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Nutrient profiles and their potential impact as a tool for public health initiatives in Europe

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"To eat is a necessity, but to eat intelligently is an art."

François de La Rochefoucaul

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List of abbreviations

µg	micrograms
DONALD study	Dortmund Nutritional and Anthropometric Longitudinally Designed Study
e.g.	exempli gratia (for example)
EFSA	European Food Safety Authority
et al.	et alii (and others)
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FDA	Food and Drug Administration
FKE	Research Institute of Child Nutrition (Forschungsinstitut fuer Kinderernaehrung)
FSA	Food Safety Authority
g	grams
i.e.	id est (that is)
kcal	kilocalories
kJ	kilojoules
mg	milligrams
OMD	Optimised Mixed Diet
RG	research gap
RQ	research question
RV	reference value
SFA	saturated fatty acids
UK	United Kingdom
US	United States
VitD	vitamin D
WHO	World Health Organization

Abstract

Nutrient profiles allow the categorisation of foods and drinks according to their overall nutritional composition. They are widely applied in Europe and around the world to guide consumers' choices towards healthier items. However, existing studies that analyse the meaningfulness of product categorisation by such schemes are mostly limited to the evaluation of generic food items as well as the number and type of products that meet the criteria.

This dissertation has addressed this shortcoming by analysing the potential impact of six existing nutrient profiling schemes on average nutrient contents in commercially available dairy products and fine bakery wares with a healthy positioning from up to five major European markets. Additionally, the potential impact of nutrient profiles on dairy-related nutrient intake in German children and adolescents was evaluated by combining profiling results with product specific intake data.

It was found that nutrient profiles could be applied to meaningfully and comprehensively identify dairy products and fine bakery wares with a significantly better nutritional composition than the average range of products positioned as healthier in major European markets. In addition, the product specific advice given by such models could help to align energy and nutrient intake levels of German children and adolescents with dietary recommendations.

It was also found that a nutrient profiling model for dairy products should include criteria for saturated fatty acids, sugars and sodium in order to obtain the most meaningful results. In this dataset, the use of separate criteria for cheeses and other dairy products seemed necessary to take into account intrinsic compositional differences. Especially for cheeses the criteria should be set carefully to avoid reducing the average calcium and vitamin D contribution of the category to the overall diet. For fine bakery wares, important parameters to take into account included energy, saturated fatty acids, sugars, sodium and fibre. Different criteria sets for subcategories of fine bakery wares did not seem necessary.

Overall, the results demonstrated the importance of testing nutrient profiles against the intended application and evaluating up-to-date information on the products that would be affected. In addition, the evaluation of product-specific intake data was critical to fully understand the potential impact of any profiling based public health intervention on nutrient intake.

Zusammenfassung

Nährwertprofile ermöglichen die Kategorisierung von Lebensmitteln anhand ihrer Nährstoffzusammensetzung. Derartige Einteilungen finden weltweit vielfältig Anwendung, um die Kaufentscheidungen von Vebrauchern zugunsten gesünderer Produkte zu beeinflussen. Bisherige Studien zur Aussagekraft der Ergebnisse beschränken sich im Wesentlichen auf die Evaluierung generischer Lebensmittel und die Anzahl und Art der ausgewählten Produkte. In dieser Dissertation wurde diese Forschungslücke addressiert, indem der mögliche Einfluss von sechs existierenden Nährwertprofilen auf durchschnittliche Nährstoffgehalte in kommerziell erhältlichen Milchprodukten und Kleinbackwaren mit nährwert- oder gesundheitsbezogenen Angaben aus bis zu fünf europäischen Ländern untersucht wurde. Zusätzlich wurde die mögliche Auswirkung ihrer Anwendung auf die Aufnahme von Nährstoffen aus Milchprodukten durch deutsche Kinder und Jugendliche untersucht. Hierfür wurden die Ergebnisse der Anwendung von Nährwertprofilen mit produktspezifischen Verzehrsdaten verknüpft.

Die Ergebnisse zeigen, dass Nährwertprofile eine umfassende Auswahl von Produkten mit einer empfehlenswerteren Nährstoffzusammensetzung im Vergleich zu anderen als gesund positionierten Produkten ermöglichen. Außerdem könnten auf den Ergebnissen basierende Verzehrsempfehlungen dazu beitragen, die Energie- und Nährstoffaufnahme von deutschen Kindern und Jugendlichen im Sinne allgemeiner Ernährungsempfehlungen zu optimieren.

Für aussagekräftige Ergebnisse müssen Nährwertprofile für Milchprodukte Grenzwerte für gesättigte Fettsäuren, Zucker und Natrium beinhalten. Die Verwendung separater Kriterien für Käse und andere Milchprodukte erscheint notwendig, um intrinsische Unterschiede in ihrer Zusammensetzung abzubilden. Käseprodukte im Speziellen bedürfen einer sorgfältigen Definition der Grenzwerte, um ihren durchschnittlichen Beitrag zur allgemeinen Kalzium- und Vitamin D-Aufnahme nicht zu reduzieren. Wichtige Parameter für Kleinbackwaren umfassen die Gehalte an Energie, gesättigten Fettsäuren, Zucker, Natrium und Ballaststoffen. Separate Kriterien für Unterkategorien erscheinen hier nicht erforderlich.

Insgesamt unterstreichen die Ergebnisse die Bedeutung der sorgfältigen Validierung von Nährwertprofilen in Zusammenhang mit ihrem vorgesehenen Anwendungsbereich und durch Evaluierung aktueller Daten zur Zusammensetzung der betroffenen Lebensmittel. Außerdem erscheint die Evaluierung produktspezifischer Verzehrsdaten entscheidend für das Verständnis möglicher Auswirkungen jeglicher auf Nährwertprofilen basierender Interventionsmaßnahmen.

1. Nutrient profiles and their potential impact as a tool for public health initiatives in Europe

1.1. Nutrition and health in Europe

1.1.1. Diet-related health challenges

The prevalence of noncommunicable diseases is rising in Europe and around the world. Recent data underline that an unbalanced diet and lack of physical activity are major risk factors. More than half of all adult citizens in the World Health Organization (WHO) European region are overweight, with levels of up to 70% in some countries (World Health Organization, 2009). Overweight in Europe is responsible for more than one million deaths and twelve million life-years of ill health every year (James *et al.*, 2004). Even more importantly, an average of 15% of the total adult European population are obese with the prevalence varying from less than 10% in Romania to close to 30% in Malta and the United Kingdom (European Commission, 2010). Not only adults are affected, as one in every four children (24%) aged 6 to 9 in Europe is overweight or obese (World Health Organization, 2010). Together with other dietary imbalances like excessive intake of energy from fat (World Health Organization, 2007) and largely insufficient intake of fruits and vegetables as well as dietary fibre (World Health Organization, 2007) these factors contribute to pre-cursors of chronic diseases, e.g. high blood pressure in more than one third and diabetes in more than 10% of all Europeans (World Health Organization, 2009).

1.1.2. From health challenges to general public health and nutrition initiatives

Several initiatives have been created in recent years to address the growing burden of disease and death resulting at least partly from unbalanced dietary choices. These include the 'WHO Global Strategy on Diet, Physical Activity and Health' (World Health Organization, 2004), the 'WHO European Charter on Counteracting Obesity' (World Health Organization, 2006), the 'WHO European Action Plan for Food and Nutrition Policy 2007-2012' (World Health Organization, 2008) as well as the European Commission's 'Strategy for Europe on Nutrition, Overweight and Obesity related health issues 2007-2013' (European Commission, 2007). Major goals include the provision of more comprehensive consumer information, e.g. through labelling of healthier

choices, and improvements in infant and young child nutrition, e.g. through appropriate marketing practices especially for products aimed at children. Both goals are of specific interest in the context of this dissertation.

1.1.3. From general initiatives to dietary recommendations

In 2003, a joint expert group of the WHO and the Food and Agriculture Organization of the United Nations (FAO) summarised the scientific evidence of links between dietary factors like excessive or insufficient intake of nutrients and foods and the risk of key chronic diseases (Joint WHO/FAO consultation, 2003). All convincing and probable relationships reported by this group that are of relevance in the context of this dissertation are summarised in **Table 1.1**. The findings serve as a widely accepted reference for nutrient and food-related dietary recommendations, e.g. in the 2004 'WHO Global Strategy on Diet, Physical activity and Health' (World Health Organization, 2004). They include the achievement of energy balance and a healthy weight as well as reductions of the energy intake from total fat. In addition, the intake of saturated fatty acids (SFA), trans fatty acids, free sugars and salt/sodium should be decreased and the consumption of fruits and vegetables, legumes, whole grains and nuts should be promoted.

1.1.4. From dietary to product specific recommendation

The 'WHO European Action Plan for Food and Nutrition Policy 2007-2012' specifically mentioned the establishment of an efficient method for assessing the nutrient quality of food products as one important enabling tool for translating general dietary recommendations into product-specific recommendations (World Health Organization, 2007). This underlines the importance of nutrient profiling as an emerging subject in nutritional sciences (see Chapter 1.2.).

Table 1.1 **Convincing or probable relationships between nutrients or non-alcoholic foods of importance in this dissertation and main diet-related diseases (adapted from Joint WHO/FAO consultation, 2003)**

Increased health risks with excessive intake		Lower health risks with adequate intake	
Nutrients			
Saturated fatty acids (SFA)	T2D, CVD[a]	NSP (dietary fibre)	OB, T2D, CVD
Trans fatty acids	CVD	Vitamin D	DD[c], OST[d]
Dietary cholesterol	CVD	Calcium	OST[d]
Free sugars	DD[b]	ALA, EPA and DHA	CVD
High intake of sodium	CVD		
Food groups			
High intake of energy-dense foods	OB	Wholegrain cereals	CVD
Salt-preserved foods and salt	CAN[e]	Fruits and vegetables	OB[f], T2D[f], CVD, CAN[g]
		Hard cheese	DD[b]
Increased health risks with inadequate intake			
Calcium	DD[c]		

ALA: α-Linolenic Acid, CAN: Cancer, CVD: Cardiovascular Disease, DD: Dental Disease, DHA: Docosahexaenoic Acid, EPA: Eicosapentaenoic Acid, NSP: Non-starch polysaccharides, OB: Obesity, OST: Osteoporosis, T2D: Type-2-Diabetes

a Evidence also summarised for selected specific fatty acids, i.e. myristic and palmitic acid
b For dental caries
c For enamel developmental defects
d In populations with high fracture incidence only; applies to men and women more than 50-60 years old
e For stomach cancer
f Based on the contributions of fruits and vegetables to non-starch polysaccharides
g For cancer of the oral cavity, oesophagus, stomach and colorectum

1.2.   Nutrient Profiles (see also Chapters 2 and 3)

In 2004, Rayner *et al.* defined nutrient profiling as the "science of categorising foods according to their nutritional composition" (Rayner *et al.*, 2004a/b). This new approach allowed the endorsement of specific single products that can be found in supermarkets rather than giving general advice on the consumption of certain food groups (such as 'low fat dairy products'). The main technical principles and considerations on nutrient profiling are summarised in **Figure 1.1** and the following paragraphs. They are also discussed in more detail in Chapter 2.

Technical principles	• Profiling of foods across the board or category specific • Choice and balance of criteria • Reference quantitiy • Calculation model
General considerations	• Application purpose • Target group
Pre-application considerations	• Testing and validation
Execution considerations	• Implementation of desired state at once or in a gradual and step-wise manner • Assessment of limiting factors and challenges • Importance of periodic revision

Figure 1.1   Overview of technical principles and important considerations on nutrient profiles

1.2.1. Technical Principles

Technically speaking, nutrient profiles categorise foods and drinks into those that meet the criteria defined by the underlying model ('eligible products') and those that do not ('non-eligible products') (**Figure 1.2**).
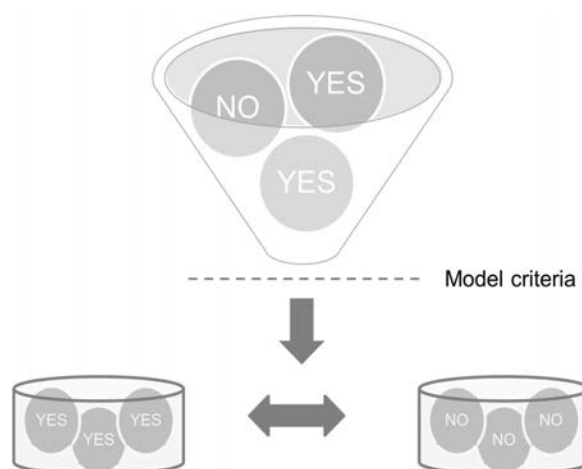
Figure 1.2   Visualisation of the categorisation of foods and drinks by nutrient profiling models

Nutrient profiling models differ, however, in a number of technical parameters that are summarised in **Figure 1.3**.

Number of criteria sets	Choice and balance of criteria	Reference quantity	Calculation model
1 (Across the board)	Disqualiying criteria	100 grams (g)	Threshold
>1 (Category specific)	Qualifying criteria	100 kilocalories (kcal)/ kilojoules (kJ)	Scoring
		Serving size	

— **Model criteria**

Figure 1.3   Overview of technical parameters to define nutrient profiling models

First, it is of importance to consider whether all foods and drinks are evaluated against the same criteria ('across the board') or whether there are specific criteria for different food groups/ categories (which in turn need to be comprehensively defined). Second, a model can define disqualifying parameters for nutrients/ingredients/food groups which have a negative impact on health if consumed in excess, and/or qualifying parameters for constituents that can affect health in a positive way if consumed in sufficient amounts. Third, the parameters can be evaluated on a per 100 grams (g), per 100 kilocalories (kcal)/ kilojoules (kJ) or a per serving size basis. Last, the calculation can be set up so that all criteria defined have to be met simultaneously ('threshold'). Alternatively, points can be allocated to the contents of both disqualifying and qualifying constituents and a final score determines whether the criteria of the model are met ('scoring'). In such a model high levels of qualifying constituents can compensate for high levels of disqualifying ones. Examples of the two different calculation models are given in **Figure 1.4**.

Calculation model	
Threshold	**Scoring**
All thresholds have to be met.	Points are allocated to each constituent. Final score has to meet threshold.

Constituent	Threshold	Actual	Result
SFA	1.4g	0.9g	YES
Added Sugars	5.0g	6.4g	NO
Sodium	120mg	44mg	YES
FINAL SCORE			NO

Constituent	Actual	Points
Energy	291kJ	+0
SFA	0.9g	+0
Total Sugars	10.8g	+2
Sodium	44mg	+0
SCORE DISQUALIFYING		+2
Protein	3.2g	-2
Dietary Fibre	0g	-0
Fruits & Vegetables	<40%	-0
SCORE QUALIFYING		-2
FINAL SCORE		0 (YES)

Figure 1.4   Examples of threshold and scoring calculation models

1.2.2. Important considerations

Apart from the technical principles a number of additional considerations should be addressed in order to develop nutrient profiling models in a meaningful manner:

Application purpose

First, the application purpose is a key consideration. In Europe, one important use of nutrient profiles is front-of-pack labelling of healthier products with specific symbols. Examples include the 'Choices International', 'Albert Heijn Gezonde Keuze', 'Finnish Heart Symbol' or 'Swedish Keyhole' programmes (Choices International Foundation, 2011; Albert Heijn, 2011; Finnish Heart Association, 2011; Livsmedelverket, 2011). Only products that meet the criteria of the underlying profiling models are eligible for carrying the symbols shown in **Figure 1.5**. It also includes the traffic light labelling developed by the Food Standards Agency (FSA) in the United Kingdom (UK) (Food Standards Agency, 2011). The symbol indicates the levels of total fat, SFA, sugar and salt, differentiating between three ranges ('high', 'medium' and 'low'). This threshold based colour coding represents another application of nutrient profiling.

Figure 1.5   Examples of profiling based front-of-pack signposting logos

Nutrient profiles are also applied by OFCOM, the national media regulator in the UK, to regulate marketing activities aimed at children. Only products that meet certain criteria are allowed to be advertised on television at times when children are likely to watch without their parents (OFCOM, 2007; Food Standards Agency, 2007).

