Sinclair, S., Hammond, D. and Goodman, S. (2013). Sociodemographic differences in the comprehension of nutritional labels on food products. *Journal of Nutrition Education and Behavior* 45(6): 767-72.

Song, J., Brown, M. K., Tan, M., MacGregor, G. A., Webster, J., Campbell, N., Trieu, K., Ni Mhurchu, C., Cobb, L. K. and He, F. J. (2021). Impact of color-coded and warning nutrition

labelling schemes: A systematic review and network meta-analysis. *PLoS medicine* 18(10): e1003765.

Storcksdieck genannt Bonsmann S., Marandola G., Ciriolo E., van Bavel R. and Wollgast J. (2020). Front-of-pack nutrition labelling schemes: a comprehensive review. EUR 29811 EN, Luxembourg, Publications Office of the European Union.

Talati, Z., Egnell, M., Hercberg, S., Julia C. and Pettigrew S. (2019). Consumers' Perceptions of Five Front-of-Package Nutrition Labels: An Experimental Study Across 12 Countries. *Nutrients* 11(8): 1934.

Temple, N. (2020). Front-of-package food labels: A narrative review. *Appetite* 144, 104485.

Traill, W. B., Chambers, S. A. and Butler, L. (2012). Attitudinal and demographic determinants of diet quality and implications for policy targeting. *Journal of human nutrition and dietetics: the official journal of the British Dietetic Association* 25(1): 87–94.

Van Camp, D.J., Hooker, N.H. and Souza-Monteiro, D.M. (2010). Adoption of voluntary front of package nutrition schemes in UK food innovations, *British Food Journal* 112 (6): 580-591.

Van Camp, D., De Souza Monteiro, D. M. and Hooker, N. H. H. (2012). Stop or go? How is the UK food industry responding to front-of-pack nutrition labels? *European Review of Agricultural Economics* 39(5): 821–842.

Van Kleef, E. and 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

Vandevijvere, S., Vermote, M., Egnell, M., Galan, P., Talati, Z., Pettigrew, S., Hercberg, S. and Julia, C. (2020). Consumers' food choices, understanding and perceptions in response to different front-of-pack nutrition labelling systems in Belgium: results from an online experimental study. *Archives of Public Health* 78(1).

Variyam, J.N. (2008). Do nutrition labels improve dietary outcomes? *Health Economics* 17: 695-708.

Vermote, M., Bonnewyn, S., Matthys, C. and Vandevijvere, S. (2020). Nutritional Content, Labelling and Marketing of Breakfast Cereals on the Belgian Market and Their Reformulation in Anticipation of the Implementation of the Nutri-Score Front-Of-Pack Labelling System. *Nutrients* 12(4): 884.

Volkova, E. and Ni Mhurchu, C. (2015). The Influence of Nutrition Labeling and Point-of-Purchase Information on Food Behaviours. *Current Obesity Reports* 4: 19–29.

Vyth, E. L. L., Steenhuis, I. H. M. H. M., Roodenburg, A. J. C. J. C. and Brug, J., Seidell, J. C. C. (2010a). Front of-pack nutrition label stimulates healthier product development: a quantitative analysis. *International Journal of Behavioral Nutrition and Physical Activity* 7(65).

Vyth, E.L., Steenhuis, I.H.M., Vlot, J.A., Wulp, A., Hogenes, M.G., Looije, D.H., Brug, J. and Seidell, J.C. (2010b). Actual use of a front-of-pack nutrition logo in the supermarket: consumers' motives in food choice. *Public Health Nutrition* 13(11): 1882-1889.

World Health Organization (2018). Better food and nutrition in Europe – Progress report.