

ORIGINAL ARTICLE

Understanding of different front-of-package labels by the Spanish population: Results of a comparative study[☆]



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KEYWORDS

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Abstract

Background and objectives: Increased prevalence of obesity and its comorbidities has shown the need to implement social policies to help curb this trend. Nutritional risk factors are recognized as key drivers of obesity and other chronic diseases in Spain and in other Western countries. Front-of-package labels (FoPLs) are efficient tools to help consumers make healthier choices. To be useful in purchasing situations, consumers need to understand the information provided by FoPLs. The study objective was to assess objective understanding by consumers of five types of FoPLs, i.e. Health Star Rating system (HSR), Multiple Traffic Lights (MTL), Nutri-Score, Reference Intakes (RIs), and Warning symbol in Spain.

Methods: In 2018, 1000 Spanish participants were recruited and requested to rank three sets of label-free products (one set of three pizzas, one set of three cakes, and one set of three breakfast cereals) according to their nutritional quality in an on-line survey. Participants were then randomized to one of the five types of FoPLs, and were requested to rank the same sets of products again, this time with a given FoPL displayed on the package. Changes in ability to correctly rank products according to FoPLs were compared between both tasks using ordinal logistic regression.

Results: For all three food categories, Nutri-Score performed significantly better, followed by MTL, the Warning symbol, HSR and RIs.

Conclusions: Nutri-Score emerged as the most efficient FoPL in conveying information on the nutritional quality of foods among Spanish consumers.

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PALABRAS CLAVE

Etiquetado nutricional;
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Política nutricional

Comprensión de diferentes etiquetados frontales de los envases en población española: resultados de un estudio comparativo**Resumen**

Antecedentes y objetivos: El incremento de la prevalencia de obesidad y de enfermedades asociadas conlleva la necesidad de aplicar políticas sociales que ayuden a frenar esta tendencia. El etiquetado frontal de los envases (EFE) es una herramienta eficiente para ayudar a los consumidores a tomar decisiones más saludables en el momento de la compra. Para ello es importante que los consumidores comprendan la información proporcionada por los EFE. El objetivo es evaluar en una muestra de consumidores españoles la comprensión objetiva de 5 tipos de EFE: sistema de clasificación de estrellas de salud, semáforo múltiple, Nutri-Score, ingestas de referencia y símbolo de advertencia.

Métodos: En 2018 se reclutaron 1.000 participantes españoles y se les pidió que clasificaran 3 productos por categoría, repitiendo esto para 3 categorías distintas de productos analizados anteriormente sin etiquetado (3 tipos de pizzas, 3 tipos de pasteles y 3 tipos de cereales de desayuno), de acuerdo con su calidad nutricional usando una encuesta *on-line*. Seguidamente, los participantes fueron asignados al azar a uno de los 5 tipos de EFE y se les pidió clasificar de nuevo los mismos productos. Se realizaron varios modelos de regresión logística multivariante.

Resultados: Nutri-Score fue el sistema que mejor clasificó los alimentos según su calidad nutricional en las 3 categorías de alimentos, seguido del semáforo múltiple, el símbolo de advertencia y el sistema clasificación de estrellas de salud respecto a las ingestas de referencia.

Conclusiones: Nutri-Score apareció, entre los consumidores españoles, como el EFE más eficiente para transmitir información sobre la calidad nutricional de los alimentos.

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Introduction

In recent decades both in Spain and worldwide, the prevalence of obesity has increased exponentially, reaching epidemic levels.^{1,2} According to the World Health Organization (WHO), the prevention of obesity and other chronic diseases is a public health priority. The increased prevalence of obesity and associated diseases such as diabetes, arterial hypertension and dyslipidemia implies the need to apply social policies to help curb this tendency.³ In this regard, the sustained implementation of policies based on scientific evidence and the promoting of regular physical activity and healthy eating habits is important. However, it is essential for these healthy dietary options to be available, affordable and easily accessible to the entire population. This is particularly relevant in those population groups with limited financial resources and a lesser knowledge of nutrition, as they often have a lower educational level and a greater prevalence of obesity.⁴

