REVIEW

Nutrient Profile Models with Applications in Government-Led Nutrition Policies Aimed at Health Promotion and Noncommunicable Disease Prevention: A Systematic Review

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ABSTRACT

Nutrient profile (NP) models, tools used to rate or evaluate the nutritional quality of foods, are increasingly used by government bodies worldwide to underpin nutrition-related policies. An up-to-date and accessible list of existing NP models is currently unavailable to support their adoption or adaptation in different jurisdictions. This study used a systematic approach to develop a global resource that summarizes key characteristics of NP models with applications in government-led nutrition policies. NP models were identified from an unpublished WHO catalog of NP models last updated in 2012 and from searches conducted in different databases of the peer-reviewed ($n = 3$; e.g., PubMed) and gray literature ($n = 15$). Included models had to meet the following inclusion criteria (selected) as of 22 December 2016: *1*) developed or endorsed by governmental or intergovernmental organizations, *2*) allow for the evaluation of individual food items, and *3*) have publicly available nutritional criteria. A total of 387 potential NP models were identified, including $n = 361$ from the full-text assessment of >600 publications and $n = 26$ exclusively from the catalog. Seventy-eight models were included. Most (73%) were introduced within the past 10 y, and 44% represent adaptations of ≥1 previously built model. Models were primarily built for school food standards or guidelines ($n = 27$), food labeling (e.g., front-of-pack; $n = 12$), and restriction of the marketing of food products to children ($n = 10$). All models consider nutrients to limit, with sodium, saturated fatty acids, and total sugars being included most frequently; and 86% also consider ≥1 nutrient to encourage (e.g., fiber). No information on validity testing could be identified for 58% of the models. Given the proliferation of NP models worldwide, this new resource will be highly valuable for assisting health professionals and policymakers in the selection of an appropriate model when the establishment of nutrition-related policies requires the use of nutrient profiling. *Adv Nutr* 2018;9:741–788.

Keywords: food quality, healthfulness, healthy food, unhealthy food, nutrient profiling, nutritional quality, nutrition policy, public health, systematic review, validation

Introduction

Worldwide, authoritative bodies increasingly recognize the value of the use of objective, transparent, and reproducible methods to evaluate the nutritional quality of foods and nonalcoholic beverages (henceforth foods) to support a vast array of nutrition-related policies (1–4). Nutrient profiling, 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" (5, 6), aims to meet this need. Nutrient profile (NP) models utilize algorithms that take into consideration the amounts or the presence of nutrients and other related food components (e.g., whole grain) in a food product to characterize its degree of "healthfulness" through either numerical scores (e.g., from 1 to 100, where 100 represents the highest nutritional quality) or more qualitative classifications (e.g., eligible/not eligible to carry a logo designating a "better-for-you" product) (7).

Although NP models characterize foods as opposed to diets, they represent a way to improve dietary choices, and hence overall dietary patterns, through a variety of applications in the field of public health (1). Such applications include, but are not limited to, the underpinning of food labeling schemes [e.g., voluntary or mandatory front-of-pack (FOP) nutrition labeling schemes to assist consumers in their food-selection decisions], the regulation of health and nutrition claims (e.g., to identify which food products

are eligible to carry a specific claim), restrictions on the commercial marketing of unhealthy foods and beverages to children, food procurement regulations or food quality standards for public institutions (e.g., schools, health facilities, government facilities), the underpinning of food taxes or subsidies for producers, manufacturers, retailers, or consumers, and nutritional surveillance (i.e., evaluation of changes across time in the nutritional quality of the food supply in a given population) (2–4).

A draft catalog of existing NP models and its accompanying report prepared by Mike Rayner and colleagues, which was last updated in November 2012, indicated that NP models are increasingly being developed worldwide [Nutrient Profiling Catalogue of Nutrient Profile Models: Summary Report; 4 March, 2013 (unpublished report prepared for the WHO); hereafter cited as draft catalog (2013); available from one of the authors (MR) upon request]. When compared with a review of NP models published 5 y earlier (8) using the same inclusion criteria, 28 new models were included in the draft catalog (2013). However, the authors stressed that the proliferation of NP models can "lead to confusion, inconsistencies between models, and possibly loss of credibility for nutrient profiling with regulators, consumers and researchers." Given these risks associated with the proliferation of NP models and the time and cost constraints associated with the development and validation of a new model, it is now highly recommended to either adopt or adapt an existing model, ideally one developed by an authoritative body (4, 6). However, an up-to-date, accessible, and global resource summarizing existing NP models is currently unavailable for assisting policymakers in the selection of a model that is appropriate for the use for which it is intended.

The overall aim of this systematic review was therefore to develop such a resource that identifies NP models built in the context of government-led nutrition policies and summarizes their key characteristics. We hypothesized that the number of existing NP models developed by authoritative bodies worldwide has increased since the last review conducted in November 2012 [draft catalog (2013)]. It should also be noted that recommending one NP model over others in the context of a given policy is outside the scope of the present work.

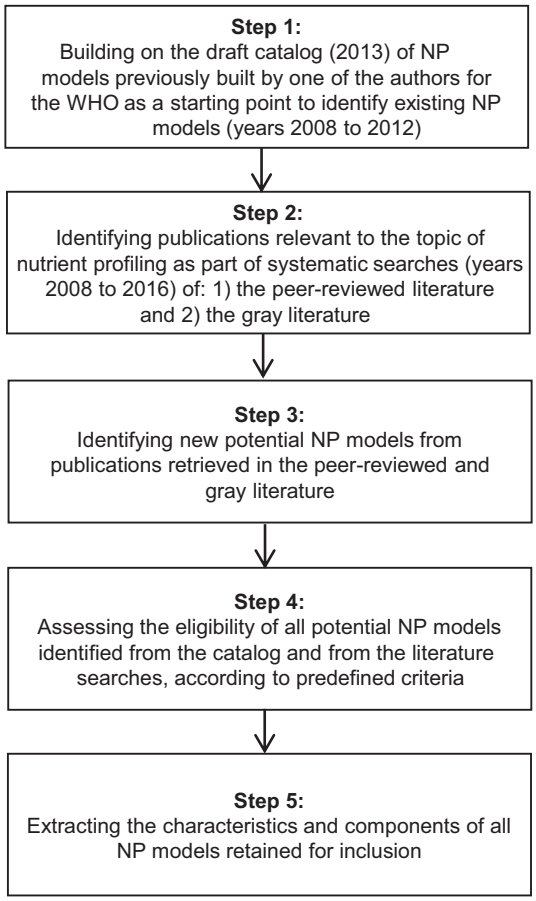

FIGURE 1 Steps of the systematic review. NP, nutrient profile.

Methods

The present review is reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement (9). The methods of the review were pre-established in a protocol that has been registered in PROSPERO (2015: CRD42015024750) (10).

The primary outcome of the systematic review was to identify NP models that exist worldwide for application specifically in government-led nutrition-related policies aimed at health promotion and noncommunicable disease (NCD) prevention. Briefly, the review was conducted following 5 main steps that are described in **Figure 1**, and further detailed in what follows after the description of the eligibility criteria.

Supported by the Canadian Institutes of Health Research (CIHR) Postdoctoral Fellowship MFE-140953 (to M-ÈL), Burroughs Wellcome Fund—Innovation in Regulatory Science grant 1014187 (to MRL, MR, and TP), an Ontario Graduate Scholarship (to MA), CIHR Frederick Banting and Charles Best Canada Graduate Scholarship grant GSD-152299 (to BF-A), a Graduate Student Fellowship of the Department of Nutritional Sciences, University of Toronto (to BF-A), British Heart Foundation grant 006/PSS/CORE/2016/OXFORD (to MR), the WHO (to MR; for work in connection with a catalog of nutrient profile models), CIHR Strategic Operating Grant 201103SOK—118150 (to MRL), and an Earle W McHenry Research Chair unrestricted research grant from the University of Toronto (to MRL).
Author disclosures: M-ÈL and BG, no conflicts of interest. TP is a graduate student and is employed part-time by Intertek Scientific & Regulatory Consultancy. MA has been a Mitacs Elevate Postdoctoral Fellow at the University of Toronto since September 2017 and she is funded jointly by Mitacs and the Nestlé Research Center. Before coming to the University of Toronto, BF-A was a PepsiCo Mexico employee (October 2009–August 2015). None of the previous companies/organizations were involved in any way in the present research. MR has given talks on the topic of nutrient profiling at workshops, seminars, and conferences for which travel and accommodation have been paid for by the organizers. Funding for MR's research center (including half his salary) comes from the British Heart Foundation. MRL has given talks on the topic of nutrient profiling at workshops, meetings, or conferences for which the registration and/or travel expenses have been paid for by the organizers.
Supplemental Tables 1–5 are available from the "Supplementary data" link in the online posting of the article and from the same link in the online table of contents at https://academic.oup.com/advances/.
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Abbreviations used: FOP, front-of-pack; NCD, noncommunicable disease; NP, nutrient profile.

Eligibility criteria

Publication eligibility criteria. The review included any type of publication (e.g., original research articles, reviews, government documents, reports, theses, abstracts, and news articles) that was deemed potentially relevant to nutrient profiling at the screening stage (see the "Publication selection" subsection) to allow for the identification of the maximum possible number of potential NP models. With regard to research articles, there was no restriction on the type of study design or type of participants eligible for inclusion.

NP model eligibility criteria. The present review included publicly available NP models developed or endorsed by government bodies for application in nutrition-related policies at the provincial/state level or higher, which provided an interpretation of the nutritional quality of individual food products based on multiple (i.e., $\geq$2) nutrients or food components, and which represented the final version in use or a draft version proposed for use within the last 3–5 y, with details available in English, French, or Spanish. Inclusion and exclusion criteria for the NP models are fully described in **Table 1**. Further details on the eligibility assessment stage are also provided in "Step 4: eligibility assessment of all potential NP models identified."

Steps of the systematic review

Step 1: Collection of information from a key previous review of NP models. The research team determined that the most- efficient approach to identify NP models would be first to build on the draft catalog of NP models (2013) previously built by one of the authors (MR; see the Introduction for more details). A total of 119 models were identified at that time based on the following: *1*) information obtained from 5 reviews of NP models conducted between the end of the year 2007 and the year 2010 (8, 11–14); *2*) searches carried out in PubMed, Google, and Google Scholar for articles published since January 2008; *3*) information obtained from key individuals and organizations following a joint WHO/International Association for the Study of Obesity technical meeting on nutrient profiling held in London on 4–6 October 2010; and *4*) information from the developers/owners of included models to ensure accuracy (summer 2011). The draft catalog included 54 models and excluded 65 models based on predefined eligibility criteria. However, because the current eligibility criteria (Table 1) differed from those used in the catalog, the total of 119 models (i.e., 54 + 65) has been used here as the basis for building a list of potential NP models to be assessed for eligibility.

Step 2: Identification of publications relevant to nutrient profiling in the peer-reviewed and gray literature.

Search strategy for the peer-reviewed literature. Searches were carried out in PubMed, EMBASE, and Scopus to identify peer-reviewed publications relevant to the topic of nutrient profiling with the use of the following search terms: nutrient, nutritional, or nutrition, each preceding the truncated term profil*. An example of the search strategy specific to each database is provided as supplementary data (**Supplemental Table 1**). Searches were limited to articles published between January 2008 and 26 May 2016, corresponding to the date that all 3 electronic databases were searched by one of the authors (M-ÈL). The same start date as the one used to build the draft catalog was retained to ensure appropriate retrieval of NP models with applications in government-led nutrition-related policies that were not necessarily captured in the catalog (e.g., food taxation, nutritional surveillance). No restriction on language was imposed during the searches. All search results were exported to a citation management software [EndNote X6; Clarivate Analytics (formerly Thomson Reuters)]. The searches were conducted again in July 2016 (7 July in PubMed, 19 July in EMBASE, and 21 July in Scopus) independently by a second author (MA) to ensure complete retrieval of all relevant articles.

Search strategy for the gray literature. Since valuable sources of information on NP models developed or endorsed by government bodies may not necessarily be identified in the peer-reviewed literature, an extensive search of the gray literature was conducted following consultation with a qualified librarian at the University of Toronto, as described in the study protocol (10). Searches were conducted by one of the authors (M-ÈL) in 15 gray literature search tools including the PAIS Index, Science.gov, ProQuest Dissertations & Theses Global, and OpenGrey between 20 July and 3 August 2016. Details on the search strategy used in each gray literature search tool are provided in **Supplemental Table 2**. Whenever possible, searches were carried out with the same terms and limits developed for the peer-reviewed literature.

In order to check for saturation of the gray literature search results, brief searches were conducted in addition in the following tools: OpenDOAR (Repository Contents), Google custom searches for Canadian documents (Canadian Government Publications on the Web and Canadian Health Departments and Agencies), Canadian Research Index, and a Google search in the European Union Domain (.eu) specifically. A rapid screening of the first 100 results in each tool (if applicable) led to the observation that only low numbers of potentially relevant records were retrieved, and that these had already been identified via the other search tools. As such, results from these additional searches were not recorded.

Additional publications identified from reference lists or other sources. Additional publications potentially relevant to nutrient profiling that were not retrieved as part of the peer-reviewed and gray literature searches were identified from the search results included in the full-text assessment stage (e.g., by checking the reference lists; see "Step 3: identification of new potential NP models from retained publications" for more details on full-text assessment). Some additional publications were also identified from other sources, consisting of personal communications received by the authors or news articles included in daily e-mail

TABLE 1 Criteria used for the eligibility assessment of all potential NP models identified[1]

	Inclusion criteria	Exclusion criteria
A	Models allowing for the classification or categorization of individual foods	Models only allowing for the classification or categorization of combinations of foods (i.e., meals or diets, such as the Healthy Eating Index)
B	Models integrating data from >1 nutrient or food component to produce a single overall score or categorization, or models with separate sets of criteria for multiple nutrients or food components (e.g., Traffic Light System in which the levels of each of the nutrients considered are interpreted separately)	Models in which only a single nutrient or food component is used, as focusing on only 1 aspect of the nutritional composition can mask the overall nutritional quality of a food product (e.g., nutrient content claim; reformulation targets for single nutrients such as sodium; Whole Grain Stamp)
C	Models with a food focus that also use criteria based on nutrients and other food components	Models with a food focus that do not use criteria based on the amounts of nutrients and other food components (e.g., a model that only states that soft soda cannot be advertised to children without considering the underlying nutritional composition of the products)
D	Models in which the output (score or classification) includes at least a modest interpretative element	Models in which the output shows little or no interpretative element (e.g., models only repeating the amounts of some nutrients found in the Nutrition Facts Table, or models showing a percentage of GDAs, a percentage of DVs, or the GDAs/DVs themselves)
E	Models developed or endorsed[2] by governmental or intergovernmental organizations and having applications in government-led nutrition policy and regulation, including, but not limited to the following: -Food certification schemes/front-of-pack labeling -Standards for food advertising or marketing -Regulation of health and nutrition claims -Food procurement regulations/food-quality standards for public institutions (e.g., schools, workplaces, hospitals, armed services, prisons, elderly care homes) -Food taxation -Food subsidies -Welfare support schemes -Food fortification -Nutritional surveillance	Models developed by different types of organizations (e.g., commercial; nongovernmental; academic) that are not endorsed[2] by government bodies (e.g., models developed by the food industry for their own voluntary marketing restrictions; models developed by heart foundations for food-certification schemes)
F	Models intended for national or international use, or for use in a jurisdiction with responsibility for the relevant food policy or regulation (e.g., models developed by states or provinces responsible for school food standards)	Models intended for use at a very specific/narrow level (e.g., municipal)
G	Details of the model are publicly available in the peer-reviewed or gray literature (e.g., government documents/websites, theses)	Details of the model are not known because they are not publicly or freely available, or they could not be found, therefore not allowing for the appropriate use or adaptation of a model or appropriate evaluation of its construct and components
H	Final versions of models that are currently in use or draft models that have been proposed for use within the last 3–5 y	Discontinued models no longer in use, or proposed models that were never implemented
I	Models that do not duplicate information included previously	Models duplicating information from another model (e.g., an exact same model is described in multiple documents, but under slightly different names)
J	Full details of the model are available in English, French, or Spanish	Full details available in another language than specified in the left column
K	N/A	"Not relevant": this represents the situation where it is found, during eligibility assessment, that a policy, regulation, standard, scheme, etc., initially considered as a potential NP model actually does not correspond to such a model (i.e., does not use any criteria to classify foods, either food-based or nutrient-based). For example, this could be a Code in which it is found, when reviewing the source document, that there is a total ban of the commercial advertising of any type of product to children, food or not. Therefore, this means that no NP model is used as part of this Code to determine which foods can or cannot be advertised to children

[1] Letters are used to indicate the reason(s) for exclusion in the list of excluded models (Supplemental Table 3). DV, Daily Value; GDA, Guideline Daily Amount; N/A, not applicable; NP, nutrient profile.
[2] For the purpose of this review, "endorsed" refers to models that are used by governmental or intergovernmental organizations or that are made reference to in government publications in relation to ≥1 of the above applications but that were not developed by such organizations.

newsletters received by the authors before the start of the eligibility assessment stage of the identified NP models.

