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A multipurpose tool to evaluate the nutritional quality of individual foods: Nutrimap®

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Abstract

Background/objectives: With obesity and nutrition-related diseases rising, public health authorities have recently insisted nutritional quality be included when advertising and labelling food. The concept of nutritional quality is, however, difficult to define. In this paper we present an innovative, science-based nutrient profiling system, Nutrimap®, which quantifies nutritional assets and weaknesses of foods.
Methods: The position of a food is defined according to its nutritional composition, food category, the consumer's nutritional needs, consumption data and major public health objectives for nutrition. Amounts of each of 15 relevant nutrients (in 100 kcal) are scored according to their ability to 'rebalance' or 'unbalance' the supply in the whole diet, compared with current recommendations and intakes. These scores are weighted differently in different food categories according to the measured relevance of the category to a nutrient's supply. Positive (assets) and negative (weaknesses) scores are totalled separately.
Results: Nutrimap® provides an overall estimate of the nutritional quality of same-category foods, enabling easy comparisons as exemplified for cereals and fruit/vegetables. Results are consistent with major nutritional recommendations and match classifications provided by other systems. Simulations for breakfasts show that Nutrimap® can help design meals of controlled nutritional value.
Conclusions: Combining objective scientific bases with pragmatic concerns, Nutrimap® appears to be effective in comparing food items. Decision-makers can set their own limits within the Nutrimap®-defined assets and weaknesses of foods and reach categorisations consistent with their objectives – from regulatory purposes to consumer information or support for designing meals (catering) or new products (food industry).

Keywords
Nutrient profiling
Nutritional quality
Food categorisation

The concept of nutrient profiling systems has recently aroused renewed interest from scientific and regulatory authorities dealing with nutrition issues[1]. Indeed, such tools can be useful in helping decision-makers on topics such as allowing a food to bear a nutrition or health claim, restricting television advertisements for certain foods or limiting their occurrence in vending machines. These profiling systems could also help educate consumers more effectively on nutritional matters and facilitate nutrition-oriented innovation and improvements in the food industry.

However, there is currently still some controversy as to the relevance of such tools, which are sometimes thought to be incompatible with, or even to jeopardise, health education programmes. To our mind, the major issue is the characteristics, adequacy and performance of the systems which are proposed. Very briefly, the existing systems can be divided into two broad categories.

Some systems favour an 'across the board' approach, in which every food is positioned using the same nutritional criteria. We have recently analysed four of these tools by comparing their performance in classifying a series of 125 food items and, although some tools seem more accurate than others, there are still difficulties in reaching full consistency[2]. An additional pitfall of this approach is its propensity to heap opprobrium on some food categories as a whole, such as fats, which nearly always appear among the least favourable food products, whatever their quality. This is in conflict with the usual, and still not debated, need for a balanced but varied diet in which any food can find its place, provided that the amount and frequency of consumption are related to its nutritional characteristics.

Another set of tools includes a variety of systems, most of the time unpublished, which take into account food groups but do not consider a given food item with the same nutritional criteria or thresholds, depending on the food group it belongs to. Such systems have been developed in Sweden[3] and The Netherlands[4], for example. The concept is interesting and probably more

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in line with the issue of a wholesome diet, but an appropriate methodology and sometimes the scientific justification for the choice of criteria and thresholds are lacking. Moreover, these systems remain relatively rigid, and cannot easily be adapted to various contexts (e.g. food for adults or children) or uses (e.g. regulatory, educational or help in formulation).

We describe here a nutrient profiling system, named Nutrimap®, that aims to position food items in relation to others within the same food category, and which pays special attention to flexibility and pragmatism. The principles, scientific background and implementation of the system are described and some uses are presented in more detail.

The position of a food product within the Nutrimap® system is defined according to its nutritional composition, the food category it belongs to, the nutritional needs of the consumer, available consumption data and major public health objectives for nutrition. Of these five items, the last two are clearly country-dependent. Nutrimap® is described here in its French/healthy adult version, but the flexibility of the system enables it to be adapted easily to other situations.

Development of Nutrimap®

Nutritional criteria

The selection of nutritional criteria has been driven by public health objectives, as detailed in several reports by the World Health Organization[5], the Eurodiet task force[6] or, in France, the PNNS[7] (National Programme for Nutrition and Health). Nutrimap® uses a set of 15 nutritional criteria (Table 1), chosen because of the nutritional issues they raise. Lipids are considered both for their quantity (% of lipid energy) and their quality (saturation level of fatty acids), as are carbohydrates (quantity as % of carbohydrate energy; quality as % of sugars). Fibre, vitamins (folic acid, C, D, E), iron, calcium and magnesium are considered because their intake in France is below the recommended levels in some adult population groups. Sodium is taken into account because of the current excessive intake by the French population[8].

Although other choices could have been made, energy has been chosen as the reference basis because it seems consistent with the increasingly consensual concepts of nutritional and/or energy density. Nutritional criteria are thus expressed in weight units per 100 kcal of food.

Scoring

Each of the criteria is then allocated a score between −1 and +1. The score depends on the amount of the nutrient present in 100 kcal of the product, as illustrated in Fig. 1. For a nutrient whose intake should be limited (fat, saturated fats, sodium and sugars), the score will be −1 if the food under study contains more than the actual recorded French intake. This would mean that the considered product increases the imbalance already observed. The score will be +1 if the considered food contains less than the recommended maximum intake, meaning that the product is able to rebalance the diet for this nutrient. The score will develop in linear fashion between −1 and +1 if the value for this nutrient is between the recommended maximum intake and the actual intake. For a nutrient whose intake should be increased (carbohydrates, fibre, polyunsaturated fats, vitamins and minerals), the argument is reversed. Nutrimap® thus uses two thresholds for each nutrient: its recommended intake and its current consumption. These thresholds, as determined for a population of French adults, are shown in Table 1. At this stage it is possible to use the system for specific purposes; for example, considering the recommended values for children and their recorded intake will address the nutritional relevance of a given food item for this age group.