In order to improve the diet of the population, one of the multiple interventions adopted by the public health authorities in the European Union is to establish nutritional labeling which provides health warnings. In this context, over the past few decades there has been an increased interest in front-of-package labels (FoPLs), with the aim of providing consumers with simple information on the nutritional quality of food, and thus facilitating the choice of foods with higher nutritional quality at the time of purchase, while also promoting the production of food products with a higher nutritional quality on the part of the food industry.^{3,5}

Several nutritional labeling models have been used in different countries. These labels can be classified into two large groups: labeling based on specific nutrients, and labeling that offers a summary of nutritional quality. Examples of the nutrient-based approach are the multiple traffic lights (MTLs) system applied in the United Kingdom since 2005⁶; the daily food guides developed and implemented internationally by the agri-food industry in 2006 and recently modified by the reference intakes (RIs)⁷; and the warning symbols applied since 2016 in Chile.⁸ With regard to the nutritional quality summaries approach, which takes into account the global nutritional quality of food, mention should be made of the Green Keyhole, introduced in the 1980s in Sweden and subsequently in Denmark⁹; the Choices logo introduced in The Netherlands in the year 2000¹⁰; the Health Star Rating (HSR) used in Australia since 2014¹¹; and the Nutri-Score system adopted in France in 2017, in Belgium in 2018, and probably also soon in Spain.¹²

Scientific research suggests that the use of logos in the FoPLs, by summarizing the nutritional information, reduces the cognitive effort and the time needed to mentally process the label content, potentially helping consumers to identify healthier food options and thus constituting an additional strategy to help reduce chronic diseases. However, this only applies to the extent that the information provided can be clearly understood by the consumer.¹³

Therefore, in order for public health authorities to recommend a specific FoPL, taking into account the socio-cultural context, it is necessary to ensure that the labeling is truly useful for consumers and that its validity is contrasted with existing labels. The present study was therefore designed to assess the specific results relating to the


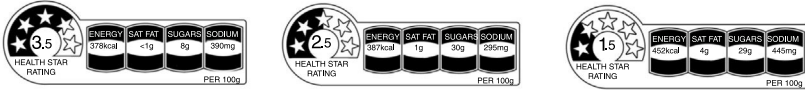




Labelling situation	Example of the breakfast cereals nutritional category
Non-labelled	
Health Star Rating system	
Multiple Traffic Lights	
Nutri-Score	
Reference Intake	
Warning symbol	

Figure 1 Example of a category of three products used in the study with the 5 front-of-package labels of the associated packages.

objective understanding of 5 types of FoPLs (HSR, MTL, Nutri-Score, RI and warning symbols) in a sample of the Spanish population included in the Front-of-Pack International Comparative Experimental study, conducted in 12 countries.¹⁴

Material and methods

A total of 1000 participants were recruited in Spain from a web panel of an ISO accredited international provider (PureProfile) using quota sampling based on gender, age and income level.

The study involved an experimental, comparative, two-phase randomized design.

The participants were exposed to three food product categories (pizzas, cakes and breakfast cereals) with great variability in their nutritional quality and commonly consumed in Spain, and to three different products in each of the categories.

These foods were presented with “fake containers” in the form of fictitious brands (Stofer), and were used to

prevent other factors such as familiarity, fidelization or consumption habits from interfering with the evaluation of the product.

In a first phase, the participants were asked to classify, at their own discretion, the nutritional quality of the three different products, and to do so for each of the categories (pizzas, cakes and breakfast cereals), as follows: “1. High nutritional quality”; “2. Intermediate nutritional quality”; “3. Low nutritional quality”; and “4. I don’t know.” In this first phase, all products of the three categories were presented to the participants without front labeling.