Publication selection. Duplicates were removed via EndNote, primarily based on the title, authors, and year of each publication. Publications remaining after this stage were screened for the presence of terms directly related to nutrient profiling or related to the possible applications (i.e., purposes) of NP models (e.g., the terms nutrient, nutritional, nutrition, or food combined with or close to terms including, but not limited to, profil*, criter*, scor*, standard*, requirement*, program*, guideline*, schem*, healthy, healthi*, healthful*, classification, advertis*, market*, labeling/labelling, subsid*, tax*, govern*). Publications containing such terms in their title, abstract, summary, or table of contents, depending on the type of document, were retained for further evaluation. Only the publications that were clearly not relevant to the objective of the systematic review were excluded at this stage (e.g., articles about the nutrient profile of animal food; experimental studies in animal models; nutrition intervention studies comparing the impact of different diets on health outcomes; nutritional profiles of patients with specific diseases, such as cancer; studies in the field of agriculture, such as comparisons of the nutrient profile of different varieties of plants or seeds; government documents on a population's status for a specified nutritional factor, such as vitamin D). Two authors (M-ÈL and MA) independently conducted the screening of articles identified from the peer-reviewed literature. Because of resource and time constraints, only 1 author (M-ÈL) performed the screening of publications identified from the gray literature.

Step 3: Identification of new potential NP models from retained publications. The full text of all publications retained after the screening stage was assessed to identify all potential NP models that were made reference to, described, tested, or used to answer a specific research question in a given publication. Any classification or scoring system, standard, requirement, program, guideline, regulation, legislation, etc., that could potentially include the use of nutritional criteria to evaluate the nutritional quality of food products was recorded as a potential NP model. A similar approach to the one used in the screening stage was adopted in which the full text of the publications was also searched for the presence of terms relevant to nutrient profiling to ensure complete identification of potential NP models.

Given the high number of full texts to review, the large size of certain documents (e.g., theses), and time constraints, the total number of publications was split approximately equally between 2 authors (M-ÈL and TP). The authors captured the names of all potential NP models included in each publication evaluated in order to build a list of models. The authors then evaluated the presence of possible duplicates in the model names, with help from the references provided for each model, and decided on a single name for each potential model. They also assessed whether each potential NP model corresponded to 1 of the 119 models previously identified in the draft catalog (2013) or if it corresponded to a newly identified model. For example, a potential model named "UK Ofcom marketing restrictions" in the authors' list clearly corresponded to the model from the United Kingdom named "Ofcom model for regulating the marketing of food to children final version (WXYfm)" in the draft catalog (2013), and therefore was given the same identifier (model no.) as in the catalog (i.e., no. 5). For all models that were not previously identified in the catalog, or if not enough information was known at this point to determine whether a model was either a previously identified model or a newly identified model, a new identifier was given to the model in preparation for eligibility assessment, starting from no. 128, which represented the number next to the last identifier given in the draft catalog (2013).

Step 4: Eligibility assessment of all potential NP models identified.

Evaluation process. All NP models previously identified in the draft catalog (2013) and newly identified as part of the full-text assessment stage were assessed against the eligibility criteria defined in Table 1. Eligibility assessment was conducted with the use of information from the catalog and from the publications retrieved in the literature searches, supplemented if necessary with information obtained from online searches about specific models (e.g., on Google or government websites), or from requests sent to a contact person in organizations that developed certain models. A preliminary eligibility assessment of the 119 models from the catalog was conducted in January–February 2016, before the literature searches and full-text assessment stage, but final assessment of these models was conducted within the same period as for the newly identified models, that is between 9 August and 22 December 2016. Eligibility assessment was completed independently by 2 authors, more specifically M-ÈL and MA for models from the catalog, and M-ÈL and TP for models identified from the full-text assessment stage. Evaluations were then compared and discordances were resolved by consensus or by involving a third author.

Models that met all eligibility criteria as of 22 December 2016 were included in the review and retained for data extraction. Models that were not eligible based on $\geq$1 of the exclusion criteria were kept in a list of excluded models (**Supplemental Table 3**). This list comprises the model number, the model name, the source reference(s), the date of last access, reason(s) for exclusion, details on reason(s) for exclusion, and additional information on the model (if relevant).

Additional NP models identified during the eligibility assessment stage. Some NP models were identified as part of the process of determining the eligibility of the models identified from the catalog and from the full-text assessment stage, through additional documentation reviewed. A few other models were also identified from other sources (e.g., personal communications or e-mail newsletters) during the

period that the eligibility assessment process occurred (9 August–22 December 2016). These additional potential NP models were assessed independently by 2 authors (M-ÈL and TP) against the eligibility criteria defined in Table 1.

Step 5: Data extraction. Data on all included NP models were extracted into a Microsoft Office Excel 2010 Workbook using fields based on and adapted from those used previously in the draft catalog (2013). Data extraction fields included, for example the model number, model name, type and name of the organization(s) that developed the model, possible applications (purposes) of the model, a list of food categories included, list of nutrients to limit and nutrients to encourage, reference amounts, outputs, and information on validation. These fields are further detailed in the review protocol (10). One of the authors (BG) conducted most of the data extraction and 3 other authors (TP, BF-A, and M-ÈL) assisted in a small proportion of the models. Most of the data were extracted between 13 October 2016 and 13 February 2017, although data on 9 of the included models had first been extracted in May or June 2016 by 1 of the authors (TP) as a pilot test. Extracted data were also independently verified between 14 November 2016 and 14 April 2017 by 1 of 2 authors (M-ÈL or TP) who did not participate in the initial data extraction of a given model.

In the present article, selected data fields have been separated into different tables to facilitate data synthesis, reading, and understandability. Although the article does not present all of the extracted data, a searchable database including all possible fields will be made available online at http://labbelab.utoronto.ca, to provide information and facilitate comparison of the components and constructs of different NP models for researchers, health and nutrition professionals, policymakers, and other knowledge users interested in nutrient profiling.

Results

Literature search results and publication selection

A total of 3865 records were initially retrieved for the identification of new potential NP models, of which 2016 records were identified from the 3 databases of the peer-reviewed literature, 1784 records from the 15 gray literature search tools, 56 from the reference lists of the publications for which full-text assessment was conducted, and 9 from other sources such as personal communications or e-mail newsletters received by the authors (**Figure 2**). Of that total, 2658 records remained after the exclusion of duplicates. However, 2052 records were excluded as part of the screening process, because they were found to be irrelevant to the topic of the review. Therefore, the full text of 606 publications was retrieved for further evaluation.

Identification of NP models and eligibility assessment

The full-text assessment stage permitted the identification of 342 potential NP models, of which 249 consisted of newly identified models and 93 were common to the 119 models from the draft catalog (2013) (Figure 2). Thus, only 26 potential NP models were identified exclusively from the draft catalog (2013), giving 368 potential NP models first assessed for eligibility. Nineteen additional potential NP models were identified during the eligibility assessment process through additional documentation reviewed, personal communications, or e-mail newsletters received by the authors, and were also assessed for eligibility. Of the total 387 potential NP models, 78 met the inclusion criteria. Of the 309 models that did not meet the inclusion criteria, over half (n = 164, 53%) were excluded because they were not developed or endorsed by a government body (Figure 2). More than one possible reason for exclusion was applicable to 40% of the excluded models (n = 123). As indicated previously, supplementary data (Supplemental Table 3) provide the detailed reason(s) for exclusion, per excluded model.

Main characteristics of included NP models

Possible applications of NP models. Each included NP model has been associated with a single primary application, representing the main purpose for which the model was built. This was essentially determined based on the model's name and on specifications provided in the source reference of the model (e.g., based on a clear mention of the model's primary purpose or, alternatively, based on the model's main output or on the order according to which all potential applications of the model were listed). **Figure 3** shows that of 12 possible primary applications identified, the top 5 consisted of school food standards/requirements (n = 27, 35%), FOP food labeling (n = 12, 15%), restriction of marketing to children (n = 10, 13%), regulation of health or nutrition claims (n = 7, 9%), and food standards/requirements in health facilities (n = 5, 6%). At least 1 additional application was identified for 37 (47%) of the included models. An additional application represented one that was specified in the source document of a model in addition to its primary application. The most common additional applications represented standards for vending machines in various settings (n = 19), restriction of marketing to children (n = 6), and reformulation (n = 6). **Table 2** provides details on the specific model numbers associated with each possible application, either primary or additional.

Characteristics related to the development of NP models. **Table 3** describes the characteristics related to the development of each NP model including the model name, the country and state/province of origin, the type(s) and name(s) of the organization(s) that developed the model, and the year of introduction or seminal publication of the model. Models were primarily listed according to their primary application and country. Two-thirds of the models originated from the following countries: United States (n = 19), Canada (n = 13), Australia (n = 10, of which 2 models were developed jointly with New Zealand), United Kingdom (n = 5), and international (n = 5; e.g., models by regional offices of the WHO). Only 4 models (5%) were solely endorsed

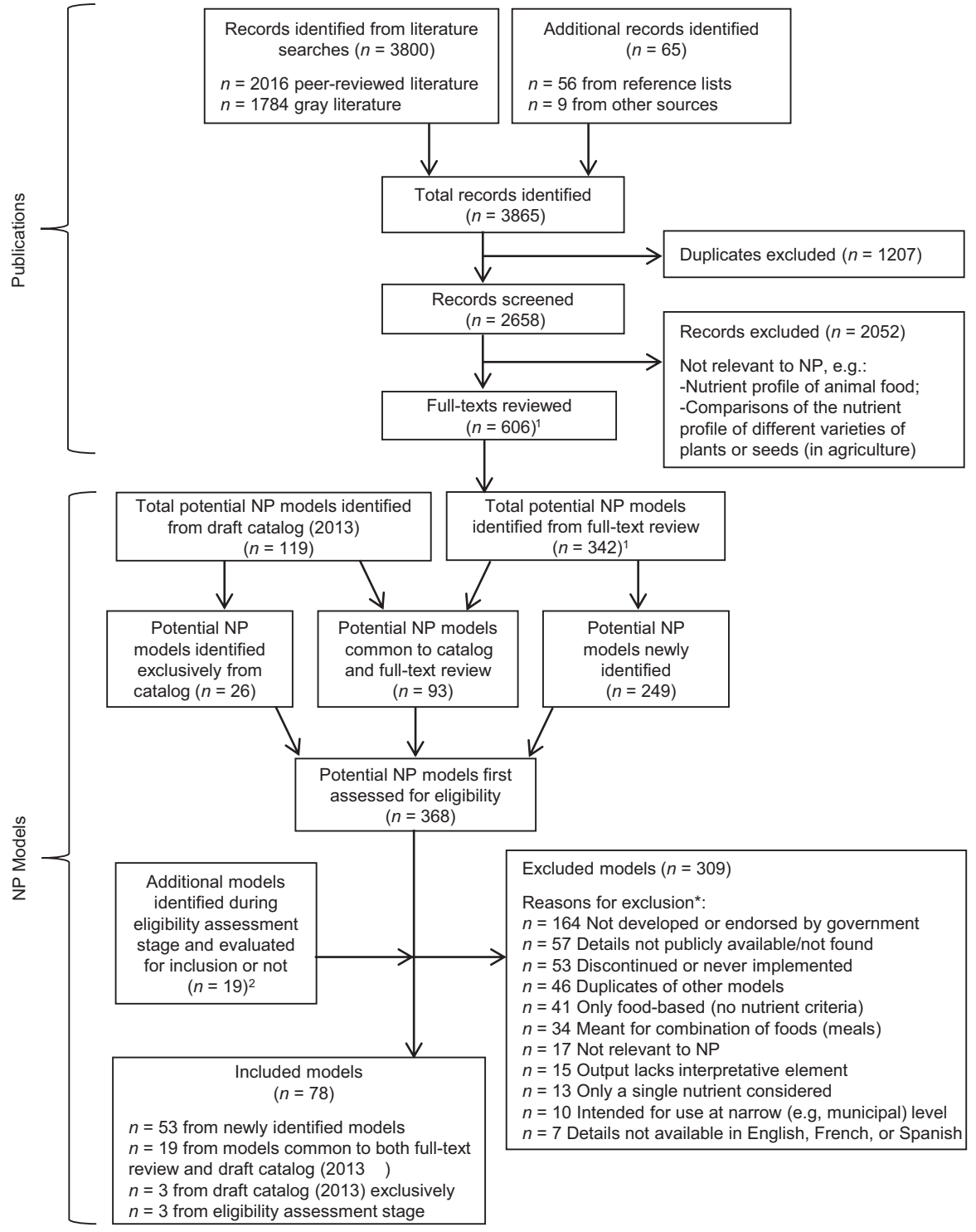

FIGURE 2 Flow diagram of the publications and NP models selection. Data are current as of 22 December 2016. [1]The number of publications included in the full-text assessment is independent of the number of potential models identified from these publications. [2]Of these 19 models, $n = 15$ were specifically identified as part of the process of assessing the eligibility of the first 368 potential models (e.g., through additional documentation reviewed) and $n = 4$ were identified from other sources (e.g., personal communication or e-mail newsletter received during the weeks that the eligibility assessment process occurred). *Note: Total is higher than 309 because $n = 123$ models are classified into ≥ 2 possible reasons for exclusion. NP, nutrient profile.

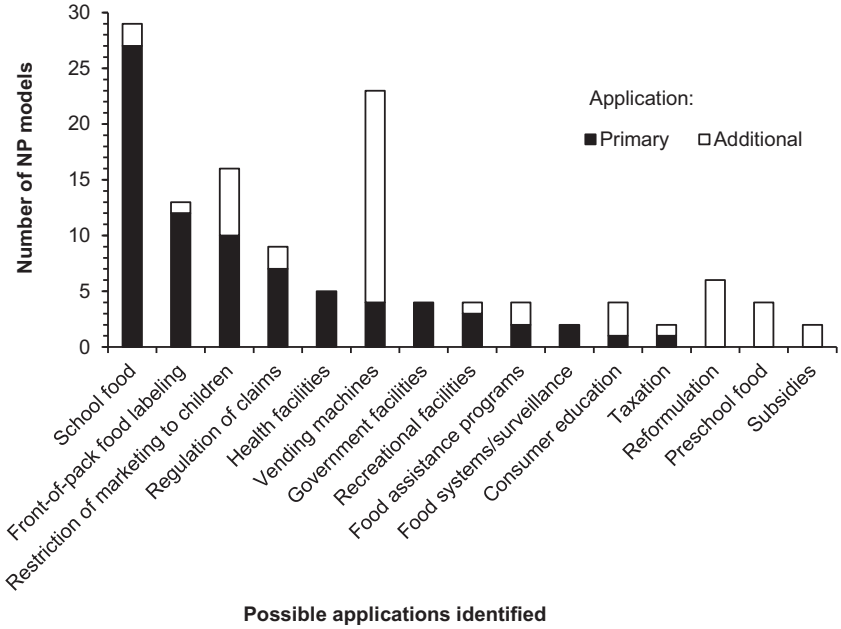

FIGURE 3 Number of NP models associated with each possible application identified. An application represents the purpose for which an NP model was built. Applications are sorted first by descending order of the number of models per primary application and second by descending order of the number of models per additional application (where relevant). Each model is associated with only 1 primary application; therefore, the total of the number of models per primary application equals 78. An additional application represents one that is specified in the source reference of a model in addition to its primary application (e.g., model no. 11 is primarily meant for front-of-pack food labeling but also has reformulation as an additional application). For a given model, the number of additional applications could range between 0 and 5. Further details on the possible applications of the models and specific model numbers associated with each one are provided in Table 2. NP, nutrient profile.

as opposed to developed either partly or completely by a governmental or intergovernmental organization. Most models ($n = 57$, 73%) were first introduced within the past 10 y, that is from 2007 onwards. Almost half of these models ($n = 27/57$; representing 35% of all included models) were more specifically introduced within the past 5 y, that is from 2012 onwards, essentially for the purposes of restricting marketing to children ($n = 7$), food labeling ($n = 5$), and school food standards/requirements ($n = 5$). Only 4 models were introduced in the 1980s or 1990s, and the year of introduction was not specified for 2 of the included models. Thirty-four models (44%) were found to be derived from another model identified as part of the present systematic review.

