Comparison of front-of-pack labels to help German consumers understand the nutritional quality of food products

Color-coded labels outperform all other systems

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Abstract

Front-of-Package labels (FoPLs) provide simplified nutritional information to consumers to help them make healthier food choices. Investigating consumers' understanding of this information is of major importance. This study compared consumers' objective understanding of five FoPLs (Health Star Rating System [HSR], Multiple Traffic Lights [MTL], Nutri-Score, Reference Intakes [RIs], warning symbol). In 2018, 1,000 German participants were enrolled in an online survey and asked to rank three sets of products according to their nutritional quality, first in the absence of any labelling, and then with an FoPL displayed on-pack (randomized). Change in ability to correctly rank products was assessed using ordinal logistic regression. For all food categories, the Nutri-Score performed best, followed by the MTL, warning Symbol, HSR and RIs. The Nutri-Score emerged as the most effective FoPL in conveying information on the nutritional quality of foods for German consumers.

Keywords: : front-of-pack nutrition label, understanding, German consumers, nutritional policy, food policy, nutrition labelling

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Introduction

Non-communicable diseases (NCDs) represent the most important causes of death worldwide, outweighing infectious diseases [1]. In Germany cardiovascular disease and cancers are the two leading causes of death, accounting for 42% and 23% of all deaths respectively among women, and 35% and 29% of all deaths among men [2]. The prevalence of obesity has increased during the last decades [3]: In 2013, 14.3% of women and 17.1% of men were obese [4], an increase of 3.3 percentage points among women and 5.0 percentage points among men compared to data collected in 1999 [5]. The prevalence of adult obesity is currently estimated to range between 16.5% and 23.9% in women and between 17.3% and 23.3% in men [6].

Multifactorial in their origin, nutrition is a common determinant of these NCDs [7]. Yet, dietary behavior is considered as a modifiable factor, yielding an important potential for the prevention of NCDs in the long term [8, 9]. Among the multiple strategies aiming at improving the dietary behavior of populations, some have been identified by the World Health Organization (WHO) as 'best buys', yielding high benefits for a reduced cost: taxation of less healthy products, regulation of marketing to children and front-of-pack labelling [8]. Front-of-Pack Labels (FoPLs) aim to enable consumers to make healthier choices at the point of purchase, by simplifying and helping them interpret the detailed nutritional information that is accessible at the back of the pack [8].

Front-of-pack Labels

In 2017, 23 different types of FoP labels were listed in the Codex Alimentarius (which provides an overview of the various approaches to simplifying nutritional information to con-

sumers) [10]. Globally, two main approaches can be described: nutrient-specific schemes vs. summary indicators [11].
While nutrient-specific schemes provide information on each of a series of nutrients, summary indicators rely on a nutrient profiling system to assess the overall nutritional quality of a food product, combining multiple elements in a single indicator.
Examples of the nutrient-specific approach include:
– Reference Intakes (promoted by agro-food-industry) which provide numerical information on the contribution of specific nutrients to the reference intakes for an adult;
– the Multiple Traffic Lights (developed in the United Kingdom [UK]) which additionally provide an interpretation of the level of each nutrient in the food with a color-code for each nutrient;
– and warning labels which are affixed on foods for which the level of a given nutrient is above a pre-defined threshold.
Examples of summary indicator schemes include endorsement schemes (such as the Choices or the Green Keyhole systems) which are affixed on foods complying with a series of nutritional criteria defining healthier foods; and graded schemes (such as the French Nutri-Score, now adopted in Spain and Belgium, or the Health Star Rating System, adopted in Australia and New Zealand) which provide an overall indication of the nutritional quality of a food on a scale from healthier to less healthy.
Schemes vary also in the degree to which they provide an interpretation of the nutritional composition of a food. Nutrient-specific schemes present only numeric data on the food composition and are considered purely informative, while those providing graphical or color-coded elements for the overall nutritional quality of the food or for the content on various nutrients are more interpretative [11].