Table 1 The nutritional criteria taken into account in Nutrimap® and thresholds of recommended intake and current consumption for healthy French adults, where relevant (i.e. not for vitamins and minerals, see text)

Nutritional criterion	Units	Recommended intake	Current supply
Total carbohydrates	% total energy	55	42
Sugars	% total energy	10	17
Total lipids	% total energy	35	37
Saturated fatty acids	% of lipid amount	29	43
Monounsaturated fatty acids	% of lipid amount	43	35
Polyunsaturated fatty acids	% of lipid amount	23	11
Fibre	g/100 kcal	1.3	0.8
Folic acid	μg/100 kcal	13.4	See text
Vitamin D	μg/100 kcal	0.2	
Vitamin C	mg/100 kcal	4.7	
Vitamin E	mg/100 kcal	0.5	
Calcium	mg/100 kcal	38.3	
Iron	mg/100 kcal	0.5	
Magnesium	mg/100 kcal	16.6	
Sodium	mg/100 kcal	102	142

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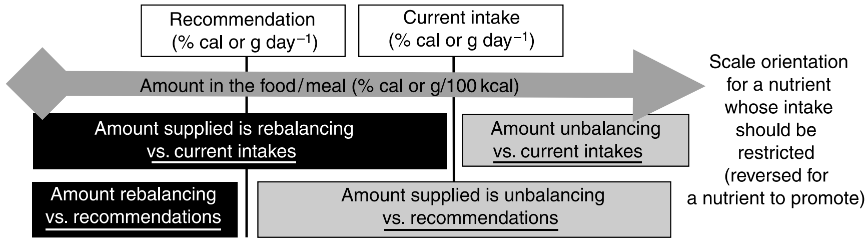

Fig. 1 Scoring mechanism for each nutrient whose intake is not consistent with recommendations

Lipid quality is estimated as the mean of the scores for saturated, mono- and polyunsaturated fats (or mono-unsaturated fats if only these are available) and only considered if more than 10% of energy is of lipid origin.

Although vitamins and minerals have been chosen in relation to a recorded gap between recommendation and current supply, this gap does not exist for the whole adult population and is different for men, women, young adults and people over 50 years of age. For this reason, the 'level of current consumption' threshold is not activated for vitamins and minerals (except sodium), and the scoring allocates a mark of ' + 1' when the supply exceeds the daily recommended intake as expressed per 100 kcal, a mark of '0' when the supply is below half this level and a mark which develops in a linear fashion between 0 and +1 otherwise; vitamin and mineral criteria cannot have a negative score. All vitamin marks are summed. In order to avoid an over-representation of vitamins, which could lead to vitamin supplementation where this is not in fact needed, the maximum score for vitamins is set at +2. A similar rule applies to minerals, apart from sodium.

Food categories

The definition of food groups is always a matter of debate. This is a pragmatic concept which has been developed to make it easier to vary diet and whose purpose is primarily to ensure an overall balanced diet. We tried here to avoid the occurrence of too many food groups, which would have been difficult to handle and interpret correctly. We have thus defined seven food categories (Table 2) in accordance with the groupings most often encountered in the literature[9] and with the dietary guidelines of various public health authorities. Five to nine food groups are usually identified. These are usually defined, based on recommendations, according to the nutrient(s) they provide[9,10]. Carbohydrates are thus supposed to be mostly provided by the 'cereals, potatoes, pulses and derived products' group; proteins by the 'meat, egg, fish' group; calcium by the 'milk and dairy products' group, and so on. One of course knows that proteins can also be provided by dairy products or that fresh potatoes contain a lot of vitamin C, but this approach remains pragmatic and is not confusing with the current food groups. However, we chose to keep a specific category for composite dishes, whose allocation to a nutrient-based group may largely depend on the recipe. We included a category for sugary foods, which also includes soft drinks (with caloric or non-caloric sweeteners) but we did not consider alcoholic and energy drinks or water.

Defining food categories is a difficult and critical issue nowadays. It appears that the answer will hardly be a straightforward scientifically based solution, because numerous other aspects such as consumer perceptions, industrial innovations and current legislative definitions also come into play. It is not our objective to address this question; however, Nutrimap® is able to adapt to any kind of categorisation.

Weighting

This step aims to take into account the relative importance of the various nutritional criteria when estimating the nutritional value of a given product. This might seem of little use and unnecessarily complex, but one should keep in mind that not considering this issue means in fact that each nutrient is allocated the same weighting and impacts the nutritional quality equally, whatever the food category. This statement is not really scientifically justified and is not consistent with the generally acknowledged nutrient-based approach. We propose here to set the weighting allocated to each nutrient in a food category in relation to the amount of this nutrient in this category. The method consists of: (1) considering the proportion of each nutrient added to the diet by each of the seven categories defined above, which is illustrated in Table 2; (2) standardising the values obtained so that, within a food category, the most abundant nutrient is allocated a value of '100' and the score allocated to each of the other nutrients remains proportional to its supply by this food category (Table 3); and (3) reducing the range to a scale of 1 to 3 (Table 3). This last step retains the relative levels between the weightings while restricting the scale and setting a minimum weighting of 1 for nutrients usually poorly supplied by products in the category yet which may appear in specific or newly developed food products, such as a butter-enriched vegetable purée or fibre-rich yoghurt.

