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FINUT SCIENTIFIC - TECHNICAL REPORT

01

Nutrient Profiling: Scientific aims *versus* actual impact on public health

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Nutrient Profiling: Scientific aims *versus* actual impact on public health

Edited by the Iberoamerican Nutrition Foundation

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Acronyms and symbols

AFSSA	French Agency for Food Safety (*Agence française de sécurité sanitaire des aliments*)
ANSES	French Agency for Food, Environmental and Occupational Health and Safety **(***Agence nationale de sécurité sanitaire de l'alimentation, de l'environnement et du travail*, France)
ANZFA	Australia and New Zealand Food Authority
CFN	Calorie for Nutrient
DeCS	Health Sciences Descriptors (*Descriptores en Ciencias de la Salud*)
DHA	Docosahexaenoic acid
EFSA	European Food Safety Authority
EFTA	European Free Trade Association
EPA	Eicosapentaenoic acid
FAO	Food and Agriculture Organization of the United Nations
FINUT	Iberoamerican Nutrition Foundation (*Fundación Iberoamericana de Nutrición)*
FOP	Front-of-package
FSA	Food Standards Agency
FSANZ	Food Standards Australia New Zealand
HDL	High density lipoproteins
IMAPP	WHO: Intake, monitoring, assessment and planning program
LDL	Low density lipoproteins
MeSH	Medical Subject Headings
MUFA	Monounsaturated fatty acids
NAOS	Strategy for Nutrition, Physical Activity and Obesity Prevention (*Estrategia para la Nutrición*, *Actividad Física y Prevención de la Obesidad*) Spain
NFI	Nutritious Food Index
NRFI	Nutrient Rich Food Index
PAOS	Spanish Self-Regulation Code for Food Advertising (*Código de Autorregulación de la Publicidad de Alimentos*)
PUFA	Polyunsaturated fatty acids

RDA	Recommended Dietary Allowance
RRR	Recommended Restricted Foods
SENC	Spanish Society of Community Nutrition (*Sociedad Española de Nutrición Comunitaria*)
SFA	Saturated fatty acids
trans-FA	*trans*-Fatty acids
UFA	Unsaturated fatty acids
WHO	World Health Organization

I. BACKGROUND

It is known worldwide that populations are constantly modifying their diet due to globalization, the access to food undergoing several technological processes, and the modification of our lifestyles to more sedentary conditions than our ancestors. In general, the recent changes in the population diets are referred as “nutrition transition” (Popkin, 2001). The increasing of overweight and the obesity epidemic, in addition to the increase of diet-related noncommunicable diseases, are among the main consequences of dietary changes, in conjunction with the physical inactivity of the populations.

The World Health Organization (WHO), in response to the global obesity epidemic, has produced several reports, strategies, and action plans published in multiple documents; for example:

- Diet, Nutrition and the Prevention of Chronic Diseases (WHO, 2003)
- Global Strategy for Infant and Young Child Feeding (WHO, 2003a).
- Global Strategy on Diet, Physical Activity and Health (WHO, 2004).
- 2008-2013 and 2013-2020 Action Plans for the Global Strategy for the Prevention and Control of Noncommunicable Diseases (WHO, 2008; WHO, 2013).
- The Second International Conference on Nutrition, 2014 (FAO & WHO, 2014).

These documents suggest several strategies that governments and entities should apply to stop the obesity epidemic. We could mention, for example, the “Global Strategy on Diet, Physical Activity and Health” (WHO, 2004) which describes the following objectives and actions: to reduce the risk of noncommunicable chronic diseases by means of essential public health action and health-promoting measures; to increase the overall awareness and understanding of the influences of diet on health; to encourage the development, strengthening and implementation of policies and action plans to improve diets and increase physical activity; to monitor scientific data and their main effects on diet and physical activity, all this engaging different sectors of the society.

Among the objectives and strategies specifically concerning the diet, the inclusion of the following recommendations addressing populations and individuals are suggested: “achieve energy balance and a healthy weight; limit energy intake from total fats and shift fat consumption away from saturated fats to unsaturated fats and towards the elimination of *trans*-fatty acids (*trans*-FA); increase consumption of fruits and vegetables, legumes, whole grains and nuts; limit the intake of free sugars; limit salt (sodium) consumption from all sources and ensure that salt is iodized”. Moreover, the action of generating comprehensible, suitable, accurate and standardized information on the content of food products is promoted in order to allow the consumer to make healthier choices (WHO, 2004).

Governments have implemented several actions to conduct the strategies suggested by the WHO with regard to the improvement of diet quality, taking steps concerning the labeling of food products through the use of the *Codex Alimentarius* (WHO & FAO, 2007), creating regulations for the front of the package labeling, commonly known as *Front-of-Package* (Hawley *et al.*, 2012; Volkova *et al.*, 2014), regulating food advertising in the media (Mejía-Díaz *et al.*, 2014; *Secretaría de Salud de los Estados Unidos Mexicanos*, 2013; *Secretaría de Salud de los Estados Unidos Mexicanos*, 2014; *Secretaría de Salud de los Estados Unidos Mexicanos*, 2014a), in addition to the creation of **nutrient profiling models** that enables the populations to select healthy food, in particular regarding processed foodstuffs (WHO, 2015; PAHO, 2016).

Currently, the countries and agencies are developing recommendations more focused on eating patterns and healthy lifestyles than on specific food items. For example, the new Dietary Guidelines for Americans 2015-2020 promote the improvement of eating patterns, referring to them as the complete combination of foods and beverages consumed by the population (U.S. Department of Health & USDA 2015). Furthermore, the new recommendations of the food pyramid of the Spanish Society of Community Nutrition (*Sociedad Española de Nutrición Comunitaria*, SENC) include, in addition to the diet suggestions, recommendations on physical activity, energy balance, emotional balance and healthy cooking techniques (*Sociedad Española de Nutrición Comunitaria*, 2015). Whereas, in 2014 the Iberoamerican Nutrition Foundation (*Fundación Iberoamericana de Nutrición*, FINUT) published a three-dimensional pyramid that combines eating patterns with healthy lifestyles within a sustainable environment, suitable for different social and cultural settings (Gil *et al.*, 2014).

Nutrient profiling have been described as a scientific method to classify foods and drinks based on their nutritional quality by national authorities of different countries to promote public health and to achieve the nutritional goals proposed for the population. Nutrient profiling constitutes a relatively new concept; in this context, some aspects related to nutrient profiling have been included in voluntary labeling of food for only 20 years now.

The first nutrient profiling model was implemented by the Coronary Prevention Group of United Kingdom in 1986 (WHO, 2010; McColl & Lobstein, 2015); then the "*Swedish Green Keyhole*" strategy took place en 1989 (Larsson *et al.*, 1999).

The European Food Safety Authority (EFSA) initiated a work to develop nutrient profiling; and by 2006 the EFSA proposed the Regulation (EC) No 1924/2006 on nutrition and health claims made on food, which came into force on January 19, 2007 (of the European Parliament and of the Council, 2007). The article 4 of this regulation enforces that the European Commission establishes specific nutrient profiling, including exemptions, of those foods or categories of foods that require nutrition or health claims (EFSA, 2008). In 2009, an additional document on the setting of nutrient profiling was presented by the European Commission (European Commission, 2009) and in 2012 the Regulation (EU) No 1047/2012, which updates the nutrition and health claims, was approved (European Commission, 2012).

In 2009, the WHO undertook the draw up of a report to provide a guideline to the Member States in order to perform an adaptation and to implement and develop nutrient profiling models and their different uses, this report was published in 2010 (WHO, 2010).

In 2013, the Ministers of Health and representatives of the Member States of the WHO Regional Office for Europe, together with the WHO Regional Director for Europe, health experts, representatives of civil society, and intergovernmental organizations adopted the Vienna Declaration on "Nutrition and Noncommunicable Diseases in the Context of Health 2020" (WHO, 2013a). This declaration highlights the high rate of diseases caused by unhealthy diets in countries of the region and emphasizes the concern about childhood overweight and obesity. This declaration includes the specific commitment to "take decisive action to reduce food marketing pressure to children with regard to foods high in energy, saturated fats, *trans*-FA, free sugars or salt"; in addition to the development and implementation of policies to promote, among other things, the use of tools such as nutrient profiling (WHO, 2013a). The development of a nutrient profiling model as a common tool for the use or adaptation to the Member States in Europe (on a voluntary basis and taking into account the individual national circumstances) has been identified as a key activity in the 2015-2020 Action Plan (WHO, 2014).

The model developed by the WHO Regional Office for Europe, in response to this plan, has been focused specifically on restricting the advertising directed at children. The 2013 report pointed out that some countries had completely implemented this restriction. Moreover, the optimal progress of the policies has been hampered by the lack of suitable nutrient profiling models or other ways of food classification (WHO, 2015).

According to the WHO, a validation and comparison of different approaches available to date, the establishment of a primary guideline to promote the use of the models by the authorities, and that these models would be effective and suitable are necessary actions (WHO, 2010).

In December 2013, a meeting of experts was held to determine the principles and required steps to develop a common nutrient profiling model. After this meeting, the WHO regional office for Europe developed a proposal of a model and conducted a series of consultations on the draft with Member States, including a pilot study presented at the "European Network on Reducing Marketing Pressure on Children", in March, 2014. The following countries have actively participated in the consultation process: Albania, Austria, Bulgaria, Czech Republic, Denmark, Estonia, Finland, Hungary, Israel, Norway, Poland, Portugal, Serbia, Slovenia, Switzerland and the former Yugoslav Republic of Macedonia, in addition to other countries that have shown interest too (WHO, *in press*).

The pilot model created in some countries at a national level has generated a list of between 100 and 200 foods that: 1) were frequently marketed to children and/or 2) were commonly consumed. Participant countries were consulted about the food categories, the nutrient thresholds, and the proposed exclusions and prohibitions. The countries were also asked to state if the model was able to classify foods in conformity with national food-based dietary guidelines. Moreover, countries were asked whether they agreed with the classification of food and the nutrient threshold, and only minor modifications were proposed. Some significant differences in the nutritional quality of commonly consumed and frequently advertised foods in participant countries were found, indicating that the advertisement and marketing varies depending on the country. However, all countries perceived that the model is highly suitable for the national context (WHO, 2015).

In Latin America, countries such as Mexico (*Secretaría de Salud de los Estados Unidos Mexicanos*, 2014), the Caribbean (PAHO, 2016), Peru (*Congreso de la República del Perú*, 2013; *Presidencia de la República del Perú*, 2015), Bolivia (*Asamblea Legislativa Plurinacional de Bolivia*, 2015), Brazil (*Agencia Nacional de Vigilancia Sanitaria de Brasil*, 2010; *Ministerio de Salud de Brasil*, 2015), Argentina (Bonfanti, 2008; *Senado y Cámara de Diputados de la Nación Argentina*, 2013) and Chile (*Ministerio de Salud de Chile*, 2012) have been working for several years on the regulation of unhealthy food by the restriction of advertisement targeting children, implementing different food labeling systems, and including the taxation of food products with high energy density, such as the case of Mexico (*Secretaría de Hacienda y Crédito Público* & *SAT*, 2013); many of these countries have already started the processes of implementation of nutrient profiling models.

In the current year 2016, the “Nutrient Profile Model” of the Pan American Health Organization (PAHO) has been presented. The objective of this report is to become a strategy to fight against the alarming increase in overweight, obesity and noncommunicable diseases, that at the same time coexists with several nutritional deficits in some regions of Latin America (such as nutrient deficiencies of iron, folate, vitamin A and other micronutrients). The main strategy of the PAHO nutrient profiling model consists in declaring critical nutrients focusing in ultra-processed foods and reverting back the consumption trends towards more traditional diets based on fresh foods (PAHO, 2016).

Within the context of interest of the Iberoamerican countries, already affected by obesity and noncommunicable chronic diseases, FINUT integrates in the present scientific-technical report, the full information concerning objectives, different applications, scientific evidence, validation, as well as advantages, disadvantages and limiting aspects of the nutrient profiling systems that have already been implemented or that are within an implementation process at international level. The intention is to provide the readership with a document that comprises the scientific intentionality during the creation of these nutrient profiling models, their applications, and the actual impact on public health that has been evaluated to date.

II. OBJECTIVES

Overall objective

To create a report based on scientific evidence about nutrient profiling at the international level.

Specific objectives

- To describe concepts, applications and justification suggested internationally for nutrient profiling by different organizations.

- To describe the diverse nutrient profiling systems implemented in different countries around the globe and their applications determined through scientific research.

- To analyze the advantages, disadvantages and limitations of the different nutrient profiling systems in the context of the public health interests.

- To present the conclusions of FINUT on nutrient profiling, its application and prospective adherence in Iberoamerican countries.

III. METHODOLOGY

This review has been developed aiming to describe the meaning of nutrient profiling and the types of nutrient profiling, their applications, advantages, disadvantages and limitations. The review questions were: What is the state of the nutrient profiling in the context of the creative scientific process? And what is the impact of nutrient profiling on public health?

All kinds of documents (original articles, regulations, reports, congress proceedings, etc.) subjected to analysis according to the proposed search equations mentioned below have been included in the study.

In order to determine the keywords for the search, the terms of the Medical Subject Headings (MeSH) (http://www.ncbi.nlm.nih.gov/mesh) developed by the U.S. National Library of Medicine, and the Health Sciences Descriptors (DeCS), (http://decs.bvs.br/E/homepagee.htm) created by BIREME (a specialized center of the PAHO) were used.

The terms “Nutrient/Nutritional Profile/Profiling” are not indexed as MeSH terms. Therefore, direct searches as “Nutrient Profiling” on the MEDLINE and SCOPUS databases were conducted. Then, keywords included in articles were identified. Finally, the following MeSH terms were applied: “Food Labeling” and “Food Packaging” in order to conduct a new search in MEDLINE and SCOPUS using the equations: [“*Nutrient Profiling*” AND “*Food labelling*”] and [“*Nutrient Profiling*” AND “*Food Packaging*”]. The grey literature, consisting of articles with diverse origins, such as: articles found in Google Scholar, articles sought directly because they were referred in the literature, articles found using as keywords those terms of nutrient profiling that appeared repeatedly in the references (for example: “nutrient rich foods”, “international choices program", etc.); in conjunction with regulations about nutrient profiling in several countries that were suggested by experts in this field, were grouped as miscellaneous literature for further use.

The search of original articles published during the last five years, was performed. However, the rest of documents, including those reports from governmental agencies, considered as "relevant documents" by the authors, were not subjected to any publication date restriction.

In order to be included in the review, the chosen documents should meet at least one of the following criteria regarding the general topic "nutrient profiling" 1) to include the explicit use of nutrient profiling; 2) to describe the types of nutrient profiling; 3) to clarify the tools used during the development of nutrient profiling; 4) to evaluate nutrient profiling systems and/or models; 5) to validate or corroborate adherence to an already developed nutrient profiling.

The reasons to exclude documents were the use of the term "nutrient profiling/profile" to refer to the following: 1) diets of individuals or of population groups; 2) health and nutrition status of populations (reports of countries); or 3) the nutrient content of a specific food or a descriptive labeling of a product.

A total of 317 documents were identified: 109 from MEDLINE, 180 from SCOPUS, 28 from LILACS and 115 articles and miscellaneous documents that address the topic of interest of the present report referred by experts in the field or referred to in other articles.

Titles, abstracts and keywords of all documents retrieved from databases and other sources were analyzed independently by two reviewers (CGA and MJS) in order to identify the studies meeting the inclusion criteria. The documents found repeatedly through different systems and search equations were discarded (n=41).

After a thorough review of the documents, a total of 159 articles or reviews were excluded, and the remaining (n=117) were evaluated. In cases of disagreement, a third reviewer (AG) was consulted to decide about the final exclusion. A total of 59 documents were excluded during this process, and 58 documents remained. The reviewers (AG and EMdV) proposed additional documents based on their expertise in this field and after consultation with other referees (n=115). Finally, a total of 173 documents were selected, composing the references of the present report (**Figure**).

