Systematic review of nutrient profile models for front-of-pack nutrition labelling

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Editor's summary

Nutrient profile models (NPMs) underpin front-of-pack nutrition labelling (FOPNL), which can help consumers make healthier food choices. This systematic review identifies and characterizes existing NPMs for FOPNL systems globally.

Abstract

Front-of-pack nutrition labelling (FOPNL) systems, based on underlying nutrient profile models (NPMs) that classify food according to their nutritional composition, are key policies to tackle diet-related non-communicable diseases. Yet, the growing number of NPMs poses a challenge for policymakers to select appropriate models for FOPNL policies. This systematic review identifies and characterises the NPMs developed and/or used for FOPNL systems, from both peer-reviewed and grey literature. We identified 42 NPMs, of which: 15 were developed for warning labels, 11 for nutrient-specific systems (including traffic-light labelling), 11 for health endorsements, four for summary scores, and one for other systems. All NPMs limited the content of sugar and most limited sodium and saturated fat. Convergent and criterion validity were demonstrated, respectively, for nine and three NPMs. Considerable heterogeneity across NPMs suggests limited consensus on what constitutes the most appropriate NPM for FOPNL, reinforcing the need for greater regional guidance and alignment.

Main

In recent years, there has been a surge in the development of nutrient profile models (NPMs) globally (1-3). The World Health Organization (WHO) defines nutrient profiling as "the science of classifying or ranking foods according to their nutritional composition for reasons related to preventing disease and promoting health" (4). Nutrient profiling uses algorithms to assess the nutritional quality of food products and non-alcoholic beverages, by assigning a score or a classification. NPMs have been recognised by authoritative bodies as essential tools to support a wide range of nutrition-related policies (5), including marketing restrictions to children, food taxes or front-of-pack nutrition labelling (FOPNL) (6).

To improve population health, it is essential to establish a food environment that encourages healthy eating. Food labelling policies (e.g., on food packages, menus) may encourage consumer to make healthier dietary choices through delivering simplified nutritional information, food producers and manufacturers to reformulate existing products, and develop new and healthier products. FOPNL systems differ in their format depending on the level of interpretation they provide for nutritional information. Some schemes are considered purely informative as these merely reflect part of the information already available on the back of the pack without additional interpretation. For example, nutritional information may be presented as the contribution of a nutrient in percentage to the guideline daily amount (%GDA). Conversely, symbols and colours facilitate the interpretation of nutritional information and are more likely to be used by consumers than other labelling formats when assessing the healthiness of food products (7).

Interpretative FOPNL systems require underlying NPMs (8), which are designed based on thresholds or scoring models. Thresholds are defined for different nutrients in different categories while scoring models calculate a score for each food based on its overall nutrient content (9). FOPNL are either nutrient-specific (e.g., traffic-light labelling or warning labels) or designed as summary indicator (10), such as Nutri-Score (11) which assigns an overall grade to products, and the Keyhole (12) represented by a single positive health endorsement logo (Figure 1).

The recent proliferation of NPMs and the inconsistency among models may create confusion for both policymakers and consumers. Previous reviews have identified NPMs with applications in government-led nutrition policies and FOPNL systems implemented in specific regions (1-3, 11). However, there is currently a lack of comprehensive dataset on all NPMs developed globally for FOPNL and endorsed by governments or intergovernmental organizations, which hinders informed decision-making by policymakers regarding the selection of a suitable model. In the European Region, ongoing discussions to develop harmonized NPMs and FOPNL could provide policymakers with stronger support from inter-governmental organisations, thereby increasing the likelihood of the adoption and implementation of these policies. Furthermore, a regional harmonised model is likely to decrease market fragmentation, and may increase acceptability among food corporations through the need to comply with only one system (12). Evidence suggests that variation in NPM adoption across different countries has allowed the food industry to interfere with or weaken subsequent policy implementation (2, 11).

This systematic review identifies and characterises all NPMs developed and/or used for FOPNL, published from peer-reviewed and grey literature. This review builds on methods used by Labonté et al. (2018), who identified and summarised key characteristics of NPMs developed globally up to 2016 (1). Their review focused on government-led nutrition policies, such as school food standards, FOPNL, and food marketing restrictions to children. The current systematic review findings will support policymakers in comparing, adapting and developing NPMs for the implementation of FOPNL systems in diverse country contexts.

RESULTS

Summary of literature and NPM screening

The flow diagram (Figure 2) presents the results of screening peer-reviewed and grey literature. In total, 1374 records were identified, of which 936 were obtained from peer-reviewed databases and 438 from grey literature. Of these, 758 remained for screening after the exclusion of duplicates and studies published before 2016. An additional 142 records were excluded after screening the titles and abstracts. Of the 616 full texts screened, 107 records were excluded. Supplementary Tables 1-2 present the reason(s) for exclusion for each publication. Supplementary Table 3 presents the included publications, as well as the NPMs mentioned in each publication. From the supplementary Google searches, 147 records were identified, resulting in an additional four NPMs that were assessed for eligibility.

In total, 183 potential NPMs were identified (Figure 2). After assessing the NPMs for FOPNL against our inclusion criteria, 42 NPMs were included in the review. NPMs not endorsed by governments (n= 67, 48%) and developed solely for other purposes (n= 50, 35%) were the most common reasons for excluding NPMs. Supplementary Table 4 presents reasons for excluding each NPM.