Characteristics related to the components of NP models. Table 4 summarizes the key characteristics related to the components of included NP models, overall and according to the 12 primary applications identified. A more -detailed summary of the key characteristics of each model is provided in Table 5. Supplementary data also provide further details on the specific nutrients and food components "to limit" and "to encourage" included in each model (**Supplemental Table 4**) and on the specific types of reference amounts and other evaluation units used in each model (**Supplemental Table 5**).

The majority of models ($n = 71$, 91%) provide summary ratings of the nutritional quality of food products based on the amounts of ≥2 nutrients or food components (Table 4). Only 3 models (4%), all meant for food labeling, solely provide separate ratings of multiple nutrients (e.g., UK Traffic Light Labelling model, no. 41; Tables 4 and 5). Four other models (5%), 2 of which are meant for food labeling, 1 for the restriction of marketing to children, and 1 for food systems/surveillance, include nutrient-specific ratings combined with a summary rating of the nutritional quality of food products (e.g., Australia and New Zealand Health Star Rating system, no. 196).

The output of 70 models (90%) consists of a classification (e.g., WHO Regional Office for Europe NP model, no. 335, which classifies food products as eligible or not eligible for marketing to children based on prespecified thresholds). The output of only 1 model, the UN World Food Program Nutrient Value Score (no. 254), is solely a numerical score. The output of 7 models, meant for either the regulation of claims ($n = 3$), restriction of marketing to children ($n = 2$), or food labeling ($n = 2$), applies classifications based on prespecified thresholds following the calculation of a score (e.g., UK Ofcom model, no. 5, in which foods with a score ≥4 and beverages with a score ≥1 are not allowed for television advertising).

TABLE 2 Applications listed for the 78 included NP models and model numbers associated with each application[1]

Applications	Primary application, *n*	Model number(s)	Additional application, other than primary, *n*	Model number(s)	Total: primary + additional application, *n*
Food labeling:					
Food certification scheme/front-of-pack labeling	12	1; 11; 27; 41; 53; 73; 156; 172; 178; 196; 291; 314	1	388	13
Regulation of claims (e.g., health and/or nutrient claims)	7	18; 20; 35; 69; 75; 319; 394	2	27; 73	9
Food in public settings:					
Schools	27	59; 60; 61; 70; 72; 76; 93; 131; 138; 140; 144[2]; 163; 167; 180; 193; 200; 205; 211; 241; 248; 259; 272; 290; 293; 325; 352; 393	2	44; 388	29
Preschools	0	N/A	4	70; 72; 131; 293	4
Recreational facilities (e.g., national parks)	3	169; 273; 376	1	131	4
Health facilities (e.g., hospitals)	5	160; 201; 285; 367; 381	0	N/A	5
Government facilities (e.g., food procurement; food sold in cafeterias)	4	174; 232; 330; 364	0	N/A	4
Vending machines (in various settings)	4	146; 256; 329; 341[3]	19	60; 61; 76; 131; 160; 169; 180; 193; 200; 241; 248; 259; 272; 293; 325; 330; 364; 367; 381	23
Restriction of the promotion/marketing of foods to children	10	5; 44; 62; 220; 251; 287; 334; 335; 388; 392	6	70; 144[2]; 156; 167; 180; 272	16
Food assistance programs	2	81; 318	2	254; 388	4
Food systems/surveillance	2	195; 254	0	N/A	2
Consumer education	1	351	3[4]	201; 367; 376	4
Taxation	1	371[5]	1	388	2
Reformulation	0	N/A	6	11; 53; 70; 178; 371[5]; 393	6
Subsidies	0	N/A	2	201; 388	2

[1] An application represents the purpose for which an NP model was built. Each model is associated with only 1 primary application; therefore, the total of the number of models per primary application equals 78. An additional application represents one that is specified in the source reference of a model in addition to its primary application (e.g., model no. 11 is primarily meant for front-of-pack food labeling but also has reformulation as an additional application). For a given model, the number of additional applications could range between 0 and 5. N/A, not applicable; NP, nutrient profile.

[2] Other additional applications for model 144 not indicated in the table include: limiting the sale of sugar substitutes; supporting healthy eating in the classroom (classroom celebrations and rewards); decreasing or eliminating bottled water.

[3] An additional application for model 341 not indicated in the table includes: concessions (meaning here food services in general; not specifically related to recreational, health, or government facilities).

[4] Also implied in most of the other models without necessarily being explicitly mentioned (e.g., model no. 291).

[5] Another additional application for model 371 not indicated in the table includes: revenue-generating tool (for the health care system).

TABLE 3 Characteristics of the development of each included NP model ($n = 78$)[1]

Country	State/ province	Model number	Model name (reference)	Organization type	Organization name	Year of introduction or seminal publication	Model derived from other models identified as part of the review? [yes (indicated by model numbers) or no]	Model that served at least in part as the basis for the development of ≥1 other included model? [yes (indicated by model numbers) or no]
School food ($n = 27$)								
Australia	N/A	93	National Healthy School Canteens Project (15, 16)	Govt or intergovt, academic	Australian Government (Department of Health) and Flinders University (with support from Flinders Partners)	2010	138	No
Australia	New South Wales	138	Australia—Fresh Tastes @ School NSW Healthy School Canteens Strategy (17)	Govt or intergovt	NSW Department of Health and NSW Department of Education and Training	2004	No	93; 140; 273; 290; 293; 367; 381
Australia	Queensland	290	Smart Choices: healthy food and drink supply strategy for Queensland schools—nutrient criteria for the "Occasional" (red) food and drink category (18)	Govt or intergovt	Queensland Government (Education Queensland and Queensland Health)	2004–2007 (revised 2016)	138	273; 381 (therefore indirectly: 367)
Australia	South Australia	293	South Australia Right Bite for schools and preschools—nutrient criteria for the "Occasional" (red) category (19)	Govt or intergovt	Government of South Australia, Department for Education and Child Development	2008 (revised 2015)	138	No
Australia	Victoria	140	Australia—State Government of Victoria—Go For Your Life healthy canteen kit—nutrient criteria for the "Occasionally" (red) food category (20)	Govt or intergovt	Office of Learning and Teaching, Department of Education and Training Victoria	2006	138	No

(*Continued*)

TABLE 3 *Continued*

Country	State/ province	Model number	Model name (reference)	Organization type	Organization name	Year of introduction or seminal publication	Model derived from other models identified as part of the review? [yes (indicated by model numbers) or no]	Model that served at least in part as the basis for the development of ≥1 other included model? [yes (indicated by model numbers) or no]
Canada	N/A	393	Canada—Provincial and Territorial nutrient criteria for foods and beverages in schools (2013) (21)	Govt or intergovt	Federal, Provincial, Territorial Group on Nutrition Working Group on Improving the Consistency of School Food and Beverage Criteria [working group included members from provincial/territorial government health departments and (federal) Health Canada]	2013	131; 144; 180; 193; 200 (therefore indirectly: 282); 241; 259; 272	No
Canada	Alberta	131	Alberta nutrition guidelines for children and youth (22)	Govt or intergovt	Government of Alberta (collaborative effort initiated by Alberta Health, Wellness Branch, Family and Population Health Division)	2008	No	393
Canada	British Columbia	144	Guidelines for food and beverage sales in BC schools (23)	Govt or intergovt	Government of BC (Ministry of Health, Population and Public Health Division and Ministry of Education)	2005 (mandated for all public schools in 2008; revised 2010 and 2013)	No	146; 393
Canada	Manitoba	193	Guidelines for foods available in K to 12 schools in Manitoba (criteria for packaged foods) (24)	Govt or intergovt	Government of Manitoba	2006 (revised 2014)[2]	No	393
Canada	New Brunswick	241	New Brunswick healthier foods and nutrition in public schools (25, 26)	Govt or intergovt	Department of Education in partnership with the Department of Wellness, Culture and Sport	2005 (revised 2008)	No	393
Canada	Nova Scotia	180	Food and beverage standards for Nova Scotia public schools (27)	Govt or intergovt	Nova Scotia Department of Education and Nova Scotia Department of Health Promotion and Protection	2006	No	393
Canada	Ontario	259	Ontario school food and beverage policy/program memorandum 150 (PPM 150) (28)	Govt or intergovt	Ontario Ministry of Education	2010 (effective 2011)	No	393

(*Continued*)

TABLE 3 *Continued*

Country	State/ province	Model number	Model name (reference)	Organization type	Organization name	Year of introduction or seminal publication	Model derived from other models identified as part of the review? [yes (indicated by model numbers) or no]	Model that served at least in part as the basis for the development of ≥1 other included model? [yes (indicated by model numbers) or no]
Canada	PEI	272	PEI school nutrition policy (29)	Govt or intergovt	PEI Healthy Eating Alliance, Eastern School District	2011 (superseded 2005 policy)	No	393
Canada	Saskatchewan	200	Healthy eating guidelines for Saskatchewan schools (Nourishing Minds) (30)	Govt or intergovt	Saskatchewan Ministry of Education in partnership with the Ministries of Health and Social Services	2009 (revised 2012)	282 (earlier version)	393
China	Hong Kong	205	Hong Kong nutritional criteria for snack classification (31)	Govt or intergovt	Department of Health	2006 (revised 2009, 2010, 2014)	No	No
Costa Rica	N/A	72	Costa Rica school food regulations (32)	Govt or intergovt	Ministerio de Educación Pública and Ministry of Health	2011 (effective 2012)	No	No
Czech Republic	N/A	167	Czech Republic draft decree for food sold and advertised in schools (33)	Govt or intergovt	Ministry of Education, Youth, and Physical Education and the Ministry of Health	2016	No	No
Greece	N/A	59	New School Canteen Standards (34)	Govt or intergovt	Greek Ministry of Health and Social Solidarity	2006	No	No
India	N/A	211	FSSAI draft guidelines for making available wholesome, nutritious, safe and hygienic food to schoolchildren in India (35)	Govt or intergovt	Central Advisory Committee of the FSSAI	2015	No	No
New Zealand	N/A	70	Food and beverage classification system nutrient criteria (Fuelled4life) (36)	Govt or intergovt, NGO	Ministry of Health, but managed by the New Zealand Heart Foundation	2007 (revised 2013)[3]	No	No
Scotland	N/A	60	Scotland nutritional requirements for food and drink in schools (37)	Govt or intergovt	Scottish Government	2008	No	No
Singapore	N/A	76	Healthy meals in schools program (Eating Healthily At The School Canteen) (38, 39)	Govt or intergovt	Health Promotion Board	2009 (former version, Model School Tuckshop Programme, introduced in 2003)	73	No

(*Continued*)

TABLE 3 *Continued*

Country	State/ province	Model number	Model name (reference)	Organization type	Organization name	Year of introduction or seminal publication	Model derived from other models identified as part of the review? [yes (indicated by model numbers) or no]	Model that served at least in part as the basis for the development of ≥1 other included model? [yes (indicated by model numbers) or no]
United Kingdom (England)	N/A	61	England requirements for school food regulations (40, 41)	Govt or intergovt	Secretary of State for Education, England	2007 (revised 2014; effective 2015)	No	No
United States	N/A	325	USDA smart snacks in school nutrition standards (also known as competitive food standards) (42)	Govt or intergovt	USDA	2013 (effective 2014)	80	163; 352
United States	California	352	California's nutrition standards SB12 and SB965 (competitive food and beverage standards for schools) (43, 44)	Govt or intergovt	California Department of Education	2005	325 (therefore indirectly: 80)	No
United States	Connecticut	163	Connecticut nutrition standards (45)	Govt or intergovt	Connecticut State Department of Education	2006 (revised 2016)[4]	325 (therefore indirectly: 80)	No
United States	North Carolina	248	Eat Smart: North Carolina's recommended standards for all foods available in school (46)	Govt or intergovt	North Carolina Division of Public Health, North Carolina Department of Public Instruction, and the North Carolina Cooperative Extension Service	2004	125	No
Front-of-pack food labeling ($n = 12$)								
International	N/A	53	Choices (47, 48)	Foundation (private initiative)	Choices International Foundation[5]	2006	No	No
Australia and New Zealand	N/A	196	Health Star Rating System (49, 50)	Govt or intergovt, commercial, NGO	Australian state and territory governments and New Zealand Government in collaboration with industry, public health, and consumer groups[6]	2014	20 (therefore indirectly: 5)	No
Chile	N/A	156	Chile "Black Octagonal Stop-Sign" warning labels (51)	Govt or intergovt	Ministry of Health (Ministerio de Salud)	2012 (effective 2015)	No	No
Ecuador	N/A	172	Ecuador traffic light labeling system (52)	Govt or intergovt	Ministry of Public Health	2014	41	No

(*Continued*)

TABLE 3 *Continued*

Country	State/ province	Model number	Model name (reference)	Organization type	Organization name	Year of introduction or seminal publication	Model derived from other models identified as part of the review? [yes (indicated by model numbers) or no]	Model that served at least in part as the basis for the development of ≥1 other included model? [yes (indicated by model numbers) or no]
Finland	N/A	27	Heart symbol (53)	NGO, govt or intergovt	Finnish Heart Association and Finnish Diabetes Association, in active collaboration with the Finnish Food Safety Authority	2000	No	No
France	N/A	178	Five-Colour Nutrition Label (5-CNL/Nutri-Score) (54)	Govt or intergovt, academic	National Nutrition and Health Program (PNNS) of ANSES[7]	2013	5	No
Singapore	N/A	73	Healthier choice symbol program (55)	Govt or intergovt	Health Promotion Board (Healthy Foods and Dining Department, Obesity Prevention Management Division)	2009	No	75; 76
Sweden, Denmark, Norway, Iceland	N/A	11	Keyhole (56)	Govt or intergovt	Swedish National Food Administration, Norwegian Directorate of Health and Norwegian Food Safety Authority, Danish Veterinary and Food Administration	1989 in Sweden (revised 2005 and 2009); 2009 in Norway and Denmark; 2013 in Iceland (revised 2015)	No	251 (therefore indirectly: 335; 334); 314
United Arab Emirates	N/A	314	United Arab Emirates nutrition labeling model (Weqaya logo) (57, 58)	Govt or intergovt, academic, commercial	Abu Dhabi Quality and Conformity Council[8]	2015	11	No
United Kingdom	N/A	41	Traffic light labeling (59)	Govt or intergovt	Food Standards Agency[9]	2007 (revised 2016)	No	172
United States	N/A	1	Fruits & veggies—More Matters (60)	NGO (nonprofit consumer education foundation), govt or intergovt	Produce for Better Health Foundation and US CDC	2007 (former version, 5 A Day Program, introduced in 1991)	No	291
United States	Colorado	291	Smart Meal Seal nutrition criteria (61, 62)	Govt or intergovt, commercial	COPAN (program of the CDPHE) with food service/industry partners[10]	2007 (revised 2012)	1; 133; 134; 135	No
Restriction of marketing to children ($n = 10$)								
International	N/A	334	WHO nutrient profile model for the Western Pacific Regional Office (WHO-WPRO) (63)	Govt or intergovt	WHO Regional Office for the Western Pacific Region	2015 (field tested); 2016 (published)	335 (therefore indirectly: 62; 251 (also implies 5; 11))	No
International	N/A	335	WHO Regional Office for Europe nutrient profile model (WHO-EURO) (64)	Govt or intergovt	WHO Regional Office for Europe in collaboration with Department of Nutrition for Health and Development at WHO headquarters	2015	62; 251 (therefore indirectly: 5; 11)	334

