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How a food scanner app influences healthy food choice☆,☆☆

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ABSTRACT

The use of mobile applications to assist with food decision making has increased significantly. Although food scanner applications provide nutritional information to consumers in the marketplace, little is known about their effects on users' intentions and behavior. This research investigates whether a mobile food scanner app can influence consumers toward healthier food choices. Four studies tested whether information displayed through a food scanner app (as opposed to no information or front-of-packaging label information) influenced purchase intentions for food products (Studies 1–3) or led consumers to make healthier food choices (Study 4). Application-provided information enhanced hypothetical choice and purchase intentions of healthy products in comparison no information, but it did not influence real behavior when participants made choices in an experimental supermarket. Information provided through a food scanner app was systematically outperformed by front-of-packaging label information.

1. Introduction

The rise of global obesity (World Health Organization, 2018) and increasing consumer demand for information (Verma & Yadav, 2021) have prompted the development of various strategies to educate consumers about the nutritional quality of food products. These strategies include the use of back-of-pack nutrition facts panels, front-of-pack (FOP) nutrition labels (e.g., Ikonen et al., 2020), and mobile applications providing food product nutritional information (Food and Drug Administration, 2017; Pigeyre et al., 2017). Over the last two decades, the technology and the usage of crowdsourcing databases (i.e., user populated databases where consumers enter products and their respective nutritional information) have facilitated the introduction of food scanner apps into the market (Maringer et al., 2019). These apps are designed to promote healthier food choices by allowing shoppers to scan barcodes of packaged foods to receive instant nutritional information while shopping. Countries like UK and Australia, health institutes, and private companies have also invested significant efforts in developing these technologies (Devlin, 2022). Just the three apps FoodSwitch, Yuka, and the UK NHS Food Scanner are used in more than 20 countries and are often presented as a strategy to inform consumers and promote healthier choices (Mottas et al., 2021; Siegrist & Hartmann, 2020). Consumers value these apps because they provide access to food information, enabling knowledge acquisition, and increasing control over food decisions (Ahmed et al., 2020; Gauthier & Bally, 2024). While these food scanner apps position themselves as health-oriented (e.g., "Make the good choice for your health" is the slogan of Yuka, the most downloaded food scanner app with 40 million users worldwide, BPI, 2023), to our knowledge, there is limited empirical evidence for their effect on behavioral outcomes (Ljusic et al., 2022; Werle, Nohlen, & Pantazi, 2022). The main objective of this research is to investigate if food scanner applications influence consumers' decisions regarding food products in grocery shopping situations.

Consumers can assess the nutritional quality of food products through different means, such as labels or digitalized apps. Research on FOP labels, for example, suggests that food labels have a small but positive impact on consumers' food choices (e.g., Dubois et al., 2021; Ikonen et al., 2020; Werle, Pruski Yamim, et al., 2022). Research on food scanner apps demonstrate that such apps can influence consumers' beliefs and attitudes about healthy eating, increasing self-efficacy and nutritional knowledge (Abao et al., 2018; Juan et al., 2019; Samoggia & Riedel, 2020). While food scanner apps leverage the connectivity and

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interactivity of apps in the marketplace to provide nutritional information, assessing whether they lead to enhanced purchase intentions for healthy products and healthier food choices is crucial. This research investigates how a food scanner app influences consumers in comparison to (a) no information and to (b) information displayed through front-of-packaging (FOP) nutrition labels.

First, it is essential to compare information provided through food scanner apps to no information to verify their effectiveness *per se*. This comparison contributes to the on-going debate about nutritional information apps' effectiveness (Lim et al., 2021; Palacios et al., 2018; Porter et al., 2016). Specifically, while recent research investigating apps to promote healthier food choices suggests positive effects (e.g., Abao et al., 2018; Juan et al., 2019; Samoggia & Riedel, 2020), literature findings have been mixed regarding the extent to which mobile apps can change behavior (e.g., Lim et al., 2021). We predict that information from a food scanner app will lead to increased purchase intentions for healthy products and to healthier food choices in comparison to no information, simply because exposure will enhance attention and consideration of nutritional information when making choices. Second, comparing app-provided nutritional information to FOP labels is important, as the latter are increasingly promoted and adopted (e.g., Ikonen et al., 2020). FOP labels enhance healthy choices when simplified and presented in an evaluative system (e.g., Newman et al., 2016; Werle, Pruski Yamim, et al., 2022). Notably, FOP labels are more effective when they provide simple information than when too detailed (Dubois et al., 2021). We thus propose that FOP label information will be more influential than information provided through a food scanner app because the latter is more detailed than the former and thus should be harder to process (Newman et al., 2016). In addition, food scanner apps provide information about one food product at a time and comparing the information from one product to another requires repeated actions from consumers (scanning multiple bar codes), making the products harder to compare. Individuals are influenced not only by information content but also by the subjective experiences of processing this information (Schwarz, 2004). Prior work showed that facility in processing nutritional information positively influences food products' evaluations resulting in higher purchase intentions (Gomez et al., 2017). Therefore, we predict that nutritional information provided though food scanner apps will be less effective to influence healthier choices than FOP labels.

2. Conceptual background

2.1. FOP labels, food scanner applications and consumer behavior

To fight the obesity epidemic, many strategies have been implemented to provide nutritional information in more understandable formats that facilitate consumers' choice of healthier diets. Authorities worldwide promote the use of FOP labels to display nutritional information (Regulation EU, 2011) and there is a plethora of research investigating their effectiveness (e.g., Campos et al., 2011; Cowburn & Stockley, 2005; Dubois et al., 2021; Grunert & Wills, 2007; Ikonen et al., 2020). While some studies suggest that consumers perceive FOP labels to be less useful (André et al., 2019), Ikonen et al. (2020)'s meta-analysis shows that they can help consumers identify healthier food options. To be effective, nutritional information displayed through FOP labels needs to be easy to understand and simplicity is key to increase their performance (Dubois et al., 2021). Evaluative FOP labels that are easy to understand have been shown to be more effective in comparison to complex (Cadario & Chandon, 2020) and to oversimplified labels (Werle, Pruski Yamim, et al., 2022).

Although FOP labels have the potential to influence consumers in different settings, it remains important to investigate how alternative means of providing nutritional information, such as food scanner applications change the way consumers behave (Shankar et al., 2016). The use of food mobile applications is an emerging trend in providing nutritional information, and it allows consumers to access multiple pieces of product information (e.g., calories, allergens, synthetic compounds) just by scanning a bar code. There is some initial evidence suggesting its effectiveness. For example, Aulbach et al. (2021) demonstrate that an app presenting a green or a red border around the images of healthy and unhealthy food products respectively influenced consumers' food intake, reducing unhealthy and increasing healthy food consumption. However, Mathisen and Johansen (2022) found no real effect of the food mobile app when evaluating its impact on diet quality. We aim to contribute to this prior work by focusing on a particular type of food mobile application, the food scanner app providing nutritional information.