NPM characteristics and components

Of the 42 NPMs for FOPNL included in this review, 23 have been developed after 2016. Of these 42 NPMs, 10 NPMs were also identified by Labonté et al. (2018), of which four have been updated since 2016: Nutri-Score was updated in 2023, Health Star Rating in 2020, Keyhole in 2022, and Weqaya logo in 2018. Martin et al. (2023), an update of the systematic review by Labonté et al. (2018), identified an additional 17 NPMs for FOPNL developed up to 2020. Additionally, this current systematic review has identified 12 new NPMs for FOPNL that have not been identified in these two previous systematic reviews (1, 3): Argentina warning label (WL), Bolivia traffic-light labelling (TFL), NutrInform Battery, South Africa WL, Venezuela WL, Colombia WL, Central American Technical Regulation Proposal-Nutritional Warning Front Labelling (CATRP-NWFL), Sri Lanka TFL on sugar-sweetened beverages (SSB), Nutrition Rating, Singapore Nutri-Grade, South Korea TFL, and UAE TFL. Various types of FOPNL were supported by the identified NPMs (Tables 1-4). About a third of the NPMs underpin a WL system (n= 15, 36% of models identified), followed by nutrient-specific FOPNL, including TFL (n= 11, 26%), and health endorsements (n= 11, 26%). Finally, summary-indicator models were less common (n= 4, 10%). Nevertheless, some of these NPMs, such as Nutri-Score and Keyhole, are implemented in multiple countries (Tables 1-4). One NPM that was identified (the Samoa NPM) did not specify the type of FOPNL system it relies on (n=1; 2%).

This review identified NPMs that have been developed and used internationally (Tables 1-4). The Region of the Americas accounted for the largest proportion of identified NPMs (n = 16, 38%), predominantly from Central and South America and primarily intended for warning-label schemes. The European Region accounted for nine NPMs (21%), followed by the Western-Pacific Region (n=7, 17%). Fewer NPMs for FOPNL were identified in South-East Asia (n=4, 10%), Eastern-Mediterranean Region (n=4, 10%) and African Region (n=2, 5%).

Most NPMs were developed by government institutions (n=37, 88%) (Tables 1-4). Two NPMs were developed by inter-governmental organisations (Pan American Health Organization (PAHO) and CATRP-NWFL), two NPMs were developed by a non-governmental institution and a private initiative (Finnish Heart Association and Choices Foundation, respectively), and one by academia (Samoa NPM).

Industry influence on NPM characteristics during their development was referenced in the source literature for six NPMs (Brazil, Colombia, Ecuador, Peru, Uruguay, Venezuela), all of which underpin warning label systems. The involvement of industry was also reported in the development of Singapore Healthier Logo, Kenya NPM and Weqaya logo (Tables 1-4).

Four models (Nutri-Score, Health Star Rating, Indian Nutrition Rating and Singapore Nutri-Grade) provide a graded summary indicator of the nutritional profile of food products based on the amounts of “positive” and “negative” nutrients and food components (Table 5). The reference amount for food within each NPM varied widely, with the majority using a weight or volume-based approach (per 100 g/100ml), rather than on the basis of energy content (per 100 kcal). Only the PAHO NPM and models based on the PAHO NPM (n= 6, 14%) followed the energy basis approach. All NPMs considered limiting sugar content of foods and drinks (76% included total sugar and 26% free or added sugars). Sodium (or salt) and saturated fat were the other key nutrients targeted for restriction in respectively 95% and 86% of the NPMs. 24% of NPMs also penalised the inclusion of artificial sweeteners. The top three nutrients or food components encouraged by NPMs were fibre (26%), protein (12%) and fruits, vegetables, nuts, and legumes (10%). The scope and categories considered varied among the NPMs (Supplementary Table 5). Most NPMs considered packaged foods, with NPMs for WL typically applying to processed and ultra-processed foods (or foods that had critical nutrients added during processing).

The prevalence of included NPMs was also analysed based on the number of mentions in the retrieved literature. Nutri-Score (153 mentions), Health Star Rating (98 mentions), and UK TFL (96 mentions) were the most common models featured in the literature (Supplementary Figure 1).

Lastly, we compared thresholds and nutrient criteria defined for WL and TFL NPMs (Supplementary Tables 6 and 7). As health endorsements present different nutrient criteria and thresholds for each food group and because summary indicators allocate a range of points according to the different nutrient contents and category, they weren’t included in this analysis. Our findings demonstrate the variety of thresholds applied across NPMs. Most TFL systems apply thresholds that are very similar to those used in the UK TFL, the first TFL system to be developed, apart from the South African TFL (Supplementary Table 6). NPMs also differ in the selection of nutrients they include. Some NPMs include either total fat or saturated fat, rather than both, and consider added sugars or sodium instead of total sugars and salt. For WL, thresholds were mostly based on the Chilean WL model or the PAHO NPM.

NPM validation

Validation studies were identified for nine of the 42 (21%) NPMs included (Supplementary Table 8). Nutri-Score was the most extensively validated NPM. Only Nutri-Score, Health Star Rating and Chilean WL demonstrated both convergent and criterion predictive validity. Convergent validity was demonstrated as well for Choices and some of the Latin America NPMs: PAHO, Uruguay WL, Peru WL, Ecuador TFL, and Bolivia TFL. No evidence of validity testing was found for the remaining 79% of the included NPMs.

NPM quality assessment

We next developed an assessment tool to evaluate all included NPMs qualitatively. The Chilean WL scored highest on the quality assessment (19/20 points), followed by Nutri-Score (18/20 points), PAHO (17/20 points) and Peru WL, Uruguay WL, Health Star Rating and Keyhole (16/20 points) (Supplementary Table 9). NPM validation, implementation in different national contexts, precision of model features and transparency of the NPM rationale were among the features contributing to a higher score. The low scores of some NPMs – South Africa WL, Weqaya, Thai Healthier Choice Logo, Republic of Korea TFL – were mostly due to the lack of information about NPMs' characteristics and their development, scoring no points for most or all of those criteria.

DISCUSSION

This systematic review aimed to identify NPMs developed or endorsed by recognised bodies globally for application in FOPNL policies. In total, 42 unique NPMs for FOPNL were identified.