In a second phase, the participants were randomized to one of the 5 FoPLs: HSR, MTL, Nutri-Score, RI or warning symbols, and were asked to again classify the different products of each food category (pizzas, cakes and breakfast cereals), but this time the products carried the FoPL logo assigned to them. Fig. 1 shows the example of one of the three categories of products used (breakfast cereals with its three products), with the 5 evaluated FoPLs.

The study protocol was approved by the Institutional Review Board of the French Institute for Health and Medical

Table 1 Description of the study population.

	N = 1000/N (%)
<i>Gender</i>	
Males	500 (50.00)
Females	500 (50.00)
<i>Age, years</i>	
18–30	339 (33.90)
31–50	331 (33.10)
>50	330 (33.00)
<i>Educational level</i>	
Primary education	21 (2.10)
Secondary education	316 (31.60)
Technical training, diploma	166 (16.60)
University to degree	282 (28.20)
University beyond degree	215 (21.50)
<i>Income level</i>	
High	330 (33.00)
Medium	330 (33.00)
Low	340 (34.00)
<i>Responsible for buying food at home</i>	
Yes	747 (74.70)
No	35 (3.50)
Divided equally	218 (21.80)
<i>Self-assessment of nutritional quality</i>	
My diet is very unbalanced	11 (1.10)
My diet is unbalanced	162 (16.20)
My diet is fairly balanced	711 (71.10)
My diet is very balanced	116 (11.60)
<i>Nutrition knowledge</i>	
I don't know anything about nutrition	26 (2.60)
My level of knowledge is not very good	287 (28.70)
My level of knowledge is quite good	609 (60.90)
I have a very good knowledge of nutrition	78 (7.80)

Research (IRB Inserm no. 17-404) and the Ethics Committee for Human Research of the University of Curtin, France (approval reference: HRE2017-0760).

Statistical analysis

Those participants who claimed to never or only very rarely purchase at least two of the three food categories were considered non-eligible.

For each participant and food category, the number of correct answers was calculated for tasks to be performed without a logo and with FoPL. An answer was considered correct when the participant correctly classified the nutritional quality of the three products in each category, while an incorrect answer was recorded when one or more of the products in the category were misclassified. For each participant, we calculated the changes in the number of correct answers to the three product categories between the situations without and with the logo that had been assigned to the participant at random.

The calculation yielded a score between -1 (a worsening) and $+1$ (an improvement), with 0 indicating that no

changes had occurred between the two situations. The sum of the scores of the three food categories obtained by the participants could range within an overall score from -3 to $+3$.

Different multivariate ordinal logistic regression models were generated to evaluate the association between the different FoPLs and the changes in the ability to correctly classify the products of the three food categories between the situations without and with the logo. The RI logo was used as a reference in the multivariate logistic regression models because on the one hand it is the logo used at the European level, and on the other hand it is far from being intuitive and indeed stands out for its low and even ineffective level of comprehension.¹² The adjustment variables included gender, age, educational level, household income, involvement in food purchase, and the self-assessment of knowledge regarding nutrition and food quality of the participant. The methodology has been published elsewhere.¹⁴

Sensitivity analyses were performed, with those participants who at the end of the questionnaire stated that they had not seen the FoPL assigned to them during the study being excluded.

Evaluation was made of the potential interactions between the different FoPLs and the individual characteristics of the participants regarding their ability to correctly classify the products of the different food categories.

The statistical analyses were performed using the SAS version 9.3 statistical package (SAS Institute Inc., Cary, NC, USA). Statistical significance was considered for $p \leq 0.05$.

Results

Table 1 shows the individual characteristics of the Spanish population sample included in the study. Fifty percent of the sample consisted of females; 33% of the participants were over 51 years of age; 28% were university graduates; 34% had a low income level; and 75% were responsible for buying food for the home. Seventy-one percent reported a fairly balanced diet, and 61% claimed to be fairly well-informed regarding nutrition.

