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The Nutri-Score for a Healthy Diet: Pros and Cons

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ABSTRACT

Packaging labels must provide comprehensible nutritional information for consumers and represent a crucial educational tool to prevent non-communicable diseases such as metabolic syndrome, cardiovascular diseases, and cancers. Since 2017, France and other European countries have adopted the 5-color Nutri-Score label. This review describes Nutri-Score and analyses the latest evidence over the last two years regarding the strengths and weaknesses of Nutri-Score. Although various recent large studies correlated the application of the Nutri-Score algorithm (the purchases of some healthy products) and the lower risk of developing chronic diseases, further studies are necessary to evaluate these relationships with a large range of products in a real-life supermarket. The validation of a unique front-packaging label model remains controversial, and to date, no consensus has been reached. Several aspects need to be improved in the algorithm, such as the consideration of the degree of processing and the presence of food additives. Probably, the combination of various front-of packages labels could be the solution. In any case, its validity should be assessed by European scientific food authorities such as EFSA with further large human studies in real-life purchase conditions.

INTRODUCTION

In Europe, one-half of adults and nearly one in three children is overweight, while almost one in five citizens is obese[1]. An unhealthy dietary pattern is a significant risk factor for obesity and other non-communicable diseases (NCDs). To prevent obesity and chronic diseases, consumers should be better informed of the nutritional properties of the products they buy to promote healthy dietary choices. Currently, nutrition labelling is based on European Regulation No. 1169/2011 on food information for consumers[2]. This regulation, in conformity with the directives of the *Codex Alimentarius*, aims at providing the consumer the basis on which he can make informed decisions and use foodstuffs in complete safety, in particular respecting health, economic, ecological, social, and ethical considerations[2]. Thus, up-to-date, mandatory information on labeling includes, for example,

KEYWORDS

NUTRI-SCORE
FRONT-OF-PACKAGE LABEL
NUTRITION LABELING
NUTRIENT PROFILE MODEL
VALIDITY
ULTRA-PROCESSED FOOD
FOOD ADDITIVES
HEALTHY DIET
NON-COMMUNICABLE DISEASES

the name of the foodstuff, the list of ingredients and potential allergens, the quantity of ingredients, the net amount of foodstuff, the date of minimum durability or use-by date, or the nutritional declaration (i.e., the table indicating the nutritional composition of the product). The mandatory nutritional statement on all pre-packaged products includes the energy value, the amount of fats and saturated fats, carbohydrates, sugars, proteins, and salt[3]. This declaration may optionally be supplemented by the contents of monounsaturated and polyunsaturated fatty acids, polyols, starch, dietary fibers, and specific vitamins and certain minerals[4]. This information must appear for 100 g or 100 mL of foodstuff and may also be expressed per portion, the size of which must be specified on the packaging[5]. In addition to the mandatory nutritional declaration on the back of the packaging, manufacturers in many European countries, including France, have adopted the voluntary Nutri-Score label[6]. A European legislative proposal on nutrition labeling will be performed in the coming months, and they intend to standardize a unique front-of-pack food label across Europe. In this context, this review aims at describing the Nutri-Score design, analyzing the latest evidence, and dissecting its strengths and weaknesses.

MATERIALS AND METHODS

A systematic literature search of the latest articles was performed using Medline (via PubMed) and Web of Science databases in the last two years on 25th October 2022. The search terms included: ("nutriscore" OR "nutri-score") AND ("food*" OR "beverage*" OR "processed foods" OR "ultra-processed food"). Table 1 illustrates the search strategies. Titles and abstracts of publications were retrieved and screened to select relevant papers. A total of 15 duplicates were eliminated and 163 publications were considered irrelevant. Twenty reviews, systematic reviews and meta-analyses, and nine randomized controlled trials were identified.

