



# Unveiling the impact of front-of-pack nutritional labels in conflicting nutrition information – A congruity perspective on olive oil

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## ABSTRACT

An increasing awareness of the importance of healthy eating prompted consumers to gather nutritional cues from various sources, often resulting in conflicting nutrition information for the same food. This can lead to unintended consequences, such as decreased consumer interest in dietary information and behaviors contrary to healthy advice, particularly when the sources are deemed highly credible by consumers.

In a series of three experiments, we aim to uncover the underlying cognitive mechanisms connected to complementary information provided by Front-of-Pack Nutritional Labels (FOPLs), exploring if conflicting nutrition information is generated when consumers integrate the labels' information with other sources. Using olive oil as a case of products associated with conflicting nutrition information (CNI), Study 1 shows that directive labels (e.g., Nutri-Score) generate CNI when combined with either internal (i.e., pre-existing health knowledge) or external entities (i.e., knowledge from scientific information). In contrast, non-directive labels (e.g., NutriInform Battery) do not, in either condition. Study 2 explains that consumers establish a lower level of congruence between information provided by the internal entity and FOPL when the label is directive. Study 3 confirms a lower level of congruence between the information available from the external entities and FOPLs when the label type is directive, compared to non-directive. Furthermore, this diminished congruence has a negative impact on consumer attitudes and their intentions to adopt Nutritional Labels.

Overall, this research delves into the interactions among various information sources from a congruence perspective, offering actionable insights for managers and policymakers to avoid becoming entangled by conflicting information.

## 1. Introduction

In recent years, healthy eating has become increasingly important among Western consumers, especially with the increase rates of overweight and obesity (WHO, 2022). A survey involving 8,000 participants from the US, UK, France, and Germany revealed that half of the respondents take healthy eating as a top priority to improve their health (Grimmelt, 2022).

In reaction, consumers turn to various sources to seek nutritional information (Vijaykumar, McNeill, & Simpson, 2021; Feick, Herrmann, & Warland, 1986), often coming across conflicting messages that offer non-uniform guidance on whether to consume or avoid a specific food item (Nutraceuticals World, 2017). Conflicting Nutrition Information (CNI) may not only involve misinformation but also conflicting nutrition

opinions about a particular food regarding the balance between risks and benefits (Spiteri Cornish & Moraes, 2015; Nagler, 2014).

Recent studies raised concerns about the detrimental impact of different nutrition-relevant information on consumer healthiness as their variety might generate confusion (Hong, 2023; Ngo, Lee, Ruthford, & Phung, 2023; Nagler, Vogel, Gollust, Yzer, & Rothman, 2022) and even lead to unhealthy dietary decisions (Vijaykumar et al., 2021). Moreover, research suggests that when this conflicting nutrition information originates from reliable resources – like health professionals –, its impact is more profound compared to information presented on social media or health websites (Vijaykumar et al., 2021).

In response to credible sources with contradictory judgments, consumers might devalue the credibility of scientific information by perceiving it as uncertain and showing negative attitudinal responses

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(Chang, 2015), sometimes leading to lower trust and interest in scientific health information (Lyons, Merola, & Reifler, 2020). This carryover effect might lead to backlash against general healthy recommendations and behavior, such as decreased vegetable consumption and exercise due to the belief that “scientists don’t really know what foods are good for you” (Vijaykumar et al., 2021; Hong, 2023; Ngo et al., 2023). Hence, prior studies have emphasized two important research directions: nutrition promotion initiatives should consider the complex effects of conflicting nutrition information when providing consumers with dietary recommendations (Ngo et al., 2023), and the need for additional research to investigate how consumers cognitively process and integrate conflicting information (Carpenter et al., 2016).

A currently unexplored credible source of conflicting information is Front-of-Pack Nutritional Labels (FOPLs), whose effects have primarily been studied from their positive effectiveness in isolation in previous research (Dubois et al., 2021; Grunert & Wills, 2007; Mazzù et al., 2022). Considering their placement on the products that are either on the shelf or at home, along with other elements present on the front of the pack, information from FOPLs is continuously available to customers, shaping preferences (García-Madariaga, López, Burgos, & Virto, 2019), and with the potential to continuously interact with other consumers’ sources of information.

The present work, utilizing products subject to CNI which are important in some traditional diets, such as olive oil, aims to understand under which conditions information from various types of FOPLs might generate CNI. In recent years, olive oil has been, on the one side, categorized as negative by some Labels (e.g., Nutri-Score C or D) and considered skewed negative but mixed nutrient (Ihekweazu, 2023). On the other side, olive oil is classified as a positive nutritional element containing essential nutrients (Pichierrri, Peluso, Pino, & Guido, 2021; Fletcher, 2019) associated with health benefits when consumed regularly and in moderation, such as decreasing the risk of cardiovascular diseases (Donat-Vargas et al., 2022), helping in preserving kidney function (Podadera-Herreros et al., 2022), and aiding in weight loss (Galvão Cândido et al., 2018). In daily practices, the internet has presented consumers with conflicting claims about the benefits and risks of dietary oils (Harvard Health, 2020; Crosby, 2018).

In order to comprehend how FOPLs information becomes entangled in CNI, this research draws upon congruity theory (Maille & Fleck, 2011; Rokeach & Rothman, 1965; Osgood & Tannenbaum, 1955), exploring a set of nutritional information available to consumers. Specifically, it aims to investigate the impact of the interplay on consumers’ cognitive processing of information offered by different types of FOPLs when combined with other sources of information, such as pre-existing internal health knowledge and external scientific information. Congruity theory suggests that neutral information is more easily assimilated and absorbed when faced with directive judgments (Osgood & Tannenbaum, 1955). However, when two different stimuli represent opposing arguments, both serving as directive judgments, the combined configuration gives rise to conflicting information, leading to consumer cognitive compromise (Osgood & Tannenbaum, 1955). In the context of conflicting nutrition information, this cognitive compromise echoes the negative attitude towards the corresponding nutritional sources and general backlash towards healthy behavior mentioned above (Hong, 2023; Ngo et al., 2023; Chang, 2015).

Following the current EU taxonomy, we differentiated FOPLs based on their directiveness (EU Commission, 2021). We utilized the Nutri-Inform Battery to represent neutral and non-directive FOPLs, providing consumers with neutral and factual nutrient information, without directive cues, and Nutri-Score to represent *directive* labels, which include specific instructive cues such as colors or stop signs aimed at shaping food healthiness perceptions. These labels often summarize the “healthiness” of a product without displaying detailed nutritional information (EU Commission, 2021).

Our results indicate that when combined with another entity, directive labels generate conflicting nutrition information, whereas non-

directive labels do not. The underlying mechanisms show that directive labels, compared with non-directive labels, result in a lower level of congruence when paired with either internal or external nutritional information. This diminished congruence leads to a reduced perception of the credibility of the information provided by the nutritional labels, further decreasing consumers’ willingness to use FOPLs in the future.

