SUPPLEMENT

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Nutrient profiling schemes: overview and comparative analysis

■ **Abstract** Nutrient profiling is a discipline aimed at classifying foods based on their nutritional composition. So far, several profiling schemes have been proposed for varied purposes world-wide. Primary aim to inventory the main profiling schemes that have been developed so far (both applied and not) and to summarise their main aspects. Secondary aim to critically review a selection of them, to test their "performance" and to evaluate their strengths and weaknesses. Scientific and popular search engines were used for identifying profiling schemes. Schemes were described concisely by providing details on four main "Building Blocks" or factors: (1) Food category declination: category-wise or "across the board"; (2) Reference amount: 100 g, 100 kcal; serving; (3) Cut-off use: thresholds or scores; (4) Nutrients Selection: balance between positive and negative nutrients and number of them. The "performance" analysis was done by testing how the selected schemes classify a sample of food. Profiling schemes display considerable variation based on the underlying approach, format and content. Moreover, the rationale of the schemes largely varies and seems to be inspired by either nutrient recommendations or regulations figures. When tested for "performance", the five selected schemes classify in the same way foods having either a very "positive" or a very "negative" nutrient profile, whereas they give inconsistent results for food products with intermediate characteristics. Strengths and weaknesses analysis shows the difficulty of finding schemes combining qualities such as simplicity, scientific relevance, ability to cope with changes in nutrient recommendations. Current proposed profiling schemes exhibit a wide range of differences both in terms of approaches and "performance". Nutrition scientists have now the challenge to develop the "ideal scheme" that, in our view, will have to be strict enough to ensure consumer protection but also flexible enough to encourage food industry innovation and to promote a "healthy" competitive market.

■ **Key words** nutrient profiling – health claim – nutritional quality – food classification – profiling schemes

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Introduction

In recent years, the prevalence of chronic non-communicable diseases including type-2 diabetes, cardiovascular disease and obesity increased in most countries. Concomitantly, awareness of the importance of a balanced diet for limiting the risk of developing these diseases grew as well.

In 2003, a report [38] of a joint WHO/FAO (World Health Organization/Food and Agriculture Organization) expert consultation pointed out the potential role of nutrients such as fat, saturated fatty acids,

trans fatty acids, sugars and salt/sodium, when excessively consumed, in the development of these chronic diseases. As a consequence, public health authorities have initiated a number of education and communication campaigns in order to promote a healthy and balanced diet, for example in the form of food-based dietary guidelines. At the same time, the food industry invested resources for both improving the nutritional composition of processed products and for developing new food products with enhanced nutritional and health properties. At the European level, the need for common rules to regulate the addition of vitamins and minerals to foods and for making claims on food were seen as an important part of the response to concerns about non-communicable diseases.

Two new EU regulations entered into force in January 2007, one for regulating vitamins and mineral addition to food [35] and one for regulating nutrition and health claims made on food [7]. These regulations are aimed at harmonising rules within Europe, but also at ensuring that food industry practices aimed to make the products "healthier" have a rational basis, are justified and are supported by scientific evidence. In the regulatory text for claims made on food [7] the following is stated: "to ensure a high level of consumer protection, give the consumer the necessary information to make choices in full knowledge of the facts, as well as creating equal conditions of competition for the food industry."

The role of nutrient profiles, as mentioned in the regulation [7], is the following: "the application of nutrient profiles as a criterion would aim to avoid a situation where nutrition or health claims mask the overall nutritional status of a food product, which could mislead consumers when trying to make healthy choices in the context of a balanced diet." In the text [7], it is also stated that the nutrient profiles should be "based on generally accepted scientific data relative to the relationship between diet and health," should "allow product innovation," and should "take into account the variability of dietary habits and traditions, and the fact that individual products may have an important role in the context of an overall diet."

Nutrient profiling can be defined as the discipline of characterising foods for specific purposes based on an assessment of their nutrient composition according to scientific and pragmatic principles. A nutrient profiling scheme is any specific frame that allows testing the suitability of a given food for a given purpose, based on its nutritional composition.

The first objective of the present publication is to review all main nutrient profiling schemes that have been conceived so far (whether applied or not), to identify "building blocks" necessary for developing a scheme and available options for each "building block."

The second objective is to describe five schemes representative of different approaches, and analyze their "performance" in classifying a group of basic products.

Materials and methods

Identification and collection of main profiling schemes that have been developed so far was done via a review of: scientific and medical literature using MedLine and Google-assisted searches; proposals issued from national organizations (Voedingscentrum in Netherlands, Center for Science in the Public Interest in United States, Food Standard Agency in United Kingdom, Food and Drug Administration in United States, Swedish National food administration in Sweden); proposals issued from food industries (Smart Spot from PepsiCo, the Sensible Solution from Kraft).

Each scheme has been analyzed by identifying the choices made on four primary factors or "building blocks": food category declination, cut-off use, reference amount, and nutrients selection. The rationale or foundation of the scheme and the purpose of the scheme have been analyzed as well.

Food category declination concerns the possibility of having the same nutritional criteria (nutrient scores and/or thresholds) for all foods (across the board scheme) or specific criteria according to the food category (category-wise scheme).

Cut-off use implies the possibility of either using threshold values for each nutrient or allocating scores depending on the nutrient composition.

Reference amount is the base for comparison; it corresponds to the portion size to which thresholds values for nutrients are applied (e.g. per 100 g; per 100 kcal, per serving).

Nutrient selection concerns the balance between "positive" and "negative" nutrients and the number of them. "Positive" nutrients are those which have a positive effect on health and whose consumption must be stimulated; "negative" nutrients are those which, when consumed excessively, have been related to chronic diseases and whose consumption must be limited.

The rationale of the scheme refers to its foundations in terms of threshold values calculation methods and nutritional goals.

The purpose of the scheme corresponds to the intended application for which the scheme has been conceived.

From among the identified profiling schemes, five were selected for detailed description, analysis of

"performance" and analysis of "strengths and weaknesses." The choice of the schemes was done in order to give an overview of the different available options for each "building block."

The analysis of "performance" is a test evaluating how a given scheme classifies a sample of food products. "Performance" testing was done by using Excel software and entering nutrient criteria of each scheme into a Macro. A limited number of foods were selected from each major food group mentioned by any typical food-based dietary guideline including some composite foods. Food composition data were selected from the food databases NEVO, 2001 [23] and McCance and Widdowson, 5th edition [18] and are available as supporting material on the *European Journal of Nutrition* and ILSI Europe's homepages. The classification of each food through each of the selected schemes was evaluated using Excel. Comparative analysis of the classification results for each scheme was performed manually by indicating the degree of consensus between them (yes, no, nearly). As the scheme "A Little, A Lot" did not provide a conclusion, we presented the conclusion as the sum of "negative" answers, where "negative" means "A Lot" for negative nutrients and "A Little" for positive ones.