Multiple studies have demonstrated the helpfulness of FoPLs in raising awareness or the consumer's understanding of the nutritional quality of pre-packaged foods [12, 13]. Among the various dimensions which should be investigated to test the effectiveness of FoPLs for consumers, the assessment of the consumers' objective understanding of schemes is among the most informative.
Objective understanding is defined as the ability for consumers to correctly interpret the information that is provided by the FoPL [14]. It can be tested by requiring consumers to rank or select food products according to their nutritional quality, using visuals of food products with and without an FoPL.
Research suggests that all schemes improve the consumers' ability to correctly interpret the nutritional quality of a food compared to a control situation with no labelling [15, 16]. Moreover, consumers' responses to FoPLs may differ depending on their specific cultural context. Therefore, comparative studies including multiple schemes are necessary in order to identify the most helpful FoPL in a given cultural context.
In this context, an international comparative experimental study assessing consumers' objective understanding in 12 countries of five FoPLs currently in use in the world was developed using a randomized experimental design. The FoPLs included were:
- Health Star Rating system (HSR)
- Multiple Traffic Lights (MTL)
- Nutri-Score
- Reference Intakes (RIs)
- Chilean Warning symbol.

The results of the study for all 12 countries have been published elsewhere [17].

Currently in Germany, there are ongoing discussions regarding the implementation of a front-of-pack nutrition label on pre-packed foods, and some consumer associations and manufacturers have declared their support for the introduction of a summary FoPL, namely the Nutri-Score.
However, very few studies have investigated the consumers' understanding of FoPLs in Germany specifically [18–21], and none has investigated comparatively the main formats already implemented around the world including the Nutri-Score.
The international comparative experimental FOP-ICE study was set to investigate consumer response to several FOP labels currently implemented in the world. Given this context, it appeared of major importance to assess comparatively the consumers' understanding of these five FoPLs on German consumers specifically, using data from the FOP-ICE study.

Methods

Participants

The recruitment was performed by the ISO-accredited international web panel provider (Pure-Profile) using quota sampling based on gender (50% men, 50% women), age (one-third of recruited participants in each of the following categories: 18–30 years, 31–50 years, over 51 years), and level of income (one-third of recruited participants in each of the following household income levels: low, medium, and high), to ensure equal coverage of the major population groups.
Individuals who reported never or rarely purchasing at least two of the three food product categories tested in the study (pizzas, cakes, and breakfast cereals) were considered ineligible to participate.
The protocol of the present study was approved by the Institutional Review Board of the French Institute for Health and Medical Research (IRB Inserm n°17-404) and the Australian Curtin University Human Research Ethics Committee (approval reference: HRE2017-0760).

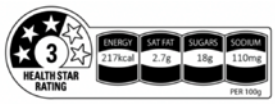
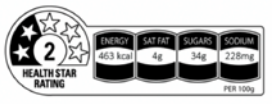
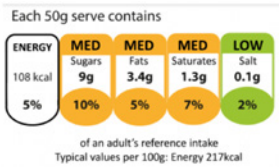
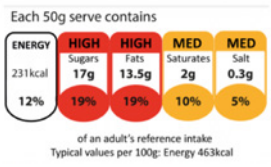
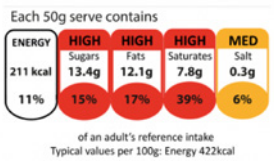
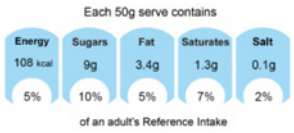
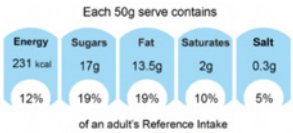
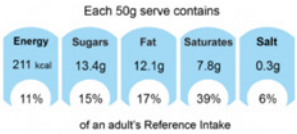
Labelling condition	Example of one food category: cakes		
no label			
Health Star Rating system			
Multiple Traffic Lights			
Nutri-Score			
Reference Intakes label			
Warning symbol			