The number of new NPMs (n=32) more than doubled since the last review by Labonté et al. (2018), where only 12 NPMs for FOPNL were identified. The large number of new NPMs corresponds to the findings of Martin et al. (2023), in which food labelling was the most frequent application of the new models identified (17 new NPMs for FOPNL identified in this update). Of the newly identified NPMs, 23 were developed or introduced after 2016. Additionally, there were four updates of previously identified NPMs. There has also been a considerable increase in new NPMs underpinning WL and a greater number of NPMs following the PAHO NPM.

We found substantial heterogeneity in the nutrients included across NPMs, especially between those underpinning WL and health endorsement. The highest number of NPMs were found in the Americas WHO Region, which correspond to the results of Labonté et al. (2018). However, most NPMs underpinned WL systems. In contrast, European, Western-Pacific and South-East Asia regions have a greater number of NPMs underpinning different types of FOPNL. Such diversity of NPMs may pose a challenge for policymakers in the selection of appropriate models for FOPNL policies.

The way recent NPMs were developed suggests that most of them derive from pre-existing models. For example, most TFLs derive from the UK TFL, and all WL derive from the Chilean NPM or, more recently, from the PAHO NPM. This may indicate that government bodies are increasingly implementing WHO's recommendation to adopt and adapt existing NPMs instead of creating new ones (13). Nutri-Score was the most frequently validated model, which was also reported by van der Bend et al. (22). The lack of NPMs validation hinders confidence in existing NPMs.

There is growing evidence that industry interference compromises the development and implementation of NPMs and FOPNL measures, by delaying implementation and pressuring countries with legal and economic concerns, promoting freedom-of-choice arguments to avoid accountability for industry's environmental and health damages, and exploring loopholes in regulations to continue promoting their products (14). Commercial actors justify their role in the food policy process by pointing to their economic importance (15-17), their contribution to improving the healthiness of diets particularly through food reformulation (15), and their funding of health promotion initiatives (15, 16). The food industry is naturally more supportive of initiatives that do not affect their sales and profits, however developments in FOPNL have the potential to do just that (17-19). Although six instances of industry involvement in NPM development and/or implementation were identified, these findings are likely an underestimation of the true extent of industry involvement, as information, where available, beyond the retrieved literature was outside the scope of this review (2, 11, 18). Though transparency about declaring industry funding was considered in the quality assessment of the NPMs, there was insufficient information to consider industry involvement in the scoring. Often, industry interference is not made transparent (20), so future research could explore this issue comprehensively (e.g., by interviewing the entities/actors responsible for the development and implementation NPMs), to understand its provenance and how it influences resultant policies.

There is growing concern around ultra-processed foods (UPFs) and how these are or should be incorporated into NPMs (21, 22). UPFs are defined by the NOVA classification as 'formulations of ingredients, mostly of exclusive industrial use, that result from a series of industrial processes' (23). Even though NPMs and the NOVA food classification system address different dimensions of foods, some efforts have been made to consider the inclusion of certain additives in NPMs. In particular, artificial sweeteners were included in the update of Nutri-Score in 2023 and are considered in most of the NPMs for warning labels.

The quality assessment tool to evaluate the NPMs developed in this study is an important strength. This tool can be applied for all NPMs for different nutrition policies, not only for NPMs underpinning FOPNL. It supports a more objective comparison of the models and reflects some important considerations when selecting or developing a model, e.g., industry interference, the transparency of the rationale, the comprehensibility of the different characteristics and components, as well as the implementation and endorsement of the NPMs. However, the quality assessment evaluation relied on information available in the literature. Therefore, when information on aspects such as the development of the model or its validation wasn't reported in the literature, the scoring of those criteria was negatively affected. Another limitation is the lack of validation of this tool, which should be explored in future research.

The searches were intentionally broad to maximise the likelihood of capturing all NPMs used for FOPNL, but it was not possible to review NPMs developed for other purposes (e.g., marketing restrictions or food taxation). This review aims to inform future decisions around NPMs for FOPNL. Even though not including NPMs for other purposes might be considered a limitation of this review, the focus on FOPNL is also a strength of this study. Providing an updated and complete list of NPMs for FOPNL, as well as supporting their comparison, may assist policymakers in selecting the most appropriate NPM for FOPNL for their context. A comprehensive search method was used, which facilitated the retrieval of an array of NPMs developed globally. One of the main strengths of this review is the volume and type of information gathered and analysed, as information on NPMs is highly dispersed, published in different languages and official websites.

The time of data collection and extraction, as well as the languages included, might have excluded potential models (e.g., Indonesia FOPNL). Additionally, keeping such a review up to date is a considerable task, given the high rate of proliferation of NPMs, as shown in the results. The lack of publicly available information for some of the 'potential' NPMs identified (including the NPM criteria or algorithm) limited the inclusion of more models (e.g., Nutri-Mark and Zambia Good Food Logo).

The current systematic review did not primarily aim to identify the level of validity of NPMs. However, the validation of a model is undoubtedly an important measure of quality and relevance when assessing a model. A limitation of this study is, therefore, the non-comprehensiveness of the information on validation. Information on a model's validity testing could be available in a publication not captured in the literature searches, as most of the official documents do not include this information (except for some testing content validity). There are other studies, such as the review by Barrett et al (2023), which address this thoroughly.

There has been a proliferation of new NPMs for FOPNL posing a potential challenge for policymakers in the selection of appropriate models for FOPNL policies. This systematic review facilitates the comparison of these models, demonstrating considerable heterogeneity in the NPMs underlying FOPNL, reinforcing the need for more guidance and regional alignment. Nevertheless, the results do also show similarities and common features, e.g., in involving key nutrients of public health concern and the most common reference amount used. This provides useful information when considering making recommendations to Member States about nutrient profiling. The results of this review have been used as the basis of a consultation with key global experts with the aim of providing recommendations for the development of NPMs for FOPNL for the WHO European Region. This demonstrates the value of this updated NPM for FOPNL database in supporting the assessment and comparison of different NPMs. The results of this systematic review also reinforce the need for more NPM validation. When developing and implementing a model, convergent and criterion predictive validity should be applied to ensure quality and alignment with the dietary guidelines, as well as its impact on relevant measures of health.