Compared to the absence of the logo, the Nutri-Score was the FoPL exhibiting a significantly greater increase in correct answers. This was observed for all products. In the pizzas category, the correct answers increased from 88 to 133 in the presence of the logo, corresponding to a 51% increment. In the cakes category, the correct answers increased from 24 to 85 in the presence of the logo, corresponding to a 254% increment. In the breakfast cereals category, the correct answers increased from 58 to 109 in the presence of the logo. Fig. 2 shows the percentages of correct answers referring to the other FoPLs. All the FoPLs improved the percentage of correct answers when compared to the non-labeled situation, though the results differed according to food category. The results of the percentages of correct answers under the two labeling conditions for each randomized FoPL group are shown in Fig. 2.

When asked whether they had seen the FoPL assigned to them, 57% of the participants said that they had seen it, 27.5% said that they had not seen it, and 15% were in doubt. Fig. 3 shows the sensitivity analyses limited to the subgroup of participants who recalled having seen the FoPL

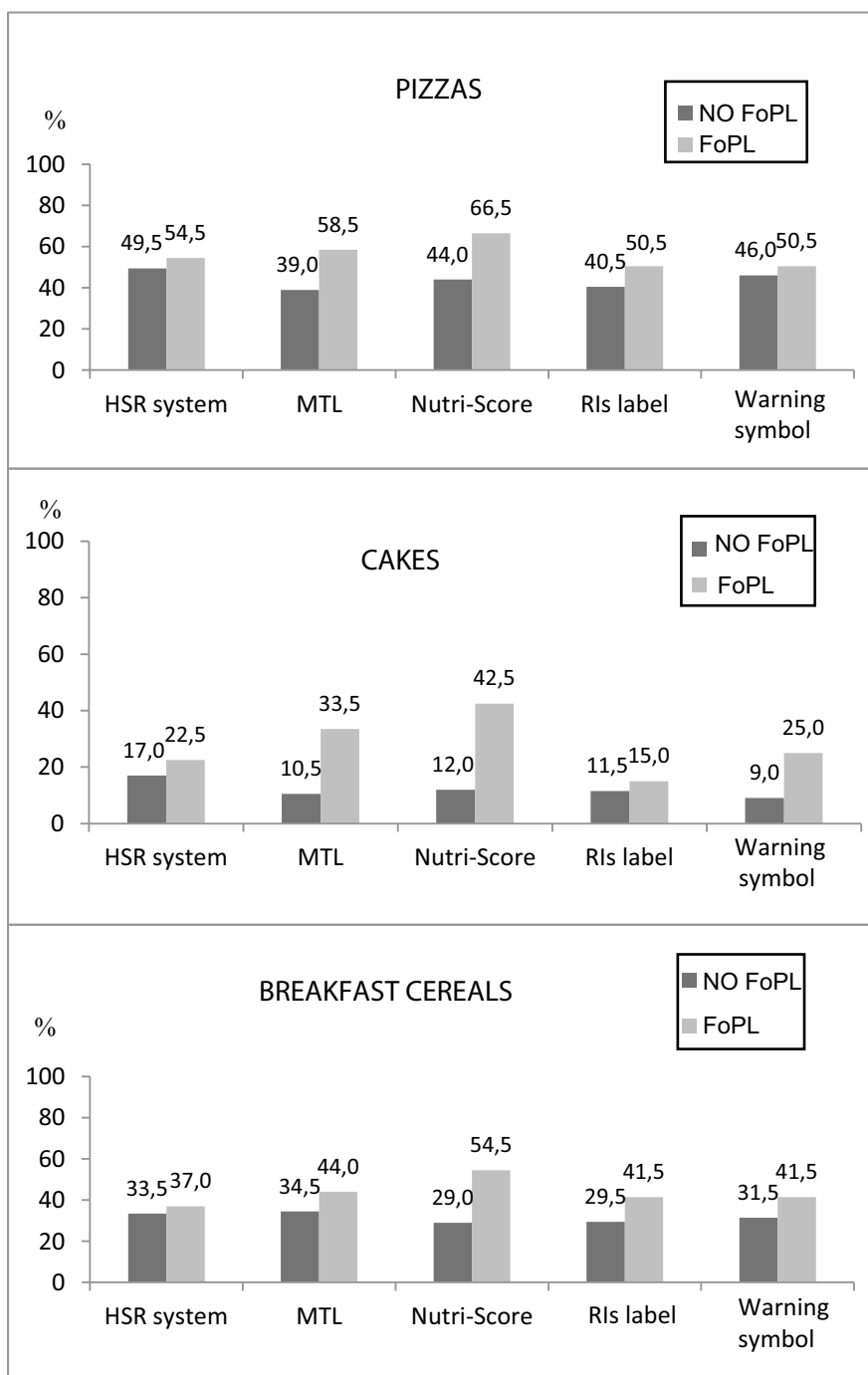


Figure 2 Percentage of correct answers in the sample studied, with the increase between the options without and with the front-of-package labels, corresponding to each labeling group and food category.

FoPL: front-of-package label; HSR: *Health Star Rating System*; MTL: *Multiple Traffic Lights*; RI: *Reference intake*, without front-of-package labeling.