Nutri-Score: an interpretative front-of-pack label

The Nutri-Score is an interpretative front-of-pack label showing the nutrient quality on a graded scale of five colors, from dark green to red, in combination with a letter (A to E)[7]. The Nutri-Score algorithm combines positive characteristics with negative characteristics to achieve a score between –15 (healthy) and +40 (unhealthy). The dark green A reflects the highest nutritional quality, while the red E represents the lowest nutritional quality[8].

The algorithm of Nutri-Score includes energy, sugars, saturated fatty acids, sodium, protein, fiber, and percentage of fruits, vegetables, legumes, and nuts. The Nutri-Score is based on the Food Standards Agency nutrient profile in the United Kingdom, developed to regulate television advertising to children but modified by the Health and Care Professions Council (HCSP) to match the French context and to be applied as a system of nutrition labeling of five classes named as score Food Standards Agency modified – Nutrient Profiling System (FSAm-NPS)[7]. The FSAm-NPS awards point according to the content of the product (food per 100 g or drink per 100 mL) in energy, simple sugars, SFA, sodium, fiber, protein, fruit, vegetables, legumes, and nuts[9]. Thus, points are awarded for the content of unfavorable elements (component A), the consumption of which should be limited from 0 to 10 points for energy (kJ), simple sugars (g), AGS (g), and sodium (mg). Then, points are allocated to the content of favorable elements (component C), the consumption of which should be encouraged, from 0 to 5 points for each of the following elements: fiber (g), protein (g), fruits, vegetables, legumes and nuts (%). Recently, a modification of the allocation of points for the content of fruits, legumes, and nuts was carried out by counting the percentage of olive oil, rapeseed, and nuts[10]. The FSAm-NPS discrete overall score is then obtained by taking the difference between the points of component A and those of component C, characterizing the overall

Table 1. Search strategies performed on 25th October 2022 (last two years).

Database	**PubMed (Medline)**	**Results**
Search strategy		
#1	nutriscore OR nutri-score	116
#2	food* OR "beverage* OR (processed AND food*) OR ultra-processed AND food	1,065,792
#3	#1 AND #2	101
Database	**Web of Science**	**Results**
Search strategy		
#1	nutriscore OR nutri-score	227
#2	food* OR "beverage* OR (processed AND food*) OR ultra-processed AND food	2,107,247
#3	#1 AND #2	117

nutritional quality of the product, theoretically between –15 points (for products of better nutritional quality) and +40 points (for products of lower nutritional quality).