METHODS

The systematic review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses reporting guidelines (PRISMA) (24). The protocol for this systematic review was published in Open Science Framework (OSF) in April 2023 (https://osf.io/pz8hw).

Search strategy

Searches were carried out in May 2023 and updated in May 2025, in three electronic databases (MEDLINE (OvidSP), CAB Abstracts (OvidSP) and Scopus) to identify relevant academic publications. Medline and CAB Abstracts were searched concurrently with duplicates removed. The search terms relating to nutrient profile models and food labelling, included "nutrient profile model*", "nutritional profil*", "food scoring system*", "nutrient scoring*" and "front of pack* label*". These search terms also formed the basis of the grey literature searches.

Keyword searches of grey literature were also conducted to ensure coverage of relevant sources outside of the academic literature e.g., reports and policy documents published by governmental and inter-governmental organisations. Grey literature searches were conducted in Google and a database of policy documents and guidelines (Overton ref: (https://www.overton.io/). Overton searches were also conducted in May 2025. Google searches were used to supplement Overton and academic literature searches in February 2026. Further details of the grey and academic literature search can be found in Supplementary Tables 10-13.

Selection criteria

All searches were limited to articles published between January 1, 2016, and May 30, 2025, and were conducted in English, Spanish and Portuguese. January 1, 2016, was chosen as the start date because this review aims to complement the systematic review conducted in 2016 by Labonté et al (2018).

The review included any type of publication, namely original research articles, reviews, reports, government documents, abstracts, and news articles, that mentioned a NPM or a FOPNL system. Additionally, there was no restriction on the study design, country context, or publication/NPM language. However, only publications or NPMs with development details available in English, Spanish, or Portuguese were included.

Only NPMs developed/and or used for FOPNL were considered. NPMs that were developed for multiple purposes (e.g. marketing restrictions, taxation, health claims), provided that one of these purposes was FOPNL, were therefore included. NPMs developed solely for other primary purposes were excluded. Additionally, NPMs underpinning a FOPNL format presenting %GDA were not included in this review because this metric is not considered sufficiently interpretive, as reported in similar analysis of FOPNL (10). NPMs were assessed for inclusion using the following criteria: NPMs allowing for the classification/categorisation or ranking/scoring of individual foods; NPMs comprising separate sets of criteria for multiple nutrients and/or food components, or NPMs integrating data from more than one nutrient and food component to obtain a single overall score or categorisation; NPMs developed or endorsed by governmental or inter-governmental organisations; and the algorithm of the NPMs being publicly available in the peer-reviewed or grey literature.

Screening

Screening was completed in two phases. The first phase of screening involved screening *publications* for inclusion – i.e., to identify papers and reports that mentioned or included a NPM that might meet the inclusion criteria. The aim of the publications' screening was to identify all potential NPMs that have been developed and could potentially be included considering our inclusion and exclusion criteria and background knowledge of the authors. Therefore, any mention of a possible NPM or FOPNL system was registered and progressed to the second phase of screening. The second phase of screening involved screening *NPMs* for inclusion. Whilst some NPMs could have been excluded under multiple criteria, we applied our criteria hierarchically and, therefore, excluded NPMs are assigned to a single reason, following this order of decision: availability of the NPM in public sources (including in the languages spoken by the authors), NPM being developed or endorsed by governmental or inter-governmental organisations and NPM being developed and/or used for FOPNL. To enhance objectivity, title and abstract screening was performed in duplicate by three review team members (MB, JR, AK) independently. Any disagreements were resolved jointly.

Once all peer-reviewed and Overton results had been screened, Google results were screened to identify models that had not been identified in the previous searches.

Data extraction

Data extraction was completed for all included models by one author (MB) by December 2025. The data extraction process and results were reviewed by all co-authors. Extraction of data was completed in several steps. First, the general characteristics of the development of the model, including country, type of organisation, and year of introduction were extracted. Second, the type of model as well as its algorithm was described, including food categories, nutrients covered and reference amount. Third, the process of developing the model was documented, considering the influence of this process on the characteristics of the NPM.

Only the most recent version of each model was included (e.g., Nutri-Score was counted as one NPM, considering only the latest version published in 2023). Multiple references and mentions of the same NPMs were initially found in the literature. We noted down the different references and mentions and at the model screening phase these were checked to assess what NPM was being considered. If the references or mentions were referring to the same model, these were counted as one NPM (e.g., "Chilean NPM" or "Chilean warning label"). Then, the total number of mentions of each discrete NPM was used to determine how many times these NPMs were mentioned in the literature.

Validation of the NPMs

It was not a primary aim of this review to identify the level of validity of the different NPMs, but considering the importance of validation, the information from the retrieved literature was analysed. Validation involves assessing whether NPMs accurately classify the healthiness of foods and beverages. There are different methods for validating a NPM. This review applies an adapted version of the WHO framework for methods for validating NPMs for FOPNL, published in the *Guiding principles and framework manual for FOP labelling for promoting healthy diet* (13). The WHO Guiding Principles consider three types of validity: content, convergent and predictive validity. This classification has been used by other studies (25), which evaluate models' validity. In this review an adapted method was used to consider criterion validity, including either prospectively (*predictive* criterion validation) or at the same time point (*concurrent* criterion validation), following a recent systematic review by Barrett et al (2023) (26). Considering that all NPMs have some level of content validity (the ability of the NPM to discriminate food products based on healthfulness (13)), this systematic review only considered the two remaining types of validity: convergent validity – the level of agreement (or convergence) of the classification of products using the NPM against other systems, for example food-based dietary guidelines (FBDG); and criterion validity – the most robust type of testing that relates to how consumption of foods based on NPMs is associated with objective measures of health.