2.2. Emerging research on food scanner apps

There are a plethora of food mobile applications available in the market (e.g., Flaherty et al., 2019), including food delivery services such as UberEats or Toast takeout, weight control apps such as LoseIt! or MyFitnessPal, and recipe apps like Tasty or Yummly. The present research focuses on one particular type of food mobile apps: those that offer consumers nutrition information by scanning the barcode on food product packaging. This type of app can be easily used in the marketplace while grocery shopping, providing direct access to nutrition information.

Previous research highlighted the capacity of food scanner apps to shape consumers' attitudes and purchase intentions (Abao et al., 2018; Anin & Helme-Guizon, 2020; Juan et al., 2019; Samoggia & Riedel, 2020). For instance, Abao et al. (2018) show that an app combining augmented reality and visual analysis of products to support consumer choices significantly increased the likelihood of users choosing the healthiest food options, when selecting from a variety of 10 product categories. Similarly, Juan et al. (2019) reported that an augmented reality app focused on carbohydrates improved participants' nutritional knowledge. In the same sense, Samoggia and Riedel (2020) showed that the use of a nutrition information app (app that reads product labels, assesses the quality of ingredients and nutritional values based on users' personal data, and recommends healthier food alternatives) for 12 weeks increased self-efficacy for healthy eating among Italian consumers. Specifically, app use decreased the perception of the barriers to healthy food eating and increased the perceived personal strength in approaching healthy food. These findings suggest that food scanner apps influence consumers' attitudes and beliefs, however less is known about how they influence food choice. Furthermore, there is little research comparing food apps to other existing means to provide nutritional information to consumers, such as FOP labels. Eyles et al. (2017) in a randomized controlled trial conducted in New Zealand tested a smartphone application that enables shoppers to scan the barcode of a packaged food and receive an immediate, interpretive, traffic light nutrition label on the screen, along with suggestions for lower salt alternatives (SaltSwitch App). They found that the app's usage for four weeks reduced household purchases of salt from packaged foods, suggesting that food scanner apps can influence consumer behavior in the marketplace. However, a systematic review on digitalized labels (technology enabled labels and interactive labels such as food scanner apps) impact on consumer behavior, shows little effects on healthy behavior (Ljusic et al., 2022).

Whether food scanner apps influence behavior is important because their impact depends on consumers' actions. Exposure to nutritional information through a mobile app requires the willingness to stop during shopping, take out the phone, and actively scan the product's bar code (Soutjis, 2020). This process is effortful and may be challenging to accomplish in a grocery shopping context (Li & Messer, 2019). From a processing fluency perspective (Schwarz, 2004), how we process information influences our attitude toward the evaluated object. Therefore, if a lot of effort is required to access nutritional information through a food scanner app, the information might have less effect, particularly when compared to FOP labels that provide immediately available nutritional information. At the same time, scanning the bar code and checking the product's nutritional information through a mobile app can make the action of reading nutritional information more pleasant and increase users' engagement with the activity (Gauthier & Bally, 2024). Therefore, it is important to investigate how food scanner applications influence consumers' decisions regarding food products in grocery shopping situations in comparison to no information, but also to information displayed through FOP labels.

We investigate this question with four studies. Study 1 tests how information displayed through a food scanner app influences the hypothetical choice of food products varying in nutritional quality. It shows that information displayed through a food scanner app led participants to make more healthy choices and less unhealthy ones compared to no information, but was outperformed by a FOP label. Study 2 replicates these effects when two food products are selected sequentially. Study 3 explored how information displayed through a food scanner app differentially impacts healthiness perceptions and purchase intentions of healthy and unhealthy products of the same product category. Results show that information displayed through a food scanner app increased purchase intentions for the healthiest product in the set but did not decrease purchase intentions for the unhealthiest one. Again, the food scanner app was outperformed by FOP labels. Finally, study 4 tests how information displayed through a food scanner app influences the real choice of food products (cereal/chocolate bars) varying in nutritional quality inside an experimental supermarket. In this realistic context, the use of a food scanner app did not influence purchase behavior in comparison to no information (control), while FOP labels increased the choice of healthier alternatives.

3. Method

3.1. *Study 1 - The impact of a food scanner app on hypothetical product choice*

Study 1 aims to investigate if the information displayed through a food scanner app influences consumers' choice of food products varying in healthiness. We expect that consumers receiving nutritional information through a food scanner app will choose healthier options compared to no information (control). However, we expect that the food scanner app information will be outperformed by FOP label information that is immediately available in the product packaging, facilitating products comparison. Using an adapted procedure from prior research testing the impact of FOP labels on food choices (Newman et al., 2016; Werle, Pruski Yamim, et al., 2022), this study aims to mimic consumers' experience of selecting food products that vary in nutritional quality while also simulating the experience of looking at a phone screen as characterized by the usage of food scanner apps (Ljusic et al., 2022; Samoggia & Riedel, 2020).