Fig. 1: **Example of a set of three products tested in the present study with the associated FoPLs**
FoPLs = Front-of-Pack Labels

Procedure

Participants were exposed to three categories of food commonly consumed in Germany: pizzas, cakes and breakfast cereals. For each category, they were first invited to rank a set of three label-free products, with distinct nutritional profiles, by selecting one of three options for each product:

1. highest nutritional quality
2. medium nutritional quality
3. lowest nutritional quality

An "I don't know" option was also included. Then, participants were randomized to one of the five FoPLs groups (HSR, MTL, Nutri-Score, RIs, or Warning symbol, resulting in 200 participants per group, and were asked to rank the same sets of three products with one of the FoPLs affixed on mock packages, depending on the randomization arm. An example of a product set used in the study with the five corresponding FoPLs tested is shown in ♦ Figure 1.

Statistical analysis

For each participant, the number of correct responses was calculated for the no label and the FoPL tasks (yielding a total number of 0 to 3 correct answers for each labelling situation, combining results of the three food categories). Ranking was considered correct if all the three products were ranked in the expected order and

	N (%)
sex	
men	500 (50.0)
women	500 (50.0)
age, years	
18–30	340 (34.0)
31–50	330 (33.0)
> 50	330 (33.0)
educational level	
primary education	97 (9.7)
secondary education	382 (38.2)
trade certificate	241 (24.1)
university, undergraduate degree	129 (12.9)
university postgraduate degree	151 (15.1)
level of monthly income	
high	327 (32.7)
medium	333 (33.3)
low	340 (34.0)
responsible for grocery shopping	
yes	769 (76.9)
no	31 (3.1)
share job equally	200 (20.0)
self-estimated diet quality	
I eat a very unhealthy diet	34 (3.4)
I eat a mostly unhealthy diet	202 (20.2)
I eat a mostly healthy diet	677 (67.7)
I eat a very healthy diet	87 (8.7)
nutrition knowledge	
I do not know anything about nutrition	15 (1.5)
I am not very knowledgeable about nutrition	193 (19.3)
I am somewhat knowledgeable about nutrition	617 (61.7)
I am very knowledgeable about nutrition	175 (17.5)
Did you see the FOP label during the survey?	
no	306 (30.6)
unsure	140 (14.0)
yes	554 (55.4)
participants who recalled seeing the FoPL they were exposed to	
HSR	90 (45.0)
MTL	128 (64.0)
Nutri-Score	136 (68.0)
RIs label	128 (64.0)
Warning symbol	72 (36.0)

Tab. 1: **Description of the population sample from Germany (N = 1,000)**

incorrect if any of the products were ranked out of order.

The main outcome variable was the change in the number of correct responses between the FoPL and no label conditions. Multivariable ordinal logistic regression was used to evaluate the association of FoPLs with change in the ability to correctly rank products from the no label to the FoPL condition, using the RIs as a reference condition.

Individual characteristics taken into account as covariates included sex, age, educational level, household income, involvement in grocery shopping, and self-estimated nutritional knowledge and diet quality. Additional information on the study methodology is available elsewhere [17].

Statistical analyses were carried out for all food categories combined and by food category, using SAS Software (version 9.3, SAS Institute Inc, Cary, NC, USA). A p-value ≤ 0.05 was considered statistically significant. As 30.6% of participants declared at the end of questionnaire not having seen the FoPL they were presented with during the survey, sensitivity analyses were performed excluding these participants (n = 446).

Results

Individual characteristics of the population sample from Germany are presented in ♦ Table 1. The sample included varied profiles, including 15% participants with a university postgraduate degree, 68% declaring having a mostly healthy diet, and 62% being somewhat knowledgeable about nutrition.