For the purposes of this review, studies that compare the strictness and agreement of different NPMs (e.g., Cooper et al (2016), Cooper, Pelly and Lowe (2017) and Poon et al (2018)), were not considered as a validation exercise since all models have some level of content validity. Face validity is an important type of validation for the format of a FOPNL system. However, this review focuses on NPMs and, therefore, does not address the validation of FOPNL systems.

Comparisons between NPMs and food-based dietary guidelines were considered as a validation exercise. Validity data for included NPMs was identified in the literature retrieved for this review. When no relevant studies were identified, the authors considered the validation studies identified in a systematic review by Barrett et al (2023) (26).

Quality assessment of the NPMs

There are multiple tools available for assessing the quality of studies included in a systematic review, most of which focus on the risk of bias. However, we are not aware of any existing approaches suitable for reviewing the quality of NPMs. Thus, the quality of NPMs was appraised according to their replicability, objectivity and transparency (Supplementary Table 14). The quality criteria were developed based on previous literature (9) and WHO guiding principles (13) to reflect the main aspects that should be considered when developing a NPM.

Limited information about the “evidence of commercial interest” was provided by source literature. As a result, this aspect was included in the tool but does not contribute to the overall scoring. Similarly, “content validity” was not considered for the scoring since all models have some level of content validity. Therefore, the maximum score a NPM could get in this review is 20 points.

Data availability

The data that support the findings of this study are available in the manuscript and supplementary information.

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Contributions

The project was conceptualized by all authors. All authors supported the development of the search strategy and M.B. conducted the peer-reviewed and grey literature searches. M.B., J.R. and A.K. conducted study screening. Data analysis and development of the tables and figures was done by M.B. with feedback from the other authors. The original draft was written by M.B. and reviewed and edited by J.R., A.K. and M.R.

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Competing interest

The authors declare no competing interests.

Table 1. NPMs for warning labels

Key characteristics of each NPM for warning labels (n=15). The key characteristics include the NPM's name, country of origin, the type(s) and name(s) of the organisation(s) responsible for its development, the year of publication of the NPM ([a] denotes instances where the year of NPM publication corresponds to the year of the FOPNL policy publication/implementation), and the process of developing the NPM when described in the source literature. NPM: Nutrient Profile Model; GOV: Government; IGO: Inter-governmental organisations; NGO: Non-Governmental Organization; WL: warning label

NPM name, Country, Year, Reference(s)	Organisation name(s)	Organisation type(s)	History of the development of the NPM
ANVISA WL **Brazil, 2020** **(27, 28)**	Brazilian Health Regulatory Agency (ANVISA)	GOV	The first proposal from ANIVSA was based on WHO and Codex Alimentarius recommendations, with two gradual thresholds. The third and final proposal incorporates an NPM previously proposed by ANVISA as an intermediate step. The regulatory process (2014-2020) was influenced by the food and beverage industry and their attempts to delay ANVISA's decision, derail the process, influence consumer opinion, and weaken the approved regulation.
Argentina WL **Argentina, 2022 [a]** **(29, 30)**	Ministry of Health	GOV	The thresholds for the warning label are based on the PAHO NPM.
CATRP-NWFL **Central America, 2017[a] (31)**	Institute of Nutrition of Central America and Panama	IGO	The proposal is underpinned by a NPM based on the PAHO NPM. In 2018, the Health Ministers from the Mercosur had agreed that FOPNL system should be in place, and the level of critical nutrients should be defined based on the PAHO recommendations.
Chilean WL **Chile, 2016 [a]** **(32, 33)**	Ministry of Health	GOV	Natural foods were used as the gold standard for setting NPM thresholds. For liquids, the cut-off values for energy, sugars, saturated fats, and sodium were based on 100 mL of cow's milk. For solids, values between the 90th and 95th percentile of natural foods from the USDA were used. The food industry was not involved in the technical committees but participated in public consultations, leading to some flexibility in the FOPNL system's implementation.
Colombia WL **Colombia, 2021 [a]** **2023, update to PAHO (34-37)**	Ministry of Health and Social Protection	GOV	This labelling law has been updated to include the criteria following PAHO's recommendations. The previous law in place was an adaptation of the Chilean NPM.
FOP nutrition symbol labelling **Canada, 2022 (38)**	Health Canada	GOV	The thresholds for the FOP nutrition symbol (the symbol) are based on Daily Values.
Israel Red WL, **Israel, 2020 (39)**	Ministry of Health	GOV	The negative label follows the Chilean NPM.
Kenya NPM	Ministry of Health, Ministry of Agriculture and Livestock	GOV	The Kenya Nutrient Profile Model was developed through a comprehensive multi-stakeholder engagement process. The

Kenya, 2025 (40)	Development, Kenya Bureau of Standards		process brought together experts from the Ministry of Health (Division of Nutrition and Dietetics and Division of Cancer and Non-Communicable Diseases), the Ministry of Agriculture and Livestock Development, the Kenya Bureau of Standards, and County Governments. Representatives from UN agencies, development partners, the food and beverage industry, consumer organizations, academia, and research institutions also participated. Technical support was provided by WHO, including both the Kenya Country Office and WHO headquarters. Additional expertise was drawn from professionals in countries that have developed or are currently developing NPMs, including Australia, South Africa, and Zambia. Furthermore, WHO regional NPMs (for the African, South-East Asia and PAHO) were reviewed and used as reference materials.
Mexican WL **Mexico, 2019** [a] **(41-43)**	Secretariat of Health	GOV	Mexico was the first country to adopt and implement PAHO NPM. Some adaptations were adopted, including additional thresholds for calories and a warning for added caffeine (intake not recommended for children), as well as removing the total fat threshold of the PAHO model (since total fat includes healthy fatty acids, which are not common in the Mexican diet and its intake needs to be promoted). The sodium threshold proposed by PAHO was also adapted considering the composition of the products available in Mexico.
PAHO **WHO Pan American Region, 2016 (44)**	Pan American Health Organization (PAHO)	IGO	The NPM criteria are based on the WHO population nutrient intake goals to prevent obesity and related NCDs and considers the updated goals of the WHO expert consultations on maximum recommended intake of ingredients of concern: sugar, fats, and sodium.
Paraguay WL **Paraguay, 2023** [a] [(45)]	Ministry of Public Health and Social Wellbeing	GOV	This information was not identified in the review or supplementary searches.
Peru WL **Peru, 2013** [a] **2022, update to PAHO (46, 47)**	Ministry of Health	GOV	Recently a judicial decision has required the Peruvian regulation to update the criteria following PAHO's recommendations. The previous law in place was an adaptation of the Chilean NPM.
South Africa WL (R3337) **South Africa, 2023** [a] **(48)**	Department of Health	GOV	The Ministry of Health has, under section 15 (1) of the Foodstuffs, Cosmetics and Disinfectants Act, 1972 (Act No.54 of 1972), published for public comment the regulations that include a "Profiling Model for Foodstuffs for South Africa for the purpose of FOPL logos on labels of pre-packaged foodstuffs that may not be marketed or advertised to children".
Uruguay WL **Uruguay, 2018** [a]	Ministry of Public Health	GOV	Uruguay first adopted a decree establishing criteria that aimed to progressively achieve