(*Continued*)

TABLE 3 *Continued*

Country	State/ province	Model number	Model name (reference)	Organization type	Organization name	Year of introduction or seminal publication	Model derived from other models identified as part of the review? [yes (indicated by model numbers) or no]	Model that served at least in part as the basis for the development of ≥1 other included model? [yes (indicated by model numbers) or no]
International	N/A	388	PAHO nutrient profile model (WHO Regional Office for the Americas) (65)	Govt or intergovt	PAHO	2016	123	No
Denmark	N/A	62	Danish Code of responsible food marketing communication to children (66)	Commercial	Forum of Responsible Food Marketing Communication[11]	2008 (revised 2010)	No	335 (therefore indirectly: 334)
Ireland	N/A	220	Ireland—broadcasting authority model for restricting the marketing of food and drink to children (67, 68)	Govt or intergovt	Broadcasting Authority of Ireland	Not specified (revised and effective 2013)	5	No
Mexico	N/A	392	Mexico—restriction on the promotion of high-caloric-density foods (69)	Govt or intergovt	Ministry of Health (Secretaria de Salud)	2014 (effective 2015)	No	No
Norway	N/A	251	Norwegian Nutrient Profile model (70)	Govt or intergovt	Norwegian Directorate of Health[12]	2012 (revised 2013)	5; 11 (were considered for the development of the present model)	335 (therefore indirectly: 334)
Singapore	N/A	287	Singapore common nutrition criteria of the guidelines for food advertising to children (71)	Govt or intergovt	Nutrition Working Group established following discussions with Ministry of Health, HPB, and ASAS	2013 (consultation); 2014 (published); effective 2015	No	No
South Korea	N/A	44	South Korea—guideline for energy-dense, nutrition-poor food for children (72, 73)	Govt or intergovt	Korea FDA	2009	No	No
United Kingdom	N/A	5	Ofcom model for regulating the marketing of food to children, final version (WXYfm) (74)	Govt or intergovt	Ofcom (broadcast regulator) and Department of Health (Food Standards Agency)	2004–2005 (revision process started in October 2016)	No	20 (therefore indirectly: 196; 394); 178; 220; 251 (therefore indirectly: 335; 334)
Regulation of claims ($n = 7$)								
Australia and New Zealand	N/A	20	FSANZ—nutrient profiling scoring criterion (75)	Govt or intergovt	FSANZ	2007	5	196; 394
France	N/A	69	The SAIN, LIM system (76)	Govt or intergovt	French Food Safety Agency (Agence Française de Sécurité Sanitaire des Aliments)	2008	227; 253	No
Singapore	N/A	75	Singapore—nutrient-specific diet-related health claims (77)	Govt or intergovt	Agri-Food and Veterinary Authority	2010	73	No

(*Continued*)

TABLE 3 *Continued*

Country	State/ province	Model number	Model name (reference)	Organization type	Organization name	Year of introduction or seminal publication	Model derived from other models identified as part of the review? [yes (indicated by model numbers) or no]	Model that served at least in part as the basis for the development of ≥1 other included model? [yes (indicated by model numbers) or no]
South Africa	N/A	394	South Africa NP model (FSANZ validated in South Africa) (78)	Govt or intergovt, academic, commercial	Centre of Excellence for Nutrition, North-West University, South Africa; FSANZ[13]	2013	20 (therefore indirectly: 5)	No
United States	N/A	18	US—requirements for foods carrying a health claim (79)	Govt or intergovt	US FDA	1993	No	No
United States	N/A	35	US—definition of a "healthy" food as an implied nutrient content claim (80)	Govt or intergovt	US FDA	1993 (revision process started in September 2016)	No	No
United States	N/A	319	US—requirements for the "extra lean" and "lean" nutrient content claims (81)	Govt or intergovt	US FDA	Not specified	No	No
Health facilities ($n = 5$)								
Australia	Queensland	381	Queensland Health's A better choice – healthy food and drink supply strategy (2007)—nutrient criteria for the red category (82)	Govt or intergovt	Queensland Government (Queensland Health)	2007	138; 290	367
Australia	South Australia	367	Healthy food and drink choices for staff and visitors in South Australia health facilities—nutrient criteria for the red category (83)	Govt or intergovt	Government of South Australia, Department of Health	2009	138; 381 (therefore indirectly: 290)	No
Canada	Nova Scotia	160	Colchester East Hants Health Authority food and beverage nutrient standards (84, 85)	Govt or intergovt	Colchester East Hants Health Authority, Nova Scotia (referred to as Nova Scotia Health Authority since April 2015)	2013	No	No
Scotland	N/A	285	Scotland nutritional standards for hospital food: Food in Hospitals (86, 87)	Govt or intergovt	Scottish Government	2008 (revised 2016)	No	No
United States	North Carolina	201	Healthy food environments pricing incentives Nutrition Criteria (88–90)	NGO (nonprofit organization)	North Carolina Prevention Partners[14]	2007 (revised 2013)	No	No

(*Continued*)

TABLE 3 *Continued*

Country	State/ province	Model number	Model name (reference)	Organization type	Organization name	Year of introduction or seminal publication	Model derived from other models identified as part of the review? [yes (indicated by model numbers) or no]	Model that served at least in part as the basis for the development of ≥1 other included model? [yes (indicated by model numbers) or no]
Government facilities ($n = 4$)								
United Kingdom (England)	N/A	174	England government buying standards for food and catering services (91)	Govt or intergovt	Department for Environment, Food and Rural Affairs	2014 (revised 2015)	No	No
United States	N/A	364	Food service guidelines for federal facilities (formerly Health and sustainability guidelines for federal concessions and vending operations; HHS/GSA guidelines) (92, 93)	Govt or intergovt	Health and Human Services General Services Administration collaborative team, Federal Health and Sustainability Team for Concessions and Vending	2011 (revised 2017)[15]	No	256; 330; 376
United States	Massachusetts	232	Massachusetts state agency food standards (94)	Govt or intergovt	Nutrition and Physical Activity Obesity Initiative, Bureau of Community Health Access and Promotion, Massachusetts Department of Public Health	2009 (revised 2012)	No	No
United States	Washington	330	Washington State healthy nutrition guidelines (95)	Govt or intergovt	Washington State Department of Health	2014	364 (in part)	No
Vending machines ($n = 4$)								
Canada	British Columbia	146	Healthier choices in vending machines in BC public buildings policy (96)	Govt or intergovt	Government of BC (Ministry of Health, Population and Public Health Division)	2006 (revised 2014)	144	No
United Kingdom (Wales)	N/A	329	Wales—health-promoting vending guidance (hospitals) (97)	Govt or intergovt	Department of Health and Health Improvement Division of the Welsh Government	2008	No	No
United States	N/A	341	Nemours Health and Prevention Services (Delaware's public health department) "Go, Slow, and Whoa" model (guide to healthier vending and concessions) (98, 99)	NGO (nonprofit foundation)	Nemours Health and Prevention Services[16]	2010	No	169

(*Continued*)

TABLE 3 *Continued*

Country	State/ province	Model number	Model name (reference)	Organization type	Organization name	Year of introduction or seminal publication	Model derived from other models identified as part of the review? [yes (indicated by model numbers) or no]	Model that served at least in part as the basis for the development of ≥1 other included model? [yes (indicated by model numbers) or no]
United States	Iowa	256	Nutrition Environment Measurement Survey-Vending (NEMS-V) traffic light system (100, 101)	Govt or intergovt, academic, NGO (nonprofit foundation)	Iowa State University Extension and Outreach, Iowa Department of Public Health, and Wellmark Foundation	2012	364 (when it was previously called Health and sustainability guidelines for federal concessions and vending operations)	No
Recreational facilities ($n = 3$)								
Australia	Queensland	273	Queensland—red criteria of the Food for Sport guidelines (102, 103)	Govt or intergovt	Department of National Parks, Sport and Racing, Queensland Government	Not specified (Queensland Government websites updated 2010 and 2011)	138; 290	No
United States	N/A	376	US National Park Service healthy food choice standards and sustainable food choice guidelines for front country operations (104)	Govt or intergovt	US National Park Service	2012 (revised 2013)	364	No
United States	Delaware	169	Delaware State Parks healthy eating initiative—"Munch Better at Delaware State Parks" (105, 106)	NGO (nonprofit foundation), govt or intergovt	Nemours Health and Prevention Services, Delaware Division of Parks and Recreation, and Delaware Health and Social Services' Division of Public Health	2010	341	No
Food assistance programs ($n = 2$)								
United States	N/A	81	Minimum requirements and specifications for food items allowed in the WIC food packages (supplemental foods) (107, 108)	Govt or intergovt	USDA, Food and Nutrition Service	1980 (interim rule 2007; final rule 2014)	No	318
United States	Georgia	318	US—Georgia WIC approved food list—criteria to evaluate an eligible food item (109, 110)	Govt or intergovt	Georgia Department of Public Health, Georgia WIC- Program, Special Supplemental Nutrition Program for WIC	Not specified (criteria to evaluate an eligible food item updated 2015; WIC-approved foods list revised 2016)	81	No

(*Continued*)

TABLE 3 *Continued*

Country	State/ province	Model number	Model name (reference)	Organization type	Organization name	Year of introduction or seminal publication	Model derived from other models identified as part of the review? [yes (indicated by model numbers) or no]	Model that served at least in part as the basis for the development of ≥1 other included model? [yes (indicated by model numbers) or no]
Food systems/ surveillance ($n = 2$)								
International	N/A	254	Nutrient value score (111, 112)	Govt or intergovt	UN World Food Program	2013	No	No
Canada	N/A	195	Health Canada Surveillance Tool tier system (113)	Govt or intergovt	Health Canada	2014	No	No
Consumer education ($n = 1$)								
Canada	Alberta	351	Alberta nutrition guidelines for adults (114)	Govt or intergovt	Government of Alberta	2012	No	No
Taxation ($n = 1$)								
Hungary	N/A	371	Hungarian public health tax (tax on food products containing unhealthy levels of sugar, salt, and other ingredients) (115–117)	Govt or intergovt	Hungarian Government	2011 (revised 5 times between 2011 and 2015)	No	No

[1] ANSES, Agence Nationale de Sécurité Sanitaire de l'Alimentation, de l'Environnement et du Travail; ASAS, Advertising Standards Authority of Singapore; BC, British Columbia; CDPHE, Colorado Department of Public Health and Environment; COPAN, Colorado Physical Activity and Nutrition Program; FSANZ, Food Standards Australia New Zealand; FSSAI, Food Safety and Standards Authority of India; Govt/govt, government; GSA, General Services Administration; HHS, Health and Human Services; HPB, Health Promotion Board; intergovt, intergovernmental; LIM, limited nutrients; N/A, not applicable; NGO, nongovernmental organization; NP, nutrient profile; NSW, New South Wales; Ofcom, Office of Communications; PAHO, Pan American Health Organization; PEI, Prince Edward Island; PNNS, Programme National Nutrition Santé; SAIN, Nutrient Adequacy Score for Individual foods; WHO-EURO, WHO-Europe; WHO-WPRO, WHO Western Pacific Region; WIC, Women, Infants and Children.

[2] Data from the 2014 version were extracted.

[3] Nutritional criteria from the September 2013 version were extracted. This information was e-mailed to one of the authors by the New Zealand Heart Foundation in February 2016. The New Zealand Heart Foundation also indicated that the criteria were due for review in 2016.

[4] Data from the 2016 version were extracted.

[5] Although the model was developed by a foundation, the initiative was initially triggered by a governmental request to the food industry in the Netherlands as indicated by Roodenburg et al. (47).

[6] Including Australian Beverages Council, Australian Chronic Disease Prevention Alliance, Australian Food and Grocery Council, Australian Industry Group, Australian Medical Association, Australian National Retail Association, CHOICE, Obesity Policy Coalition, and Public Health Association of Australia.

[7] The model specifically proposed by Serge Hercberg (professor at the University Paris-XIII and director of the PPNS) as per a request by the Minister of Social Affairs and Health (Ministre des Affaires Sociales et de la Santé) in June 2013.

[8] The working Group consists of members from Abu Dhabi Quality and Conformity Council, Health Authority Abu Dhabi, Abu Dhabi Food Control Authority, Emirates Authority For Standardization and Metrology, United Arab Emirates University, Abu Dhabi University, AGTHIA Company, Al FOAH Company, and AbuDhabi Farmers Service Centre.

[9] The responsibility for the policy was transferred to the Department of Health as of October 2010. Also, it is stressed that the updated 2016 guidance document was developed by the Department of Health, the Food Standards Agency, and devolved administrations in Scotland, Northern Ireland, and Wales in collaboration with the British Retail Consortium.

[10] COPAN partnered with the Colorado Restaurant Association and owners of large and small restaurants to help shape and define the Smart Meal Seal program.

[11] The model is endorsed by the Danish government as indicated in the reference document of the WHO Regional Office for Europe nutrient profile model (no. 335).

[12] The working group consisted of the Norwegian Directorate of Health, Consumer Ombudsman, Food Safety Authority, Ministry of Children and Equality, Ministry of Health and Care Services, and Secretariat: Ministry of Health and Care Services.

[13] The original model (no. 20) was developed by government. Stakeholders for the present model no. 394 included government (Department of Health, South Africa, Directorate: Food Control; FSANZ), the food industry, and academia (North-West University).

[14] According to the USDA webpage, the present program is part of the Supplemental Nutrition Assistance Program (SNAP)-Ed Strategies & Interventions Toolkit. The model therefore appears to be endorsed by the government.

[15] Data from the 2011 version were extracted.

[16] The model was developed by a foundation but is endorsed or used by Delaware State Parks (refer to model no. 169).