3.1.1. *Participants and procedure*

Six-hundred sixteen workers of a French online panel ($M_{age} = 47.48$; 57.1% Females) participated in this one-factor three-level (type of information: food scanner app vs FOP label vs no information—control) between-subjects experiment in exchange for a monetary reward. Participants saw a set of five potato chips varying in nutritional quality. In the scanner food app condition, we presented a picture of a smartphone screen with the product's nutritional information displayed in a food scanner app under each product's image. This procedure was used to mimic consumers' experience of visualizing the nutritional information while grocery shopping and using their mobile phones. We displayed information as it appears in the food scanner app named Yuka. We selected this app because it is well-known in France and used by more than 40 million users in 12 countries (BPI, 2023). The app displays nutritional information about the product using a score ranging from 0 (the unhealthiest score, presented in red) to 100 (the healthiest score, presented in green). This score is based on the product's nutritional quality (60%), presence of additives (30%), and organic status (10%). The product score relies on the crowdsourcing database Open Food Facts, which is obtained by scanning each product's barcode. In addition to a general score, the app also presents the main product qualities and defaults (e.g., high in calories, salt, fat, sugar, fiber, and proteins) with separate color-based grades for attributes. For the FOP label condition, we used the Nutri-Score, a labelling system created by the French public health agency, adopted nationally in 2017 on a voluntary basis, and also implemented in several other countries after that date. The Nutri-Score system assigns products a grade ranging from A to E, where A is the healthiest option in dark green and E the unhealthiest one, in dark orange. The Nutri-score is based on the nutritional quality rating scale proposed by the British Food Standards Agency (FSA), which considers in its calculation the amount of energy, saturated fat, sugar, protein, salt, fiber, as well as percentage of fruits and vegetables present in 100 g (g) of a product. The FSA score varies from -15 (healthiest product) to +40 (least healthy product). The FSA score is a continuous indicator of the nutritional quality of foods that has been validated in the French context (Ducrot et al., 2016). The entire Nutri-score scale, with the product respective color and letter highlighted, is displayed on the label. In the FOP label and the food scanner app conditions, the nutritional information for each product was presented under the packaging. No additional information about the products was presented in the control condition (see Fig. 1). Before viewing the set of five products, participants read a short paragraph explaining the respective nutritional information (food scanner app or Nutri-Score) or informing that food products vary in nutritional quality (control). This reading task was included to explain the means used to display nutritional information but also to ensure that all experimental conditions received a similar briefing. After seeing the set of five products, participants were required to choose one of them as if they were in a supermarket and buying it for themselves (i.e., "Imagine you are in the supermarket buying a few items. Which of the chips below would you be most willing to buy?"). Participants then answered our manipulation checks to assess exposure to a mobile application (i.e., "The product's nutritional information was presented with a cell phone application.") and presence of a nutritional label (i.e., "The nutritional information of the products was presented with a label."), both measured in 7-points scales anchored strongly disagree and strongly agree. Finally, we measured demographics (age, gender). Our key dependent variables were the frequency of choice of the products, as well as the energy density and the Food Standard Agency (FSA) score of the chosen product.

3.1.2. *Results*

3.1.2.1. *Manipulation check.* We first tested whether our manipulations worked. There was a significant effect of the condition on participants' perception of receiving information through a nutritional label ($F(2,586) = 8.505$, $p < 0.001$) and through a mobile app ($F(2,586) = 77.293$, $p < 0.001$). Results show that participants in the food scanner app condition reported receiving the information through a mobile app application more ($M_{\text{Food scanner}} = 5.54$) than participants in the control ($M_{\text{control}} = 3.57$, $p < 0.001$) and FOP label ($M_{\text{FOP label}} = 3.64$, $p < 0.001$) conditions. We found no difference between the FOP label and control conditions ($p = 0.721$). Also, participants in the FOP label condition reported receiving the information through a nutritional label more ($M_{\text{FOP label}} = 5.00$) than participants in the control ($M_{\text{control}} = 4.33$, $p < 0.001$) and food scanner ($M_{\text{Food scanner}} = 4.54$, $p = 0.006$) conditions. We found no difference between the food scanner and control ($p = 0.187$). These findings confirm that our manipulations worked.

3.1.2.2. *Products choice.* To assess the impact of information type on product choice, we ran a chi-square analysis comparing the product choice frequency per grade, depending on condition (food scanner app vs FOP label vs control), see Table 1. Results show a significant effect of

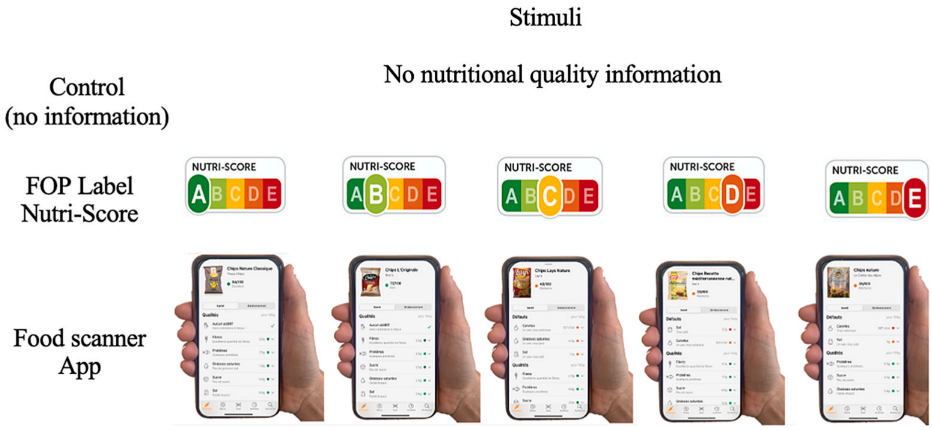

Fig. 1. Stimuli for study 1.

Table 1
Percentage of choice per nutritional quality grade depending on type of nutritional information displayed (study 1).

	Healthy products		Neutral		Unhealthy products
	A	B	C	D	E
Food scanner app	51 (25%)[a,b]	77 (37.7%)	45 (22.1%)	45 (10.8%)[b]	9 (4.4%)[a]
FOP label	69 (38.5%)[b,c]	60 (33.5%)	37 (20.7%)[c]	11 (6.1%)[b,c]	2 (1.1%)[c]
Control	12 (5.8)[a,c]	57 (27.5%)	67 (32.4%)[c]	40 (19.3%)[c]	31 (15.0%)[a,c]

[a] Reflects a statistically significant difference between the Food scanner app and the control conditions.
[b] Reflects a statistically significant difference between the FOP label and the Food scanner app conditions.
[c] Reflects a statistically significant difference between the FOP label and the control conditions.

condition on the frequency of choice of the products varying in healthiness (χ^2 (1) = 99.949, $p < 0.001$). Participants exposed to the food scanner app condition selected the healthiest option more often (25%) than those in the control (5.8%, $p < 0.05$), but less than those exposed to the FOP label (38.5% $p < 0.05$). Participants who saw the FOP label also selected the healthier option more often than those in the control group. In the same sense, participants exposed to the food scanner app selected the unhealthiest option less often (4.4%) than those who received no nutritional information (15%, $p < 0.05$), but not differently than those exposed to the FOP label (1.1%, $p > 0.05$). Participants who saw the FOP label also selected the unhealthiest option less often than those in the control condition ($p < 0.05$).

3.1.2.3. Energy density and FSA score of the product chosen. We also tested whether the influence of type of information on participants' choice reflected in products with different energy density and FSA score. To do so, we conducted two separate ANOVAs entering the condition (food scanner app vs FOP label vs control) as an independent factor predicting energy density and FSA score of the product chosen. Results show a significant effect of the type of information on energy density (F (2, 587) = 20.909, $p < 0.001$). The average energy density of the chosen product was inferior among participants who saw the nutritional information from the food scanner app (M = 509.9, SD = 33.5) in comparison to control (M = 521.5, SD = 27.7, $p < 0.001$), but was higher than those exposed to the FOP label (M = 500.5, SD = 35.0, $p = 0.004$). We also found a significant difference between the FOP label and the control conditions ($p < 0.001$).