Also, nutrient profiles are foreseen for the European Union (EU)-wide regulation of nutrition and health-related product communication, like that already applied by the Food and Drug Administration (FDA) in the United States (US) (Food and Drug Administration, 2010). This is outlined in the 'EU regulation on nutrition and health claims made on foods' (hereafter 'EU Health Claims Regulation') (European Community, 2006). Detailed information on different types of claims and their foreseen regulation can be found in Chapter 3. **Figure 1.6** summarises the most important claim types analysed as part of this dissertation, provides examples and states how each claim type is supposed to be regulated through the application of nutrient profiles.
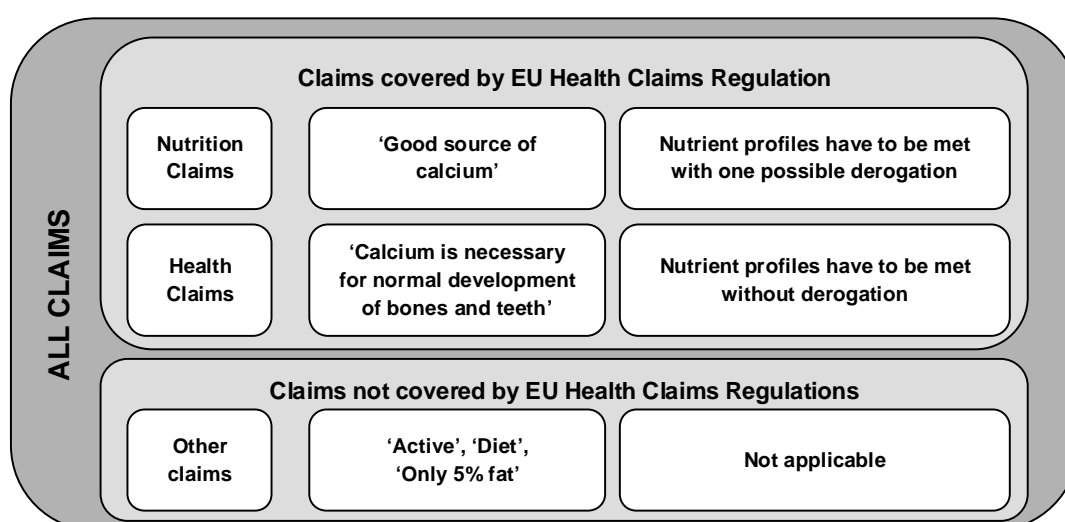
Figure 1.6   Different claim types, examples and their foreseen regulation through nutrient profiles in the EU

Other application purposes of nutrient profiling include the guidance of product development in the food industry (Nijman *et al.*, 2007) and recommendations for school meals (Crawley, 2005).

Target group

Another important factor to consider is the target group (e.g. children, adults or the elderly). A nutrient profiling model needs to be based on both the nutritional intake status as well as specific nutritional requirements of the selection of consumers that are intended to be addressed.

Testing and validation

Before the implementation of a profiling model it should be tested carefully and validated against the intended purpose. It is important to note that the validation of a profiling model for one specific purpose does not necessary mean it can be meaningfully applied in other contexts.

Implementation of desired state at once or in a gradual and step-wise manner

The possibility to advertise with claims or front-of-pack logos can motivate food manufacturers to reformulate products so that they meet nutrient profiles. However, if the criteria are defined very restrictively compared to the average nutritional composition of already existing successful products in the market they may choose not to take the risk of jeopardising market share by changing the formulations. In these cases it could be helpful to implement nutrient profiles that only require smaller changes in the first place. These can later be altered towards the desired state in a step-wise manner as the market follows.

Assessment of limiting factors and challenges

Not all desired changes in the nutritional composition of food products can be implemented immediately and without significant research and/or development efforts. In order to reduce especially the levels of total fat, SFA or sugar, often ingredients that play a significant role for

food quality, safety, processing and/or cost may have to be replaced. While strict criteria in nutrient profiles can be an effective tool to foster innovation in these areas, they also have to take into account the most recent state of science and technology in order to set realistic goals.

On the other hand, if the criteria are not restrictive enough, some manufacturers may apply the logo to products that are perceived as less healthy, thereby inviting criticism by health experts and undermining the credibility of the program.

Importance of periodic review and revision

The average nutritional composition of food products in a specific category is changing constantly with shifts in consumer behaviour, product reformulations or new product launches. It is therefore necessary to regularly test any profiling model with up-to-date input data to understand whether any parameter adjustments are required.

1.3. Research problem

1.3.1. Research gaps

The key to understanding the potential impact of nutrient profiles lies in testing and validating models with varying technical principles. First, a full evaluation cycle consists of analysing product specific profiling results. Second, the efficacy (i.e. the impact on consumers' shopping behaviour in a controlled setting) and effectiveness (i.e. the impact on consumers' shopping behaviour in real life) of the application need to be taken into account. Finally, the impact on the diet needs to be assessed by measuring the individual product intake by each household member (**Figure 1.7**).
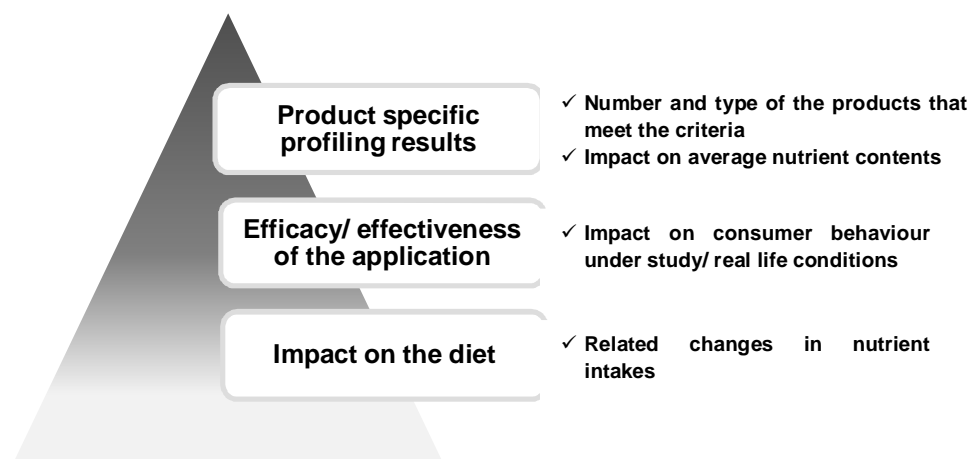
Figure 1.7   Evaluation scheme to assess the impact of nutrient profiles

Literature research based on the evaluation scheme identified the following research gaps (RGs):

RG1.   There is no study that assesses the impact of nutrient profiles for the regulation of claims by evaluating commercially available products with claims in Europe.

The purpose of a nutrient profiling model has often not been taken into account when such models have been tested. When claim regulation is introduced in an existing market, it is more critical to understand what impact profiling would have particularly on the commercially available products that carry a claim, as opposed to the impact on a wide range of generic products.

RG2.   Previous studies on nutrient profiling have not taken into account product specific composition data of commercially available items.

Previous studies have focused on assessing nutrient profiles by evaluating a wide range of food composition data from generic nutrition tables (Azais-Braesco *et al.*, 2006; Arambepola *et al.*, 2007; Garsetti *et al.*, 2007; Quinio *et al.*, 2007; Scarborough *et al.*, 2007; Volatier *et al.*, 2007; Drewnowski *et al.*, 2008a/b; Drewnowski & Fulgoni, 2008; Darmon *et al.*, 2009; Fulgoni *et al.*, 2009). The results were then compared to judgments by nutrition experts, measures of diet quality (such as dietary patterns or index foods linked to health) or compatibility with general

nutrition recommendations. Such an approach is limited because it does not take into account the actual composition of products sold in the market.

RG3.   There are no results on potential changes in average nutrient contents when applying nutrient profiles.

Most studies so far have only looked at the type and number of products that would meet a nutrient profile. In order to best evaluate the impact of any model, however, it is important to also investigate the expected level of improvements in the average nutritional composition of products that meet the criteria in comparison with the current range of all products sold.

RG4.   There are no studies that assess the results of multiple nutrient profiles with different underlying principles in combination with product-specific consumption data to evaluate the potential impact on nutrient intake.

Finally, the most realistic impact assessment combines product-specific profiling results with product-specific intake data in order to evaluate the potential effect on nutrient intake levels. Such predictions were calculated for one profiling model mostly based on generic food composition (Roodenburg *et al.*, 2009; Roodenburg *et al.*, 2011). However, there is no study that compares the potential impact of various profiling models with different underlying principles in one study and evaluates individual consumption data on commercially available products.The efficacy and effectiveness of the application used play a critical role in this context, as any application of nutrient profiles can change nutrient intake only to the extent at which consumer change their buying and consumption behaviour.

1.3.2. Research focus and research boundaries

The research focus in this dissertation lies on the assessment of nutrient profiles with different technical principles by evaluating realistic product and food intake data. At the current time, the most prominent interest in nutrient profiles in Europe is linked to their application for the regulation of nutrition and health claims. Therefore, one main part of the dissertation has dealt

with the potential impact of nutrient profiles on commercially available products with claims. A second main part has focused on the potential impact of nutrient profiles on nutrient intake in German children and adolescents, as specific nutrient intake recommendations are well defined for this group. A joint research project was initiated with the Research Institute of Child Nutrition (Forschungszentrum fuer Kinderernaehrung, FKE) in Dortmund, Germany. The DONALD study (Dortmund Nutritional and Anthropometric Longitudinally Designed Study) run by this institute offers intake data that is product specific, covers complex, multi-component commercial products and contains enough detail to run a comprehensive analysis.

The evaluation of various profiling models including a large number of products requires a large amount of data processing. Therefore, the analyses had to be limited to two main product categories (dairy products and fine bakery wares). In addition, for the intake impact analysis it had to be assumed that the efficiency of the nutrient profiling application was 100%, i.e. it was assumed that participants would only consume products that meet the nutrient profiles. In general, data on the efficacy especially of labelling applications in laboratory settings is contradictory and efficiency data on changes in buying and consumption behaviour is very limited.

1.3.3. Research questions

Based on the previously identified focus areas for research and limitations the following research questions (RQs) arise:

RQ1.   **Could the regulation of claims by nutrient profiles have a significant effect on the nutritional composition of commercially available dairy products and fine bakery wares with a healthier image in Europe?**

    a) How many products with claims are marketed in a selection of EU countries?

    b) How many of the products sold today would meet the profiles?

    c) What would be the key disqualifying parameters?

    d) To what extent would the average nutritional composition of the eligible products differ from the total set of products?

    e) To what extent would models agree on the categorisation of the products?

RQ2. **If nutrient profiles could have a significant impact on the nutritional composition of these products, what are the key technical principles that have to be applied?**

    a) Can all products be evaluated against one set of criteria or are subcategory-specific criteria required?

    b) Which nutrients/ ingredients/ food groups are required as parameters?

    c) Which reference quantity should be applied?

    d) Should the calculation model be based on threshold or scoring?

RQ3. **What impact could nutrient profiles for dairy products and fine bakery wares have on the nutrient intake of children and adolescents in Germany?**

    a) How many of the products consumed today would meet the profiles?

    b) How does the number of eligible products compare to the share of consumption represented?

    c) To what extent would the average nutritional composition of the eligible products differ from the total set of products?

    d) To what extent would the average intake of key nutrients change if only eligible products were consumed?

RQ4. **Which conclusions can be drawn from the generated results for recommended testing and validation procedures for nutrient profiles models in general?**

1.3.4. Analytical approaches

For this dissertation an automated calculation model was developed using Microsoft Excel (version 2007, Microsoft Corporation, Redmond, WA, USA). After collection and preparation of all input data this model provided tailor-made evaluations to address the key research questions. Furthermore, the model could be expanded to cover further research approaches in the future. **Figure 1.8** shows a flowchart of the full analytical model.

Input data (approx. 34,000 values)	• Product • (Sub-)category • Country of sale • Manufacturer	• Categorisation by NP model • (Claim type) • Nutrition values • (Consumption data)

Automated calculation (approx. 65,000 steps)	Overall results per product and NP model	

Automated calculation (approx. 195,000 steps)	Overall results per NP model and • Subcategory • (Claim type) • Key nutrient parameters	• Impact on nutritional composition • (Potential impact on dietary intake) • Inter-model agreement

NP: Nutrient profiling

Figure 1.8   Process flowchart of the applied automated calculation model

1.3.5. Theoretical and practical relevance

The aim of this dissertation is to present a new and comprehensive approach of testing and validating nutrient profiling models to better understand their potential impact as a tool for public health initiatives. It introduces substantial new considerations for the future development of such models. In addition, the results can serve all interested stakeholders as detailed guidance for technical principles of a profiling model that appropriately and meaningfully categorises dairy products and fine bakery wares according to their nutritional composition.

1.4. The potential impact of nutrient profiles on commercially available products with a healthier image

Several nutrient profiling approaches have been proposed for the purpose of regulating claims in the EU and a highly controversial debate has been ongoing for years. In 2008 and following a request by the European Commission and the EU Member States, the European Food Safety Authority (EFSA) developed a training database to test nutrient profiles in the course of development (the so called 'Limited Food Basket'). This database contains 1,494 food items from all categories selected from national food composition databases (European Commission, 2008). At the same time, a 'National Food Basket' with 19,885 items from 9 member states and a 'Commercial Food Basket' containing 2,648 products as sold to the consumer were assembled. However, none of the databases contains information on which products really carry claims today. Therefore, no testing based on these data can show the full potential market impact of a nutrient profile applied for the regulation of claims.

Due to the lack of data, a collection of food label information was undertaken from various European countries. Data on dairy products and fine bakery wares were collected from supermarket shelves and in online supermarkets in three (France, Germany and the UK) and five (France, Germany, Spain, Sweden and the UK) different countries, respectively. The information collected included product name and manufacturer, product category in the supermarket setting, ingredient list, all nutrition information available as well as the claim type and wording. The data were entered into the automated calculation model, where additional information required for the evaluation was added (e.g. categorisation of each product in the different nutrient profiling models or reference amounts for the calculation). The products were then analysed by applying six existing nutrient profiling models that cover a variety of different technical principles (**Table 1.2**). The SAIN,LIM score can only be fully calculated based on data on 9 positive (Score d'Adéquation Individuel aux recommandations Nutritionnelles, SAIN) and 3 negative (Score de composés à LIMiter sur le plan nutritionnel, LIM) nutrients. Due to the restricted availability of nutrition values for the products assessed, most of the analyses in this dissertation were performed for the LIM score only. For the same reason thresholds for dietary cholesterol or trans fatty acids in other profiling models were excluded.

Table 1.2 Overview of the applied nutrient profiling models (Choices International Foundation, 2009; Darmon *et al.*, 2009; Food Standards Agency, 2009; Livsmedelverket, 2009; Smart Choices Program, 2009a/b; Food and Drug Administration, 2010)

	Swedish Keyhole	Choices Programme	Smart Choices Program	FSA/ OFCOM	SAIN,LIM	FDA Health Claims
Country/ Region of (intended) application	Sweden	Worldwide	United States	United Kingdom	European Union	United States
Objective of current use	FOP[1]	FOP[1]	FOP[1]	ADV[2]	CL[3,4]	CL[3]
Number of (sub) categories	26	1+22	1+19	1[5]	1	1
Calculation approach	Threshold	Threshold	Threshold	Scoring	Scoring	Threshold
Number of nutrients (negative/positive)	(5/1)	(4/1)	(6/ 1out of 7 nutrient or 1 out of 4 food groups)	(4/3)	(3/5+4)	(4/ 1 out of 6)
List of nutrients	Total Fat SFA Total Sugars Refined Sugars Sodium Fibre	Energy Total Fat SFA Trans Fatty Acids Added Sugars Sodium Fibre	Total Fat SFA Trans Fatty Acids Cholesterol Addes Sugars Sodium Calcium Potassium Magnesium Fibre Vitamin A Vitamin C Vitamin E Fruits Vegetables Whole grains Fat-free/Low-fat milk products	Energy SFA Total Sugars Sodium Fruits, Vegetables & Nuts Fibre Protein	SFA Added Sugars Sodium Protein Fibre Vitamin C Calcium Iron Optional: Vitamin D Vitamin E α-Linoleic Acid Monounsaturated Fattty Acids	Total Fat SFA Cholesterol Sodium One out of: Vitamin A Vitamin C Iron Calcium Protein Fibre
Reference value	100g/kcal	100g/kcal	One serving/ 100kcal	100g	100g/ 100kcal	One serving

[1] Positive front-of-pack signposting [2] Advertising regulations [3] Claims regulation [4] proposed for this purpose [5] model distinguishes between foods and drinks

1.4.1. Example: Dairy products (see also Chapter 4)

Data on 317 commercially available dairy products with any type of nutrition or health related claim from France, Germany and the UK were collected. The products were categorised into two major categories ('*Cheese products*' & '*Other dairy products*'), with the former being divided into two subcategories ('*Fresh cheeses*' and '*Other cheeses*') and the latter into four ('*Milk/* -

drinks', '*Yogurt drinks*', '*Yogurts*' and '*Dessert quark/Fromage frais*'). They were also grouped according to the type of claim they carried. These included health and nutrition claims as well as other claims like 'diet' claims to indicate the suitability for diabetics, recipe claims like 'only 5% fat' and other indirect claims like 'fit' or 'active'. All products were evaluated against all six profiling models listed in **Table 1.2**. The main results are summarised below. More comprehensive information can be found in Chapter 4.

Distribution of products across categories and claim types

About one third of all dairy products analysed in the study were *Cheese products*. *Other dairy products* made up about two thirds of all items, with *Yogurts* being the biggest subcategory in the study. The majority of products carried either health or nutrition claims, with much higher prevalence of health claims on *Other dairy products* than on *Cheese products*.

Proportion and type of eligible products

Overall, the proportion of products that met the criteria of the respective nutrient profiles ranged from 26% in the case of the Swedish Keyhole to 68% in the case of the FDA model. Products with health or nutrition claims were more likely to meet the criteria than products with other claims. The results also differed significantly with the product (sub)category, with far less *Cheese products* than *Other dairy products* qualifying according to most of the models.