It is generally not easy to obtain reliable data about the amounts of nutrients supplied at different meals, thus

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Table 2 The proportion of nutrients supplied by different food categories, using data from the INCA survey[8]. Total of percentages is not 100, because alcoholic drinks, energy drinks and water are not considered. This concerns less than 3% of most nutrients, except for minerals for which 10.8% are supplied by water

Food category	Total lipids (%)	Lipid quality* (%)	Total available carbohydrates (%)	Sugars (%)	Fibre (%)	Sodium (%)	Minerals* (excl. sodium) (%)	Vitamins* (%)
Cereals, legumes, potatoes, derived products (including biscuits, pastries and breakfast cereals)	17.3	14.1	55.0	12.7	50.4	34.6	16.0	11.5
Milk, dairy products, cheeses	15.4	18.3	4.4	12.7	0.0	11.9	33.2	5.2
Meat, fish, eggs	25.0	23.7	0.5	0.3	0.2	20.3	18.5	22.7
Vegetal and animal fats, oily seeds	19.2	17.4	0.4	0.8	1.3	0.2	0.8	13.3
Fruits, vegetables and derived products (including juices)	0.7	4.1	11.4	25.9	36.0	12.2	9.2	25.3
Composite dishes	12.3	10.0	7.2	1.0	10.0	16.5	7.5	4.9
Sugar-rich foods (not cereal- or milk-based)	3.9	3.6	14.2	32.0	1.3	0.6	2.3	1.4

* The contribution of each food category to the lipid quality of the whole diet is estimated to be the highest value of the three fatty acid categories (saturated, monounsaturated and polyunsaturated), standardised by dividing by the sum of the maximum values obtained for each food category. A similar procedure is used to obtain a global weight for minerals and vitamins.

Table 3 Weighting coefficients allocated to each group of nutritional criteria according to the food category or moment of consumption. For the seven food categories, the values are obtained by standardising the figures shown in Table 2: the value of '100' is allocated to the nutrient for which the category is the highest contributor, and then other nutrients are allocated proportional values (figure into brackets). The final weighting is established when the scale is reduced from 1 to 3

Food category	Total lipids	Lipid quality	Total available carbohydrates	Sugars	Fibre	Sodium	Minerals (excl. sodium)	Vitamins
Cereals, legumes, potatoes, derived products (including biscuits, pastries and breakfast cereals)	1.3 (31.5)	1.1 (26.5)	3.0 (100)	1.1 (23.1)	2.8 (91.5)	2.1 (62.9)	1.2 (29.0)	1.0 (20.8)
Milk, dairy products, cheeses	1.9 (46.2)	2.1 (55.1)	1.3 (13.2)	1.8 (38.2)	1.0 (0)	1.7 (35.8)	3.0 (100)	1.3 (15.7)
Meat, fish, eggs	3.0 (100)	2.9 (95.1)	1.0 (1.9)	1.0 (1.4)	1.0 (0.7)	2.6 (81.3)	2.5 (74.2)	2.8 (90.8)
Vegetal and animal fats, oily seeds	3.0 (100)	2.8 (90.7)	1.0 (1.8)	1.1 (4.0)	1.1 (6.8)	1.0 (1.0)	1.1 (4.0)	2.4 (69.2)
Fruits, vegetables and derived products (including juices)	1.0 (1.9)	1.2 (11.3)	1.6 (31.6)	2.4 (71.9)	3.0 (100)	1.7 (33.9)	1.5 (25.6)	2.4 (70.3)
Composite dishes	2.5 (74.4)	2.2 (60.6)	1.8 (43.8)	1.0 (6.1)	2.2 (60.4)	3.0 (100)	1.8 (45.7)	1.5 (30.0)
Sugar-rich foods, (not cereal- or milk-based)	1.2 (12.3)	1.2 (11.2)	1.9 (44.5)	3.0 (100)	1.0 (4.6)	1.0 (1.9)	1.1 (7.2)	1.1 (4.4)
Food product for children's breakfast/breakfast meals	3	1	2	3	2	1	1.5	1.5

making it difficult to use the same method to allocate weightings to nutrients when questioning the nutritional values of composite meals. The weightings proposed for children's breakfasts in Table 3 are based only on the expertise of paediatric nutritionists and can therefore be challenged.

Final calculations and mapping

Separate totals are then compiled for the positive scores (corresponding to the nutritional benefits of the product) and the negative scores (nutritional weaknesses). Both these scores will characterise the product and are not further aggregated. These scores are then mathematically standardised to a scale of 100 (100 corresponding to the theoretical maximum positive or negative score in the food group considered). A graph can then be plotted on which one can easily visualise the position of a given food product, both individually and in comparison to others belonging to the same food group.

Summary

To summarise, the following steps are used to evaluate the nutritional quality of an individual product:

1. Assignment of the food to a category. Nutrimap® does not define categories, but rather adapts to any given category definition.
2. Calculation of the 15 nutrient values, for 100 kcal of the product and according to available food composition tables or specific analyses.
3. Separate scoring of each nutrient, which is allocated a value between -1 and $+1$, according to the mechanism detailed above and in Fig. 1. The thresholds for recommended and actual consumption depend on the country and the population group (see Table 1 for figures in a French context).
4. Weighting of each score, using a coefficient which differs from one food category to another, according to the contribution of the food category to the intake of this nutrient by the considered population (Tables 2 and 3).
5. Separate additions of negative and positive scores, and standardisation of the values on a 100-scale.

