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Nutrient Profiling Systems, Front of Pack Labeling, and Consumer Behavior

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Abstract

Purpose of Review Guiding consumers toward more healthful food choices may help address the high prevalence of poor dietary quality and diet-related diseases. The use of front-of-package labels (FOPL) on food items is expanding to provide focused nutritional information or representations, often based upon nutrient profiling systems.

Recent Findings FOPL provide a source of nutrition and health information that is readily understood by consumers, including those with limited literacy. There is evidence that FOPL can shift consumer behavior toward more nutritious and healthful choices. However, assessments of the effectiveness of FOPL have been restricted in scope and rely largely on simulation models rather than real-world environments.

Summary FOPL are a direct source of nutritional guidance at the point-of-purchase and provide an opportunity to convey critical information on ingredients that are associated with health promotion and/or increased risk of non-communicable diseases. However, limited evidence regarding the most effective forms of FOPL to achieve behavior change and challenges from the food industry impedes the establishment of standardized nutrient profiles and algorithms. Future opportunities for FOPL include the potential for integrating nutritional profiles with non-nutrient factors affecting health such as food processing and environmental sustainability.

Keywords Front-of-pack label · Nutrient profiling systems · Nutrition labeling · Healthy food choices · Consumer behavior

Introduction

The increasing global prevalence of most chronic, non-communicable diseases is linked to consumer choices of specific foods and overall poor dietary patterns [1]. Within industrialized countries, the number of options for different foods and beverages, as well as where and how they can be purchased and consumed, seems only to grow. Consumer selection of specific items is influenced by a variety of factors including national dietary guidelines and commercial advertising and related promotional media campaigns as well as local and national food policies such as mandatory ingredient labeling and food taxes. The Codex Alimentarius Commission of the Food and Agriculture Organization (FAO) describes three forms of nutrition labeling: (i) nutrient statements, (ii) nutrition and health claims, and (iii) additional nutrition information [2••]. Front-of-package labels (FOPL) fall under the third category and can immediately influence shopper selections at the point of purchase. Helping consumers make healthy food choices with the availability of FOPL may be one approach to impact both personal nutrition and public health [3].

As part of the 2013–2020 Global Action Plan for the prevention and control of non-communicable diseases, the World Health Organization (WHO) encouraged multisectoral efforts by governments, consumer groups, and food industries to formulate marketing and other promotional strategies that reduce unhealthy dietary practices and provide consumers with food information that is upfront and understandable [4]. This plan suggests a standardized format for FOPL consistent with Codex Alimentarius and related international standards. In

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2010, the White House Childhood Obesity Task Force also recommended collaborative efforts between government agencies along with food and beverage manufacturers to establish a standardized FOPL system, utilizing scientific evidence to support healthy choices, in a format that facilitates both comprehensibility and utilization [5]. Similarly, the Institute of Medicine and Centers for Disease Control in the USA evaluated the FOPL landscape and recommended a single and simplified FOP symbol that offered guidance about food healthfulness that would be easy to interpret and required no advanced nutritional knowledge to understand [6]. Though still without a consensus on the type or design of FOPL, the WHO, FAO of the United Nations, the US National Academy of Medicine, and others have recommended their application to food products [4, 7–14].

Front of Package Labeling

As a part of the food environment, FOPL are intended to direct consumers toward making more nutritious or healthful choices, particularly to encourage selection of foods and beverages with more positive and less negative attributes [12, 15–17]. While some FOPL are simple warning labels that a single serving contains an ingredient that may be harmful in excess, most are based on algorithms of nutrient profiling systems (NPS) that serve to integrate the benefits and risks from several different ingredients [18, 19]. The ingredients and their amounts are included within an NPS as a function of the algorithm and can vary markedly between different NPS [20•]. To assess the variation in potential rating outcomes of FOPL, the content and scoring methodology of the underlying NPS must be known [21].