Number and type of disqualifying nutrients

Fat played the most important role as a disqualifying nutrient criterion in all threshold models, either as total fat or SFA. Sugars proved to be an effective threshold for *Other dairy products*, while the maximum sodium level was exceeded at a significant level in *Cheese products* in one of the models. Positive nutrients (in the case of this category specifically calcium) as required by two of the models contributed only little to the non-eligibility of products. Scoring models could not be analysed for disqualifying nutrients as qualifying nutrients can compensate for these.

Potential impact on nutrient levels in products with claims

Many of the nutrient profiles identified products with average contents of SFA, total sugars and sodium that were more than 30% lower compared to all products that were analysed. At the same time, *Cheese products* identified as healthier by the FSA/OFCOM and LIM models contained significantly lower average levels of calcium.

Inter-model comparison

Across all subcategories, the Swedish Keyhole and the Smart Choices Program models showed almost perfect agreement on the categorisation of each product (>80% identical ratings). Product ratings by all other models coincided moderately (41-60%) to substantially (61%-80%), with the FSA/OFCOM and FDA models compared with most others in the lower ranges (50-66% concordance).

1.4.2. Example: Fine bakery wares (see also Chapter 5)

In a second study, 238 commercially available fine bakery wares with any type of nutrition or health related claim from five European countries (France, Germany, Spain, Sweden and the UK) were evaluated against five of the six profiling models. The Swedish Keyhole model does not define criteria for any snack products and was therefore excluded.

For a more accurate analysis the products were categorised into sweet (biscuits) and savoury (crackers) items. Like for dairy products they were also grouped according to the claim type they carried.

Again, the main results of the evaluation with nutrient profiles are summarised below and more details can be found in Chapter 5.

Distribution of products across categories and claim types

The product search identified almost three times more sweet than savoury items with a healthy positioning. Nutrition claims made up the majority of claims overall, followed by recipe claims. The latter almost exclusively appeared on sweet products. Health claims were found on items from both product groups in proportionally similar numbers (20% approx.).

Proportion and type of eligible products

Overall, the proportion of products that met the criteria of the respective profiling models was lower than for dairy products with 6% in the case of the Choices Programme model and up to 37% according to the criteria defined by the FDA model, the most lenient in the study. Again, slightly higher proportions of products with health or nutrition claims than items with other claims fulfilled the criteria. Like for dairy products the evaluation also showed subcategory-specific results, with significantly more savoury than sweet items qualifying.

Number and type of disqualifying nutrients

Fat was the nutrient criterion that was exceeded most often across all threshold models, either as total fat or SFA. Fibre as a qualifying nutrient criterion was required by two threshold models only, but almost all products that failed these profiles did not meet this requirement. Other effective thresholds were energy and total or added sugars, especially for sweet items, and sodium for savoury products. Total fat and energy thresholds were exceeded simultaneously in many cases, whereas sugar and energy were rather independent criteria.

Potential impact on nutrient levels in products with claims

When compared to the total set of products, the products rated eligible by the profiling models showed significantly lower average levels of SFA (down by 50% to 80%) and significantly higher average contents of dietary fibre (up by two thirds to 150%). In addition, sweet items were significantly lower in average sugar contents and savoury items contained less sodium. On the other hand, energy contents were not reduced substantially.

Inter-model comparison

Overall, all models but the FDA model showed substantial (60-80%) to almost perfect (>80%) agreement on the individual categorisation of each product in the study.

1.5.   The potential impact of nutrient profiles on energy and nutrient intake in German children and adolescents

1.5.1. Example: Dairy products (see also Chapter 6 and Appendix A)

For the analysis of the potential impact of nutrient profiles on energy nutrient intake in German children and adolescents two main data sources were used.

Product-specific intake data of participants between the age of 4 and 18 and between the years 2003 and 2008 (2208 records) were sourced from the DONALD study, an open cohort study that has been run by the FKE since 1985. Details of the study have previously been published by Kroke *et al.* (2004). Due to the complexity of the data, the first analysis was limited to dairy products, which are of particular importance in the diet of children and adolescents. First, all dairy products intended for direct consumption were selected that represented at least 95% of the total consumption of these categories. Dietary consumption data were then consolidated in product subcategories and evaluated per age group and sex, including mean daily consumption levels of all participants (see Appendix A for further details).

Energy and nutrient intake data were generated by combining the product intake data with food composition data from LEBTAB, a database in which all basic or commercial products mentioned in the DONALD dietary records are covered (Sichert-Hellert *et al.*, 2007). Evaluated parameters included mean consumption levels of product subcategories and intake of energy, protein, carbohydrates, total fat, SFA, fibre, sodium, calcium and vitamin D (VitD) (see Appendix A). Total sugar intake could not be evaluated due to a lack of data. Furthermore, the contributions of all dairy products to daily energy and nutrient intake were also assessed. Daily reference values (RVs) issued by the German Nutrition Society (Deutsche Gesellschaft für Ernährung, 2002) were assessed as percentages, e.g. % energy from dairy products out of total energy (kcal/ day) and % calcium from total diet or dairy products in comparison with calcium

RV (milligrams (mg)/ day). For reference, the FKE also provided data on the participants' total average energy and nutrient intake from all food groups (see Appendix A). This data showed that the mean VitD intake of children and adolescents of both sexes fell significantly short of the recommendations. Calcium intake was particularly low for female adolescents. The intake of carbohydrates, total fat, fibre, and energy fell slightly short of the RVs, whereas SFA, protein and sodium were consumed in amounts that exceed RVs.

In order to evaluate the potential impact of nutrient profiles on the determined nutrient intake all products were evaluated against five of the six profiling schemes listed in **Table 1.2**. In this part of the study the full SAIN,LIM was applied, including positive nutrients. In 2009, the Smart Choices Program was suspended after heavy criticism on the criteria and intervention by the FDA. It was therefore excluded from this analysis. In a first step, the percentage of items that met all criteria of any given profiling model ('eligible products') and the average and median proportion of reported consumption they represented were determined. In addition, the nutrient content of the eligible products was compared with that of all products in the study. For the analysis of the potential impact of the profiling models on energy and nutrient intake, it was assumed that participants only consumed eligible products. To simulate this, we kept the total consumption levels (in grams) in each DONALD record the same but replaced the consumption of non-eligible products by proportionally increasing the consumption of eligible products reported in the record. Based on this simulated scenario, median intakes of energy, SFA, sodium, calcium and VitD were calculated for each profiling model and compared to the equivalent standard intake reported in the DONALD study.

In total, 307 dairy products recorded in the LEBTAB categories of interest represented more than 95% of the total consumption. They were re-categorised into two groups of basic food choices ('*Cheeses*' and '*Other dairy products*') and four more specific subgroups ('*Fresh cheeses*', '*(Semi) hard cheeses*', '*Dairy drinks*' (incl. milk) and '*Dairy desserts*').

The average daily consumption level across all age groups and subcategories was 234g. It increased slightly with age for boys and remained stable for girls. However, the consumption of cheeses increased substantially with age for both sexes.

Dairy products contributed a disproportionally large amount to the dietary intake of calcium and substantially to the intake of VitD, SFA, protein, total fat and energy. The increase in the

consumption of cheeses with age improved the VitD supply for both sexes. It also helped boys to keep up with the increase in recommended calcium intake. For girls, the increase in cheese consumption was not sufficient to compensate for a reduced calcium contribution of other dairy products (**Figure 1.9**).
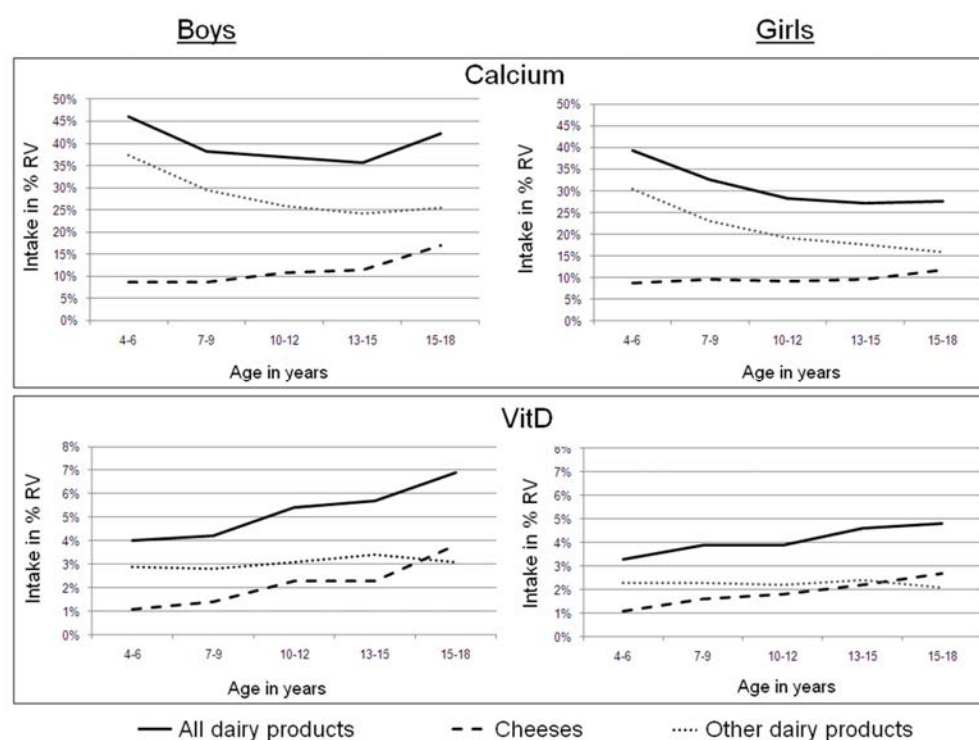
Figure 1.9   **Average calcium and VitD intake from all dairy products, cheeses and other dairy products in comparison with RVs by sex and age group**

Between 14% and 55% of all products in the study met the criteria defined by the different profiling schemes. At the same time, the qualifying products represented between 6% and 59% of the total average and between 0% and 71% of the median dairy consumption level. In most cases, the percentage of products meeting a model's requirements was not directly related to the level of dairy consumption these items represented (**Figure 1.10**).
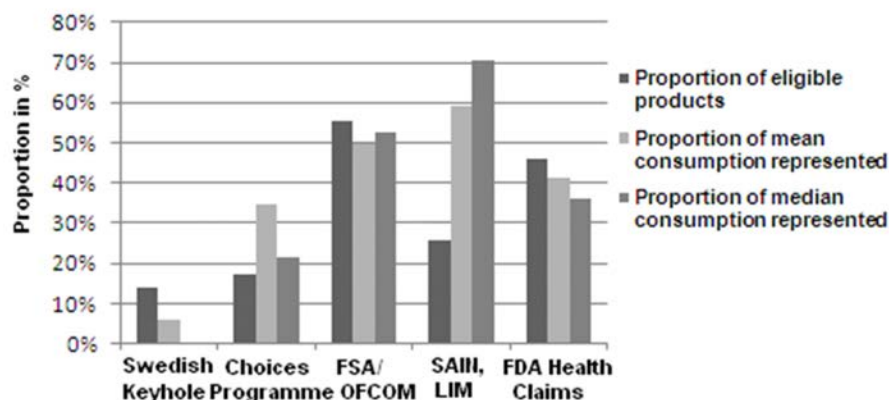
Figure 1.10   Proportion of eligible products and levels of consumption represented by nutrient profiling model

The simulated substitution of non-eligible with eligible items was performed for each profiling model and within groups of similar product choices, i.e. for dairy products within the groups of *Dairy drinks*, *Dairy desserts* and *Cheeses*. The participants' intake of energy, SFA, sodium, calcium and VitD would be reduced significantly (P<0.0001) if only qualifying products were consumed. The impact on nutrient intake levels was not directly related to the impact on nutrient content levels in the products. Lower fat consumption was correlated with reduced VitD intake, and the models' disqualification of (semi) hard cheeses had a negative impact on calcium intake (**Figure 1.11**).
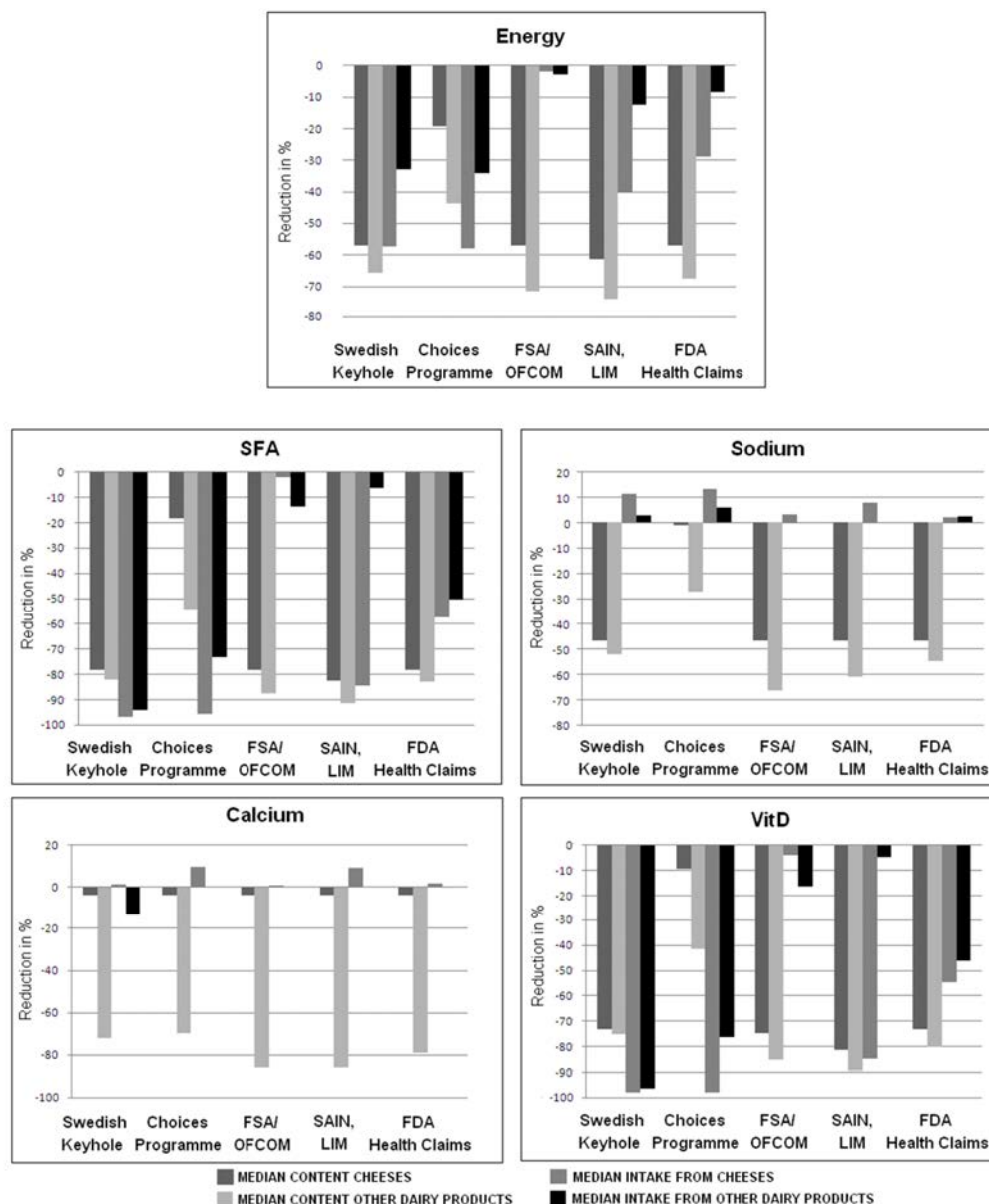
Figure 1.11   Potential impact of various profiling models on median contents and intake of energy, SFA, sodium, calcium and VitD

1.5.2. Example: Fine bakery wares

The same analyisis as described in Chapter 1.5.1. was also initiated for fine bakery wares. In this category, 49 items represented more than 95% of the total consumption. The average daily consumption level was 6g and the products contributed very little to the total intake of the nutrients of concern (**Table 1.3**). Furthermore, only one of the products qualified according to

one nutrient profiling model, all other models disqualified all 49 items. Therefore, fine bakery wares were not analysed further.

Table 1.3 **Average daily intake of key nutrients from fine bakery wares across all participants in %RV**

	Energy	SFA	Carbohydrates	Sodium	Dietary Fibre
All fine bakery wares	1.4%	3.0%	1.6%	1.9%	1.0%

1.6.   Discussion of results

The potential impact of nutrient profiles on commercially available products with a healthier image

The market analyses conducted as part of this dissertation have shown that a considerable number of dairy products and fine bakery wares in major European markets seek to provide a healthy product image through on-pack communication. Such positioning can guide consumers' choices towards these items (Ford *et al.*, 1996; Geiger, 1998; Tuorila & Cardello, 2002; Bech-Larsen & Grunert, 2003; Teratanavat & Hooker, 2006; Van Trijp & Van der Lans, 2007; Grunert & Wills, 2007; Pothoulaki & Chryssochoidis, 2009). However, products that are marketed as healthy options, e.g. highlighting high amounts of nutrients positively linked to health, sometimes also contain significant amounts of nutrients that are linked to chronic diseases when consumed in excess and whose intake should be limited.