The Nutri-Score produced the greatest increase in the number of correct answers compared to the control situation with no label, for pizzas and breakfast cereals: from 70 in no labelling to 109 correct answers in the FoPL condition for pizzas, corresponding to an increase of 56%, and from 58 in no labelling to 99 correct answers in the FoPL condition for cereals, corresponding to an increase of 71%. For cakes, the MTL performed best (increase: 139%), followed by the Nutri-Score (increase: 114%). The MTL performed second best after Nutri-Score for pizzas and cereals, while results of the other FoPLs varied depending on the food category.

The results of percentages of correct answers in the two labelling situations for each FoPL are presented in ♦ Figure 2. Consistently, all

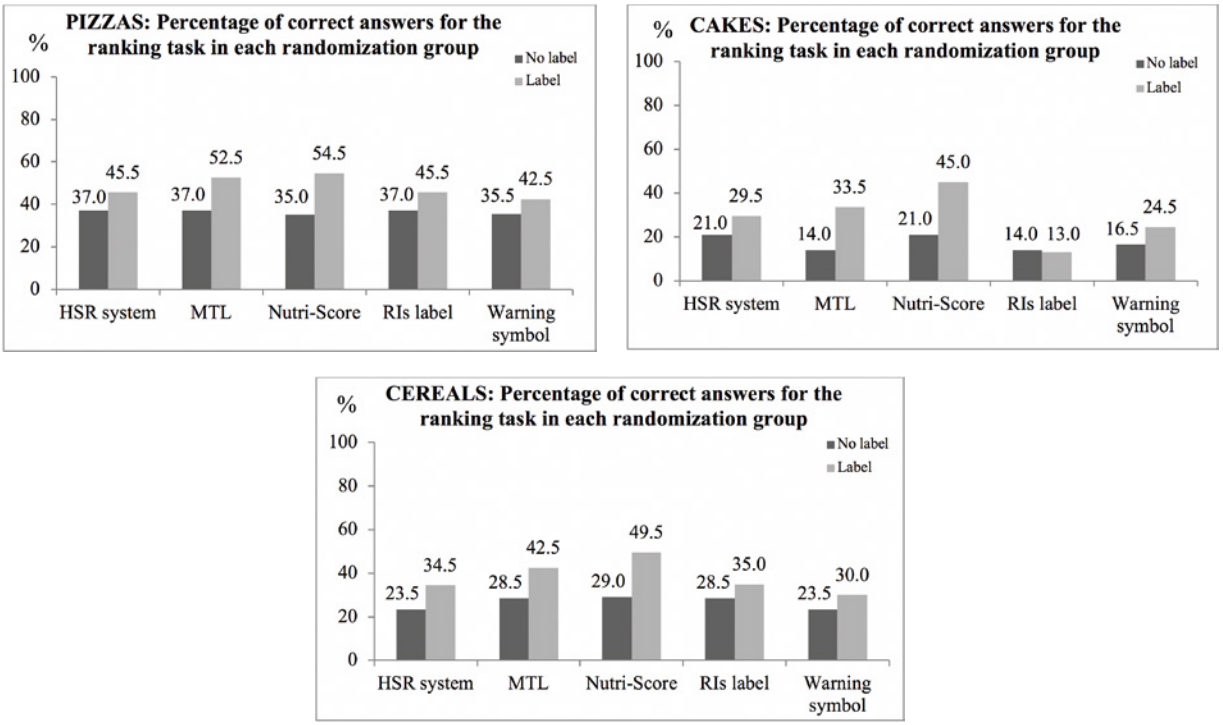


Fig. 2: **Percentage of correct answers for the sample from Germany with the change compared to no label, by FoPL and food category**
FoPL = Front-of-Pack Label; HSR system = Health Star Rating system; MTL = Multiple Traffic Lights; RIs = Reference Intakes

FoPLs improved the percentage of correct answers, but the Nutri-Score showed the largest increase in the percentage of correct responses compared to the no label situation while results of the other FoPLs were inconsistent depending on the food category.