We find a similar pattern on results for the FSA score. Results show a significant effect of the type of information on the average FSA score of the product chosen (F (2, 587) = 52.051, $p < 0.001$). The FSA score of the chosen product was lower (reflecting higher nutritional quality) among participants who saw the nutritional information from the food scanner app (M = 3.8) in comparison to control (M = 6.3, $p < 0.001$). The FSA score was however higher in the food scanner app condition than in the FOP label condition (M = 2.6, $p = 0.001$), suggesting that the FOP label led to more healthy choices than the food scanner app. We also found a significant difference between the FOP label and the control conditions ($p < 0.001$).

3.1.3. Discussion

Study 1 findings demonstrate that providing nutritional information via a food scanner app led participants to make more healthy choices and less unhealthy choices compared to no information. These results provide initial evidence that the usage of food scanner apps can have an effective impact on consumers' behavior, here in a hypothetical purchasing decision in which consumers are exposed to the nutritional information of all food products simultaneously. However, this study also demonstrates that nutritional information provided via a FOP label like the Nutri-Score outperforms food scanner app information, both increasing healthy choices and decreasing unhealthy ones.

Study 1 focused on only one product category and participants were asked to make only one choice. We designed study 2 to complement these findings by testing the effect of nutritional information provided through a food scanner app on the choice of products from two product categories.

3.2. Study 2 - The impact of a food scanner app on sequential product choices

Study 2 aims to investigate the impact of the type of nutritional information when consumers make more than one food choice. Specifically, in this study, consumers were asked to choose two products: one from the potato chip category and one from the cereal/chocolate bar category. Similarly to study 1, we expect that consumers receiving nutritional information through a food scanner app will choose healthier options in comparison to no information, but the food scanner app information will be outperformed by the FOP label.

3.2.1. Participants and procedure

One-hundred-fifteen undergraduate students (M_{age} = 22.03; 50.4% Males) participated in this one-factor three-level (type of information: food scanner app vs. FOP label vs. no information—control) between-subjects experiment in exchange for course credit. Participants were randomly assigned to one of the three conditions. The procedure was exactly the same as for study 1, except that participants were asked to make two different choices: they selected a pack of chips out of five options varying in nutritional quality and then they selected a cereal bar out of five options varying in nutritional quality. Finally, participants completed demographic information, were thanked, and debriefed. Our key dependent variables were the frequency of choice of each product, but also the energy density and the FSA score of the basket composed of the two products chosen.

3.2.2. Results

3.2.2.1. Product choice of chips. To assess the impact of information type on product choice, we ran a chi-square analysis comparing the product choice frequency per grade, depending on condition (food scanner app vs FOP label vs control), see Table 2 for detailed report of comparison between conditions. Results show a significant effect of condition on the frequency of choice of the products varying in healthiness (χ^2 (1) = 28.801, $p < 0.001$). We found no difference between conditions on the frequency of the healthiest option, but we do find a difference regarding the choice of the unhealthiest options in the set. Participants exposed to the food scanner app condition selected the unhealthiest options less often (choice frequency of products D = 2.7% and E = 0%) than those in the control (product D = 17.9%, product E = 15.4%, both p's < 0.05). Participants in the FOP label also selected less unhealthiest products (0% for products D and E, $p < 0.05$) than control.

3.2.2.2. Product choice of cereal bar. A chi-square analysis comparing the product choice frequency per grade shows a significant effect of condition on the frequency of choice of the products varying in healthiness (χ^2 (1) = 22.950, $p = 0.003$). We find no difference between participants exposed to the food scanner app (16.2%) and those in the control condition on how frequently they selected the healthiest item (23.1%, $p > 0.05$). However, participants exposed to the FOP label selected the healthiest product more often (51.3%) than those in the control condition ($p < 0.05$), and those in the food scanner app condition ($p < 0.05$). Participants who saw the FOP label also selected the unhealthiest option less often (12.8%) than those who received no nutritional information (38.5%, $p < 0.05$), but not less than those who saw the nutritional information from the food scanner app (29.7%, $p > 0.05$). We did not find differences between the food scanner app and the control conditions ($p > 0.05$).

3.2.2.3. Energy density and FSA score of the shopping basket. We calculated the average energy density and the average FSA score of the two products chosen to test if the nutritional quality of participant's choices differed between conditions. We conducted two separate ANOVAs entering the type of information (food scanner app vs FOP label vs control) as an independent factor predicting the energy density and FSA score of the shopping basket. Results show a significant effect of the type of information on the average energy density of the basket (F (2, 112) = 3.907, $p < 0.001$). There was no significant difference among those who saw the nutritional information from the food scanner app (M = 457.1, SD = 24.9) and the control condition (M = 467.0, SD = 29.1, $p = 0.123$) nor the FOP label condition ($p = 0.234$). The FOP label, however, led to the choice of a basket with lower energy density (M = 449.5, SD = 28.8) in comparison to the control condition ($p < 0.001$).

We find similar results for the FSA score of the basket. Results show a significant effect of the type of information on the FSA score of the basket (F (2, 112) = 9.098, $p < 0.001$). The FSA score of the basket was marginally lower (indicating higher nutritional quality) when participants saw the food scanner app (M = 4.8, SD = 3.2) in comparison to the control condition (M = 6.5, SD = 4.4, $p = 0.06$). The FOP label however led to an even lower FSA (M = 2.7, SD = 3.9) in comparison to both the food scanner app ($p = 0.023$) and the control conditions ($p < 0.001$).

3.2.3. Discussion

Study 2 findings demonstrate that providing nutritional information via a food scanner app led participants to make less unhealthy choices for the chips compared to no information, but not for the cereal products. However, this study also demonstrates that nutritional information provided via a FOP label like the Nutri-Score outperforms food scanner app information, both increasing healthy choices and decreasing unhealthy ones.

Results regarding the nutritional quality of the basket indicate that the food scanner app did not lead to the choice of a shopping basket with lower energy density. There was a marginal effect when nutritional quality was assessed using the FSA score: nutritional information displayed through the food scanner app led to the choice of a basket with marginally higher nutritional quality in comparison to no information. Again, nutritional information displayed through the FOP label outperformed the food scanner app leading to the choice of a basket with higher nutritional quality when assessed through the FSA score, but not when assessed through energy density.

In studies 1 and 2 we explored how nutritional information delivered through a food scanner app influenced hypothetical food choices. Study 3 complements these findings in two important ways. First, it explores the roles of perception of healthiness. Past work on FOP labels shows that the display of nutritional information changes healthiness perceptions of food products (e.g., Werle, Pruski Yamim, et al., 2022) and this construct mediates the influence of nutritional information on behavioral outcomes. Study 3 thus measures healthiness perceptions to see if

Table 2
Percentage of choice per nutritional quality grade depending on type of nutritional information displayed (study 2).