An example is detailed in Fig. 2. These five steps could, in theory, be carried out by hand, but software performs all the calculations quickly and easily. Instructions and detailed data are available from the corresponding author.

Comparison with other nutrient profiling systems

The best way to really validate a nutrient profiling system would probably be to demonstrate that the long-term preferential intake of foods which are positively ranked by the system is significantly associated with a lower incidence of nutrition-related diseases, or at least with positive changes to validated biomarkers. This is a very challenging objective requiring extensive and specifically designed studies, which were not undertaken here. However, we did make some attempts to compare the final position of some foods with the results provided by other systems and especially by the ones developed by the UK Food Standards Agency (FSA)[11] and by the Dutch Vovo system[4]. These systems classify foods as healthy/less healthy respectively with an 'across the board' approach or as preferable/medium course/exceptional with criteria depending on the category. For the purpose of this comparison, and from the Nutrimap® classification, threshold values for nutritional weaknesses and benefits have been arbitrarily determined to split foods into three categories: 'healthy', 'intermediate' and 'less healthy' (Table 4).

Results

The data used to assess the nutritional quality of foods within the French context of healthy adults come from the McCance & Widdowson[12] and CIQUAL[13] food composition tables, from Eurodiet and the French nutritional recommendations[14] and from the French food consumption survey[8] for the current nutrient intake information.

Example 1: Products in the same category

A mapping of products belonging to the carbohydrate-rich food category, which includes cereals, pulses, potatoes and derived products, is shown in Fig. 3, along with the final positive and negative scores. Figure 4 is the mapping of fruit and vegetables, with derived products, including juices. The mappings are highly discriminative, with lentils and muesli in the upper right part (more benefits than weaknesses) whereas wafers and potato crisps are in the lower left part (more weaknesses than benefits). If such a sophisticated tool does not seem necessary to distinguish between the nutritional quality of boiled potatoes and wafer biscuits or between tomato ketchup and green beans, it becomes more useful when comparing the overall nutritional quality of croissants and cookies, or spaghetti and oven potato chips.

Example 2: Meal and time of consumption

We have compared individual products regularly eaten for breakfast (Fig. 5) and whole breakfast meals composed of these products (Fig. 6). The nutritional composition of each breakfast is calculated by adding the contribution of each food relative to its amount and the calculations are then made considering 100 kcal of the meal as a whole. The corresponding weighting of criteria, with a specific focus given to lipid quality and quantity and to sugars, is shown in Table 4 and aims at being a translation of usual dietary recommendations for breakfasts, although these recommendations are not really precise: this mapping should thus be primarily regarded as an illustration of the ability of Nutrimap® to address whole meals as well as individual foods. Nutrimap® makes it easy to differentiate

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Step 1 – Choice of category: cereal and derived products

Nutritional composition per 100 g is: total lipids, 5.6 g; saturated fatty acids (SFA), 0.9 g; monounsaturated fatty acids (MUFA), 2.9 g; polyunsaturated fatty acids (PUFA), 1.8 g; total carbohydrates, 72.2 g; sugars, 26.2 g; fibre, 6.4 g; Na, 380 mg; Mg, 85 mg; Fe, 5.8 mg; Ca, 110 mg; vitamin C, 25 mg; vitamin B_9, 140 µg; vitamin E, 4.3 mg; vitamin D, 3.1 µg; energy, 363 kcal.

(a) Scores are attributed to each nutrient according to the thresholds shown in Table 1. See text

(b) Scores are weighted with the coefficients related to the 'cereal category', shown in Table 3. See text

NUTRIENT	AMOUNT (**Step 2**)	SCORING (**Step 3**) (a)	WEIGHTING (**Step 4**) (b)
Total lipids	13.9% of energy	1	1.6
Lipid quality (FA in % of lipid quantity)	SFA, 16; MUFA, 52; PUFA, 32	1	1.5
Total carbohydrates	79.6% of energy	1	3
Sugars	28.9% of energy	–1	–1.5
Fibre	1.7 g/100 kcal	1	2.8
Sodium	104 mg/100 kcal	0.9	2
Minerals	2 minerals >5% of recommendations	2	3.2
Vitamins	2 vitamins >5% of recommendations	2	2.8

Step 5 – Addition of positive (4.9) and negative (–1.5) scores, and normalisation relative to the theoretical maximal positive (18.7) and negative (12.7) scores. The final figures are 90.3 (normalised positive score) and 11.8 (normalised negative score), which are used as coordinates on the two-dimensional graph below.