Strengths and weaknesses analysis was done based on some objective criteria: simplicity for use, rationale relevance and validation essay, sensitivity, and penalization of some food category. For estimating simplicity of use, we took into account both the type of calculation and the accessibility of composition data to be used for the scheme. Simplicity is therefore a function of food category declination, nutrient selection (number of nutrients, accessibility of the composition data from the package and label), and reference amount. For example, a complex scheme would be a scoring scheme, category-wise, which requires many micronutrient data and entering those data per energy value. On the contrary, a simple scheme would be a threshold scheme applied across-the-board and per 100 g. Sensitivity is the capacity of a scheme to differentiate between products that have small differences in composition.

Results

Twenty-three profiling schemes were identified. They are summarised in Table 1.

Most profiling schemes are across-the-board, use 100 g as a reference amount and are threshold systems. The rationale given is usually very simple and a validation test is seldom proposed.

Category-wise schemes utilize different ways for grouping food products, inspired from many sources (food-based dietary guidelines, regulatory authorities, etc.). In some intermediate cases, only two main categories are identified, solid and liquid foods.

Threshold schemes are characterised by either 1 or 2 cut-off values for each nutrient leading respectively to 2 (high/low) or 3 classes (high/intermediate/low). In most of the systems, all nutrient criteria have to be satisfied at the same time in order to obtain a positive global evaluation.

With respect to nutrient selection, a wide variety of choices have been observed. While some schemes include only "negative" nutrients (saturated fatty acids, trans fatty acids, fat, energy, sugars, salt, cholesterol) others include also "positive" nutrients (usually fibre, minerals, vitamins, proteins, omega-3 fatty acids). Finally, in some cases, food groups (e.g. fruits and vegetables) and/or ingredients (e.g. wholemeal flour) are also included.

The rationale of a scheme is usually not included in its description and often remains partly obscure. It is often either based on nutritional recommendations or on regulatory rules for food labelling. In case of nutrient recommendations, a recommendation for the whole diet can be used directly as it is or adapted/transformed in order to be applied to a food product.

Schemes have been developed for the purpose of helping consumers to make food choices, of identifying products suitable for bearing health claims or claims addressed to children, of ensuring a better and clearer food labelling and of evaluating the nutritional quality.

An attempt at validation of a scheme by testing the robustness of the scheme has been observed only in two cases: the "A Little, A Lot" scheme and the "FSA Scoring System for Children."

The five schemes selected for an in-depth-analysis are the following: "A Little, A Lot" scheme (UK, Ministry of Agriculture), "USA Health Claims" scheme (USA, Food & Drug Administration—FDA), Tripartite Classification Model (The Netherlands, Netherlands Nutrition Center), "FSA Scoring System for Children" (UK, Food Standard Agency—FSA), "GRFMC" scheme (Guidelines for Responsible Food Marketing to Children, USA, Center for Science in the Public Interest). Table 2 summarises the differences between these five schemes. The selected schemes are representative of various approaches because they allow seeing for each "building block" the different available options. For example, for the building block food category declination, the five schemes show the following different options: the Tripartite Classification Model is a fully category-wise scheme, using many different food categories, the "GRFMC" scheme and "FSA Scoring System for Children" are intermediate schemes with just a few categories (liquid/solid), the "USA Health Claim" scheme takes into account food category through serving sizes and the scheme

Table 1 Summary of the collected profiling schemes

"Scheme"—Country —Organization	Aim	Food cat. decl.	Cut-Off use	Nutrients selection	Rationale/foundation	Ref. amount	Ref.
"Rule of Thumb"—UK —Coronary Prevention Group	A	Across the board	Threshold	(–): Fat, SFA, Cho, NMES, Na (+): Fib	-Scientific- Thresholds fixed at 50% and 150% of Nut. Rec. (OMS, 1990 and Dietary reference values for the UK, 1991)	100 g	[2]
"A Little A Lot"—UK—Food Standard Agency	A	Across the board	Threshold	(–): Fat, SFA, NMES, Na (+): fib	-Scientific- Thresholds fixed at 1/5 and 1/30 of Nut. Rec. (UK GDAs)	100 g	[3]
"Tripartite Classification Model"—NL—Netherlands Nutrition Center	A	Cat-wise	Threshold	(–): SFA, Energy, TSug (+): fib, VitC, Folate, ω-3 According to the Food Cat	Scientific/pragmatic- Calculation: THRE = AVG – AIM%- THRE: cut-off value for a given nutrient in a given Food Cat.- AVG = average content of the nutrient in a given Food Cat (Market evaluation) – AIM% = delta between intake of the nutrient and nut. rec. or Nutritional Policy Objectives	100 g	[27]
"Keyhole" —SW—National Food Administration	A	Cat-wise	Threshold	(–): fat, ASug (+): fib, %wholecereal According to the Food Cat.	Regulatory/scientific- Thresholds are based on regulatory values (ex: "No fat") + Nut. Rec. (Eurodiet)	100g; 100 kcal	[24]
"The Tick Program"—AUS—National Heart Foundation	A	Cat.-wise	Threshold	(–): fat, SFA, Eergy, ASug, Na (+): fib According to the Cat	Regulatory- Thresholds correspond to denominations such as "low in", "rich in"	Svg	[26]
"Food Certification Program"—USA—American Heart Association	A	Across the board	Threshold	(–): fat, SFA, Cho, Na, (+): 1 Nut among VitC, VitA, Pro, Fib, Ca, Fe	– Regulatory- Thresholds correspond to denominations such as "low in", "rich in OR are based on a % of the DV	Svg	[25]
"Smart Spot"—PepsiCo	A	Cat-wise	Threshold	(–): fat, SFA, Na, TFA, ASug (+): 1 Nut among VitC, VitA, VitC, Pro, Fib, Fe	-Scientific- Nut. Rec. applied to a product (Food Drug Administration and National Academy of Sciences)	Svg	[29]
"The Sensible Solution"—Kraftfoods	A	Cat-wise	Threshold	(–): energy, Asug, Na, fat, SFA, TFA... (+): pro, VitA,C,E, Ca, Mg According to the Cat.	Partly regulatory- Two ways for qualifying the product: (1) providing beneficial Nut or a functional benefit; (2) being "low/reduced/free in" energy, fat, SFA, sugars or Na	Svg	[19]
"Model B"—UK—Food Standard Agency	B	Across the board	Threshold	(–): fat, SFA, Na, (+): 1 Nut. among VitC, VitA, Pro, Fib, Ca, Fe	-Regulatory- Based on the ANFZA and Canadian approaches thresholds at 10% of the Nut. Rec./Svg (RDA, RNI)	Svg	[36]
"Model C" UK—Food Standard Agency	B	Across the board	Threshold	(–): SFA Na, ASug.	Mainly regulatory- Model B was made as the "less stringent"	100 g	[36]
"FSA Scoring System for Children"—UK—Food Standard Agency	C	Across the board	Scoring	(–): TSug. SFA, Na Energy (+): pro, Fib. Fruit and veg and nut	-Scientific- Scoring scales are based on % of Nut. Rec. (UK GDAs). Cut-off values of the final score defined in order to "put out" junk foods	100 g	[33]
"USA Health Claim Scheme" - USA—Food & Drug Administration	B	Across the board	Threshold	(–): fat, SFA, Na, Cho, (+): 1 Nut. among VitC, VitA, Pro, Fib. Ca, Fe	-Regulatory- Thresholds at 20% of the Nutr Rec./Svg (corresponding to the claim "rich in")	Svg	[6]
"ANFZA scheme" —AUS/NZ—New Zealand Food Authority	B	Across the board	Threshold	(–): Fat, SFA, Na, (+): 1 Nut among all Vit, Min, Fib.	-Regulatory- Threshold at 20% of the Nut. Rec./Svg (corresponding to the claim "rich in")	Svg	[1]
"Danish Proposal" —DK—Danish Food Administration	B	Cat-wise	Threshold	(–): fat, SFA, TFA, TSug, Na (+): vit, min According to the Cat	Mainly regulatory- Thresholds are mainly based on regulatory values (ex: "low fat") + partly Nut. Rec. (Eurodiet)	100g	[22]
"GRFMC scheme"—USA—Center for Science in the Public Interest	C	Across the board	Threshold	(–): fat, SFA, Na, ASug (+): 1 Nut among VitC, VitA, VitE, pro, fib, Mg, K, Ca, Fe, fruit and veg; whole grain flour	-Scientific- Nut. rec. applied to a product (Food & Drug Administration and National Academy of Sciences)	100 kcal; Svg	[6]
"The Nutrition score" Unilever Food & health research Institute	D	Across the board	Threshold	(–): TFA, SFA, Na, ASug	Scientific/pragmatic- Based on national and international Nut. Reco (OMS 2003). Sometimes adaptation of Nut. Rec. for technological or taste factors	100 kcal	[28]
"RRR" Douglas et al., 2004 (J Nut Ed Behav)	E	Across the board	Scoring	(–): energy, Cho, TSug, Na, TFA (+): Ca, Fib, Pro, Fe, VitA, VitC	-Scientific- Ratio between positive and negative Nut. expressed in %DV (2,000 kcal)	Svg	[9]

