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A study is 21 times more likely to find unfavourable results about the nutrition label Nutri-Score if the authors declare a conflict of interest or the study is funded by the food industry

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Diseases related to unhealthy diets were responsible for 11 million deaths worldwide in 2017.[1] Non-communicable diseases, such as type 2 diabetes, cardiovascular diseases and cancer, are responsible for 80% of the disease burden in European Union countries. They are the leading cause of avoidable premature deaths and have become a major burden for health systems.[1 2] Dietary factors have long been recognised as one of the leading risk factors of these chronic diseases[1–5] and key policy levers for public health as they represent modifiable determinants that could be addressed through primary prevention interventions.[3] This is why worldwide government-led strategies and policies have introduced interventions aiming at improving diets in the population. Among the different possible interventions, front-of-pack nutrition labels (FoPNLs) have received growing attention of public health authorities by delivering simple at-a-glance nutritional information allowing consumers to easily compare nutritional quality across food products.

The Nutri-Score is a summary-graded colour-coded FoPNL aiming to inform consumers, in a simple and understandable way, about the overall nutritional value of food products. That way it helps them make better-informed and healthier choices at the point of purchase. It also encourages manufacturers to improve the nutritional quality of their products.[4] It uses a five-colour scale (from dark green to dark orange) associated with letters, from A (the best) to E (the worst).

Scientists, health professionals, learned societies, expert committees and public health authorities consider that the Nutri-Score relies on very strong scientific evidence, both in how the score is developed and in the demonstration of its effectiveness and usefulness in terms of public health.[5 6] Given the evidence these experts consider that Nutri-Score should become mandatory in Europe. On the other hand, Nutri-Score is the subject of much criticism and numerous attacks by food manufacturers and some agricultural sectors. Some of this criticism is also relayed by politicians and political parties. These detractors claim that scientific studies are insufficient to support the use of Nutri-Score. Since this nutrition labelling was first used in 2014, numerous scientific studies have been published in peer-reviewed scientific journals investigating the validity of its underlying nutrient profile model and graphic design. A review of the literature (see online supplemental appendix) found a total of 149 scientific articles on Nutri-Score (or its initial version, the five-colour FoPNL or 5C label) have been published in peer-reviewed journals between January 2013 and September 2022.

SUMMARY BOX

⇒ Many scientists and health professionals consider that scientific evidence that supports front-of-pack nutrition labelling, such as 'Nutri-Score', becomes mandatory in Europe to help consumers make healthier choices at the point of purchase.
⇒ Politicians and political parties, food manufacturers and some agricultural sectors are opposed to nutrition labelling such as 'Nutri-Score' as they claim that scientific studies insufficiently support making it into a policy.
⇒ The findings of 83% of studies published in peer-reviewed journals support nutrition labelling such as 'Nutri-Score'.
⇒ The probability for an article to show results that are not favourable to nutrition labelling such as 'Nutri-Score' is 21 times higher if the authors declare a conflict of interest or if the study is funded by the food industry.

Of these, 15 articles focused on the description of some food characteristics and/or evaluation of its implementation, including the evolution of its adoption by the food manufacturers and the role of industry lobbying. Of the 134 articles (110 original articles and 24 general reviews) investigating the effectiveness of the Nutri-Score using various criteria (validation of the underlying nutrient profile model or graphic design), 111 (83%) have conclusions favourable to the Nutri-Score. These articles, for example, demonstrated the relevance of the underlying algorithm,[7] a better performance than other existing nutrition labels in terms of perception/attractiveness,[8] an impact on food selection and on the nutritional quality of food purchases.[9]

Only 23 of the 134 articles (17%) on the effectiveness of the labelling model had results not favourable to the Nutri-Score. These 23 articles did not demonstrate its effectiveness, or showed less favourable effects than other labels,[10] or suggested that its algorithm be improved.[11]

Of the 111 studies considered favourable to the Nutri-Score, only 2 included declarations of a conflict of interest or indicated that the authors had received funding from the food industry (1.8%). Conversely, 9 of the 23 studies presenting results which are not favourable (39.1%) included a conflict of interest by the authors or that the study had received funding from the food industry. Among these nine studies, six[11–16] are narrative reviews or papers not presenting any original research. These especially aim to sow doubts about the validity of the algorithm underlying the computation of Nutri-Score and/or on those demonstrating its efficiency in terms of objective understanding, food choice and impact on the nutritional quality of food purchases.