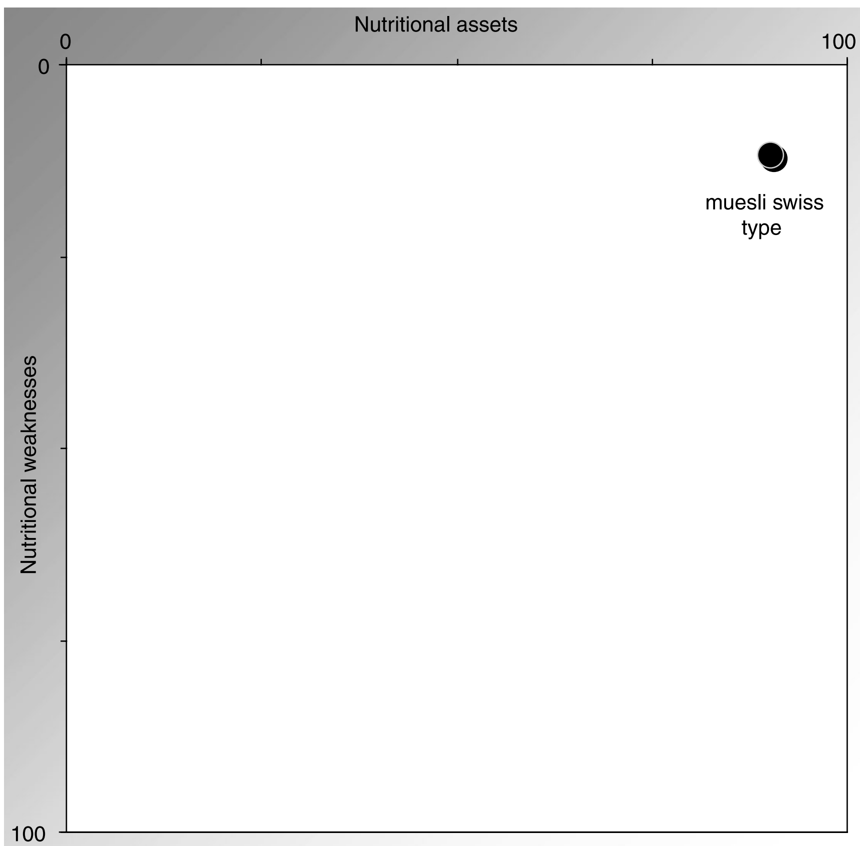

Fig. 2 Step-by-step positioning and the resulting diagram of muesli, Swiss type

between different types of breakfasts and to evaluate the nutritional consequences of substituting orange juice with an orange (breakfasts 1 and 2), or bread and butter with a croissant (breakfasts 10 and 11). It is interesting to note that the distribution obtained by mapping the individual food items is no broader than the distribution obtained by mapping whole breakfasts. This is somewhat contrary to the generally accepted idea that a varied dietary supply is

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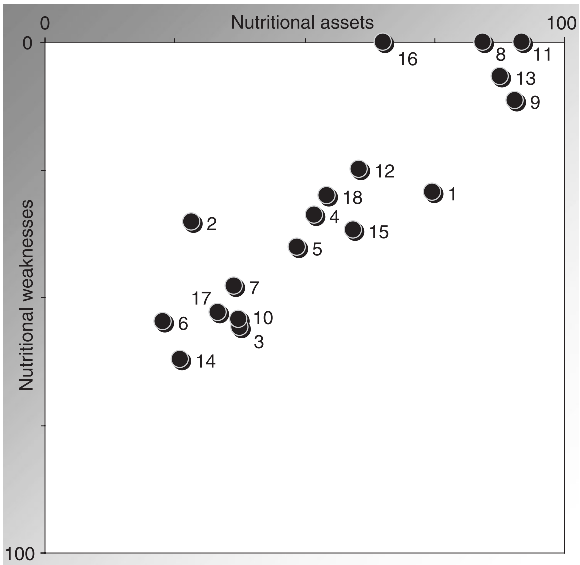
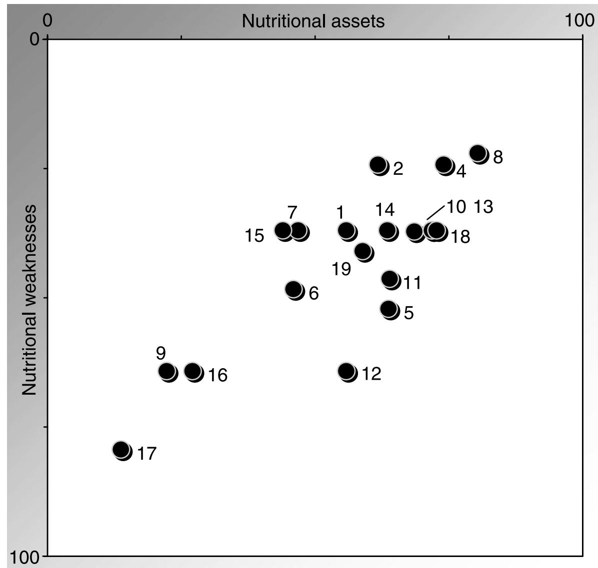


Code	Product	Assets (/100)	Weaknesses (/100)
1	All-Bran	75	29
2	Chips, French fries, retail	28	35
3	Chocolate chip cookies	38	56
4	Coco Pops	52	34
5	Corn Flakes	49	40
6	Croissants	23	55
7	Digestive biscuits, plain	36	48
8	Lentils, green and brown, whole, dried, boiled in salted water	84	0
9	Muesli, Swiss style	91	12
10	Oat-based biscuits	37	54
11	Old potatoes, boiled in unsalted water	92	0
12	Old potatoes, mashed with butter	60	25
13	Oven chips, frozen, baked	88	7
14	Potato crisps	26	62
15	Potato crisps, low-fat	59	37
16	Spaghetti, white, boiled	65	0
17	Sponge cake, jam-filled	33	53
18	White bread, French stick	54	30

Fig. 3 Mapping of selected cereals, potatoes and derived products and table of nutritional assets and weaknesses