FOPL serve as a companion to mandatory nutrition facts labels typically found on the back of the package. Generally presenting as graphical or interpretive labels or symbols that convey nutritional information, FOPL have an advantage over the more detailed nutrition facts panel, in that they more readily draw the attention of the consumer through both placement and design features which are intended to be attractive and promote information processing in the early stage of food product assessment and choice [15]. FOPL are often categorized into two broad groups: nutrient-specific and summary indicators. A variety of approaches have been utilized in the design of FOPL, e.g., labels that reflect the content of both positive and negative attributes illustrated by "Multiple Traffic Lights" or "Guidelines for Daily Amounts" providing quantitative values, colors, letters, tic marks, and/or symbols to provide an interpretative or summary recommendation. Other FOPL provide warning symbols for foods that contain in a single serving a high amount of a negative attribute like salt, added sugar, or saturated fat. While FOPL are not legally allowed to make explicit claims about reducing the risk of and/or treating disease, implied claims are evident in some such as the use of heart-shaped logos [6].

Nutrient-specific FOPL may be in non-interpretive formats in which numerical information is directly declared or in an interpretive fashion in which symbols appear alongside nutrient values, such as the stop sign warning in Chile or the multiple traffic light in the UK. Alternatively, summary indicators as a single logo are utilized to deliver a simple "good choice" indication such as the Nordic Keyhole (the design is a plate on top of a food pyramid), introduced in 1989, employed in Denmark, Iceland, Lithuania, Norway, and Sweden and the Healthy Choice checkmark instituted in 2006 and now found in the Czech Republic and Poland [22•]. Ratings can also be displayed across a scoring spectrum such as the Nutri-Score, created in 2017, now in Belgium, France, Germany, Netherlands, and Spain as well as the Health Star Rating in Australia and New Zealand [23••]. The Nutri-Score FOPL was initially adapted from the NPS of the UK Food Standards Agency with modifications to its algorithm defined by the French High Council of Public Health for cheese, added fats, and beverages to better align with its recommendations for these food groups [24–27]. The Nutri-Score has been adopted by selected food brands such as Nestlé, PepsiCo, and the Kellogg Company as well as being used by some companies in Austria, Portugal, Slovenia, and Switzerland albeit absent official recommendations by the respective government authorities. The adoption of an FOPL by a country can change, e.g., The Netherlands originally employed the Healthy Choice system but later switched to Nutri-Score. Examples of common FOPL designs are illustrated in Fig. 1.

The Italian Ministry of Economic Development with some trade groups are opposed to the Nutri-Score system as it grades poorly iconic Italian products such as Parma ham, Parmgiano cheese, and olive oil. Nutri-Score values for vegetable oils, even those recommended by the WHO, never achieve a better rating than "C" or "D." Thus, they are proposing the NutrInform battery system FOPL in monochrome which instead of grading foods green-to-red, details the percentage of energy, fats, sugars, and salt in a self-defined portion of food in relation to optimum daily intake. The charged part of the battery graphically represents the percentage of energy or nutrients contained in the single portion, allowing a visual estimation. The sum of what you eat during the day can "fill" the battery charge, without going further, in order not to exceed the recommended daily intake quantities. Interestingly, the positive connotation of filling a battery might allow a shopper to incorrectly infer a parameter such as caloric energy. It is worthwhile noting that FOPL always characterize individual foods and not dietary patterns but, nonetheless, may serve to improve overall dietary choices [20].

Historically, FOPL have been developed by food companies and organizations to highlight some positive attribute of a