Table 1 Summary of the collected profiling schemes

"Scheme"—Country—Organization	Aim	Food cat. decl.	Cut-Off use	Nutrients selection	Rationale/foundation	Ref. amount	Ref.
"NFI" Nutritious Food Index Gazibarich and Ricci, 1998 (Austr J Nutr)	E	Across the board	Scoring	(−): fat, SFA, Na, Cho; (+): Ca, Fe, Mg, P, K, Zn, VitB3, VitB2, VitB1, VitA, VitC, Folate, Fib	Scientific- NFI = score of quality − score of faults- score Nut_i = weight $_{\text{Nut}\,i}$ x %DV $_{\text{Nut}\,i}$ - Weight : arbitrary value specific to the Nut.	Svg	[15]
"S.A.I.N." Darmon, 2005 (J Am Diet Assoc)	E	Across the board	Scoring	(−): SFA, Na, Cho, TSug; (+): Pro, Fib, VitA, Folate, VitD, VitE, VitB1, VitB2, VitB3, VitB5, VitB6, VitB12	Scientific- S.A.I.N. $= \sum(\text{Nutrient}_i/\text{DV}_{\text{Nut}i}) \times 100/16$	100 g	[8]
"Naturally Nutrient Rich Score" Drewnowski, 2005 (Am J Clin Nutr).	E	Across the board	Scoring	(+): Pro, Ca, Fe, VitA, VitC, VitB1, VitB2, VitB12, Folate, VitD, VitE, MUFA, K, Zn, Fib, VitB5	Scientific- NNR $= \sum\%\text{DV}_{2,000\text{kcal}}/16$	100 g	[10]
Nutrimap Labouze 2007 (Public Health Nutr)	E	Across the board	Scoring	(−): carb, Tsug, Fat, SFA, Na; (+): Ca, Fib, Fe, MUFA, PUFA, Mg, VitD, VitC, VitE, Folate	Scientific- Two distinct scores qualifying nutritional assets and weaknesses Based on the food potential re-balance or to un-balance the diet	100 kcal	[21]
Food Profiler Labouze (submitted, April 2007)	B	Across the board	Scoring	(−): fat, SFA + TFA, ASug, ANa; (+): Ca, Fib, Fe, PUFA	Scientific and pragmatic- Two distinct scores qualifying nutritional assets and weaknesses Based on the food potential re-balance or to un-balance the diet	100 kcal	[20]

Cat: category. Food Cat Decl.: food category declination. DV: daily value. Svg: serving. Ref.: reference. Nut. Reco: nutritional recommendations. Avg: average.- Aim: A: Help consumers to make food choices. B: Eligibility for health claims. C: Eligibility for marketing programmes directed to kids. D: Labelling purposes. E: Evaluation of the nutritional quality- Nutrients: Nut: nutrient. Min: minerals. Vit: vitamin. Na: Sodium. Ana: Added sodium. Ca: calcium. Mg: magnesium. Fe: iron. P: phosphorus. K: potassium. Zn: zinc; Cho: cholesterol. TSug: total sugars. ASug: added sugars. o-3: omega-3 fatty acids. SFA: saturated fatty acids. TFA: trans fatty acids. MUFA: mono-unsaturated fatty acids. PUFA: poly-unsaturated fatty acids. NMES: non milk extrinsic sugars. Fib: dietary fibre. Pro: protein, Veg: vegetables.- RRR: Ratio of recommended to restricted food components- RDA: Recommended daily allowances- RNI: Recommended nutritional intake

"A Little, A Lot" is fully across-the-board. With respect to the reference amount, the five selected schemes exhibit the three different options: the Tripartite Classification Model, the "A Little, A Lot" scheme and the "FSA Scoring System for Children" utilise 100 g; the "USA Health Claim" scheme utilises the serving size; the "GRFMC" scheme utilises the energy value.

The scheme "A Little, A Lot" was first published by the Ministry of Agriculture, Fisheries and Food, UK [37]. Since 1996 the scheme appeared, more or less modified, in several publications and more recently in some leaflets produced by the FSA [14] and by the British Heart Foundation [3]. This scheme was developed to help consumers make reasoned food choices as indicated in the title: "Use your label: making sense of nutrition information." This is a threshold-profiling scheme and makes it possible to conclude about each nutrient one by one, but not about the overall nutrient profile of the food product.