		Healthy products		Neutral		Unhealthy products
		A	B	C	D	E
Chips	Food scanner app	9 (24.3%)	19 (51.4%)	8 (21.6%)	1 (2.7%)[a]	0 (0%)[a]
	FOP label	6 (15.4%)	28 (71.8%)	5 (12.8%)	0 (0%)[c]	0 (0%)[c]
	Control	4 (10.3%)	18 (46.2%)	4 (10.3%)	7 (17.9%)[a,c]	6 (15.4%)[a,c]
Cereal bar	Food scanner app	6 (16.2%)[b]	4 (10.8%)	14 (37.8%)[a]	2 (5.4%)	11 (29.7%)
	FOP label	20 (51.3%)[b,c]	3 (7.7%)	6 (15.4%)	5 (12.8%)	5 (12.8%)[c]
	Control	9 (23.1%)[c]	3 (12.8%)	5 (12.8%)[a]	7 (17.9%)	15 (38.5%)[c]

[a] Reflects a statistically significant difference between the Food scanner app and the control conditions.
[b] Reflects a statistically significant difference between the FOP label and the Food scanner app conditions.
[c] Reflects a statistically significant difference between the FOP label and the control conditions.

they mediate the effect of type of nutritional information on downstream consequences in the present research. Second, study 3 specifically analyzes the influence of type of nutritional information on the evaluation and purchase intention of the healthiest and the unhealthiest product of the set. This is important because past research showed stronger effects of nutritional information for healthier products (e.g., Zou and Liu, 2019).

3.3. Study 3 - mediation by healthiness perceptions

Study 3 aims to assess how a food scanner app influences consumers' judgments of food products, and consequently, purchase intentions. Specifically, we aim to test if the information displayed through the food scanner app influences consumers' perception of the healthiness of food products, and if these healthiness perceptions then influence purchase intentions. This study also assesses how information displayed through a food scanner app differentially impacts healthiness perceptions and purchase intentions of healthy and unhealthy products of the same product category. Past work on FOP labels showed that their effects are reversed depending on whether consumers evaluate healthy or unhealthy products (Newman et al., 2016; Werle, Pruski Yamim, et al., 2022): FOP labels increased purchase intentions for healthy products but decreased purchase intentions for unhealthy ones. We predict a similar pattern of results for information displayed through a food scanner app: we expect that, in comparison to no information, the food scanner app will be more likely to positively influence participants' healthiness assessments of the healthiest product, and consequently will have a stronger effect on purchase intentions in comparison to the unhealthiest product. Following our previous studies, we also predict that the FOP label Nutri-Score will outperform the food scanner app in influencing consumers' healthiness judgments and purchase intentions.

3.3.1. Participants and procedure

Three-hundred sixty-four workers of a French online panel (M_{age} = 47.48; 57.1% Females) participated in this product evaluation study in exchange for a monetary reward. We adopted a 3 (type of information: food scanner app vs FOP label vs control) by 2 (type of target product: healthiest vs unhealthiest) between-subjects design. Participants saw a set of five options from the same product category (cereal bars), featuring either the food scanner app information, the FOP label information, or no nutritional information. We adopted the same manipulations used in studies 1 and 2. As in past studies, before viewing the set of products, participants read a short paragraph explaining each type of nutritional information or informing that food products vary in nutritional quality (control). After viewing the set of products, participants were asked to assess either the healthiest (graded A in the Nutri-Score) or the unhealthiest (graded E in the Nutri-Score) product of the set. Next, participants indicated their perceptions of the healthiness of the target product with three items (α = 0.879; e.g., "Please consider the nutrition level of the food product shown. Do you believe that the food product is …"; 1 = "not at all healthy," and 7 = "very healthy"; 1 = "not at all nutritious," and 7 = "very nutritious"), as well as purchase intentions with two items (r = 0.968, "About purchasing this product, it is 1 = "very unlikely, and 7 = "very likely"; 1 = "not probable," and 7 = "very probable" that I will do it"). Participants then completed the same manipulation checks as in study 1, as well as demographics (age, gender). The questionnaire also featured an attention check question (i.e., "This question is an attention verification question. To demonstrate that you are reading this questionnaire carefully, please select option 2"). Inattentive participants who failed this question (N = 18) were automatically excluded and not allowed to complete the entire questionnaire.

3.3.2. Results

3.3.2.1. Manipulation check. We first tested if our manipulations worked. There was a significant effect of the participants' perception of receiving the information through a FOP label ($F(2, 361) = 8.190$, $p < 0.001$) and through a mobile app ($F(2, 361) = 127.907$, $p < 0.001$). Participants in the food scanner app condition reported receiving the information through a mobile app application more ($M_{Food\ scanner}$ = 6.12) than participants in the control ($M_{control}$ = 2.81, $p < 0.001$) and FOP label ($M_{Fop\ label}$ = 3.12, $p < 0.001$) conditions. We found no difference between the FOP label and control conditions ($p = 0.172$). Meanwhile, participants in the FOP label condition reported receiving the information through a nutritional label more ($M_{FOP\ label}$ = 5.39) than participants in the control ($M_{control}$ = 4.57, $p < 0.001$) and food scanner app ($M_{Food\ scanner}$ = 4.63, $p < 0.001$) conditions. We found no difference between the food scanner app and control ($p = 0.815$).

3.3.2.2. Perceived healthiness. An ANOVA with type of information (Food scanner app vs FOP label vs control) and type of product (healthiest vs unhealthiest) as the independent variables, predicting perceived healthiness of the target product, reveals a significant interaction between the factors ($F(1, 358) = 24.835$, $p < 0.001$). The main effects of product type ($F(1, 358) = 188.732$, $p < 0.001$) and type of information ($F(2, 358) = 3.268$, $p = 0.039$) were also significant. Pairwise comparisons show that when participants assess the unhealthiest product in the set, the product is judged as unhealthier in the food scanner app condition ($M_{Food\ scanner}$ = 3.46 SD = 1.39) than in the no information condition ($M_{Control}$ = 4.40 SD = 1.64, $p < 0.001$). However, participants judged the unhealthiest product as healthier in the food scanner app condition in comparison to the FOP label condition ($M_{FOP\ label}$ = 2.80 SD = 1.48, $p = 0.004$). Participants also judged the unhealthiest product as unhealthier in the FOP label condition in comparison to the control condition ($p < 0.001$). When assessing the healthiest product, participants judged it as healthier in the food scanner app condition ($M_{Food\ scanner}$ = 5.38 SD = 1.07) than in the no information condition ($M_{Control}$ = 5.07 SD = 1.22, $p = 0.050$) but not in comparison to the FOP label condition ($M_{FOP\ label}$ = 5.84 SD = 0.87, $p = 0.185$). Participants also judged the healthiest product as healthier in the FOP label condition in comparison to the control condition ($p < 0.001$).