This can be seen, for example, in two recently narrative reviews funded by the food industry that resulted in negative findings on Nutri-Score, questioning the positive conclusions of the authors of the original scientific works.[12 14] Three private structures were involved in the funding (or conflicts of interest of authors) of studies not favourable to Nutri-Score: the Dutch Dairy Association, Federalimentare (the Italian Federation of the Food Industry) and the Italian Nutrition Foundation (supported by 18 Italian food manufacturers). The impact of such private support to research specifically aims to prevent Nutri-Score from being adopted in 2023 as the single mandatory FoPNL in Europe as part of the Farm to Fork Strategy of the European Commission.

The probability for an article to show results that are not favourable to nutrition labelling such as 'Nutri-Score' is 21 times higher if the authors declared a conflict of interest or if the study was funded by the food industry. This finding of unfavorable results to Nutri-score in papers declaring aconflict of interest or that are funded by the food industry persists and is seven times higher even if all studies where the academic research team that developed Nutri-Score (without any conflict of interest) are excluded (38articles published by the academic research team and 35 articles publishedin collaboration between the team and other academic research teams).

These results about the role of financial conflicts of interest on the results of studies on Nutri-Score confirm the links between funding for studies and their results, the so-called funding bias, already described in several publications.[12 17–22] A study[20] analysing articles published in 2018 in 10 nutrition and dietetics journals found that more than half (55%) of the articles for which the food industry provided funding had results aligned to the interests of the food industry, compared with only 9.7% of the articles published without food industry support.

This review shows that industry-funded research focuses on narrative reviews aimed at casting doubt on the relevance of findings of previous scientific papers whose results are favourable to Nutri-Score. Taking into account conflicts of interest and industrial funding appears to be an important indicator when assessing the relevance and the performance of a public health tool such as FoPNL Nutri-Score. Such focus on funding sources and conflicts of interest can help shed light on the various strategies used by the food production and processing industry and other economic actors to discredit tools or policies that are deemed a threat to the economic interests of these actors.[23] The food industry is only one of many private sector groups trying to influence policy and practice.

Addressing this issue requires on the one hand strong government support for independent scientific research. On the other hand, policymakers need to be made aware and held accountable if and when conflicts of interest arise in decision-making processes.

Accountability can be promoted by academia and civil society through research, publications and debates of these issues in the public domain including in scientific journals. Scientific journals also play a key role in guaranteeing that conflicts of interests are disclosed. Finally, it is important to guarantee maximum transparency on funding from private sources so that certain private sector interests do not take precedence over science.

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Annex : methodology for the review presented in the commentary

We identified all studies performed on Nutri-Score (and its initial version, the 5-colours FoPNL or 5C label) published between January 1st 2014 and September 30th 2022 by a systematic search in PUBMED, using the keywords « Nutri-Score », « 5-C label », « 5-C label + Front-of-pack nutrition labels » and « Nutri-Score + Front-of-pack nutrition labels ».

The articles were then classified by two independent scientific readers into:

1) original articles (including articles presenting specific results about the characteristics and performances of the Nutri-Score assessed alone or in comparison to other nutrition labels);

2) general reviews (systematic reviews, narrative reviews, conceptual articles and papers about the context of the Nutri-Score roll out).