(49-51)			PAHO's guidelines, but modifications were made following recommendations of technicians from the Ministry of Industry moving the criteria away from PAHO's Nutrient Profile Model. The approved NPM is a flexible version of the Chilean NPM.
Venezuela WL **Venezuela, 2020 (only sodium)[a] 2021[a]** **(52, 53)**	Ministry of Health	GOV	The law required the warnings to follow PAHO's recommendations, but the regulation issued implemented a weakened version of Chile's criteria.

Table 2. NPMs for other nutrient-specific systems

Key characteristics of NPMs for other nutrient-specific systems, including traffic-light labelling (n=11). The key characteristics include the NPM's name, country of origin, the type(s) and name(s) of the organisation(s) responsible for its development, the year of publication of the NPM ([a] denotes instances where the year of NPM publication corresponds to the year of the FOPNL policy publication/implementation), and the process of developing the NPM when described in the source literature.

NPM: Nutrient Profile Model; GOV: Government; IGO: Inter-governmental organisations; NGO: Non-Governmental Organization; TFL: traffic-light labelling.

NPM name, Country, Year, Reference(s)	Organisation name(s)	Organisation type(s)	History of the development of the NPM
Bolivia TFL Bolivia, 2016[a] (54)	Ministry of Health	GOV	This information was not identified in the review or supplementary searches.
Ecuador TFL Ecuador, 2014[a] (55, 56)	Ministry of Public Health	GOV	The thresholds were defined based on the recommendations from PAHO, even though industry proposed they be based on percentages. Additionally, discussions with industry led to more concessions, namely the definition of sugars, sweeteners and salt.
Iran TFL Iran, 2014[a] (became mandatory in 2016) (57)	Ministry of Health and Medical Education	GOV	Low level of evidence-informed decision making.
NutrInform Battery Italy, 2020 (58)	Ministries of Health, Agriculture, Foreign Affairs and Economic Development	GOV, academia	The reference parameters for calibrating the single batteries (one for each critical element: calories, fats, sugars, and salt) are based on table VIII of EU Regulation no. 1169/2011 – art. 35, which are aligned with Italian population reference nutrient levels. The battery's fill level shows the percentage of how much each nutrient (considering the recommended portion) is contributing to the diet, based on Reference Intakes (part B of Annex XIII of EU Regulation 1169/2011). Nutritionists from the Italian Institute of Health, the Food and Economic Research Council, and representatives from food, agriculture, and consumer sectors contributed to the project, led by four Ministries: Health, Industry, Agriculture, and Foreign Affairs.
FDA Nutrition Box United States of America, 2025 (59)	Food and Drug Administration	GOV	The Food and Drug Administration (FDA) has proposed front-of-package nutrition labels on most foods that are currently mandated to carry a Nutrition Facts label. The proposed system would emphasize nutrients identified by the Dietary Guidelines for Americans (2020-2025) as components to limit, namely saturated fat, sodium, and added sugars, in order to promote healthier dietary patterns. The products would be categorized as "Low," "Medium," or "High" in these nutrients based on their percent Daily Value (%DV). "Low" would correspond to 5% DV or less, "Medium" to 6%–19% DV, and "High" to 20% DV or more. This proposal was open for public consultation until 15 July 2025.
South Korea TFL Republic of Korea, 2011[a] (60, 61)	Korea Food and Drug Administration	GOV	This information was not identified in the review or supplementary searches.
Saudi Arabia TFL Saudi Arabia, 2018 (62, 63)	Saudi Food and Drug Authority	GOV	Adapted from the UK traffic-light system.
Sri Lanka TFL on SSB Sri Lanka, 2016[a] (64, 65)	Minister of Health, Nutrition and Indigenous Medicine	GOV	The development was led by the Environment and Occupational Health and Food Safety Directorate of the Ministry of Health in collaboration with the NCD Bureau and the Nutrition Coordination Division of the Ministry of Heath, Ministry of Education, Ministry of Trade and Commerce, and the Consumer Protection Authority.
Sri Lanka TFL Sri Lanka, 2019[a] (66)	Minister of Health, Nutrition and Indigenous Medicine	GOV	Several factors have influenced the development and approval of the legislation, including; the increasing burden of NCDs in Sri Lanka, the positive international momentum for evidence-based interventions, a dedicated Food Control Administration unit within the Ministry of Health to coordinate and implement legislation, and the Food Advisory Committee — a multiple stakeholder committee to advise the Minister of Health on formulation of regulations under the provisions of the Food Act in Sri Lanka.
UAE TFL United Arab Emirates, 2019[a] (67, 68)	National Programme for Happiness and Wellbeing, Food Security Office	GOV	In 2019, the UAE Cabinet approved a voluntary food label requirement intended to become mandatory by January 2022. However, following the UAE government's focus on supporting the performance and competitiveness of the industrial sector and easing procedures, the UAE Cabinet has amended the FOPNL from mandatory to voluntary.
UK TFL United Kingdom, 2013 (69)	Food Standards Agency	GOV	Low or 'green' signals follow the EU health and nutrition claims Regulation, aligned with Codex Alimentarius standards for nutrient-related claims. High or 'red' signals indicate nutrient levels above 25% of the GDA. For sugar, the FSA, based on an independent expert group (convened to review the industry GDA) set a lower limit of 60g per day (rather than 90g per day). The criteria were revised to apply to added, not total, sugars. Medium or 'amber' signals fall between the green and red levels.