Nutri-Score *versus* no labels and other front-of-pack nutrition labels

All recent randomized controlled trials (RCTs) demonstrated significant improvements in the choice of healthy foods and diet quality with Nutri-Score compared with no labels or other labels (Table 2). An RCT of 2431 French consumers demonstrated that the Nutri-Score led to purchase intentions of products with significantly lower calories and saturated fatty acids content compared with no label or reference intakes[11]. These differences resulted from participants avoiding some packaged products (sweets, dairy, and starches) and purchasing more considerable amounts of fresh fruit and meat[11]. Khune et al recently assessed that Nutri-Score label led people (354 Swiss consumers) to buy more products, which were, in general, healthy products but also included rather unhealthy products compared with a healthy food label, nutrient (sugar)-specific label conditions (manga and comic) or no label[12]. Another RCT of 2530 British consumers[13] compared five front-of-pack labels such as Nutri-Score, Multiple Traffic Lights, Warning Label, Positive Choice tick, and no-label in the purchase intentions of pizza, drinks, cakes, crisps, yogurts, breakfast cereals showing that the probability of correctly ranking the healthiest product was significantly greater for the Nutri-Score, Multiple traffic lights and Warning Label across all products [13]. In a Swiss RCT of 354 University students, participants exposed to the Nutri-Score chose products with a higher nutritional quality – i.e., 8% higher healthy trolley index (HETI), 3.3% less sugar, 7.5% less saturated fat. Interestingly, participants with low food literacy seemed to benefit from the front-of-pack labels – e.g., 11% higher HETI, 10.5% less sugar, 5.5% less saturated fat[14]. Goiana da Silva et al also found that the Nutri-Score led to a greater improvement for all food categories compared to the reference intakes (p<0.0001) and to a higher percentage to correctly rank choices according to nutritional quality[15]. Finally, post-hoc analyses from three recent RCTs of three French-specific populations – students (n=1866), low-income individuals (n=336), and subjects suffering from cardiometabolic diseases (n=1180) – compared Nutri-Score, reference intake, and no label[16]. The Nutri-Score affixed on pre-packed foods contained a higher proportion of unpacked products – especially raw fruits and meats (with no label), compared to participants purchasing with no label (p<0.0001) or with the Reference Intakes (p<0.0001). This higher proportion was partly explained by fewer purchases of pre-packed processed and ultra-processed products overall in the Nutri-Score group[16]. A recent study of 1064 Italian consumers compared Nutri-Score with NutrInform battery in the choice of breakfast products, breakfast cereals, and added fats[17]. The NutrInform Battery is a nutrient-specific non-interpretive scheme indicating the content of nutrients in a portion of a food product. It is a new enriched informative label promoted by the Italian Ministry of Health and deeply studied by the Center for Study and Research on Obesity, Milan University[18]. Fialon et al showed that Nutri-Score outperformed NutrInform in all food categories, with the highest odds ratio being observed for added fats (OR = 21.7 [15.3-31.1], p<0.0001)[17]. Moreover, with Nutri-Score, Italian participants were more likely to intend to purchase nutritionally healthier products than with NutrInform (OR = 5.29 [4.02-6.97], p<0.0001). Focusing on olive oil, the Nutri-Score group had a higher purchase intention of olive oil compared to those in the NutrInform group (OR = 1.92 [1.42-2.60], p<0.0001) after manipulating the label[17].

Notwithstanding these results, all these RCTs have some bias that cannot be neglected. Indeed, the purchasing intentions, rather than real food purchases, were investigated. Moreover, these trials involved voluntary consumers who have probably greater knowledge of nutrition than the general population. Despite the diversity of the food studied, the number of products was limited, and some participants may not have found their usual product and chose foods they would not buy in a real shopping situation. Furthermore, the setting of most of the studies was an "online supermarket"; conversely, in a real supermarket, consumers first obtain an overview of the product range in a certain category before they look more closely at a few selected products to make a purchase. In future studies, the representability of the food product categories should be carefully assessed in real-life conditions.

Nutri-Score in the same pre-packed food category

In the choice of six cereal products, an RCT of 300 Dutch participants compared the Nutri-Score, Multiple Traffic Light label, or no label and showed that the Nutri-Score promotes the choice of the healthiest cereal[19]. The study by Julia et al confirmed these results by assessing the ability of the Nutri-Score to discriminate nutritional quality between types of breakfast cereals within a category and in equivalent products[20]. Variability in the nutritional quality of breakfast cereals was high, as reflected by the FSA score (range –7-22 for a theoretical range of –15-40) and the Nutri-Score (all five categories represented).

Table 2. Results of the most recent randomized controlled trials on the effectiveness of Nutri-Score on purchase intention of healthy products choices (classified by chronological order).