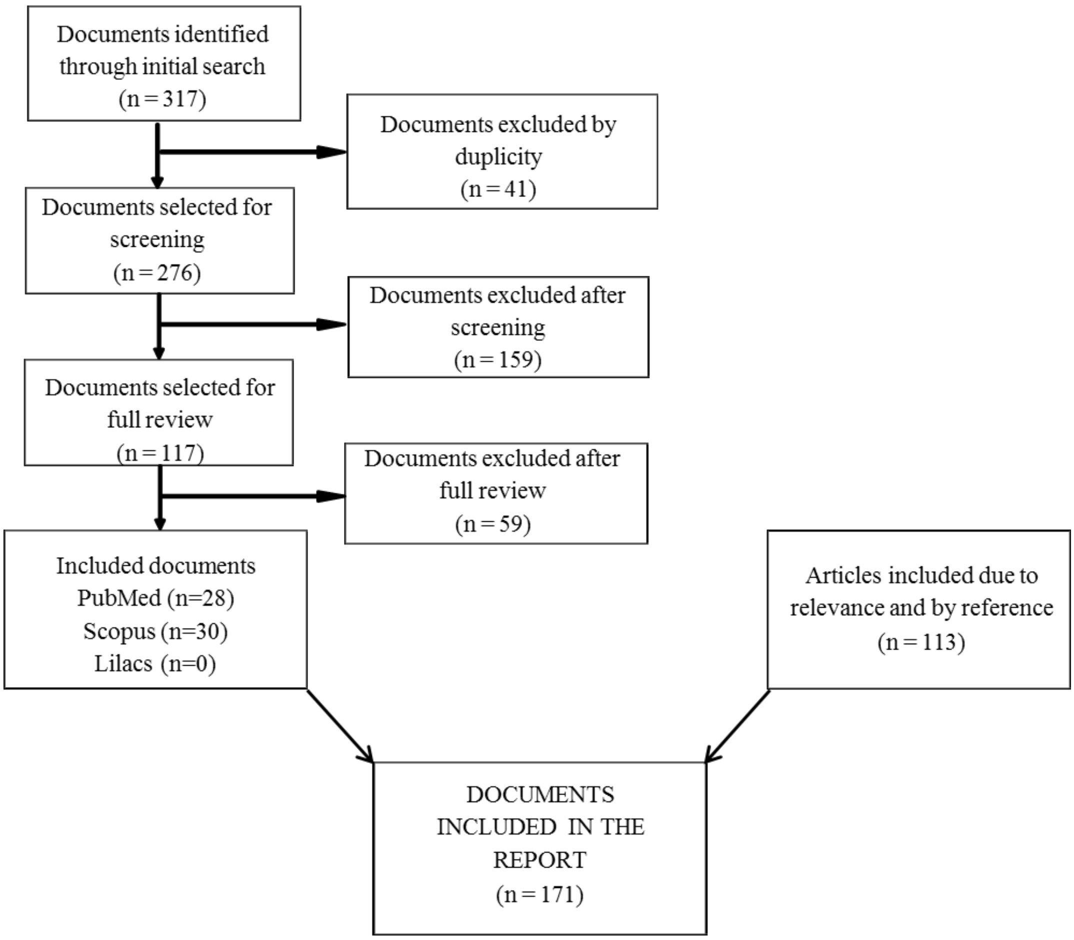

Figure: Flow chart of the selection process for the documents included in the report.

IV. CONCEPTS, TERMS AND TOOLS USED TO DEVELOP AND TO DESCRIBE NUTRIENT PROFILING

The need for regulations that allow consumers to have the option and easiness to choose healthier foods for consumption, has led to several actions and concepts for the term "nutrient profiling". According to EFSA (2008), the term "nutrient profile" refers to the nutrient composition of a food or diet. In contrast, in the context of the Regulation No 1924/2006, the term "nutrient profiling" refers to the categorization of foods for specific objectives, based on their nutrient composition. In this regard, the only purpose is the regulation of nutrition and health claims made on foods.

According to Rayner *et al.* (2004), the term "nutrient profiling" is defined as the "science of categorizing foods based on their nutritional composition". According to Tetens *et al.* (2007), "nutrient profiling" is defined as "the categorization of foods for specific objectives on the basis of their nutrient composition according to scientific principles".

The WHO report (WHO, 2010) proposes the same definition for "nutrient profiling" than the proposed by Rayner *et al.* (2004). This definition is subjected to discussion since it has been described as too simple and it needs to be adapted to meet its objective to categorize foods based on whether they are healthy or not. This suggests that "classifying" could be better than "categorizing", since the nutrient profile model based on "food groups" already includes categories of foods. For this purpose, differentiating between the model and its application is important. The term "model" is used for the general expression of a system that includes the nutritional criterion that supports an application (for example, a specific type of nutrition labeling).

The last definition for "nutrient profiling" has been proposed by the WHO in 2015: "the science of classifying or ranking foods according to their nutritional composition for reasons related to preventing disease and promoting health" (WHO, *in press1*). The action of classifying foods through nutrient profiling has been recognized by the WHO as a useful tool for a variety of applications and it is considered critical for implementation and restriction of marketing of foods to children (WHO, 2010a). In addition, nutrient profiling provides a means to differentiate between foods and non-alcoholic beverages that are more likely to be part of a healthy diet from those that are less likely (notably, those foods that may contribute to excess consumption of energy, saturated fats, *trans*-FA, sugar and salt). Nutrient profiling is a tool to categorize foods, not diets, but can be used through policies to improve the overall nutritional quality of diets (WHO, 2015). Of course, these concepts and definitions have been used and described in the last "PAHO Nutrient Profile Model", recently published and launched in the whole region (PAHO, 2016).

The nutrient profile of the habitual diet is a key determinant of health; and the profile of a balanced diet is defined by dietary recommendations of energy and nutrients based on scientific evidence. However, single foods could influence on the overall diet, depending on the nutrient profile of each food in particular and its intake frequency. Therefore, when foods are classified as "potential" to make nutrition or health claims, in addition to the positive aspects and the supply of relevant nutrients such as fiber, iron, etc., the possible side effects on the overall diet, and therefore on health, should be considered from the scientific point of view (European Commission, 2001; EFSA, 2008). This consideration in particular, refers to those nutrients for which there is available evidence of contributing to dietary imbalance of the population and that might lead to overweight and obesity, or other diet-related diseases such as cardiovascular diseases, diabetes and other disorders (EFSA, 2008).

When developing a nutrient profiling scheme, the relevance of the food groups and the contribution of their nutrients to the overall diet of the population (or specific population groups) should be considered in order to guarantee that specific food items, from food groups that are relevant to the overall diet, become eligible for bearing nutrition or health claims. The role of each food group is related to the differences in the nutrient composition, as well as in the habitual intake of foods belonging to each group, which is commonly detailed in the dietary guidelines of each country. These guidelines also draw distinctions between food items from these groups based on their potential to influence, in a beneficial or harmful manner, on the overall diet due to their specific nutrient content.

The dietary role of nutrients and foods that can be included in a nutrient profiling model can differ between countries, considering the variability of dietary habits and traditions of each country. The experience with the implementation of nutrient profiling models has demonstrated the need to adapt their implementation according to the particular addressed population, making them compatible with the different dietary patterns of the citizens of a particular country. These population features supply the information about which are the foods susceptible to be included within those regulated by nutrient profiling. The European Regulation requires that this diversity is taken into account when developing and implementing nutrient profiling models (EFSA, 2008).

Nutrients of public health relevance

Available evidence shows that, for a certain number of nutrients and food groups, an unbalanced diet may increase the risk of obesity and other diet-related diseases (for example, cardiovascular disease, cancer, diabetes *mellitus*, osteoporosis or dental diseases) which are significant for global public health.

In the report "Diet, Nutrition and the Prevention of Chronic Diseases", the WHO highlighted the relationship between diet and chronic diseases based on scientific evidence (WHO, 2003). This evidence had been exposed previously (WHO, 2000). The report shows a convincing causal relationship between the intake of energy-dense foods (positive), dietary fiber, fruits, and vegetables (negative) and obesity; also between the intake of saturated fatty acids (SFA), *trans*-FA (EFSA, 2010; FAO & FINUT, 2012; Ros *et al.*, 2015), and sodium (positive) and the intake of omega-3 polyunsaturated fatty acids (PUFA), potassium, fruits, and vegetables (negative) and cardiovascular diseases; as well as the intake of vitamin D, and calcium (negative) and osteoporosis. In addition, the relationship between the intake of added sugars and dental diseases has been identified (WHO, 2015a; Moynihan & Petersen, 2004; Institute of Medicine, 2005); although, caries is much more associated with oral hygiene practices rather than with sugar consumption (Hurlbutt *et al.*, 2014; Miller *et al.*, 2012; Barnes *et al.*, 2005).

The relevance of certain nutrients and foods in public health has been identified through the nutrient recommendations, and the national and international dietary guidelines. Limits have been established for the intake of the following nutrients: total fat, SFA, *trans*-FA, proteins, carbohydrates, sugars, dietary fiber and salt. Among food groups, an increased intake of fruits and vegetables has been recommended (EU Pledge, 2015). The dietary goals have been established in certain number of countries. In general, these dietary goals, which are the main objective of the prevention of public health problems derived from a poor nutrition and sedentary lifestyles, are consistent but without a unified criterion for all the countries.

Frequently, the habitual dietary intakes exceed the recommended values and should be reduced for some of these nutrients (for example, SFA and sodium), whereas for others, such as dietary fiber, the intakes are commonly below the recommended levels and their consumption should be increased to improve the health of the population.

Nutrients whose intakes may exceed the recommendations

Energy: diets with high energy-density (content of energy per unit of weight), tend to be high in fats, high in added sugar and low in water content (WHO, 2003; Institute of Medicine, 2005; EFSA, 2013)

Total fat: in general, high-fat diets have a high energy-density and can contribute to an excessive energy intake that promotes weight gain. However, it is important to pay attention to the dietary fat quality (EFSA, 2008; FAO & FINUT, 2012; Ros *et al.*, 2015).

Saturated fatty acids: high-SFA diets increase low density lipoproteins (LDL cholesterol) in plasma and have been associated with higher risk of cardiovascular disease (EFSA, 2010; FAO & FINUT, 2012; Ros *et al.*, 2015; *Federación Española de Sociedades de Nutrición, Alimentación y Dietética*, FESNAD, 2015).

***Trans*-fatty acids:** Diets high in *trans*-FA increase LDL cholesterol and reduce high density lipoproteins (HDL cholesterol) in plasma; this condition is associated with the increased risk of cardiovascular disease (EFSA, 2010; FAO & FINUT, 2012; Ros *et al.*, 2015; FESNAD, 2015).

Sugars: the increase in risk of dental caries in children is associated with a high frequency (more than 4 times per day) of cariogenic sugars intake (sucrose, glucose and fructose) compared with total sugars intake. Since added sugars are mainly found in high energy rich foods, sugar consumption is also associated with higher risk of overweight and obesity (WHO, 2015a).

The recently published PAHO Nutrient Profile Model includes either artificial or natural non-caloric sweeteners or caloric sweeteners in the group “nutrients” of public health relevance (PAHO, 2016). Sweeteners are food additives other than monosaccharides or disaccharides which contribute to the sweet taste of food and that commonly have no energy content. This highlights that some products such as honey or other ingredients can be used to sweeten, although they are not associated to the term “sweetener”.

Sodium: the most known adverse effect of a high intake of sodium is a high blood pressure. The main source of dietary sodium are processed foods, that provide about 70-75% total of dietary intake; a 10-15% coming from foods in their natural state and approximately 10-15% is added at cooking or in the table (EFSA, 2005).

Nutrients whose intakes may be inadequate in relation to recommendations

Dietary fiber: The adequate consumption of fiber is related with a better bowel function and a risk reduction of cardiovascular disease and other chronic diseases. However, the dietary intake of fiber is usually low in several populations; for example, in Europe it varies between 16-26 g per day in adults and generally it is below the recommended intake of 25 g/day (Elmadfa & Weichselbaum, 2005).

Unsaturated fatty acids (UFA): in contrast with SFA and *trans*-FA, the monounsaturated fatty acids (MUFA) and PUFA have beneficial effects on plasma lipid profile. Evidence shows that an adequate intake of both omega-6 PUFA, usually from vegetable oils, and omega-3 PUFA, from fish and fish oil, can help reducing the risk of cardiovascular disease (EFSA, 2010; Ros *et al.*, 2015). The UFA mean intake in Europe is below the recommended amount. The consumption of this kind of fats, especially omega-3 PUFA is almost absent in many Latin American countries (FAO & FINUT, 2012; FESNAD, 2015).

Vitamins/minerals: Evidence shows that certain deficiencies of some vitamins and minerals can be found in specific population groups, influencing negatively on their health. The role of calcium and vitamin D in osteoporosis is noteworthy, as well as potassium intake and its relation with lower blood pressure and its intake through fruits and vegetables. Furthermore, anemias caused by iron deficiency or low intake of folic acid, and iodine deficiency have been the subject of the main health objectives in public health in many countries for the last decades (WHO, 2003).

Relevant food groups in the diet of the population

The relevance of the chosen food groups is based on their presence in dietary guidelines of different countries that, in general, promote their regular consumption whereas the guidelines distinguish between different products included in these groups based on their potential ability to influence, in a beneficial or harmful manner, the overall balance of the diet and its consequences on public health.

Vegetable oils: contribute greatly to the intake of UFA, both MUFA and PUFA, as well as vitamin E intake. Some oils, such as palm or coconut oils, have a higher content of SFA. Whereas other oils, such as olive or sunflower oil, have very low content of SFA. With the exception of the oils that can be hydrogenated, oils in general do not contribute to *trans*-FA intake. The most consumed oils in Latin America are sunflower, corn and canola, and to a lower extent olive oil. Because of the high availability of coconut oil in the Caribbean and the coasts of the countries in the American continent, coconut oil is used for the preparation of foods (EFSA, 2010; FAO & FINUT, 2012, Ros *et al.*, 2015).

Vegetable shortening and classic margarines: Vegetable shortening and classic margarines obtained by hydrogenation of oils in the presence of metallic catalysts have a high content of SFA and *trans*-FA, so their use is discouraged.

Fat spreads: Among them, margarines obtained by transterification and butter spreads. Fat spreads contribute importantly to the intake of PUFA and fat-soluble vitamins (E, A and D) depending on the composition of the fats and oils source. Some products, such as those from animal fats possess a higher content of SFA. This group used to contribute to the content of *trans*-FA, but a reformulation and improvement of the technology for their production has allowed to decrease and even to remove *trans*-FA (EFSA, 2010).

Dairy products: Such as milk, yogurt and cheese, contribute to the intake of calcium and proteins, as well as to the intake of vitamins and trace elements. Some of these products contribute to the intake of SFA, sodium (added) and sugar (added). The content of SFA depends on the total fat content, and *trans*-FA are found naturally in dairy products, but in very low amounts.

Cereals and their derivatives: including bread, breakfast cereals, baked goods, rice, and pasta. They contribute to the intake of carbohydrates and dietary fiber, B group vitamins, vitamins, minerals and trace elements. Some of these products contribute to the intake of SFA, sodium (added) and sugar (added).

Pulses, fruits, vegetables and derivatives: Pulses constitute a good source of protein, mainly when they are accompanied by other foods (for example, cereals) that complement them providing the limiting amino acids. All these products provide fiber to the diet and they contain a great variety of phenolic compounds, specially a high proportion of condensed tannins that nowadays are considered bioactive compounds of the diet because of their antioxidant capacity (*Sociedad Española de Nutrición Comunitaria*, 2015; *Ministerio de Salud de Brasil*, 2015). Fresh fruits and vegetables, fruit juices, fruit salads and vegetable juices constitute a group that contains low energy-density foods and, at the same time, it contains a great amount of nutrients such as vitamin C, folic acid, minerals such as potassium and magnesium, and also dietary fiber (Ruiz-López *et al.*, 2010). There is scientific evidence demonstrating that the regular consumption of fruits and vegetables is associated with a lower risk of developing some chronic diseases (Chiuve *et al.*, 2011; Pem & Jeewon, 2015). However, the wide variety of products can contribute significantly to the overall dietary intake of sugar (added) or sodium (added).

Meat, meat products and eggs: such as fresh (red, white and offal) and processed meat (cured, sausages, etc.), contribute to the dietary intake of high quality proteins, iron, vitamins (A, B_{12}, folate and vitamin D) and UFA (EFSA, 2008). Some meat products, especially those derived from fatty meat, contribute to the intake of SFA and added salt, the latter in processed meats. Eggs are an important source of proteins and are used as ingredient in a wide variety of foods and desserts, although eggs can provide SFA and cholesterol to the diet (*Sociedad Española de Nutrición Comunitaria*, 2015).

Fish and fish products: Fresh fish, salted and smoked fish belong to this group. They are the main foods contributing to the intake of omega-3 PUFA (EPA/DHA). They also contribute to the intake of high quality proteins, vitamins (A and D), iodine and other micronutrients. Some fishes also contribute to the intake of SFA and added salt when consumed as processed products (EFSA, 2008).

Non-alcoholic beverages: including water, energy drinks and soft drinks. Their relevance is due to their role in the hydration status of individuals (Boza *et al.*, 2010). Some products, such as sugar-sweetened beverages, including juices, fruit nectars and soft and energy drinks, can contribute to the intake of added sugar to the diet.

The role and the contribution of each food group and each food belonging to a specific group between countries based on the dietary-cultural practices and on the products availability. For example, potatoes are an important source of carbohydrates available at the North of Europe and in the Latin American region. The main dietary source at the South of Europe is pasta or rice, whereas corn is the main source of carbohydrates in most Latin American countries. In addition, the amount and type of dairy products consumed as a source of calcium and proteins differ between countries. Moreover, the consumption of non-alcoholic beverages with or without added sugars varies a lot between countries. The specific regulation of each country requires taking into account all this variability in dietary habits before the development of specific nutrient profiling.

Tools for the development of nutrient profiling models

Software identifying a set of important points and including these points in "*ad hoc*" algorithms have been developed with the aim of facilitating the development of nutrient profiling models adapted to the needs of different countries. A brief summary of recommendations about useful tools for the development of nutrient profiling in different countries is presented below, including the use of the IMAPP software “WHO intake, monitoring, assessment and planning programme” (WHO, 2009).