The most important parameters for the identification of dairy products with a truly favourable nutritional composition in this dissertation were the levels of total fat and SFA for all dairy products, sodium for cheeses and sugars for other dairy products. The levels of total fat and SFA were highly correlated. Therefore, it can be concluded that the inclusion of SFA alone as a profiling parameter is sufficient, given their potential health impact beyond the caloric value. Dietary cholesterol could have played a role as disqualifying criterion as well, but could not be analysed as the data was not part of the labelled nutrition information. In addition, nutrient profiles that applied the same criteria to all dairy products more often disqualified cheeses and cheese products which typically contained higher calcium levels compared to other dairy

products. Thus, a significantly reduced average calcium content was observed across all qualifying products. Because of fundamental differences in composition and common eating behaviour between cheeses and other dairy products it therefore seems essential that separate criteria sets are defined for both subcategories.

The results also show that nutrient profiles including criteria on total fat, SFA and fibre can identify fine bakery wares with a preferred nutritional composition. In addition, the sugar content was a discriminating parameter for sweet products and sodium for savoury items. It was shown that total fat could be replaced by a parameter on energy, whereas significantly more products would have qualified without a specific criterion on sugars. Other potentially important criteria include the levels of whole grain and trans fatty acids, which could not be evaluated due to a lack of data. It seems that all fine bakery wares can be evaluated against the same set of nutrient criteria. They can be included in an even broader food group, since none of the models with a generic 'snacks' category or even an across-the-board approach generated anomalies in results.

Finally, for both categories the choice and balance of nutrients, and for dairy products the subcategory specifity of the criteria sets, had a much bigger impact on the profiling results than the reference quantities and calculation models applied.

The potential impact of nutrient profiles on average nutrient intake in German children and adolescents

The findings of this dissertation on age-related dairy intake trends, such as the increasing consumption of cheeses, are in line with previous studies (Mensink *et al.*, 2007; Kersting & Bergmann 2008; Kranz *et al.*, 2007; Max Rubner-Institut, 2008). The results also underline the importance of dairy products as contributors to the dietary intake of energy, protein, total fat, SFA, sodium, calcium and VitD in children and adolescents. The increasing consumption of cheeses with age is crucial to maintain adequate calcium intake levels for boys and to limit the decrease of the dairy calcium supply for girls. However, it is not enough to fully meet recommended daily intake of VitD for both sexes. The shortages of both calcium and VitD have previously been reported by Mensink (2007), Mensink *et al.* (2007)*,* Kersting & Bergmann (2008) and the German National Food Consumption Survey (Max-Rubner-Institut, 2008).

The results of this research also show the importance of taking into account product-specific intake data in order to fully understand the potential impact of the application of nutrient profiles. It is critical to not only assess how many products qualify according to a profiling model and how their average nutrient contents compare to all products in the category. Much more, the testing and validation of a profiling model has to include an analysis of the proportion of total consumption represented by the eligible items, as the two are not necessarily correlated. The contribution of individual products to the overall nutrient intake depends significantly on the quantities that are consumed. The higher the consumption levels of products with a noticeably favourable composition the bigger the potential impact of an exclusive consumption of eligible items, irrespective of the nutrient contents. Actual consumption levels of specific products are difficult to estimate because of the dynamic nature of product market share. Thus, the analysis of data from the DONALD cohort has provided a unique and valuable opportunity to assess the public health implications of various nutrient profiling strategies.

The results of this research confirm the previous finding that nutrient profiles can help to meaningfully identify dairy products with a more favourable nutritional composition. They also strongly underline the necessity to have separate criteria sets for cheeses and other dairy products. Calcium and VitD intake were highly impacted when the profiling models excluded (semi) hard cheeses. Very restrictive criteria on fat contents also led to considerably reduced intake of VitD, as the fat-soluble vitamin is reduced when skimming milk. This means in turn that an increased consumption of items that are supposed to be the better choices can undermine the originally important contribution of the category to essential nutrient intake. In the case of dairy products, a potential reduction of the intake of calcium and VitD when following the results of the nutrient profiling models would strongly contradict nutritional advice, given their importance for bone mass development.

In summary, carefully designed nutrient profiling models can potentially lead to considerable reductions in critical nutrient intake from dairy products in German children and adolescents. Nutrient profiles could therefore effectively help this consumer group eat a more balanced and healthy diet while maintaining general consumption habits.

1.7. Conclusions

From the results generated in all studies included in this dissertation the following conclusions can be drawn, linked to the previously formulated research questions:

RQ1. **Could the regulation of claims by nutrient profiles have a significant effect on the nutritional composition of commercially available dairy products and fine bakery wares with a healthier image in Europe?**

The analyses presented in this dissertation have shown that nutrient profiling models can meaningfully and comprehensively identify dairy products and fine bakery wares with a significantly improved nutritional composition than the average range of products positioned as healthier.

RQ2. **If nutrient profiles can have a significant impact on the nutritional composition of these products, what are the key technical principles that have to be applied?**

For meaningful results a nutrient profiling model for dairy products needs to include criteria for SFA, sugars and sodium. The use of separate criteria for cheeses and other dairy products seems necessary to account for intrinsic compositional differences. Criteria should be set carefully to avoid reducing the calcium and VitD contributions of the category. For fine bakery wares, important parameters to account for include energy, SFA, sugars, sodium and fibre. Different criteria sets for subcategories of fine bakery wares do not seem necessary.

Furthermore, it has been shown that all reference quantities and both threshold and scoring models can provide meaningful results. Only when using energy-related thresholds for other critical nutrients (such as x% of sugars per 100kcal) a limit on total energy content is necessary. Otherwise, the mere addition of calories would allow for higher contents of unfavourable nutrients.

RQ3. What impact could nutrient profiles have on the nutrient intake of children and adolescents in Germany?

The application of nutrient profiling for guiding dairy product consumption of German children and adolescents could help reduce the intake of less-desirable nutrients, such as saturated fatty acids and sodium. However, models that are too restrictive might negatively impact calcium and VitD intake. Making (semi) hard cheeses eligible and fortifying dairy products with VitD may be necessary to minimise these effects.

RQ4. Which conclusions can be drawn from the generated results for the recommended testing and validation procedures for nutrient profiling models in general?

As stated previously, a nutrient profiling model should be tested in the context of the intended application. When assessing a profile developed for regulatory purposes it is therefore necessary to evaluate up-to-date information on the commercially available products that would be affected. In this research, the evaluation of product-specific intake data was critical to understand the potential impact of any profiling scheme on nutrient intake. Without such level of detail the potential impact of a profiling based intervention cannot be fully assessed.

1.8. Future research

In order to limit complexity and create a defined scope this dissertation focused on the qualification of dairy products and fine bakery wares under different nutrient profiling schemes, and the implications of such profiling schemes on the dietary intake of children and adolescents in Germany. Previous studies have identified a number of different food categories on which nutrient profiles should and could be applied. Also, nutrient profiles are intended to be applied internationally and to have an impact on the diets of a wide range of consumers. Further research could therefore be conducted to apply a similar research approach to other categories and to evaluate intake data of additional consumer groups.

Furthermore, it will be critical to better understand the potential efficacy/efficiency of the regulatory and consumer information tools designed to guide consumers' choices towards healthier items. The final impact of any nutrient profiling model is always heavily dependent upon the impact of the intervention programme within the population it is applied to.

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2. An industry perspective on nutrition profiling in the European environment of public health and nutrition

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An industry perspective on nutrition profiling in the European environment of public health and nutrition

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Modern lifestyle habits are seen as a major cause of public health issues in many countries around the world. The burden of non-communicable diseases, such as obesity, cardiovascular disease, type 2 diabetes and certain types of cancer, is constantly growing and closely linked to a general lack of physical activity, unbalanced eating habits and dietary patterns. Many countries in Europe have measured the prevalence of overweight and results ranged between 32% and 79% in men and between 28% and 78% in women. Numbers have risen threefold and more over the last two decades and more and more children and adolescents are affected. Adult obesity is already responsible for up to 6% of the health-care expenses in the region (Branca *et al.* 2007).

Various members of the food industry and retailers, as well as health organisations and authorities, have recognised this growing public health issue and have developed initiatives to highlight the importance of healthy eating behaviour and physical activity. In 2004, the World Health Assembly (WHA) (WHO 2004) developed its Global Strategy on Diet, Physical Activity and Health which specifically points at the elevated consumption of energy-dense and nutrient-poor foods. The overall nutrient profile of foodstuffs is the centre of attention, as high levels of fatty acids, saturated fatty acids, free sugars and salt are presented as major risk factors that account for much of the growing health burden. In addition, an increase in the consumption of fruits and vegetables, legumes, wholegrains and nuts is targeted.

In this context, nutrition profiling methodologies have been developed to classify food and beverage products according to the levels of key nutrients they contain. This classification is used for several applications with the intention of helping consumers make the right food choices, including:

- product development guidance;
- signpost labelling;
- (self-)regulation of advertising and marketing;
- (self-)regulation of nutrition and health claims.

The different areas in which it can be applied and the variety of methodologies require in-depth consideration of the appropriateness, strengths and limitations of such models.

Nutrition profiling as a useful tool for various applications related to foodstuffs

Product development guidance

Several major food companies use nutrition profiling models to guide the development of new products (Kraft Foods 2005b; Danone 2006; Nestlé 2006; Unilever 2006), including those likely to be consumed by children. They have developed models that take into account a selection of key nutrients that are either over-consumed in many countries (total fat, saturated fatty acids, *trans* fatty acids, sugars, sodium, as well as total energy) or proven to positively affect the diet (polyunsaturated fatty acids, protein, fibre, vitamins, minerals, phytonutrients etc.). The overall goal is to shift the portfolios towards an improved nutrient profile. In most cases product developers are given pre-defined targets for certain nutrients. These thresholds are category-specific and address in detail the nature of the product, such as key nutrients of concern and any challenges in terms of regulations, technology and/or taste.

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Signpost labelling

Several retailers, manufacturers and health organisations have already started to use nutrition profiling to proactively identify 'better for you' options and positively 'signpost' these items. These models include, among others, the Kraft Foods *Sensible Solution Program* (2005b), Pepsico's *Smart Spot* (2007), the Unilever *Choices Programme* (2006), the Swedish *Key Hole* (2005), the *Health Check* by the Heart and Stroke Foundation of Canada (2007), the *Food Certification Program* by the American Heart Association (2007), the *Heart March* by the Heart and Stroke Foundation of South Africa (2007) and the *Pick the Tick* programme by the National Heart Foundation of New Zealand (2007). All these programmes identify healthier options in order to label them with specially designed front-of-pack health logos. This labelling makes the healthy choice the easy choice for the consumer and allows identification of healthy food options 'at a glance'. Additional off-pack information can help to create general awareness of the importance of balanced nutrition through websites, consumer brochures, school campaigns etc.

Consumer research has shown that easily accessible information on healthier products can increase the sales of these items. The signposting is of particular help for lower socio-economic groups. However, evidence is not yet conclusive and the complexity of influencing factors demands further research.

Advertising and marketing

Guidelines for responsible marketing of food products to children often refer to marketing techniques only. Over recent years, however, both food manufacturers and official bodies have recognised as inappropriate the marketing of certain food products to children and hence developed guidelines on the right selection of products that will be allowed to be marketed to children. Once again, nutrient profiles are used to distinguish between appropriate and non-appropriate products and to shift the balance towards 'better for you' choices within product categories. Kraft Foods, for example, has decided not to market any products directly to children up to 6 years of age (Kraft Foods 2005a). Only products that fulfil the requirements of the company's *Sensible Solution* program are allowed to be marketed to children aged 6–11 years. In the US, Campbell Soup Company, Danone, Kraft Foods, Mars and PepsiCo have collaborated with the Alliance for a Healthier Generation, a partnership between the American Heart Association and the William J. Clinton Foundation, to establish nutrition guidelines for snack foods

sold in schools (Alliance for a Healthier Generation 2007). In the UK, the Food Standards Agency (FSA) has developed a model which has now been adopted by the media regulator Ofcom (2006) as a basis for the restriction of product advertising to children. In the USA, detailed guidance on the marketing of food products to children has been developed and published by the Center for Science in the Public Interest (2005).

Regulation of nutrition and health claims

Consumer information plays a critical role in the marketing of functional and 'better for you' products. The main and traditional vehicles for this type of communication are nutrition and health claims, *i.e.* the labelled information that products have an improved level of certain specifically mentioned nutrients and/or offer functional benefits. Hence, an increasing number of food products bear such claims.

Several studies have shown that there is widespread consumer interest in on-pack nutrition information across Europe (Grunert & Wills 2007). The standard information provided on food labels, however, is only helpful if the consumer is motivated towards nutrition. The key hurdle still is lack of understanding. Overall, very few consumers want to and even fewer use nutrition information in an active and systematic way. Simple and precise on-pack nutrition or health claims, however, are well used and do influence purchase intent, *e.g.* 'light' and 'low-fat' categories or products have a real 'better for you' status and are seen as 'nutritious'.

Several authorities and consumer organisations have criticised that nutrition or health claims made on foods often relate to single nutrients only. They point out that such claims may encourage consumers to make choices which negatively impact their overall intake of key nutrients that have an undesirable health effect, including food over-consumption. Different studies have shown that many consumers do not have the necessary background knowledge and do not clearly distinguish between nutrition/nutrient content and health claims. Many view food as healthier if it carries a health claim and might consequently not seek further nutrition information. Furthermore, a study conducted by the European Food Information Council suggests that nutrition labels are not actively used, not seen as involving and generally not understood (EUFIC 2005).

In order to protect the consumer, address the above-mentioned concerns and regulate the use of product communication related to nutrition quality and health, the European Commission (EC) brought forward a proposal for a *Regulation on Nutrition and Health Claims*

made on Foods, which finally came into force in January 2007 (European Community 2006). It applies to any commercial communication that contains a message or representation, including pictorial, graphic or symbolic representation, which states, suggests or implies that a food has particular nutrition and health characteristics. The use of such nutrition- and health-related communication on or closely linked to food and drink products will be limited to those products that meet certain nutrient profiles. These restrictions will ensure that consumers are not misled by nutrition and health claims, but are fully informed when trying to make healthy choices. The use of nutrient profiles will avoid the potential of claims masking the presence of high levels of nutrients that have an undesirable effect, *i.e.* total fat, saturated fatty acids, *trans* fatty acids, sugars and sodium. At the same time fair competition will be ensured for food and drink manufacturers through consistent European Union (EU) wide requirements that promote and protect new product innovation and reformulation efforts.

The European Food Safety Authority (EFSA) has been asked to give scientific advice to the EC and certain principles have been set for the development of the profiles. First, they shall be based on generally accepted scientific data regarding diet and health. Second, they shall take into account the role and importance of the food or categories of food in the overall diet, which includes different dietary habits and traditions. Finally, the overall nutritional composition of the products, in particular the contents of the above-mentioned nutrients of concern, shall be looked at when establishing the criteria. These principles certainly make the development of a profiling model a highly complex task and require the involvement of all stakeholders in the decision process.

There is no 'one size that fits all' – key considerations when developing nutrition profiling models

First analyses have shown that evaluations of food products based on the different profiling models vary considerably. It is therefore highly important to have the intended purpose in mind when deciding on the most suitable profiling methodology and model.

All existing profiling schemes use a selection of nutrients with either undesirable or positive impacts on health and take (inter-)national dietary recommendations, food intake data, dietary habits, food consumption patterns, average product compositions and/or local legislation into account. Nutrients that are covered are, on the one hand, those with an often too high intake

when compared with dietary guidelines, *e.g.* total fat, saturated fatty acids, sugar and sodium. On the other hand, some models also include beneficial nutrients and ingredients of which too little is consumed, such as certain vitamins and minerals, polyunsaturated fatty acids, dietary fibre, wholegrains or fruits and vegetables.

Various questions arise when working with nutrient profiles. These include, first and foremost, the intended application, which all other considerations regarding the most appropriate model should be based on. In addition, certain aspects have to be focused on:

The target group

Nutrition requirements vary considerably, *e.g.* with age, sex or the level of physical activity. Together with the intended purpose, any profiling model therefore has to be based on appropriate and scientifically based nutrition recommendations for the specific target group. Ultimately, the use of a profiling-based application has to have a measurable impact on the eating behaviour of these consumers.

Profiling of foods in general and/or categories of food

In a generic model, all foodstuffs are evaluated against one set of criteria. This approach certainly is the least complex and easiest to use when establishing nutrient profiles. It allows a direct comparison between items across the whole range of foods. Dietary habits and the role of the foods in the diet, however, can hardly be taken into account when applying such a model. Furthermore, intrinsic differences between food categories cannot be addressed. If intended for (self-)regulatory purposes, it is hence impossible to establish achievable nutrient profile requirements for all foodstuffs.

More complex models are based on category-specific criteria. Groups of products can be defined, for example, by eating occasion (*e.g.* breakfast, full meal, snack), biological basis (*e.g.* dairy, cereals, meat), food groups (*e.g.* fruits and vegetables, milk and dairy, meat and fish) or regulatory dimensions (legal requirements for certain food products in the EU). Detailed criteria are then specifically set for each product category, which allows the model to address intrinsic differences between food items.