TABLE 4 Main characteristics of NP models, overall and according to the 12 primary applications identified[1]

Characteristics	Total ($n = 78$)	School food ($n = 27$)	Front-of-pack food labeling ($n = 12$)	Restriction of marketing to children ($n = 10$)	Regulation of claims ($n = 7$)	Health facilities ($n = 5$)	Government facilities ($n = 4$)	Vending machines ($n = 4$)	Recreational facilities ($n = 3$)	Food assistance programs ($n = 2$)	Food systems/ surveillance ($n = 2$)	Consumer education ($n = 1$)	Taxation ($n = 1$)
Type of rating system													
Summary rating of the nutritional quality	71 (91)	27 (100)	7 (58)	9 (90)	7 (100)	5 (100)	4 (100)	4 (100)	3 (100)	2 (100)	1 (50)	1 (100)	1 (100)
Nutrient-specific rating	3 (4)	—	3 (25)	—	—	—	—	—	—	—	—	—	—
Combination of both	4 (5)	—	2 (17)	1 (10)	—	—	—	—	—	—	1 (50)	—	—
Type of output													
Classification	70 (90)	27 (100)	10 (83)	8 (80)	4 (57)	5 (100)	4 (100)	4 (100)	3 (100)	2 (100)	1 (50)	1 (100)	1 (100)
Score	1 (1)	—	—	—	—	—	—	—	—	—	1 (50)	—	—
Combination of both	7 (9)	—	2 (17)	2 (20)	3 (43)	—	—	—	—	—	—	—	—
Food categories[2]													
Level(s) at which nutrient criteria are applied (major, sub-, and/or sub-subcategory level)													
Major only	36 (46)	5 (19)	6 (50)	6 (60)	6 (86)	3 (60)	2 (50)	3 (75)	2 (67)	1 (50)	2 (100)	—	—
Major and sub	21 (27)	12 (44)	2 (17)	3 (30)	—	—	1 (25)	1 (25)	—	1 (50)	—	—	1 (100)
Major, sub, and sub-sub	6 (8)	—	1 (8)	1 (10)	—	2 (40)	1 (25)	—	1 (33)	—	—	—	—
Sub only	12 (15)	9 (33)	2 (17)	—	—	—	—	—	—	—	—	1 (100)	—
Sub and sub-sub	3 (4)	1 (4)	1 (8)	—	1 (14)	—	—	—	—	—	—	—	—
Total number of food categories including nutrient criteria (major, sub-, and sub-subcategories combined, if applicable) (min–max)	1–99	2–73	2–99	1–31	1–99	3–9	3–27	5–14	2–9	15–22	1–4	25	12
Nutrients and food components													
Number/type of nutrients and food components may vary across the model's food categories/types of food product evaluated	60 (77)	26 (96)	6 (50)	7 (70)	2 (29)	5 (100)	4 (100)	4 (100)	2 (67)	2 (100)	0 (0)	1 (100)	1 (100)

(*Continued*)

TABLE 4 *Continued*

Characteristics	Total ($n = 78$)	School food ($n = 27$)	Front-of-pack food labeling ($n = 12$)	Restriction of marketing to children ($n = 10$)	Regulation of claims ($n = 7$)	Health facilities ($n = 5$)	Government facilities ($n = 4$)	Vending machines ($n = 4$)	Recreational facilities ($n = 3$)	Food assistance programs ($n = 2$)	Food systems/ surveillance ($n = 2$)	Consumer education ($n = 1$)	Taxation ($n = 1$)
Inclusion of nutrients[3] to limit	78 (100)	27 (100)	12 (100)	10 (100)	7 (100)	5 (100)	4 (100)	4 (100)	3 (100)	2 (100)	2 (100)	1 (100)	1 (100)
Number of nutrients[3] considered (min–max)	2–12	3–12	3–12	2–8	3–11	3–9	3–10	4–12	4–6	7–12	2–4	11	6
Top 3 nutrients[3] considered (% of models that include the nutrient)[4]	1. Total sodium (91)	1. Total sodium (93)	1. Total sodium (100)	1. SFAs (90)	1. SFAs (100)	1. SFAs (100)	1. Energy (100)	1. Free/added sugars (100)	1. Energy (100)	1. Added fat (100)	1. Total fat (100)	N/A	N/A
	2. SFAs (83)	2. SFAs (89)	2. SFAs (83)	2. Total sodium (90)	2. Total sodium (86)	2. Energy (80)	2. Total sugars (100)	2. SFAs (100)	2. Total sodium (100)	2. Added sodium (100)	2. Energy (50)		
	3. Total sugars (73)	3. Total fat (81)	3. Total sugars (75)	3. Total sugars (90)	3. Cholesterol (57)	3. Total sodium (80)	3. Total fat (75)	3. Total fat (100)	3. SFAs (67)	3. Free/added sugars (100)	3. SFAs (50)		
					4. Total fat (57)		4. Total sodium (75)	4. Total sodium (100)	4. Total fat (67)	4. Total fat (100)	4. Total sodium (50)		
							5. *trans* fat (75)			5. Total sodium (100)	5. Total sugars (50)		
										6. Total sugars (100)			
Inclusion of nutrients[3] to encourage	67 (86)	25 (93)	9 (75)	6 (60)	6 (86)	5 (100)	4 (100)	4 (100)	3 (100)	2 (100)	1 (50)	1 (100)	1 (100)
Number of nutrients[3] considered (min–max)	1–15	1–14	1–8	1–8	3–8	1–2	2–5	1–5	1–2	14–15	9	7	1
Top 3 nutrients[3] considered (% of models that include the nutrient)[4]	1. FVNL (64)	1. Fiber (60)	1. Fiber (89)	1. Fiber (67)	1. Fiber (100)	1. Fiber (40)	1. FVNL (100)	1. FVNL (100)	1. Fiber (67)	Many[5]	N/A	N/A	N/A

(*Continued*)

TABLE 4 *Continued*

Characteristics	Total ($n = 78$)	School food ($n = 27$)	Front-of-pack food labeling ($n = 12$)	Restriction of marketing to children ($n = 10$)	Regulation of claims ($n = 7$)	Health facilities ($n = 5$)	Government facilities ($n = 4$)	Vending machines ($n = 4$)	Recreational facilities ($n = 3$)	Food assistance programs ($n = 2$)	Food systems/ surveillance ($n = 2$)	Consumer education ($n = 1$)	Taxation ($n = 1$)
	2. Fiber (63) 3. Protein (43)	2. FVNL (56) 3. Whole grain (48)	2. FVNL (89) 3. Whole grain (44)	2. Protein (67) 3. FVNL (50)	2. Protein (83) 3. Calcium (67)	2. FVNL (40) 3. Energy (20) 4. Protein (20) 5. Whole grain (20)	2. Fiber (75) 3. Calcium (50) 4. Whole grain (50)	2. Whole grain (75) 3. Calcium (25) 4. Fiber (25) 5. Milk/dairy-based content (25) 6. Protein (25) 7. Small serving size (25) 8. Vitamin D (25) 9. Water (25)	2. FVNL (33) 3. Whole grain (33)				
Reference amounts/units													
Top 3 types of reference amounts or other units considered (% of models that include the reference amount/ unit)[6]	1. Per serving (76) 2. Presence/ position (64) 3. Per 100 g and/or mL (60)	1. Per serving (89) 2. Presence/ position (78) 3. Per 100 g and/or mL (44)	1. Per 100 g and/or mL (83) 2. Per serving (58) 3. Presence/ position (50)	1. Per 100 g and/or mL (80) 2. Presence/ position (60) 3. Per serving (30)	1. Per 100 g and/or mL (86) 2. Per serving (71) 3. Per 419 kJ (i.e., 100 kcal) (43)	1. Per serving (100) 2. Per 100 g and/or mL (60) 3. Presence/ position (60)	1. Per serving (100) 2. Presence/ position (75) 3. Maximum size (50)	1. Per serving (100) 2. Presence/ position (100) 3. Maximum size (50)	1. Per serving (100) 2. Per 100 g and/or mL (67) 3. Maximum size (33) 4. Per 419 kJ (i.e., 100 kcal) (33) 5. Presence/ position (33)	1. Per 100 g and/or mL (100) 2. Per other prespecified amount (100) 3. Per serving (100) 4. Presence/ position (100)	1. Per 100 g and/or mL (50) 2. Per serving (50)	N/A	N/A

(*Continued*)

TABLE 4 *Continued*

Characteristics	Total ($n = 78$)	School food ($n = 27$)	Front-of-pack food labeling ($n = 12$)	Restriction of marketing to children ($n = 10$)	Regulation of claims ($n = 7$)	Health facilities ($n = 5$)	Government facilities ($n = 4$)	Vending machines ($n = 4$)	Recreational facilities ($n = 3$)	Food assistance programs ($n = 2$)	Food systems/ surveillance ($n = 2$)	Consumer education ($n = 1$)	Taxation ($n = 1$)
Some degree of validity testing identified (e.g., content, construct/ convergent, face, and/or criterion/predictive validity)	33 (42)	5 (19)	7 (58)	7 (70)	5 (71)	1 (20)	1 (25)	3 (75)	1 (33)	0 (0)	2 (100)	0 (0)	1 (100)
Number of models derived from other models, either included or excluded, identified as part of the review	34 (44)	11 (41)	5 (42)	5 (50)	4 (57)	2 (40)	1 (25)	2 (50)	3 (100)	1 (50)	—	—	—
Number of models that served at least in part as the basis for the development of ≥1 other included model	24 (31)	11 (41)	4 (33)	4 (40)	1 (10)	1 (20)	1 (25)	1 (25)	—	1 (50)	—	—	—

[1]Values are *n* (%) of models unless stated otherwise. A more detailed summary of the key characteristics of each model is provided in Table 5. Supplementary data also provide further details on the specific nutrients and food components "to limit" and "to encourage" included in each model (Supplemental Table 4) and on the specific types of reference amounts and other evaluation units used in each model (Supplemental Table 5). FVNL, fruits, vegetables, nuts, and legumes; min-max, minimum–maximum; NP, nutrient profile; N/A, not applicable.

[2]Major food categories represented the first and sometimes only level of categories described in a model. In some models, ≥1 major category was subdivided into subcategories. In a few cases, ≥1 subcategory was further subdivided into sub-subcategories (e.g., Nordic Keyhole model, no. 11, in which the major category of meat and meat products includes 2 subcategories, and 1 of these also includes 3 sub-subcategories).

[3]Also implies food components.

[4]Nutrients are listed in descending order of the proportion of models that include them; alphabetical order was used when proportions were equal; therefore, the number of nutrients listed may be >3. N/A was used when the number of models evaluated was equal to 1.

[5]Calcium, FVNL, iron, magnesium, phosphorous, potassium, protein, riboflavin, vitamin A, vitamin B-12, vitamin C, vitamin D, and whole grain are all nutrients/food components included in both models evaluated.

[6]Reference amounts and other evaluation units are listed in descending order of the proportion of models that include them; alphabetical order was used when proportions were equal, therefore the number of reference amounts/units listed may be >3. N/A was used when the number of models evaluated was equal to 1. Presence/position refers to the presence (or absence) of a nutrient or food component in a product (e.g., no added sweeteners) or to its position in the ingredient list (e.g., the first ingredient must be a whole grain).

TABLE 5 Summary characteristics of the 78 included NP models[1]

Model number	Model name	Type of model[2]	Output[3]	Category level(s) at which nutrient criteria are applied[4]	Number of food categories with nutrient criteria[5]	Model including only nutrients/food components to limit (A) or nutrients/food components to limit and to encourage (B)[6]	Number/type of nutrients and food components may vary across the model's food categories/types of food product evaluated (Y/N)	Total nutrients/food components to limit[7]	Total nutrients/food components to encourage[7]	Type of reference amount/unit considered			
										Per 100 g and/or per 100 mL	Per 419 kJ (i.e., 100 kcal) or % of energy	Per serving	Other reference amount or unit[8]
School food ($n = 27$)													
93	National Healthy School Canteens Project	A	A	Major, sub	6–23[9]	B	Y	4	1	Y	—	Y	—
138	Australia—Fresh Tastes @ School NSW Healthy School Canteens Strategy	A	A	Major, sub	73[10,11]	B	Y	3	1	Y	—	Y	—
290	Smart Choices: healthy food and drink supply strategy for Queensland schools—nutrient criteria for the "Occasional" (red) food and drink category	A	A	Sub	7	B	Y	3	1	Y	—	Y	—
293	South Australia Right Bite for schools and preschools—Nutrient criteria for the "Occasional" (red) category	A	A	Sub	6	B	Y	3	1	Y	—	Y	—
140	Australia—State Government of Victoria—Go For Your Life healthy canteen kit—nutrient criteria for the "Occasionally" (red) food category	A	A	Sub	7	B	Y	3	1	Y	—	Y	—
393	Canada—Provincial and Territorial nutrient criteria for foods and beverages in schools (2013)	A	A	Sub	19	B	Y	10	3	—	—	Y	Y

(*Continued*)

TABLE 5 *Continued*

Model number	Model name	Type of model[2]	Output[3]	Category level(s) at which nutrient criteria are applied[4]	Number of food categories with nutrient criteria[5]	Model including only nutrients/food components to limit (A) or nutrients/food components to limit and to encourage (B)[6]	Number/type of nutrients and food components may vary across the model's food categories/types of food product evaluated (Y/N)	Total nutrients/food components to limit[7]	Total nutrients/food components to encourage[7]	Type of reference amount/unit considered			
										Per 100 g and/or per 100 mL	Per 419 kJ (i.e., 100 kcal) or % of energy	Per serving	Other reference amount or unit[8]
131	Alberta nutrition guidelines for children and youth	A	A	Sub	25	B	Y	11	5	—	—	Y	Y
144	Guidelines for food and beverage sales in BC schools	A	A	Sub	21	B	Y	10	4	—	—	Y	Y
193	Guidelines for foods available in K to 12 schools in Manitoba (criteria for packaged foods)	A	A	Major	6	B	Y	8	6	—	—	Y	Y
241	New Brunswick healthier foods and nutrition in public schools	A	A	Major, sub	19	B	Y	9	8	—	—	Y	Y
180	Food and beverage standards for Nova Scotia public schools	A	A	Major	5	B	Y	8	2	—	—	Y	Y
259	Ontario school food and beverage policy/program memorandum 150 (PPM 150)	A	A	Sub	33	B	Y	9	6	—	—	Y	Y
272	PEI school nutrition policy	A	A	Major	5	B	Y	7	3	—	—	Y	Y
200	Healthy eating guidelines for Saskatchewan schools (Nourishing Minds)	A	A	Major	5	B	Y	5	9	—	—	Y	Y
72	Costa Rica school food regulations	A	A	Sub	17	A	Y	7	0	Y	—	—	Y
167	Czech Republic draft decree for food sold and advertised in schools	A	A	Major, sub	16	B	Y	8	7	Y	—	—	Y

(*Continued*)

TABLE 5 *Continued*

Model number	Model name	Type of model[2]	Output[3]	Category level(s) at which nutrient criteria are applied[4]	Number of food categories with nutrient criteria[5]	Model including only nutrients/food components to limit (A) or nutrients/food components to limit and to encourage (B)[6]	Number/type of nutrients and food components may vary across the model's food categories/types of food product evaluated (Y/N)	Total nutrients/food components to limit[7]	Total nutrients/food components to encourage[7]	Type of reference amount/unit considered			
										Per 100 g and/or per 100 mL	Per 419 kJ (i.e., 100 kcal) or % of energy	Per serving	Other reference amount or unit[8]
59	New School Canteen Standards	A	A	Major, sub	18	B	Y	9	0	Y	—	Y	Y
205	Hong Kong nutritional criteria for snack classification	A	A	Sub, sub-sub	12	B	Y	9	1	Y	—	Y	Y
211	FSSAI draft guidelines for making available wholesome, nutritious, safe and hygienic food to schoolchildren in India	A	A	Major	2	A	N	6	0	—	—	Y	—
70	Food and beverage classification system nutrient criteria (Fuelled4life)	A	A	Sub	38	B	Y	11	2	Y	—	Y	Y
76	Healthy meals in schools program (Eating Healthily At The School Canteen)	A	A	Major, sub	2	B	Y	12	8	Y	—	Y	Y
60	Scotland nutritional requirements for food and drink in schools	A	A	Major, sub	16[11]	B	Y	8	1	Y	—	Y	Y
61	England requirements for school food regulations	A	A	Major, sub	10[11]	B	Y	5	3	—	—	—	Y
325	USDA smart snacks in school nutrition standards (also known as competitive food standards)	A	A	Major, sub	10	B	Y	10	4	—	—	Y	Y

(*Continued*)

TABLE 5 *Continued*

Model number	Model name	Type of model[2]	Output[3]	Category level(s) at which nutrient criteria are applied[4]	Number of food categories with nutrient criteria[5]	Model including only nutrients/food components to limit (A) or nutrients/food components to limit and to encourage (B)[6]	Number/type of nutrients and food components may vary across the model's food categories/types of food product evaluated (Y/N)	Total nutrients/food components to limit[7]	Total nutrients/food components to encourage[7]	Type of reference amount/unit considered			
										Per 100 g and/or per 100 mL	Per 419 kJ (i.e., 100 kcal) or % of energy	Per serving	Other reference amount or unit[8]
352	California's nutrition standards SB12 and SB965 (competitive food and beverage standards for schools)	A	A	Major, sub[12]	5–8[13]	B	Y	10	14	—	Y	Y	Y
163	Connecticut nutrition standards	A	A	Major, sub	13	B	Y	10	5	—	Y	Y	Y
248	Eat Smart: North Carolina's recommended standards for all foods available in school	A	A	Major, sub	3–4[14]	B	Y	6	4	—	Y	Y	Y
Front-of-pack food labeling ($n = 12$)													
53	Choices	A	A	Major, sub	31	B	Y	5	1	Y	Y	Y	Y
196	Health Star Rating System	C	C	Sub	6	B	N	4	3	Y	—	—	—
156	Chile "Black Octagonal Stop-Sign" warning labels	B	A	Major	2	A	N	4	0	Y	—	—	—
172	Ecuador traffic light labelling system	B	A	Major	2	A	N	3	0	Y	—	—	—
27	Heart symbol	A	A	Sub	75	B	Y	10	3	Y	Y	—	Y
178	Five-Colour Nutrition Label (5-CNL/Nutri-Score)	A	C	Major	2	B	N	4	3	Y	—	—	—
73	Healthier Choice Symbol program	C	A	Sub, sub-sub	99	B	Y	11	8	Y	—	Y	Y
11	Keyhole	A	A	Major, sub, sub-sub	46	B	Y	10	6	Y	Y	Y	Y
314	United Arab Emirates nutrition labeling model (Weqaya logo)	A	A	Major, sub	20	B	Y	12	3	Y	—	Y	Y
41	Traffic light labelling	B	A	Major	2	A	N	4	0	Y	—	Y	—