1. Use of IMAPP to identify the following important points:
    - Prevalence of deficiencies (protein and other macronutrients).
    - Prevalence of intakes that could be excessive (macronutrients and micronutrients).
    - Impact of the aforementioned prevalences on projected changes in foods retrieved from simulations.
2. Food composition tables and databases.
3. Reference databases with serving sizes for each type of food.
4. Population-based dietary surveys to know the nutrients with the highest deficiency risk.
5. To use a simple software to suggest likely suitable models.
6. To perform training programs to be used in a practical way for the development of nutrient profiling.
7. Methods to categorize or to classify foods.
8. A list of approaches to nutrient profiling that could be implemented successfully.

The Nutrimap® software was proposed by Labouze *et al.* (2007) to assess the nutrient quality of single foods and resulted consistent with dietary recommendations and recommended serving sizes. Therefore, this software could contribute to the challenge of creating adequate nutrient profiling models and thus reaching the goal of reducing the incidence of diet-related diseases.

Visioli *et al.* (2007) presented a new method developed by Bio Intelligence Service to evaluate nutrient profiling based on that foods are not good or bad when counting energy, the profiling should be universally applicable, macronutrients and micronutrients should be taken into account, the products innovation should be allowed and the software systems should be easily accessible, with simple calculations and be updated frequently. This method is available in: www.thefoodprofiler.com.

The EFSA recommends, regarding the selection of nutrients to be included in nutrient profiling, to take into account whether these nutrients are critical for public health. In Europe, for example, these nutrients include SFA, UFA, sodium and dietary fiber, and those nutrients not meeting dietary recommendations in each country individually.

In case of stating the SFA content in a food product, then no statement of the UFA content is considered necessary. The *trans*-FA should be included but they have lost relevance for public health in many countries since their levels were reduced considerably in industry. The use of dietary fiber should be restricted to those food groups that are important sources of fiber, such as cereal products. Depending on the adopted approach based on the energy-density or total fat, as well as other nutrients, the total sugar content could be included in specific food groups; for example, soft drinks and pastry products. However, the total number of nutrients included should be limited to avoid an excessive complexity in nutrient profiling (EFSA, 2008).

Units used in nutrient profiling

There are three kinds of classifications useful to express nutrients content. These classifications could be considered separately:

- Serving size.

- Weight/volume, for example 100 g / 100 ml.
- Energy, for example amount per 100 kcal or for macronutrients, as percentage of energy content (E%).

Alternatively, a combination of the three approaches can be used to reduce the disadvantages of each one of them. Expressing the nutrient content by serving or portion is the only approach that is directly related to the amount of food consumed regularly, a determinant factor associated with adverse effects that a certain food might contribute to in the overall diet. This approach has been used in the United States for the regulation of nutrition claims and servings. Currently, food labeling allows showing the nutrient content per serving, in addition to per 100 g or 100 ml. Even though, this label is used in many products, serving sizes are not standardized for the different foods included in each group; such fact represents a disadvantage for this approach.

The use of weight or volume (for example per 100 g or 100 ml) should be consistent with existing legislation on food labeling in each country or region. Many labels state the food content of key nutrients per 100 g or 100 ml. However, the amount of consumed food differs significantly in many occasions from those 100 g or 100 ml. Some examples of servings below 100 g can be fat spreads, oils, cheese, breakfast cereals. Examples of servings above 100 ml could be the case of any kind of beverage. Moreover, differences in water content in foods could influence the amount of nutrients expressed as weight/volume and can be confused when comparing foods, such as the amount of fat in milk or cheese. This variable becomes an important disadvantage for the general profiling system compared with the system based on food groups; for example, when considering beverages separated from solid foods (Rayner *et al.*, 2005).

Expressing the nutrient content in relation to the energy could be performed if the amount is 100 kcal or, for macronutrients, as percentage of total energy (E%). These expressions facilitate the comparison between foods with different water content. The relationship of nutrient content according with energy also allows comparing nutrient content of a food with recommendations expressed per total energy of the diet, or with the reference values of labeling that come from these recommendations (EFSA 2008). However, the nutrient content in foods and beverages with low energy content can seem high when based on the energy of the product; whereas the nutrient content could seem low when it is expressed as the habitually consumed amount; for example, dietary fiber in fruits and vegetables, whose water content is high. To date, no standardization of the reference amount for nutrient profiling has been achieved (Drewnowski *et al.*, 2009).

The EFSA recommends basing the selection of the reference unit on pragmatic considerations related to the special need of a specific nutrient profiling model. Drewnowski *et al.* (2009) suggested that models based on serving sizes and on 100 kcal are preferred for scoring “positive” nutrients, and that models based on 100 g are desired for scoring “negative” nutrients.

Table 1 compares advantages and disadvantages of each reference unit used for nutrient profiling.

Table 1. Advantages and disadvantages of reference amounts for nutrient profiling

	Advantages	Disadvantages
100 g or 100 ml	• Consistent with food labeling • Easy to standardize • Consistent with current legislation • Easy to reinforce • 100 g is internationally accepted for claims by the *Codex Alimentarius* (WHO, 2007), but the reference value in the United States is per serving.	• Problems with small serving sizes (for example: 10 g butter) • Difficult to understand by consumers • Does not take into account the energy content • Does not take into account health recommendations
Serving	• Reflects the consumed amount • Easy to understand by consumers • Industry decides the size • Helps reformulation • Easy comparison between foods • Higher consistency between countries • Less chance to manipulation • Can be applied to unpackaged products	• Does not differ on serving sizes for different groups of population (children, adult and elder people) • May not reflect actual intake because it does not take into account the consumption frequency • There is no data in composition tables for all foods
100 kcal	• Helps meeting nutritional objectives (e.g. reducing saturated fat), and controlling obesity (total of consumed energy) • Can be regulated easily • Allows comparing foods by their energy-density • Reference energy intakes can be adapted per groups of age, sex, etc.	• Can be against products reformulation • Problems for foods that are very poor in energy • Difficult to understand by consumer and difficult to legislate

Adapted from EFSA, 2007; Tetens *et al.*, 2007.

Validation of nutrient profiling

Validation is defined as the capacity of a nutrient profiling to compile the dietary habits of a population and, through this information, to be able to recognize foods whose recommendations are easy to understand by consumers in order to choose and to put on their tables healthier (or less harmful) food products.

In 2006, four nutrient profiling models for food in general were analyzed and their principles were compared with their application. The assessment was performed through the classification of a series of 125 foods based on their nutrient composition. Classifications were compared among them by a group of experts in nutrition (Azaïs-Braesco *et al.*, 2006). Based on the systems found in scientific literature, different approaches led to a distinction between “healthy and unhealthy food”, that then was the subject of a review conducted by Hawkes who analyzed the aforementioned concepts with a critical view (Hawkes, 2009). Finally, the following methods were evaluated: Calorie for Nutrient (CFN), Nutritious Food Index (NFI), Ratio of Recommended to Restricted Foods (RRR) and Nutrient Profiling of FSA (Food Standards Agency). The four models classified foods in an objective and reproducible manner. In general, all models obtained similar results and fruits and vegetables were on the top of the healthier food scale. Regarding sugary foods and fats, they were among the less healthy. It should be mentioned that there were many discrepancies between models; in that moment, the model proposed by the FSA was catalogued as the most robust. Currently, the FSA model has raised concern about its effectiveness. For this reason, the analyzed nutrient profiling systems were confirmed as potential tool to translate nutritional information related with overall diet into single and certain foods. Nutrition experts should be consulted in order to establish easy-to-validate food categories, and to obtain efficient tools and consensus about them easily. The Facet A of the thesaurus of the

LanguaL system for classifying food (www.langual.org) (Azaïs-Braesco *et al.*, 2006) could be included among these tools.

As proposed in 2006 (Azaïs-Braesco *et al.*, 2006), a validation of different nutrient profiling models with a standard scale of 120 foods was performed the following year, which was approved by nutrition professionals. The aim was to compare the evaluation of the way in which models categorize food and their approach with the point of view of professionals (Scarborough *et al.*, 2007). The evaluated models were: SSCg3d model and WXYfm model developed by the FSA, the NFI, the RRN, the Naturally Nutrient Rich Score model, the Australian Heart Foundation´s Tick, the American Heart Association´s Heart Check, and the Tripartite Classification Model. The objective of the first four models was to compare the nutritional quality of different foods. The objective of the last two models was to be able to label foods as "healthy". After analyzing the results, the SSCg3d model (Rayner *et al.*, 2005a) and the WXYfm are suggested that categorize and made a scale meeting the point of view of nutrition experts. Consistently with these results, the same experts group concluded in 2008 that the WXYfm model demonstrated to be the best for a satisfactory validation in categorizing foods and it was related with a healthier diet (Arambepola *et al.*, 2008).

Different nutrient profile models were analyzed in 2007: "A Little, A Lot" scheme, USA Health Claims Scheme, Tripartite Classification Model, FSA Scoring System for Children and the GRFMC Scheme. Results were not consistent for almost half of the selected products. Heterogeneity of individual responses and disagreement regarding basic foods that constitute the population's daily diet, such as bread or pasta, included in the Mediterranean Diet were found. This highlights the difficulty in achieving consistency in all foods and that each model has advantages and disadvantages. Therefore, being aware of the specific objective of the model is important to decide which one should be applied (Garsetti *et al.*, 2007).

Thorough reviews on available nutrient profiling models have been performed at different moments, concluding a series of recommendations: 1) foods included should have a special relevance in daily diet; 2) dietary reference intakes should be based on the stated by the regulations and be related to food labeling; 3) should be simple and transparent; 4) the chosen models should be validated with independent measurements of what a healthy diet represents and, if possible, with results on health; 5) the chosen models should be assessed with the food prices and encourage the consumer to take part in the assessment of the models (Drewnowski & Fulgoni, 2008). The "Nutrient Rich Food Index" and the "Go, Slow, and Whoa Foods" model have also been studied; being the latter a strategy of the U.S. National Heart, Lung and Blood Institute as part of a guideline to improve children's diet. The conclusion about the comparison of these two models is that there is disagreement in the classification of fortified cereals, some dairy products and sweetened beverages; however, these models are useful classifying foods belonging to the same category, which could help consumer to make healthier choices (Drewnowski & Fulgoni, 2011). Moreover, these authors suggest that taking into account that most models classify food based on energy-density and not in nutrient content is necessary in order to validate nutrient profiling models (Drewnowski *et al.*, 2009a). A study performed a consumer nutrition education program through nutrient profiling and found an improvement in the diet, but the study concluded that more studies are needed to get more robust results (Glanz *et al.*, 2012).

In 2010, a study was conducted to establish the validation of the U.S. nutrient profiling systems aiming to improve consumers' diet quality through the improvement of their choices. The NRF, Smart Choices, Guiding Stars and NuVal were compared with nine validation approaches, and no consensus between systems was achieved due to differences found between systems. Therefore, national systems should be implemented in order to consider demographic and cultural features of the U.S. consumers (Townsend, 2010). Furthermore, the NRFI model has been evaluated in several occasions and this model has been related with a higher adherence to dietary guidelines, assisting consumer to identify healthy food (Drewnowski, 2010; Sluik *et al.*, 2015). In general, several studies find it difficult to unify conclusions without having a standardized methodology for the validation of different nutrient profile models (Arambepola *et al.*, 2009; Sluik *et al.*, 2015; Drewnowski & Fulgoni, 2011).

In Europe, the growing interest in nutrient profiling lead to the continuous development of new approaches for their validation. In 2013 a new validation method based on a diet modeling with linear programming was proposed. This method was used to assess five European nutrient profile models that lack a standardized methodology to make the validation reliable enough (Clerfeuille *et al.*, 2013).

In 2014, three nutrient profiling models were validated and approved for the assessment of diet quality, not only of individual foods: the French SAIN/LIM model, the British FSA-Ofcom model (Rayner *et al.*, 2009) and the NRF9.3 index (Drewnowski & Fulgoni, 2014). Recently, a validation in which the British nutrient profiling model has been satisfactorily applied in France has been performed, resulting in a higher adherence to nutritional recommendations (Julia *et al.*, 2014; Julia *et al.*, 2014a).

Furthermore, studies applying nutrient profiling models to specific food groups, such as breakfast cereals, have been conducted (Harris *et al.*, 2011; Soo *et al.*, 2016; Julia *et al.*, 2015; Maschkowski *et al.*, 2014). These studies concluded that regulating health claims and marketing, specifically addressed to children, is needed. In New Zealand, legislation regulating health claims are being implemented, and after analyzing breakfast cereals for children offered in supermarkets, the 72% were classified as unhealthy. Therefore, a food labeling system that is easy to understand is also required (Devi *et al.*, 2014; Hughes *et al.*, 2013). With regard to food advertising that targets children, several authors suggest using a series of strategies, such as nutrient profiling, in order to regulate food advertising and to achieve an improvement in food selection (Mejía-Díaz *et al.*, 2014; Rayner *et al.*, 2013; Scarborough *et al.*, 2013).

V. NUTRIENT PROFILING SYSTEMS AND APPLICATIONS IN DIFFERENT COUNTRIES

Nutrient profiling is also used with objectives other than regulation of claims, for example, nutritional education conducted by health professionals, and be a guideline for consumers and assist them to make “healthier” decisions against a wide variety of products offered in the market, nutrient profiling strategies have also increased privately and publicly to establish industrial food labeling using graphs or representative symbols (logos) on the products to communicate nutritional information to the consumer or to label products as “healthy” food (Wartella *et al.*, 2011; Volkova *et al.*, 2014). Since classifications can also be applied during the products development and the reformulation, they are also useful as a tool to assess and improve nutritional quality of products (Nijman *et al.*, 2007; Labouze *et al.*, 2007). In the United Kingdom, the first nutrient profiling model was established by the FSA (Rayner *et al.*, 2004) aiming to regulate the promotion of food to children, for example, restricting advertisement of products rich in fat, SFA, salt and/or sugar (EFSA, 2008).

According to the regulations of the United States, Canada, Australia/New Zealand and Switzerland, foods should meet general and specific criteria regarding nutrient composition to obtain nutrition or health claims. Despite the strategies regulate, expressing direct messages to consumers is not intended. However, the objective of the strategies is that food claims do not confuse the consumer by masking the remaining nutrients of the product.

Main nutrient profiling systems

Nutrient profiling based on categories or food groups

When grouping food items (for example, cereals, dairy, etc.) to establish nutrient profiling models, each food group can possess a specific profile related with the potential of the foods included in each group, either to affect the overall diet in a negative manner or based on their relevance for public health. Thus, nutrient profiling based on food categories take into account the role of food groups in the overall diet, such required by the legislation.

An advantage is the general comparison by serving size, intake frequency and consumption pattern of products belonging to each group, which would facilitate the application of a unique nutrient profiling. Moreover, due to the similarity of composition of foods belonging to each group, nutrient profiling would be simpler (with only a few nutrients in order to discriminate well between products) and be easily adapted; in other words, the system should be flexible (EFSA, 2008).

No groups of standardized foods based on their nutrient contribution to overall diet are available. Since the offer or diversity of food groups is getting more complex, creating a great number of food groups would be necessary in order to be able to include all foods. The main disadvantage of this system is the complexity of defining and managing a large number of foods (EFSA, 2008). In this sense, as stated above, the LanguaL system could help standardizing the classification and categorization of food groups with scientific criteria (www.langual.org).

During the ILSI Europe Workshop held in 2006 (Tetens *et al.*, 2007), the experts stated that a simple approach with a reference amount can be used at the beginning, and if it does not work in practice, then various combinations of different systems and approaches could be performed. However, most experts were in favor of using the system of categorizing foods by groups. Thus, considering other aspects, such as the process type (fried, fortified, frozen, smoked, dried, etc.) and identifying categories for each population group (children, adults or elder people) would be interesting in order to create a food category system. In addition, this approach should focus on "negative" nutrients and the levels of each nutrient should be clearly defined for each food category.

Nutrient profiling for food in general ("across the board") based and applied to all foods in a unique way

The EFSA considers that a nutrient profiling for food in general, when needed, with the exception of a certain number of food groups which are critical at a population level, would be able to avoid the main disadvantages of the two systems and these exceptions could allow that some foods from these food groups could bear nutrition or health claims (EFSA, 2008).

Even though this approach does not have the problem of defining and managing all food groups, it shows the need of taking into account the huge differences in their nutritional composition (for example, water content). This fact could lead to a higher complexity in these nutrient profile schemes, which would be more difficult to adapt than those profiling models based on the food groups system (EFSA, 2008).

Mainly, total exclusion of a food group to comply with an overall nutrient profile should be based on the role and relevance of the food group in the diet, for example, fresh or minimally processed fruits and vegetables. Alternatively, specific nutrient profiling for food groups in particular should be established based on the different nutrients they contain, through scores or thresholds. The following aspects should be taken into account to establish specific nutrient profiling for each food group:

- Potential reformulation of the product.
- The number of foods that are likely to request claims of each specific group, while a diversity of products bearing claims are allowed.
- The availability of food composition data of good quality and the range of nutrients contained in each group.