The choice and balance of nutrients

The right selection of nutrients strongly depends on the intended outcome of a profiling analysis. Existing profiling models mostly take into account the nutrients

of concern as outlined by the World Health Organization (WHO), *i.e.* total fat, saturated fatty acids, sugars and sodium. This approach allows clear distinction to be made between products with a comparatively low content of these critical nutrients, such as reduced fat products, and those products with an undesirable impact on health if consumed in abundance. It must be noted, however, that the total fat content includes both saturated fatty acids, which have been shown to increase the risk of cardiovascular disease, as well as monounsaturated and polyunsaturated fatty acids, which have beneficial health effects. The energy content in combination with the level of saturated fatty acids is therefore seen as a more appropriate criterion to cover the adverse health effects of dietary fat.

If the intention is to identify healthier products with beneficial effects, *e.g.* for marketing to children, it is necessary to extend the selection of nutrients to include e.g. protein, vitamins and minerals, unsaturated fatty acids, fibre, phytonutrients or groups of ingredients like wholegrains, fruits and vegetables or nuts.

The choice of nutrients can be limited and very specific in a category-based model, while a generic approach requires a wide range to cover all characteristics of the different foods.

The reference quantity

Profiling models can be based on either standard quantities such as 100g or on portion sizes. In a generic model there is a clear difference between the two approaches, as category-specific dietary habits cannot be taken into account when applying universal quantities. With an across-the-board approach, a margarine high in polyunsaturated fatty acids would have to fulfil the same criteria as a ready-to-eat meal, although the quantity consumed at one eating occasion is much lower. In a category-specific model, criteria can be set on a portion basis and then easily translated into a per 100g base, which is globally used as a standard reference amount for nutrition labelling and various other regulations such as content claims, fortification or upper limits of critical substances.

Another approach is to refer to the nutrient density, expressed as the amount of the nutrients of choice per 100 kcal. This methodology refers to the general idea that the intake of recommended daily amounts of beneficial nutrients shall be ensured within the boundaries of the daily energy allowance. The overall goal is to improve the 'quality of calories', *i.e.* limit the consumption of 'empty calories' in favour of products that deliver both energy and other essential nutrients.

The calculation model

One way to assess the nutrition characteristics of a product is to compare its nutrient profile with a pre-defined set of benchmarks (thresholds). A product qualifies if it meets all or a minimum number of the benchmarks for, *e.g.* saturated fatty acids, sodium and sugar. Acceptable levels of the selected nutrients have to be carefully determined and be based on suitable reference data.

Another way is to assign points for the level of each nutrient and calculate a final score. In such a system higher levels of beneficial nutrients can usually compensate for critical nutrient contents.

Feasibility and validation

Any profiling model has to be tested against a representative sample of foods in order to prove its feasibility and meaningfulness. Reliable data sources are available through a variety of food composition tables; for product development purposes, a specification system of a food manufacturer might be more appropriate.

Both positive and negative indicator foods are normally used when a profiling model is to be applied to a wide range of foods. These are chosen based on input from nutritionist panels, consumer behaviour or market research data. The quality of a profiling model can be assessed through the proportion of misclassified indicator foods, always evaluated against the intended purpose. Careful attention has to be paid, however, in order not to simply reverse engineer a suitable model that fits a pre-defined list of indicator foods.

Assessment of limiting factors and challenges for product modifications

With the knowledge about stringent dietary recommendations and the intention to significantly improve the nutrient profile of certain foods it can be tempting to set highly challenging targets for product reformulation. Nevertheless, it is important to bear in mind the boundaries that are set by consumer acceptance, food safety, technology and legal requirements.

Consumers are less likely than ever to compromise taste for health benefits. Successful better for you food and drink products preferably have to be tasty, natural, convenient and fresh.

At the same time, nutrients with an undesired health effect like sodium, sugar and fat have a very long tradition in natural food preservation and processing. Their use often plays a critical role in ensuring food safety, an essential part of health protection and therefore a key

consumer need. The preservation is often directly linked to the amount of added natural 'additives' and certain minimum requirements apply.

Third, certain nutrients of concern are essential for the manufacturing of food products, such as sugars for the freezing properties of ice cream or emulsifier salts for the texture of processed cheese. On the other hand, low-calorie foods are sometimes composed of highly sophisticated ingredients that imitate the properties of a food matrix containing fat. This approach contradicts the consumer desire for natural ingredients rather than 'highly processed' alternatives.

Finally, the composition of many foods is regulated at a European level and national regulations also apply. Ingredients that are rated as 'unhealthy' in the discussion about balanced nutrition often are required components of traditional recipes. Therefore, industrial reformulation efforts often lead to products that can no longer be sold under the original product identity. To establish new product identities requires high investments and imposes big challenges, especially to small and medium-sized companies.

A methodical approach of gradual changes, *i.e.* the implementation of (self-)regulatory profiling models in a step-wise manner, as opposed to the implementation of the finally desired improvements in one single and radical step, can help overcome many of these limitations. It offers the advantage of a smooth transition, as consumers can more easily adjust to the foods and the dietary changes, while food manufacturers have more time to develop and bring to market more food options that meet the evolving standards.

The importance of periodic review and revision

Dietary recommendations are not static and are adjusted with evolving science in the field of nutrition and health. At the same time, consumer habits and market standards change, while technological limitations are overcome. It is therefore important to periodically review any criteria and routinely evaluate whether the intended effect is still being achieved.

A suggested nutrition profiling methodology for the EU Regulation on Nutrition and Health Claims

It is generally accepted that nutrient profiles for the purpose of regulating claims on foods should be based on scientific knowledge about diet, nutrition and health. There is a lot of discussion, however, about the best methodology.

There is wide consensus, not only in the food industry, that any model has to promote and protect innovation. It should impose a reasonable challenge but at the same time allow food manufacturers to innovate and reformulate and thereby reach the minimum requirements that allow claims to be made. Category-based models offer significant advantages in this context, as they take into account the varying nature of different food groups as well as constraints that derive from legal, technical and sensory aspects or overall consumer acceptance. Through merging of subcategories, the complexity of such a model can be significantly reduced to a manageable number of categories.

A general reference quantity of 100g aligns the model with the rest of the claims regulations, as the basic requirements for content claims are based on the same amount (15% of the recommended daily allowance per 100g to make a 'source of' claim). However, alternative measures such as energy or serving size-based criteria can help overcome anomalies if category boundaries cannot be clearly defined.

The intention of the EU Regulation is to restrict the use of claims on food products that would have a significant negative effect on the overall intake of certain critical nutrients. It is therefore regarded as appropriate in our view to exclude positive nutrients and to limit the scope of the model to a few critical nutrients, *i.e.* saturated fatty acids, *trans* fatty acids and sodium. The link between these nutrients and disease risk is widely accepted and scientifically substantiated. A simple and precise threshold model with clearly defined limits for these nutrients should be developed for easy application by manufacturers and regulators. In addition, an energy threshold can help to indirectly limit total fat and total sugar contents, while it leaves flexibility for recipe innovation.

Another justification for not taking positive nutrients into account is that it cannot be scientifically substantiated that they balance out the presence of critical (negative) nutrients. In any case, if they are contained in significant amounts, there is the opportunity to highlight positive nutrients through claims.

It is widely accepted that all food groups can be part of a balanced diet if consumed in appropriate proportions. The thresholds should therefore be chosen so that typical foods within a given category meet the criteria, *e.g.* a medium fat cheese can be an important source of calcium as part of a balanced diet. However, products that are unreasonably high in one or more of the nutrients of concern should be excluded from the possibility to make claims. The intention of the regulation is to avoid health claims on unfavourable products and not to identify 'better for you' items.

In order to avoid anomalies, a list of single foods or food groups should be defined that are exempt from profiling. This should be based on general food-based dietary recommendations (*e.g.* unprocessed fruits and vegetables) and can contribute to a reduced complexity of the model. Fat limits for a potential snacks category for example might be appropriate for many processed items. However, they might at the same time demonise unprocessed nuts, the consumption of which is generally intended to be promoted. The exemption of unprocessed nuts would therefore help avoid contradictory nutritional advice without the need to create a more complex model by adding categories and/or alternative thresholds.

Nutrition profiling in the wider context of health strategies, policies and other initiatives

Overall, the WHO Global Strategy for Diet, Physical Activity and Health outlines the central role of governments in developing and implementing policies and actions that help consumers make healthier dietary choices. Healthier choices are certainly partly defined by the overall nutrient profile of the products. Therefore, nutrition profiling is a powerful tool to guide consumer choice. In addition, the food industry can help consumers make the right choices by other means. Besides improved nutritional compositions, these include pre-portioned options, reduced and/or limited portion sizes, re-closable packs, detailed nutrition information on as many products as possible, marketing and consumer information as well as nutrition education. Overall, food and drink manufacturers have started to take a number of initiatives to meet these challenges and satisfy consumer needs. Many products have been fortified and/or reformulated and so-called 'better for you' choices are available across all product categories.

In response, consumers have started to make certain changes to their diets. Functional foods and other healthier food options have increased in market share as consumers have become more aware of the need for behavioural change. Health and wellness is now a major market and many companies build important parts of their business strategies on this trend.

The EU has also followed the direction of WHO and taken several steps to address diet and health, including voluntary and regulatory approaches. Among the former is the EU Platform for Action on Diet, Physical Activity and Health, a common forum for action led by the EC (EU Platform on Diet, Physical Activity and Health 2005). Several European stakeholders, including the food, retail, catering and advertising industries, consumer organisations and health non-government organisations are brought together to catalyse voluntary action across the EU. From this joint effort, more than 90 commitments made by platform members for action emerged in 2006. The commitments covered areas like consumer information, including labelling, education, physical activity promotion, marketing and advertising, composition of foods as well as the availability of healthier food options and portion sizes.

Most food and drink companies develop strategies to meet consumer needs for 'better for you' products. Promoting public health is seen as a key element of corporate responsibility activities. Innovation is an important factor in economic growth and an answer to current consumer demands. New product development and reformulation towards healthier food and drink products, as well as better communication about product composition, are therefore in the best interest of the consumers and the food industry.

Conclusions

Health and wellness is a major consumer trend in Europe and elsewhere. For several years public health issues related to the field of nutrition have been the subject of constant media coverage and numerous policy initiatives. Hence, food and drink buyers around the world are aware more than ever of the opportunities to improve the quality of life through healthy eating. Consumer information campaigns run by authorities, health organisations, the media and the food industry add to an increasing demand for healthier food choices. Promoting healthy diets, changing eating habits and encouraging physical activity are regarded as key determinants that will have an influence on healthy living and disease risk reduction. Additional incentives for food and beverage companies to develop more and more innovative, healthy food products and highlight scientifically substantiated product benefits will therefore make a major contribution to the wellbeing and welfare of European consumers.

Nutrition profiling and communication are helpful tools to drive consumer choice towards healthier eating by classifying food and beverage products according to their nutritional composition. It can be applied to many purposes and its use for various health and wellness initiatives by food and drink manufacturers is constantly growing. These initiatives include improved consumer information, guidance for the development of new and healthier products, as well as guidance for

advertising and marketing, especially to children. Public policy makers have also started to use profiling models for the regulation of nutrition and health claims as well as advertising and marketing.

Profiling methodologies vary considerably and it is crucial to clarify the objectives in order to be able to select the most appropriate model type, parameters and details. There is no 'one size that fits all'. Lastly, any model has to be tested against the intended purpose.

One main application of nutrient profiles in Europe will be the classification of foods into products that are allowed to carry nutrition and/or health claims and others that are banned from any such communication, as outlined in the recently adopted EU regulation. Several conclusive profiling approaches have been brought forward by food manufacturers, as well as other scientists, which use a category-based profiling approach, taking into account the quantities of key nutrients contained, the role and importance of the respective food categories in the diet, the overall nutrition composition of the food categories as well as the presence of nutrients that have been scientifically recognised to have an effect on health. A simple and precise category-based threshold model supported with adjustable upper limits for energy content, saturated fatty acids, and sodium would, in our view, be in line with the spirit of the regulation. It can avoid misleading consumer information and best promote industrial innovation efforts. For other application purposes, however, different models may be more appropriate.

Finally, it is important to evaluate whether any specific initiative concerning healthier product composition or more responsible marketing has a significant impact on consumer choice, leads to considerable changes in dietary behaviour and, in the context of all other efforts, results in measurable improvements in public health terms. The classification of individual foods according to a specific system can certainly not fully reflect the idea of a balanced diet, but it must be shown that the chosen model(s) effectively promote the right food choices.

It is in the best interest of all stakeholders that authorities, health and consumer organisations and the food industry work together in order to promote the principles of balanced nutrition with the aim of improving public health.

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3. Funktionelle Lebensmittel und Health Labelling (in German)

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Vom Arzneimittel zum Lebensmittel?

Zur Abgrenzung von Arznei- und Lebensmitteln
im europäischen und deutschen Recht

herausgegeben von

Thilo Marauhn
und Nadine Ruppel

Mohr Siebeck 2009

Funktionelle Lebensmittel und Health Labelling

JAN TRICHTERBORN

Das Interesse am Zusammenhang von Ernährung, körperlicher Bewegung und der Gesundheit wächst nicht zuletzt aufgrund alarmierender Entwicklungen im Bereich der öffentlichen Gesundheit stetig. Nach Schätzungen der Weltgesundheitsorganisation (WHO) sind weltweit mehr als eine Milliarde Menschen übergewichtig. Bis 2015 könnte diese Zahl auf 1,5 Milliarden steigen. Jährlich sterben über 2,5 Millionen Menschen weltweit an Krankheiten, die durch Übergewicht ausgelöst oder zumindest begünstigt werden.[1] Allein in der Europäischen Region der WHO sind jeder zweite Erwachsene und jedes fünfte Kind betroffen. Von dieser Gruppe ist bereits mindestens ein Drittel adipös.[2]

„Funktionelle Lebensmittel", ein rechtlich nicht definierter Begriff, nehmen in diesem Bereich eine wichtige Rolle ein. Nach einer Definition des europäischen Aktionsprojektes FUFOSE (Functional Food Science in Europe) versteht man hierunter Lebensmittel oder Lebensmittelbestandteile mit einem Zusatznutzen, der über Sättigung, Zufuhr von Nährstoffen und die Befriedigung von Genuss und Geschmack hinausgeht und zu einer Verbesserung des individuellen Gesundheitszustandes oder des Wohlbefindens führen kann. Diese Definition schließt auch die Verringerung des Risikos, an bestimmten Krankheiten zu erkranken, mit ein. Ein funktionelles Le-

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[1] World Health Organization (2005) Preventing chronic diseases: a vital investment. WHO Global Report. <http://www.who.int/chp/chronic_disease_report/contents/en/ index.html> (Online, abgerufen im Januar 2007).

[2] World Health Organization (2006) European Charter on counteracting obesity. WHO European Ministerial Conference on Counteracting Obesity. Istanbul, Turkey, November 2006. <http://www.euro.who.int/Document/ E89567.pdf> (Online, abgerufen im Januar 2007).

bensmittel ist dabei Teil normaler Ernährungsgewohnheiten. Gezielt ausge-schlossen werden Darreichungsformen wie Pillen oder Kapseln.[3]

Die WHO hat mit einer globalen Strategie gezielt die Aspekte Ernährung, körperliche Bewegung und Gesundheit in den Fokus ihrer Aktivitäten ge-rückt. Schwerpunkte bilden dabei die Bereiche Werbung und Marketing, Lebensmittelkennzeichnung, gesundheitsbezogene Aussagen („Health Claims") sowie die Schulverpflegung.[4] Hauptziele bezüglich Änderungen der Ernährungsweise sind dabei zum einen die Reduktion der Aufnahme von Fett, gesättigten Fettsäuren, trans-Fettsäuren, Natrium und freien Zu-ckern. Zum anderen soll der Verzehr von Früchten und Gemüse, Vollkorn, Hülsenfrüchten sowie Nüssen gesteigert werden.

Die Europäische Union ist der Weltgesundheitsorganisation gefolgt und hat diverse Aktivitäten initiiert, die im Grünbuch zur Förderung gesunder Ernährung und Bewegung zusammengefasst sind.[5] Dazu gehört die EU-Plattform für Ernährung, Bewegung und Gesundheit. In ihr haben sich unter anderem Lebensmittelhersteller, Einzelhändler, Mitglieder des Gaststätten-gewerbes und der Genossenschaftsbewegung, Verbraucherschutzorganisati-onen, Gesundheitsorganisationen und Werbeagenturen zusammen-geschlossen. Im Jahr 2006 wurden mehr als 140 freiwillige Selbstverpflich-tungen durch die Mitglieder eingegangen. Diese umfassen die Bereiche Verbraucherinformation, körperliche Aktivität, Marketing und Werbung, die Zusammensetzung sowie die Entwicklung von Lebensmitteln. Unter an-derem hat sich die Lebensmittelindustrie zur Verabschiedung gemeinsamer Werbegrundsätze verpflichtet, die bis 2007 in 80 % der Mitgliedstaaten ein-geführt werden sollen.[6] Mit einem Diskussionspapier der Generaldirektion Gesundheit und Verbraucherschutz wurde darüber hinaus eine strategische Überprüfung von Lebensmittelkennzeichnungsverordnungen in der EU an-gestoßen.[7]

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[3]   *Diplock, Aggett, Ashwell, Bornet, Fern, Roberfroid* (1999) Scientific concepts of functional foods in Europe: consensus document. British Journal of Nutrition 81, Suppl.1: 1-27.