(*Continued*)

TABLE 5 *Continued*

Model number	Model name	Type of model[2]	Output[3]	Category level(s) at which nutrient criteria are applied[4]	Number of food categories with nutrient criteria[5]	Model including only nutrients/food components to limit (A) or nutrients/food components to limit and to encourage (B)[6]	Number/type of nutrients and food components may vary across the model's food categories/types of food product evaluated (Y/N)	Total nutrients/food components to limit[7]	Total nutrients/food components to encourage[7]	Type of reference amount/unit considered			
										Per 100 g and/or per 100 mL	Per 419 kJ (i.e., 100 kcal) or % of energy	Per serving	Other reference amount or unit[8]
1	Fruits & veggies—More Matters	A	A	Major	3	B	Y	4	2	—	Y	Y	Y
291	Smart Meal Seal nutrition criteria	A	A	Major	2	B	N	5	3	—	—	Y	Y
Restriction of marketing to children ($n = 10$)													
334	WHO nutrient profile model for the Western Pacific Regional Office (WHO-WPRO)	A	A	Major, sub	21	A	Y	8	0	Y	—	—	Y
335	WHO Regional Office for Europe nutrient profile model (WHO-EURO)	A	A	Major, sub	20	A	Y	8	0	Y	—	—	Y
388	PAHO nutrient profile model (WHO Regional Office for the Americas)	C	A	Major	1	A	N	6	0	—	Y	—	Y
62	Danish Code of responsible food marketing communication to children	A	A	Major	10	A	Y	2	0	Y	—	—	Y
220	Ireland—broadcasting authority model for restricting the marketing of food and drink to children	A	C	Major	2	B	N	4	3	Y	—	—	—
44	South Korea—guideline for energy-dense, nutrition -poor food for children	A	A	Major	2	B	Y	4	1	—	—	Y	Y

(*Continued*)

TABLE 5 *Continued*

Model number	Model name	Type of model[2]	Output[3]	Category level(s) at which nutrient criteria are applied[4]	Number of food categories with nutrient criteria[5]	Model including only nutrients/food components to limit (A) or nutrients/food components to limit and to encourage (B)[6]	Number/type of nutrients and food components may vary across the model's food categories/types of food product evaluated (Y/N)	Total nutrients/food components to limit[7]	Total nutrients/food components to encourage[7]	Type of reference amount/unit considered			
										Per 100 g and/or per 100 mL	Per 419 kJ (i.e., 100 kcal) or % of energy	Per serving	Other reference amount or unit[8]
392	Mexico—restriction on the promotion of high-caloric-density foods	A	A	Major, sub	31	B	Y	5	1	Y	—	Y	Y
251	Norwegian nutrient profile model	A	A	Major	8	B	Y	7	1	Y	—	—	Y
287	Singapore common nutrition criteria of the guidelines for food advertising to children	A	A	Major, sub, sub-sub	27	B	Y	7	8	Y	—	Y	Y
5	Ofcom model for regulating the marketing of food to children, final version (WXYfm)	A	C	Major	2	B	N	4	3	Y	—	—	—
Regulation of claims ($n = 7$)													
20	FSANZ—nutrient profiling scoring criterion	A	C	Major	3	B	N	4	3	Y	—	Y	—
69	The SAIN, LIM system	A	C	Major	1	B	N	3	5	Y	Y	—	Y
75	Singapore—nutrient-specific diet-related health claims	A	A	Sub, sub-sub	99	B	Y	11	8	Y	Y	Y	Y
394	South Africa nutrient profile model (FSANZ validated in South Africa)	A	C	Major	3	B	N	4	3	Y	—	—	—
18	US—requirements for foods carrying a health claim	A	A	Major	3	B	N	4	6	—	—	Y	Y
35	US—definition of a "healthy" food as an implied nutrient content claim	A	A	Major	6	B	Y	4	6	Y	Y	Y	Y
319	US—requirements for the "extra lean" and "lean" nutrient content claims	A	A	Major	4	A	N	3	0	Y	—	Y	—

(*Continued*)

TABLE 5 *Continued*

Model number	Model name	Type of model[2]	Output[3]	Category level(s) at which nutrient criteria are applied[4]	Number of food categories with nutrient criteria[5]	Model including only nutrients/food components to limit (A) or nutrients/food components to limit and to encourage (B)[6]	Number/type of nutrients and food components may vary across the model's food categories/types of food product evaluated (Y/N)	Total nutrients/food components to limit[7]	Total nutrients/food components to encourage[7]	Type of reference amount/unit considered			
										Per 100 g and/or per 100 mL	Per 419 kJ (i.e., 100 kcal) or % of energy	Per serving	Other reference amount or unit[8]
Health facilities ($n = 5$)													
381	Queensland Health's A better choice – healthy food and drink supply strategy (2007)—nutrient criteria for the red category	A	A	Major, sub, sub-sub	9	B	Y	4	1	Y	—	Y	Y
367	Healthy food and drink choices for staff and visitors in South Australia health facilities—nutrient criteria for the red category	A	A	Major, sub, sub-sub	9	B	Y	4	1	Y	—	Y	Y
160	Colchester East Hants Health Authority food and beverage nutrient standards	A	A	Major	7	B	Y	9	2	—	—	Y	Y
285	Scotland nutritional standards for hospital food: Food in Hospitals	A	A	Major	3	B	Y	3	2	—	—	Y	Y
201	Healthy food environments pricing incentives nutrition criteria	A	A	Major	7[15]	B	Y	8	1	Y	—	Y	Y
Government facilities ($n = 4$)													
174	England government buying standards for food and catering services	A	A	Major	8[11]	B	Y	3	2	Y	—	Y	Y

(*Continued*)

TABLE 5 *Continued*

Model number	Model name	Type of model[2]	Output[3]	Category level(s) at which nutrient criteria are applied[4]	Number of food categories with nutrient criteria[5]	Model including only nutrients/food components to limit (A) or nutrients/food components to limit and to encourage (B)[6]	Number/type of nutrients and food components may vary across the model's food categories/types of food product evaluated (Y/N)	Total nutrients/food components to limit[7]	Total nutrients/food components to encourage[7]	Type of reference amount/unit considered			
										Per 100 g and/or per 100 mL	Per 419 kJ (i.e., 100 kcal) or % of energy	Per serving	Other reference amount or unit[8]
364	Food service guidelines for federal facilities (formerly Health and sustainability guidelines for federal concessions and vending operations; HHS/GSA guidelines)	A	A	Major, sub[16]	3–6[17]	B	Y	8	5	—	—	Y	Y
232	Massachusetts state agency food standards	A	A	Major, sub, sub-sub	27	B	Y	7	3	—	—	Y	Y
330	Washington State healthy nutrition guidelines	A	A	Major, sub	8	B	Y	10	3	—	—	Y	Y
Vending machines ($n = 4$)													
146	Healthier choices in vending machines in BC public buildings policy	A	A	Major	14	B	Y	9	5	—	—	Y	Y
329	Wales—health promoting vending guidance (hospitals)	A	A	Major, sub	13	B	Y	4	1	Y	—	Y	Y
341	Nemours Health and Prevention Services (Delaware's public health department) "Go, Slow, and Whoa" model (guide to healthier vending and concessions)	A	A	Major	11	B	Y	11	3	—	—	Y	Y
256	Nutrition Environment Measurement Survey-Vending (NEMS-V) traffic light system	A	A	Major	5	B	Y	12	5	—	—	Y	Y

(*Continued*)

TABLE 5 *Continued*

Model number	Model name	Type of model[2]	Output[3]	Category level(s) at which nutrient criteria are applied[4]	Number of food categories with nutrient criteria[5]	Model including only nutrients/food components to limit (A) or nutrients/food components to limit and to encourage (B)[6]	Number/type of nutrients and food components may vary across the model's food categories/types of food product evaluated (Y/N)	Total nutrients/food components to limit[7]	Total nutrients/food components to encourage[7]	Type of reference amount/unit considered			
										Per 100 g and/or per 100 mL	Per 419 kJ (i.e., 100 kcal) or % of energy	Per serving	Other reference amount or unit[8]
Recreational facilities ($n = 3$)													
273	Queensland—red criteria of the Food for Sport guidelines	A	A	Major, sub, sub-sub	9	B	Y	4	1	Y	—	Y	Y
376	US National Park Service healthy food choice standards and sustainable food choice guidelines for front country operations	A	A	Major	2	B	Y	4	2	Y	—	Y	Y
169	Delaware State Parks healthy eating initiative—"Munch Better at Delaware State Parks"	A	A	Major	2	B	N	6	1	—	Y	Y	—
Food assistance programs ($n = 2$)													
81	Minimum requirements and specifications for food items allowed in the WIC food packages (supplemental foods)	A	A	Major, sub	22[11]	B	Y	7	14	Y	—	Y	Y
318	US—Georgia WIC approved food list—criteria to evaluate an eligible food item	A	A	Major	15[18]	B	Y	12	15	Y	—	Y	Y
Food systems/surveillance ($n = 2$)													
254	Nutrient value score	C	B	Major	1	B	N	2	9	Y	—	—	—
195	Health Canada Surveillance Tool tier system	A	A	Major	4	A	N	4	0	—	—	Y	—

(*Continued*)

TABLE 5 *Continued*

Model number	Model name	Type of model[2]	Output[3]	Category level(s) at which nutrient criteria are applied[4]	Number of food categories with nutrient criteria[5]	Model including only nutrients/food components to limit (A) or nutrients/food components to limit and to encourage (B)[6]	Number/type of nutrients and food components may vary across the model's food categories/types of food product evaluated (Y/N)	Total nutrients/food components to limit[7]	Total nutrients/food components to encourage[7]	Type of reference amount/unit considered			
										Per 100 g and/or per 100 mL	Per 419 kJ (i.e., 100 kcal) or % of energy	Per serving	Other reference amount or unit[8]
Consumer education ($n = 1$)													
351	Alberta nutrition guidelines for adults	A	A	Sub	25	B	Y	11	7	—	—	Y	Y
Taxation ($n = 1$)													
371	Hungarian public health tax (tax on food products containing unhealthy levels of sugar, salt, and other ingredients)	A	A	Major, sub	12	B	Y	6	1	Y	—	—	Y

[1] BC, British Columbia; FSANZ, Food Standards Australia New Zealand; FSSAI, Food Safety and Standards Authority of India; GSA, General Services Administration; HHS, Health and Human Services; LIM, limited nutrients; major, major category; N, no; NP, nutrient profile; NSW, New South Wales; Ofcom, Office of Communications; PAHO, Pan American Health Organization; PEI, Prince Edward Island; Sub/sub, subcategory; sub-sub, sub-subcategory; SAIN, Nutrient Adequacy Score for Individual foods; WHO-EURO, WHO-Europe; WHO-WPRO, WHO Western Pacific Region; WIC, Women, Infants and Children; Y, yes.

[2] A, summary indicator system; B, nutrient-specific system; C, combination of both.

[3] A, classification; B, score; C, combination of both.

[4] Major, sub-, or sub-subcategory level. Major food categories represented the first and sometimes only level of categories described in a model. In some models, ≥1 major category was subdivided into subcategories. In a few cases, ≥1 subcategory was further subdivided into sub-subcategories (e.g., Nordic Keyhole model, no. 11, in which the major category of meat and meat products includes 2 subcategories, and 1 of these also includes 3 sub-subcategories). It should be noted that certain models included "exempted" and/or "excluded" foods within the list of food categories, whereas other models did not and therefore presented "exempted" and/or "excluded" foods separately.

[5] It should be noted that certain models established nutrient criteria at the major, subcategory, and/or sub-subcategory levels. As such, the number of food categories at any level may not correspond to the number of food categories with nutrient criteria. Although the term "nutrient" criteria is used, the data presented here may include nutrient-based and/or food-based criteria because certain models provided a combination of nutrient-based and/or food-based criteria for all or a selection of the food categories.

[6] None of the included models considered only nutrients and food components to encourage.

[7] Total excludes optional nutrients and food components that can be considered as part of some models but that are not mandatory. Details on the specific nutrients and food components considered in each model are provided in Supplemental Table 4.

[8] Details on the other possible reference amounts/units for each model are provided in Supplemental Table 5. These may include, e.g., the evaluation of some nutrients or food components in terms of other prespecified amounts (in g or mL; e.g., per 250 mL), % of total fat, % daily value or reference daily intake, % weight/quantity of a component in a product (e.g., % fruit content), the presence (or absence) of a nutrient or food component in a product (e.g., no added sweeteners) or its position in the ingredient list (e.g., the first ingredient must be a whole grain).

[9] For the nutrient-based criteria presented in the boxes from pages 17–34 of the National Healthy School Canteens Guidelines (15): 23 food categories with nutrient criteria. For the "nutrient criteria for foods categorized as amber": 7 food categories with nutrient criteria. For the "nutrient criteria to help make 'healthier choices' within some food subcategories": 6 food categories with nutrient criteria.

[10] Across all green, amber, and red foods.

[11] Primarily food-based criteria.

[12] For elementary schools: major, sub. For middle/high schools: sub.

[13] For elementary schools: 5 food categories with nutrient criteria. For middle/high schools: 8 food categories with nutrient criteria.

[14] For grades pre-K–5 and 6–8: 4 food categories with nutrient criteria. For grades 9–12: 3 food categories with nutrient criteria.

[15] Not including optional meal category.

[16] For concessions: major. For vending: major, sub.

[17] For concessions: 6 food categories with nutrient criteria. For vending: 3 food categories with nutrient criteria.

[18] Two of the food categories are under consideration.

Food categories were not described in a consistent manner in the source documents of the different NP models. Thirty-three models (42%) were described as including only a single level of food categories (i.e., major food categories), with the number ranging between 1 and 15 (e.g., 2 categories: foods and drinks, in the Ofcom model no. 5). In other words, none of these models had subcategories within any of their major categories. The other 45 models included ≥1 subcategory in addition to major categories [e.g., WHO Regional Office for Europe NP model, no. 335, in which the major category of beverages is divided into (a) juices, (b) milk drinks, (c) energy drinks, and (d) other beverages]. Nine of these models also included sub-subcategories (e.g., Nordic Keyhole model no. 11, in which the major category of meat and meat products includes 2 subcategories, and 1 of these subcategories also includes 3 sub-subcategories). It was possible to find either the same or different nutritional criteria at the same or a different level (i.e., major category, subcategory, or sub-subcategory level) within a given model. Therefore, the total number of food categories with different nutritional criteria within a given model, combining the major categories, subcategories, and sub-subcategories if applicable, ranged between 1 and 99. When dividing models per primary application, the largest variations (maximum–minimum) in this number were observed in models related to school food, the regulation of claims, and food labeling (Table 4).

All 78 models included nutrients or food components for which the consumption should be limited, with the number ranging between 2 and 12 depending on the model (Table 4). The top 3 nutrients to limit included in the various models were sodium (91% of models), SFAs (83%), and total sugars (73%). Sixty-seven models (86%) additionally included between 1 and 15 nutrients or food components for which consumption should be encouraged. The top 3 nutrients or food components to encourage were "fruits, vegetables, nuts, and legumes" (i.e., ingredients of plant origin; $n = 43/67$ models, 64%), fiber (63%), and protein (43%). The overall number and type of nutrients and food components considered in a model were food-category specific for 60 (77%) of the models (e.g., Healthier Choices in Vending Machines in British Columbia Public Buildings Policy, no. 146, in which whole grains and SFAs are taken into account in the category of grain products, but not in the category of milk and alternative-based foods).