In the first version [37], the scheme focused on five nutrients, those for which a Guideline Daily Amount (GDA) was set: sugars (based on the population goal for Non-Milk Extrinsic Sugars (NMES), i.e. all sugars excluding lactose from milk), fat, saturated fatty acids (SFA), fibre (based on the dietary reference value for Non-Starch Polysaccharide (NSP) and sodium. The advice to consumers was the following: "Try using these rules of thumb to give you an idea of how much is A Lot or A Little of the most important nutrients for making healthy food choices." The suggested criteria and relative thresholds are provided in Table 3. Nevertheless the FSA [3] has subsequently considered only nutrients with a negative connotation, taking fibre out of the scheme.

At the beginning these amounts were per serving in case of whole meals and main dishes, otherwise per 100 g [37]; in 2002, FSA [3] has proposed to use 100 g as a base for all foodstuffs.

For defining the cut-off values, William et al. [37] decided first that they should be related to the GDAs, i.e. the Guidelines Daily Amounts for the UK population from 1991 and amended in 1994 [4, 5]. For every nutrient the proportion of food qualifying for "A Lot" or for "A Little" should be neither too small nor too large. The cut-offs should ensure that approximately one-third of the foods had "A Lot" of a given nutrient, one third had "A Little" and that one-third had an intermediate amount to allow consumers to have the greatest discrimination. When deciding the exact proportions, consideration was given to the proportions of foods, which qualify as containing "A Lot" or "A Little" of each of the nutrients and the similarity of the Rules of Thumb to the UK Food Advisory Committee (FAC) and Codex criteria for nutrition claims.

Table 2 Differences in the building blocks between the five selected systems

Scheme	Food category declination			Cut-off use		Reference amount			Nutrients selection	
	Not	Partly	Yes	Threshold	Score	100 g	100 kcal	Svg	"Positive" Nut	"Negative" Nut
A Little A Lot	X			X		X			**1**	4
USA health Claim Scheme	X			X				X	6	4
FSA Scoring System for Children		X solid and liquid			X	X			3	4
Tripartite Classification Model			X	X		X			4	3
CPSI Scheme		X solid and liquid		X			X		8	4

In bold the peculiarity of each system is underlined
Nut: nutrient; Svg: Serving

Table 3 Synthesis of the criteria for the scheme: "A Little, A Lot" (UK, Ministry of Agriculture)

A Lot (/100 g)	A Little (/100 g)
> or = 10 g of non-milk extrinsic sugars	< or = 2 g of non-milk extrinsic sugars
> or = 20 g of fat	< or = 3 g of fat
> or = 5 g of saturated fatty acids	< or = 1 g of saturated fatty acids
> or = 3 g of non-starch polysaccharides fibre	< or = 0.5 g of non-starch polysaccharides fibre
> or = 0.5 g of sodium	< or = 0.1 g of sodium

As explained by Rayner and colleagues [34], the cut-offs are defined as one-fifth of the corresponding GDA for "A Lot" and one-thirtieth of these same GDA for "A Little." The GDA was based on 2,245 kcal/day, the estimated average requirement for energy for persons aged 19–50 years defined by COMA in 1991 [4]. This can be considered the rationale of this scheme.

In an attempt for validating the scheme, Rayner and colleagues [34] performed a test on 1,184 foods of known composition (McCance and Widdowson) and showed that less than approximately one-third of foods had "A Lot" of the nutrient and a bit more than one-third had "A Little" amount. The fact that the market was divided by these thresholds in a balanced way was considered to a positive outcome.

The "USA Health Claim" scheme (Table 4) was defined by FDA in the United States [6] in 2002 and was intended to identify products eligible for approved health claims. This is a threshold scheme with an "across the board" approach. FDA takes into account 10 nutrients considered as "disqualifying" (total fat, SFA, cholesterol and sodium) or "qualifying" (vitamin A, vitamin C, iron, calcium, protein, or fibre prior to any fortification). The reference amount is the serving size. The rationale for threshold values is inspired by regulatory rules (Daily Values), based on nutritional recommendations, calculated for a 2,000 kcal diet. For fat, SFA, cholesterol and sodium the cut-off values correspond to 20% of the Daily Values; for vitamin A, vitamin C, iron, calcium, protein, or fibre the cut-off values correspond to 10% of the Daily Value. In order to bear a health claim, foods must meet the levels for all the "disqualifying" nutrients and at least for one of the "qualifying" nutrients by nature, i.e. not as a consequence of for-

tification. The reason why thresholds of 20% and 10% have been selected is not explained in detail.

Although the criteria of this scheme are not category specific, disparities between food categories are taken into account since a lot of "exemptions" are listed, such as specific rules according to the health claim carried by the product. For example, a lower level of sodium for claims related to hypertension is prescribed. This scheme did not undergo any validation essay.

The Tripartite Classification Model was published in 2005 [16, 27] by the Netherlands Nutrition Center (Voedingscentrum, Voorlichtingsbureau voor de Voeding, Dutch Food Information Bureau) based on a

Table 4 Synthesis of the criteria for the "USA Health Claims Scheme" (FDA, USA)

Nutrient	Maximum amount[a] (disqualifying threshold)/serving size	Meaning
Total fat	13 g	20% DV
SFA	4 g	20% DV
Cholesterol	60 mg	20% DV
Sodium	480 mg	20% DV

Nutrient	Minimum amount[a] (qualifying threshold) for at least one out of the following six nutrients/serving size	Meaning
Vitamin A	500 UI	10% DV
Vitamin C	6 mg	10% DV
Iron	1.8 mg	10% DV
Calcium	100 mg	10% DV
Protein	5 g	10% DV
Fibre	2.5 g	10% DV

[a]Source: Reference Daily Intakes (RDI) and Daily Reference Values (DRV) in FDA site
Per serving, or for 50 g in case of servings <30 g

Table 5 Synthesis of the criteria for the ''Tripartite Classification Model'' for foods (Voedingscentrum, Netherlands)