on the packages. The results showed use of the Nutri-Score to result in greater improvement in the assessment of the nutritional quality of the products evaluated. The exception was the pizzas category, where MTL and Nutri-Score yielded similar results. Table 2 shows the results of the association of the different FoPLs with the ability to correctly classify the products. For the three food product categories, and compared to the reference labeling (RI), the Nutri-Score was

associated with a significantly greater increase in the ability to correctly classify the products, followed by MTL, warning symbols and HSR.

Table 3 shows the results of the association of the different FoPLs with change in the ability to correctly classify the products among the participants who recalled having seen the logo. For the three food categories, the Nutri-Score was associated with a significantly greater increase in the ability

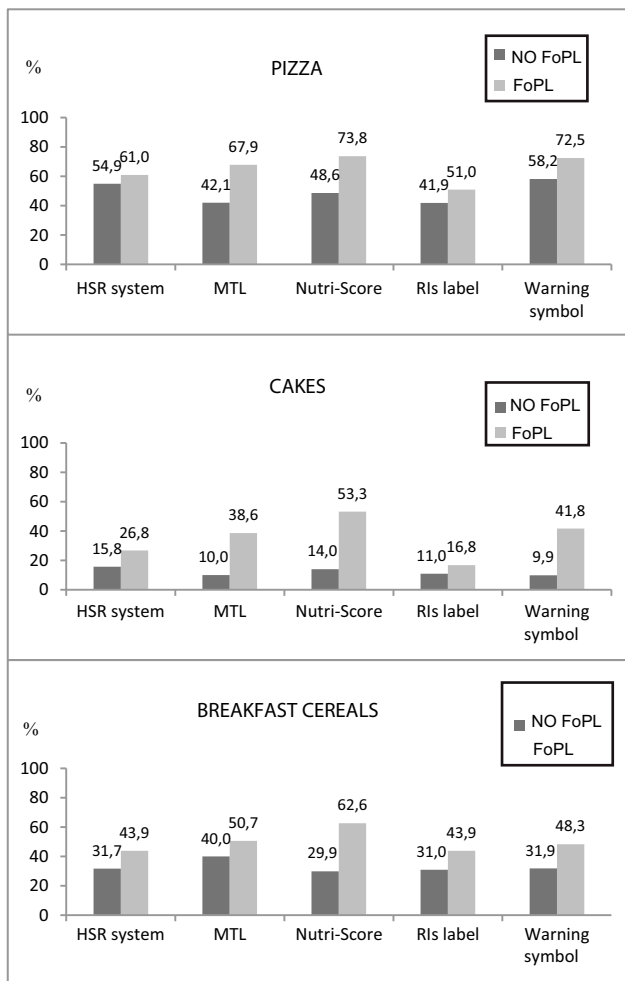


Figure 3 Percentage of correct answers among the participants that recalled seeing the logo, with the increase with respect to the non-labeled situation, according to front-of-package labeling and food category. FoPL: front-of-package label; HSR: *Health Star Rating system*; MTL: *Multiple Traffic Lights*; RI: *Reference intake*, without front-of-package labeling.

to correctly classify the products versus the RI. The warning symbol ranked behind the Nutri-Score in the cakes category and behind the MTL in the pizzas category.