The top 3 types of reference amounts considered in the NP models consisted of per serving ($n = 59$, 76%), per 100 g ($n = 47$, 60%; combined with per 100 mL in 23 of these models), and per 419 kJ (100 kcal) or % of energy ($n = 12$, 15%). The evaluation of food components/ingredients according to their presence or absence in a product (e.g., no added sweeteners) or to their position in the ingredient list (e.g., first ingredient must be a whole grain) was also highly prevalent (64% of models). Most NP models ($n = 68$, 87%) considered ≥2 different types of reference amounts or other evaluation units (Table 5). Only 2 models used a reference amount per serving only, 4 models used per 100 g only, and 4 models used per 100 g or mL only (Table 5, Supplemental Table 5).

Information on the validation of NP models. Different forms of validation exist for NP models including, but not limited to, content validity, face validity, construct validity (also named convergent validity, depending on the author), and criterion (predictive) validity, as described in further detail by Townsend (118), Cooper et al. (119), and the WHO (6). The present systematic review shows that information on any form of validity testing could not specifically be identified for 58% of the included NP models ($n = 45$; Table 4 and **Table 6**) (119). Among these, 6 models were nevertheless classified as being indirectly validated because they were adapted from another model for which some validity testing had been conducted, or because information on validity testing could be identified for an earlier, but relatively different version of the model. Among models for which ≥1 form of validity testing could be identified ($n = 33$), construct/convergent validity was the most common form reported ($n = 24/33$; e.g., comparison and assessment of the agreement between classifications made by a model and those made by other similar models). Some degree of criterion (predictive) validity testing, the most robust form of validation, which, for example, assesses how well NP models predict changes in health outcomes, was identified for only 8 models (10% of all included models). Interestingly, between 70% and 75% of models primarily built for restricting marketing to children, for the regulation of claims, and for standards for vending machines were found to be validated at least to a small extent. The UK Ofcom model (no. 5) remained the most frequently validated model, as also reported by Cooper et al. (119).

Discussion

The present systematic review aimed to identify NP models developed or endorsed by authoritative bodies worldwide for application in government-led nutrition-related policies aimed at health promotion and NCD prevention and to serve as an up-to-date and accessible resource that summarizes the key characteristics of such models. Several points of consideration emerged from this work and need to be highlighted.

The total number of NP models meeting our current inclusion criteria ($n = 78$) more than tripled since the last review of NP models conducted in November 2012 [draft catalog (2013)], from which 22 models were included here. Indeed, searches of the peer-reviewed and gray literature and information obtained from other sources (e.g., e-mail newsletters) led to the inclusion of 56 new additional models, of which close to half were first introduced between 2012 and 2016 inclusively. Such a growth in the number of NP models developed or endorsed by authoritative bodies therefore supports the relevance and usefulness of the present work for government bodies and others who increasingly recognize the merit of the use of nutrient profiling to underpin nutrition-related policies. Moreover, new types of primary applications for NP models are revealed in the present systematic review as compared with the draft catalog (2013), including food procurement regulations or food-quality

TABLE 6 Information on validity testing for the 78 included NP models[1]

Model number	Model name	Some degree of validity testing identified (Y/N/indirect)	Comments
School food ($n = 27$)			
93	National Healthy School Canteens Project	Indirect	No information identified on the validity testing of the present model per se. However, the present model is based on the Fresh Tastes @ School NSW Healthy School Canteens Strategy (model no.138) for which an assessment of the construct/convergent validity has previously been done (see model no.138 for details).
138	Australia—Fresh Tastes @ School NSW Healthy School Canteens Strategy	Y	Validated in a limited sense, in terms of construct/convergent validity: it was assessed once by Walker et al. (120), as described in the review by Cooper et al. (119).
290	Smart Choices: healthy food and drink supply strategy for Queensland schools—nutrient criteria for the "Occasional" (red) food and drink category	N	Not identified
293	South Australia Right Bite for schools and preschools—nutrient criteria for the "Occasional" red category	N	Not identified
140	Australia—State Government of Victoria—Go For Your Life healthy canteen kit—nutrient criteria for the "Occasionally" (red) food category	Indirect	No information identified on the validity testing of the present model per se. However, the present model is based on the Fresh Tastes @ School NSW Healthy School Canteens Strategy (model no.138) for which an assessment of the construct/convergent validity has previously been done (see model no.138 for details).
393	Canada—Provincial and Territorial nutrient criteria for foods and beverages in schools (2013)	Y	Validated in a very limited sense, in terms of content validity. In Fall 2011, stakeholders were invited to provide feedback, in person on 11 October 2011 and during a 30-d online open period, on the draft, proposed set of nutrient criteria for Choose Most Often foods and beverages. Following the first round of stakeholder engagement the Choose Most Often were revised, and the Choose Sometimes food and beverages criteria were developed. In September and October 2012, 9 (BC, AB, SK, MB, NS, NB, PEI, NL, and NWT) jurisdictional stakeholder engagement dialogs were hosted locally with key stakeholders in their jurisdiction. In November 2012, a final Provincial/Territorial-led engagement dialogue was held with key stakeholders as well as stakeholder input being received during a 30-d online submission. See the source reference of the model for more details (21).
131	Alberta nutrition guidelines for children and youth	Y	Validated in a limited sense, in terms of construct/convergent validity, specifically in the context of recreational facilities and vending machines: assessment of the agreement between the present model and other Canadian models through evaluation of vending machine products in recreation and sport settings by Olstad et al. (121); and investigation of the awareness, adoption, and implementation of the guidelines in recreational facilities as part of a PhD thesis also by Olstad (122). See the database for more details.
144	Guidelines for food and beverage sales in BC schools	N	Not identified
193	Guidelines for foods available in K to 12 schools in Manitoba (criteria for packaged foods)	N	Not identified
241	New Brunswick healthier foods and nutrition in public schools	N	Not identified
180	Food and beverage standards for Nova Scotia public schools	Y	Validated in a limited sense, in terms of construct/convergent validity, specifically in the context of vending machines: assessment of the agreement between the present model and other Canadian models through evaluation of vending machine products in recreation and sport settings by Olstad et al. (121). See the database for more details.
259	Ontario school food and beverage policy/program memorandum 150 (PPM 150)	N	Not identified
272	PEI school nutrition policy	N	Not identified

(*Continued*)

TABLE 6 *Continued*

Model number	Model name	Some degree of validity testing identified (Y/N/indirect)	Comments
200	Healthy eating guidelines for Saskatchewan schools (Nourishing Minds)	N	Not identified
72	Costa Rica school food regulations	N	Not identified
167	Czech Republic draft decree for food sold and advertised in schools	N	Not identified
59	New School Canteen Standards	N	Not identified
205	Hong Kong nutritional criteria for snack classification	N	Not identified
211	FSSAI draft guidelines for making available wholesome, nutritious, safe and hygienic food to schoolchildren in India	N	Not identified
70	Food and beverage classification system nutrient criteria (Fuelled4life)	Y	Validated in a limited sense, in terms of construct/convergent validity, specifically in the context of the restriction of the promotion of foods to children: classifications made by the present model compared with other models (no. 196 and no. 335) in an article by Ni Mhurchu et al. (123).
76	Healthy meals in schools program (Eating Healthily At The School Canteen)	N	Not identified
60	Scotland nutritional requirements for food and drink in schools	N	Not identified
61	England requirements for school food regulations	Indirect	No information identified on the validity testing of the present version of the model per se, but retrieved research articles evaluated the earlier version of the model (e.g., effect of the legislation on the quality of English secondary-school vending provision). It is stressed that the earlier version of the model somewhat differed from the present one. See the database for more details.
325	USDA smart snacks in school nutrition standards (also known as competitive food standards)	N	Not identified
352	California's nutrition standards SB12 and SB965 (competitive food and beverage standards for schools)	N	Not identified
163	Connecticut nutrition standards	N	Not identified
248	Eat Smart: North Carolina's recommended standards for all foods available in school	N	Not identified
Front-of-pack food labeling ($n = 12$)			
53	Choices	Y	Validity testing for the present model included the assessment of its construct/convergent validity, face validity, and criterion (predictive) validity as part of different research articles, some of which are described by Cooper et al. (119). See the database for more details on specific research articles or other publications that tested the present model.
196	Health Star Rating System	Y	Validated in a limited sense, in terms of content and construct/convergent validity, i.e., assessment of whether the model categorized foods in accordance with national dietary guidelines in Australia and comparison of classifications made by the present model with other models, respectively. See the database for more details on specific research articles or other publications that tested the present model.

(*Continued*)

TABLE 6 *Continued*

Model number	Model name	Some degree of validity testing identified (Y/N/indirect)	Comments
156	Chile "Black Octagonal Stop-Sign" warning labels	N	Not identified
172	Ecuador traffic light labeling system	N	Not identified
27	Heart symbol	Y	Validated in a very limited sense, in terms of construct/convergent validity, based on preliminary and unpublished results found in a PowerPoint presentation that compared classifications made by the present model with classifications made by model nos. 11 and 53[2]
178	Five-Colour Nutrition Label (5-CNL/Nutri-Score)	Y	Validity testing for the present model included different forms of validation (e.g., construct/convergent validity), such as whether the model allowed "discriminating the nutritional quality of foods at various levels of detail in foods marketed in France", whether it was consistent with French nutritional recommendations, and whether it allows selecting healthier food choices as compared with other front-of-pack systems. The Ofcom score (model no. 5; underlying the present model) has also been validated in the French context, including prospective associations with the onset of metabolic syndrome. See the database for more details on specific research articles or other publications that tested the present model.
73	Healthier choice symbol program	N	Not identified
11	Keyhole	Y	Validity testing for the present model included the assessment of different forms of construct/convergent validity as part of different research articles, some of which are described by Cooper et al. (119). See the database for more details on specific research articles or other publications that tested the present model.
314	United Arab Emirates nutrition labeling model (Weqaya logo)	N	Not identified
41	Traffic light labeling	Y	Validity testing for the present model included the assessment of its construct/convergent validity, face validity, and criterion (predictive) validity as part of different research articles, some of which are described by Cooper et al. (119). See the database for more details on specific research articles or other publications that tested the present model.
1	Fruits & veggies—More Matters	N	Not identified
291	Smart Meal Seal nutrition criteria	Y	Validated in a very limited sense, in terms of criterion (predictive) validity, based on a study conducted by McDonald's that used sales data which showed "statistically significant increases in Smart Meal Seal sales compared to the control area and statistically significant decreases in side order sales of non-Smart Meal items" (61). However, it is stressed that a specific reference to the McDonald's data was not provided on the Center TRT website. See the database for more details.
Restriction of marketing to children ($n = 10$)			
334	WHO nutrient profile model for the Western Pacific Regional Office (WHO-WPRO)	Y	Validated in a very limited sense, in terms of content validity: The present model is an adapted version of model no. 335 and the regional adaptation consisted of a 3-step process. The first step was country field-testing with 8 countries applying the model to a nationally generated list of 100–200 foods that are either frequently marketed to children, or commonly consumed by children. Countries commented on various aspects including food categories, nutrient thresholds, exclusions, and prohibitions, and confirmed that foods categorized by the model are in line with national food-based dietary guidelines. The second step included a technical meeting with experts involved in step 1 who concluded that the draft model was adaptable and revised as needed. The third step involved an invitation from all countries of the WHO Western Pacific Region to provide input on the draft model. See the source reference of the model for more details (63).

(*Continued*)

TABLE 6 *Continued*

Model number	Model name	Some degree of validity testing identified (Y/N/indirect)	Comments
335	WHO Regional Office for Europe nutrient profile model (WHO-EURO)	Y	Validated in a limited sense, in terms of content and construct/convergent validity (i.e., comparison of classifications made by the present model with other models). Regarding content validity, development of the model included various expert/technical meetings, a series of consultations with Member States, and field-testing in 6 different countries. The in-country pilot testing involved countries applying the proposed model to a nationally generated list of 100–200 foods that were either: *1*) frequently marketed to children or *2*) commonly consumed (ideally a combination of both). Countries were asked to comment on the food categories, the nutrient thresholds, the proposed exclusions, and prohibitions, and to confirm that the model categorized foods in line with national food-based dietary guidelines. See the database for more details on specific research articles or other publications that tested the model.
388	PAHO nutrient profile model (WHO Regional Office for the Americas)	Y	Validated in a limited sense, in terms of construct/convergent validity (i.e., comparison of classifications made by the present model with other models). More specifically, the model was compared to 2 models by the WHO and the UK FSA/Ofcom model (model no. 5). Models were applied to 1992 packaged foods and beverages. The PAHO NP model's criteria for food classification were found to be similar to the other models, but PAHO's criteria were the most stringent. See the source reference of the model for more details (65).
62	Danish Code of responsible food marketing communication to children	Y	Validity testing for the present model included the assessment of its construct/convergent validity as described by Cooper et al. (119). See the database for more details on specific research articles or other publications that tested the present model.
220	Ireland—broadcasting authority model for restricting the marketing of food and drink to children	Indirect	No information identified on the validity testing of the present model per se. However, the present model is a slightly modified version of the Ofcom model (model no. 5), which has been validated in various ways.
44	South Korea—guideline for energy-dense, nutrition-poor food for children	Y	Validated in a limited sense, in terms of construct/convergent validity, in the context of a simulation study that used dietary intake data from the Korea NHANES. Information obtained from the draft catalog by Rayner and colleagues last updated in November 2012.
392	Mexico—restriction on the promotion of high caloric-density foods	N	Not identified
251	Norwegian nutrient profile model	N	Not identified
287	Singapore common nutrition criteria of the guidelines for food advertising to children	Y	Validated in a very limited sense, in terms of construct/convergent validity, based on the source document of the model (71), which indicates that "resulting draft common nutrition criteria were subjected to a preliminary validation process, involving benchmarking against indicator foods and against companies' product portfolios and the database of packaged food and beverage products available in the Singapore supermarkets." However, it is stressed that a specific reference to those data was not provided in the source document. See the database for more details.
5	Ofcom model for regulating the marketing of food to children, final version (WXYfm)	Y	Validity testing for the present model included the assessment of its construct/convergent validity and criterion (predictive) validity as part of different research articles, some of which are described by Cooper et al. (119). See the database for more details on specific research articles or other publications that tested the present model. The Ofcom model is one of the most studied models in the scientific literature.
Regulation of claims ($n = 7$)			
20	FSANZ—nutrient profiling scoring criterion	Y	Validity testing for the present model included the assessment of different forms of construct/convergent validity, e.g., modeling/testing against >10,000 foods with the use of a compiled database of Australian and New Zealand food products, and the comparison of classifications made by the present model with other models as part of several research articles published over the last few years. See the database for more details on specific research articles or other publications that tested the model.