Analyses conducted among participants recalling having seen the FoPL during the survey only, showed similar results (♦ Figure 3).

Results of associations between FoPLs and participants' ability to correctly rank products are displayed in ♦ Table 2. Compared to the RIs, the Nutri-Score was the FoPL associated with the highest improvement in participants' ability to correctly rank products, overall (Odds Ratio [OR]: 2.72, 95% confidence interval [1.83–4.05]) and for each of the three food categories. The MTL performed second best, overall (OR: 2.15 [1.44–3.21]), largely driven by a high performance in the cakes category (OR: 4.12 [2.38–7.15]); results were not statistically significantly different to the RIs among pizzas and cereals. The Warning symbol, followed by the HSR, significantly improved participants' ability to correctly rank products among cakes only, but with lower magnitude of effects.

Results of the associations between FoPLs and change in ability to correctly rank products among participants recalling having seen the FoPL are shown in ♦ Table 3. The Nutri-Score produced the greatest increase in participants' ability to correctly rank products (OR: 2.86 [1.77–4.60]), followed by the Warning symbol (OR: 2.72 [1.55–4.77]) and then the MTL (OR: 2.24 [1.38–3.63]). Depending on the food category, the magnitude of effects varied, with higher performance in the cakes category, for which the Warning symbol was the FoPL with the highest performance.

Discussion

In the present study, the Nutri-Score displayed the highest performance in helping consumers understand the nutritional quality of food products, with consistent results in all food categories. For other labels, though some displayed similar performance to the Nutri-Score overall (MTL in particular), this performance appeared variable depending on the tested food category.

Indeed, while the Nutri-Score displayed similar ORs across all food categories, the high overall OR observed for the MTL appeared largely driven by higher performance in the cakes category specifically, with non-significant improvements compared to the RIs for pizzas or breakfast cereals.