The determination of the existence of conflicts of interest was based on the informations given by the authors within the publications in both the Conflict of Interest section and the Funding section. This include declaration about if some of the authors were salaried employees or received grants, contracts and honoraria from private entities with an interest in the topic and/or if some served directlty as consultant for the specific study and/or if they received financial support for conducting the literature search and writing the manuscript and/or if some were members (even non-paid) of working group, institutes or organization supported by food companies and/or if the authors declared that the research received fundinds from private entities

Articles were classified as ‘supporting’ if the authors reported positive findings regarding the validation of the nutrient profile model (alignment with dietary recommendations, associations with dietary intakes, nutritional status or health events in the expected direction) or validation of the graphical design (favourable perception, objective understanding, effects on purchasing intention or purchases in the expected direction).

Articles were classified as ‘non-supportive’ if they reported non-significant associations or results in the opposite direction as expected. For reviews, articles were classified as ‘supporting’ if they overall concluded in favour of the Nutri-Score, and ‘non-supportive’ otherwise.

Appendix to support the publication text

The table presenting the 134 articles (titles, 1st author, review and references). It also presents the classification made on the conclusions of the articles in favorable (F, n=111) and unfavorable (U, n=23) but also the information on the COI or not and of interest/private funding (with the description of COI) (2 F/111 and 9 U/23). Finally, it presents the articles published by EREN researchers alone (n= 38, row with O in the column entitled articles published by scientidts of EREN only) or within the framework of publications in cooperation with other researchers (n=35, row with O in the column entitled articles that associate scientists of EREN and scientists from other teams).

		Articles favorable to Nutri-Score	Articles unfavorable to Nutri-Score	Articles with COI of authors and/or ptivate fundings (declared in the paper)	Articles published by scientidts of EREN (only)	Articles that associate scientists of EREN and scientists from other teams
1	Introducing the Front-Of-Pack Acceptance Model: the role of usefulness and ease of use in European consumers' acceptance of Front-Of-Pack Labels. Mazzù MF et al *Int J Food Sci Nutr. 2022 May;73(3):378-395*		U			
2	Association between the nutrient profile system underpinning the Nutri-Score front-of-pack nutrition label and mortality in the SUN Project : a prospective cohort study Gómez-Donoso C et al *Clin Nutr. 2021 Mar;40(3):1085-1094.*	F				
3	Front-of-package food labels : A narrative review Temple NJ. *Appetite. 2020 Jan 1 ;144:104485. doi : 10.1016/j.appet.2019.104485. Epub 2019 Oct 9*		U			
4	Food consumption based on the nutrient profile system underlying the Nutri-Score and renal function in older adults.	F				

	Montero-Salazar H et al *Clin Nutr. 2022 Jul;41(7):1541-1548.*					
5	Associations Between the Modified Food Standard Agency Nutrient Profiling System Dietary Index and Cardiovascular Risk Factors in an Elderly Population Khoury N et al *Front. Nutr., 14 July 2022*	F		COI JSS served on the board of the International Nut and Dried Fruit Council and received grant support through this institution. He also served in the Executive Committee of the Instituto Danone, Spain, and on the Scientific Committee of the Danone International Institute. He received research support from the Patrimonio Comunal Olivarero, Spain, and Borges S.A., Spain. He received consulting fees or travel expenses from Eroski Foundation, the Instituto Danone, Spain, Mundipharma and Abbot Laboratories. ER reports grants, personal fees, non-financial support, and others from California Walnut Commission and Alexion, personal fees, non-financial support, and others from Ferrer International and Danone, and personal fees from Amarin, other than the submitted study.		
6	The Nutri-Score nutrition label : a public health tool based on rigorous scientific evidence aiming to improve the nutritional status of the population	F				O
7	Nutri-Score labeling has improved a lot Rodríguez Artalejo F et al *Nutr Hosp. 2022 Dec 20;39(6):1203-1204.* *doi: 10.20960/nh.04503*	F				
8	Five-color Nutri-Score labeling and mortality risk in a nationwide, population-based cohort in Spain : the Study on Nutrition and Cardiovascular Risk in Spain (ENRICA) Donat-Vargas C et al	F				