[4]   World Health Organization (2004) Global Strategy on Diet, Physical Activity and Health. Fifty-seventh World Health Assembly. WHA57.7.

[5]   Kommission der Europäischen Gemeinschaften (2005) Grünbuch „Förderung gesunder Ernährung und körperlicher Bewegung: eine europäische Dimension zur Ver-hinderung von Übergewicht, Adipositas und chronischen Krankheiten". KOM(2005) 637.

[6]   European Platform on Diet, Physical Activity and Health (2005) Diet, Physical Activity and Health – A European platform for action. <http://ec.europa.eu/health/ph_ determinants/life_style/nutrition/platform/docs/platform_charter.pdf> (abgerufen im Ja-nuar 2007).

[7]   Kommission der Europäischen Gemeinschaften (2005) Generaldirektion Ge-sundheit und Verbraucherschutz: Wettbewerbsfähigkeit, Verbraucherinformation und bessere Rechtsetzung für die EU. Diskussionspapier der GD Sanco, Februar 2005.

Generelle Nährwertinformationen helfen vor allem an Ernährung interessierten Verbrauchern. Verschiedene Studien haben aber gezeigt, dass die vorhandenen Informationen nur selten aktiv und systematisch verwendet werden.[8] Häufig ist das notwendige Hintergrundwissen zum Thema Ernährung nicht vorhanden, um die komplexen Nährwertinformationen zu verstehen.[9] Einfache und präzise Angaben werden hingegen häufig wahrgenommen und beeinflussen das Kaufverhalten.[10]

Verbraucherinformation spielt eine zentrale Rolle für die Vermarktung nährwertoptimierter oder funktioneller Lebensmittel. Nährwert- und gesundheitsbezogene Angaben stellen dabei die klassischen Formen der produktbezogenen Kommunikation dar. Produkte mit erhöhtem Gehalt an bestimmten Nährstoffen oder Substanzen beziehungsweise mit Zusatznutzen werden häufig insgesamt als gesünder eingestuft. Diese Einstufung hat dann Einfluss auf das Kaufverhalten. Insgesamt verzeichnet die Ernährungsindustrie hohe Wachstumsraten im Bereich der Ernährung für Gesundheit und Wohlbefinden.

Die bisherige Verwendung von nährwert- und gesundheitsbezogenen Angaben auf Lebensmitteln führte allerdings immer wieder zu Kritik von Verbraucherverbänden, weil Lebensmittel mit derartiger Kennzeichnung (manchmal irrtümlich) als gesünder eingestuft werden. Derartige Produkte können gleichzeitig hohe Gehalte an Nährstoffen mit unerwünschten physiologischen Effekten aufweisen. Auch können die gemachten Angaben teilweise falsch oder irreführend sein. Im Dezember 2006 wurde eine neue EU-Verordnung veröffentlicht, die die nährwert- und gesundheitsbezogene Kommunikation über Lebensmittel regelt.[11] Sie ist ab Juli 2007 gültig und umfasst alle Lebensmittel, die als solche an den Endverbraucher abgegeben werden. Die Regelungen umfassen neben Kennzeichnung und Aufmachung von Lebensmitteln auch die Werbung für diese, einschließlich Lebensmit-

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<http://ec.europa.eu /food/food/labellingnutrition/betterregulation/competitiveness_ con sumer_info_de.pdf> (Online, abgerufen im Januar 2007).

[8]   EUFIC (2005) Nutrition Information & Food Labelling – Results of the EUFIC Consumer Research conducted in May-June 2004. EUFIC Forum No 2 February 2005. <http://www.eufic.org/images/Eufic_Forum_final.pdf> (Online, abgerufen im Januar 2007).

[9]   Grunert KG & Wills JM (2007) A review of European research on consumer response to nutrition information on food labels. Journal of Public Health (im Druck).

[10]   BEUC (2005) Report on European Consumer's Perception of Foodstuffs Labeling. BEUC/X/032/2005, <http://www.beuc.org/1/GAHBJCMALACAODEKEDBEOIMCPDB1 9DBN7Y9DW3F71KM/BEUC/docs/DLS/2005-00692-01-E.pdf>, (online, abgerufen im Januar 2007).

[11]   Europäische Gemeinschaften (2006) Verordnung (EG) Nr. 1924/2006 des Europäischen Parlaments und des Rates vom 20. Dezember 2006 über nährwert- und gesundheitsbezogene Angaben über Lebensmittel. Amtsblatt der Europäischen Gemeinschaften L 404: 9-25; corrigendum, ibid., Nr. 12, 18. Januar 2007, 3-18.

teln für die Gemeinschaftsverpflegung sowie Handelsmarken, Markenna-
men oder Phantasiebezeichnungen. Als ein wesentliches Ziel verfolgt die
Verordnung eine verbesserte Verbraucherinformation. Eindeutig geregelte
nährwert- und gesundheitsbezogene Angaben sollen Verbrauchern helfen,
sich gesund zu ernähren. Gleichzeitig sollen sie vor falschen und irrefüh-
renden Angaben geschützt werden. Als weitere Ziele sind die Verbesserung
des freien Warenverkehrs innerhalb des europäischen Binnenmarktes, er-
höhte legale Sicherheit für Unternehmen sowie die Sicherstellung eines fai-
ren Wettbewerbs im Lebensmittelsektor genannt.

Die neue Verordnung ergänzt bestehende Grundsätze über die Etikettie-
rung und Aufmachung von sowie die Werbung für Lebensmittel. So ist nach
Richtlinie 2000/13/EG bereits allgemein die Verwendung von Informatio-
nen untersagt, wenn diese den Käufer irreführen können oder den Lebens-
mitteln medizinische Eigenschaften zuschreiben. Letztere umfassen die
Vorbeugung, Behandlung oder Heilung einer menschlichen Krankheit.[12]

Im Wesentlichen unterscheidet die Verordnung zwei Haupttypen von
Produktkommunikation. Zum einen nährwertbezogene Angaben, die durch
einen Kriterienkatalog im Anhang der Verordnung genau geregelt sind. Er
enthält spezifische Bedingungen für die Verwendung solcher Aussagen. So
darf ein flüssiges Lebensmittel zum Beispiel den Zusatz „fettarm" enthalten,
wenn es nicht mehr als 1,5 Gramm Fett pro 100 Milliliter enthält. Ähnliche
Kriterien sind unter anderem definiert für Kennzeichnungen wie „energiere-
duziert", „zuckerfrei" oder „hoher Ballaststoffgehalt". Zusätzlich müssen
die Produkte allgemeine Anforderungen an das Nährwertprofil einhalten.
Diese werden noch weitergehend erläutert. In der Verordnung enthaltene
Angaben, die sich auf die Verringerung von Fett, gesättigten Fettsäuren,
Zucker und Salz/Natrium in einem Lebensmittel beziehen, sind in jedem
Fall ohne Bezug auf das Nährwertprofil erlaubt.

Zum anderen definiert die Verordnung gesundheitsbezogene Angaben,
die sich weiter in funktionelle Angaben sowie Angaben über die Reduzie-
rung eines Krankheitsrisikos sowie die Entwicklung und die Gesundheit von
Kindern aufteilen.

Funktionelle Angaben im Sinne des §13 der Verordnung umfassen An-
gaben bezüglich

– der Bedeutung eines Nährstoffs oder einer Substanz für Wachstum, Ent-
  wicklung und Körperfunktionen

– psychischer Funktionen oder Verhaltensfunktionen sowie bezüglich

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[12] Europäische Gemeinschaften (2000) Richtlinie 2000/13/EG des Europäischen Par-
laments und des Rates vom 20. März 2000 zur Angleichung der Rechtsvorschriften der
Mitgliedstaaten über die Etikettierung und Aufmachung von Lebensmitteln sowie die
Werbung hierfür. L 109: 29-42.

– schlank machender oder gewichtskontrollierender Eigenschaften, einer Verringerung des Hungergefühls, eines verstärkten Sättigungsgefühls oder verringerter Energieaufnahme.

Ein einfaches Beispiel dieses Typs wäre eine Aussage zur unterstützenden Funktion von Kalzium für den Erhalt starker Knochen. Sämtliche dieser Angaben müssen sich laut Verordnung auf allgemein anerkannte wissenschaftliche Nachweise stützen und vom durchschnittlichen Verbraucher richtig verstanden werden. Innerhalb von drei Jahren nach Inkrafttreten der Verordnung wird eine Liste erlaubter funktioneller Angaben veröffentlicht. In den Zulassungsprozess sind die Mitgliedsstaaten, die Europäische Behörde für Lebensmittelsicherheit (EFSA) sowie die EU-Kommission involviert. Die Mitgliedsstaaten übermitteln nationale Antragslisten bis spätestens Ende Januar 2008. Darin werden die spezifischen Voraussetzungen für die Angaben sowie die wissenschaftlichen Quellen enthalten sein. Insgesamt werden Anträge für mehrere hundert Angaben erwartet. Die EU Kommission konsultiert dann die EFSA und verabschiedet spätestens Ende Januar 2010 eine Gemeinschaftsliste zulässiger Angaben. Änderungen der bestehenden Liste sind danach auf Antrag der Kommission oder eines Mitgliedsstaates möglich. Lebensmittelunternehmen können darüber hinaus einen Antrag auf Aufnahme zusätzlicher Angaben stellen, basierend auf neuen wissenschaftlichen oder geschützten Daten.

Angaben über die Reduzierung eines Krankheitsrisikos sowie die Entwicklung und die Gesundheit von Kindern sind grundsätzlich genehmigungspflichtig. Dazu werden von der Kommission sowie der EFSA Leitlinien erarbeitet, an denen sich die Lebensmittelunternehmen bei der Beantragung orientieren können. Innerhalb von fünf Monaten nach Antrag soll dann eine Stellungnahme der EFSA vorliegen, aufgrund derer eine eventuelle Gemeinschaftszulassung erfolgen kann. Beispielhaft wäre an dieser Stelle eine Aussage über ein Lebensmittel zu nennen, das nachweislich den Cholesterinspiegel senkt, was wiederum zu einem verringerten Risiko für Herzerkrankungen führen kann.

Alle gesundheitsbezogenen Angaben müssen von wesentlichen Hinweisen und Informationen begleitet sein. Dazu zählt zunächst ein allgemeiner Hinweis auf die Bedeutung einer abwechslungsreichen und ausgewogenen Ernährung. Darüber hinaus muss klar hervorgehen, welche Menge des Lebensmittels verzehrt werden muss, um die behauptete positive Wirkung zu erzielen. Ebenfalls erforderlich sind unter Umständen ein Hinweis an Personen, die das Lebensmittel nicht verzehren sollten, sowie ein geeigneter Warnhinweis bei Produkten, die bei übermäßigem Verzehr eine Gesundheitsgefahr darstellen können.

Gleichzeitig werden bestimmte gesundheitsbezogene Aussagen gezielt untersagt. Dazu zählen Angaben

- die den Eindruck erwecken, dass durch den Verzicht auf das Lebensmittel die Gesundheit beeinträchtigt werden könnte
- über Dauer und Ausmaß einer Gewichtsabnahme
- die auf Empfehlungen von einzelnen Ärzten hinweisen
- auf Getränken mit mehr als 1,2% vol Alkohol

Der Nährstoffzusammensetzung der Lebensmittel kommt durch die neue Verordnung eine besondere Bedeutung zu. Bestimmte Lebensmittel sollen durch die Anwendung regulierender Nährwertprofile von der Verwendung nährwert- und gesundheitsbezogener Aussagen ausgeschlossen werden. Somit soll sichergestellt werden, dass die positiven Angaben nicht zum Konsum von Lebensmitteln entgegen einschlägiger wissenschaftlicher Empfehlungen führen.

Die festzulegenden Nährwertprofile, eine Art Kriterienkatalog für Lebensmittel, sollen sich laut Verordnung auf wissenschaftliche Nachweise über die Ernährung und ihre Bedeutung für die Gesundheit stützen und entsprechende Produktinnovationen ermöglichen. Die Festlegung der Kriterien soll dabei unter Berücksichtigung der in den Lebensmitteln enthaltenen Mengen bestimmter Nährstoffe und Substanzen erfolgen. Als Beispiele nennt die Verordnung Fett, gesättigte Fettsäuren, trans-Fettsäuren, Zucker und Salz beziehungsweise Natrium. Ferner sollen die Rolle und die Bedeutung in der Ernährung sowie die allgemeine Nährstoffzusammensetzung der Produkte Eingang in die Profile finden.

Die Möglichkeit der Verwendung nährwert- und gesundheitsbezogener Angaben ist generell durch die Nährwertprofile geregelt. Zwar sind Angaben bezüglich der Verringerung von Fett, gesättigten Fettsäuren, trans-Fettsäuren, Zucker und Salz grundsätzlich erlaubt. Für andere Aussagen muss das definierte Nährwertprofil jedoch erfüllt werden. Einzige Ausnahme bilden nährwertbezogene Aussagen, bei denen eine Überschreitung des Profils für einen Nährstoff erlaubt ist. Ein Milchprodukt dürfte beispielsweise also auch dann mit einem Hinweis auf den hohen Kalziumgehalt beworben werden, wenn es die Vorgaben für den Natriumgehalt überschreitet, alle anderen Grenzwerte (gesättigte Fettsäuren, trans-Fettsäuren etc.) jedoch einhält. Auf einem solchen Produkt muss dann jedoch in gleicher Deutlichkeit und in unmittelbarer Nähe zur Aussage über Kalzium auf den Natriumgehalt des Produktes hingewiesen werden.

Mit Hilfe von Nährwertprofilen lassen sich allgemein Lebensmittel anhand ihres Energiegehalts, ihrer Nährstoffzusammensetzung und/oder dem Gehalt anderer Substanzen kategorisieren. Bei ihrer Festlegung müssen wesentliche Grundsatzentscheidungen getroffen werden. Von entscheidender Bedeutung ist dabei die Überlegung, für welchen Zweck die Profile verwendet und welche Gruppe von Konsumenten in ihrem Ernährungsverhalten

beeinflusst werden soll. Auf eine Reihe von Beispielen der Verwendung von Nährwertprofilen soll am Ende eingegangen werden.

Weiter ist wichtig, ob die Profile für Lebensmittel im Allgemeinen oder in Lebensmittelkategorien festgelegt werden.

Drittens kommt der Auswahl der betrachteten Nährstoffe und Substanzen eine wichtige Bedeutung zu. Möglich sind hier die Beschränkung auf solche, deren Aufnahme verringert werden soll (Gesamtenergie, Fett, gesättigte Fettsäuren, trans-Fettsäuren, Zucker und Salz beziehungsweise Natrium), wie auch die Ausweitung auf solche, deren Konsum gesteigert werden soll (Vitamine, Mineralstoffe, Ballaststoffe, ungesättigte Fettsäuren, aber auch Lebensmittelgruppen wie Vollkornprodukte, Früchte und Gemüse).

Einen Einfluss auf das Ergebnis der Anwendung solcher Profile hat darüber hinaus die verwendete Referenzgröße, auf die sich das Modell bezieht. Denkbar wäre die Verwendung von Größen wie Nährstoffgehalt pro 100g, pro 100kJ oder auch pro Portion.

Ferner beeinflusst die Auswahl des Berechnungsmodells entscheidend das Ergebnis der Profilierung. Bereits existierende Anwendungen verwenden dabei entweder ein Grenzwert- oder Punktbewertungsmodell. Bei Grenzwertmodellen werden für die ausgewählten Nährstoffe Obergrenzen definiert. Ein Lebensmittel muss dann eine festzulegende Mindestanzahl dieser Kriterien erfüllen, um ein positives Gesamturteil zu bekommen. Bei Punktbewertungsmodellen werden für die Gehalte an ausgewählten Nährstoffen und Substanzen Zwischenpunkte vergeben, die dann zu einem Endergebnis summiert werden. In diesen Modellen lässt sich in der Regel ein höherer Gehalt an unerwünschten Nährstoffen, beispielsweise Fett, durch einen hohen Gehalt an erwünschten Substanzen, beispielsweise Ballaststoffen, zumindest teilweise ausgleichen. Insgesamt wird dann eine maximale Endpunktzahl für die positive Qualifikation eines Lebensmittels festgelegt.

Schlüssige wissenschaftliche Beiträge zur Diskussion über die Anwendung von Nährwertprofilen im Rahmen der EU-Verordnung deuten in Richtung kategoriespezifischer Grenzwertmodelle. So wäre zum Beispiel eine Festlegung von Maximalgehalten an Energie, gesättigten Fettsäuren und Natrium für Käseprodukte denkbar. Nährstoffe mit positivem Effekt werden in diesen Modellen meist nicht betrachtet.