Theoretically, this research advances knowledge related to the creation mechanisms of CNI, employing the comparative framework of congruity theory (Maille & Fleck, 2011) to test the effects of information provided by different typologies of FOPL in interactions with other internal or external nutritional information sources. Moreover, within the context of the “From-farm-to-fork” strategy, it offers managers and policymakers a perspective regarding the differential effects of generating CNI from different FOPLs and insights to select credible sources that consumers can continuously rely on in resolving conflicting nutrition information.

## 2. Theoretical background and hypothesis development

### 2.1. Conflicting nutrition information

Conflicting nutrition information (CNI) is defined as the co-existence of contradictory information about eating the same food and the potential distinct outcomes the specific food may bring (Ihekweazu, 2023; Nagler, 2014). The formation of CNI is due to the presence of information in multiple sources (Ngo et al., 2023; Spiteri Cornish & Moraes, 2015), such as social media, mass media (e.g., TV, newspaper), government health communication, and scientific reports, as well as the ones derived from Front-of-Pack Nutritional Labels. In this landscape, misinformation and advocative statements might be present (Ngo et al., 2023; Spiteri Cornish & Moraes, 2015); for example, non-registered dietitian bloggers might provide conflicting and non-evidence-based nutrition proposals on social media to advocate for nutrition-based alternatives against conventional medicine to attract public attention and commercial benefits (Chan, Drake, & Vollmer, 2020).

However, conflicting nutrition information is not necessarily misinformation when evidence-based contexts are clarified so that consumers can believe in conflicting information at the same time (Ihekweazu, 2023). Exposure to CNI generates consumer negative cognitive perceptions, such as a decrease in cognitive acuteness and accuracy (Barnwell, Fedorenko, & Contrada, 2022), an increase in nutritional confusion (Ngo et al., 2023; Hong, 2023), and perceived ambiguity (Ahn & Kahlor, 2022). In turn, consumers might form a belief that scientists keep changing opinions (Nagler, 2014) and therefore devalue the credibility of media and scientific information, perceive scientific information as uncertain, and show negative attitudinal responses (Nagler et al., 2022; Chang, 2015). Moreover, the confusion about the nutritional information might lead to nutritional backlash in the form of decreased consumer intention to follow professional guidance (Lyons et al., 2020) or reduction of vegetable consumption and exercise (Hong, 2023; Ngo et al., 2023; Nagler et al., 2022; Nagler, 2014). Interestingly, Vijaykumar et al. (2021) reported that CNI from health professionals increases backlash while the social media involved in CNI do not result in a backlash effect. This might be due to the disregard of non-credible information from social media and the increased cognitive processing of credible information from health professionals (Ngo et al., 2023; Hong, 2023). Consequently, researchers highlighted the importance of considering the complex backlash effects of CNI exposure when policymakers design dietary recommendations (Ngo et al., 2023).

### 2.2. Front-of-Pack nutritional labels as a component of conflicting nutrition information

Front-of-Pack Nutritional Labels provide consumers with nutritional information on the front of the food package, aiming to make the nutritional content more salient and understandable (Newman, Burton,

Andrews, Netemeyer, & Kees, 2018). According to the European Union taxonomy (EU Commission, 2021), FOPLs (Table 1) are classified by the level of their directive guidance (Hodgkins et al., 2012).

The advocacy for a harmonized Front-of-Pack nutritional labeling system, as recently recommended as a compulsory directive by the European Union Commission, aims to facilitate the consistent provision and accessibility to nutritional information to consumers throughout the EU (EU Commission, 2021).

The standardization of FOPLs underscores the necessity for policy-makers to address potential adverse ramifications (Mazzù et al., 2022), as these labels may introduce conflicting nutrition information (Vijaykumar et al., 2021). Nevertheless, existing literature predominantly concentrates on established sources of Consumer Nutrition Information such as television, social media, and scientific reports (Ngo et al., 2023; Vijaykumar et al., 2021; Nagler, 2014) while neglecting the upcoming mandatory FOPLs as a potentially widespread source of CNI.

CNI essentially arises from diverse information that suggests the contradictory health outcomes of a particular food or nutrient (Ihekweazu, 2023; Nagler, 2014). In this context, while the independent use of the FOPLs as extrinsic stimuli in changing consumer perceptions of the pack is widely studied, limited attention has been given to how different nutrition information interacted with different types of Nutritional labels (Mauri, Grazzini, Ulqinaku, & Poletti, 2021; Ikonen, Sotgiu, Aydinli, & Verlegh, 2020). In fact, FOPLs serve not only as nutrition information per se but might help make sense of conflicting information toward healthier food decisions. In this respect, they should be considered a full part of the information system available to customers when assessing the healthiness of a specific food.

Therefore, in the context of FOPL exposure, the potential difference in perceived healthiness between the information exposure of a product without a label and the same condition with added labeling indicates the potential for CNI arising from the label.

Prior investigations have demonstrated that diverse FOPLs elicit varying degrees of perceived healthiness when attached to identical food items (He, Mazzù, & Baccelloni, 2023; Pettigrew, Jongenelis, Jones, Hercberg, & Julia, 2022; Ikonen et al., 2020; e.g., Newman, Howlett, & Burton, 2014; Andrews, Burton, & Kees, 2011). Notably, findings from a meta-analysis (Ikonen et al., 2020) indicate that the directive labels might alter the perceived healthiness of food, while non-directive FOPLs do not. These outcomes suggest the emergence of directive FOPL exposure as an integral component of CNI. Consequently, we posit the following hypotheses.

H1: Directive (vs. non directive) FOPL leads to the generation of CNI, as indicated by the deviation (vs. absence) in the perceived healthiness of the product with the presence of the FOPL compared to the condition without FOPL.


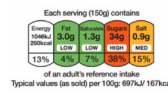




2.3. The underlying mechanism of the generation of CNI: Healthiness perception congruence

Congruence is defined as “two information entities going well together” (Maille & Fleck, 2011; Osgood & Tannenbaum, 1955). Entities can be either external (e.g., media, website information) or internal information (e.g., the schema in mind, self-conception); in the context of food consumption, the external entities can be associated with information channels (e.g., FOPLs scientific media) –, while internal entities are related to consumer previous knowledge.

The congruity theory (Osgood & Tannenbaum, 1955) holds the potential to explain the emergence of CNI, particularly in the context of exposure to multiple sources. Specifically, the congruence level is high when different pieces of information align. However, when the information is contradictory, the congruence between the pieces decreases. Notably, neutral sources that avoid explicit judgments facilitate congruence with other presented sources.

In the context of FOPLs (Storcksdieck, Marandola, & Ciriolo, 2020), our proposition posits that directive labels will result in a diminished

Table 1 Front-of-pack labels taxonomy.