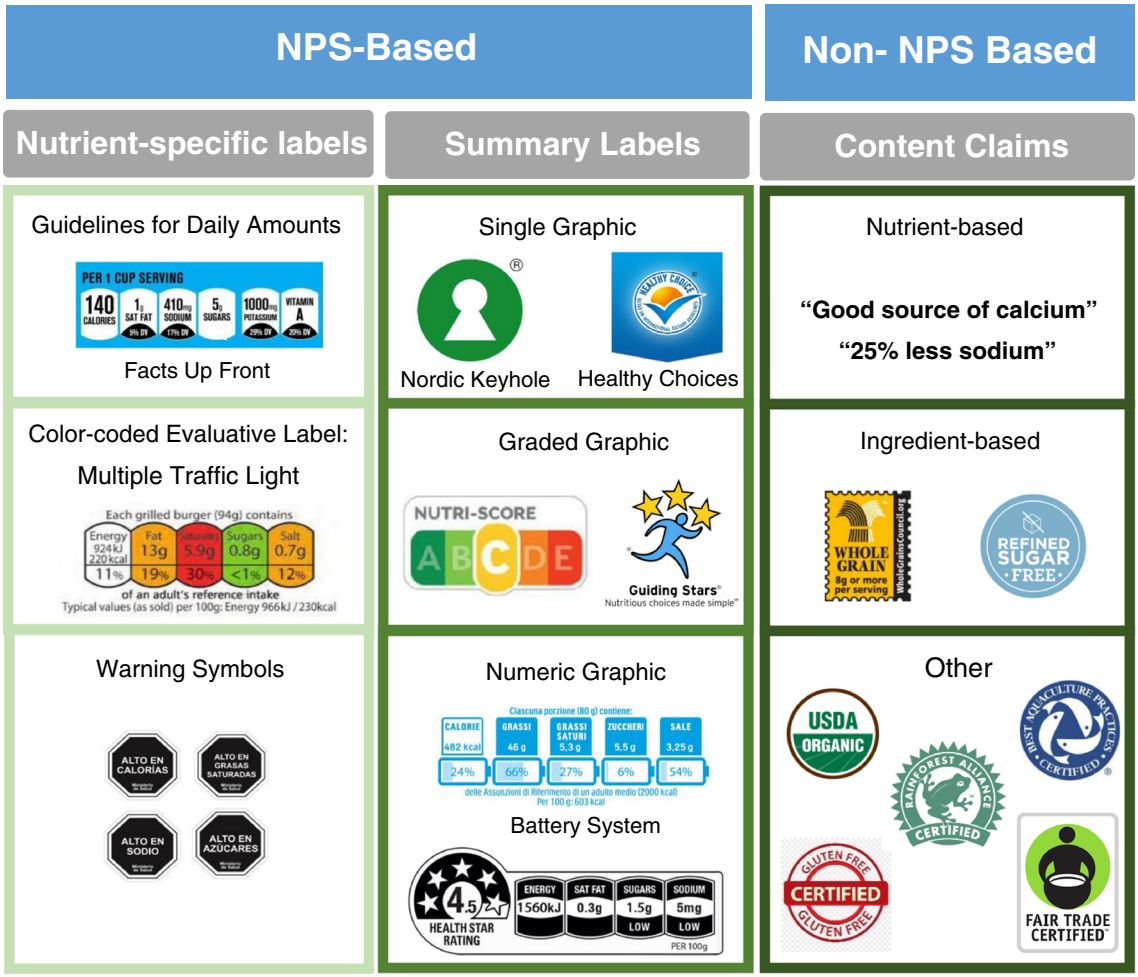

Fig. 1 Front of package label categories and representative examples

food for competitive purposes, e.g., the former Smart Choices Program FOPL developed by the Grocery Manufacturers Association (GMA, now the Consumer Brands Associations) [28]. Interestingly, after media attention to the application of this checkmark on foods commonly considered "junk," the program was precipitously ended; thereafter, the GMA, together with the Food Marketing Institute, introduced the numeric Facts Up Front (or Nutrition Keys) FOPL which served to place selected nutrients from the Nutrition Facts panel on the back of the package to the front, i.e., the approach of a Guidelines for Daily Amounts, sometimes referred to as a Daily Intake Guide. When a new FOPL is introduced, it is to be expected that media as well as consumers will first be interested in apparent anomalies, so advance planning of complementary communications is essential.

The type of representational graphics and the underlying NPS of FOPL have since expanded over the last few years, becoming more plentiful and prominent [29]. However, so too have other types of logos, many identified as "certified" that can be found on the front and/or back of food packages. Some of these logos are relevant to the nutrient content of the product, e.g., indicating they are "free from" dairy, gluten, lactose, nuts, palm oil, refined sugar, and other ingredients considered by many consumers as harmful. Other logos reference consistency with self-selected dietary patterns, e.g., halal, ketogenic, kosher, paleolithic, plant-based, vegan, and vegetarian. Additional logos address the process or source of the product, e.g., animal cruelty free or animal welfare approved, bee-friendly, fair trade, non-GMO, organic, safe to rainforest, and sustainable. Product packaging may also contain logos citing the product as being "green," healthy, or natural, though definitions remain absent for such terms. While the use of multiple logos on the front of food packages might create more confusion, studies of FOPL have not examined the impact of concurrently competing messages such as those listed here.