	Am J Clin Nutr. 2021 May 8;113(5):1301-1311					
9	Objective understanding of Nutri-Score Front-Of-Package nutrition label according to individual characteristics of subjects : Comparisons with other format labels Egnell M et al *PloS one 13, no 8, 2018 : e0202095*	F			O	
10	Comparison of appropriateness of Nutri-Score and other front-of-pack nutrition labels across a group of Moroccan consumers : awareness, understanding and food choices Aguenaou H et al *Archives of Public Health, May 6;79(1):71.*	F				
11	Modelling the impact of different front-of-package nutrition labels on mortality from non-communicable chronic disease Egnell M et al *Int. J. Behav. Nutr. Phys. Act. 2019, 16, 56.*	F				O
12	Nutritional quality of food as represented by the FSAm-NPS nutrient profiling system underlying the Nutri-Score label and cancer risk in Europe : Results from the EPIC prospective cohort study. Deschasaux M et al *PLoS medicine 15, no 9, 2018 : e1002651.*	F				O
13	Are self-reported unhealthy food choices associated with an increased risk of breast cancer ? Prospective cohort study using the British Food Standards Agency nutrient profiling system Deschasaux M et al *BMJ open 7, no 6, 2017 : e013718.*	F			O	
14	Association between nutritional profiles of foods underlying Nutri-Score front-of-pack labels and mortality : EPIC cohort study in 10 European countries Deschasaux M et al *BMJ. 2020 Sep 16;370:m3173. doi: 10.1136/bmj.m3173. PMID: 32938660; PMCID: PMC7491938*	F				O

15	Prospective association between a dietary quality index based on a nutrient profiling system and cardiovascular disease risk Adriouch S et al *European journal of preventive cardiology 23, no 15 (2016) : 1669-76*.	F			O	
16	Prospective association between cancer risk and an individual dietary index based on the British Food Standards Agency Nutrient Profiling System Donnenfeld M et al *British Journal of Nutrition 114, no 10 (2015) : 1702 10.*	F			0	
17	Joint association of food nutritional profile by Nutri-Score front-of-pack label and ultra-processed food intake with mortality: Moli-sani prospective cohort study Bonaccio M et al *BMJ* 2022; 378 doi: https://doi.org/10.1136/bmj-2022-070688	F				
18	Prospective associations between a dietary index based on the British Food Standard Agency nutrient profiling system and 13-year weight gain in the SU. VI. MAX cohort Julia C et al. *Preventive medicine 81 (2015) : 189 94.*	F			O	
19	Nutri-Score : the results 3 years after its official adoption In France Hercberg S Rev Prat 2021 Feb ;71(2):151-154	F			O	
20	Performance of the Front-of-Pack Nutrition Label Nutri-Score to Discriminate the Nutritional Quality of Foods Products : A Comparative Study across 8 European Countries Dréano-Trécant L, et al. *Nutrients 2020, 12(5), 1303*	F			O	
21	Ability of the Nutri-Score front-of-pack nutrition label to discriminate the nutritional quality of foods in the German food market and consistency with nutritional recommendations	F			O	

	Szabo de Edelenyi F *Archives of Public Health (2019)*					
22	Performance of a five category front-of-pack labelling system–the 5-colour nutrition label–to differentiate nutritional quality of breakfast cereals in France Julia C et al *BMC public health 15, no 1 (2015) : 179.*	F			O	
23	Application of the British Food Standards Agency nutrient profiling system in a French food composition database Julia C et al *British Journal of Nutrition 112, no 10 (2014) : 1699 1705.*	F			O	
24	Alignment of Nutri-Score with Mediterranean Diet Pyramid: A Food Level Analysis. Vlassopoulos, A et al *Nutrients* 2022, *14*, 5097	F				
25	Food Choice Under Five Front-of-Package Nutrition Label Conditions : An Experimental Study Across 12 Countries Talati Z et al *Am J Public Health. 2019 ;109(12):1770 5*	F				O
26	Relationship between front-of-pack labeling and nutritional characteristics of food products: An attempt of an analytical approach. Martini D et al *Front Nutr. 2022 Aug 19;9:963592*		U	COI *Open access publication fees are supported by Nutrition Foundation of Italy (NFI). Authors AP and FM are, respectively, President and Scientific Director at NFI, a non-profit organization partially supported by 18 food companies*		
27	Validation of the FSA nutrient profiling system dietary index in French adults—findings from SUVIMAX study Julia C et al. *European journal of nutrition 55, no 5 (2016) : 1901 10.*	F			O	
28	The 5-CNL front-of-pack nutrition label appears an effective tool to achieve food substitutions towards healthier diets across dietary profiles Julia C et al *PloS one 11, no 6 (2016) : e0157545.*	F			O	