Taxonomies	Examples
<p><b>Non-directive:</b> Front-of-Pack Nutritional labels that include information elements only, such as nutrient names, grams, and percentages.</p>	<ul style="list-style-type: none"> <li> <p><b>Numerical Labels:</b> non-interpretative (non-evaluative) labels, providing numerical information on the content of four nutrients (fat, saturates, sugars, salt) and on the energy value, as well as on how much this represents as a percentage of the daily reference intake</p>  </li> <li> <p><b>Multiple Traffic Light</b></p>  </li> </ul>
<p><b>Semi-directive:</b> Front-of-Pack Nutritional labels that include nutritional information and are complemented by evaluative elements such as specific colours according to nutrient levels.</p>	<ul style="list-style-type: none"> <li> <p><b>Colour-Coded Labels:</b> labels providing numerical information on the content of four nutrients (fat, saturates, sugars, salt) and the energy value, as well as on how much this represents as a percentage of the daily reference intake. Colours are used to classify those nutrients as “low” (green), “medium” (amber), or “high” (red)</p> </li> <li> <p><b>Endorsement Logos:</b> labels providing a synthetic appreciation of a product’s overall nutritional value through a positive (endorsement) logo that is applied only to foods that comply with nutritional criteria</p>  </li> <li> <p><b>Graded Indicators:</b> labels providing a synthetic appreciation of a product’s overall nutritional value through a “graded indicator” that provides graded information on the nutritional quality of foods that is applied on all food products</p>  </li> </ul>
<p><b>Directive:</b> Front-of-Pack Nutritional labels that include the least amount of information, often aggregated in one symbol or icon.</p>	<ul style="list-style-type: none"> <li> <p><b>Keyhole logo</b></p>  </li> <li> <p><b>Nutri-Score</b></p>  </li> </ul>

Source: Adapted from Storcksdieck et al. (2020).

perceived congruence relative to other explicit entities (e.g., scientific knowledge, prior health perceptions of the food). This effect is particularly pronounced in situations where existing health knowledge is present and conflicting, exemplified by the case of olive oil. In contrast, non-directive labels, such as the NutriInform Battery, serving as neutral entities for judgment, are more likely to exhibit congruence when compared to other explicit entities like scientific knowledge and prior health knowledge present in the consumer's mind, especially in comparison to directive labels like Nutri-Score.

H2: Directive (vs. non-directive) FOPLs lead to a reduction level of perceived congruence when compared with another directive entity.

#### 2.4. Perceived credibility, attitude, and adoption intention towards the FOPL

The consumers' perceived credibility of nutritional information is their personal subjective perception of how believable the information is – a critical element in shaping their attitudes and consequent healthy behavior (Jeong & Jang, 2017; Chang, 2015; Metzger & Flanagin, 2015). Previous studies have shown that credibility enhances the perceived usefulness of the information and facilitates consumer decision-making (Mazzù, Pozharliev, et al., 2023; Flavián, Akdim, & Casaló, 2023; Jaeger & Weber, 2020). When the perceived credibility of the information is low, consumers do not believe in the sources and avoid the exposure of the relevant information (Chang, 2015). In fact, according to the truth-default theory (Levine, 2014), individuals tend to naturally assume that the information communicated by others is credible. However, the message's credibility is undermined when there is a lack of coherence in the message content or a mismatch between the communication and existing knowledge of reality.

In the context of nutritional labels, Garretson and Burton (2000) revealed that when consumers perceive incongruity between health claims and nutritional labels concerning the fat content and its corresponding perception of healthiness, they tend to perceive the health claims as lacking credibility. However, this incongruence does not appear to trigger credibility concerns regarding Nutritional Labels. This observation could be attributed to the inherently promotional nature of health claims, making them less credible.

Moreover, Sicilia et al. (2023) recently reported that the condition where FOPL and credible influencer content are incongruent leads to a reduction in consumers' perceived credibility of FOPL. On the contrary, under congruent conditions, the influencer content seems to amplify the credibility of FOPLs.

To this end, in the present paper, we hypothesize that incongruence

between FOPLs and other nutritional informational sources devoid of commercial interests could impact the perceived credibility of the Front-of-Pack Nutritional Labels. Specifically, a higher perceived congruence between FOPLs and non-commercial entities, either scientific knowledge (represented as an external entity) or consumer pre-existing nutritional knowledge about olive oil in their mind (represented as an internal entity) will lead to higher consumer credibility perceptions of the information provided by FOPLs. In turn, a higher perceived credibility of FOPL will generate a more positive attitude toward the label itself, as well as a greater adoption intention of the label. This encompasses utilizing the label for food purchases and intending to recommend its use to friends for food purchases. Formally, we make the following hypotheses.

H3: a reduced perceived congruence between nutritional information about olive oil from FOPLs and another entity will lead to lower perceived credibility of the information provided by the FOPL, which in turn reduces consumer attitude towards the FOPL and intention to adopt FOPL as a reference for nutritional information.

To test our hypothesis, we developed a series of three studies (Fig. 1).

Specifically, in Study 1a, we first tested H1 by assessing whether exposure to different types of FOPLs (namely, Nutri-Score and Nutri-form Battery) leads to the activation of CNI when consumers integrate label information with the internal entity (i.e., consumer knowledge about the healthiness of olive oil) and, in Study 1b, an external entity, as the scientific knowledge about the healthiness of olive oil. In study 2, we tested H2 and H3 by examining the underlying mechanism and the outcomes of the entanglement of FOPLs as part of CNI in the context of combining with the internal entity presented by congruence perception, perceived credibility, and acceptance of the front-of-pack nutritional labels. In study 3, we tested H2 and H3 again by examining how the combined and contemporary exposure of individuals to different types of FOPLs and the external entity leads to the activation of CNI. We also explored the consequences of CNI by exploring perceived congruence, the credibility of nutritional information, attitude, and adoption intentions towards the FOPLs.

### 3. Study 1. Effects of exposure to Front-of-Pack nutritional labels

#### 3.1. Study 1a: The emergence of CNI from the FOPL exposure when compared with consumer nutritional knowledge about olive oil

##### 3.1.1. Methods

We conducted a between-subject preliminary test to determine whether the exposure to FOPLs generates varying levels of CNI,

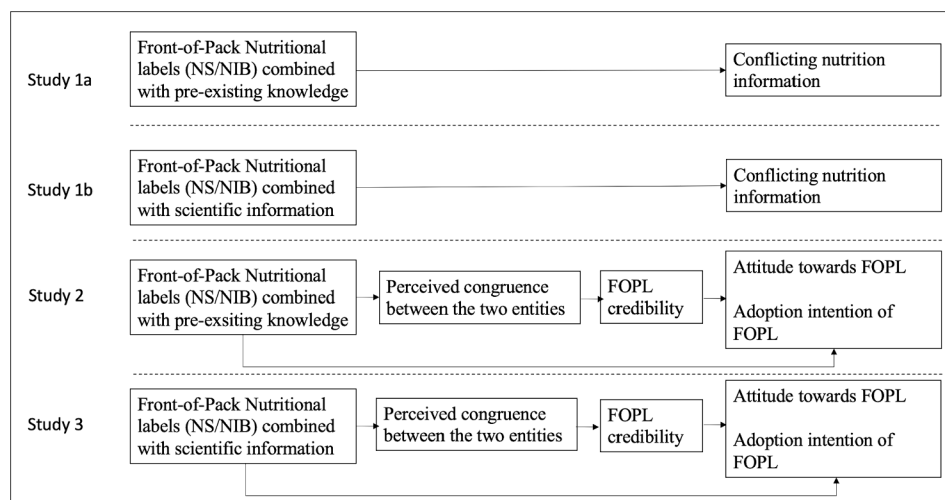


Fig. 1. Conceptual model and series of studies.

measured by the deviation of consumer perceived healthiness (Ares & Gámbaro, 2007) from the condition where no FOPL is present. 210 participants ( $M_{age} = 36.43$ ,  $SD = 8.79$ , 35.7 % female) were recruited through the Prolific platform in exchange for a nominal payment from European Union EU countries, except for France, Germany, Belgium, and Luxembourg that have widely adopted the Nutri-Score. Participants were shown one of the three conditions (i.e., Nutri-Score, NutrInform Battery, No FOPLs) attached to the same olive oil package. Next, participants had to indicate on a 7-point Likert scale the extent to which they perceive the olive oil as healthy, based on Ares and Gámbaro (2007) scale (Fig. 2).