Governmental policies and guidelines, partly through efforts of the Codex Alimentarius Commission and other agencies, have sought to standardize FOPL and encourage voluntary participation where not already mandated [2, 23]. These regulatory efforts have promoted a trend toward greater use of FOPL and adherence to international standards for export markets [30]. However, the market-based and profit-driven

structure of food industry can be at odds with the interest of public health [31•, 32]. While many food companies are working to reformulate old products, e.g., to reduce salt and sugar content, and/or improve the healthfulness of their overall product portfolios, some NPS algorithms can produce misleading FOPL. There is also growing focus on employing stronger warnings against foods deemed less healthy, and away from symbols that only indicate general positive characteristics without attention to negative attributes, which may have higher propensity to affect product sales [23]. For example, use of micronutrient fortification, non-nutritive sweeteners, and synthetic fibers in ultra-processed foods might achieve positive ratings without being products to encourage shoppers to choose [33].

Some attempts by government or regulatory authorities, including the Codex Alimentarius, to establish guidelines and oversight of FOPL have been made to ensure information is presented in an appropriate context without deception or misdirection [30]. Having labels that are understandable, accurate, and consistent can increase consumer trust and usage of the system. In turn, trustworthy FOPL may encourage buy-in from the food industry to voluntarily adhere to FOPL practices and work to reformulate products to be more nutritious and healthful [34]. In this manner, FOPL also have the potential to serve as a governmental regulatory mechanism to ensure the integrity of nutrition information on food products.

FOPL have been assessed on a variety of elements, each linked to their intended goals and structure [15, 23, 34]. Fundamental to the validity of FOPL are the number and selection of nutrient components and food ingredients in the NPS incorporated into the algorithm and scoring criteria [35]. The basis for evaluating the ingredients, e.g., on mass (per 100 g or 100 mL), serving size (e.g., Reference Amounts Customarily Consumed), or energy (per 100 kcal) can make a significant difference in the final score and is often a marker of evaluation [20]. Use of mass or volume can allow for easy comparison between similar products but requires numeracy skills to calculate the amount per portion if not explicit within the FOPL. Use of mass also tends to benefit energy dense foods and disadvantage fruits and vegetables. Use of energy is not consistent with most back-of-package labeling of nutrition facts and can be difficult to communicate to consumers; however, this approach better allows for comparisons between food groups and benefits food with high water content while disadvantaging energy dense foods. While adjusting the NPS for serving size is simple for consumer understanding, there is no international standard for portion sizes and results are case dependent. Parameters of common NPS are presented in Table 1.

The developer of the FOPL—a food company or organization, a government agency, an academic institution, or some combination thereof—also determines the inclusion and exclusion criteria for its application, e.g., only to packaged foods or excluding all baby foods. Many FOPL focus on "nutrients of concern" such as energy (as calories), saturated fat, trans fat, sodium, and sugars [8, 36], while others include dietary fiber, total carbohydrates, protein, whole grains, and/or micronutrients. For example, Nutri-Score analyzes nutrients to limit: energy, sugars, saturated fatty acids, and sodium along with elements to increase: fruits, vegetables, legumes, nuts, fibers, and proteins [37]. The approach to algorithms and scoring systems applied to the NPS may be universal (across all foods) or specified to broad food categories such as animal-based dairy, meat, and seafood; plant fats and oils; fruits and vegetables; and grains. The validation of FOPL programs requires transparency of the NPS and scoring algorithm. While the available evidence is limited, it is important to note that the use of FOPL may have a positive effect in encouraging food