Product group	A: 'preferable'	B: 'middle course'	C: 'exceptional'
A. Basic food groups			
Potatoes, rice, pasta, pulses	Fibre: min 3 g/100g SFA: max 1 g/100g	Fibre: 2–3 g/100 g SFAt: max 1 g/100 g	Fibre: less than 2 g/100 g
Bread, bread substitutes, breakfast cereals	Fibre: min 6 g/100g SFA: max 1 g/100g	Fibre: 5–6 g/100 g or Fibre: min 6 g/100 g SFA: min 1 g/100 g	Fibre: less than 5 g/100 g
Vegetables, fruit and fruit juices	Vitamin C: min 1 mg/100g Folate: min 1 mg/100g Fibre: min 1 g/100g SFA: max 1 g/100g Sugars: not added	Vitamin C: min 1 mg/100 g Folate: min 1 mg/100 g	Vitamin C: not present
Milk and milk products	SFA: max 0.5/100g	SFA: 0.6-1 g/100 g or SFA: max 0.5 g/100 g	SFA: more than 1 g/100 g or SFA: 0.6-1 g/100 g
	Sugars: max 6 g/100 g	Sugars: more than 6 g/100 g	Sugars: more than 6 g/100 g
Cheese	SFA: max 12 g/100g Energy: max 300 kcal/100 g	SFA: 13–18 g/100 g or SFA: max 12 g/100 g Energy: more than 300 kcal/100 g	SFA: more than 18 g/100 g
Meat, prepared meat products, chicken, eggs	SFA: max 4 g/100 g Energy: max 200 kcal/100 g	SFA: 4–5 g/100 g or SFA: max 4 g/100 g Energy: more than 200 kcal/100 g	SFA: more than 5 g/100 g
Fish	SFA: max 4 g/100 g Omega-3 fatty acids: max 2 portions for recommendation Energy: max 200 kcal	SFA: 4–5 g/100 g Omega-3 fatty acids: 2–4 portions for recommendation	SFA: more than 5 g/100 g Omega-3 fatty acids: more than 4 portions for recommendation
Spread and cooking fats	SFA: max 16 g/100 g	SFA: 17–24 g/100 g	SFA: more than 24 g/100 g
B. Other food groups			
Product groups	'Low' in SFA	'High' in SFA	'High' in fibre
Snacks, spicy filling	max 4 g/100 g	>5 g/100 g	n.a.
Sauces	max 2 g/100 g	>4 g/100 g	n.a.
Cake, pastry, nuts, savoury snacks	max 6 g/100 g	>6 g/100 g	≥2 g/100 g
Sweets, sweet filling	max 3 g/100 g	>4 g/100 g	≥1 g/100 g
Cream	max 12 g/100 g	>18 g/100 g	n.a.
Evaporated milk	max 1 g/100 g	>3 g/100 g	n.a.

Note: 'SFA' is understood to be the sum of saturated and trans fatty acids

draft proposed earlier on the website. The scheme was developed to help consumers to compare the nutritional quality of foods and to make a "healthy" food choice within a food category. The primary objective of the system is promotion of healthy dietary patterns and discouragement (but not prohibition) of "unhealthy" products. However, the Voedingscentrum specified that this scheme could be used to define nutritional profiles within the framework of legislation to detect products eligible for health claims.

This category-wise scheme allows the classification of foods in three groups ("preferable": qualifying a food which should be consumed preferably, "middle course": qualifying a food which should be consumed occasionally, and "exceptional": qualifying a food which should be consumed only exceptionally).

Nutritional criteria are selected according to the intrinsic characteristics of each food category, in addition to nutrition policy objectives. Foods are divided into two groups: basic foods and other foods. Basic foods are major products in a typical Dutch diet, with a high nutrient density and recommended daily intakes. Other foods include products with a low nutrient density and usually, a high energy density. For these other foods there is no tripartite classification, but just an evaluation of SFA and fibre quantities. Threshold values are set per 100 g. Table 5 illustrates the scheme in detail.

For beverages, no numerical criteria are defined in the final version of the system, but the text specifies that water (mineral), coffee, tea and light soft drinks are classified as "preferable" types of beverages.

The rationale of this scheme appears to be quite sophisticated. The definition of threshold values is based upon the desired change in the current dietary intake of the selected nutrients in order to reach an optimal intake (defined according to epidemiological data and recommendations or dietary goals set by the Dutch Health Council). This rationale can be explained by an example: if the intake of fibre is 2.3 g/MJ and the recommended intake is 3 g/MJ there is a gap (negative balance) of 0.7 g/MJ. So, fibre intake should be increased by approx. 25%. This can be accomplished by increasing the current content of fibre in all foods by 25%. For example, if the current content of fibre in a cereal product is 4.5 g/100 g, the

new target value should be 6 g/100 g (=25% more). With this methodology, each food category contributes similarly to reach the nutritional goal.

The "FSA Scoring System for Children" was developed by the FSA after a few years of exploration of the field. The subject was first approached by doing a review of the existing systems in 2003 [36]. In 2004, the FSA started to develop a new nutrient profiling model to support Ofcom's work on the further regulation of broadcast advertising of foods to children in UK. FSA proposed a first version in October 2004 [31], and after a public consultation [11] and a scientific workshop [12], a second version in July 2005 [33]. Following another public consultation, some supplementary refinements were added, and a final model was delivered on 6 December 2005 to Ofcom [30].

To develop and scrutinise the first version of this nutrient profiling system, the FSA commissioned a consultancy led by the British Heart Foundation Health Promotion Research Group and also convened an expert group (comprising nutrition scientists, dieticians, food industry and consumer organization representatives, and policy makers). After a literature review of existing profiling schemes [36], the consultants developed a systematic approach to the development of this model. A series of potential models was developed and tested to identify the approaches that were most effective in categorising foods (sample of foods from the McCance and Widdowson database) in accordance with the views of nutritionists and dieticians and with healthy eating advice (the Balance of Good Health). The Expert Group sought to develop an approach that was clearly linked to dietary recommendations and practical to implement.

The Expert Group recommended a model that applies across all food categories to avoid inconsistencies at the margins.

The model was initially developed for children aged 11–16, but was subsequently found to be equally applicable from a scientific point of view to all people over the age of 5 years based on further consideration of a salt threshold [32].

The final scheme [30] is a scoring system, where points are awarded according to the content of seven nutrients or food components considered of priority for public health by the Expert Group: energy, SFA, sugars, sodium, fruits, vegetables, nuts, fibre (Non Starch Polysaccharide (NSP) or Total Fibre as determined by the AOAC method), protein. This final scheme is summarized in Table 6. The lower the global score, the healthier the product. The choice of assessing nutrients on a per 100 g basis was used to avoid unnecessary complexity and manipulation of recommended portion sizes.

The rationale of this scheme is science-based, complex and has been made transparent. One point for each nutrient corresponds to 3.75% of the UK Guideline Daily Amount. The reason why this band of 3.75% was selected is not clearly explained. Points are capped to a maximum of 37.5% of GDA for "negative" nutrients (maximum 10 points for each criterion) and 18.75% for "positive" nutrients (maximum five points for each criterion).