Table 3. NPMs for health endorsements

Key characteristics of NPMs for health endorsements (n=11). The key characteristics include the NPM's name, country of origin, the type(s) and name(s) of the organisation(s) responsible for its development, the year of publication of the NPM ([a] denotes instances where the year of NPM publication corresponds to the year of the FOPNL policy publication/implementation), and the process of developing the NPM when described in the source literature. NPM: Nutrient Profile Model; GOV: Government; IGO: Inter-governmental organisations; NGO: Non-Governmental Organization.

NPM name, Country, Year, Reference(s)	Organisation name(s)	Organisation type(s)	History of the development of the NPM
Healthier Choice Logo **Brunei, 2016 (updated 3rd edition 2021) (70)**	Ministry of Health	GOV	The nutrient criteria are adapted from Singapore's Health Promotion Board Healthier Choice Symbol Nutrient Guidelines, taking into consideration the nutritional profile of the products available in Brunei Darussalam. The initiative was developed by the Ministry of Health with the support of stakeholders.
Choices **Czech Republic, Poland, 2008 (revised 2010, 2014, 2018) (71, 72)**	Choices International Foundation	NGO	The Choices Programme defined the criteria following the WHO Global Strategy on Diet, Physical Activity, and Health (2004). The criteria is designed to select the healthiest 20% products within the food categories of basic foods and the top 10% for of non-basic foods.
Heart Symbol **Finland, 2008[a] (73)**	Finnish Heart Association, Finnish Diabetes Association	NGO	Criteria are based on the Finnish nutrition recommendations.
Healthy Living Guarantee Mark **Croatia, 2016 (74)**	Croatian Institute of Public Health	GOV	The basis for setting criteria for more appropriate selection of foods within the same food category is the recommended daily intake of energy and selected nutrients (total fat, saturated fatty acids, carbohydrates, sugars, proteins, salt) per adult (Annex XIII, Part B, Regulations on the provision of food information to consumers (OG 8/2013), Directive on the provision of food information to consumers No. 1169 /2011).
Israel Green Label **Israel, 2020[a] (39)**	Ministry of Health	GOV	The criteria for the positive label were based on the Mediterranean diet principles, with adjustments to the Israeli dietary habits, focusing on the health positive impact of foods and considering processing level.
Keyhole **Sweden1989 – last revision 2021** **(75, 76)** **Original in Sweeden; 2009 in Norway and Denmark; 2013 in Iceland (revised 2015); 2013 in Lithuania; 2015 in Macedonia**	Swedish National Food Administration, Norwegian Directorate of Health and Norwegian Food Safety Authority, Danish Veterinary and Food Administration	GOV	The criteria for determining the food products that are eligible to display the Keyhole are based on the Nordic Nutritional Recommendations, which constitutes the scientific basis for national nutrient recommendations and food-based dietary guidelines in the Nordic countries. In 2021 the rules were updated to cover more plant-based food and healthy ready meals.
Healthier Choice Logo **Malaysia, 2017 (updated 2023) [a] (77)**	Ministry of Health	GOV	Initiative introduced by the Ministry of Health. The companies may send in proposals to create a new food group or product category and its nutrient criteria.
Healthier Choice Symbol **Singapore, 1998 (last revision August 2022)[a] (78, 79)**	Health Promotion Board, Ministry of Health	GOV	The criteria and Guidelines for the Healthier Choice Symbol were developed with industry. To identify the nutritional benchmarks, was conducted a market research for each category, determining the median levels. The guidelines were then established below these medians to encourage manufacturers to reformulate their products. The guidelines are reviewed periodically and made more stringent to further drive reformulation.
Thai Healthier Symbol Logo **Thailand, 2016 [a] (80)**	Thai National Food Committee Ministry of Public Health	GOV	The National Food Consumption Survey indicated that Thai population was consuming food products with excessive amounts of sugar and/or sodium. The "Healthier Choice" criteria used for each food category are established according to technical guidance of the sub-committee on the development and promotion of a simplified nutrition labelling. The guidance must then be approved by the National Food Committee and in alignment with the Public Health Ministry Notification on food labelling.
Weqaya **Abu Dhabi, 2018 (81)**	Abu Dhabi Quality and Conformity Council	GOV	The working group comprised members from the Department of Health and food safety authorities, academia, and food companies.
Healthy Symbol **United States of America, 2024 (82)**	Food and Drug Administration	GOV	The US Food and Drug Administration (FDA) is currently working on a voluntary symbol depicting the nutrient content claim "healthy" on packaged foods. The nutrient criteria is the same as for the "healthy" claim.

Table 4. NPMs for graded summary indicators and other systems

Key characteristics of NPMs for graded summary indicators (n=4), and for one NPM for other (non-specified) FOPNL system. The key characteristics include the NPM's name, country of origin, the type(s) and name(s) of the organisation(s) responsible for its development, the year of publication of the NPM ([a] denotes instances where the year of NPM publication corresponds to the year of the FOPNL policy publication/implementation), and the process of developing the NPM when described in the source literature.

NPM: Nutrient Profile Model; GOV: Government; IGO: Inter-governmental organisations; NGO: Non-Governmental Organization.