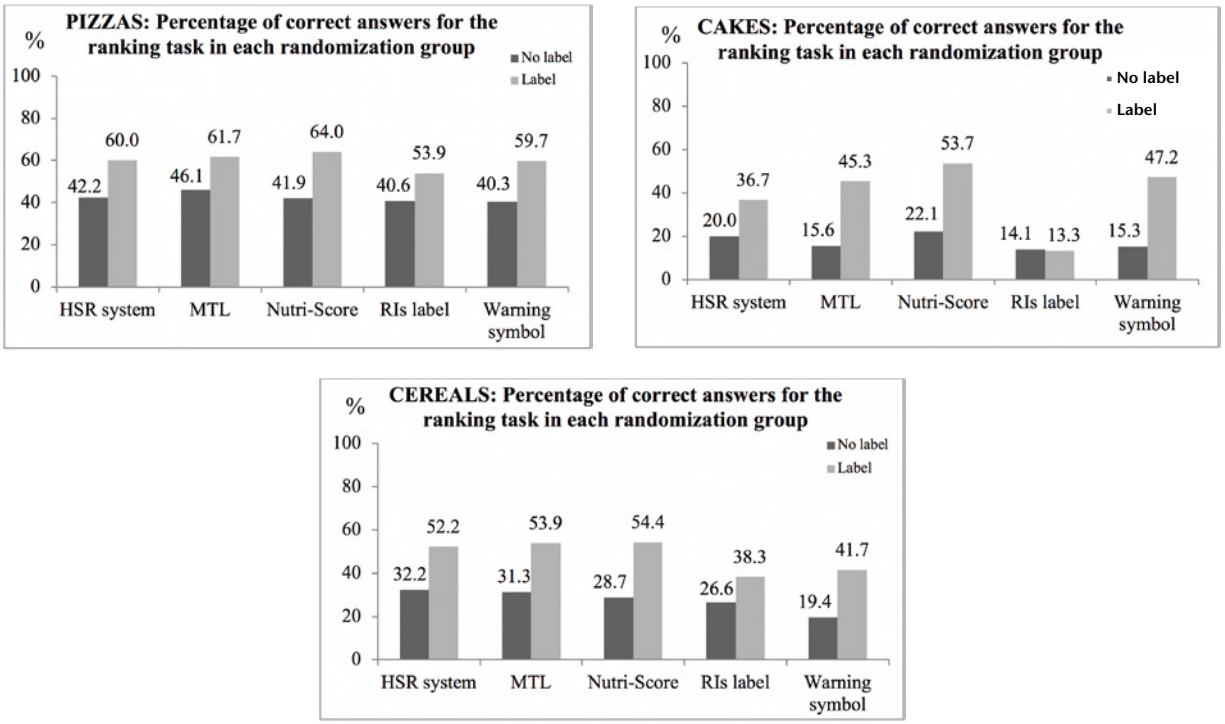


Fig. 3: **Percentage of correct answers for the sample from Germany with the change compared to no label, by FoPL and food category, among participants recalling having seen the FoPL**
FoPL = Front-of-Pack Label; HSR system = Health Star Rating system; MTL = Multiple Traffic Lights; RIs = Reference Intakes

The Warning symbol and HSR displayed an overall lower performance, with significant improvements in consumers' objective understanding compared to RIs only in one food category.

Among participants recalling having seen the label during the survey, the Nutri-Score remained the FoPL with the highest performance, but followed by the Warning symbol and then the MTL.

Some caution is required regarding extrapolation of the results given that the recruitment was performed using set quotas rather than attempting to generate a population representative sample. However, this method allowed for the inclusion of a diverse sample in terms of socio-demographic profiles.

The superior performance of the Nutri-Score in helping consumers rank foods according to their nutritional quality is consistent with previous studies in France [22] and with the overall results of the FOP-ICE study in the remaining 11 countries tested [17]. In the light of these results, some graphical characteristics of the FoPLs tested may have impacted their performance, and more specifically the use of color-coding using the green-red scale (with Nutri-Score and MTL, which performed the best). The green-red scale may be important to identify the label, as these colors are more quickly recognized by the human eye [23], and as they provide intuitive stop and go signals [24]. Conversely, monochrome labels such as the RIs, Warning labels and HSR may be less noticeable on food packages. A previous study in Germany highlighted that German consumers preferred color-coded MTL to GDAs [25]. Thus, results among participants recalling having seen the label during the survey would suggest that a warning format might be better understood in more salient colors [26].

Beyond color-coding, a key aspect of the higher performance of the Nutri-Score may be related to its use of a single summary indicator of the food's nutritional quality, rather than multiple nutrient-related assessments. This finding is consistent with prior studies finding that summary indicators are more easily understood by consumers [13, 15], in particular in vulnerable populations, which are an important target for public health nutrition policies. Given the very short period when decisions are made in purchasing situations [18], the use of a single indicator, such as the Nutri-Score, may also provide an advantage through the limited cognitive workload needed for interpretation [27]. Hence, the stronger performance of the Nutri-Score on consumers' objective understanding may be related to its use of the combination of both semantic colors and a simple and intuitive summary graded design which appears understandable for all.

Category	N	HSR		MTL		Nutri-Score		Warning symbol	
		OR (95% CI)	p	OR (95% CI)	p	OR (95% CI)	p	OR (95% CI)	p
all categories	1,000	1.20 [0.80–1.80]	0.4	2.15 [1.44–3.21]	**0.0002**	2.72 [1.83–4.05]	< **0.0001**	1.10 [0.73–1.65]	0.7
pizzas	979	0.96 [0.57–1.59]	0.9	1.45 [0.88–2.37]	0.1	1.84 [1.13–3.01]	**0.01**	0.94 [0.56–1.57]	0.8
cakes	976	2.01 [1.14–3.53]	**0.02**	4.12 [2.38–7.15]	< **0.0001**	5.37 [3.11–9.28]	< **0.0001**	2.18 [1.23–3.87]	**0.008**
breakfast cereals	879	1.45 [0.83–2.52]	0.2	1.68 [0.98–2.90]	0.06	2.55 [1.49–4.34]	**0.0006**	0.95 [0.54–1.68]	0.9