Use of thresholds or scores in different nutrient profiling systems

Methods for the calculation of nutrient profiling lead to a disaggregation of foods by meeting or not the nutrient threshold value, to be considered suitable and bear nutrition or health claims. These methods can be classified into two main types: depending on the use of a threshold for each nutrient included in the nutrient profiling system; or on the use of a combination of thresholds for individual nutrients generating the score for a food product. These two principles have been applied to the food in general approach and in the food category-based approach. The reference values on which threshold criteria are based take into account the country where they are being developed. The assessment of different nutrient profiling systems should always use the same food and same references of food composition data bases.

Thresholds

A threshold is defined as a single value for each nutrient that must not be exceeded (upper limit) or that must be reached (lower limit) in a food to be eligible to bear a claim. The legislation allows the exemption of some nutrients in case of nutrition claims, whereas all nutrients should meet thresholds to bear a health claim. In some nutrient profiling systems based on food in general (“across the board”), when a nutrition claim should be made, if the food has low levels in the threshold of several nutrients, therefore, at least one of the nutrients must meet the established threshold to achieve the claim. Several methodologies have been proposed:

- Thresholds for a specific food product can be derived from the nutrient intake recommendations in the total diet. This approach implies that food bearing claims should have a composition corresponding to dietary recommendations. This approach is easier to apply to the system based on food in general.
- A threshold could be determined at the mean or median value of the nutrient content of foods constituting this group by using food composition data. This could be easier to apply to food category-based systems. Alternatively, statistical approaches could be used to derive the thresholds from products identified by experts as eligible for bearing claims (AFSSA, 2008).
- Using data of nutrient intake. For example, in the Dutch Tripartite system (Netherlands Nutrition Center, 2006), thresholds could be established for the different food groups by using the intended changes in the population nutrient intake.
- More complex threshold systems could be proposed based on the choices made for other reasons; for example, if a food exceeds the limit of 10% total fat, then a second threshold value that takes into account the fatty acid profile could be considered.

According to Foltran *et al.* (2010), no universally accepted food categories are available, and many different systems are used depending on the circumstances. This critical review considers that nutrient profiling systems by thresholds are intrinsically more complex than scoring systems. The threshold systems are more accurate than scoring systems, but tend to be impractical for some objectives. Threshold is the most used method to ease food labeling (Foltran *et al.*, 2010).

Score

Points are assigned to food items because they meet the criteria for the content of each of the nutrients that are part of the nutrient profiling, and these points are finally accumulated to obtain the total score. The scoring systems can be classified as follows:

- *Method of calculation of the points*: points can be assigned according to the position of the value in pre-set reference intervals or, alternatively, based on its position on a continuous reference scale. In some systems, the points are calculated based on the ratio of the nutrient amount in the food to the reference value or based on the position of the nutrient value in the food compared to two references, nutrient recommendation and average consumption.
- *Method of calculation of the final score:* some methods result in two separate scores, while others allow counteracting "negative" nutrients with the "positive" nutrients, leading to a single score. In the second case, some additional considerations must be taken into account because the same score could be obtained from very different foods. For example, a food with a high content of a "positive" nutrient and moderate content of a "negative" nutrient can have the same score that a food with a low content of a "positive" nutrient and absence of a "negative" nutrient, whereas the two foods might have different relevance for the balance of the overall diet.

The most used (or proposed) strategies of nutrient profiling for regulation purposes are based on the food in general system (across the board) or category-based nutrient criteria. According to Foltran *et al.*, 2010, nutrient profiling with scoring approach can be easily converted in a threshold approach simply by establishing a score as a threshold.

During the ILSI Europe Workshop on nutrient profiling (Tetens *et al.*, 2007), the experts discussed about these two methods and several comments were pointed out: based on the objective of the nutrient profile model, which needs to have two decision options (for example, OK/not OK or qualified/disqualified), the approach applied should allow these types of conclusions. With this regard, experts stated that the threshold approach is more appropriate because it allows for a distinction between OK/not OK or qualified/disqualified; and then limits could be established. After discussing about the scoring approach and the threshold approach, experts concluded that both methods are very similar since the threshold approach is also a scoring method. This means that a threshold can always be indicated for each food included in a nutrient profile model. All nutrients and their respective values and scoring factors can be summed up in a final nutrient profiling; though the scoring factor can be zero for some nutrients. In fact, nutrients with a scoring factor of zero do not contribute to the overall nutrient profiling of a scoring method.

Therefore, the main conclusions of the meeting of experts, whose objective was to review, analyze and discuss, as well as to consolidate the different points of view of the legislation, of food industry and consumer, can be summarized in the following points:

- From the point of view of the legislation, nutrient profiling was viewed as a risk management tool rather than a risk assessment tool. It was highlighted that the main objective of current legislation is to achieve a high level of consumer protection, as well as to increase legal security for economic operators, promoting a fair trade and innovation in the area of foods. The aim of including nutrient profiling in the legislation is to prevent likely fraudulent health claims made on certain food features (Tetens *et al.*, 2007).

- According to the food industry, a nutrient profiling model should be based on scientific evidence, in food categories, be non-discriminatory, simple and applicable by all operators of food industry. Moreover, as required by the regulations, a nutrient profiling model should be established at community level, rather than at regional or national level, and it should not hinder product innovation. In addition, it should be applicable to all daily-consumed food and ready-to-eat food (Tetens *et al.*, 2007). Some strategies promoted by the industry, such as the proposal of Unilever company (Cunningham *et al.*, 2015) are already available in scientific literature.
- From the point of view of the consumer, the nutrient profiling model should be rapidly applied, achieve nutritional objectives and be consistent with nutritional recommendations. The long-term goals of nutrient profiling models should promote the optimal health state and the decrease of the risk of food-related diseases, including stopping the ascendant obesity curve and the prevention of cardiovascular diseases. It should be based on scientific evidence and be globally applicable. In addition, nutrient profiling models should take into account the changes in dietary patterns when possible (Tetens *et al.*, 2007).

Food labeling systems based on nutrient profiling

Food labeling systems have been established based on nutrient profiling systems. Food labeling systems correspond with the information on the front of the food package, providing nutritional information about the product in a simple and visual manner, as well as information about the quality of the product. Although displaying information by using labels, logos, symbols, icons or number pads is not new, their introduction in food is relatively recent (Dean *et al.*, 2015). Currently, the importance of food labeling is increasing and it is constantly subject to debate among governments, health organizations, food industry and consumers' associations (Kleef & Dagevos, 2014). The main labeling are: the percentage of the recommended dietary allowances, the traffic light system and the health logos.

These systems can help consumer to make healthier choices; however, there is often lack of consumer attention (Trijp, 2009). People more susceptible to be concerned about nutrition labeling of food are those buying a certain food for the first time, looking for food for children, loosing weight or searching for a nutrient in particular (Lobstein & Davies, 2009).

Furthermore, Emrich *et al.*, (2015), conducted a comparative study with foods displaying a standardized symbol in the front of the package *versus* foods displaying non-standardized symbols, or simply not displaying any symbol; regarding their content in energy, saturated fat, sodium and sugar. The results suggested that the front-of-package symbols are not a reliable indicator for choosing a food, since the nutrient profile of foods displaying symbols was not better. Likely, front-of-package symbols are being applied for marketing and sales purposes rather than for the promotion of healthier choices. The need of standardized minimum rules to regulate nutrients of interest in public health is expressed. The aim is to help consumers to rely on symbols as a guideline for healthier choices, being these choices part of a diet that promotes reduction of the risk of chronic diseases. In this regard, Sacks *et al.* (2011) have proposed the use of nutrient profiling with these objectives. After analyzing foods sold in supermarkets, a study conducted in New Zealand concluded that most packaged food are ultra-processed and possess an unhealthy nutrient profiling. Therefore, these authors suggest, similarly, an improvement and standardization of the food labeling, to have a greater supply of healthier food and to increase the effort to reformulate products offered in supermarket chains (Luiten *et al.*, 2015).

In 2007, the FSA proposed a food labeling system based on the colors of the traffic light: red, amber and green to indicate the amount of fat, saturated fat, sugars and salt present in the food (FSA, 2007). In 2008, a study assessing several types of front-of-package labeling regarding the sodium content in foods was conducted. The traffic light label, which incorporated content descriptors and color coding, was the most effective at helping participants select low-sodium products. Results demonstrated a good predisposition to choose food with lower sodium content, which suggests that this kind of food labeling is a good strategy to help consumers making healthier choices (Goodman *et al.*, 2012). However, the consumer perception of whether a food is healthy or not, for those products in which this system has been used, is not clear (Rosentreter *et al.*, 2013) since the concept of "healthy" could be wrongly interpreted when a food bear health claims. For example, in the case of dairy products, the regulation of food labeling by using nutrient profiling is needed to avoid confusing the consumers (Gerrior, 2010; Miklavec *et al.*, 2015; Trichterborn *et al.*, 2011; Walker *et al.*, 2010). Similarly, this kind of regulation is needed for bakery products (Trichterborn *et al.*, 2011a) and other food targeting specific population groups, such as gluten-free foods (Wu *et al.*, 2015).

The choice of "less healthy" foods is promoted by large discounts on price promotions, that are not usually applied to healthier foods. Additionally, in many occasions, "less healthy" foods are displayed in non-food stores and at child height to motivate their purchase (Wright *et al.*, 2015).

Applications of nutrient profiling in different regions and countries

The concept of nutrient profiling is not new; however, most nutrient profiling models have not been developed in a systematic manner because each nutrient profiling model is created to meet different goals. The use of a structured, transparent and logical process would be necessary. Broadly, the following steps are suggested: 1) to decide which is the main objective of the model; 2) to decide which is the target population; 3) to select which type of system is going to be used: food in general ("across the board") or based on food categories; 4) to choose which nutrients or other food ingredients are going to be included; 5) to decide which reference units are going to be used; 6) to select which type of model is going to be used; 7) to choose the thresholds that are going to be used (Scarborough et al., 2007a).

The main nutrient profiling systems and their applications in different countries are described below.

World Health Organization Regional Office for Europe nutrient profiling model

During the past years several documents that include strategies like nutrient profiling for the prevention of overweight, obesity and diet-related diseases have been published (Commission of the European Communities, 2007; Department of Health UK, 2005; Department of Health UK, 2011). Certain number of models was considered for the use and adaptation at the European level. The governments of several countries, including: Australia, Ireland, New Zealand, Norway, Switzerland, United Kingdom and United States, have developed nutrient profiling models. However, three main models are currently being considered for this process: the Danish, the Norwegian and the Anglo-Saxon. These are the only ones that are being used in Europe to limit the marketing directed at children; in addition, they have been developed by the government (such the case of Norway), or promoted by the governments.

After these considerations of particular countries, it was decided that the European nutrient profiling model should be based only on two previously used models: the model developed by the Norwegian government and adapted by the industry with slight changes for the voluntary Norwegian restrictions (Norwegian Directorate of Health, 2012; EFTA, 2013; Norwegian Directorate of Health, 2014), and the Danish model developed by the Forum of Responsible Food Marketing Communication (2014) and promoted by the government of Denmark. Despite the three previously selected models are considered relatively strict and they categorize foods in a similar way (for example, in most of the cases, the same foods could or could not be allowed for marketing according to the different models), the bases for choosing the Danish and the Norwegian model was due to the fact that they are based on food categories instead of on scoring systems. The models with specific categories are considered easier to adapt or modify than models based on scoring, this is an important consideration for the regional model that countries can use at the national level (WHO, 2015).

The final model consists of a total of 17 food categories (with some subcategories). The categories 1-7 and 9 of the WHO Regional Office for Europe model are almost the same that the 8 categories of the Norwegian model. The categories 8, 11 and 13-17 are taken from the Danish model. The categories 10 and 12 are new categories that have been added during the process of consultation to the different countries. Descriptions of the food products, included or not among the food categories of both models, have been obtained from both models and have been supplemented with further examples. The list is not exhaustive and could be complemented when used at national level.

Additionally, more information can be found on which foods fall within each of these categories using the international tariff codes. These were first used in Hungary to implement their Public Health tax and subsequently used in the Norwegian nutrient profiling model. The tariff codes used for foods included in the WHO Regional Office nutrient profiling model have been taken from the Harmonized Commodity Description and Coding System, which is used globally, including the European Union. These codes are provided with two levels of detail: four digits, which are the position in which the food is placed and which is normally related to the category of each food, and where possible a six-digit suffix that provides more details about the specific subcategory of foodstuffs. At the national level, the tariff codes can be specified to 8 digits or product numbers. When adopting or adapting this model at the national level, countries should consider using the 8-digit code. The food industry should be familiar with the international tariff code system (WHO, 2015).

The thresholds for the model have been taken from the Norwegian and Danish models. The nutrients included by the model are: total fat, saturated fat, total sugars, added sugars and salt. Energy has been included for category 9 (ready-to-eat meals, convenience foods and composite dishes), while non-sugar sweeteners have been included in category 4 (specifically for subcategories 4b milk drinks and 4d other beverages).

According to the presented model, marketing is not allowed for five food categories, for this case no nutritional criterion is needed. The same principle applies to the two categories for which marketing is always allowed. In some cases, the used thresholds were stricter since they were subjected to consultation with countries to determine whether they meet the WHO nutrition guidelines criterion.

Marketing is prohibited if the product contains > 1 g per 100 g total fat in processed foods containing *trans*-FA, or ≥ 0.5% of total energy in the form of alcohol.

The 17 food groups included in this model and the regulation for advertising are listed below: **1) sugar confectionery and chocolates, energy bards, sweet toppings and desserts** (marketing is not permitted); **2) cakes, sweet baker's wares or pastries, sweet biscuits and mixes for making them** (marketing is not permitted); **3) savory snacks**, including all products made from corn, potatoes or rice, pretzels, popcorn and nuts (marketing allowed when the product does not exceed on a per 100 g basis any of the threshold criteria); **4) beverages; 4a) juices**, including 100% natural juices and those reconstituted from fruit or vegetable concentrates, as well as smoothies (marketing no allowed); **4b) milk drinks**, including sweetened milks and vegetable drinks (frequently called "milks") made of soya, oat, almond and rice (marketing allowed according to specific threshold criteria); **4c) energy drinks** (marketing not allowed); **4d) other beverages**, including cola drink, lemonade, orangeade, other soft drinks (marketing allowed when the content of added sugars or caloric sweeteners is zero); **5) edible ices** (marketing not allowed); **6) breakfast cereals** (marketing allowed according to specific threshold criteria); **7) yoghurts, sour milk, cream, and other similar products** (marketing allowed according to specific threshold criteria); **8) cheese** (marketing allowed according to specific threshold criteria); **9) ready meals, composite foods, and convenience foods** (marketing allowed according to specific threshold criteria); **10) butter and other fats and oils** (marketing allowed according to specific threshold criteria); **11) bread and bread products** (marketing allowed according to specific threshold criteria); **12) fresh or dry pasta, rice and grains** (marketing allowed according to specific threshold criteria); **13) fresh or frozen beef and poultry meat, eggs, fish and similar** (marketing always allowed); **14) processed beef, poultry, fish**

and similar (marketing allowed according to specific threshold criteria); **15) fresh and frozen fruits, vegetables and pulses** (marketing always allowed); **16) processed fruits, vegetables and pulses** (marketing allowed according to specific threshold criteria); **17) sauces, dips, and dressings** (marketing allowed according to specific threshold criteria) (WHO, 2015).

United Kingdom

This model has been developed by a group of experts within the British Heart Foundation together with the FSA. In 2004, the FSA constituted a working group that agreed with the models, this group identified available data, and they assessed about 50 models approximately. Subsequently, the same institution built different scoring options and examined them, which led them to identify an improved model (Rayner *et al*., 2004; Scarborough *et al*., 2005). This improved model was validated, comparing it with the scoring models of various food and with the opinions of 850 nutrition experts and dietitians consulted through on-line questionnaires (Scarborough *et al*., 2007). The researchers also compared different nutrient profiling models using foods consumed in the United Kingdom according to the National Food Survey. In addition, the diet quality of each participant in the survey was assessed. The results showed that the number of healthy food consumed did not vary among the diet quality score quartiles. It was emphasized that the best validation manner could be a cohort study in which the disease incidence could be compared with the dietary intake, assessed using the nutrient profiling. When the model was developed, initially the FSA tried to create a list of foods representative of the United Kingdom diet, a questionnaire of food consumption frequency was used, and then the groups were appropriately selected (FSA, 2009; FSA, 2009a). However, despite it is considered difficult to adapt nutrient profiling models that are validated in one country to another country with different feeding practices, the

FSA model has been used and validated in France with positive results (Julia *et al*., 2014, Julia *et al*., 2014a). Moreover, a methodology to evaluate nutrient profiles of the most habitual meals in the United Kingdom has been recently developed (Benelam & Stanner, 2015).

France

This model has been developed by the former French Agency for Food Safety (*AFSSA, Agence française de sécurité sanitaire des aliments*) that has changed its name to National Agency for Food, Environmental and Occupational Health and Safety (*ANSES, Agence nationale de sécurité sanitaire de l'alimentation, de l'environnement et du travail*).