3.3.2.3. Purchase intention. In an ANOVA with type of information (Food scanner app vs FOP label vs control) and type of product (healthiest vs unhealthiest) entered as the independent variables, predicting participants' intentions to purchase the target product, we find a significant main effect of product type ($F(1, 358) = 22.183$, $p < 0.001$). Participants reported higher purchase intentions for the healthiest product (M = 4.00 SD = 1.93) than for the unhealthiest one (M = 3.03 SD = 1.81). The type of information had no significant effect ($F(2, 358) = 1.081$, $p = 0.340$). Importantly, we found a significant interaction between the type of product and type of information ($F(1, 358) = 4.767$, $p = 0.009$). Pairwise comparisons show no difference in purchase intention for the unhealthiest product of the set between the food scanner app and the control condition ($p = 0.930$). Participants reported lower intention to purchase the unhealthiest product of the set in the FOP label condition ($M_{FOP\ label}$ = 2.59 SD = 1.76) than in the control condition ($M_{Control}$ = 3.34 SD = 1.98, $p = 0.035$) and the food scanner app condition ($M_{Food\ scanner}$ = 3.31 SD = 1.65, $p = 0.030$). When assessing the healthiest product, participants reported higher purchase intention in the food scanner app condition ($M_{Food\ scanner}$ = 4.18 SD = 1.89) than in the no information condition ($M_{Control}$ = 3.55 SD = 1.88, $p = 0.035$) but not in comparison to the FOP label condition ($M_{FOP\ label}$ = 4.28 SD = 1.98, $p = 0.770$). Participants also reported higher intention to purchase the healthiest product in the FOP label condition than in the control condition ($p = 0.027$).

3.3.2.4. Moderated mediation. To determine if the influence of the type of information on purchase intentions is mediated by consumers' perceptions of product healthiness and moderated by product type, we conducted a moderated mediation analysis with PROCESS Model 8 (5000 samples, Hayes, 2017). We considered type of information as the independent variable (using dummy coding with the control condition as the reference category), perceived healthiness of the target product as mediator, product type (healthiest vs unhealthiest) as a moderator of the path between type of information and perceived healthiness, and purchase intention as the dependent variable. We find significant moderated mediation for both dummy variables (index of moderated $\text{mediation}_{\text{Control vs FOP label}} = -2.0332$, 95% CI: [−2.6480, −1.4072]; index of moderated $\text{mediation}_{\text{Control vs Food scanner app}} = -1.0713$, 95% CI: [−1.6786, −0.4203]). For the healthiest product, we identify a mediation through healthiness perception for the contrast comparing the control (reference category) with the FOP label condition (ab = 0.6562; 95% CI: [0.3344, 0.9844]) but not with the food scanner app (ab = 0.2657; 95% CI: [−0.0918, 0.6137]) condition. These findings show that the FOP label information increased healthiness perceptions of the healthiest product, which then increased purchase intentions in comparison to the no information condition. However, we find no influence of the food scanner app in comparison to the control condition, showing that healthiness perceptions do not mediate the food scanner app effect on purchase intention for the healthiest product in the set. Regarding assessments of the unhealthiest product in the set, we find the opposite significant mediation when contrasting the control condition with the FOP label (ab = −1.3770, 95% CI: [−1.8993, −0.8416]). We also find a significant mediation through product healthiness perception when comparing the control and the food scanner app (ab = −0.8056, 95% CI: [−1.3151, −0.2846]) conditions. These findings suggest that both FOP information and food scanner information decreased healthiness perceptions of the unhealthiest product, which then decreased purchase intentions in comparison to the control condition.

To provide the results for the comparison between the FOP label and the food scanner app conditions, we ran the same PROCESS Model 8, using the food scanner app condition as the reference category when dummy coding the type of information variable. We again find a significant index of moderated mediation ($\text{index}_{\text{Food scanner app vs FOP label}} = -0.9619$, 95% CI: [−1.5002, −0.4469]). Results show that the FOP label outperformed the food scanner app, leading to increased perceptions of healthiness and higher purchase intention for the healthiest product (ab = 0.3905; 95% CI: [1.005, 0.6993]). We find the opposite significant mediation for the unhealthiest product (ab = −0.5713, 95% CI: [-0.9964, −0.1320]) in the set. These mediation results show that the FOP label information increased healthiness perceptions of the healthiest product in the set, which then increased purchase intentions in comparison to the food scanner app information. The opposite happened to the unhealthiest product. The FOP information reduced healthiness perceptions, reducing purchase intentions compared to the food scanner app information.

3.3.3. Discussion

Study 3 results show that information displayed through the food scanner app can be beneficial in influencing healthiness perceptions and purchase intentions towards food products, but is outperformed by the FOP label Nutri-Score. For the healthiest product in the set, healthiness perceptions and purchase intentions were higher when participants saw nutritional information in a food scanner app than no nutritional information, with no difference in comparison to the FOP label. It is noteworthy, however, that healthiness perceptions did not mediate the effect of the type of information on purchase intentions. For the unhealthiest product, although the food scanner app information did reduce healthiness perceptions, it did not reduce purchase intentions in comparison to no information. Furthermore, the food scanner app was systematically outperformed by the FOP label in all outcomes. These results demonstrate that the impact of food scanner apps can vary depending on the nutritional quality of the product judged, being more impactful influencing the evaluation and choice of healthy products than unhealthy ones.

Studies 1–3 were based on hypothetical situations and choices. Furthermore, in these studies participants saw the nutritional information of all products at the same page, and were not required to scan the bar codes, as it would be needed to access food scanner apps' information in real life. In study 4 we test the effect of nutritional information displayed through a food scanner app in a more realistic consumption context during a grocery shopping situation inside an experimental supermarket.

3.4. Study 4 - The impact of a food scanner app on product choices in an experimental supermarket

In study 4, we explore the impact of using a food scanner app to assess nutritional information on consumers' product choices within an experimental supermarket, where a wide range of products is available for selection. This investigation is conducted in comparison to two other shopping situations: a situation in which no nutritional information is provided (control) and a situation in which nutritional information is provided through a FOP label, specifically the Nutri-Score. Once again, we predict that consumers will make healthier choices when utilizing a food scanner app, as opposed to when no information is provided. However, we anticipate that the nutritional information in FOP labels will surpass the food scanner app in influencing healthier choices.