First author. Year,Country	Population	Sample size	Comparator	Products	Results	Limitations
Fialon 2022, France	Italian consumers	1064	NutrInform battery	Breakfast products, breakfast cereals, and added fats	● Compared with NutrInform, Nutri-Score has, in all food categories, the highest OR for added fats (OR = 21.7 [15.3-31.1], p<0.0001) ● With Nutri-Score, Italian participants were more likely to purchase nutritionally good products than with NutrInform (OR = 5.29 [4.02-6.97], p<0.0001). Focusing on olive oil, participants of the Nutri-Score group had higher purchase intention of olive oil than those in the NutrInform group (OR = 1.92 [1.42-2.60], p<0.0001)	The diet is represented by only 23 products of three specific categories
Egnell, 2022 France	French consumers	2431	Reference intake or no label	Products from experimental online supermarket	●The Nutri-Score led to significantly lower calories and saturated fatty acids content than both Reference intake and no label.	● Evaluations of purchasing intentions rather than actual food purchases ● Online supermarket
Khune, 2022 Swizterland	Swiss consumers	354	Healthy food label, nutrient (sugar)-specific label conditions (manga and comic) or n label	Products offerings of a small online store	● More products (+7.3 products) – although mostly healthy ones – and thus more calories (+1732 kcal) were purchased in the label conditions than in the control condition. ● No significant differences between the Nutri-Score and the control group in terms of mean FSA score.	● Online supermarket
Packer, 2022 United Kingdom	British consumers	2530	Multiple Traffic Lights, Warning Label, Positive Choice tick, no-label	Pizza, drinks, cakes, crisps, yoghurts, breakfast cereals	● Compared to the control, the probability of correctly ranking the healthiest product at follow-up was significantly greater for the Nutri-Score, Multiple traffic lights, and Warning Label across all products. ● The time to accurately complete the ranking was the fastest for the Nutri-Score, Positive choice tick, and no-label control.	● Only six food categories were studies
Fuchs, 2022 Switzerland	Swiss University students	135	No label	Products offering digital online supermarket	● Individuals exposed to the Nutri-Score chose products with a higher nutritional quality (e.g., 8% HETI, 3.3% less sugar, 7.5% less saturated fat). ● Users with low food literacy seemed to benefit from the FoPL (e.g., 11% higher HETI, 10.5% less sugar, and 5.5% less saturated fat).	● Small sample size ● University students not representative of the entire population ● Evaluations of purchasing intentions rather than actual food purchases ● Online supermarket

The Nutri-Score allowed for discrimination across types of cereals, within categories of breakfast cereals and for equivalent products[20]. Thus, the Nutri-Score makes it possible to differentiate the nutritional quality of foods having the same use but from different brands (for example, among various types of breakfast cereals or different types of vegetable fats). Similar pre-packed foods such as breakfast cereals exhibit a wide variability in nutritional quality, and consumers do not quickly grasp differences.

Nutri-Score and the risk of developing chronic diseases

Recent large cohort studies over many years (from 6 to 17 years) showed that the consumption of foods with less favorable ratings on Nutri-Score was associated with an increased risk of developing metabolic syndrome or excessive weight gain, cardiovascular disease, and cancer[21-24]. A large Spanish cohort study followed 12,054 participants between 2008 and 2017. A continuous Nutri-Score Dietary Index (DI) (% of energy) was calculated

Table 2. Results of the most recent randomized controlled trials on the effectiveness of Nutri-Score on purchase intention of healthy products choices (classified by chronological order). *(continues)*

First author. Year,Country	Population	Sample size	Comparator	Products	Results	Limitations
Goiana-da-Silva 2021 Portugal	Portuguese consumers	1059	Health Star Rating, Multiple Traffic Lights, Reference Intakes or Warning symbol or no label	Pizzas, cakes, and breakfast cereals	• All FoPLs led to a higher percentage of correct responses on the ranking task than the no-label condition. • The Nutri-Score was among the FoPLs producing the most significant improvement across all food categories compared to the reference intakes (<0.0001) and facilitating the highest percentage to correctly rank products according to nutritional quality.	•Evaluations of purchasing intentions rather than actual food purchases • Online supermarket • Evaluated specific food categories representing only part of the diet
Jansen, 2021 Netherlands	Dutch consumers	550	No label	Breakfast cereals, crackers, pizza, and muesli bars	• Significant improvement of the combined nutrient profiling score with Nutri-Score compared to the control condition.	• Limited number of products used • Evaluations of purchasing intentions rather than actual food purchases
Van den Akker, 2021 Netherlands	Dutch consumers	300	Multiple Traffic Light label or no label	Six cereal products	•The Nutri-Score promotes choice of the healthiest cereal. Dieting behavior and health-conscious shopping did not moderate this effect, and the labels did not affect serving size selection.	• Limited number of products used • Evaluations of purchasing intentions rather than actual food purchases
Egnell, 2021 France	French consumers	3 specific populations-students (N = 1866), low-income individuals (N = 336) and subjects suffering from cardiometabolic diseases (N=1180)	Reference Intakes or no label	Pre-packed foods	•The Nutri-Score affixed on pre-packed foods contained higher proportion of unpacked products – especially raw fruits and meats, i.e., with no label – compared to participants purchasing with no label (p<0.0001) or with the Reference Intakes (p<0.0001).	•The population may differ from the entire population • Evaluations of purchasing intentions rather than actual food purchases