### 3.1.2. Results

The results show the consumer perception of the healthiness of olive oil when exposed to Nutri-Score ( $M_{NS} = 4.67$ ,  $SD_{NS} = 1.09$ ), NutrInform Battery ( $M_{NIB} = 5.63$ ,  $SD_{NIB} = 0.98$ ), and No FOPLs ( $M_{Control} = 5.70$ ,  $SD_{Control} = 1.24$ ). An Oneway ANOVA test confirms the deviation of the perceived healthiness between the three groups ( $F(2, 209) = 18.78$ ,  $p < 0.01$ ).

We then conduct the Levene's test and confirm the assumption of homogeneity of variances (Levene's Statistic = 0.28,  $p = 0.76 > 0.05$ ). The Post Hoc analyses via the Tukey method test the mean deviation of FOPLs exposure from the control group and report that  $Mean_{(Control-NS)} = 1.03$ ,  $p < 0.01$ , suggesting that consumer perceived healthiness is deviated from the general consumer existing knowledge about olive oil when they are exposed to directive labels (i.e., Nutri-Score);  $Mean_{(Control-NIB)} = 0.07$ ,  $p = 0.92$ , suggesting that consumer perceived healthiness are not deviated from the general consumer existing knowledge about olive oil when they are exposed to non-directive labels (i.e., NutrInform Battery).

As a result, study 1a confirms H1. Specifically, the results suggest that, in the case of olive oil, the exposure to directive FOPL, when compared with consumer pre-existing knowledge, generates CNI regarding the healthiness of the product, while non-directive FOPL does not.

### 3.2. Study 1b. The emergence of CNI from the FOPL exposure when paired with scientific nutritional knowledge about olive oil

#### 3.2.1. Methods

We conducted a similar between-subject preliminary test to confirm whether the contemporary exposure to FOPLs and scientific information generates varying levels of conflicting nutrition information. We then measured the deviation of consumer perceived healthiness (Ares & Gámbaro, 2007) from the condition where only scientific information is present. 207 participants were recruited ( $M_{age} = 36.80$ ,  $SD = 8.52$ , 63.8 % male, 35.3 % female, 1 % non-binary) from the European Union, excluding countries already adopting Nutri-Score as France, Germany, Belgium, and Luxembourg, through Prolific in exchange for a nominal payment. Participants were shown one of the three conditions attached to the same olive oil (i.e., Nutri-Score combined with scientific evidence, NutrInform Battery combined with scientific evidence, and scientific evidence alone). Next, participants had to indicate on a 7-point Likert scale the extent to which they perceived the olive oil as healthy.

#### 3.2.2. Results

The results report the consumer perception of the healthiness of olive oil when exposed to Nutri-Score combined with scientific evidence ( $M_{NS} = 5.00$ ,  $SD_{NS} = 1.21$ ), NutrInform Battery combined with scientific evidence ( $M_{NIB} = 5.58$ ,  $SD_{NIB} = 0.87$ ), and the control group that provides scientific evidence alone ( $M_{Control} = 5.94$ ,  $SD_{Control} = 1.10$ ). An Oneway ANOVA test confirms the deviation of the perceived healthiness between the three groups ( $F(2, 206) = 13.10$ ,  $p < 0.01$ ).

We then confirmed the assumption of homogeneity of variances (Levene's Statistic = 1.78,  $p = 0.17$ ). The Post Hoc analysis via the Tukey method reports the mean deviation of the combination of FOPL

Construct/variable	Source	Scale
1. perceived healthiness	Ares, G., & Gámbaro, A. (2007).	Please indicate how healthy you perceived the above-mentioned olive oil (with 7-Likert scale).
	Influence of gender, age and motives underlying food choice on perceived healthiness and willingness to try functional foods. <i>Appetite</i> , 49(1), 148-158.	Q1: Not at all healthy—very healthy
2. perceived congruence	Rifon, N. J., Choi, S. M., Trimble, C. S., & Li, H. (2004).	(S2) Please express your opinion on the relationship between the nutritional information included in sponsorship: The mediating role of sponsor credibility and consumer attributions of sponsor motive. <i>Journal of advertising</i> , 33(1), 30-42.
	Congruence effects in	the front-of-pack label and your previous knowledge about the healthiness of the olive oil (with 7-Likert scale).
3. Perceived credibility of the message	Block, L. G., & Keller, P. A. (1995). When to accentuate the negative: The effects of perceived efficacy and message framing on intentions to perform a health-related behavior. <i>Journal of marketing research</i> , 32(2), 192-203.	(S3) What do you think of the relationship between the scientific knowledge of olive oil and the nutritional information from the front-of-pack label: Q1: Not compatible—compatible Q2: Not a good fit—good fit Q3: Congruent—Not congruent
		What do you think of the front-of-pack label information about olive oil above: Q1: The information from the front-of-pack label is credible. Q2: I think the information from the front-of-pack label is exaggerated. Q3: I think the information from the front-of-pack label is unbelievable.
		Q1: Negative-positive Q2: Bad-Good Q3. Unfavorable-Favorable
4. Attitude toward the Front-of-pack Nutritional Label	Burnkrant, R. E., & Unnava, H. R. (1995). Effects of self-referencing on persuasion. <i>Journal of consumer research</i> , 22(1), 17-26.	Please indicate your attitude towards the Front-of-pack label: Q1: Negative-positive Q2: Bad-Good Q3. Unfavorable-Favorable
	Mazzù, M. F., Baccelloni, A., Romani, S., & Andria, A. (2022c). The role of trust and algorithms in consumers' front-of-pack labels acceptance: a cross-country investigation. <i>European Journal of Marketing</i> , 56(11), 3107-3137	Q1. I will use this front-of-pack label for food purchases in the future. Q2. I will recommend this front-of-pack label for food purchases to my friends.