Table 1 Parameters of common nutritional profiling systems

NPS/FOP	Developer	Nutrient/food criteria	Assessment
Guiding Stars	Alhold-Delhaize	Vitamins, minerals, fiber, whole grains, specific fatty acid types, trans fat, saturated fat, added sodium, added sugars	Per 100 kcal: gradient assessment of nutrients to encourage and discourage; 0 to 3-point graded scale
Keyhole	ICA Gruppen and Swedish National Food Agency	Added fat, saturated fat, total fat; added sugar, total sugar; salt; fiber	Per 100 g: presence of FOPL represents positive assessment; binary scale with criteria based on food group
Nutri-Score	French Ministry of Health	Energy, total sugar, saturated fat, sodium, fruit, vegetables, nuts, fiber, protein	Per 100 g or 100 mL: gradient assessment of nutrients to encourage and discourage; 5-point color grade scale
Health Star Rating	Australian government agencies with external partnerships	Energy, protein, saturated fat, fiber, sugar, sodium, fruit, nuts, vegetables, legumes	Per 100 g or 100 mL: gradient assessment of nutrients to encourage and discourage with criteria based on food group: 10-point graded scale
Multiple Traffic Light	UK Department of Health	Energy, total fat, saturated fat, sugar, sodium	Per 100 g or 100 mL: gradient assessment of nutrients to encourage and discourage; 5-point color traffic light scale

companies to reformulate their products in an effort to receive a tick mark or better score. For example, compared with unlabeled food products, products labeled with a Health Star Rating higher frequency of reformulation, which resulted overall in small but significant reductions in nutrients to limit, such as sodium and saturated fat, along with increases in nutrients to promote, such as fiber [38].

Nutrient Profiling Systems

Intended for quantitative assessment of the healthfulness of foods, NPS are defined by the WHO as "the science of classifying or ranking foods according to their nutritional composition for reasons related to preventing disease and promoting health" [39]. NPS typically utilize scoring algorithms derived from dietary/nutritional guidelines from authoritative bodies such as the WHO, US Department of Agriculture, Dietary Reference Intakes, and US Food and Drug Administration. NPS algorithms score food items for the presence and value of beneficial food attributes, e.g., micronutrients and fiber; food groups to encourage such as fruits, vegetables, and whole grains; and/or detrimental components such as salt, sugar, and saturated fat as well as additives like trans fats [40]. Scoring thresholds and schemes vary between NPS.

While a credible NPS is an essential foundation for all FOPL, not all of these models are suitable for application to labeling as some are created with different objectives or in regions with different food composition or dietary patterns [41–43]. The WHO maintains a catalog of Nutrient Profile Models, last updated in 2013 but expanded in 2018 to 387 NPS by Labonté et al. [20]. Of these NPS, 78 were examined and found to have primary applications to (i) food labeling, including FOPL, food certifications, and guidelines ($n = 22$); (ii) foods in public settings, i.e., schools, recreational facilities, health facilities, governmental facilities, and vending machines ($n = 67$); (iii) restrictions on the promotion/marketing of foods to children ($n = 16$); (iv) food assistance programs ($n = 4$); (v) food systems/surveillance ($n = 2$); (vi) consumer education ($n = 4$); (vii) taxation ($n = 2$); (viii) reformulation by food companies ($n = 6$); and (ix) food subsidies ($n = 2$).

Of the 119 NPS models presented in the WHO review, only 19 were found to have undergone validation via assessment of (i) content validity, which accounts for nutrients and/or dietary factors of public health concern; (ii) criterion validity, where the content is compared against a "gold standard" reference where possible; (iii) convergent and discriminant validity, comparing the NPS in question to similar models; and (iv) construct validity, to evaluate the scoring model against diet quality indices scoring among population dietary intake [21, 44]. Scarborough et al. found low agreement between eight NPS proposed for regulating the number and type of foods that may be marketed to children during television viewing [45].