Code	Product	Assets (/100)	Weaknesses (/100)
1	Apples, eating, average, raw, peeled	56	37
2	Avocado, average	62	24
3	Baked beans, canned in tomato sauce, re-heated	69	37
4	Broccoli, green, boiled in unsalted water	74	24
5	Celery, boiled in salted water	64	52
6	Fruit pie, one crust	46	48
7	Grapes, average	47	37
8	Green beans/French beans, frozen, boiled in unsalted water	81	22
9	Jam, fruit with edible seeds	22	64
10	Kiwi fruit	72	37
11	Onions, fried in corn oil	64	46
12	Orange juice, unsweetened	56	64
13	Oranges	72	37
14	Peaches, raw	64	37
15	Pears, canned in syrup	44	37
16	Sorbet, fruit	27	64
17	Tomato ketchup	14	79
18	Tomatoes, raw	73	37
19	Vegetable soup, canned	59	41

Fig. 4 Mapping of selected fruits, vegetables and derived products and table of nutritional assets and weaknesses

more balanced than a unique foodstuff, which should have resulted in a grouping of the various breakfasts in the central region of the map. Indeed, when examining the composition of these breakfasts, it can be seen that combining cereal-based, dairy-based and fruit-based products is not in itself sufficient to ensure the adequate balance of the resulting meal: the nutritional characteristics of each of the individual products remain key factors.

Comparison with other nutrient profiling systems

The comparison has been made for 98 foods, but Table 4 shows data for 40 food items only, belonging to three different categories, according to Nutrimap®, the FSA and Dutch tripartite systems. Although a straightforward comparison remains hazardous, it shows that it is possible with Nutrimap® to define thresholds of benefits and weaknesses which classify foods as more or less healthy. The resulting classification is highly consistent with the one provided by the FSA system, except for the fat group and composite food groups (not shown). Indeed, only 10 foods out of 81 (12%) are classified differently by the two systems when not considering fats and composite foods. This proportion reaches 21% of discrepancies for all the food products assayed. The discrepancies observed for fats can be explained by the lipid quantity criteria which cannot be adapted in the FSA scheme. Comparison with the Dutch tripartite system cannot be made on the same basis, since there is more possibility of discrepancies with

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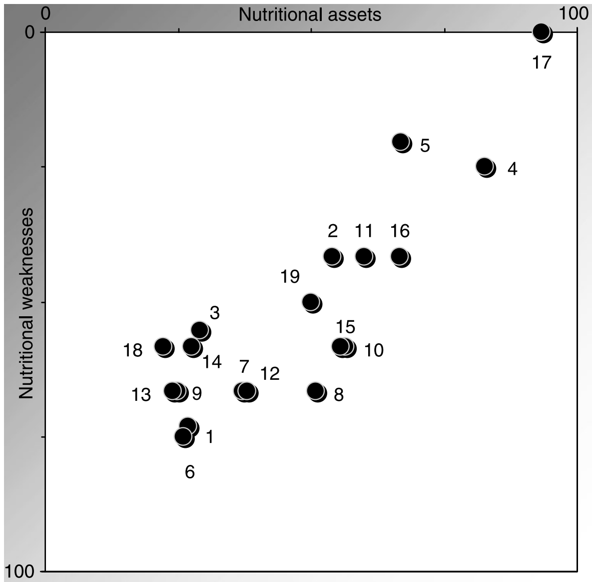


Code	Product	Assets (/100)	Weaknesses (/100)
1	Chocolate chip cookies	27	73
2	Coco Pops	54	42
3	Croissants	29	55
4	Muesli, Swiss style	83	25
5	White bread, sliced	67	20
6	Cheddar cheese	26	75
7	Semi-skimmed milk, UHT	37	67
8	Yoghurt, low-fat, plain	51	67
9	Bacon rashers, fried	25	67
10	Eggs, chicken, fried	57	58
11	Ham	60	42
12	Pork sausages, fried	38	67
13	Butter	24	67
14	Jam, fruit edible seeds	27	58
15	Orange juice	56	58
16	Oranges	67	42
17	Oatmeal, quick cook, raw	93	0
18	Sugar, white	22	58
19	Flavoured milk, chocolate	50	50

Fig. 5 Mapping of selected products consumed at breakfast and table of nutritional assets and weaknesses

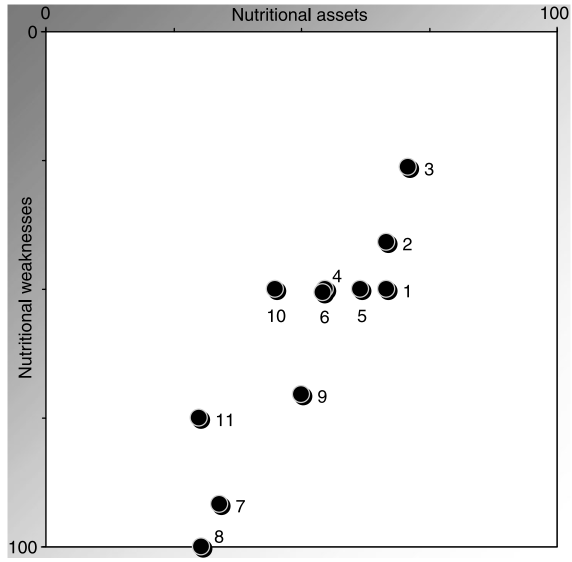
three categories than two. However, if we focus only on food products which are 'strongly misclassified' ('healthy' instead of 'less healthy' and 'less healthy' instead of 'healthy'), there are only eight misclassifications for 98 food products (8%). Although these comparisons are indicative only, they confirm that Nutrimap® has a comparable level of performance to tools promoted by official agencies. A case-by-case examination of discrepancies would provide additional insights.