29	Score de qualité nutritionnelle des aliments de la Food Standards Agency appliqué aux consommations alimentaires individuelles des adultes en France Deschamps V et al *BEH, 24-25- 7 juillet 2015*	F			O	
30	Experimental study of front-of-package nutrition labels' efficacy on perceived healthfulness of sugar-sweetened beverages among youth in six countries. Hock K et al *Prev Med Rep. 2021 Sep 28;24:101577.*		U			
31	Food Choice Under Five Front-of-Package Nutrition Label Conditions : An Experimental Study Across 12 Countries Talati Z et al *Am J Public Health. 2019 ;109(12):1770 5*	F				O
32	A cross-country experimental study on consumers' subjective understanding and liking on front-of-pack nutrition labels Mazzù MF et al *Int J Food Sci Nutr. 2021 Sep;72(6):833-847.*		U	COI This research received non-conditional funding from Federalimentare		
33	Objective understanding of the Nutri-score front-of-pack label by European consumers and its effect on food choices : an online experimental study Egnell M et al *International Journal of Behavioral Nutrition and Physical Activity (2020)*	F				O
34	Consumers' Perceptions of Five Front-of-Package Nutrition Labels : An Experimental Study Across 12 Countrie Talati Z et al *Nutrients. 2019 Aug 16 ;11(8)*	F				O
35	Associations between the Nutrient Profiling System Underlying the Nutri-Score Nutrition Label and Biomarkers of Chronic Low-Grade Inflammation: A Cross-Sectional Analysis of a Middle- to Older-Aged Population. Millar SR et al *Nutrients. 2022 Jul 29;14(15):3122.*	F				

36	Literacy and Its Associations with Understanding and Perception of Front-of-Package Nutrition Labels among Higher Education Students. Hoge A et al *Int J Environ Res Public Health. 2022 Jul 19;19(14):8751.*	F				
37	The impact of the Nutri-Score nutrition label on perceived healthiness and purchase intentions De Temmerman J et al *Appetite (2021)*, 157:104995. doi: 10.1016/j.appet.2020.104995	F				
38	Nutri-Score and Nutrition Facts Panel through the Eyes of the Consumer : Correct Healthfulness Estimations Depend on Transparent Labels, Fixation Duration, and Product Equivocality Bossuyt S et al *Nutrients 2021, 13; 9, 2915*	F				
39	Consumers' food choices, understanding and perceptions in response to different front-of-pack nutrition labelling systems in Belgium: results from an online experimental study. Vandevijvere S et al *Arch Public Health. 2020, 3;78:30.*	F				O
40	Bulgarian consumers' objective understanding of front-of-package nutrition labels : a comparative, randomized study Andreeva VA et al *Public Health 78, 35 (2020).*	F				O
41	Cross-sectional comparisons of dietary indexes underlying nutrition labels: nutri-score, Canadian 'high in' labels and Diabetes Canada Clinical Practices (DCCP). Paper L et al *Eur J Nutr* 2022. Epub 2022 Aug 12.	F				O
42	Types and Aspects of Front-of-Package Labeling Preferred by Parents: Insights for Policy Making in China. Cui J et al *Nutrients. 2022 Feb 14;14, 4:800.*		U			