The SAIN-LIM model, proposed by the AFSSA, classifies food based on "positive" nutrients (for example, fiber, vitamin C, and calcium) and "negative" nutrients (for example, fats, sugars, and salt/sodium) to obtain a "nutrient density score" and a "score of limiting nutrients", a comparison with dietary reference intakes is taken into account for both scores. Both scores are used to categorize foods in a two-dimensional system that allows the validation if they are suitable for bearing health claims.

In other words, this method evaluates favorably the healthy aspects (SAIN) and, unfavorably the less healthy aspects (LIM) of each food, in a manner that allows classifying it in four categories: 1) recommended for health; 2) neutral; 3) recommended in small amounts; and 4) its consumption should be limited (Foltran *et al*., 2010). Based on this classification, nutrition and health claims could be borne or not:

- High-SAIM / Low-LIM, access to nutrition and health claims.

- Low-SAIN / Low-LIM, access to nutrition claims.
- High-SAIN / High-LIM, without claims with some exceptions.
- Low-SAIN / High-LIM, without claims with some exceptions.

The existence of a separated formula for beverages and foods composed by more than 97% fat (oils) is considered necessary. This system is not in use, but it was developed as a proposal to consider in the European Union regulations on health claims (Foltran *et al*., 2010).

Spain

In 2005, the Spanish Ministry of Health launched the Spanish Strategy for Nutrition, Physical Activity and Prevention of Obesity, known as the NAOS Strategy (*Estrategia NAOS*) (*Agencia Española de Seguridad Alimentaria y Nutrición*, 2005). This strategy integrates the following fields: family and community, school, business and health system in a series of measures and actions to meet the main objective, which is "to promote a healthy diet and foster physical activity to invert the growing trend of the prevalence of obesity and thus to substantially reduce morbidity and mortality attributable to chronic diseases". Within the implemented measures, there are some that could be considered as a nutrient profiling system for specific food categories with the use of thresholds; for example, the strategy refers to an agreement reached with the bakery industry for the progressive reduction in the percentage of salt used in the production of bread from 2.2% to 1.8% in a 4 years period. In 2005, as a response to the commitment created by the NAOS Strategy, the food industry developed the Code of Co-Regulation of Advertising for Food Products and Beverages Directed to Children, Prevention of Obesity and Health (PAOS Code) (*Código de Autorregulación de la Publicidad de Alimentos Dirigida a Menores, Prevención de la Obesidad y Salud;*

Código PAOS) (*Agencia Española de Seguridad Alimentaria y Nutrición*, 2005a), developed aiming at "establishing a set of rules to guide adhering companies through the development, implementation and dissemination of their advertising messages directed to children" the code was drafted in line with Principles of Food and Beverage Product Advertising of the Confederation of Food and Drink Industries in the EU (CIAA), approved in February 2004 (*Confédération des Industries Agro-Alimentaires de l'UE*, 2004). In 2014, the Spanish Agency for Consumer Affair, Food Safety and Nutrition drew up a scientific report on objectives and nutritional recommendations and physical activity to tackle obesity in the framework of the NAOS Strategy, reiterating and updating the country strategies (*Agencia Española de Consumo, Seguridad Alimentaria y Nutrición*, 2014).

Regional model of the Pan American Health Organization

Obesity and overweight already affect 62% of the population in the Americas and childhood obesity continues increasing. There is a clear trend towards replacing fresh or minimally processed foods, which contain more fiber, vitamins and minerals, by "ultra-processed" products, which contain more sodium, unhealthy fats and free sugars. Therefore, the critical nutrients included in this model are: free sugars, sodium, SFA, total fat and *trans*-FA. In addition to these critical nutrients, "other sweeteners" were also included, even though they are not categorized as nutrients in any other reference, because it is known that the regular consumption of food with sweet flavor (with sugar or sweetener) could promote the subsequent preference for sweet foods and beverages, especially in children that are still forming their food habits (PAHO, 2016). However, the last systematic review published aiming to determine the influence of the use of sweeteners on the energy intake and body weight, found considerable evidence (studies in humans of all ages) supporting that the substitution of sugar by non-caloric sweeteners helped to reduce weight and energy intake, suggesting that the questions about goodness and effectiveness of sweeteners should be focused on how they can be useful to achieve public health goals on reduction of free sugars consumption (Rogers *et al*., 2016).

Based on this model, the foods and beverages that should be evaluated are exclusively processed and ultra-processed foods, which usually contain large amounts of sodium, free sugars, saturated fats, total fats and *trans*-FA added by the food industry. For example, processed products: tinned food, sauces, fruits in syrup, canned fish, salted meat and fish, cheeses, breads and bakery products; and ultra-processed products: sweet or salted snacks, biscuits, ice creams and confectionery products, soft drinks with or without gas, pastries, sugared dairy products, precooked products, breaded meat and fish, etc.

According to the PAHO, it is not necessary to apply this model to fresh or minimally processed food, such as vegetables, pulses, fruits, nuts, tubers, dairy products, eggs, fresh meat and fish, since these foods are in line with the recommendations of the dietary guidelines. However, the objective of this model is not to classify culinary ingredients such as salt, vegetable oils, lard, butter, sugar and honey, because their consumption, as ingredients, is not frequent according to the PAHO. In many Latin American countries, this is far from reality, since ingredients such as sugar, fat or salt are part of the regular culinary use in households where, for example, desserts such as cakes, coffee, tea, *atole* and other types of infusions or sugared fruit beverages, deep frying with fats with high SFA content, etc., are prepared.

The use of this model requires the mandatory labeling of prepackaged foods with the following information:

a) Declaration of the content of the following items: energy, sodium, total sugars, total fats, saturated fats, and *trans* fats; and

b) A list of all the ingredients of the product, included non-sugar sweeteners.

Although the nutrient content could be expressed in absolute values ("per serving"), the PAHO recommends to express it relative to the weight or volume ("per 100 g" or "per 100 ml" of the food product).

Some examples of policies that could benefit from the use of the PAHO nutrient profiling model are the following:

- Establishment of restrictions on the marketing and promotion of unhealthy food and beverages to children;
- Regulation of food in the school environment;
- Warnings in the front-of-package labeling;
- Application of taxes to limit the consumption of unhealthy foods;
- Evaluation or revision of the agricultural subsidies; and
- Drawing guidelines for food provided by social programs to vulnerable populations (PAHO, 2016).

Canada

Canada is currently trying to promote or facilitate the standardization of the available nutrient profiling models, in a non-regulatory context; it is not certain if the involved parties would agree with the use of other systems. The country will use reports of the Institute of Medicine of the National Academies (Washington, D.C.) as reference. Many health actors are asking the federal government to play a leading role in the development of several policies; among them, the front-of-package labeling of foods and the marketing to children (Health Canada, 2001; WHO, 2010a).

To date, several provinces are considering the application of taxation to carbonated drinks, snacks and confectioneries. Moreover, the Healthy Food for Healthy Schools Act and the *Trans* Fat Regulation came into effect on September 1, 2008 in Ontario. These policies encourage the promotion of healthy food by schools, the elimination of *trans* fats and the establishment of mandatory nutritional standards for food and beverages sold in schools (Health Canada, 2007; PAHO, 2016).

United States

The Centers for Disease Control and Prevention working group have proposed tools that develop standards for:

- Current legislations on nutrition and health claims (Center for Food Safety and Applied Nutrition, 2015)
- Dietary Guidelines for Americans, 2005; that have been updated recently in 2015 (U.S. Department of Health and Human Services & U.S. Department of Agriculture, 2015).
- Reports of the Institute of Medicine of the United States (for example, on reference dietary intakes and nutritional standards for food at schools).

The nutrients of concern regarding children's health are: SFA, *trans*-FA, added sugars and sodium. Three levels of standardization have been proposed. The first level includes food excluded from regulations on marketing strategies, since they are considered appropriate within a healthy diet, which is why these products should be targeted to children:

- 100% fruit and fruit juices in all their forms
- 100% vegetables and vegetable juices in all their forms, without exceeding 140 mg of sodium per the reference amount customarily consumed (RACC).
- 100% low-fat milk and yoghurt
- 100% whole grains
- 100% water

The second standardization level states that if foods are directed at children, they should provide a significant contribution to achieve a healthier diet. The two proposals are:

- Food should contain at least 50% of: fruit, vegetables, whole grains, low-fat milk or yoghurt, fish, lean meat, eggs, nuts and seeds, pulses, or the combination of all groups.
- Foods should contain: a specific amount, in relation with the RACC; for example, 0.5 cups of fruit or fruit juice, 0.6 cups of vegetables or vegetable juice or 0.75 ounce equivalent of 100% whole grain.

For the last level, foods directed at children should not contain more of the specified quantities of SFA, *trans*-FA, sugars and sodium. The thresholds for SFA, *trans*-FA and sugars are based on healthy values for children. Sodium is usually at half of the required for adults. These proposals took place in 2009, but have not been adopted yet. In addition, some regulatory experiences have been conducted in the United States to modify foods offered in the school environment through:

1) Subsidy programs for fruits and vegetables in some schools
2) The prohibition of vending machines

3) The establishment of the FAO/WHO rules for school programs of food and nutrition, as well as other programs for institutional environments such as hospitals, jails, kindergartens, etc. (PAHO, 2016).

Front-of-Package labeling of the Institute of Medicine of the United States

The situation regarding obesity and chronic diseases (WHO, 2003) has led to the proliferation of different front-of-package food labeling systems in the United States. Their criteria are inconsistent and therefore the Institute of Medicine has evaluated them. First, the various systems available in the United States and abroad and the public health problems and their relationship with the excessive or limited consumption of specific nutrients were analyzed. The committee identified more than 30 different systems assessing their advantages and disadvantages based on scientific evidence. Then, they focused on the consumer acceptance of a wide variety of symbols, and it was concluded that a unique front-of-package food labeling system shown through icons is the most effective and the most recommended for being implemented. Then, the Smart Choices Program was also proposed as a result of the work of scientists, government, food industry and nutrition educators (Smart Choices Program, 2009).

Mexico

Mexico has a national strategy to fight obesity. A guide system for beverages has been developed; it is not a conventional nutrient profiling model, but it is simply based on different categories: frequency and amounts that should be consumed. Mexico has managed to establish requirements for SFA and *trans*-FA, total energy and energy-density (but this was rejected by the industry, so that the fat percentage was used instead). In January 2014, taxes of 1 Mexican peso per liter (approximately 10%) were implemented to sugar-sweetened beverages and another tax of 8% was implemented to processed foods (excluding the minimally processed foods) with high energy-density, that is, with more than 275 kcal/100 g (*Secretaría de Hacienda y Crédito Público y SAT*, 2013). In addition, restrictions to food advertisements on television have been established to those programs with a large audience and are directed at children below 12 years old (*Secretaría de Salud de los Estados Unidos Mexicanos*, 2014; *Secretaria de Salud de los Estados Unidos Mexicanos*, 2014a). On the other hand, the mandatory front-of-package labeling could be approved based on the system of Guideline Daily Amounts that would be implemented as soon as possible. The Mexican dietary guidelines have been updated, restricting recommendations on sugar-sweetened beverages and packaged foods or forbidding them completely (PAHO, 2016).

Costa Rica

Currently, there is a decree that regulates school cafeterias so that they are not allowed to offer: 1) packaged beverages and bagged snacks with sugar or fats as a main ingredient or without the nutrient labeling; 2) carbonated beverages or energy drinks; 3) other beverages containing more than 15 g of sugar per serving; 4) sausages not labeled as "light" and 5) processed food that might contain *trans* fats (*Presidencia de la República de Costa Rica*, 2012; PAHO, 2016).

The Caribbean

The Caribbean Community (CARICOM) policies for food labeling are currently in force. However, nutrition labeling is voluntary, except regarding nutrient or health claims. Several countries are drafting policies and guidelines for foods sold in schools, focusing specially on fats, sugars, and other nutrients. The Caribbean Public Health Agency (CARPHA) Nutrition Advisory Committee has suggested several areas to achieve a better nutrition, for example: 1) food labeling; 2) nutrition policies and guidelines for schools and other institutions; 3) food marketing; 4) nutritional quality of food supply (concentration of noxious ingredients); 5) trade and fiscal policy measures; and 6) incentives along the food chain (*Parlamento Latinoamericano y Caribeño*, 2012; PAHO, 2016).

Ecuador

In August 2014, the use of warning labels became mandatory, in the front-of-package or other formats, based on the "traffic light" system, with threshold values proposed by the Food Standards Agency of the United Kingdom in 2007. Currently, a draft law that regulates the marketing of food and beverages to children is under discussion in the Congress (*Órgano de Gobierno del Ecuador*, 2014; *Gobierno de Ecuador,* 2014; PAHO, 2016).

Peru

In 2013, a law to regulate the marketing of food and beverages to children was proposed; the rules of this law are still under development (*Congreso de la República del Perú*, 2013, *Presidencia de la República del Perú*, 2015). The limits proposed are according to the PAHO's Recommendations on the Marketing of Food and Non-Alcoholic Beverages to Children in the Americas (PAHO, 2011; PAHO, 2016).

Bolivia

The use of the food in general ("across the board") nutrient profiling system with thresholds grouping processed foods in three categories based on their concentration of SFA, added sugar and sodium was approved by the Plurinational Legislative Assembly in 2015. The front-of-package labeling uses a red bar with the statement "very high in", a yellow bar with the statement "medium in" and a green bar with the statement "low in"; in addition to regulations on the promotion of certain products to children (*Asamblea Legislativa Plurinacional de Bolivia*, 2015).

Brazil

Brazil has some data of dietary surveys since 2011; the labeling of some nutrients, such as *trans*-FA is mandatory. By 2010, the authorities of Brazil were not sure if they needed the development of a new nutrient profiling model or if they needed to adapt the model available at that moment. The nutrients of concern in Brazil were the same as those identified in the WHO strategy (WHO, 2010).

In 2010, a law establishing that food and beverages with high content in saturated fats, *trans* fats, sodium and sugar, advertised in different mass media (television, radio and written media) should declare this content. However, the law did not come into force because there were many detractors stating that it was unconstitutional (PAHO, 2016). In 2015, the Brazilian Ministry of Health published the dietary guidelines for Brazilian population, as an strategy to implement the appropriate and healthy guidelines that integrates the National Policy of Food and Nutrition (*Agencia Nacional de Vigilancia Sanitaria de Brasil*, 2010; *Ministerio de Salud de Brasil*, 2015).

Argentina

A law with mandatory limits for the salt content of certain food products has been applied. This law is being implemented gradually (Bonfanti, 2008; *Senado y Cámara de Diputados de la Nación Argentina*, 2013; PAHO, 2016).

Chile

In 2012 a law that: 1) regulates marketing of food and beverages to children on the television, in packages and other media, as well as food sold in school kiosks; and 2) establishes the front-of-package labeling including warning messages, as a result of a governmental decision of using a nutrient profiling model to guide the policies, was promulgated. The implementation of the law was executed by June 2016. Taxation was applied to sugar-sweetened beverages and other taxes to solid food with high content of sugar are being considered. In addition, a draft of a law with restrictions on ultra-processed food is currently under discussion (*Ministerio de Salud de Chile*, 2012; PAHO, 2016).

Australia

Initially, the Food Standards Australia New Zealand (FSANZ) proposed an "across the board" system with a threshold method based on serving size, but this system led to several problems. For example, some pastry products were approved, but the fruit could not be assessed. This issue happens because many of the recommended foods contain relatively large amounts of some undesirable nutrients, in addition to the wide range of other nutrients (for example, the fruit contains sugars, the bread contains salt, the meat and dairy products contain SFA), so the FSANZ noticed that a more complex system would be necessary.

The FSANZ described some aspects of the adaptation of the United Kingdom model with the objective of regulating health claims in other countries, such as Australia and New Zealand (Foods Standards Australia New Zealand, 2011). In general, the FSANZ has proposed a nutrient profiling method by scores to manage the food characteristics on which the nutrition or health claim would be done, commonly known as the nutrient profiling scoring criterion (NPSC).

Six models were evaluated, and the FSA was the closest one to the FSANZ requirements and in consonance with its criteria. However, the model required changes to allow that foods with UFA and spreadable fats, as well as low fat cheeses could be included in the list of healthy products. Currently, the FSANZ is defining more accurately the NPSC. It was highlighted that the negative result never should appear in the food label, but focus on the claim of only positive aspects. For example, if the FSANZ scores a product containing SFA, total sugars, sodium, etc., the only claim could be, for example, “source of iron, which helps maintain a healthy blood levels”. In 2015, the FSANZ used a new model proposed in 2011 (Food Standards Australia New Zealand, 2011), which calculates the food score based on three well defined categories: 1) beverages; 2) the rest of foods; 3) oils, spreadable fats and cheeses with high calcium content per 100 g or 100 ml of food. The final score depended on the score obtained for energy, saturated fat, sugar and sodium; and was modified based on the percentage of fruit, vegetables, nuts, dietary fiber and proteins. Thus, it was determined if a food was “healthy” or not to bear a health claim (Australia and New Zealand Food Regulation Ministerial Council, 2014; Food Standards Australia New Zealand 2013; Eržen *et al.*, 2015).