Fig. 2. Measurement scales.

and scientific evidence from the control group  $Mean_{(scientific\ evidence\ alone-NS\ with\ scientific\ evidence)} = 0.94, p < 0.01$ , suggesting that consumer perceived healthiness of olive oil deviates from scientific evidence alone when they are exposed to a combination of directive labels (i.e., Nutri-Score) and scientific evidence. In contrast, when consumers are exposed to a combination of non-directive labels (i.e., NutriInform Battery) and scientific evidence, there's no significant deviation in consumer perceived healthiness from the healthiness perception of olive oil indicated by scientific evidence alone  $Mean_{(scientific\ evidence\ alone-NIB\ with\ scientific\ evidence)} = 0.36, p = 0.13$ .

As a result, study 1b confirms H1. Specifically, in the case of olive oil, the results confirm that directive FOPL, when combined with the external entity (i.e., scientific evidence), generates CNI regarding the healthiness of the product. In contrast, the non-directive FOPL does not generate CNI when combined with the same external entity.

#### 4. Study 2. The underlying mechanism of consumer response to FOPL when compared with consumer nutrition knowledge

We then explore the underlying mechanism and the outcome of CNI by investigating how different types of FOPLs (i.e., directive vs. non-directive FOPL), when engaged with the pre-existing nutritional knowledge of olive oil, shape congruence perception, credibility, attitudinal and behavioural responses.

##### 4.1. Stimuli and measurement scales

We utilized a real package of an olive oil product, deleting all branding elements to avoid any bias toward the specific brand and virtually sticking FOPLs in a visible part of the pack. Following official guidelines, we paid attention to generating FOPLs specific to the olive oil product. Nutri-Score was selected as representative of the directive label and the NutriInform Battery as representative of the non-directive ones, as they are at the center of the policy-making debate at the EU level, relevant for the "From Farm to Fork" strategy and belong to the polarizing extremes of the European taxonomy. Except for the types of FOPLs, stimuli remained uniform in the conditions with the Nutri-Score and the NutriInform Battery.

In terms of measurement, we utilized pre-validated scales from extant literature (Fig. 2), measured with a 7-point Likert scale.

Construct/ variable	Source	Scale
1. perceived healthiness	Ares, G., & Gámbaro, A. (2007). Influence of gender, age and motives underlying food choice on perceived healthiness and willingness to try functional foods. <i>Appetite</i> , 49(1), 148–158.	Please indicate how healthy you perceived the above-mentioned olive oil (with 7-Likert scale).Q1: Not at all healthy—very healthy
2. perceived congruence	Rifon, N. J., Choi, S. M., Trimble, C. S., & Li, H. (2004). Congruence effects in sponsorship: The mediating role of sponsor credibility and consumer attributions of sponsor motive. <i>Journal of advertising</i> , 33(1), 30–42.	(S2) Please express your opinion on the relationship between the nutritional information included in the front-of-pack label and your previous knowledge about the healthiness of the olive oil (with 7-Likert scale).(S3) What do you think of the relationship between the scientific knowledge of olive oil and the nutritional information from the front-of-pack label:Q1: Not compatible—compatibleQ2: Not a good fit—good fitQ3: Congruent—Not congruent
3. Perceived credibility of the message	Block, L. G., & Keller, P. A. (1995). When to accentuate the	What do you think of the front-of-pack label information about olive oil above:Q1: The information from

(continued on next column)

(continued)

Construct/ variable	Source	Scale
	negative: The effects of perceived efficacy and message framing on intentions to perform a health-related behavior. <i>Journal of marketing research</i> , 32 (2), 192–203.	the front-of-pack label is credible. Q2: I think the information from the front-of-pack label is exaggerated. Q3: I think the information from the front-of-pack label is unbelievable.
4. Attitude toward the Front-of-pack Nutritional Label	Burnkrant, R. E., & Unnava, H. R. (1995). Effects of self-referencing on persuasion. <i>Journal of consumer research</i> , 22 (1), 17–26.	Please indicate your attitude towards the Front-of-pack label:Q1: Negative-positiveQ2: Bad-GoodQ3: Unfavorable-Favorable
5. Adoption intention of the Front-of-pack Nutritional Label	Mazzù, Baccelloni, et al. (2022). The role of trust and algorithms in consumers' front-of-pack labels acceptance: a cross-country investigation. <i>European Journal of Marketing</i> , 56 (11), 3107–3137	Q1. I will use this front-of-pack label for food purchases in the future.Q2. I will recommend this front-of-pack label for food purchases to my friends.

##### 4.1.1. Methods

We conducted an online experiment with a sample of 143 participants ( $M_{age} = 36.48, SD = 8.81, 62.2\%$  male) recruited through the Prolific platform. Respondents were informed that the study is about an assessment of consumers' responses regarding food FOPLs, and participants were randomly assigned to one of the two tested conditions (i.e., Nutri-Score and NutriInform Battery). Participants were asked to engage in evaluation tasks, utilizing their pre-existing nutritional knowledge about the healthiness perception of olive oil accompanied by one FOPL.

We measured participants with the same scale as Study 1, which confirmed their reliability for perceived congruence ( $\alpha = 0.79$ ), perceived credibility of FOPLs ( $\alpha = 0.87$ ), and attitude towards the FOPLs ( $\alpha = 0.95$ ), and adoption intention towards FOPLs ( $\alpha = 0.89$ ).

##### 4.1.2. Results

Based on our comparative analyses, Nutri-Score showed significantly lower values than NutriInform Battery in terms of *Perceived congruence* ( $M_{NIB} = 5.25, SD_{NIB} = 0.96$  vs.  $M_{NS} = 3.97, SD_{NS} = 1.03, t(141) = 7.68, p < 0.01$ ; Cohen's  $d = 1.28$ ). *Perceived Credibility of FOPLs* ( $M_{NIB} = 5.53, SD_{NIB} = 0.92$  vs.  $M_{NS} = 4.61, SD_{NS} = 1.27, t(141) = 4.98, p < 0.01$ ; Cohen's  $d = 0.83$ ). *Attitude towards FOPLs* ( $M_{NIB} = 5.58, SD_{NIB} = 0.98$  vs.  $M_{NS} = 4.50, SD_{NS} = 1.27, t(141) = 5.70, p < 0.01$ ; Cohen's  $d = 0.95$ ). *Adoption intention for FOPLs* ( $M_{NIB} = 4.80, SD_{NIB} = 1.28$  vs.  $M_{NS} = 4.20, SD_{NS} = 1.48, t(141) = 2.57, p = 0.01$ ; Cohen's  $d = 0.43$ ).