NPM name, Country, Year, Reference(s)	Organisation name(s)	Organisation type(s)	History of the development of the NPM
Health Star Rating 2020 Australia, 2020 (Original 2014) (83, 84)	Food Standards Australia New Zealand	GOV	The criteria were adapted from an existing model (Nutrient Profiling Scoring Criteria, NPSC) used to regulate eligibility to display health and nutrient content claims in both countries, contained within the Australia New Zealand Food Standards Code. The NPSC itself was derived from the validated United Kingdom Ofcom model.
Nutrition Rating India, 2022[a] (85)	Food Safety and Standards Authority of India	GOV	The Indian Nutrition Rating was introduced in Draft Regulations so it was not possible to collect information on its implementation in the review or supplementary searches.
Nutri-Score 2023 France, 2023 (86, 87) **Original 2017 (revised 2023) in France; 2018 in Spain; 2019 in Belgium, Germany, Switzerland, and Netherlands; 2020 in Luxembourg**	Agence Nationale Sécurité Sanitaire Alimentaire Nationale (Anses) / Sante Pulique France	GOV, academia	Nutri-Score derived from the United Kingdom's Food Standards Agency nutrient profile model, which was developed by Ofcom to regulate television advertising to children. The Nutri-Score was updated in 2023 to incorporate the latest evidence from the scientific literature and to be more in line with the main food-based dietary guidelines of the countries across Europe, by an international Scientific Committee of experts, with a number of constraints: cross-sectional calculation method, calculation of the score per 100 g or 100 mL of food, conservation of the current main components of the algorithm already validated, among others.
Nutri-Grade Singapore, 2021 (revised February and June 2023) (88)	Health Promotion Board, Ministry of Health	GOV	This information was not identified in the review or supplementary searches.
Other (n=1)			
Samoa NPM Samoa, 2018 (89)	Food and Agriculture Organization of the United Nations, the World Health Organization and the Ministry of Health in Samoa	Academia, IGO, GOV	Nutrient thresholds were selected for food categories that either (i) contained a high density of nutrients being targeted for NCD prevention or (ii) contributed significantly to overall intake of nutrients linked to NCDs. The thresholds were developed based on desired level of decrease per nutrient per person necessary to reduce population intake in line with specific targets, by analysing local household expenditure data combined with international best practise approaches and standards (as WHO recommendations, Nutrient Reference Values developed by Food Standards Australia New Zealand and the United States of America Department of Agriculture nutrient intake recommendations). The threshold groups were aligned to the Samoan Guide to Healthy Eating.

Table 5. Characteristics of NPMs for FOPNL.

Comparison of the identified NPMs for FOPNL, in terms of type of model, reference amount and nutrients and components considered. Orange shade refers to nutrients/components that the NPMs aims to limit consumption (those that overconsumption of is commonly associated with poorer health outcome). Green shade refers to nutrients/components that the NPMs aim to encourage/promote consumption (those associated with health benefits)

Model name	Type of model		Base			Nutritional indicators											
	Summary indicator	Nutrient specific	Per 100 kcal	Per 100 g/ml	Per serving	Energy	Total fat	Saturated fat	Total sugars	Free sugars	Other sweeteners	Sodium	Trans fat	Protein	Fibre	F&V	Other
ANVISA WL																	
Argentina WL				energy						added sugars							
CATRP-NWFL																	
Chilean WL										added free sugars							
Colombia WL																	
FOP nutrition symbol labelling																	
Israel Red Label																	
Kenya NPM																	
Mexican WL																	caffeine
PAHO																	
Peru WL																	
Paraguay WL																	
South Africa WL (R3337)																	
Uruguay WL																	
Venezuela WL																	
% of NPMs fulfilling criterion	0%	100%	40%	60%	7%	13%	33%	100%	60%	40%	33%	100%	40%	0%	0%	0%	7%
Bolivia TFL										added sugars							
Ecuador TFL																	
Iran TFL												salt					
NutrInform Battery												salt					
FDA Nutrition Box										added sugars							
Saudi Arabia TFL												salt					
South Korea TFL												salt					
Sri Lanka TFL on SSB																	
Sri Lanka TFL												salt					
UAE TFL												salt					
UK TFL												salt					
% of NPMs fulfilling criterion	0%	100%	0%	82%	36%	9%	73%	64%	82%	18%	0%	91%	9%	0%	0%	0%	0%
Health Star Rating																	
Indian Nutrition Rating																+ nuts, legumes and millets	
Nutri-Score																+ nuts	
Singapore Nutri-Grade																	
% of NPMs fulfilling criterion	100%	0%	0%	100%	0%	75%	0%	100%	100%	0%	50%	75%	0%	75%	75%	75%	0%
Brunei Healthier Choice Logo																	Calcium, % wholegrain
Choices										added sugars		salt					
Heart Symbol												salt					
Healthy Living Guarantee Mark																	
Israel Green Label																	additives
Keyhole												salt					wholegrains
Malaysia Healthier Choice Logo																	wholegrain content, micronutrients
Singapore Healthier Choice Symbol																	calcium, % wholegrain
Thai Healthier Choice Logo																	iron, calcium
Weqaya										added sugars							% wholegrain; preservatives, caffeine
US Healthy Symbol										added sugars							
% of NPMs fulfilling criterion	0%	100%	0%	91%	18%	27%	73%	82%	82%	27%	27%	100%	36%	18%	73%	9%	64%
Samoa NPM																	
TOTAL % of NPMs fulfilling criterion	**10%**	**90%**	**14%**	**79%**	**17%**	**21%**	**52%**	**86%**	**76%**	**26%**	**24%**	**95%**	**26%**	**12%**	**26%**	**10%**	**19%**

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Figure legends

Figure 1. Types of FOPNL and examples

Types of FOPNL (and corresponding examples) divided according to the way the information of the nutrients is presented (separate in nutrient-specific or combined in summary indicators) and how the output is presented (graded or binary).

Figure 2. Flow diagram.

The flow diagram presents the screening process and selection of publications and thereafter of the NPMs for FOPNL.

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