Results according to the individual characteristics of the participants

No interactions were observed with respect to gender, age, educational level, income level, involvement in food purchase, and the self-assessment of nutrition knowledge and food quality of the participants.

Discussion

This is the first study which demonstrates in the Spanish population the superiority of the Nutri-Score FoPL in helping consumers to better classify the nutritional quality of food products. Compared to the RI (the reference FoPL),

Table 2 Association^a between the different front-of-package labels and change in the ability to correctly classify products between the non-labeled and labeled situations.

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	1000	0.81 [0.55-1.20]	0.3	1.77 [1.20-2.61]	0.004	3.00 [2.04-4.41]	<0.001	1.17 [0.79-1.72]	0.4
Pizzas	994	0.73 [0.43-1.22]	0.2	1.68 [1.03-2.73]	0.04	2.11 [1.30-3.42]	0.003	0.72 [0.43-1.20]	0.2
Cakes	975	1.14 [0.68-1.91]	0.6	3.09 [1.87-5.11]	<0.001	4.72 [2.88-7.75]	<0.001	2.10 [1.26-3.48]	0.004
Breakfast cereals	940	0.64 [0.39-1.06]	0.08	0.95 [0.58-1.55]	0.8	1.98 [1.25-3.14]	0.004	0.91 [0.56-1.48]	0.7

HSR: *Health Star Rating system*; CI: confidence interval; MTL: *Multiple Traffic Lights*; OR: *odds ratio*.
^a *Reference Intakes* was used as reference for the multivariate logistic regression models. The multivariate models were adjusted for: gender, age, educational level, household income, involvement in food purchase, self-assessment of nutrition knowledge and nutritional quality. The values in boldface correspond to significant values after multiple test corrections ($p \leq 0.05$).

Table 3 Association^a between the different front-of-package labels and change in the ability to correctly classify products between the non-labeled and labeled situations, among those participants that noted the logo.

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	575	1.15 [0.68–1.95]	0.6	2.26 [1.44–3.55]	0.0004	4.21 [2.60–6.83]	<0.001	2.38 [1.44–3.94]	0.0007
Pizzas	571	0.80 [0.39–1.63]	0.5	2.41 [1.36–4.28]	0.003	2.46 [1.33–4.52]	0.004	1.44 [0.74–2.79]	0.3
Cakes	563	1.30 [0.66–2.54]	0.5	3.24 [1.84–5.69]	<0.001	5.60 [3.09–10.13]	<0.001	3.60 [1.95–6.68]	<0.001
Breakfast cereals	547	1.07 [0.56–2.04]	0.8	0.93 [0.53–1.62]	0.8	2.42 [1.38–4.24]	0.002	1.21 [0.66–2.23]	0.5

HSR: Health Star Rating system; MTL: Multiple Traffic Lights; OR: odds ratio; CI: confidence interval.

^a Reference Intakes was used as reference for the multivariate logistic regression models. The multivariate models were adjusted for: gender, age, educational level, household income, involvement in food purchase, self-assessment of nutrition knowledge and nutritional quality. The values in boldface correspond to significant values after multiple test corrections ($p \leq 0.05$).

the Nutri-Score showed a greater increase in the ability to correctly classify the products, followed by MTL, warning symbols and HSR. The results corresponding to the other FoPLs differed according to the category of the products evaluated.