by summing up the product number of calories consumed from each food/beverage by its corresponding FSA score (ranging from +40 to –15) and dividing by total calorie intake. The higher the continuous Nutri-Score DI (% of energy), the more consumption of unhealthy foods. The authors demonstrated a higher risk of all-cause mortality (hazard ratio (HR) 1.93, 95% confidence interval (CI), 1.34-2.79, p=0.001), cardiovascular mortality, and cancer for the highest versus the lowest quartile of baseline Nutri-Score DI[21]. A European Prospective Investigation into Cancer and Nutrition (EPIC) cohort from 23 centers in 10 European countries (521 324 adults) assessed that consuming foods with a higher FSAm-NPS score (lower nutritional quality) was associated with higher mortality for all causes (HR 1.07, 95% CI 1.03 to 1.10, p<0.001) and for cancer and cardiovascular, respiratory and gastrointestinal diseases, supporting the relevance of FSAm-NPS to characterize healthier food choices through Nutri-Score label[24].

Nutri-Score uses the "per 100 g or 100 ml"

As described above, the Nutri-Score is based on allocating points according to the nutritional composition of 100 g or 100 ml of product. One of the main reasons for the choice of using 100 g as a reference for the calculation of Nutri-Score, is that the nutritional composition (calories, sugars, fats, saturated fatty acids, salt, proteins, etc.) that currently appear on food packaging are expressed per 100 g or 100 ml (Annex XV to the INCO Regulation, 2011) as a mandatory requirement.

We wonder whether the reference unit "per 100 g or 100 ml" of the Nutri-Score could be misleading for the consumer[25]. Indeed, for example, ready-to-eat meals may score relatively favorably despite being high in salt and saturated fat, as they are scored based on nutrient levels per 100 g. However, these products are consumed in portions greater than 100 g, and their Nutri-Score may be underestimated[25]. Conversely, 100 ml of extra-virgin olive oil or 100 g of Parmesan Cheese may result too caloric *per se*. However, an olive oil standard portion is almost 10 ml and a portion of Parmesan should not exceed 50 g, according to Italian standards (LARN). Using a serving size instead of a "per 100 g or 100 ml" baseline might better reflect the amount of food typically eaten. However, assessing a serving of any size (expressed in grams) is complex because it depends on age, gender, and physical activity of the consumer. Furthermore, various studies[26, 27] have shown that consumers cannot easily estimate and accurately assess the amount corresponding to a serving. Moreover, the portion size is often defined by the manufacturer and this leads to great heterogeneity among products.

Nutri-Score, degree of processing, and food additives contents

A growing number of studies have established significant associations between the higher purchases or consumption of ultra-processed food and the incidence of chronic diseases such as obesity and other metabolic diseases, especially in children and adolescents[28-31]. Indeed, a Brazilian study showed that Brazilians in the highest quintile of ultra-processed food consumption had 0.94 kg/m^2 higher BMI and were 26% more likely to be obese compared with those in the lowest quintile[29]. Canella et al confirmed these findings showing a significantly higher prevalence of obesity (+3.7%) among children and adults living in household strata in the highest compared with the lowest quartile of ultra-processed food purchases[30]. Moreover, higher ultra-processed food intake among Brazilian preschoolers was associated with greater increases in total and LDL cholesterol between ages 3-4 and 7-8 years[31]. Furthermore, a population-based prospective cohort study of 104 707 French adults showed a significant relationship between ultra-processed food consumption and type 2 diabetes (multi-adjusted HR 1.15, 95% CI, 1.06-1.25; median follow-up, 6.0 years)[32]. Thus, a validated food label should consider the degree of processing of food.