3.4.1. Participants and procedure

A total of 141 undergraduate students ($M_{age} = 20.06$ SD = 14.30; 50.2% Females) from a French business school participated in this study in exchange for course credit. Participants entered an experimental supermarket to complete a grocery shopping task, using a shopping list with three product categories, including two filler categories (toothpaste and fruit juice) and our category of interest (cereal/chocolate bar). Before starting their purchases, participants read a short document explaining the nutritional information available in the supermarket and how they could assess it if they wanted to (either by scanning the barcode in the food scanner app condition, or by looking at the label in the FOP label condition). Participants in the control condition read a similar paragraph informing that food products varied in nutritional quality, but the text did not mention nutritional information available. Participants in both the food scanner app condition and in the FOP label condition were free to either use the nutritional information available or not. The cereal/chocolate bar shelf displayed 58 products (Nutri-Score grades: 2 products A, 4 products B, 13 products C, 17 products D, and 22 products E). The shelves reproduced the contents of a typical small supermarket assortment.

In the food scanner app condition, we added a barcode on the same tag that included the product price and provided participants with a smartphone to scan the code if they wanted to. In the FOP label condition, we added the corresponding nutritional information on the location of the barcode and, again, participants were free to look at it or not. In the control condition, participants did not see a FOP label and were not given a smartphone to scan the barcodes. For this between-subjects design, we asked participants to select one product of each category, as if they were doing their actual grocery shopping. We presented nutritional information (FOP labels or food scanner app) also for the fruit juice category to keep consistency in the study procedure, but we did not analyze nor discuss this product category because it was designed as a filler option and chosen because of the limited variance of nutritional quality of the products. For the other filler products we did not display any nutritional information because they were non-food products. Because the products on the target shelf varied according to size and number of portions contained in each package, we used the energy density (kcal/100g of product) and the FSA score of the chosen product as the key dependent variables (Werle, Pruski Yamim, et al., 2022). Once they had completed their shopping, we measured demographics (age, gender).

3.4.2. Results

3.4.2.1. Product choice. To assess the impact of the type of nutritional information (food scanner app vs control vs FOP label) on product choice healthiness, we conducted an ANOVA with condition as the independent variable predicting the energy density of the product chosen. The results show a significant effect of the type of information (F (2,134) = 3.626, p = 0.029). While the usage of the food scanner app ($M_{food\ scanner}$ = 452.41, SD = 128.70) did not influence the energy density of participants choice in comparison to the control condition ($M_{control}$ = 472.48, SD = 73.04; p = 0.402), the presence of the FOP label (M_{FOP} = 393.56, SD = 167.14) outperformed the food scanner app leading participants to choose products of lower energy density (p = 0.041). The FOP label also led to the choice of lower energy density products in comparison to control (p = 0.008).

A separate ANOVA predicting the FSA score of the product chosen shows a similar pattern of results. The results show a marginally significant effect of the type of information (F (2,129) = 2.878, p = 0.06). The food scanner app ($M_{food\ scanner}$ = 15.78, SD = 8.39) did not influence the FSA of the product chosen in comparison to the control condition ($M_{control}$ = 17.12, SD = 10.62, p = 0.457). The presence of the FOP label (M_{FOP} = 11.41, SD = 8.75) marginally outperformed the food scanner app leading participants to choose products with a lower FSA score (p = 0.063). The FOP label also led to the choice of products with a lower FSA in comparison to the control condition (p = 0.018). Although the effects were marginally significant, these findings follow the same pattern observed for energy density: information displayed through a food scanner app did not influence the FSA of the chosen product and was outperformed by information displayed through a FOP label.

3.4.3. Discussion

Different from studies 1–3, study 4 assessing behavioral choice demonstrates that information displayed through a food scanner app does not lead to healthier food choices compared to when no information is provided, and it is outperformed by information displayed through a FOP label. These results indicate that, in a realistic situation when consumers need to use a smartphone to scan bar codes to access nutritional information through a food scanner app, the food scanner app does not increase healthy food choice. It is noteworthy that the study design was a particularly strong test of the effect of the food scanner app: participants received instructions about how the app operates and were provided a smartphone with the app already installed to scan the products. Although we did not ask them to scan the products, the procedure emphasized the role of the app. We tried to control for this effect by also presenting instructions about the products' nutritional quality for the other two conditions, making the instructions similar across groups. The effects documented seem therefore related to the fact of having to use the app to obtain the information.

Differently from Studies 1 to 3, in study 4 we do not find a significant effect of nutritional information provided through the food scanner app in promoting healthier food choices. A potential reason for the different findings between the hypothetical choices (Studies 1–3) and real choice in a grocery shopping task (Study 4) can be driven by the manner how participants accessed the information. In the grocery shopping, participants simulated accessing the food scanner app information by scanning the bar codes. It required more effort from them to access nutritional information, thus rendering it less effective, especially in comparison to the FOP labels, which provide the nutritional information without any effort.

4. General discussion

This research investigates the impact of nutritional information provided through a food scanner app on consumers' food choices across four studies. Study 1 revealed that the use of a food scanner app led to increased hypothetical healthy choices and decreased unhealthy choices in comparison to having no information, although FOP labels outperformed both options. Study 2 replicates these findings when two products are chosen sequentially. Study 3 demonstrates that intentions to purchase healthy products were higher when participants saw the nutritional information in the food scanner app than when there was no nutritional information. Furthermore, the app also enhances consumers' healthiness perception of healthy food products. However, the food scanner app had no effect on influencing consumers' intentions to purchase unhealthy items. Again, the FOP label systematically outperformed both the food scanner app and the control conditions. Importantly, in study 4, conducted in a realistic context of grocery shopping, we found no significant differences in consumer behavior between the use of a food scanner app and the absence of nutritional information, while FOP labels increased the choice of healthier alternatives.

Overall, this research shows that a food scanner app can affect consumers' purchase intentions, but has no effect on actual food choice. Furthermore, results show that FOP labels perform better than a food scanner app in all contexts. Although both FOP labels and food scanner apps provide simplified information about the healthiness of the products for consumers, their effects are different. The simple design and immediately available information in FOP labels is more influential than digitalized online information accessed through a food scanner app. Food scanner apps allow access to nutritional information (Ljusic et al., 2022) and can influence purchase intentions, a finding aligned with the literature suggesting that food scanner apps can improve healthy eating attitudes (Shankar et al., 2016) as well as nutrition knowledge (Abao et al., 2018; Juan et al., 2019; Samoggia & Riedel, 2020).