Consumer Behavior

Evaluating a FOPL system requires tests of effectiveness upon application for the improvement of diet quality and public health [6]. Studies examining FOPL have sought to understand consumers' ability to identify product healthfulness, factors influencing intent to purchase items, and acceptability of different types of FOPL [46–58] while a subset of studies have focused on participant energy intake resulting from the exposure to FOPL [16, 59–62]. Most of this work has been conducted among adults and college students [16, 47•, 48–60, 62]. Study settings have varied to include a cafeteria setting [59], locations off-site of target restaurants [16, 60, 61], community centers [62], and online simulated grocery stores or prepared food items [46–49, 51••, 52–58]. Studies examining the impact of FOPL on grocery store item preference and intention to purchase found that the use of color-coding allowed participants to accurately identify nutrient content in savory and sweet foods. Multiple Traffic Light (MTL) and summary FOPL were found to improve performance on nutrient quizzes compared with other variations of labels or no-label controls regarding accuracy in determining the healthfulness of two similar food items as well as identification of nutrients to limit such as fat, sugars, and sodium [47, 51, 55, 56, 58]. The colors in an MTL FOPL appear to provide consumers greater information to make decisions regarding the healthfulness of specific ingredients in the product due to the color "grade" provided [15, 34]. This differs greatly from non-quantitative, symbol-only FOPL which attach degrees of healthfulness to an entire product. In addition, it appears important that within a country FOPL be consistent in having the same pattern of size and location so shoppers can appropriately identify it and distinguish it from the many other images and statements present on the front of the package.

In a study comparing the use of different FOPL on similar grocery store items, Findling et al. found that the beneficial effects of each FOP label could be tied to different consumer competencies [51]. For example, single color and MTL FOPL performed well when similar items were compared against each other while MTL enabled respondents to more accurately estimate saturated fat, sugar, and sodium. Aschemann-Witzel et al. found that color and text were important for consumers when choosing the healthiest options; however, this impact on behavior change was not transferred to items that they personally preferred [47]. In contrast, other studies found the MTL format decreased the preference for a food if presented as less healthy [51, 55].

Simple warning labels indicating an unhealthful ingredient is high in the product appear readily understood by consumers

even in the presence of a positive FOPL [53, 54•, 63]. In a qualitative study in Chile, Correa et al. found that the recent use of warning labels received favorable responses from mothers with young children and their ability to readily understand this FOPL, thus making improved purchasing decisions for their families [64]. In a survey of household beverage purchases before and after the 2016 implementation of Law of Food Labeling and Advertising in Chile, significant decreases were seen in total volume as well as calories from total packaged beverage purchases [65]. Using focus groups in Ecuador, Freire et al. found the use of MTL FOPL was helpful to consumers in identifying foods high in fat, sugar, or salt and that behavior change is a possible outcome of this awareness [66]. In Singapore, use of the Healthier Choices symbol was associated with an increase in sales of labeled products and shown to be correlated with improved diet quality [67]. A number of independent studies across the world now show that the Guideline for Daily Amounts or Daily Intake Guide FOPL are the least impactful and effective on a number of dimensions compared with other FOPL systems [68–74].

In a systematic review and meta-analysis that assessed FOPL effects on consumer behaviors among 60 intervention studies, pooled analyses indicated statistically significant associations between the label and 6.6% lower energy intake ($n = 31$), 10.5% lower total fat ($n = 13$), and reduced consumption of other unhealthy dietary options by 13.0% ($n = 16$). At the same time, food labeling was significantly associated with 13.5% greater vegetable intake ($n = 5$). A decreasing trend for sodium at 15.3% ($n = 5$) was observed but no significant change was found among intakes of total carbohydrate, protein, saturated fat, fruit, whole grain, or other healthful dietary targets [75••]. These findings were consistent whether the results were based on self-reported information or on sales/purchase data. Further exploration of various clinical endpoints, such as adiposity or metabolic risk factors, yielded too few intervention studies ($n = 4$) to qualify for meta-analysis. Thus, more research on this topic would fill an important gap in the available scientific evidence that could be useful for future performance assessment of FOPL [75••].

When compared with no label controls, studies find that any provision of nutritional information can be beneficial for consumer education, assist in behavior change, and overcome preferences for unhealthy choices [52, 56]. However, consumer confusion can arise from the inconsistent application of FOPL within a store. For example, 3 years after implementation of the Health Star Rating in Australia, this FOPL appeared on only 28% of eligible products [76]; 4 years post-implementation in New Zealand, this figure was only 21% [30]. The ministries in charge of this FOPL have agreed that should voluntary implementation by industry be inadequate, a mandatory approach would be considered [77] .