Thailand

Thailand has used nutrient profiling in the past. This country presented high rates of dental caries in children due to the low level of breastfeeding and the frequent use of infant formula with high content of sugars. The medical advice was insufficient to reverse this situation and Thailand used nutrient profiling to show the relationship between caries and sugars consumption. Then, a law about labeling of snacks containing salt, sugar, fat, energy, iron and vitamin A was drafted. Some products already provide information about their effects, but this is not the case of traditional foods (WHO, 2010).

Philippines

The manual of the WHO technical meeting about nutrient profiling held in London was reported as suitable for Philippines because this country would like to validate a certification or seal on products that they started to develop and to be assisted with, especially regarding the identification of the products directed at children (WHO, 2010a).

Global model of the International Choices Programme

The objective of this model was to create a generic global system, as a private initiative, for the front-of-package food labeling, that helps consumers to choose healthier foods and that stimulate the reformulation of products. In order to achieve this, foods are classified as "basic" and "discretionary". This model is characterized by being a transparent tool based on the scientific evidence designed to encourage the industry to provide healthier food (Roodenburg *et al*., 2011). According to its designers, this model can be used globally to stimulate a healthier consumption and the innovation of products, supported by studies that have used this model. For example, it would be interesting in developing countries such as India, Brazil or Mexico, where the food industry is growing rapidly. However, this approach has been criticized and has been the subject of scientific discussions on how to judge and manage food supply, the definition used for the concept of "healthy", as well as the availability and the role that the food composition databases play in the development of the nutrient profiling criteria and models (Jansen & Roodenburg, 2016). However, this nutrient profiling model could be useful to achieve a healthier diet (Jansen & Roodenburg, 2016; Roodenburg *et al.*, 2013).

Table 2 shows a summary of nutrient profiling models and their applications in different countries or regions.

Table 2. Examples of nutrient profiling strategies developed at international level, either for bearing health claims or for limiting the use and consumption of some foods of public health interest.

Country/authority	Type of profiling	Approach used in the calculation	Reference amount	Nutrients subject to a maximum level in food	Nutrients subject to a minimum level in food	Comments
Europe (WHO, 2015)	Based on groups (n=17)	Threshold	Weight and volume (not exceeding 100 g or ml)	Energy, total fat, SFA, total sugars, added sugars, salt, non-caloric sweeteners	n/a	Different thresholds are included for each one of the 17 groups. For example, the group "breads" can be marketed if it is below the threshold of 10 g / 100 g total fat, 10 g / 100 g total sugars and 1.2 g / 100 g salt; whereas the marketing of energy drinks is forbidden.
France (AFFSA, 2008)	Food in general (Across the board)	Score	Energy and weight	SFA, *trans*-FA and sugars	Proteins, dietary fiber, iron, vitamin C, and fat-soluble vitamins	Based on two independent scores: limiting nutrient score, and nutrient density score.
Sweden (Swedish National Food Administration, 2005)	Based on groups	Threshold	100 g (weight %)	Total fat, sodium and added sugar	Dietary fiber	Criterion linked to the green symbol "keyhole".
Belgium (Belgian NHFP, 2007)	Based on groups	Threshold	Per serving	Energy	n/a	Criterion based on the energy content of foods.
Latin America and the Caribbean (PAHO, 2016)	Food in general (Across the board)	Threshold	Energy	Sodium (≥1 mg / kcal), free sugars (≥10% energy), sweeteners (any amount), total fat (≥30% energy), SFA (≥10% energy), *trans*-FA (≥1% energy)	n/a	The PAHO suggests the application of several measures to ultra-processed food (based on a specific list) that exceed the threshold, such as: restrictions in marketing and promotion to children; regulation in the school environment; warning front-of-package labels; application of taxes to limit their consumption; evaluation of agricultural subsidies; and evaluation of guidelines.
Canada (Health	Based on	Threshold		SFA	>10% recommended	There are no specific requirements for the

Canada; 2001)	groups				intakes at least for one of the vitamins/minerals	nutrient composition of food requiring a claim. Food can be labeled as “other food” of the Canada’s food guide; for example, foods that are high in salt, sugar, fat, and beverages.
USA (United States Food and Drug Administration, 2002)	Food in general (Across the board)	Threshold	Per serving	Total fat (<13 g), SFA (< 4 g), Cholesterol (<60 mg), sodium (<480 mg) Per serving	>10% daily value of at least the following nutrients: vitamin A (500 IU) or C (6 mg) or Calcium (100 mg) or Fe (1.8 mg) or protein (5 g) or dietary fiber (2.5 g) per serving	Except for dietary supplements. In addition, other specific criteria should be met for nutrients subject to a maximum and a minimum level.
Mexico (*Secretaría de H. y Crédito Público y SAT*, 2013)	Food in general (Across the board) and Based on groups	Threshold	Energy and weight	Energy (≥275 kcal / 100 g), free sugars (any amount in beverages)	n/a	Tax to beverages with sugar of 1 Mexican peso per liter (approx 10%) and 8% to processed foods (excluding minimally processed foods) with high energy density.
Peru (*Presidencia de la Rep. del Perú* 2015)	Food in general (Across the board)	Threshold	Weight and volume	Sugar (≥2.5 g / 100 ml or ≥ 5 g / 100 g), salt (≥300 mg / 100 ml or 100 g), saturated fat (≥0.75 g / 100 ml or ≥1.5 g / 100 g)	n/a	In addition to regulations of promotion and advertisement of these products, the inclusion of the statement “High in (sugar, sodium, saturated fats), avoid the excessive consumption” is requested. In the case of *trans* fats, the following statement should be included “contains *trans* fats, avoid its consumption”.
Bolivia (*Asamblea Legislativa Plurinacional de Bolivia*, 2015)	Food in general (Across the board)	Threshold, color scale (traffic light)	Weight and volume	Low Concentration: SFA (≤1.5 g / 100 g or 0.75 g/100 ml), added sugar (≤5 g / 100 g or 2.5 g / 100 ml), sodium (≤120 mg / 100 g or 100 ml)	n/a	Graphic system that should use a red bar with the statement “very high in…” for processed food that meets the criterion. Yellow bar with the statement “medium in…” for processed food that meets criterion of medium concentration (not detailed). Green bar with the statement

				Very High Concentration: SFA (≥10 g / 100 g or 5 g / 100 ml), added sugar (≥15 g / 100 g or 7.5 g / 100 ml), sodium (≥600 mg / 100 g or 100 ml)		"low in…" for processed foods that meets criteria of low concentration.
Chile (*Ministerio de Salud de Chile*, 2012)	Food in general (Across the board)	Threshold	Per serving	Energy (≥200 kcal), sodium (≥300 mg), total sugars (≥18 g), fats (≥3 g)		Specific message inside an octagon (or "Stop" sign" that indicate "high in…".
Australia/ New Zealand (ANZFA; 2001)	Food in general (Across the board)	Threshold	Per serving (for specific products per 100g or 100 kJ)	Total fat (<14 g) SFA (<5 g) Sodium (<500 mg)	>10% RDA of all nutrients other than sodium or potassium	The nutrient profiling by scoring method is under development taking into account the total levels of sugar, fat, SFA, proteins, and content of fruit and vegetables (modified from the EFSA model in UK) (FSANZ, 2013)

VI. ADVANTAGES, DISADVANTAGES AND LIMITATIONS OF NUTRIENT PROFILING FOR PUBLIC HEALTH

Advantages and disadvantages during the development of nutrient profiling systems

Currently, a standardized methodology to assess nutrient profiling is not available yet. The use of different systems in the same food or food group has been studied by several working groups and the previously described advantages and disadvantages have been also encountered.

The nutrient profiling systems based on food groups have the advantage of allowing a general comparison by serving size, intake frequency and consumption pattern of products from each group, which could ease the application of a single nutrient profiling model. In addition, due to the similarity of food composition within each group, nutrient profiling would be simpler for each food group (including only few nutrients in order to differentiate well between products) and would also be adapted easily. It is a flexible system that allows establishing nutrient profiling for specific food groups. However, the absence of standardized food groups at regional level (European or American) based on their nutrient contribution to the overall diet is known, and since the food groups' offer is becoming more complex, the creation of a large number of food groups to cover the inclusion of all foods and food products would be necessary. Consequently, the main disadvantage of this system is the complexity of defining and managing a wide number of food groups in the whole region of interest with each food assigned to a single group unambiguously.

The "across the board" system using scoring methods can represent better the overall quality of a food or meal and could be more appropriate for products that are a good source of "positive" nutrients whereas they also contain high levels of "negative" nutrients. This could seem complex when using them, especially if the number of nutrients is limited. If a scoring method is established, a reference threshold should also be taken into account in order to apply the legislation about health claims. The derogation of a nutrition or health claim is easier when using "across the board" systems by the scoring method because it does not require the separation of thresholds, for example, the removal of a single "negative" nutrient from the score calculation of a food group, can lead to an improved total score. In this context, it could be stated that if a food has 1 point for energy, 6 points for salt, 3 points for sugar, 2 points for SFA and 6 points for "positive" nutrients, the score for negative nutrients would be 12, so placing value on "positive" nutrients would not be allowed. Therefore, this food would not be allowed to bear a nutrition claim. If the sodium criterion is removed then the remaining is 6 points for negative, which allows place value to positive nutrients because they provide an equal score, the total score would be zero; the food could bear a claim and should be labeled stating that it is high in sodium. Theoretically, the scoring methods should leave more room for product evolution. The "across the board" systems by the scoring method, particularly those calculated by continuous scoring are less sensitive to the effects of thresholds.

The advantage of the systems using the threshold method is their simplicity and being very practical: these systems can be easily explained to manufacturers, they are useful for the reformulation of the product and for the control in the laboratories; moreover, their application to reject nutrition or health claims is simple. A disadvantage is that these systems can be too simplistic and may need to create specific thresholds for particular food groups.

The manufacturers use both methods of the "across the board system", the threshold and the score, apparently with the same efficiency and satisfaction. The scoring method may be more or less strict than the threshold method, depending on the threshold used for the final score.

The EFSA recommends that the selection of the system should be based on pragmatic considerations related to the specific needs of each system, whereas the score or threshold values should be chosen to facilitate a better classification of foods (EFSA, 2008).

Table 3 highlights the main advantages and disadvantages of the different nutrient profiling methods.

Table 3. Main advantages and disadvantages of the different nutrient profiling methods

	Advantages	Disadvantages
Scoring method	• Reflects better the global quality of foods • Identifies products that are a good source of a nutrient but high in other nutrients • Eases the reformulation conducted by the industry since the scoring method presents several nutrients susceptible to reformulation • Could be easier to use, especially if the number of nutrients is limited • Could allow more discrimination between products	• Does not allow the consumer to compensate/compare a product with another • Could seem that a food is very good or very bad • Could be difficult to know which nutrients are "positive" • There are no standardized objectives that allow comparisons
Threshold method	• Simple • Provides the industry with simple goals for product reformulation • Eases the comparisons between products for industry and consumer (promoting the competitiveness) • Does not require to decide which food are "good" (standardized objectives from food guidelines)	• Difficulty to deal with products that possess specific thresholds • Could be too simplistic • It might be difficult to choose the reference values if there is a wide range of thresholds against the reformulation.

Adapted from: EFSA (2007).

Advantages and disadvantages of the implementation and validation of the nutrient profiling systems

Scientific studies showing the nutrient profiling used in food labeling are useful tools for allowing the consumer to identify (Drewnowski *et al*., 2010; Glanz *et al*., 2012; Masset *et al*., 2015) and to increase (Maillot *et al*., 2011) the consumption of healthy food have been conducted. The choice of healthier foods improves with consumer education programs to explain how to make food choices (Glanz *et al*., 2012). However, given the great volume of different front-of-package labeling systems at the global level, a standardization of symbols and the establishment of criteria for their use are required due to the fact that foods displaying labels could confuse the consumers and led them to believe that these foods are healthier than foods not displaying any kind of label (Emrich *et al*., 2013). These results are consistent with the recently described in a study that analyzes nutrition claims of 382 products in United Kingdom, and the results indicate that these products are not healthier than foods not bearing a claim; consequently, the utility of nutrient profiling to regulate these claims is reinforced (Kaur *et al*., 2015). Another recent study showed that there is a high correlation between nutrient profiling score and the subjective evaluation of the consumer about whether a food is healthy or not. By contrast, there was a tendency to underestimate saturated fat, salt and protein when evaluating entire meals (Bucher *et al*., 2015).

Due to the sharp fluctuation in food prices, a number of scientific studies aimed to analyze it have emerged. In 2010, Monsivais *et al*. published the prices differences between healthy and unhealthy food for the period 2004-2008 (Monsivais *et al*., 2010), concluding similarly to other authors that food groups with healthier nutrient profiling have a higher price that the less healthy, which suggests that the current structure of price policies could be a great barrier for a better adherence to recommendations of dietary guidelines, and especially for the low-income households (Maillot *et al*., 2007). This issue was studied more deeply by Darmon *et al*. in 2014, whose results confirmed that low-income families make less healthy choices and consume less fruit and vegetables than middle-income families, suggesting that the current prices policies could increase the financial inequality to access healthier food (Darmon *et al*., 2014). However, an experimental study was performed in 2015 providing information on the nutrient profiling of foods and decreasing the price of healthier foods and increasing the price of the unhealthy foods. The results of this study showed that the solely fact of providing the nutrient profiling to the consumer improves the quality of purchased food, but not in combination with changes in price policy; in addition, no significant benefits were found in the overall diet quality when both strategies where combined (Epstein *et al*., 2015). These results are inconsistent with the recommendations on changes in food prices of models such as the Mexican one (*Secretaría de Hacienda Y Crédito Público y SAT-Servicio de Administración Tributaria*, 2013) or the PAHO model (PAHO, 2016). A significant measure regarding price policies is the awareness about the differences in nutrient quality of foods of registered trademark and the store brand, that could have a lower price and similar nutritional quality (Faulkner *et al*., 2014)

The nutrient profiling models, as they are being used, can be applied only for processed food. These foods have “critical” nutrients as part of their composition, such as salt, sugar, saturated, *trans*- and total fats. The nutrient profiling are restricted to rate only processed food containing “critical” nutrients as ingredients, but they cannot classify “critical” food like that because country dietary guidelines determine populations for the regulation of the consumption of these foods. For this reason, nutrient profiling cannot be used as the only reference, the population should be informed through dietary guidelines and learn to choose the food with a “better” nutrient profiling, as well as to balance its overall diet. Whether the use of nutrient profiling improves overall dietary profiling of different populations should be confirmed.

Another disadvantage, that references specify regarding the implementation of nutrient profiling, is the interest of food industry to function as a lobby group for the decisions regarding nutrient profiling models and laws and regulations that the health bodies try to develop (Laplace, 2006; Foltran *et al*., 2010).

It should not be forgotten that the proposal of nutrient profiling is very important for the health of the population (Donnenfeld *et al*., 2015), even though it is sometimes inconsistent with the results of some nutrigenetic and metabolomic studies (Whitfield *et al*., 2004; Gibney *et al*., 2005; Foltran *et al*., 2010) indicating that the intake of amounts of different nutrients based on the genetic profile can influence health to a greater or lesser extent, such as the cases of sodium or fat. However, according to Gregori *et al*. (2011), there is a great disagreement in the classification of foods based on the nutrient profiling model used and, therefore, the data derived from the nutrigenetic tests are inconsistent and more research on this issue is needed.

VII. CONCLUSIONS

The growing global overweight and obesity epidemic, as well as the increasing prevalence of diet-related noncommunicable diseases, have led international, national and regional bodies to take a series of measures and agreements to improve the quality of the diet and increase healthy dietary habits between populations. The nutrient profiling is established in response to those measures and agreements as a very valuable tool to support citizens in the choice of healthier food based on their nutrient composition.

The nutrient profiling models represent useful tools for taking measures and making decisions, such as the regulation of marketing, front-of-package food labeling and policies on subsidies or taxation to different food groups based on their role, positive or negative, in public health.

For the particular case of processed food, the main target of nutrient profiling, the continuous review of the nutrient profiling is justified by the emergence of new foods, new formulations and new processing techniques that affect their nutrients composition and bioavailability.

The nutrient profiling systems and models that have been implemented and validated to date have been the subject of several scientific studies showing a heterogeneous range of results and conclusions regarding their actual impact on public health. The nutrient profiling models should be always subject to review, including substantial changes, based on the results obtained using standardized validation processes.

The nutrient profiling should be used as a complementary tool to show the population how to make healthy decisions, regarding food, being dependent on the dietary guidelines of each country. For this reason, the implementation of nutrient profiling should be accompanied and supported by the nutrition education targeting the population of each country, aiming to warrantee the correct interpretation of the term "healthy".

The creation of nutrient profiling should respond to a systematic, transparent and logic methodological process, ideally agreed between the different sectors of each country or region involved (governmental organizations, public bodies, food industry and consumers' organizations). The nutrient profiling created to date to meet different objectives, may cause confusion or doubts on the objectivity of the methodology used for food choice and the establishment of the thresholds. These could become impossible to meet if the nutrient profiling should be maintained without affecting the safety and/or palatability of a food item. This situation leads to the need for consensus between the different stakeholders involved in the diet of the population.