*Serial Mediation Analysis.* We found a significant negative effect of Nutri-Score, compared to NutriInform Battery, on consumer attitude towards FOPLs ( $b = -0.54, [SE] = 0.10, t(141) = -5.70, P < 0.01$ ) and adoption intention ( $b = -0.30, [SE] = 0.12, t(141) = -2.57, P = 0.01$ ) towards the FOPLs. The mediation model was run with PROCESS macro for SPSS (Model 6; Hayes, 2017), with FOPLs types (NutriInform Battery = -1; Nutri-Score = 1) as the independent variable, perceived congruence and perceived credibility as the mediators, and attitude and adoption intention as the dependent variables. To test the proposed underlying process, we used bias-corrected bootstrapping to generate a 95 % confidence interval around the indirect effect of perceived congruence and credibility, where mediation occurs if the confidence interval excludes zero (Hayes, 2018). The analysis (5,000 bootstrap samples; bias-corrected confidence intervals estimated and reported) revealed a significant indirect effect for congruence ( $ab = -0.30, [SE] = 0.06; 95\%LLCI = -0.44, 95\%ULCI = -0.19$ ) but not for perceived

credibility ( $ab = -0.06$ ,  $[SE] = 0.04$ ; 95 %LLCI =  $-0.15$ , 95 %ULCI =  $0.02$ ) on consumer attitude towards FOPLs; no significant indirect effect for congruence ( $ab = -0.15$ ,  $[SE] = 0.09$ ; 95 %LLCI =  $-0.33$ , 95 %ULCI =  $0.01$ ) or credibility ( $ab = -0.06$ ,  $[SE] = 0.05$ ; 95 %LLCI =  $-0.18$ , 95 %ULCI =  $0.02$ ) on consumer adoption intentions for the FOPLs. Importantly, the serial indirect effect was significantly different from zero for the attitude ( $ab = -0.14$ ,  $[SE] = 0.04$ ; 95 %LLCI =  $-0.23$ , 95 %ULCI =  $-0.07$ ) and the adoption intentions ( $ab = -0.16$ ,  $[SE] = 0.05$ ; 95 %LLCI =  $-0.28$ , 95 %ULCI =  $-0.07$ ).

The results show that, compared to NutriInform Battery, Nutri-Score reduced perceived congruence, which decreased perceived credibility, subsequently negatively affecting consumer attitude and adoption intention toward the FOPLs (Fig. 3 and Fig. 4).

### 5. Study 3. The underlying mechanism of consumer response to FOPL when compared with scientific knowledge

Study 3 aimed first to confirm the effect of directive FOPLs in generating CNI when shown to consumers in the presence of scientific information. Scientific information included in the stimuli were based on the content present in extant academic literature (e.g., Podadera-Herreros et al., 2022; Galvão Cândido et al., 2018; Owen et al., 2000), which remained consistent in both tested conditions. The study then explores the underlying mechanism and compares the impact of combining information derived from different Nutritional Labels (Nutri-Score vs. NutriInform Battery) with scientific evidence on consumers' perceived congruence, credibility, and attitudinal and behavioural responses.

#### 5.1. Methods

We conducted an online experiment with a sample of 139 participants recruited through Prolific ( $M_{age} = 36.84$ ,  $SD = 8.69$ ; 31.7 % female) with the same criteria as the pre-test. Respondents were informed that the study is about FOPLs, were randomly assigned to one of the two conditions (i.e., Nutri-Score combined with scientific evidence and NutriInform Battery combined scientific evidence), and engaged in an evaluation task after looking carefully at both the scientific evidence and the product label. We then measured on a 7-point Likert scale (see Fig. 2): we measured perceived congruence with three items measured (1="Strongly disagree", 7="Strongly agree"; Rifon, Choi, Trimble, & Li, 2004;  $\alpha = 0.70$ .); perceived credibility of the label with three items (Block & Keller, 1995;  $\alpha = 0.80$ ); attitude towards the label with three items (Burnkrant & Unnava, 1995;  $\alpha = 0.94$ ); adoption intention of Front-of-Pack Nutritional Label (Mazzù, Baccelloni, et al., 2022;  $\alpha = 0.89$ ).

### 5.2. Results

Nutri-Score combined with scientific evidence showed significantly lower results than the ones of NutriInform Battery combined with scientific evidence in terms of *Perceived congruence* ( $M_{NIB} = 4.84$ ,  $SD_{NIB} = 1.09$  vs.  $M_{NS} = 4.40$ ,  $SD_{NS} = 1.03$ ,  $t(137) = 2.46$ ,  $p = 0.02$ ; Cohen's  $d = 0.42$ ). *Perceived Credibility* ( $M_{NIB} = 5.51$ ,  $SD_{NIB} = 0.96$  vs.  $M_{NS} = 4.92$ ,  $SD_{NS} = 1.27$ ,  $t(137) = 3.07$ ,  $p < 0.01$ ; Cohen's  $d = 0.52$ ). *Attitude towards Front-of-Pack Nutritional Label* ( $M_{NIB} = 5.69$ ,  $SD_{NIB} = 1.04$  vs.  $M_{NS} = 4.67$ ,  $SD_{NS} = 1.42$ ,  $t(137) = 4.83$ ,  $p < 0.01$ ; Cohen's  $d = 0.82$ ). *Adoption intention for Front-of-Pack Nutritional Label* ( $M_{NIB} = 4.71$ ,  $SD_{NIB} = 1.33$  vs.  $M_{NS} = 4.25$ ,  $SD_{NS} = 1.41$ ,  $t(137) = 2.01$ ,  $p = 0.05$ ; Cohen's  $d = 0.34$ ).

*Serial mediation Analysis.* The mediation model was run with PROCESS macro for SPSS (Model 6; Hayes, 2017), with Front-of-Pack Nutritional Label types (NutriInform Battery combined with scientific evidence = -1, Nutri-Score combined with scientific evidence = 1) as the independent variable, the perceived congruence between the scientific knowledge and Front-of-Pack Nutritional Label types, and perceived credibility as the mediators, and attitude and adoption intention as the dependent variables. The serial mediation analyses are reported below (Fig. 5 and Fig. 6). We used bootstrapping to generate a 95 % confidence interval around the indirect effects of perceived congruence and credibility, as well as the indirect effect through both mediators in a serial order, where mediation occurs if the confidence interval excludes zero (Hayes, 2018).

The analysis (5,000 bootstrap samples) revealed a significant indirect effect for perceived congruence ( $ab = -0.12$ ,  $[SE] = 0.06$ ; 95 %LLCI =  $-0.25$ , 95 %ULCI =  $-0.03$ ), and credibility ( $ab = -0.09$ ,  $[SE] = 0.04$ ; 95 %LLCI =  $-0.19$ , 95 %ULCI =  $-0.01$ ) on attitude towards the FOPL; a significant indirect effect for perceived congruence ( $ab = -0.12$ ,  $[SE] = 0.05$ ; 95 %LLCI =  $-0.22$ , 95 %ULCI =  $-0.03$ ), and credibility ( $ab = -0.08$ ,  $[SE] = 0.04$ ; 95 %LLCI =  $-0.18$ , 95 %ULCI =  $-0.01$ ) on consumer adoption intentions toward the FOPL. Moreover, the serial indirect effect was significantly different from zero for the attitude ( $ab = -0.04$ ,  $[SE] = 0.02$ ; 95 %LLCI =  $-0.09$ , 95 %ULCI =  $-0.01$ ) and the adoption intentions ( $ab = -0.04$ ,  $[SE] = 0.02$ ; 95 %LLCI =  $-0.08$ , 95 %ULCI =  $-0.01$ ).

The results show that, compared to the NutriInform Battery, Nutri-Score leads to a reduction of perceived congruence when combined with scientific evidence. This decreased congruence will then affect perceived credibility, attitude, and adoption intention towards the FOPLs.