Discussion

FOPL present a source of nutritional guidance at the point-of-purchase and provide an opportunity to convey information on beneficial as well as harmful ingredients. FOPL have been demonstrated to modestly shift consumer behavior toward more nutritious and healthful choices. However, assessments of the effectiveness of FOPL have been restricted in scope and still often rely on simulation models rather than real-world environments. There is a need for the implementation of studies which move beyond simulation and capture consumer behaviors in real time. Additionally, acceptability studies should be implemented to understand and facilitate the continued refinement of labels. Results from such research might encourage regulatory agencies to move forward in providing standard guidelines for FOPL and promote international harmonization. Interestingly, while FOPL may avoid limitations associated with poor literacy and/or understanding of numerical concepts, their use in low- and middle-income countries is rare or absent. While some analyses indicate a positive impact in disadvantaged populations [37], new research is needed to examine the effectiveness of FOPL in different cultures and regions. The effectiveness of food labels may be linked to the perceived trustworthiness of the organization or entity behind the FOPL, e.g., with established nonprofit medical organizations such as the American Heart Association or American Diabetes Association scoring high (59% and 47% of 1008 grocery shoppers responding to a survey) and government health agencies such as FDA and USDA following closely behind, and independent scientific or nutritional labels or panels at less (33%). When grocery retailers or food manufacturers were responsible for the FOPL, the level of public trust among shoppers was found at 7% or less [6].

Nutrition labeling, including FOPL, is influenced by cultural, economic, political, and social factors. Thus, approaches to their development and implementation as well as public education campaigns should be context-specific to meet the needs of a country's demographics, including factors such as health and nutrition literacy, as well as its food system. However, these approaches can be met with opposition and interference from stakeholders whose interests conflict with the introduction of FOPL and thus require consideration of policy design as well [31, 78, 79]. While both government and industry agree to the potential value of FOPL, controversy arises from issues related to whether implementation should mandatory or voluntary, which type of label should be employed, and what nutrients (and their thresholds) should be included within the algorithm [80, 81]. Industry has often challenged FOPL via several different tactics [17]. For

example, implementation can be delayed by demands for more testing, longer periods of consultation, or denying the effectiveness of the FOPL in question. Opponents to an FOPL program can develop and promote their own labeling scheme and divide support for a single approach or file legal challenges via domestic, international trade, or investment law mechanisms. Issues about FOPL can also be reframed to descriptions of government interference with individual choice or personal responsibility. Such challenges can be partially met through clear rules concerning which foods are covered and a validated underlying scoring algorithm as well as a framework for monitoring and evaluation [14]. As noted above, there are also indications that food labeling can effectively promote product reformulation. In six studies reviewed by Shangguan et al. that evaluated industry responses to food labeling, a clear effect was seen in the case of trans fats, with a 64.3% reduction in their content among food products. Sodium was found to have a more modest decrease of 8.9%, and no significant product reformulations were found in the content of other nutrients [75••].

FOPL characterize individual foods and not dietary patterns but, nonetheless, may serve to improve overall dietary choices. In this context, value could be added to NPS and FOPL by consideration of other factors that could help consumers achieve dietary goals beyond ensuring nutrient adequacy. For example, incorporating dietary bioactive components, such as phytochemical classes and probiotics, that have been associated with promotion of health or a reduction in risk of chronic disease could serve to broaden the diversity and quality of food product ingredients. Highly processed foods have been linked to untoward health outcomes and, while not a nutrient per se, databases are now available of ingredients and food and drink products categorized by the degree of processing so that this information could be incorporated into FOPL scoring schemes that would promote unprocessed and minimally processed foods [66, 82]. While issues regarding the sustainability of the food system are complex, the notion that some related metrics from life cycle assessment such as global warming potential, water scarcity, and land use might be incorporated into NPS and FOPL that would advance consumers' ability to choose food products for both personal and planetary health [83–85]. As food marketing increasingly migrates online, opportunities and challenges exist for FOPL when package images may be small or absent; however, the potential application of the grading or scoring schemes derived from NPS might serve as a funnel toward more healthful choices by the online shopper [86].

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Compliance with Ethical Standards

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- • Of importance
- •• Of major importance

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