Thus, Nutri-Score could be supplemented by a signal to distinguish ultra-processed foods. Indeed, consumers could have an additional tool – the black background of the logo, with the words 'ultra-processed' – to identify the most critical health products. Nutri-Score would integrate the NOVA system, i.e., the classification of foods into four categories according to their level of processing (raw or minimally processed foods, cooking ingredients, processed foods, ultra-processed foods) developed by prof. Carlos A. Monteiro and recognized by FAO[33]. However, a study has been published in Nature[34] investigating the validity of the NOVA classification by asking nutritionists to implement the system as intended by its creators. Nutritionists had them assess a list of marketed foods and a list of food products commonly consumed in France. Evaluators were inconsistent in their assignments, regardless of professional background and many foods were not consistently assigned to the same NOVA group[34].

The algorithm of Nutri-Score does not include either the quantities of food additives such as artificial sweeteners, colorants, preservatives, emulsifiers, etc.) nor the pesticides, or other environmental contaminants (antibiotics, dioxins, heavy metals) underestimating the importance of the quality of production of products. As regards pesticides use, organic label – indicating that the product contains at least 95% organically produced ingredients – is already implemented and well-known by consumers. Moreover, even if a product is organic, this does not necessarily entail that such product is healthy and nutritionally qualitative since some organic products could be ultra-processed such as cakes, biscuits, and ready-to-eat salads. As regards food additives (artificial sweeteners, emulsifiers, preservatives, colorants), health concerns about the widespread consumption of these substances are currently growing[35-37]. Indeed, various recent studies demonstrated that artificial sweeteners and emulsifiers could be associated with gut dysbiosis leading to obesity, gut inflammation, insulin-resistance, and glucose intolerance[38-40]. Moreover, the synergic effects of food additives remain poorly understood. Thus, even if the EFSA has initiated to rigorously re-evaluate all existent food additives, the quantities of food additives are

still lacking on the product labels. Implementing a European label should be the opportunity to make consumers aware of these substances.

Nutri-Score should be included in a global food education campaign

For the consumer, the algorithm for Nutri-Score calculation remains interpretative without helping consumers in adopting a correct combination of various foods. Indeed, adopting a healthy diet depends both on the quantity of foods consumed and the frequency of their consumption, but also on the structure of the diet (considering that the nutritional balance of the diet is not achieved based on the consumption of a single food, nor at the scale of a meal, or even at a day…). The structure of a healthy diet is based on the selection of food products but also on their relative combination in appropriate amounts and frequency consumption. Educational programs should empower consumers to understand what a healthy diet is and how it relates to FOPL such as Nutri-Score[41]. Consequently, during the implementation of such a front-packaging label model, to avoid potential misinterpretation, it would be recommendable to combine the introduction of Nutri-Score with an educational campaign to inform consumers how to correctly interpret food labels[42].

CONCLUSIONS

The validation of a unique front-packaging label model remains controversial, up to date no consensus has been reached. Although various studies have demonstrated significant positive associations between the intention purchases of some healthy products, the Nutri-Score algorithm, and the lower risk of developing chronic diseases – further studies are necessary to evaluate these relationships with a large range of products in a real-life supermarket. Thus, the effect of Nutri-Score as well as other potential labels should be investigated and compared on real food purchases in different countries which can differ in terms of dietary patterns adopted by the population such as the Western diet and Mediterranean diet. Furthermore, as previously mentioned, there are several aspects to further investigate and improve in the algorithm Nutri-Score such as the consideration of degree of processing, the presence of food additives, and other contaminants. Probably, the combination of various front-of packages labels could be the solution. Its validity should be assessed by European scientific food authorities such as EFSA with large human studies in real-life purchase conditions.

Conflict of Interest

The authors declare that they have no conflict of interest.

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