43	Compared to other front-of-pack nutrition labels, the Nutri-Score emerged as the most efficient to inform Swiss consumers on the nutritional quality of food products Egnell M et al *Plos One (2020) Feb 27;15(2):e0228179*	F				O
44	The Effect of Randomly Providing Nutri-Score Information on Actual Purchases in Colombia Mora-García CA et al *Nutrients 2019, 11, 491*		U			
45	Awareness, Perception and Self-Reported Impact on Food Choices among French Adolescents. Ducrot P et al *Nutrients. 2022 Jul 29;14(15):3119*	F				O
46	Appropriation of the Front-of-Pack Nutrition Label Nutri-Score across the French Population: Evolution of Awareness, Support, and Purchasing Behaviors between 2018 and 2019. Sarda B et al. *Nutrients 2020, 12, 2887*	F				O
47	Perception of different formats of front-of-pack nutrition labels according to sociodemographic, lifestyle and dietary factors in a French population : cross-sectional study among the NutriNet-Santé cohort participants Julia C et al *BMJ Open 7, 6 (2017) : e016108.*	F			O	
48	Perception de différents systèmes d'information nutritionnelle actuellement proposés en France en fonction du statut pondéral Julia C et al *Obes. 12, 1, 2017, 5-15.*	F			O	
49	Effectiveness of front-of-pack nutrition labels in French adults : results from the NutriNet-Sante cohort study Ducrot P et al *PloS one 10, 10 ; 2015 : e0140898.*	F			O	
50	Objective understanding of front-of-package nutrition labels among nutritionally at-risk individuals	F			O	

	Ducrot et al *Nutrients 7, 8, 2015 : 7106 25.*					
51	The influence of the Nutri-Score on the perceived healthiness of foods labelled with a nutrition claim of sugar. Jürkenbeck K et al. *PLOS One17, 8: e0272220.*	F				
52	Nutri-Score : Effectiveness of the Nutrition Label introduced in France Julia C et al *Ernhahrung Umschau, 2017, 64, no 12 : M685 91.*	F			O	
53	Front-of-pack Nutri-Score labelling in France : an evidence-based policy Julia C et al *Lancet Public Health 3, no 4 (2018) : e164.*	F			O	
54	Comparison of front-of-pack labels to help German consumers understand the nutritional quality of food products. Colour-coded labels outperform all other systems Egnell M et al *Ernhahrung Umschau*, *66, 5, 76-84, 2019*	F				O
55	Online Consumer Survey Comparing Different Front-of-Pack Labels in Greece Kontopoulou L et al *Nutrients 2022, 14, 46.*	F				
56	Nutri-Score and NutrInform Battery: Effects on Performance and Preference in Italian Consumers. Fialon M et al *Nutrients. 2022 Aug 26;14(17):3511*	F				O
57	Effects on consumers' subjective understanding of a new front-of-pack nutritional label : a study on Italian consumers Mazzù MF et al *International Journal of Food Sciences and Nutrition 2021 May, 72, 3:357-366*		U	COI This research received non-conditional funding from Federalimentare		
58	Le logo nutritionnel Nutri-Score : un outil au service du consommateur marocain. Aguenaou H et al *Rev Mar Sciences Agron Vet 6, 3, 2018*	F				O

59	Nutri-Score and NutrInform Battery: Effects on Performance and Preference in Italian Consumers. Fialon M et al *Nutrients. 2022 Aug 26, 14, 17, 3511*	F				O
60	Guideline Daily Amounts Versus Nutri-Score Labeling: Perceptions of Greek Consumers About Front-of-Pack Label. Kontopoulou L et al *Cureus 2022, 14(12)*: e32198	F				
61	Impact of different front-of-pack nutrition labels on foods according to their nutritional quality : a comparative study in Mexico Hernández-Nava LG et al *Salud Publ Mex.Oct 2019, 61(5):609-18*	F				
62	Polish Consumers' Understanding of Different Front-of-Package Food Labels: A Randomized Experiment. Andreeva VA et al *Foods. 2022 Jan 5;11(1):134*	F				O
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64	Impact of different front-of-pack nutrition labels on online food choices. Santos O et al *Appetite. 2020 Nov 1;154:104795*		U			
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