### 6. General discussion

Consumers are increasingly relying on nutritional information in their food selection toward healthier dietary habits. The presence of multiple different sources, easily accessible via multiple media channels,

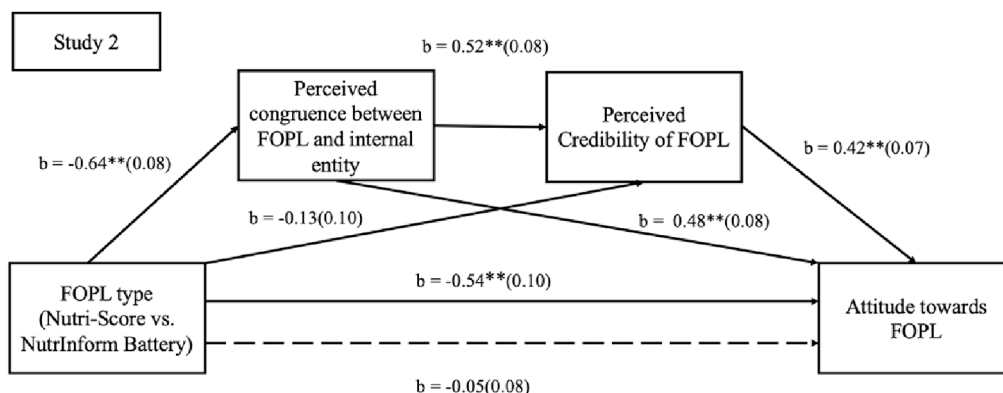


Fig. 3. Serial mediation model on attitude toward FOPL.

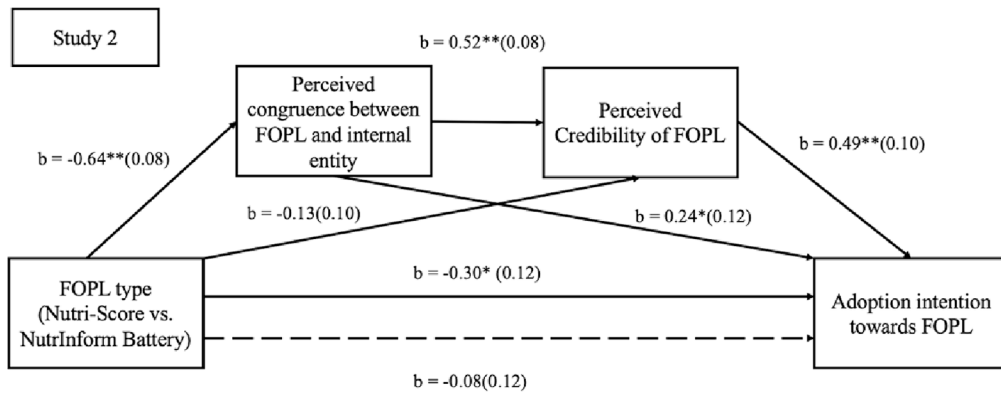


Fig. 4. Serial mediation model on adoption intention toward FOPL.

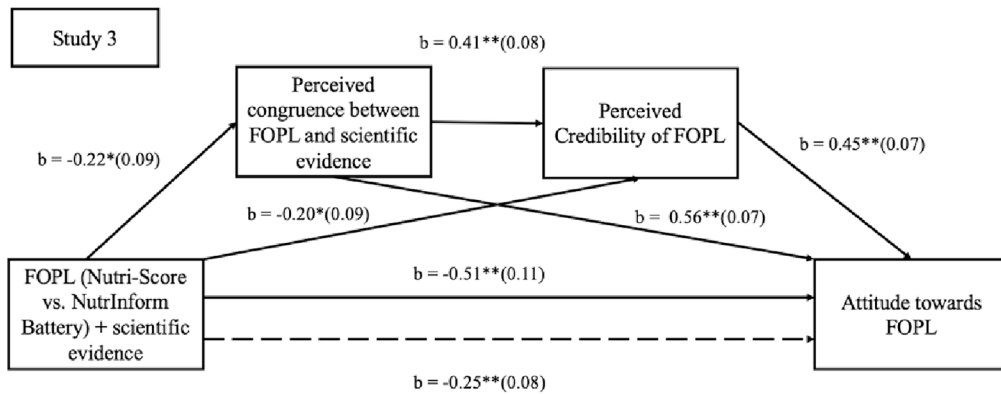


Fig. 5. Serial mediation model on attitude toward FOPL.

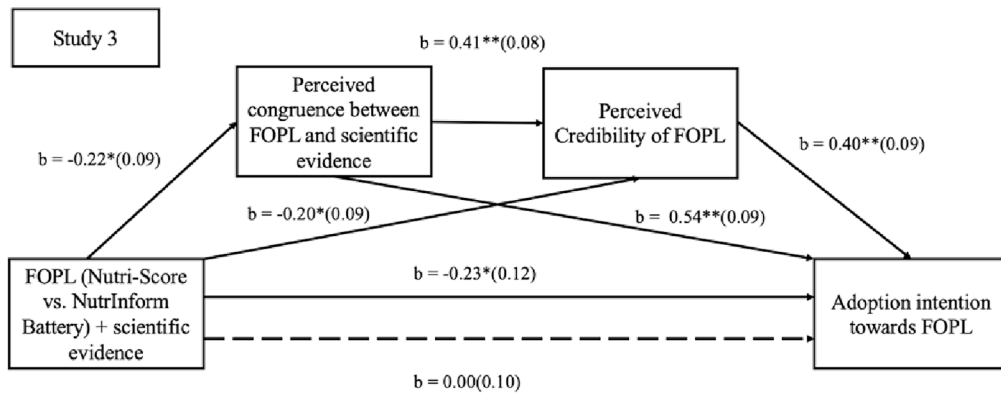


Fig. 6. Serial mediation model on adoption intention toward FOPL.

generates an overload of information, sometimes conflicting, with the risk of yielding adverse consequences for the appropriateness of food selection by consumers (Hong, 2023; Ngo et al., 2023; Nagler et al., 2022).

In markets where Front-of-Pack Nutritional Labels have been introduced, they are a key source of information for customers to gauge the nutritional value of their food purchases. The push for a standardized Nutritional Label across the European Union presents a chance to make the widespread nutritional information available for consumers. This holds the potential for policymakers to offer explicit guidelines for promoting health-conscious food consumption.

In fact, while the previous literature predominantly compared the advantages of different types of FOPLs in instructing consumers toward healthy eating, both cognitively and behaviorally (Dubois et al., 2021;

Grunert & Wills, 2007), the potential harm that FOPLs can bring remains scant in the literature. Moreover, as existing literature (Mauri et al., 2021; Ikonen et al., 2020) predominantly evaluated the immediate and isolated impacts of different types of labels in shaping perceptions of food healthiness and the consequent formation of attitudes and behaviors (Mazzù et al., 2023) we propose that these labels should be viewed as integral components within a broader nutritional information system. The system entails interactions with various sources of information, such as nutritional information from scientific reports, consumers' pre-existing nutritional knowledge, as well as data and opinions available on internet from sources that might be judged as credible by consumers, even in absence of scientific backing.