Discussion

Nutrimap® is technically a very simple system. It comes as an Excel-type spreadsheet and can be used without any specific technical skill, except knowledge and expertise in nutrition and dietetics. It is a powerful and innovative tool which efficiently describes the nutritional quality of foods or meals by focusing on the concept of rebalancing non-optimal diets. For this purpose, it integrates dietary consumption data – which are not usually taken into account in such systems – and develops an original method for measuring the balancing potential of a food in relation to both nutritional recommendations and the reality of nutrient supplies. Nutrimap® considers both the benefits and weaknesses of each food, and keeps this duality until the final step; this positions foods clearly while avoiding a compensation of nutritional weaknesses by benefits.

Nutrimap® is probably one of the most objective nutrient profiling systems available: significant efforts have been made to base calculations on data that come from analyses (food composition), surveys (food consumption data) or strong quantitative scientific consensus (nutritional recommendations). These factual data drove the choice of nutrients, the nutrient scoring method and the weighting of nutrients within a food category. However, we should recognise that some decisions are not fully justified from a scientific point of view, such as the weighting of nutrients when addressing specific meals, or score corrections, or even choices made following recommendations that are not always based on very reliable scientific evidence. Although some of these flaws can be sorted out methodologically, it is likely that a subjective dimension will remain present in these tools. The important point here is to remain aware of what comes from reliable data and what comes from human expertise.

Nutrimap® is also extremely flexible: via simple and rapid changes to the scoring scale, and provided that the required data exist, it can adapt to various population groups (recommended intake levels), different geographic conditions (intake levels and nutrient weighting) or changing official dietary advice. One of the strongest advantages of Nutrimap® lies in this flexibility, which allows it to meet several goals while keeping a strong overall consistency because the principles and the methods remain unchanged. It can thus be used in a wide variety of contexts and for different purposes, bearing in mind that such a tool is intended only to help with decisions. Nutrimap® provides a positioning of foods (or meals) and decision-makers still have to set the limits for categorisation according to their own objectives. We have seen above that Nutrimap® can be of assistance for meal designers: by comparing the nutritional quality of various proposals, they can decide if the requested change in their habits and suppliers is worthwhile or not. Another potential use of Nutrimap® can be to assist in the development or revival of industrial food products. In most food companies, the nutritional consequences of changes in recipe are very seldom considered; a system such as Nutrimap® could be a very rapid and convenient way to simulate or



Code	Composition of Breakfast	Quantity (g)	kcal/100 g	Assets (/100)	Weaknesses (/100)
1	Coco Pops	50	93	67	50
	Semi-skimmed milk, UHT	125			
	Orange juice, unsweetened	150			
2	Coco pops	50	94	67	41
	Semi-skimmed milk, UHT	125			
	Oranges	150			
3	Muesli, Swiss style	50	90	71	26
	Semi-skimmed milk, UHT	125			
	Orange juice, unsweetened	150			
4	Coco pops	50	142	55	50
	Semi-skimmed milk, UHT	125			
5	White bread, sliced	40	117	62	50
	Butter	6			
	Jam, fruit with edible seeds	20			
	Orange juice, unsweetened	150			
	Sugar, white	5			
6	Eggs, chicken, fried in vegetable oil	100	98	54	51
	Bacon rashers, streaky, fried	0			
	White bread, sliced	40			
	Orange juice, unsweetened	150			
	Yoghurt, low-fat, plain	125			
	Sugar, white	5			
7	Pork sausages, chilled, fried	120	146	34	92
	Oatmeal, quick cook, raw	30			
	Semi-skimmed milk, UHT	125			
	Orange juice, unsweetened	150			
	Sugar, white	10			
8	White bread, sliced	40	134	30	100
	Cheddar cheese	40			
	Orange juice, unsweetened	150			
9	White bread, sliced	40	87	50	70
	Butter	6			
	Ham	120			
	Yoghurt, low-fat, plain	125			
	Orange juice, unsweetened	150			
10	Flavoured milk, pasteurised, chocolate	200	105	45	50
	White bread, sliced	40			
	Butter	6			
11	Flavoured milk, pasteurised, chocolate	200	135	30	75
	Croissants	60			

Fig. 6 Mapping of composite breakfasts and table of nutritional assets and weaknesses

monitor the effect on nutritional characteristics of the product of any change in the ingredient list, enabling nutrition to be integrated as a quantitative, and therefore easily measurable, item in industrial decisions.

Nutrimap® can also help public health authorities to take up consistent positions concerning legal limitations for some products, such as those appearing in television advertisements targeting children, or being available in

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Table 4 Comparison of the categorisation of 40 individual foods belonging to three different food groups by Nutrimap®, the UK Food Standards Agency (FSA) system and the Dutch tripartite system