These results are consistent with those previously obtained in France^{15,16} and with those observed in the other 11 countries of the Front-of-Pack International Comparative Experimental study.¹⁴ This superiority was shown in all categories regarding age, gender, educational level and socioeconomic status. Given these results, two main characteristics appear to influence understanding among Spanish consumers: the use of colors known for their meaning, and the fact of informing about overall nutritional quality instead of specific data per nutrient. The FoPLs associated with the greatest increase in objective understanding were the Nutri-Score and MTL, which are the only FoPLs of the 5 considered in the study that are expressed with colors. The second element of an FoPL that may influence and increase understanding of the nutritional quality of a product is the fact of offering a summary rather than simply providing data according to nutrients. In fact, of the two color logos, the Nutri-Score summarizing logo yielded significantly better results than MTL, which refers to specific nutrients. This observation is consistent with previous results showing that consumers understand summarizing labels better^{17–19} than per nutrient labeling, since they minimize possible confusion related to interpretation of the nutritional terms (e.g., saturated fats, sugar, sodium, etc.).²⁰

The Nutri-Score, by summarizing the nutritional information, reduces the cognitive effort required and the time required to process the labels, thereby allowing for the easier interpretation of the information provided.^{16,21} While the MTL logo provides 5 different specific nutrient information elements, the Nutri-Score appears to be a more effective tool for influencing consumer choice at the moment of purchase, when decisions are usually made very quickly.¹⁸ For these reasons, the added value of the Nutri-Score regarding objective comprehension is the use of properly interpretable colors, as well as its simple, intuitive, summarizing and gradual design that is comprehensible to all consumers.

In addition to its interest in helping consumers to recognize the nutritional quality of food and guide their shopping choices toward healthier foods, a recent study has shown the superiority of the Nutri-Score over other logos (MTL and the Evolved Nutrition Label [ENL], a logo recently proposed by a consortium of 5 large multinationals)²² in reducing the size of food portions considered to be less healthy.²³ The results of our study show that the Nutri-Score, and to a lesser extent MTL, allows for reducing the size of portions of products considered less favorable to health, thus helping consumers to improve their identification of the overall quality of their diet. This latter aspect is particularly interesting and positive from a public health point of view. By contrast, the ENL, with the same graphic format as MTL but calculated per serving and not per 100 g of food, was found to have a limited and even unfavorable impact on the size of the portions selected by the participants in relation to the studied product categories. This suggests that the ENL could lead to a potential increase in the size of the portions of foods for which small amounts are advised. In conclusion, in our study the Nutri-Score appears to be the most

effective FoPL for transmitting information about nutritional quality of food to Spanish consumers. It may therefore be a useful tool in terms of public health, since it helps consumers guide their purchasing choices, so improving their nutritional status and preventing chronic diseases resulting from inadequate nutrition.

Authorship

All the authors contributed to the design, analysis and interpretation of the results, and to the writing and critical review of the manuscript. ME, JC, SH and SP contributed to data collection. Analysis and interpretation of the results were performed primarily by ME, CJ, SH, PG, NB and JS-S. The critical review of the article was the contribution mainly of ME, CJ, SH, PG, NB, JS-S and SP. All the signing authors have approved the final version of the manuscript.

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Conflicts of interest

The authors declare that they have no conflicts of interest.