Delving into the underlying mechanism, our research, by using the case of olive oil, a product characterized by the presence of conflicting



nutrition information from different sources, draws on the congruity theory and endeavors to unveil the backfire effects that FOPL could get entangled as a component of conflicting nutrition information.

Anchored in the comparative congruity model (Maille & Fleck, 2011), the research analyzes the perceived congruence – a vital explanatory mechanism shaping consumer perceptions, attitudes and behaviors – across dual information entities, investigating the cases of the external-external congruity between entities (i.e., nutritional information available from FOPLs and scientific reports), and the external-internal one (i.e., nutritional information available from FOPLs and from consumers' pre-existing nutritional knowledge). We focused our investigation on the comparison of the effects between directive Nutritional labels (Nutri-Score) and non-directive/neutral (NutriInform Battery), supporting the evidence that different types of Front-of-Pack Nutritional Labels generate different levels of perceived congruence.

Our empirical results therefore offer policymakers a cautionary perspective in terms of sustaining the credibility and encouraging consistent utilization of mandatory FOPLs. More specifically, Study 1 shows that, compared to the condition without FOPL exposure, a combined exposure of directive FOPL and another entity, either internal or external entity, leads to the generation of CNI. On the other hand, CNI does not emerge when participants are exposed to the combination of non-directive FOPL and another entity. In study 2, we examine the underlying mechanism and report that when consumers assimilate the nutritional information from the Front-of-Pack Nutritional Label into their internal entity (i.e., pre-existing knowledge about olive oil), the Nutri-Score, compared with NutriInform Battery, leads to a reduction of perceived congruence between the label information and their pre-existing nutritional understanding. This decreased congruence subsequently contributes to the diminishing effects on the perceived credibility of the FOPL, which in turn decreases consumers' favorable attitudes and adoption intention towards FOPL. Complementarily, the results of Study 3 show that "Nutri-Score combined with scientific evidence", compared with "NutriInform Battery combined with scientific evidence," decreases perceived congruence, which then decreases consumers perceived credibility of Front-of-Pack Nutritional Label and consumers' attitude and adoption intention towards the FOPL. While prior investigations predominantly concentrated on the effects of the nutritional label in isolation, with limited exceptions such as the examination of the combined effects of distinct types of labels (Mazzù, Marozzo, et al., 2023), nutritional labels alongside health claims (Garretson & Burton, 2000), and FOPL paired with influencer posts (Sicilia, López, & Palazón, 2023), this study extends the exploration of combined nutritional information effects of labels and scientific reports.

Study 2, combined with study 3, empirically examined the comprehensive comparative congruence framework (Maille & Fleck, 2011), showing that the congruence effect is activated in both external-external and external-internal entity comparison and indicating that consumers find Nutri-Score less congruent when combined with nutritional information from the pre-existing nutritional knowledge or scientific reports about the healthiness of olive oil. Additionally, the studies emphasize the causal influence of a reduced level of perceived congruence, leading to a decrease in perceived credibility, attitudinal and further adoption intentions towards FOPLs in the case of olive oil. Despite the recent update to the Nutri-Score algorithm adjusting the scoring levels for olive oil (Sarda et al., 2024), the olive oil available on shelves still ranks at a lower healthiness level. This overtime discrepancy in healthiness ratings for the same product (i.e., olive oil) from the same FOPL source, complemented by a misalignment with the scientific and perceived knowledge of consumers, may pose risks of credibility backlash. Furthermore, comparative graphs of product distribution in various countries show that the adoption of the new algorithm presents a shift in nutritional evaluation (Aesan, 2022), potentially leading to new misalignments. As in the Dutch case, the updated FOPL presents a 19 % misinterpretation of healthy foods as unhealthy and a 25 % error in evaluating unhealthy foods as healthy, in categories such as cheese, solid milk products, fish,

potatoes, and tubers (Gerritsen, Verhagen, & Peters, 2024).

While this paper has introduced a novel perspective by considering Nutritional Labels as vital constituents within the broader nutritional information system, it presents several limitations. Firstly, it explores the case of olive oil, a typical daily dietary ingredient renowned for being perceived as healthy both in scientific literature and public attention, where the incongruence information from directive FOPL can decrease the general label credibility of the category. While in terms of generalizability, the same mechanism might be replicated on other products considered healthy from a part of scientific literature, such as some dairy products (Thorning et al., 2016; Lorenzen & Astrup, 2011), dark chocolates (Lippi, Franchini, Montagnana, Favaloro, Guidi, & Targher, 2009; Araujo, Gattward, Almoosawi, Silva, Dantas, & Araujo Júnior, 2016) or specific cheeses as parmesan (Summer et al., 2017), more research should be developed to explore other food categories to understand potential differential effects.

Furthermore, this research also tests congruity effects on countries that were not exposed to Nutritional Label. Future research might then examine the impact of previous usage of nutritional labels in influencing the perception of conflicting nutrition information with other sources. The research also does not analyze the potentially different impacts as a function of the type of external sources utilized, including social media, mass media, recommendations from peers and family members, and more. Future research could also explore how Front-of-Pack Nutritional Labels interact with these sources and analyze the impact of different socio-demographics on the perceived trust of different sources.

## 7. Conclusion

While Front-of-Pack Nutritional Labels have the potential to be a relevant guiding factor in directing consumers towards healthier food choices, they pose the risk of being entangled in conflicting nutrition information. As an integral component within the nutritional information system, different Nutritional Labels present different congruity effects, accounting for the underlying mechanism of the emergence of CNI when FOPL is in combination with another entity (either internal or external entities of nutritional information). Across the experiments conducted in this research, the results of study 1a and study 1b confirmed hypothesis 1 by reporting that directive FOPL, when compared with either consumer knowledge of the healthiness of olive oil or scientific information about olive oil, generate CNI, rather than non-directive FOPL. Study 2 and study 3 confirmed hypothesis 2 and hypothesis 3 by revealing the underlying mechanism of the emergence of CNI in the olive oil FOPL exposure process and suggesting that directive labels, such as the Nutri-Score, compared to non-directive labels, like the NutriInform Battery, reduce perceived congruence, and perceived credibility of FOPL, when interacting with other nutritional information, either from scientific reports (representing external entity) or consumers' pre-existing nutritional information (representing internal entity). Policymakers should then further consider the impact of diverse Front-of-Pack Nutritional Labels within a more comprehensive communication environment.

## CRedit authorship contribution statement

**Marco Francesco Mazzù:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Resources, Project administration, Methodology, Investigation, Funding acquisition, Conceptualization. **Jun He:** Writing – review & editing, Writing – original draft, Visualization, Software, Methodology, Formal analysis, Data curation, Conceptualization. **Angelo Baccelloni:** Writing – review & editing, Visualization, Validation, Software, Investigation, Formal analysis, Conceptualization.

## 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.

## Data availability

The data that has been used is confidential.

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