In addition to the public consultations and a scientific workshop, FSA "validated" the accuracy of its

Table 6 Synthesis of the criteria for "FSA Scoring System for Children" (FSA, UK)

Points	0	1	2	3	4	5	6	7	8	9	10
A. Negative nutrients per 100 g											
Energy (kJ)	≤335	>335	>670	>1,005	>1,340	>1,675	>2,010	>2,345	>2,680	>3,015	>3,350
Sat fat (g)	≤1	>1	>2	>3	>4	>5	>6	>7	>8	>9	>10
Total sugar (g)	≤4.5	>4.5	>9	>13.5	>18	>22.5	>27	>31	>36	>40	>45
Sodium (mg)	≤90	>90	>180	>270	>360	>450	>540	>630	>720	>810	>900
B. Positive nutrients per 100 g or as a percentage of weight											
Points	0	1	2	3	4	5					
Fruit, veg and nuts (%)	≤40	>40	>60	–	–	>80					
NSP fibre (g)	≤0.7	>0.7	>1.4	>2.1	>2.8	>3.5					
Or AOAC fibre (g)[a]	≤0.9	>0.9	>1.9	>2.8	>3.7	>4.7					
Protein (g)	≤1.6	>1.6	>3.2	>4.8	>6.4	>8					
C: Overall score as compared to healthiness[b]											
Category		Healthier	Intermediate			Less healthy					
Food	Overall score	0 or less	1	2	3	4 or more					
Drink	Overall score	0 or less				1 or more					

[a] use of the alternative AOAC definition of fibre is allowed so long as a conversion factor is used
[b] (If a food or drink scores 11 or more, with regard to negative points (sum of negative criteria), then it cannot score points for protein unless it also scores 5 points for fruits, vegetables and nuts)

model by sending an on-line questionnaire to numerous nutrition professionals, who were asked to rank 40 foods (selected at random from a master list of 120 foods representative of actual diets), as "more healthy" (i.e. to be eaten frequently and/or in large amounts) or "less healthy" (i.e. to be eaten occasionally and/or in small amounts) on a six point scale. There was a strong level of agreement between the values given by the model and the views of nutrition and dietetic professionals (700 responses).

The Center for Science in the Public Interest, an American consumer advocacy organization has proposed "Guidelines for Responsible Food Marketing to Children" (called in this paper the "GRFMC" scheme), in 2005 [17], with the goal to minimize the risk of obesity in children and youth. These guidelines aim to identify products that provide some positive nutritional benefit and that could help children meet the Dietary Guidelines for Americans. This scheme is an "across the board" system, conceived to limit the intake of calories, saturated and trans fatty acids, refined sugars and sodium in children (Table 7). Criteria (macronutrients) are based on percentage of calories or amount per serving.

Thresholds in energy percentage for fat, SFA and added sugars seem to correspond to American population goals [14], and most of the other thresholds are correspond to meaningful levels in US regulation (nutrient content, portion size).

Results of the "performance" test of these five schemes are presented in Table 8. For almost half of the selected food products, the results are not consistent (29 products amongst 62). It is interesting to note that this inconsistency of classification concerns almost all the categories and not only some specific well-known problematic categories like "composed foods" or "bakery products". A consistent positive classification is found for the following products: strawberry, carrots, skimmed milk, low calorie yoghurt; whereas a consistent negative classification is found for the following products: bakery products (but high in fibre!), cheddar cheese, beef burger, sausages, palm oil, cola, quiche, pizza and ice cream.

The analysis of the strengths and weaknesses of the five selected schemes is presented in Table 9. This analysis is mainly focused on the simplicity of use of the schemes, the relevance of their rationale, their sensitivity and the presence or lack of validation.

Discussion

Many nutrient profiling schemes have been developed world-wide. They largely vary in format, content and purpose for which they were developed. The 23 schemes listed in Table 1 differ from each other because of the nutrients selection, the figures used as cut-off values, the use of individual thresholds or

Table 7 Synthesis of the criteria for the "GRFMC Scheme" guidelines for responsible food marketing to children (Center for Science in the Public Interest, USA)

Nutrient	Criteria
A: Solid foods	
Fat	Less than 30% of total calories, excluding nuts, seeds, and peanut or other nut butters
SFA + Trans Fat	Less than 10% of calories
Added sugars	Less than 25% of calories (added sugars exclude sugars naturally occurring from fruit, vegetable, and dairy ingredients)
Sodium	Not more than 150 mg per serving of chips, cereals, crackers, cheeses, baked goods, French fries, and other snack items
	Not more than 480 mg per serving for soups, pastas, meats, main dishes
	Not more than 600 mg for meals
Portion size—individual items	Not larger than the standard serving size used for Nutrition Facts labels
Portion size—meals	Not more than one-third of the daily calorie requirement for the average child in the age range targeted by the marketing
Nutrient content	Contains one or more of the following: (1) 10% of the DRI (naturally occurring/without fortification) of vitamins A, C, or E, calcium, magnesium, potassium, iron, or fibre, (2) half a serving of fruit or vegetable, or (3) 51% or more (by weight) whole grain ingredients
B: Beverages	
Nutritious/healthful beverages	Low-nutrition beverages
Water and seltzer without added caloric sweeteners	Soft drinks, sports drinks, punch, ice tea, and other drinks with less than 50% real juice and that contain added caloric sweeteners
Beverages that contain at least 50% juice and no added caloric sweeteners	Drinks containing caffeine (except low-fat and fat-free chocolate milk, which contain trivial amounts of caffeine)
Low-fat and fat-free milk, including flavored milks and calcium-fortified soy and rice beverages	