So far, the target population for regulating the advertising of food by using nutrient profiling has been the children because the eating habits are established at the pediatric age. Therefore, the involvement of teachers with the introduction of topics related to food and nutrition in the school curriculum is advisable. Furthermore, the nutrition education of parents and legal guardians as responsible parties for the food choices and purchases for the household food items is important. In any case, the management of food advertising should be adjusted to each country due to the particular habits and customs of each population. This adjustment represents a very important challenge for the development of nutrient profiling and regulatory measures in each nation.

VIII. FURTHER CONSIDERATIONS

There is still a long way to go regarding the definition, implementation and evaluation of nutrient profiling. Whether the nutrient profiling would be positively adapted by the countries taking into account the relevance of food groups, their role in the diet and the contribution of the nutrients to the overall diet of a population or a particular group within a population is an arising question. Furthermore, it is not clear if, in addition to the nutrient composition of food, the habitual food intake within each culture and its position in specific dietary guidelines would also be taken into account. Moreover, whether the classification or categorization of single foods would lead to positive changes in overall dietary patterns of the populations is still uncertain. Therefore, it is important to continue with the evaluation and constant improvement of the different nutrient profiling models at international level and their application or adaptation to specific countries.

IX. REFERENCES

Agencia Española de Consumo, Seguridad Alimentaria y Nutrición (AECOSAN) (2014) Informe del Comité Científico de la Agencia Española de Consumo, Seguridad Alimentaria y Nutrición (AECOSAN) sobre objetivos y recomendaciones nutricionales y de actividad física frente a la obesidad en el marco de la Estrategia NAOS. Revista del Comité Científico de la AECOSAN. Número 19. Madrid

Agencia Española de Seguridad Alimentaria y Nutrición (AESAN) (2005) Estrategia para la nutrición, actividad física y prevención de la obesidad (NAOS). Ministerio de Sanidad, Servicios Sociales e Igualdad. Madrid

Agencia Española de Seguridad Alimentaria y Nutrición (AESAN) (2005a) Código de autorregulación de la publicidad de alimentos dirigida a menores, prevención de la obesidad y salud (código PAOS). Ministerio de Sanidad, Servicios Sociales e Igualdad. Madrid

Agencia Nacional de Vigilancia Sanitaria de Brasil. Perfil Nutricional Dos Alimentos Procesados. Informe ténico n. 43/2010. 2010.

Agence nationale de sécurité sanitaire de l'alimentation, de l'environnement et du travail (antigua AFFSA) (2008) Setting of nutrient profiles for accessing nutrition and health claims: proposals and arguments

Arambepola C, Scarborough P, Rayner M (2008). Validating a Nutrient Profile model. Public Health Nutr 11(4):371–8

Arambepola C, Scarborough P, Boxer A, Rayner M (2009) Defining "low in fat" and "high in fat" when applied to a food. Public Health Nutr 12(3):341–50

Asamblea Legislativa Plurinacional de Bolivia (2015) Ley de promoción de alimentación saludable

Australia and New Zealand Food Authority (ANZFA) (2001) Inquiry Report: Proposal P153. Review of Health and Related Claims. Available: http://www.foodstandards.gov.au/standardsdevelopment/proposals/proposalp153healthandrelatedclaims/index.cfm (accessed March 08, 2016)

Australia and New Zealand Food Regulation Ministerial Council (2014) Legislative and Governance Forum on Food Regulation - Final Communique

Azaïs-Braesco V, Goffi C, Labouze E (2006) Nutrient profiling: comparison and critical analysis of existing systems. Public Health Nutr 9(5):613–22

Barnes CM (2005) Dental hygiene participation in managing incipient and hidden caries. Dent Clin North Am 49(4):795-813

Belgian National Food and Health Plan (NFHP) (2007) Mandate project 'Food product references to the Belgian National Food and Health Plan (NFHP) nutritional objectives'. Final version July 2007

Benelam B, Stanner S (2015) Development of a methodology to assess the Nutrient Profile of popular UK meals. Nutr Bull 40(4):315–25

Bonfanti N (2008) Perfiles nutricionales. Centro de estudios de nutrición infantil Dr. Alejandro O´donnell. Centro de Estudios sobre Nutrición Infantil, Argentina

Boza J, Kettler S, Knowles ME (2010) Capítulo 12. Bebidas refrescantes. En: Tratado de Nutrición. Tomo II. Composición y calidad nutritiva de los alimentos

Bucher T, Müller B, Siegrist M (2015) What is healthy food? Objective Nutrient Profile scores and subjective lay evaluations in comparison. Appetite 95:408–14

Center for Food Safety and Applied Nutrition (2015) U.S. Food and Drug Administration. Labeling & Nutrition - Proposed Changes to the Nutrition Facts Label

Chiuve SE, Sampson L, Willett WC (2011) Adherence to the Overall Nutritional Quality Index and Risk of Total Chronic Disease. Am J Prev Med 40(5):505–13

Clerfeuille E, Vieux F, Lluch A, Darmon N, Rolf-Pedersen N (2013) Assessing the construct validity of five Nutrient Profiling systems using diet modeling with linear programming. Eur J Clin Nutr 67(9):1003–5

Commission of the European Communities (2007) White paper on - A Strategy for Europe on Nutrition, Overweight and Obesity related health issues

Confédération des Industries Agro-Alimentaires de l'UE (CIAA) (2004) Principles of food and beverage product advertising". Available: http://www.pfpz.pl/index/?id=766d856ef1a6b02f93d894415e6bfa0e. (Accessed, March 8, 2016)

Congreso de la República del Perú (2013) Ley de promoción de la alimentación saludable para niños, niñas y adolescentes

Cunningham K, Kamonpatana K, Bao J, Ramos-Buenviaje J, Wagianto A, Yeap Pw (2015) Unilever Nutrition Strategy and Examples in Asia. J Nutr Sci Vitaminol 61:39–40

Darmon N, Lacroix A, Muller L, Ruffieux B (2014) Food price policies improve diet quality while increasing socioeconomic inequalities in nutrition. Int J Behav Nutr Phys Act 11(1):66

Dean M, Spence M, Hodgkins C, Raats MM (2015) Front-of-pack (FOP) labelling of foods and beverages. Adv Food Beverage Labelling 113-131

Deparment of Health UK (2005) Nutrient Profiling: How the Agency's model has developed

Department of Health UK (2011) Nutrient Profiling Technical Guidance. January:1–18

Devi A, Eyles H, Rayner M, Mhurchu CN, Swinburn B, Lonsdale-Cooper E, *et al.* (2014) Nutritional quality, labelling and promotion of breakfast cereals on the New Zealand market. Appetite 81(3704413):253–60

Donnenfeld M, Julia C, Kesse-Guyot E, Méjean C, Ducrot P, Péneau S, et al (2015) Prospective association between cancer risk and an individual dietary index based on the British Food Standards Agency Nutrient Profiling System. Br J Nutr 114(10):1702–10

Drewnowski A (2010) The nutrient rich foods index helps to identify healthy, affordable foods. Am J Clin Nutr 91:1095–101

Drewnowski A, Fulgoni V (2008) Nutrient Profiling of foods: Creating a nutrient-rich food index. Nutr Rev 66(1):23–39

Drewnowski A, Fulgoni V (2011) Comparing the Nutrient Rich Foods Index with “Go,” “Slow,” and “Whoa” Foods. J Am Diet Assoc 111(2):280–4

Drewnowski A, Fulgoni V (2014) Nutrient density: Principles and evaluation tools. Am J Clin Nutr 99(5)

Drewnowski A, Maillot M, Darmon N (2009) Should Nutrient Profiles be based on 100 g, 100 kcal or serving size? Eur J Clin Nutr 63(7):898–904

Drewnowski A, Maillot M, Darmon N (2009a) Testing Nutrient Profile models in relation to energy density and energy cost. Eur J Clin Nutr 63(5):674–83

Drewnowski A, Moskowitz H, Reisner M, Krieger B (2010) Testing consumer perception of nutrient content claims using conjoint analysis. Public Health Nutr 13(5):688–94

Elmadfa I, Weichselbaum E (2005) Energy and nutrient intake in the European Union. European Nutrition and Health Report 2004. Forum Nutr 58:19-46

Emrich TE, Cohen JE, Lou WY, L’Abbé MR (2013) Food Products Qualifying for and Carrying Front-of-Pack Symbols: a Cross-sectional Study Examining a Manufacturer Led and a Non-profit Organization Led Program. BMC Public Healthn 13(846):1–9

Emrich TE, Qi Y, Cohen JE, Lou WY, L’Abbe ML (2015) Front-of-pack symbols are not a reliable indicator of products with healthier Nutrient Profiles. Appetite 84:148–53

Epstein L, Finkelstein E, Katz D, Jankowiak N, Pudlewski C, Paluch R (2015) Effects of Nutrient Profiling and price changes based on NuVal® scores on food purchasing in an online experimental supermarket. Public Health Nutr 23:1–8

Eržen N, Rayner M, Pravst I (2015) A comparative evaluation of the use of a food composition database and nutrition declarations for Nutrient Profiling. J Food Nutr 54(2):93–100

European Commission (2001) Directorate General and Consumer Protection. Discussion Paper on Nutrition Claims and Functional Claims

European Commission (2009) Health and Consumers Directorate General. Working document on the setting of Nutrient Profiles. Preliminary draft Legal proposal

European Commission (2012) Commission Regulation (EU) No 1047/2012 amending Regulation (EC) No 1924/2006 with regard to the list of nutrition claims. Official Journal of the European Union L310/36-37

European Food Safety Authority (EFSA) (2005) Opinion of the Scientific Panel on Upper Intake Level of Sodium. The EFSA Journal 209: 1-26 Available: http://www.efsa.europa.eu/EFSA/efsa_locale-1178620753812_1178620767128.htm (accessed March 8, 2016)

European Food Safety Authority (2007) Nutrient Profiling for foods bearing nutrition and health claims

European Food Safety Authority (EFSA) (2008) The settings of Nutrient Profiles for foods bearing nutrition and health claims pursuant to article 4 of the Regulation (EC) No 1924/2006. Scientific opinion of the panel on dietetic products, nutrition and allergies. The EFSA Journal 644: 1-44

European Food Safety Authority (EFSA) (2010) Panel on Dietetics Products, Nutrition and Allergies, Scientific Opinion on Dietary Reference Values for fats, including saturated fatty acids, polyunsaturated fatty acids, monounsaturated fatty acids, trans fatty acids, and cholesterol. EFSA Journal 8(3):1461

European Food Safety Authority (EFSA) (2013) Panel on Dietetics Products, Nutrition and Allergies, Scientific Opinion on Dietary Reference Values for energy. EFSA Journal 11(1):3005

European Free Trade Association (EFTA) (2013) Appendix 1 to Draft Regulations. Foods and beverages that are considered unhealthy under these Regulations [e-document].Oslo: Helsedirektoratet; 2013 http://www.eftasurv.int/media/notification-of-dtr/ Appendix-to-Regulations.-Unhealthy-foods---9005.pdf (accessed 8 March 2016)

European Parliament and Council (2007) Corrigendum to Regulation (EC) No 1924/2006 of the European Parliament and of the Council of 20 December 2006 on nutrition and health claims made on foods. Official Journal of the European Unipon L12/3-18 Available: https://www.fsai.ie/uploadedFiles/Cor_Reg1924_2006(1).pdf (Accessed March 8, 2016)

EU Pledge (2015) Nutrition Criteria White Paper 1–49

Faulkner GP, Livingstone MBE, Mccaffrey TA, Kerr MA (2014) Supermarket own brand foods: Lower in energy cost but similar in nutritional quality to their market brand alternatives. J Hum Nutr Diet 27:617–25

Federación Española de Sociedades de Nutrición, Alimentación y Dietética (FESNAD) (2015) Consenso sobre las grasas y aceites en la alimentación de la población española adulta

Foltran F, Verduci E, Ghidina M, Campoy C, Jany K, Widhalm K, et al (2010) Nutritional profiles in a public health perspective: a critical review. J Int Med Res 38(2):318–85

Food and Agriculture Organization of the United Nations (FAO), Iberoamerican Nutrition Foundation (FINUT) (2012) Report No. 91 Grasas y ácidos grasos en nutrición humana. Granada

Food and Agriculture Organization of the United Nations (FAO), World Health Organization (WHO) (2014) Second International Conference on Nutrition. Rome Declaration on Nutrition

Food Standards Agency (FSA) (2007) Food, using Traffic Lights to make healthier choices. United Kingdom

Food Standards Agency (FSA) (2009) Nutrient Profiling Technical Guidance. United Kingdom

Food Standards Agency (FSA) (2009a) FSA´s Nutrient Profiling model review. United Kingdom

Food Standards Australia New Zealand (2011) Calculation method for determining foods eligible to make health claims: Nutrient Profiling Calculator. United Kingdom

Food Standards Australia New Zealand (2013) Short guide for industry to the Nutrient Profiling Scoring Criterion (NPSC) in Standard 1.2.7-Nutrition, Health and Related Claims

Forum of Responsible Food Marketing Communication (2014) Code of responsible food marketing communication to children. Copenhagen Available: https://kodeksforfoedevarereklamer.di.dk/SiteCollectionDocuments/Code%20with%20guide%20english%20october%202014%20-%20endelig1.pdf (accessed 8 March 2016)

Garsetti M, de Vries J, Smith M, Amosse A, Rolf-Pedersen N (2007) Nutrient profiling schemes, overview and comparative analysis. Eur J Nutr 21:15-38

Gerrior SA (2010) Nutrient profiling systems: are science and the consumer connected? Am J Clin Nutr 91:1116S–1117S

Gibney GMJ, Walsh M, Brennan L, Roche HM, German B, van Ommen B (2005) Metabolomics in human nutrition: opportunities and challenges. Am J Clin Nutr 82: 497 – 503

Gil A, Ruiz-Lopez MD, Fernandez-Gonzalez M, Martinez de Victoria E (2014) The FINUT healthy lifestyles guide: Beyond the food pyramid. Adv Nutr 14;5(3):358S-67S

Glanz K, Hersey J, Cates S, Muth M, Creel D, Nicholls J, et al (2012) Effect of a Nutrient Rich Foods consumer education program: Results from the Nutrition Advice Study. J Acad Nutr Diet 112(1):56–63

Gobierno de Ecuador (2014) Reglamento Sanitario Sustitutivo de Etiquetado de Alimentos Procesados para el Consumo Humano. Ministerio de salud pública

Goodman S, Hammond D, Hanning R, Sheeshka J (2012) The impact of adding front-of-package sodium content labels to grocery products: an experimental study. Public Health Nutr 16(3):1–9

Gregori D, Foltran F, Verduci E, Ballali S, Franchin L, Ghidina M, et al (2011) A genetic perspective on nutritional profiles: Do we still need them? J Nutrigenet Nutrigenomics 4(1):25–35

Harris JL, Thompson JM, Schwartz MB, Brownell KD (2011) Nutrition-related claims on children's cereals: What do they mean to parents and do they influence willingness to buy? Public Health Nutr 14(12):2207–12

Hawkes D (2009) Defining "Healthy" and "Unhealthy" Foods: An International Review. Office of Nutrition Policy and Promotion, Health Canada

Hawley KL, Roberto CA, Bragg MA, Liu PJ, Schwartz MB, Brownell KD (2012) The science on front-of-package food labels. Public Health Nutr 16,3, 430–439

Health Canada (2001) Product-Specific Authorization of Health Claims for Foods – A Proposed Regulatory Framework. Bureau of Nutritional Sciences Food Directorate Health Products and Food Branch

Health Canada (2007) Guide to developing accurate nutrient values

Hughes C, Wellard L, Lin J, Suen KL, Chapman K (2013) Regulating health claims on food labels using Nutrient Profiling: what will the proposed standard mean in the Australian supermarket? Public Health Nutr 16(12):2154–61

Hurlbutt M, Young DA (2014) A best practices approach to caries management. J Evid Based Dent Pract.14 Suppl:77-86

Institute of Medicine (IoM) (2005) Dietary Reference Intakes: energy, carbohydrates, fiber, fat, fatty acids, cholesterol, protein, and amino acids (Macronutrients). Institute of Medicine. National Academy Press, Washington DC. USA

Jansen L, Roodenburg AJ (2016) The use of food composition data in the Choices International Programme. Food Chem 15:193;196-202

Julia C, Kesse-Guyot E, Touvier M, Méjean C, Fezeu L, Hercberg S (2014) Application of the British Food Standards Agency Nutrient Profiling system in a French food composition database. Br J Nutr 112:1699–705

Julia C, Touvier M, Mejean C, Ducrot P, Peneau S, Hercberg S, et al (2014a) Development and Validation of an Individual Dietary Index Based on the British Food Standard Agency Nutrient Profiling System in a French Context. J Nutr 144(12):2009–17

Julia C, Kesse-Guyot E, Ducrot P, Péneau S, Touvier M, Méjean C, et al (2015) Performance of a five category front-of-pack labelling system - the 5-colour nutrition label - to differentiate nutritional quality of breakfast cereals in France. BMC Public Health 15(1):179