4.1. Contributions to Theory

This research contributes to literature on the impact of food scanner apps on consumer food choices and to the ongoing debate surrounding their effectiveness. Whereas former literature demonstrated the influence of food scanner apps on consumers' attitudes towards food (Abao et al., 2018; Juan et al., 2019; Samoggia & Riedel, 2020), this research investigates the effects of food scanner apps on consumers' purchase intentions and decisions. Moreover, while prior work on the Yuka app demonstrated its influence on consumer attitudes towards food and well-being (Anin & Helme-Guizon, 2020) and on consumer access to information, knowledge acquisition, and control over food decisions (Gauthier & Bally, 2024), the present research goes beyond, testing how this food scanner app influences consumers' choice towards healthier food options. By showing that the nutritional information displayed through a food scanner app influences purchase intentions but not actual choice, we complement prior work on the effectiveness of smartphone apps (Mathisen & Johansen, 2022; Shankar et al., 2016). Specifically, as Mathisen and Johansen (2022)'s work on smartphone apps and healthy eating, we found no effect of the food scanner app in an experimental supermarket, a context that mimics real shopping contexts. An app may be complicated to use during shopping (Mathisen & Johansen, 2022) and ease of use is a major concern for consumers when using nutritional information (Werle, Nohlen, & Pantazi, 2022). Future research is warranted to explore whether easiness of use may explain the differential effects of food scanner apps on intentions and behavior.

These results also contribute to the ongoing debate on the effectiveness of FOP labels (André et al., 2019; Dubois et al., 2021; Ikonen et al., 2020; Khandpur et al., 2019), showing that FOP labels are effective in orienting consumers' choices towards healthy products, confirming studies such as Ducrot et al. (2016), Elshiewy et al. (2016) and

Mazzù et al. (2021). We introduced an additional layer of understanding by comparing food scanner apps with FOP labels, thus showing the greater effectiveness of the latter on consumers' choices. In contrast to the systematic review conducted by Ljusic et al. (2022), we demonstrate through four studies that physical FOP labels are more impactful on consumer behavior than a food scanner app. Consequently, this research suggests that while food scanner apps and technological tools can serve as useful and engaging instruments to motivate consumers (Abao et al., 2018), their influence pales compared to FOP labels when promoting healthy choices. This finding contributes to the ongoing research on means of providing food information other than through packaging labels (Werle, Nohlen, & Pantazi, 2022). By investigating the case of the widely adopted Yuka app, we showed that the influence of a food scanner app on consumer behavior remains limited and less performant than FOP labels.

4.2. Implications

Many public policies have favored the use of FOP labels to tackle the obesity issue (e.g., Ikonen et al., 2020). The results of the studies presented here substantiate this approach and open the prospect of cultivating or endorsing specialized nutrition apps to aid consumers in their food choices. In the context of advancing public policy initiatives aimed at fostering healthier food habits, our investigation reveals that while food scanner apps are sometimes capable of influencing consumers, FOP labels hold the potential for even greater efficacy. It is noteworthy that a growing number of brands and retailers have begun integrating QR codes into their promotional strategies to provide information about products and exclusive offers. Recently, Food and Drug Administration (FDA) has also promoted the regulation and usage of QR codes to promote food security and authentication. This research suggests that such strategy might not be the most efficient to reach consumers and change their behavior. Importantly, as the scanning apps' impacts are dependent on consumers' agency to access the information, their influence is contingent on one's interest and, therefore, might not reach consumers who need to be the most influenced.

This research findings provide support to European Consumer Organisation's (BEUC, 2021) proposition, which states that digital labels cannot be seen as an alternative to on-pack labels because they will prevent consumers from having immediate access to information about food products. From a public policy point of view, FOP labels should be widely supported so that they can apply to every food product, in order to give consumers more information and enable them to adopt healthier behavior. Public policy should also promote the development of scanner apps as an additional source of information that does not substitute FOP labels.

4.3. Limitations and further research

Our different studies were performed in laboratory settings with clear shopping instructions, and while excluding incentives such as discounts. It is important to acknowledge the difficulty to precisely simulate participants' daily shopping behavior in the real world, where distractions might moderate the impact of FOP labels and food scanner apps. As suggested by Dubois et al. (2021), further studies could focus on tracking participants' shopping behavior during one or multiple sessions. In addition, in our studies we tested the impact of nutrition information in one or two food choices. Consumers, however, often make multiple food choices in the same consumption episode. Further research could test the impact of the type of nutrition information in the nutritional quality of a shopping basket with multiple food items.

We here explored the impact of food scanner app on consumer's purchase intention and food choice, compared to no information and FOP labels. Further research could also study the effectiveness of the simultaneous use of both sources of information (FOP labels and food scanner app) to see how consumers combine information sources in order to make healthier choices. Furthermore, research can test if combining labels with digitalized information can be even more effective to nudge consumers towards healthy eating (Ljusic et al., 2022).

In this research we tested if age and gender influenced the impact of nutritional information displayed through a food scanner app in comparison to no information and to FOP labels. However, as we did not collect any variable assessing socioeconomic status, we could not test whether our effects were dependent on this factor. A recent study of FOP and back-of-product labels (Bryła, 2020) shows that socioeconomic variables have no effect on the understanding of those labels. However, future research can test whether food scanner apps can influence consumers differently depending on their socioeconomic level, as individuals with lower socioeconomic level are the ones in most need for a behavioral change towards healthy eating (Anekwe et al., 2020).

Finally, as suggested by the results of Casteran and Plotkina (2023) and Pan and Chiou (2011), the proximity and trust between consumers and the app could be further explored to test its role in changing consumer behavior. A food scanner app may be considered more trustworthy by consumers than FOP labels displayed by food manufacturers, in particular for consumers who use this type of app frequently. Further research is needed to investigate this proposition.

Ethical statement

This research was evaluated by an ethical committee, which approved the project. In all studies, we have informed the participants about the main objective of the study (i.e., assessing food products depending on the shopping situation context) and obtained their consent to participate before any data was collected.

All participants were compensated by their participation either in a monetary way (studies 1 and 3) or by receiving credits for a discipline (studies 2 and 4). Participants were also allowed to discontinue their participation if they desire.

All information collected was anonymized and used only in a collective way (as observations of a bigger dataset).

CRediT authorship contribution statement

Carolina O.C. Werle: Conceptualization, Methodology, Investigation, Writing – original draft, Writing – review & editing. **Caroline Gauthier:** Conceptualization, Investigation, Funding acquisition, Writing – original draft, Writing – review & editing. **Amanda P. Yamim:** Conceptualization, Methodology, Formal analysis, Data curation, Writing – original draft, Writing – review & editing. **Frederic Bally:** Conceptualization, Writing – review & editing, Writing - review & edition.

Declaration of competing interest

The authors declare that there is no conflict of interest. This research was fully funded by the academic institution of the authors.

Data availability

Data can be available upon request.

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