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References

- Basterra-Gortari FJ, Bes-Rastrollo M, Ruiz-Canela M, Gea A, Martinez-Gonzalez CJ. Prevalence of obesity and diabetes in Spanish adults 1987–2012. *Med Clin (Barc)*. 2017;148:250–6.
- Arroyo-Johnson C, Mincey KD. Obesity epidemiology worldwide. *Gastroenterol Clin North Am*. 2016;45:571–9.
- OMS. [Internet]. Estrategia mundial sobre régimen alimentario, actividad física y salud. Available at: http://www.who.int/dietphysicalactivity/strategy/eb11344/strategy_spanish_web.pdf [accessed 22.11.18].
- WHO. [Internet]. Obesity and overweight. Available at: <http://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight> [accessed 22.11.18].
- Kleef EV, Dagevos H. The growing role of front-of-pack nutrition profile labeling: a consumer perspective on key issues and controversies. *Crit Rev Food Sci Nutr*. 2015;55:291–303.
- Food Standard Agency [Internet]. Front-of-pack traffic light signpost labelling technical guidance; Food Standard Agency: Kingsway, UK; 2007. Available at: https://www.foodwatch.org/fileadmin/Themen/Ampelkennzeichnung/guidance_ampel.issue_1.januar.2007.pdf [accessed 22.11.18].
- Food and Drink Federation. [Internet]. Reference intakes (previously Guideline Daily Amounts). Available at: <http://www.foodlabel.org.uk/label/reference-intakes.aspx> [accessed 22.11.18].
- Carreño I. Chile's black STOP sign for foods high in fat salt or sugar. *Eur J Risk Regul*. 2015;6:622–8.
- Asp Nils G, Bryngelsson S. Health claims in the labelling and marketing of food products: the Swedish food sector's code of practice in a European perspective. *Scand J Food Nutr*. 2007;51:107–26.
- Vyth EL, Steenhuis IHM, Mallant SF, Mol ZL, Brug J, Temminghoff M, et al. A front-of-pack nutrition logo: a quantitative and qualitative process evaluation in the Netherlands. *J Health Commun*. 2009;14:631–45.
- About Health Star Ratings. [Internet]. Australian Government Department of Health and Ageing. Available at: <http://healthstarrating.gov.au/internet/healthstarrating/publishing.nsf/content/about-health-stars> [accessed 22.11.18].
- Julia C, Hercberg S. Development of a new front-of-pack nutrition label in France: the five-colour Nutri-Score. *Public Health Panor*. 2017;3:712–25.
- Grunert Klaus G, Wills Josephine M. A review of European research on consumer response to nutrition information on food labels. *J Public Health*. 2007;15:385–99.
- Egnell M, Talati Z, Hercberg S, Pettigrew S, Julia C. Objective understanding of front-of-package nutrition labels: an international comparative experimental study across 12 countries. *Nutrients*. 2018;10:pii:E1542.
- Ducrot P, Mejean C, Julia C, Kesse-Guyot E, Touvier M, Fezeu LK, et al. Objective understanding of front-of-package nutrition labels among nutritionally at-risk individuals. *Nutrients*. 2015;7:7106–25.
- Ducrot P, Mejean C, Julia C, Kesse-Guyot E, Touvier M, Fezeu L, et al. Effectiveness of front-of-pack nutrition labels in French adults: results from the NutriNet-Sante Cohort Study. *PLoS ONE*. 2015;10:e0140898.
- Hersey JC, Wohlgenant KC, Arsenault JE, Kosa KM, Muth MK. Effects of front-of-package and shelf nutrition labeling systems on consumers. *Nutr Rev*. 2013;71:1–14.
- Feunekes GI, Gortemaker IA, Willems AA, Lion R, van den Kommer M. Front-of-pack nutrition labelling: testing effectiveness of different nutrition labelling formats front-of-pack in four European countries. *Appetite*. 2008;50:57–70.
- Arrúa A, Machín L, Curutchet MR, Martínez J, Antúnez L, Alcaire F, et al. Warnings as a directive front-of-pack nutrition labelling scheme: comparison with the guideline daily amount and traffic-light systems. *Public Health Nutr*. 2017;20:2308–17.
- Helper P, Shultz TR. The effects of nutrition labeling on consumer food choice: a psychological experiment and computational model. *Ann NY Acad Sci*. 2014;1331:174–85.
- Mejean C, Macouillard P, Peneau S, Hercberg S, Castetbon K. Consumer acceptability and understanding of front-of-pack nutrition labels. *J Hum Nutr Diet*. 2013;26:494–503.
- ENL Taskforce [Internet]. Promoting healthier diets through evolved nutrition labelling—project on defining the reference portion amounts. Available at: https://ec.europa.eu/health/sites/health/files/nutrition_physical_activity/docs/ev_20170309_co08_en.pdf [accessed 22.11.18].
- Egnell M, Kesse-Guyot E, Galan P, Touvier M, Rayner M, Jewell J, et al. Impact of front-of-pack nutrition labels on portion size selection: an experimental study in a French cohort. *Nutrients*. 2018;10:1268, <http://dx.doi.org/10.3390/nu10091268>.