Kaur A, Scarborough P, Matthews A, Payne S, Mizdrak A, Rayner M (2015) How many foods in the UK carry health and nutrition claims, and are they healthier than those that do not? Public Health Nutr 9:1–10

Kleef EV, Dagevos H (2014) The Growing Role of Front-of-Pack Nutrition Profile Labeling: A Consumer Perspective on Key Issues and Controversies. Crit Rev Food Sci Nutr 55(3):291–303

Labouze E, Goffi C, Moulay L, Azaïs-Braesco V (2007) A multipurpose tool to evaluate the nutritional quality of individual foods: Nutrimap. Public Health Nutr 10(7):690–700

Laplace JP (2006) Health and nutrition claims made on food: what future? Bull Acad Natl Med 190:1663–1680 [in French]

Larsson I, Lissner L, Wilhelmsen L (1999) The Green Keyhole revisited, nutritional knowledge may influence food selection. Eur J Clin Nutr 52:776-780

Lobstein T, Davies S (2009) Defining and labelling “healthy” and “unhealthy” food. Review article. Public Health Nutr 12(3):331–40

Luiten CM, Steenhuis IH, Eyles H, Ni Mhurchu C, Waterlander WE (2015) Ultra-processed foods have the worst Nutrient Profile, yet they are the most available packaged products in a sample of New Zealand supermarkets. Public Health Nutr 19(3):530–8

Maillot M, Darmon N, Darmon M, Lafay L, Drewnowski A (2007) Nutrient-dense food groups have high energy costs: an econometric approach to Nutrient Profiling. J Nutr 137(7):1815–20

Maillot M, Drewnowski A, Vieux F, Darmon N (2011) Quantifying the contribution of foods with unfavourable Nutrient Profiles to nutritionally adequate diets. Br J Nutr 105(8):1133–7

Maschkowski G, Hartmann M, Hoffmann J (2014) Health-related on-pack communication and nutritional value of ready-to-eat breakfast cereals evaluated against five Nutrient Profiling schemes. BMC Public Health 14(1):1178

Masset G, Scarborough P, Rayner M, Mishra G, Brunner EJ (2015) Can Nutrient Profiling help to identify foods which diet variety should be encouraged? Results from the Whitehall II cohort. Br J Nutr 113:1800–9

McColl K, Lobstein T (2015) Nutrient Profiling: Changing the food of Britain. London: Coronary Prevention Group and World Obesity Federation

Mejía-Díaz DM, Carmona-Garcís IC, Giraldo-López PA, González-Zapata L (2014) Contenido nutricional de alimentos y bebidas publicitados en la franja infantil de la televisión colombiana. Nutr Hosp 29(4):858–64

Miklavec K, Pravsta I, Grunert KG, Marija Klopčič J, Pohar U (2015) The influence of health claims and nutritional composition on consumers' yoghurt preferences. Food Qual Prefer 43:26–33

Miller FY, Campus G, Giuliana G, Piscopo MR, Pizzo G (2012) Topical fluoride for preventing dental caries in children and adolescents. Curr Pharm Des 18(34):5532-41

Ministerio de Salud de Brasil (2015) Guías alimentarias para la población brasileña. Brasilia

Ministerio de Salud de Chile. Subsecretaría de Salud Pública (2012) Ley 20.606. Sobre composición nutricional de los alimentos y su publicidad. Biblioteca del Congreso Nacional de Chile

Monsivais P, Mclain J, Drewnowski A (2010) The rising disparity in the price of healthful foods: 2004-2008. Food Policy 35(6):514–20

Moynihan P, Petersen PE (2004) Diet, nutrition and the prevention of dental diseases. Public Health Nutr. 7:201–226

Netherlands Nutrition Center (NNC) (2006) Criteria for nutritional evaluation of foods. Available: www.voedingscentrum.nl (accessed March 8, 2016)

Nijman CAJ, Zijp IM, Sierksma A, Roodenburg AJC, Leenen R, van den Kerkhoff C, Weststrate JA, Meijer GW (2007) A method to improve the nutritional quality of foods and beverages based on dietary recommendations. Eur J Clin Nutr 61:461–471

Norwegian Directorate of Health (2012) European Network on reducing marketing pressure on children

Norwegian Directorate of Health (2014) WHO European Action Network on reducing marketing pressure on children Report from the 9th meeting. April:1–20

Órgano del Gobierno de Ecuador (2014) Reglamento Técnico Ecuatoriano "Rotulado de productos alimenticios procesados, envasados y empaquetados." Registro Oficial Ecuador 1–12

Pan American Health Organization (PAHO) (2011) Recommendations from a Pan American Health Organization Expert Consultation on the Marketing of Food and Non-Alcoholic Beverages to Children in the Americas. Washington, D. C.

Pan American Health Organization (PAHO) (2016) Pan American Health Organization Nutrient Profile Model. Washington, D. C.

Parlamento Latinoamericano y Caribeño (2012) Proyecto de Ley Marco para América Latina. Sobre la regulación de la publicidad y promociones de alimentos y bebidas no alcohólicas dirigido a los niños, niñas y adolescentes

Pem D, Jeewon R (2015) Fruit and Vegetable Intake: Benefits and Progress of Nutrition Education Interventions. Narrative Review Article. Iran J Public Health 44:10;1309-1321

Popkin BM (2001) The nutrition transition and obesity in the developing world. J Nutr 131:871S-873S

Presidencia de la República de Costa Rica (2012) Reglamento para el funcionamiento y administración del servicio de soda en los centros educativos públicos

Presidencia de la República del Perú (2015) Decreto Supremo nº 007-2015-SA. Reglamento que establece los parámetros técnicos sobre los alimentos y bebidas no alcohólicas procesados referentes al contenido de azúcar, sodio y grasas saturadas. El Peruano 550859-60

Rayner M, Scarborough P, Stockley L, Foundation BH (2004) Nutrient Profiles: Options for definitions for use in relation to food promotion and children's diets. Final report

Rayner M, Scarborough P, Boxer A, Stockley L (2005) Nutrient Profiles: Development of Final Model Final Report

Rayner M, Scarborough P, Stockley L, Boxer A, Foundation BH (2005a) Nutrient Profiles : Further refinement and testing of Model SSCg3d. Final report

Rayner M, Scarborough P, Lobstein T (2009) London: The UK Ofcom Nutrient Profiling Model

Rayner M, Scarborough P, Kaur A (2013) Nutrient Profiling and the regulation of marketing to children. Possibilities and pitfalls. Appetite 62:232–5

Rogers PJ, Hogenkamp PS, de Graaf C, Higgs S, Lluch A, Ness AR et al (2016) Does low-energy sweetener consumption affect energy intake and body weight? A systematic review, including metaanalyses of the evidence from human and animal studies. Int J of Obesity 40:381–394

Roodenburg A, Popkin B, Seidell J (2011) Development of international criteria for a front of package food labelling system: the International Choices Programme. Eur J Clin Nutr 65(11):1190–200

Roodenburg A, van Ballegooijen AJ, Dötsch-Klerk M, van der Voet H, Seidell JC (2013) Modelling of Usual Nutrient Intakes: Potential Impact of the Choices Programme on Nutrient Intakes in Young Dutch Adults. PLoS One 8:(8)

Ros E, López-Miranda J, Picó C, Rubio MA, Babio N, Sala-Vila A, et al (2015) Consenso sobre las grasas y aceites en la alimentación de la población española adulta; postura de la Federación Española de Sociedades de Alimentación, Nutrición y Dietética (FESNAD). Nutr Hosp 32(2):435-477

Rosentreter SC, Eyles H, Mhurchu CN (2013) Traffic lights and health claims: A comparative analysis of the Nutrient Profile of packaged foods available for sale in New Zealand supermarkets. Aust N Z J Public Health 37(3):278–83

Ruiz-López MD, García-Villanova, Abellán P (2010) Frutas y productos derivados. Capítulo 2. En: Tratado de Nutrición. Tomo II. Composición y calidad nutritiva de los alimentos

Sacks G, Rayner M, Stockley L, Scarborough P, Snowdon W, Swinburn B (2011) Applications of Nutrient Profiling: potential role in diet-related chronic disease prevention and the feasibility of a core nutrient-profiling system. Eur J Clin Nutr 65(3):298–306

Scarborough P, Rayner M, Boxer A, Stockley L (2005) Application of the Nutrient Profiling model: Definition of “fruit, vegetables and nuts” and guidance on quantifying the fruit, vegetable and nut content of a processed product

Scarborough P, Rayner M, Stockley L (2007) Developing Nutrient Profile models: a systematic approach. Public Health Nutr 10(4):330–6

Scarborough P, Boxer A, Rayner M, Stockley L (2007a) Testing Nutrient Profile models using data from a survey of nutrition professionals. Public Health Nutr 10(4):337–45

Scarborough P, Payne C, Agu CG, Kaur A, Mizdrak A, Rayner M, et al (2013) How important is the choice of the Nutrient Profile model used to regulate broadcast advertising of foods to children? A comparison using a targeted data set. Eur J Clin Nutr 67(8):815–20

Secretaría de Hacienda y Crédito Público y SAT-Servicio de Administración Tributaria (2013) Ley del impuesto especial sobre producción y servicios última reforma publicadaDOF11-12-2013. Available: http://www.sat.gob.mx/comext/certificacion_exportadoras/Documents/LIEPS.doc. (accessed March 8, 2016)

Secretaría de Salud de los Estados Unidos Mexicanos (2013) Estrategia nacional para la prevención y el control del sobrepeso, la obesidad y la diabetes. Primera edición. México, D.F Available:

http://promocion.salud.gob.mx/dgps/descargas1/estrategia/Estrategia_con_portada.pdf. (accessed March 8, 2016)

Secretaría de Salud de los Estados Unidos Mexicanos (2014) Ley General de Salud en Materia de Publicidad. Diario Oficial

Secretaría de Salud de los Estados Unidos Mexicanos (2014a) Lineamiento de criterios nutrimentales y de publicidad para publicitar productos en televisión y cine. Diario Oficial de la Federación de los Estados Unidos Mexicanos

Senado y Cámara de Diputados de la Nación Argentina (2013) Ley 26.905. Consumo de sodio

Sluik D, Streppel MT, van Lee L, Geelen A, Feskens EJM (2015) Evaluation of a nutrient-rich food index score in the Netherlands. J Nutr Sci 4(e14):1–9

Smart Choices Program (2009) Nutrition Criteria for the Smart Choices Program. Available: http://smartchoicesprogram.com/pdf/Smart%20Choices%20Program%20Nutrition%20Criteria%20Matrix.pdf (accessed 08 March 2016)

Sociedad Española de Nutrición Comunitaria (2015) Pirámide de la Alimentación Saludable SENC 2015

Soo J, Letona P, Chacon V, Barnoya J, Roberto CA (2016) Nutritional quality and child-oriented marketing of breakfast cereals in Guatemala. Int J Obes 40:1–6

Swedish National Food Administration (SNF) (2005) Livsmedelsverkets föreskrifter omanvändning av viss symbol LIVSFS 2005:9 (Ordinance with conditions for the use of certain symbols) Swedish National Food Administration. Swedish

Tetens I, Oberdörfer R, Madsen C, De Vries J (2007) Nutritional characterisation of foods: Science-based approach to Nutrient Profiling - Summary report of an ILSI Europe workshop held in April 2006. Eur J Nutr 46(Suppl. 2):4–14

Townsend MS (2010) Where is the science? What will it take to show that nutrient profiling systems work? Am J Clin Nutr 91(suppl):1109S–1115S

Trichterborn J, Harzer G, Kunz C (2011) Nutrient Profiling and food label claims: evaluation of dairy products in three major European countries. Eur J Clin Nutr 65(9):1032–8

Trichterborn J, Harzer G, Kunz C (2011a) Fine bakery wares with label claims in Europe and their categorisation by Nutrient Profiling models. Eur J Clin Nutr 65(3):307–12

Trijp HC (2009) Consumer understanding and nutritional communication: key issues in the context of the new EU legislation. Eur J Nutr 48 (Suppl 1):S41–S48

U.S. Department of Health and Human Services, U.S. Department of Agriculture. (2015) Dietary Guidelines for Americans 2015–2020. 8th Edition. Available: http://health.gov/dietaryguidelines/2015/guidelines/ (accessed March 8, 2016)

United States Food and Drug Administration (FDA) (2002) Code of Federal Regulations, Title 21-Food and drugs (volume 2), Chapter I-Food and Drug Administration, Department of Health and Human Services, Part 101-Food Labeling-Table of Contents, Subpart A-General Provisions, Sec. 101.14 Health claims: General requirements and Subpart E-Specific requirements for Health Claims. U.S

Visioli F, Poli A, Peracino A, Luzi L, Cannella C, Paoletti R, et al (2007) Assessment of nutritional profiles : a novel system based on a comprehensive approach. Review article. Br J Nutr 98:1101–7

Volkova E, Neal B, Rayner M, Swinburn B, Eyles H, Jiang Y, et al (2014) Effects of interpretive front-of-pack nutrition labels on food purchases: protocol for the Starlight randomised controlled trial. BMC Public Health 14(1):968

Walker KZ, Woods J, Ross J, Hechtman R (2010) Yoghurt and dairy snacks presented for sale to an Australian consumer: are they becoming less healthy? Public Health Nutr 13(07):1036–41

Wartella EA, Lichtenstein AH, Yaktine A, Nathan R, Sciences NA (2011) Front-of-Package Nutrition Rating Systems and Symbols: A Consumer Health Literacy Perspective. Promoting Healthier and Symbols. Institute of Medicine. Washington 1–163

Whitfield PD, German AJ, Noble PJ (2004) Metabolomics: an emerging post-genomic tool for nutrition. Br J Nutr 92: 549 –555

World Health Organization (WHO) (2000) Fifty-third world health assembly. Global strategy for the prevention and control of noncommunicable diseases. Geneva: World Health Organization

World Health Organization (WHO) (2003) Diet, nutrition, and the prevention of chronic diseases. Geneva: World Health Organization

World Health Organization (WHO) (2003a) Global strategy for infant and young child feeding. Geneva: World Health Organization

World Health Organization (WHO) (2004) Global strategy on diet, physical activity and health. Geneva: World Health Organization

World Health Organization (WHO) and Food and Agriculture Organization of the United Nations (FAO) (2007) Codex Alimentarius. FOOD LABELING: Fifth edition. Geneva: World Health Organization

World Health Organization (WHO) (2008) Action plan for the global strategy for the prevention and control of noncommunicable diseases 2008-2013. Geneva: World Health Organization

World Health Organization (WHO) (2009) WHO Meeting on Estimating Appropriate Levels of Vitamins and Minerals for Food Fortification Programmes: The WHO Intake Monitoring, Assessment and Planning Program (IMAPP). Geneva: World Health Organization

World Health Organization (WHO) (2010) Nutrient Profiling: Report of a WHO/IASO technical meeting. Geneva: World Health Organization

World Health Organization (WHO) (2010a) Marketing of foods and non-alcoholic beverages to children [website]. Geneva: World Health Organization. Available: http://www.who.int/dietphysicalactivity/marketing-food-to-children/en/ (accessed: March 8, 2016)

World Health Organization (WHO) (2013) Global action plan for the prevention and control of noncommunicable diseases 2013-2020. Geneva: World Health Organization

World Health Organization (WHO) (2013a) Vienna Declaration on Nutrition and Noncommunicable Diseases in the Context of Health 2020. Copenhagen: WHO Regional Office for Europe. Available: http://www.euro.who.int/__data/assets/pdf_file/0009/193878/Vienna-Declaration.pdf (accessed 8 March 2016)

World Health Organization (WHO) (2014) European Food and Nutrition Action Plan 2015–2020. Regional Committee for Europe 64th Session. Copenhagen: WHO Regional Office for Europe

World Health Organization (WHO) (2015) Nutrient Profile Model. Copenhagen: WHO Regional Office for Europe

World Health Organization (WHO) (2015a) Guideline: sugars intake for adults and children. Geneva: World Health Organization

World Health Organization (WHO). Development of a regional nutrient profile model for marketing of food children in Europe. Report of meeting. Copenhagen: WHO Regional Office for Europe (*in press*)

World Health Organization (WHO). Guiding principles and framework manual for the development or adaptation of nutrient profile models. Geneva: World Health Organization (*in press*1)

Wright J, Kamp E, White M, Adams J, Sowden S (2015) Food at checkouts in non-food stores: a cross-sectional study of a large indoor shopping mall. Public Health Nutr 18(8):1–8

Wu JHY, Neal B, Trevena H, Crino M, Stuart-Smith W, Faulkner-Hogg K, et al (2015) Are gluten-free foods healthier than non-gluten-free foods? An evaluation of supermarket products in Australia. Br J Nutr 114:448–54

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According to the World Health Organization (WHO), **nutrient profiling** is defined as "the science of classifying or ranking foods according to their nutritional composition for reasons related to preventing disease and promoting health". During the last two decades, different governmental, public, and private entities have been dedicated to developing nutrient profiling models with the aim of helping the populations to choose healthier foods. This technical-scientific report of FINUT was created with the intention to provide the readership a document that comprises the scientific intentionality during the creation of these nutrient profiling models, their applications, and their actual impact on public health.

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