(*Continued*)

TABLE 6 *Continued*

Model number	Model name	Some degree of validity testing identified (Y/N/indirect)	Comments
69	The SAIN, LIM system	Y	Validity testing for the present model included the assessment of its construct/convergent validity as part of different research articles, some of which are described by Cooper et al. (119). The source reference of the model (76) also indicates that it was tested for content validity: it was indeed tested on >600 food items listed in the Food Quality Information Centre (Ciqual/Afssa) food-composition table and results showed that classifications made by the model were in line with dietary recommendations. Where misclassifications were identified, solutions were considered such as introducing food categories, or the use of a modified range of nutrients. Criterion (predictive) validity was additionally tested as part of a PhD thesis by Masset (124). See the database for more details on specific research articles or other publications that tested the present model.
75	Singapore—nutrient-specific diet-related health claims	N	Not identified
394	South Africa NP model (FSANZ validated in South Africa)	Y	Validity testing for the present model included the assessment of different forms of content and construct/convergent validity, e.g., agreement of the model with dietary guidelines, agreement between classifications made by the nutrient profile model and those made by dietetic professionals in South Africa, and linear programming. See the database for more details on specific research articles or other publications that tested the model.
18	United States—requirements for foods carrying a health claim	Y	Validity testing for the present model included the assessment of different forms of construct/convergent validity, e.g., comparison of classifications made by the present model with other models and the evaluation of the potential impact of nutrient profiling–based food choices on energy and nutrient intake. See the database for more details on specific research articles or other publications that tested the model.
35	United States—definition of a "healthy" food as an implied nutrient content claim	Y	Validity testing for the present model included the assessment of different forms of construct/convergent and face validity, e.g., comparison of classifications made by the present model with other models and consumers' perception of the healthfulness of foods based on the components that define a "healthy" food. See the database for more details on specific research articles or other publications that tested the model.
319	United States—requirements for the "extra lean" and "lean" nutrient content claims	N	Not identified
Health facilities ($n = 5$)			
381	Queensland Health's A better choice – healthy food and drink supply strategy (2007)—nutrient criteria for the red category	N	Not identified
367	Healthy food and drink choices for staff and visitors in South Australia health facilities—nutrient criteria for the red category	N	Not identified
160	Colchester East Hants Health Authority food and beverage nutrient standards	N	Not identified
285	Scotland nutritional standards for hospital food: Food in Hospitals	N	Not identified

(*Continued*)

TABLE 6 *Continued*

Model number	Model name	Some degree of validity testing identified (Y/N/indirect)	Comments
201	Healthy food environments pricing incentives nutrition criteria	Y	Validated in a very limited sense, in terms of criterion (predictive) validity, based on information found on the Center TRT website (89) which indicates that: "Healthy Food Environments is a practice-tested policy intervention" and that "At FirstHealth's Moore Regional Hospital (the site submitted for review), overall sales increased after 9 mo of implementation of the pricing incentive. However, it cannot be stated that this increase is due solely to the pricing incentive. Increasing access, marketing, and/or other variables may play a role, as well." Still, the table on page 6 of the document referenced herein shows the % increase in volume of healthier food sales and % decrease in volume of less healthy food sales 1 y after the implementation of the incentive [see "full description" in (89)].
Government facilities ($n = 4$)			
174	England government buying standards for food and catering services	N	Not identified
364	Food service guidelines for federal facilities (formerly Health and sustainability guidelines for federal concessions and vending operations; HHS/GSA guidelines)	Y	Validated in a very limited sense, in terms of content validity: examination by D'Souza (125) of the status of implementation (and challenges) of the HHS/GSA guidelines in GSA and HHS facilities, including basic comparisons (e.g., whether models contain similar elements such as limits on sodium) with other models. See the database for more details.
232	Massachusetts state agency food standards	N	Not identified
330	Washington State healthy nutrition guidelines	N	Not identified
Vending machines ($n = 4$)			
146	Healthier choices in vending machines in BC public buildings policy	Y	Validated in a limited sense, in terms of construct/convergent validity: assessment of the agreement between the present model and other Canadian models through evaluation of vending machine products in recreation and sport settings by Olstad et al. (121). See the database for more details.
329	Wales—health promoting vending guidance (hospitals)	N	Not identified
341	Nemours Health and Prevention Services (Delaware's public health department) "Go, Slow, and Whoa" model (guide to healthier vending and concessions)	Y	Validated in a limited sense, in terms of criterion (predictive) validity: Appendix D of the source reference of the model (98) indicates, in the context of vending machines, that healthier vending options generate revenue, or at least do not have a negative impact on revenue.
256	Nutrition Environment Measurement Survey-Vending (NEMS-V) traffic light system	Y	Validated in a limited sense, in terms of face validity (consumer use and understanding) and interrater and test-retest reliability of the tool as described by Voss et al. (101), as part of a field study with undergraduate students.
Recreational facilities ($n = 3$)			
273	Queensland—red criteria of the Food for Sport guidelines	N	Not identified
376	US National Park Service healthy food choice standards and sustainable food choice guidelines for front country operations	Y	Validated in a very limited sense, in terms of content validity: basic comparisons (e.g., whether models contain similar elements such as limits on sodium) of the present model with other models in D'Souza (125). See the database for more details.
169	Delaware State Parks healthy eating initiative—"Munch Better at Delaware State Parks"	N	Not identified

(*Continued*)

TABLE 6 *Continued*

Model number	Model name	Some degree of validity testing identified (Y/N/indirect)	Comments
Food assistance programs ($n = 2$)			
81	Minimum requirements and specifications for food items allowed in the WIC food packages (supplemental foods)	Indirect	No information identified on the validity testing of the present version of the model per se, but could be considered validated in a limited sense, in terms of criterion (predictive) validity, based on a systematic review conducted in 2012 by Black et al. (126), which primarily included studies reporting on a previous version of the WIC program. It showed that the program was leading to improved intakes of targeted nutrients and foods, such as fruit and vegetables, as well as to some improvements in perinatal outcomes.
318	United States—Georgia WIC approved food list—criteria to evaluate an eligible food item	Indirect	No information identified on the validity testing of the present model per se. However, the present model (state level) is based on the Minimum requirements and specifications for food items allowed in the WIC food packages (federal level; model no. 81), for which criterion (predictive) validity might be inferred based on a previous version of the WIC program (see model no. 81 for details).
Food systems/surveillance ($n = 2$)			
254	Nutrient value score	Y	Validated in a limited sense, in terms of construct/convergent validity, based on correlations assessed between scores from the Nutrient value score and the UK Ofcom model (model no. 5) in an article by Payne et al. (112).
195	Health Canada Surveillance Tool tier system	Y	Validity testing for the present model included the assessment of its construct/convergent validity, e.g., use of 500 simulated diets based on popular food choices for each of the DRI age and sex groups in order to validate the classification system [see source reference of the model (113), section "Validation and final adjustments to the classification", pp. 12–13 for more details]. Two articles by Jessri et al. (127, 128) also assessed the applicability and relevance of the HCST as a measure of diet quality among nationally representative samples of adults and children and adolescents who participated to the Canadian Community Health Survey 2.2. The first (127) suggests that the HCST has achieved face validity: "In addition, our results confirm previous research indicating that older, female, physically active, and nonsmoker individuals have healthier dietary quality, which is also an indication of the face validity of HCST in the Canadian population" (p. 10,464).
Consumer education ($n = 1$)			
351	Alberta nutrition guidelines for adults	N	Not identified
Taxation ($n = 1$)			
371	Hungarian public health tax (tax on food products containing unhealthy levels of sugar, salt, and other ingredients)	Y	Validated in a limited sense, in terms of criterion (predictive) validity: the source reference of the model (115) mentions an evaluation that noted positive benefits following the implementation of the tax, i.e., increased revenue for health care, decreased sales and consumption of taxed items, reformulation with removal of taxed ingredients, increased consumer awareness, and impact on population-level consumption of salt and sugar.

[1] AB, Alberta; BC, British Columbia; Center TRT, Center for Training and Research Translation; FSA, Food Standards Agency; FSANZ, Food Standards Australia New Zealand; FSSAI, Food Safety and Standards Authority of India; GSA, General Services Administration; HCST, Health Canada Surveillance Tool; HHS, Health and Human Services; LIM, limited nutrients; MB, Manitoba; N, no; NB, New Brunswick; NL, Newfoundland; NP, nutrient profile; NS, Nova Scotia; NSW, New South Wales; NWT, Northwest Territories; Ofcom, Office of Communications; PAHO, Pan American Health Organization; PEI, Prince Edward Island; SAIN, Nutrient Adequacy Score for Individual foods; SK, Saskatchewan; WHO-EURO, WHO-Europe; WHO-WPRO, WHO-Western Pacific Region; WIC, Women, Infants and Children; Y, yes.

[2] Rayner M. Nutrient profiling for front-of-pack labelling. FAO/WHO Information Meeting on Front-of-Pack Nutrition Labelling, Charlottetown, Prince Edward Island, 16 May 2013 [Internet]. 2013 [cited 2016 Jul 25]. Available from: http://www.who.int/nutrition/events/2013_FAO_WHO_workshop_frontofpack_nutritionlabelling_presentation_Rayner.pdf.

standards for health facilities, for government facilities, or for recreational facilities and standards for vending machines in various settings, consumer education, and food taxation. The observation that a substantial proportion (44%) of the included models were built based on ≥1 other NP model also suggests that the adoption or adaptation by government bodies of an already existing model is becoming a more frequent practice, as per the WHO's recommendations (1, 6).

Models primarily developed for school food standards or guidelines were the most prevalent in the present review. Interestingly, 20 out of these 27 models were newly identified as part of our literature searches, and they actually represented the largest proportion of new models included in the review (n = 20/56, 36%). Such results suggest that one of the priorities with regard to the use of nutrient profiling by governments in recent years pertained to the establishment of school food standards or guidelines based on objective nutritional criteria, more particularly at the provincial/state level in Canada, Australia, and the United States. Food labeling nevertheless remained one of the main reasons why governments develop or endorse NP models, along with the restriction of the marketing of foods and beverages to children and the regulation of health or nutrition claims.

Only a low number of models (n = 6) were formally identified as having reformulation as a possible application, an observation that can be considered surprising given that this objective is often behind several nutrition-related policies, particularly FOP labeling. Formal recognition of reformulation as an objective of nutrient profiling by policymakers should be considered important and be monitored in the future, since it has been argued that having NP models that incentivize reformulation might represent one of the key ways by which strategies such as FOP labeling could impact health at the population level (129).

We observed wide variations in the number and nature of food categories, in the number and types of nutrients and food components "to limit" and "to encourage," and in the number and types of reference amounts considered in the various NP models' algorithms. These variations were observed not only between models as a whole but also between models built for the same application. This suggests that some NP models might be more complex to use or adapt than others. Importantly, anyone involved in the development or adaptation of an NP model needs to be aware of the considerations underlying the choice of the elements included in a model in order to make the best decisions possible in relation to the policy for which the model is intended. With respect to food categories, this implies finding the appropriate balance between robustness of the profiling method and being able to apply it in the desired contexts. For example, a small number of categories (e.g., foods compared with beverages) is clearly easier to define and apply in regulations, leaving less room for subjectivity in the classification of food products. On the other hand, a low number of categories, compared with a higher number of food categories, is less likely to account for the natural variation in the nutritional composition of food products across food categories (e.g., naturally high amount of total fat and SFAs in some core foods such as nuts). Implications around the choice of food categories and other characteristics of NP models are further described in publications by Sacks et al. (3), Scarborough et al. (7), and Rayner et al. (4). Verhagen and van den Berg (130) also propose a useful tool for easily and quickly visualizing differences between NP models in some of the main characteristics related to their development and adaptation.

The nutrients to limit most frequently taken into account in NP models were sodium, SFAs, and total sugars, which is consistent with the observation that data on these nutrients are usually readily available in food-composition databases and reported on food labels, therefore facilitating their use in NP models' algorithms. However, there are also controversies around the consideration of these nutrients. For example, it is increasingly argued that the onus should be on free or added sugars as opposed to total sugars in national dietary guidelines (131–133). Interestingly, free or added sugars were among the top nutrients to limit included in models primarily meant for use in the context of vending machines and food assistance programs. Moreover, 46% of models that consider free or added sugars were introduced not long ago, that is from 2010 onwards. This supports the idea that refinement in the elements taken into consideration in NP models may be starting to emerge in light of the recent recommendations by some authoritative sources (132, 134). It is also interesting to note that most models consider nutrients or food components to encourage in their algorithm, particularly in the context of food served in public settings (i.e., school food, health facilities, government facilities, recreational facilities, and vending machines), where 93–100% of the models include such nutrients or food components. This is consistent with a view of encouraging consumers to opt for nutrient-dense foods in public settings as opposed to simply discouraging them from choosing nutrient-poor options. Finally, in over three-quarters of the included models, the types and number of nutrients or food components varied across all or some of a model's food categories. This most likely reflects an attempt by authoritative bodies to take into account the nutrients and food components that are most relevant to certain food categories.

The WHO and scientific community highly recommend that NP models be validated before they are used (1, 4, 6, 118, 119). Although some level of predictive validity testing, the strongest form of validation, was conducted for just a very small proportion of the models (10%), information on at least some degree of validity testing could be identified for 42% of included models. Also, the lack of information on validity testing for the remaining 58% of models does not necessarily mean that these models have not been validated in some way. It is possible that information on early testing of the models, for example during the development phase, was simply not reported by the developers. It is also possible, despite the fact that extensive searches of the peer-reviewed and gray literature were conducted, that a publication describing the validity testing of a given model was not retrieved as part

of our searches because they were not planned a priori to fully capture information on validation. Capturing this information can also be challenging given the different types of validity testing that exist and the different definitions given by various authors in the field (4, 118, 119). Our observations therefore have to be interpreted with caution, but they at least suggest that there is still room for improvement in the area of validation of NP models. This is true not only with regard to the types of tests that are carried out but also to the reporting of the results of such tests.

Some limitations of this systematic review need to be pointed out. First, nutrient profiling is a rapidly evolving field in which current NP models might be updated and new NP models might be proposed for use at almost any moment. Adding to this the extensive time and resources required to identify existing NP models, to assess their eligibility, and to extract their numerous characteristics, keeping the current systematic review completely up-to-date is therefore a difficult and onerous task. This explains why we established that potentially relevant NP models that were published or that we became aware of following 22 December 2016, representing the date that the last eligibility assessment was conducted, would not be included in the systematic review [e.g., the WHO Regional Office for the Eastern Mediterranean NP model, published in the early months of 2017 (135)]. Although a few additional and most likely eligible models might not have been included here given the cutoff date specified, we are confident that the majority of the most relevant models at the present time have been retrieved based on our very extensive searches of both the peer-reviewed and gray literature. These extensive searches represent a strength of the present review.

Second, the systematic review usually included the version of a model that was in effect on the day that the initial data extraction was carried out for that model. This approach ensured consistency during the data-verification process. However, some models were updated between the moment that their data were first extracted by one of the team members and the time of their verification by another. When such a situation occurred, a note was added to our data-extraction worksheet indicating that a new version of the model was now available but that a previous version had been used for data extraction.

Third, approximately half of the excluded models were not considered because they were not developed or endorsed by government bodies, suggesting that sectors outside governments including commercial, research/academic, and nongovernmental organizations also show increasing interest towards the use of nutrient profiling for different purposes (e.g., NP model built by a food company for the reformulation of its own portfolio of products). Non–authoritative-based models might be less likely to be adopted and used by government bodies, explaining why we did not retain them here. This is particularly the case for industry-based models, for which their adoption by a government body could lead to potential conflicts of interest and possible loss of trust by consumers. Still, we cannot rule out the fact that models developed by nonauthoritative organizations might deserve consideration in some instances. For that reason, our list of excluded models (Supplemental Table 3) will be a useful tool for anyone interested in identifying and learning more about such models.

Fourth, the many different ways that authoritative bodies used to describe the NP models in the various source documents introduced challenges in our effort to extract, interpret, summarize, and report the information from all models in a consistent manner. As shown previously, there was wide variability in how food categories were presented across the NP models, with some including only major categories and others including subcategories and even sub-subcategories, with nutritional criteria sometimes applied at different levels within the same model. Some fields therefore had to be modified or added to our data-extraction sheet as compared with those described in the original protocol in order to report the information from the models as precisely as possible.

In conclusion, this systematic review showed that NP models developed or endorsed by authoritative bodies worldwide for application in government-led nutrition-related policies aimed at health promotion and NCD prevention have mostly been introduced within the last 10 y. These models essentially originate from the Americas, followed by the Asia/Pacific region, and they have primarily been built for school food standards or guidelines, FOP food labeling, and the restriction of the marketing of foods and beverages to children. All models include nutrients to limit, with sodium, SFAs, and total sugars being the nutrients most frequently considered, and most models also include $\geq$1 beneficial nutrient or food component, such as ingredients of plant origin. No information on validity testing could be identified for over half of the included models. Data from the present review, which will be made available in a more detailed, online, searchable format, will be highly valuable for assisting health professionals, nutrition professionals, and policymakers wishing to compare the constructs and components of existing NP models and to identify gaps in the field that may need to be addressed. This new resource will ultimately assist policymakers in the selection of an appropriate NP model when the establishment of specific nutrition-related policies or regulations requires the use of nutrient profiling.

Acknowledgments

All authors read and approved the final manuscript.

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