Table 8 Results for a limited sample of food tested with the five chosen systems

Category	Product	A little A Lot	USA Health Claim Scheme	Tripartite Classification Model	FSA Scoring System for Children	GRFMC Scheme	Consensus
Cereal products	Boiled potatoes	0	Ok	Not Ok	Ok	Not Ok	No
	French fries	1	Not Ok	Not Ok	Not Ok	Not Ok	Nearly
	Potato crisps	3	Ok	High in SFA, high in fibre	Not Ok	Not Ok	No
	Potato crisps low fat	3	Ok	High in SFA, high in fibre	Not Ok	Not Ok	No
	Boiled white rice	0	Not Ok	Not Ok	Ok	Not Ok	No
	Fried rice	0	Not Ok	Not Ok	Inter	Not Ok	No
	Corn flakes	1	Ok	Not Ok	Not Ok	Not Ok	No
	Weetabix	0	Ok	Ok	Ok	Ok	Yes
	All-bran	2	Ok	Ok	Not Ok	Not Ok	No
	Muesli	1	Ok	Inter	Ok	Ok	Nearly
	Popcorn plain	1	Not Ok	Low in SFA	Not Ok	Not Ok	Yes
Bread	White bread	1	Not Ok	Not Ok	Inter	Not Ok	Nearly
	Wholemeal bread	1	Ok	Ok	Ok	Not Ok	no
Bakery products	Croissant	2	Not Ok	High in SFA, high in fibre	Not Ok	Not Ok	Yes
	Shortbread biscuit	3	Not Ok	High in SFA, high in fibre	Not Ok	Not Ok	Yes
	Chocolate biscuit	3	Not Ok	High in SFA, high in fibre	Not Ok	Not Ok	Yes
	Fruit cake	2	Not Ok	High in SFA, high in fibre	Not Ok	Not Ok	Yes
	Sprits pieces	3	Not Ok	High in SFA	Not Ok	Not Ok	Yes
Fruits	Orange	1	Ok	Ok	Ok	Ok	Nearly
	Apple raw	1	Ok	Ok	Ok	Ok	Nearly
	Currants	1	Ok	Not Ok	Not Ok	Ok	No
	Banana	1	Ok	Ok	Ok	Ok	Nearly
	Pineapple	1	Ok	Ok	Ok	Ok	Nearly
	Canned pineapple (syrup)	1	Ok	Inter	Ok	Not Ok	No
	Strawberry	0	Ok	Ok	Ok	Ok	Yes
	Strawberry on syrup can/glas	1	Ok	Inter	Ok	Not Ok	No
Vegetables	Carrots can/glas	0	Ok	Ok	Ok	Not Ok	No
	Carrots boiled salted	0	Ok	Ok	Ok	Ok	yes
Milk prod	Whole milk	0	Not Ok	Not Ok	Inter	Not Ok	no
	Skimmed milk	0	Ok	Ok	Ok	Ok	Yes
	Semi-skimmed milk	0	Ok	Inter	Ok	Not Ok	No
	Fresh cheese plain	0	Not Ok	Not Ok	Inter	Not Ok	No
	Very low fat fresh cheese	0	Ok	Inter	Ok	Not Ok	No
	Whole milk yoghurt plain	0	Ok	Not Ok	Ok	Not Ok	No
	Whole milk yoghurt fruits	0	Ok	Not Ok	Inter	Not Ok	No
	Low fat yoghurt plain	0	Ok	Inter	Ok	Ok	Nearly
	Low calorie yoghurt	0	Ok	Ok	Ok	Ok	Yes
Cheese	Camembert	3	Not Ok	Inter	Not Ok	Not Ok	Nearly
	Cheddar	3	Not Ok	Not Ok	Not Ok	Not Ok	Yes
	Cheese spreadable- 40+	2	Ok	Ok	Not Ok	Not Ok	No
Meat and poultry	Corned beef	2	Not Ok	Not Ok	Not Ok	Not Ok	Yes
	Beef <10 g fat	0	Ok	Ok	Ok	Not Ok	No
	Chicken nuggets	0	Ok	Inter	Not Ok	Not Ok	No
	Beef burger (fried)	2	Not Ok	Not Ok	Not Ok	Not Ok	Yes
	Sausages (grilled)	3	Not Ok	Not Ok	Not Ok	Not Ok	Yes
	Sausages low fat (grilled)	2	Not Ok	Inter	Not Ok	Not Ok	Nearly
Fish	Salmon can	0	Not Ok	Ok	Inter	Not Ok	No
	Salmon smoked	1	Not Ok	Ok	Not Ok	Not Ok	No
	Cod (baked, fillets)	0	Ok	Ok	Ok	Not Ok	No
	Tinned tuna (in brine)	0	Ok	Ok	Ok	Not Ok	No
Nuts	Walnuts	2	Not Ok	Low in SFA, high in fibre	Ok	Not Ok	No
	Nuts, mixed	2	Not Ok	high in SFAhigh in fibre	Inter	Not Ok	nearly
Fat	Palm oil	2	Not Ok	Not Ok	Not Ok	Not Ok	Yes
	Olive oil	2	Not Ok	Ok	Not Ok	Not Ok	No
Drinks	Cola	1	Not Ok	Not Ok	Not Ok	Not Ok	Yes

scores, the type of reference amounts and the rationales behind the schemes.

The fact that the most common reference amount used in the schemes that were reviewed is 100 g is not surprising. It is a particularly simple reference and is in line with the labelling system in the EU. It penalizes foods that are consumed in small quantities, while it favors those that are consumed in big quantities. The reference amount "serving size" is used less often at least in Europe, probably because European con-

Table 8 Results for a limited sample of food tested with the five chosen systems

Category	Product	A little A Lot	USA Health Claim Scheme	Tripartite Classification Model	FSA Scoring System for Children	GRFMC Scheme	Consensus
	Diet Cola	0	Not Ok	Ok	Ok	Ok	No
	Orange juice	0	Ok	Inter	Ok	Ok	Nearly
Dishes	Cheese and egg quiche	2	Not Ok	High in SFA	Not Ok	Not Ok	Yes
	Pizza cheese and tomatoes	2	Not Ok	High in SFA	Not Ok	Not Ok	Yes
	Lasagne with sauce and meat	0	Not Ok	Ok	Inter	Not Ok	No
Other	Chocolate mousse	1	Not Ok	Low in SFA	Not Ok	Not Ok	Yes
	Dairy ice cream Vanilla	2	Not Ok	High in SFA	Not Ok	Not Ok	Yes

can/glas: canned/glass
"OK" means "allowed to bear a health claim" in the USA Health Claim Scheme, "preferable" in the Tripartite Classification Model, "healthier Choice" in the FSA Scoring System for Children and "allowed to be marketed to children" in the GRFMC Scheme
"Inter" means "middle course" in the Tripartite Classification Model and "intermediate" in the FSA Scoring System for Children
"Not OK" means "not allowed to bear a health claim" in the USA Health Claim Scheme, "exceptional" in the Tripartite Classification Model, "less healthy" in the FSA Scoring System for Children and "not allowed to be marketed to children" in the GRFMC Scheme
For the "A little A Lot" scheme, each food is qualified by "A Lot" or "A Little" for each nutrient, one by one. The conclusion is expressed as the sum of "A Lot " for the negative nutrients

Table 9 Strengths and weaknesses of the five selected schemes

Scheme	Strengths	Weaknesses
A Little A Lot	Simple to use Validation essay	Weak rationale Lack of global conclusion on the food Low sensitivity
USA Health Claims Scheme	Real consumptions conditions are considered via serving size The use of serving size as a reference amount allows "fair comparisons" between foods	Low sensitivity Weak rationale
Tripartite Classification Model	Relevant rationale Nutrients are selected as a function of the food category	Difficult to use (category declination; difficult access to some composition data) The overall quality of a food is not taken into consideration as only a few nutrients are taken into account
FSA Scoring System for Children	Scientific basis Sensitive Validation essay	Difficult to use (complex calculation; access to some composition data) High energy dense foods are penalised
GRFMC Scheme	Scientific basis Energy as referent amount allows "fair" comparisons (ex: Dry matter does not affect the results)	Difficult to use (conversion of values into % energy; many nutrients and ingredients requested) Low sensitivity

sumers are not very familiar with it. However, a reference amount based on serving size could be more informative for consumers because foods are consumed in variable portions and not in 100 g quantities. Unfortunately, the use of serving sizes as reference amount necessitates some standardization and this has as yet not been achieved in Europe. The reference 100 kcal is used very seldom. This is probably due to the fact that its use implies conversion of labelling values per weight or volume into nutrient density values. From a nutritional point of view, this reference amount appears to be very relevant because it allows assessing the real richness or lack of a nutrient in a food, irrespective of the water content.