Nährwertprofile können über die Regulierung von nährwert- und gesundheitsbezogenen Angaben hinaus vielseitig angewendet werden. Zahlreiche Beispiele aus nationalen Richtlinien, Industrieinitiativen oder Aktivitäten von Gesundheitsorganisation zeigen die erfolgreiche Umsetzung dieses Ansatzes. So haben sich bereits mehrere Lebensmittelhersteller eigene Kriterien für die Werbung von Produkten an Kinder auferlegt. Lediglich Werbung für Produkte, die bestimmte Profile erfüllen, darf zum Beispiel gezielt an Vorschulkinder gerichtet werden. In Großbritannien und Nordirland hat

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ein derartiger Ansatz bereits Eingang in die nationale Gesetzgebung gefunden. Lebensmittelhersteller wenden diese Methode darüber hinaus für die ernährungsspezifische Optimierung ihrer Produktpaletten an. So werden mit Hilfe von Nährwertprofilen gezielt Vorgaben für die Produktentwicklung definiert. Ein wichtiges Anwendungsgebiet stellt auch die Kennzeichnung gesünderer Produkte dar. Lebensmittel, die die festgelegten Kriterienkataloge erfüllen, werden mit einem einfachen Symbol gekennzeichnet und sind so für den Verbraucher leicht zu erkennen.

4. Nutrient profiling and food label claims: evaluation of dairy products in three major European countries

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Running title: Nutrient profiling and dairy product label claims

ORIGINAL ARTICLE

Nutrient profiling and food label claims: evaluation of dairy products in three major European countries

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Background/Objectives: This study reviews commercially available dairy products with nutrition or health-related on-pack communication against selected nutrient profiling models. It aims to provide guidance on the model characteristics required to appropriately categorise products into those that are suitable for carrying claims, versus those whose overall nutritional composition does not support such product communication.
Subjects/Methods: More than 300 dairy products carrying claims were identified in Germany, France and the UK and evaluated against six existing nutrient profiling models. All models were assessed regarding their underlying principles, generated results and inter-model agreement levels.
Results: In most cases, products failed the criteria of a given model because of too high levels of total fat, saturated fatty acids, sugars and/ or sodium. The Swedish Keyhole and the Smart Choices Program were the most restrictive models and showed the highest level of agreement. In general, the application of nutrient profiles helped to select products with significantly lower average levels of nutrients that are linked to chronic diseases when consumed in excess. However, calcium levels were also highly impacted in some cases.
Conclusions: A nutrient profiling model that targets saturated fatty acids, sugars and sodium can meaningfully and comprehensively identify dairy products with a favourable nutritional composition. However, thresholds have to be set carefully to not reduce the average calcium contribution of the category. The use of separate criteria for cheeses and other dairy products seems necessary to take into account intrinsic compositional differences.
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Introduction

Nutrition and health claims have been shown to potentially influence consumer purchase behaviour (Ford *et al.*, 1996; Geiger, 1998; Tuorila and Cardello, 2002; Bech-Larsen and Grunert, 2003; Teratanavat and Hooker, 2006; Grunert and Wills, 2007; Van Trijp and Van der Lans, 2007; Pothoulaki and Chryssochoidis, 2009). Therefore, the new European Regulation on Nutrition and Health Claims made on Foods (hereafter 'EU Health Claims Regulation') foresees the use of nutrient profiling to prevent the use of health claims on products that contain unreasonably high levels of nutrients unfavourably linked to health (European Community, 2006).

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In a previous study on fine bakery wares with nutrition or health-related on-pack communication, we had outlined that usually studies on the validation of nutrient profiling models remain rather generic and do not reflect the composition of commercial products (Trichterborn *et al.*, 2011). Also, they often do not take into account the specific application of a profiling model (for example, the regulation of claims). In this study we focused on dairy products with claims that are commercially available in Europe. Our aim was to provide guidance on the required characteristics of a profiling model that can be used to identify products that are suitable for carrying nutrition or health-related product communication and to contribute to the discussion around nutrient profiles in the EU Health Claims Regulation.

Materials and methods

In this study, dairy products with any sort of on-pack product communication that gave the impression of

'healthier' products were identified in supermarkets in France, Germany and the UK between January 2007 and December 2009. Whenever the same or very similar items were identified in more than one country, these products were assessed only once. For all analyses, the products were grouped into two main categories ('cheeses (products)' and 'other dairy products'), with the former being divided into two subcategories ('fresh cheeses' and 'other cheeses') and the latter into four ('milk/-drinks', 'yogurt drinks', 'yogurts' and 'dessert quark/fromage frais'). This classification was based on the product sections found in most supermarkets. The type of on-pack communication included nutrition and health claims as specified in the EU Health Claims Regulation as well as labelling of dietetic foodstuffs, claims on specific ingredients or other indirect claims, for example, labelling including words like 'fit' or 'active'.

Nutrition values for all products were recorded from product labels, or partly collected in online supermarkets (Ooshop, 2009; Sainsbury's, 2009; Tesco, 2009). Generic items in nutrition tables (Food Standards Agency, 2002; Kirchhoff, 2005; Agence Francaise de Securite Sanitaire des Aliments, 2008) were used whenever values were not available on branded items.

All items were consequently evaluated against six nutrient profiling schemes that are validated by published or submitted scientific research and applicable to at least a majority of foods and drinks, including dairy products. Compared with our previous study on fine bakery wares the range of profiling models was extended by one, as the Swedish Keyhole model contains criteria for dairy products but not for biscuits and crackers. The main parameters of the chosen nutrient profiling models are summarised in Table 1 (Food and Drug Administration, 2002b; Darmon et al., 2007; Choices International Foundation, 2009; Food Standards Agency, 2009; Livsmedelverket Swedish National Food Administration, 2009; Smart Choices Program, 2009). All models were assessed regarding their underlying principles, their applicability and their categorisation of the selected products. In a second step, the particularities of results were assessed, such as the number of products that qualified in each subcategory of products, nutrients that are specifically addressed by any of the models and the results for products with health, nutrition or other claims. Third, it was calculated what impact each model would have on the average levels of energy, saturated fatty acids, total sugars, sodium and calcium in the products eligible for carrying claims. Finally, it was determined how the results generated by each model compared with all others.

Results

Ease of application and accuracy of the models

For all selected products energy, protein, fat and carbohydrates were labelled on pack. In many cases more complete information was given, including saturated fatty acids, total sugars, dietary fibre and sodium contents. None of the models, however, could be applied based on this set of information only and the availability of data varied strongly with the country, being most comprehensive in the UK, followed by France and then Germany. Missing data was estimated based on the overall category profile and safe assumptions for dairy products, that is, saturated fatty acids accounting for ~two thirds of the total fat content, sodium and calcium levels set as per the average content of similar generic products in nutrition tables (Food Standards Agency, 2002; Kirchhoff, 2005; Agence Francaise de Securite Sanitaire des Aliments, 2008), dietary fibre and added sugar contents based on ingredient assessments, trans fatty acids not exceeding the thresholds due to a lack of addition of partially hydrogenated fats and fruit contents not exceeding the 40% minimum requirement set in the FSA model. Based on the generated data, all products could be assessed using the Swedish Keyhole, Choices Programme and FSA/OFCOM models. The Smart Choices Program and FDA models additionally require the cholesterol levels, which were not available for any of the products and had to be estimated based on data of similar generic products listed in nutrition tables (Food Standards Agency, 2002; Kirchhoff, 2005; Agence Francaise de Securite Sanitaire des Aliments, 2008).

Table 1 Overview of chosen nutrient profiling models and their key parameters

	Swedish Keyhole	Choices Programme	Smart Choices Program	FSA/OFCOM	SAIN/LIM	FDA
Objective of current use	FOP[a]	FOP[a]	FOP[a]	ADV[b]	CL[c,d,e]	CL[c]
Number of (sub) categories	25	1 + 22	1 + 19	1[f]	1	1
Calculation approach (T = threshold, S = scoring)	T	T	T	S	S	T
Number of nutrients (negative/positive)	(5/1)	(4/1)	(6/1 out of 7)	(4/3)	(3/15)	(4/1 out of 6)
Reference value	100 g/kcal	100 g/kcal	One serving/100 kcal	100 g	100 g/kcal	One serving

[a]Positive front of pack signposting.
[b]Advertising regulations.
[c]Claims regulation.
[d]Proposed for this purpose.
[e]In this study, only the LIM criteria could be applied (see Results).
[f]Model distinguishes between foods and drinks.

The SAIN/LIM score can only be fully calculated based on data on 15 positive (SAIN) and three negative (LIM) nutrients. Due to the restricted availability of nutrition values for the commercial products assessed, the analyses in this study were performed for the LIM score only.

In addition to dealing with missing nutrient data, categorising the milk/dairy products and cheese products according to the Swedish Keyhole, Choices Programme and Smart Choices Program models required some interpretation, as some of the products manufactured through acid coagulation of milk could fall into any of the categories. As a result, in this study, the categorisation was based on product groupings found in supermarkets. Therefore, all products generally used as (bread) spreads or dips (such as quark with herbs) were classified as fresh cheeses and more broadly as cheese (products). All other products (such as quark with fruit topping) were classified as dessert quark/ fromage frais and more broadly as other dairy products.

Serving sizes were not indicated on most of the products. This meant that for the Smart Choices Program and FDA models the analyses had to be based on the reference amounts customarily consumed (RACC) as defined by the FDA (Food and Drug Administration, 2002a).

Market screening of dairy products with label claims
The majority of products assessed in this study could be considered by consumers as healthier alternatives as they carried a nutrition and/or health claim as defined in the EU Health Claims Regulation. In addition, and especially in Germany, product communication on the suitability of products for people with diabetes contributed to this impression, as in these cases the word 'diet' was used as part of the product names. In the same market, as well as in France, there was also a considerable number of claims on the mere content of certain nutrients and/or ingredients (recipe claims), such as 'X% fat' or 'contains one portion of fruit'. Other claims that are indirectly linked to nutrition and health (such as 'less sweet' or 'active') played a minor role for German products only. Products with two different types of claims were counted only once and grouped in a defined sequence of priority: (1) health claims, (2) nutrition claims, (3) diet claims, (4) recipe claims, (5) other indirect claims).

Application to all products with a healthier product image
The FDA model proved to be the most lenient with ~two thirds of the evaluated products being eligible. The other models roughly split products into two groups with either half (FSA/OFCOM, Choices Programme, LIM score) or one quarter to one third (Smart Choices Program, Swedish Keyhole) of the products meeting the respective criteria. With the exception of the Choices Programme, fewer cheese (products) qualified compared with other dairy products (Table 2).

Application to products carrying nutrition or health claims
In general, products carrying a defined nutrition or health claim were less likely to meet the respective criteria than products with diet, recipe or indirect claims (Table 2). Some models also specifically allowed more products from certain subcategories to qualify, such as milk and milk drinks in the case of the LIM score, yogurts and desserts in the FSA/OFCOM model or yogurt drinks in the case of the FDA model. In the case of cheese (products), significantly more fresh cheeses than other cheeses qualified, with the FDA model being the only exception. More specifically, the cheese products assessed, other than fresh cheese, almost completely failed the criteria of half of the models (Table 2).

Number and type of disqualifying nutrients
An evaluation of the type of disqualifying parameters identified significant differences in the effective complexity of the models. The Swedish Keyhole model sets up to three, the Choices Programme model four, the FDA model five and the Smart Choices Program model six different criteria to be met simultaneously. However, in all cases the majority of non-eligible products only exceeded one or two of these criteria at the same time.

Fat played the most important role as disqualifying nutrient criterion in all threshold models, either as total fat (Swedish Keyhole), saturated fatty acids (FDA and Choices Programme) or both (Smart Choices Program). Sugars proved to be an effective threshold for other dairy products, whereas sodium was exceeded at a significant level by cheese (products) in one of the models. Positive nutrients (in the case of this category specifically calcium) as required by two of the models contributed only slightly to the non-eligibility of products.

Scoring models, as opposed to threshold models, represented unique challenges. The FSA/OFCOM and LIM models could not be directly analysed for key nutrient criteria, as the scoring approach they employ means that there is no predetermined maximum amount for a nutrient. However, typically the contents of saturated fatty acids, (total or added) sugars and sodium contributed significantly to exceeding overall scores. In the case of the FSA/OFCOM model, saturated fatty acids and total sugars counted twice due to their additional impact on the overall energy content.

Potential impact on nutrient levels in products with claims
In a theoretical scenario it was assumed that nutrition and health claims would have to be removed from all products that did not meet the nutrient profile criteria. All products were first categorised by applying the different models. Second, the extent was determined for each model to which the average contents of energy, saturated fatty acids, total sugars, sodium and calcium in the qualifying products would change compared with all products that carry a claim today (Table 3). The possibility to disclaim one derailing nutrient

Table 2 Percentages of dairy products that met the respective nutrient profiles (by categories and claim types)

	Swedish Keyhole (%)	Choices Programme (%)	Smart Choices Program (%)	FSA/OFCOM (%)	LIM (%)	FDA (%)
Products with a healthier image						
All categories (n = 317)	26	56	33	58	51	68
Other dairy products (n = 218)	32	44	35	78	69	78
Milk/-drinks (n = 19)	32	58	32	47	95	79
Yogurt drinks (n = 46)	20	39	22	35	67	100
Yogurts (n = 114)	38	46	42	93	69	79
Dessert quark/fromage frais (n = 39)	31	36	33	97	56	49
Cheese (products) (n = 99)	11	82	28	14	12	45
Fresh cheeses (n = 30)	20	93	43	47	40	47
Other Cheeses (n = 69)	7	77	22	0	0	45
Products with nutrition and/or health claims						
All categories (n = 242)	20	52	28	55	48	64
Other dairy products (n = 163)	25	39	28	77	67	75
Milk/-drinks (n = 12)	0	42	0	42	92	75
Yogurt drinks (n = 40)	23	40	23	40	68	100
Yogurts (n = 83)	33	43	37	93	69	77
Dessert quark/fromage frais (n = 28)	18	25	21	96	50	32
Cheese (products) (n = 79)	10	80	27	10	8	42
Fresh cheeses (n = 18)	22	94	44	44	33	39
Other cheeses (n = 61)	2	75	21	0	0	43
Products by claim type						
All claims (n = 317)	24	56	33	58	51	68
Health and nutrition claims (n = 242)	20	52	28	55	48	64
Health claims (n = 106)	15	37	21	66	58	64
Nutrition claims (n = 136)	24	65	33	46	39	64
Other claims (n = 75)	43	67	51	67	63	80
Diet claim (n = 15)	53	60	60	80	87	67
Recipe claim (n = 58)	40	69	48	62	57	84
Indirect claims (n = 2)	50	50	50	100	50	50

Table 3 Differences in average critical nutrient contents in products with claims today and after theoretical application of the models (summary)

All products n = 242 Subcategories i = 6	Swedish Keyhole	Choices Programme	Smart Choices Program	FSA/OFCOM	LIM	FDA
Categories without qualifying products	Milk/-drinks	—	Milk/-drinks	Other Cheeses	Other cheeses	—
Total average changes (other dairy products/ cheese (products)) of						
Energy[a]	−40/−25%	−30/−7%	−34/−35%	−4/−60%	−17/−83%	−11/−17%
Saturated fatty acids[a]	−92/−62%	−69/−21%	−90/−60%	−4/−85%	−31/−90%	−41/−38%
Total sugars[b]	−39%/−	−30%/−	−30%/−	−7%/−	−20%/−	−1%/−
Sodium[c]	−/−53%	−/−3%	−/−13%	−/−57%	−/−62%	−/−1%
Calcium[a]	+8/−12%	+5/−1%	+9/−16%	+3/−76%	+3/−77%	±0/−5%
Subcategories with min. 30% reduction of						
Energy[a]	4/6	2/6	2/6	2/6	1/6	1/6
Saturated fatty acids[a]	5/6	4/6	5/6	3/6	3/6	4/6
Total sugars[b]	3/4	2/4	2/4	1/4	1/4	0/4
Sodium[c]	2/2	0/2	0/2	0/2	1/2	0/2
Subcategories with reduction less than 10% of						
Energy[a]	1/6	2/6	0/6	2/6	0/6	3/6
Saturated fatty acids[a]	0/6	1/6	0/6	2/6	0/6	1/6
Total sugars[b]	0/4	0/4	0/4	2/4	1/4	3/4
Sodium[c]	0/2	2/2	2/2	0/2	0/2	2/2

[a]All subcategories (i = 6).
[b]Other dairy products only (i = 4).
[c]Cheese (products) only (i = 2).

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in the case of nutrition claims as foreseen in the EU Health Claims Regulation was not included in this analysis. The reductions in total sugars were analysed for other dairy products, and sodium was only assessed for cheese (products), based on the overall importance of these nutrients for each subcategory.

Overall, the Swedish Keyhole model showed the biggest differences in average nutrient contents between all analysed products on one side and eligible products only on the other. In almost all relevant subcategories eligible product contained at least 30% less saturated fatty acids, total sugars, and sodium on average; only one subcategory showed a reduction of less than 10% and only in the case of the energy content. The application of the Smart Choices Program model showed similar results, but did not result in a substantial difference in average sodium content in cheese (products).

Products rated eligible according to the Choices Programme model specifically were specifically lower in average saturated fat contents. Although energy and sugar contents were noticeably reduced in other dairy products, the model did not lead to major reductions in the caloric and sodium contents of cheese (products).