	FSA		Nutrimap®				Dutch tripartite system		Discrepancies	
Food product	FSA score	FSA classification	Nutrimap assets	Nutrimap weaknesses	Nutrimap category – thresholds	Nutrimap classification	Dutch tripartite classification ranking	Dutch tripartite food category	Nutrimap vs. FSA	Nutrimap vs. tripartite
Skimmed milk, UHT	−2		50.0	59.2	MILK and DAIRY PRODUCTS – **less healthy**,	H	H			
Semi-skimmed milk, UHT	0		49.1	63.3	defaults >80 THEN qualities <25 – **healthy**,	I	LH			
Whole milk, UHT	2	LH	41.8	82.7	defaults <60 AND qualities >50 –	LH	LH	Milk and milk products		
Cottage cheese, plain	1		35.8	81.6	**intermediate**, others	LH	LH		X	
Fromage frais, plain	3		35.3	69.6		I	LH			
Fromage frais, fat-free	−4		59.2	41.8		H	H			
Whole-milk yoghurt, fruit	5	LH	45.6	63.3		I	LH		X	
Yoghurt, low-fat, plain	0		59.9	63.3		I	LH			
Yoghurt, fat-free, plain	−2		50.0	50.1		H	I			
Ice cream, dairy, vanilla	12	LH	33.4	82.7		LH	LH			
Drinking yoghurt	1		59.2	41.8		H	I			
Whole-milk yoghurt, plain	0		59.2	63.3		I	LH			
Camembert	19	LH	33.2	81.6		LH	I	Cheese		
Cheddar cheese	23	LH	26.9	81.6		LH	LH			
Spreadable cheese, full-fat	16	LH	24.2	64.3		LH	LH			
Spreadable cheese, low-fat	5	LH	33.5	81.6		LH	H			
Eggs, chicken, fried	1		67.5	43.5		I	H			
Eggs, chicken, boiled	0		68.7	43.5	MEAT, EGG, FISH – **less healthy**,	I	H			
Beef, rump steak, barbecued	−1		65.0	26.6	defaults <50 THEN qualities <45 – **healthy**,	H	H	Meat, chicken, eggs		
Pork, loin chops, grilled	3		34.5	43.5	defaults <40 AND qualities >50 –	I	LH			
Chicken, breast, casseroled	−3		53.1	17.4	**intermediate**, others	H	H			
Chicken, dark meat, roasted	0		39.2	43.5		I	H			
Chicken, light meat, roasted	−4		64.4	17.4		H	H			
Liver, ox, stewed	1		54.7	47.2		I	H			
Lamb, loin chops grilled	13	LH	28.4	62.4		LH	LH			
Bacon rashers, streaky, fried	23	LH	18.6	66.1		LH	LH			
Salami	25	LH	6.6	67.3		LH	LH			
Chicken nuggets, takeaway	6	LH	27.3	66.1		LH	I			
Ham	12	LH	57.6	40.0		H	H			
Cod, baked	−1		57.4	40.0		H	H	Fish		
Prawns, boiled	6	LH	40.7	40.0		I	H		X	
Crème fraîche	14	LH	13.2	77.9	FAT and OILY SEEDS – **less healthy, defaults**	LH	LH	Spread and cooking fats		
Crème fraîche, half-fat	10	LH	20.1	77.9	>50 THEN qualities <40 – healthy, defaults	LH	H			X
Margarine, soft, no PUFA	27	LH	40.0	49.0	<50 AND qualities >40 – **intermediate**, others	I	LH		X	
Margarine, soft, PUFA	26	LH	46.6	49.0		H	I		X	
Fat spread (60% fat)	23	LH	25.9	52.7		LH	H			X
Olive oil	20	LH	32.8	49.0		I	H		X	
Rapeseed oil	16	LH	44.3	49.0		H	H		X	
Sunflower oil	20	LH	32.8	49.0		I	LH		X	
Butter	25	LH	16.1	77.9		LH	NE		X	

UHT – ultra heat-treated; PUFA – polyunsaturated fatty acids. H – healthy/preferable; I – intermediate/medium course; LH – less healthy/exceptional; NE – not eligible (no criteria proposed by the Dutch system for this category of food). Discrepancy is mentioned by an 'X' when a food classified as healthy by Nutrimap® is not classified as such by each one of the other systems and when a food classified as healthy by these vending machines, or bearing nutrition or health claims. The final decision about where the border lies would remain difficult yet would be founded on scientific and consistent bases. On Nutrimappings, it is possible to set limits for nutritional flaws (a horizontal line on the mapping) and qualities (vertical line) that can be more or less severe according to the final purpose.

Nutrimap® can of course be improved still further, for example by introducing n–3 fatty acids or by addressing more specifically the issue of drinks, which should probably not be considered as solid foods. Nutrimap® does not consider energy as a criterion; however, by introducing the quantities of lipids, sugars and carbohydrates, energy is duly taken into account. This is shown in Fig. 5, where the breakfasts are placed on the mapping diagonal from the least (upper right) to the most (lower left) energetic meals. Another limitation, which cannot be attributed to the system itself, is the existence and accuracy of nutritional composition data; this is the pragmatic reason for limiting the number of criteria to 15 nutrients in the usual version of Nutrimap®.

Although Nutrimap® will probably not end the controversy surrounding the intrinsic principles of nutrient profiling systems, the tool addresses some of the criticisms levelled at these methods. First, most of the decisions made when developing the model are justified, by referring to the soundest available data or consensus, thus making the system less dependent on subjective opinions. Second, it does not classify the food products strictly, which can rapidly lead to the concept of 'good foods and bad foods', but rather gives separate information on the nutritional benefits and weaknesses of the foods. Third, it can handle not only individual foods but also composite meals, and even whole diets, and so it can be a real help in improving dietary management, especially for people in charge of planning meals for canteens or restaurants.

Nutrimap® is a nutrient profiling system which considers each food in its own category and is consistent with food-based dietary guidelines that recommend consuming a given number of servings from each category each day. Nutrimap® is indeed the tool needed to complement these approaches, by giving information about the best choice that can be made within a food group; this seems to be a key issue in the worldwide challenge of fighting the dramatic increase in nutrition-linked pathologies.

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Authorship responsibilities: The Nutrimap® tool has been developed and improved by E.L.V.A.-B. worked on the practical examples for specific food categories and prepared the manuscript. C.G. carried out the analyses with the software and designed the tables and figures. L.M. collected the nutritional information on products and gave advice on the manuscript.

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