Across the board schemes seem to be more frequent than food category based schemes. This may be due to the difficulty of grouping foods in categories. Therefore, category-wise schemes often differ from each other not only for selected nutrients and cut-off values but also for the way foods are categorised, making comparisons difficult. Category-wise schemes tend to be more sensitive to small differences in composition of foods within one category. However, sensitivity is interesting only when specific nutrients are selected and the grouping of foods into categories is not aberrant. These are the most vulnerable points of such schemes.

Across-the board schemes are generally more robust in this respect because in these schemes the selection of nutrients is based on considerations of public health issues and not on intrinsic characteristics of the food category that is considered. Some

"intermediate" schemes make a distinction between liquid foods (or drinks or beverages) and solid foods. Unfortunately, an accurate definition of beverage and/or liquid is not usually provided with these schemes and this can lead to problems in application.

Threshold systems are more common than scoring systems. As a principle, a scoring system is less severe than a threshold system because it allows the product to have some defaults if they are "compensated" with some qualities. This fits with the concept that the right balance of nutrients can be easily achieved with a varied diet but, as a rule, not by one food alone.

Nutrient selection appears to be the parameter that varies the most across the different schemes. The main differences concern the number of nutrients included and the balance between "positive" and "negative" nutrients and depend on the final goal to be achieved. Nutrient selection will probably focus on "negative" nutrients if the goal is to roughly identify the most "problematic" food categories according to their nutritional "defaults." If, on the contrary, the goal is to classify food products according to slight differences in composition, both with regard to nutritional "defaults" and "virtues," nutrient selection will include an increased number of "positive" nutrients.

The different approaches lead to different schemes with very different sensitivity. Some schemes exclude entire food categories, e.g. from bearing a health claim, whereas other schemes, less strict, systematically allow a percentage of products to bear a claim in each food category. The primary aim of Regulation 1924/2006 is to exclude certain extreme food products from bearing a claim and not to provide a classification of foods on the label.

For the five schemes that were described in detail, we can conclude that all of them have both strengths and weaknesses. The scheme "A Little, A Lot" [3] is a very simple scheme that gives well a rough idea of the content of some nutrients in a food. Interesting is also the pragmatic way of judging its "validity" by verifying that the cut-off values divide the food market in an acceptable way. However, its main weaknesses are the absence of a clear rationale and the absence of an overall conclusion for the whole food. Moreover, the presence of only two very distant thresholds per nutrient highly reduces the sensitivity and makes it impossible to discriminate between very different products (e.g. between a product containing 21 g fat/100g and a product containing 40 g fat/100g).

The "USA Health Claim" scheme [6] is also quite simple to use and understand. The rationale to define thresholds is not clear and therefore the meaning of the cut-off values is debatable. This scheme is not very sensitive because of applying only one threshold value per nutrient. This scheme is remarkable for utilising serving sizes as reference amounts.

The "Tripartite Classification Model" [27] is slightly complicated, being category-wise and requiring data for SFA and fibre. However, its rationale is particularly well founded and based both on dietary intake data, food composition data and nutrition policy objectives. Relevant appears to be the choice of nutrients per food category, because a very small number of nutrients is selected, which simplifies calculations and allows sensitivity within a given food category.

The "FSA Scoring System for Children" [33] appears to be the most complex nutrient profiling scheme. Complexity depends both on the use of scores and on the need for food composition data, some of which, like the percentage of fruit and vegetables and nuts, are usually not easily accessible. It is the only profiling scheme that has been "validated" with a systematic and transparent approach by expert judgement, and this makes this system one step further than others. This "validation" step has shown a very high correlation of the classification of products by the scheme with classification through personal judgement by experts. However, the relevance of this validation method is debatable.

The "GRFMC" scheme [17] is interesting for the choice of 100 kcal as the reference amount, which is exceptional among the existing nutrient profiling schemes. This may be considered to be the most relevant way to compare foods, as results are not dependent on energy density and water content. However it requires composition data to be converted into nutrient density data for a relatively high number of nutrients and this may make its utilization slightly complex.

The classification of the selected food sample by the five selected schemes demonstrates the difficulty of achieving consistency for all foods. We observed a consistent positive evaluation of fruits and vegetables and a consistent negative evaluation of fatty and sugary products such as sugars and oils, in agreement with dietary guidelines. This is reassuring from a scientific point of view, but does not appear very useful, as staple foods usually are not the object of health claims. In contrast, most processed foods, that may be the object of health claims, are not classified similarly by the selected schemes. The differences of rationales, nutritional recommendations and calculations at the back of the existing schemes lead to differences in food classification. This could also lead to the conclusion that at least some schemes are not accurate.

It seems that the "ideal" scheme has not been developed yet. In our opinion, the ideal scheme should be simple in order to be easily and largely

applied. Even though simple for the final user, the "ideal" scheme should also be sophisticated in its foundations in order to be meaningful and science-based. A scheme should be sensitive enough to detect small but relevant differences between products. In addition, the "ideal" scheme should be sufficiently flexible to cope with evolution of knowledge in nutrition and health science. Finally, the "ideal" scheme should be conceived not for censuring, but for encouraging food companies to reformulate and improve the nutritional quality of their products. These general characteristics would be desirable regardless of the purpose for which the profiling scheme has been developed. The purpose of the scheme and the public health objectives associated to its implementation should help to define the actual rationale and the subsequent figures to be used as cut-off values.

With respect to a profiling scheme aimed at identifying food products eligible for health claims some questions need to be addressed. A food product carrying a claim may have a specific benefit on a specific body function but may have a nutrient profile that over time leads to an imbalance of the nutrient intake. Probably a risk/benefit analysis needs to be run for every product. This risk/benefit analysis should take into account the frequency of consumption of each food by the target population, data of prevalence of many chronic diseases and the relationship between each nutrient and each disease. This would be incredibly time consuming and almost impossible to effectuate in an accurate way, due to the huge differences in individual responses.

A cautious approach would be to select for health claims only products that have a perfect nutrient profile. The impact on the population would be probably tiny due to the small number of foods carrying a claim, but would be certainly in the right direction. However, this approach would not stimulate food companies to improve their products. The issue is complicated and cannot be solved in a simplistic way.

In conclusion, nutrient profiling is much more than delivering cut-off values for e.g. fat and cholesterol via a specific scheme. Dependent on the intended use it can be a very complex and challenging discipline that needs to integrate not only nutritional recommendations and principles, but also behavioral science, mathematics and statistics, market data, epidemiological observations and economical inputs.

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