Tab. 2: **Associations[a] between FoPLs and change in ability to correctly rank products between no label and labelling conditions**
[a] The reference of the multivariate ordinal logistic regression for the categorical variable 'label' was the RIs.
The multivariate model was adjusted on sex, age, educational level, level of income, responsibility for grocery shopping, self-estimated diet quality, and self-estimated nutrition knowledge level.
Bold values correspond to significant results corrected for multiple testing ($p \leq 0.05$).
CI = confidence interval; FoPL = Front-of-Pack Label; HSR system = Health Star Rating system; MTL = Multiple Traffic Lights; OR = Odds Ratio; RIs = Reference Intakes

Category	N	HSR		MTL		Nutri-Score		Warning symbol	
		OR (95% CI)	p	OR (95% CI)	p	OR (95% CI)	p	OR (95% CI)	p
all categories	554	1.57 [0.92–2.67]	0.1	2.24 [1.38–3.63]	**0.001**	2.86 [1.77–4.60]	< **0.0001**	2.72 [1.55–4.77]	0.0005
pizzas	541	1.16 [0.61–2.19]	0.6	1.04 [0.58–1.86]	0.9	1.54 [0.87–2.70]	**0.1**	1.43 [0.73–2.80]	0.3
cakes	537	3.42 [1.55–7.54]	**0.002**	6.78 [3.28–14.05]	< **0.0001**	8.43 [4.09–17.38]	< **0.0001**	9.66 [4.3–21.74]	< **0.0001**
breakfast cereals	497	1.70 [0.87–3.34]	0.1	1.77 [0.96–3.27]	0.07	2.38 [1.29–4.38]	**0.005**	1.83 [0.89–3.77]	0.1

Tab. 3: **Associations[a] between FoPLs and change in ability to correctly rank products between no label and labelling conditions, among participants recalling having seen the label during the survey**
[a] The reference of the multivariate ordinal logistic regression was the RIs.
The multivariate model was adjusted on sex, age, educational level, level of income, responsibility for grocery shopping, self-estimated diet quality, and self-estimated nutrition knowledge level.
HSR: Health Star Rating system; MTL: Multiple Traffic Lights; OR: Odds Ratio; CI: Confidence Interval.
Bold values correspond to significant results corrected for multiple testing ($p \leq 0.05$).
CI = confidence interval; FoPL = Front-of-Pack Label; HSR system = Health Star Rating system; MTL = Multiple Traffic Lights; OR = Odds Ratio; RIs = Reference Intakes

Moreover, recent studies suggest that beyond food purchases, the Nutri-Score, and to a lesser extent the MTL, may have an impact on food consumption, by reducing the portions size selected for foods considered of lower nutritional quality (cheese, biscuits and spreads) [28]. Therefore, overall, research suggests that FoPLs, and the Nutri-Score in particular, are helpful to increase consumers' awareness in nutrition, improve their understanding of the nutritional quality of food products, stimulate healthier food purchases and may impact the nutritional quality of the diets [29].

Conclusion

The results of this study are of particular interest in the European Union, where the debate over the implementation of FoPLs has recently gathered attention from policy makers and industry. While the MTL have been implemented since 2005 in UK, the Nutri-Score, initially applied in France in 2017, has recently been adopted by Belgium, with a voluntary commitment of several manufacturers and retailers.
The results of this study suggest that among the available options, the Nutri-Score appears as the most efficient scheme to inform consumers on the nutritional quality of foods, in particular in Germany, where it would be a helpful tool for consumers in purchasing situations.

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Conflict of Interest
The authors declare no conflict of interest.

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