The LIM score showed a slightly more moderate approach with average levels of all nutrients to limit that were considerably lower in the eligible products but fell short of a 30% difference. However, the criteria had a higher impact on saturated fatty acids in cheese (products), where the reduction of average contents reached 80%. A similar pattern could be identified for the FSA/OFCOM model. Unlike for the LIM score, however, the average levels of energy and critical nutrients in dairy desserts rated eligible by the FSA/OFCOM model were not lower than in the full range of products.

The application of the FDA model almost exclusively identified products with lower average levels of saturated

fatty acids, with slightly lower total energy contents. Average total sugars and sodium contents in eligible products were not noticeably different to the levels in eligible and non-eligible items combined.

According to all models eligible other dairy products showed the same or similar calcium contents as the totality of products in the study. For cheese (products), however, average calcium levels were 76–77% lower when applying the FSA/OFCOM and LIM models. The Swedish Keyhole and Smart Choices Program models still led to a minor difference, whereas the Choices Programme and FDA models had almost no effect on calcium contents in this product group.

Inter-model comparison
Similarities between all product ratings were compared to determine the uniqueness of each model and the different approaches to nutrient profiling. Table 4 shows the levels of agreement between any two models, that is, the number of products that were rated the same ('eligible'/'eligible' or 'non-eligible'/'non-eligible').

Across all subcategories, the Swedish Keyhole and the Smart Choices Program models showed almost perfect concordance (>80% identical ratings). All other models agreed moderately (41–60%) to substantially (61–80%), with the FSA/OFCOM and FDA models compared with most others in the lower ranges (50–66% concordance) (Table 4).

The level of agreement was highly dependent on the main product categories, as some models generated very similar results for other dairy products but disagreed considerably on cheese (products), or vice versa.

No further statistical analyses were conducted on the generated data, due to the deterministic and non-random nature of the product rating assignments.

Table 4 Identical inter model ratings for all products carrying claims

	Choices Programme (%)	Smart Choices Program (%)	FSA/OFCOM (%)	LIM (%)	FDA (%)
All categories (n = 242)					
Swedish Keyhole	65	87	61	69	52
Choices Programme	—	74	50	58	64
Smart Choices Program	—	—	59	66	60
FSA/OFCOM	—	—	—	77	56
LIM	—	—	—	—	66
Other dairy products (n = 163)					
Swedish Keyhole	82	93	47	58	49
Choices Programme	—	88	59	72	64
Smart Choices Program	—	—	50	61	53
FSA/OFCOM	—	—	—	67	56
LIM	—	—	—	—	71
Cheese (products) (n = 79)					
Swedish Keyhole	30	73	90	92	58
Choices Programme	—	47	30	28	62
Smart Choices Program	—	—	76	76	75
FSA/OFCOM	—	—	—	97	56
LIM	—	—	—	—	56

Discussion

In this study it has been shown that a considerable number of dairy products in major European markets seek to provide a healthier product image through on-pack communication, notably in the UK and France and to a lesser extent in Germany. Label claims can guide consumers' choice towards products with significant amounts of positive nutrients, such as protein or calcium. At the same time, however, these products can contain significant amounts of nutrients that are linked to chronic diseases when consumed in excess and whose intake should be limited.

The analyses in the present study have shown that nutrient profiles that target saturated fatty acids for all dairy products, sodium for cheese (products) and sugars for other dairy products can meaningfully categorise dairy products regarding their suitability for carrying claims. The application of such profiles with reasonable threshold levels can help to lower the average amounts of those nutrients in products with label claims. In the case of sugars, some nutrient profiling systems employ a threshold for added sugars and others limit the content of total sugars. None of the two approaches fits all purposes of nutrient profiling. For the regulation of claims in Europe it is critical that compliance with the profiles can be confirmed easily by analysing the products. Therefore, it seems most reasonable to apply a limit on total sugars.

Furthermore, it seems essential that fundamental compositional differences between cheeses and other dairy products are taken into account. The application of criteria sets suitable for other dairy products automatically excludes the majority of cheese (products), which are important contributors to the dietary intake of calcium. Two individual criteria sets also adequately reflect common eating behaviour, as both subcategories are complementary to each other.

It is important to note that these results do not necessarily apply to other purposes where nutrient profiling models are used. For front-of-pack signposting of healthier options overall, more restrictive thresholds for nutrients to limit could be applied than for guiding product suitability for carrying specific claims. Also, the inclusion of positive nutrients seems necessary for many categories in this case.

Additional research should focus on the interaction between nutrient profiling and eating behaviour to better understand the potential impact of nutrient profiling for the individual, for example apply nutrient profiles to items that show high consumption levels in product-based dietary surveys.

Ultimately, nutrient profiles can only lead to reduced intakes of nutrients to limit if their application results in changes of the buying behaviour, that is, consumers do not buy products anymore that are not allowed to carry claims. Further research is needed to better understand the impact of nutrition and health claims on buying behaviour, specifically at the point of sale. Second, the manufacturers can choose to reformulate the products. In that case, it will be of critical importance that the new products not only meet the nutrient profile criteria, but even more importantly deliver against the most important drivers of consumer linking, such as taste and price.

Conclusions

A nutrient profiling model that targets saturated fatty acids, sugars and sodium can meaningfully and comprehensively identify dairy products with a favourable nutritional composition. However, thresholds have to be set carefully to not reduce the average calcium contribution of the category. The use of separate criteria for cheeses and other dairy products seems necessary to take into account intrinsic compositional differences.

Conflict of interest

Acknowledgements

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CORRIGENDUM

Nutrient profiling and food label claims: evaluation of dairy products in three major European countries

J Trichterborn, G Harzer and C Kunz

Correction to: *European Journal of Clinical Nutrition* (2011) 65, 1032–1038; doi:10.1038/ejcn.2011.52

Since the publication of this paper, the authors have been made aware that 'SAIN,LIM' is the correct spelling of one of the nutrient profiling models mentioned in the study. In addition, the most recent version of the model contains 5 basic and 4 optional positive nutrient criteria and not 15 as mentioned in the text and in Table 1 (Darmon *et al.*, 2009). The corrected Table 1 and the corresponding reference to the model are shown below. These errors do not have any impact on the results of the study, as the positive criteria were not applied.

The authors would like to apologise for any inconvenience caused.

Reference

Darmon N, Vieux F, Maillot M, Volatier JL, Martin A (2009). Nutrient profiles discriminate between foods according to their contribution to nutritionally adequate diets: a validation study using linear programming and the SAIN,LIM system. *Am J Clin Nutr* 89, 1227–1236.

Table 1 Overview of chosen nutrient profiling models and their key parameters

	Swedish Keyhole	Choices Programme	Smart Choices Program	FSA/OFCOM	SAIN,LIM	FDA
Objective of current use	FOP[a]	FOP[a]	FOP[a]	ADV[b]	CL[c,d,e]	CL[c]
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Calculation approach	T	T	T	S	S	T
Number of nutrients (negative/positive)	(5/1)	(4/1)	(6/1 out of 7)	(4/3)	(3/5 + 4)	(4/1 out of 6)
Reference value	100 g/kcal	100 g/kcal	One serving/100 kcal	100 g	100 g/kcal	One serving

Abbreviations: ADV, advertising; CL, claims; FDA, Food and Drug Administration; FOP, front-of-pack; FSA, Food Standards Agency; S, scoring; T, threshold.
[a]Positive front-of-pack signposting.
[b]Advertising regulations.
[c]Claims regulation.
[d]Proposed for this purpose.
[e]In this study, only the LIM criteria could be applied (see Results).
[f]Model distinguishes between foods and drinks.

5. Fine bakery wares with label claims in Europe and their categorisation by nutrient profiling models

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Running title: Nutrient profiling and fine bakery product claims

ORIGINAL ARTICLE

Fine bakery wares with label claims in Europe and their categorisation by nutrient profiling models

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Background/Objectives: This study assesses a range of commercially available fine bakery wares with nutrition or health related on-pack communication against the criteria of selected nutrient profiling models. Different purposes of the application of nutrient profiles were considered, including front-of-pack signposting and the regulation of claims or advertising.
Subjects/Methods: More than 200 commercially available fine bakery wares carrying claims were identified in Germany, France, Spain, Sweden and United Kingdom and evaluated against five nutrient profiling models. All models were assessed regarding their underlying principles, generated results and inter-model agreement levels.
Results: Total energy, saturated fatty acids, sugars, sodium and fibre were critical parameters for the categorisation of products. The Choices Programme was the most restrictive model in this category, while the Food and Drug Administration model allowed the highest number of products to qualify. According to all models, more savoury than sweet products met the criteria. On average, qualifying products contained less than half the amounts of nutrients to limit and more than double the amount of fibre compared with all the products in the study. None of the models had a significant impact on the average energy contents.
Conclusions: Nutrient profiles can be applied to identify fine bakery wares with a significantly better nutritional composition than the average range of products positioned as healthier. Important parameters to take into account include energy, saturated fatty acids, sugars, sodium and fibre. Different criteria sets for subcategories of fine bakery wares do not seem necessary.
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Introduction

Nutrient profiling allows the categorisation of foods and drinks according to their overall nutritional composition. National food administrations, media and advertising authorities, food manufacturers and other institutions in different countries around the world apply profiling models for the regulation of claims like the Food and Drug Administration (FDA) in the United States (Food and Drug Administration, 2002b), for the regulation of advertising and marketing to children like OFCOM and the Food Standard Agency (FSA) in the United Kingdom (Food Standards Agency, 2007), for front-of-pack labelling of healthier product choices like the Swedish Keyhole, Choices International or Smart Choices logos (Livsmedelverket, 2007;

Choices International Foundation, 2009a; Smart Choices Program, 2009a), for guidance of product development in the food industry (Nijman *et al.*, 2007) and for recommendations for school meals (Crawley, 2005). In Europe, the discussion around nutrient profiling has gained significant momentum with the incorporation of such an approach in the European Union (EU) Regulation on Nutrition and Health Claims made on Foods (hereafter 'EU Health Claims Regulation') (European Community, 2006). In this case, the aim is to only allow products whose nutritional composition does not contradict general nutritional advice to carry nutrition and/or health claims.

In the past, nutrient profiling models were usually assessed by analysing generic nutrition data of foods, mostly drawn from standard nutrition tables (Azais-Braesco *et al.*, 2006; Arambepola *et al.*, 2007; Garsetti *et al.*, 2007; Quinio *et al.*, 2007; Scarborough *et al.*, 2007; Volatier *et al.*, 2007; Drewnowski and Fulgoni, 2008; Drewnowski *et al.*, 2008a, b; Darmon *et al.*, 2009). In this study, we collected data on commercially available fine bakery wares with nutrition and/or health claims from five European countries (France, Germany, Spain, Sweden and the UK) in order to

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understand the potential market impact of nutrient profiling models. We assessed the models specifically based on their originally intended application, that is, the front-of-pack signposting of healthier product choices and the regulation of claims or advertising.

Methods

This study focused on commercially available fine bakery wares with on-pack communication that links the products to nutrition and health in any possible way. Such products were identified in supermarkets in France, Germany, Spain, Sweden and United Kingdom between January 2007 and December 2009. The type of label claims included nutrition and health claims as specified in the EU Health Claims Regulation, as well as statements on specific nutrient or ingredient levels or the labelling of dietetic foodstuffs. The selected products were grouped into two subcategories (sweet and savoury).

Nutrition data of all items were collected from product labels, online supermarkets (Ooshop, 2009; Sainsbury's, 2009; Tesco, 2009) or manufacturers' websites. Generic items in nutrition tables (Food Standards Agency, 2002; Kirchhoff, 2005; Agence Francaise de Securite Sanitaire des Aliments, 2008) were used whenever values were not available on branded items.

Five nutrient profiling schemes that are validated by published or submitted scientific research and applicable to at least a majority of foods and drinks, including fine bakery wares were selected and applied against the selected items. The profiling models analysed covered the FDA (Food and Drug Administration, 2002b), FSA/OFCOM (Food Standards Agency, 2009), Choices Programme (Choices International Foundation, 2009b), Smart Choices Programme (Smart Choices Program (2009b)) and in addition the SAIN/LIM model, which was proposed by the French INRA institute for the regulation of claims in the EU (Institut National de la Recherche Agronomique, 2008). All models were assessed

regarding their underlying principles and application purposes (Table 1). Consequently, they were applied to all products identified in the market screening. Subsequently, the particularities of the results were assessed, that is, sweet versus savoury products, nutrients that are specifically addressed by any of the models or the rating of products with health claims versus the items with nutrition or other claims. In another step, it was calculated to what extent each model would change the average levels of energy, saturated fatty acids, total sugars and fibre in qualifying products versus the total set of items. Finally, it was assessed how the results generated by each model compared with all others.

Results

Ease of application and accuracy of the models
The ease of application and likely accuracy of the assessment differed significantly between the models, mainly driven by the availability of required nutrient data and whether or not the models were based on serving sizes.

Big eight nutrient information could be obtained for almost all selected products. However, all models required additional data which had to be estimated based on generic category data from standard nutrition tables (Food Standards Agency, 2002; Kirchhoff, 2005; Agence Francaise de Securite Sanitaire des Aliments, 2008) or product ingredient lines, that is, added sugars, *trans*-fatty acids, cholesterol and whole grain levels. The SAIN/LIM score can only be fully calculated based on 15 positive (SAIN) and 3 negative (LIM) nutrients. Due to the restricted availability of nutrient values for the commercial products assessed, the analysis in this study was performed for the LIM score only.

Serving sizes were also not indicated on many products. The reference amount customarily consumed of 30 g as defined for these categories by the FDA (Food and Drug Administration, 2002a) was therefore applied as a reference basis for the North America specific Smart Choices

Table 1 Overview of chosen nutrient profiling models and their key parameters

	Choices Programme	Smart Choices programme	FSA/OFCOM	SAIN/LIM	FDA
Objective of current use	FOP[a]	FOP[a]	ADV[b]	CL[c,d,e]	CL[c]
Number of (sub-) categories	1 + 22	1 + 19	1[f]	1	1
Calculation approach	T	T	S	S	T
Number of nutrients (negative/positive)	(4/1)	(6/1 out of 7)	(4/3)	(3/15)	(4/1 out of 6)
Reference value	100 g/kcal	One serving/100 kcal	100 g	100 g/kcal	One serving

Abbreviations: ADV, advertising; CL, claims; FDA, Food and Drug Administration; FOP, front-of-pack; FSA, Food Standard Agency; T, threshold; S, scoring.
[a]Positive front-of-pack signposting.
[b]Advertising regulations.
[c]Claims regulation.
[d]Proposed for this purpose.
[e]In this study only the LIM criteria could be applied (see Results).
[f]Model distinguishes between foods and drinks.

Programme model. The serving size related energy threshold in the Choices Programme model was also based on a portion of 30 g, which many of the European products with Guideline daily amounts labelling state as an approximate average serving size. For its own model, the FDA requires the application of a minimum reference serving base of 50 g (Food and Drug Administration, 2002b).

Market screening of fine bakery wares with label claims
Most products assessed in this study were positioned as healthier product alternatives by carrying a nutrition claim as defined in the EU Health Claims Regulation. Recipe or health claims were also made on a considerable number of items, whereas only one German product was marketed with a 'diet' claim, indicating the suitability of this product for people with diabetes. Products with two different types of claims were counted only once and grouped in a defined sequence of priority ((1) health claims, (2) nutrition claims, (3) diet claims and (4) recipe claims). Overall, claims were most often found in Spain and the UK, followed by France, Germany and Sweden.

Application of models used for positive front-of-pack signposting
Firstly, it was assessed which products with a healthier label image could also carry a positive front-of-pack signposting logo as granted by two models in this study. While the Choices Programme would allow only 6% of the products to carry such a logo, 16% of the products qualified according to the Smart Choices Programme. In both cases, significantly more savoury than sweet products met the criteria. All numbers increased slightly when only products with nutrition or health claims were evaluated and those with recipe or diet claims were excluded (Table 2).

Application of models used for the regulation of claims or advertising
In a second step, those models that are currently applied for the regulation of claims (FDA), proposed for the same purpose (LIM) or applied for the regulation of advertising to children (FSA/OFCOM) were analysed. The latter two models showed fairly similar results, with around 10% of all products qualifying and around 15% of those products with nutrition or health claims meeting the criteria. The FDA model proved to be the most lenient, with more than one third of all items rated positively. Again, in all cases significantly more savoury than sweet products met the profiles (Table 2).

Number and type of disqualifying nutrients
An evaluation of the type of disqualifying parameters identified significant differences in the effective complexity of the models. While the Choices Programme and FDA models define five parameters that have to be met simultaneously, this number increases to seven for the Smart Choices Programme model.

Fat proved to be the nutrient criterion that was exceeded most often across all the threshold models, either as total fat or as saturated fatty acids. Fibre as a positive nutrient criterion was required only by two threshold models, but almost all products that failed these profiles overall did not meet the fibre requirement. Other effective thresholds were the levels of energy and total or added sugars, especially for sweet items, and the sodium contents for savoury products. This was the case especially for the Choices Programme model, where the thresholds are set rather restrictively. *trans*-Fatty acids can play an important role in this category through the addition of partially hydrogenated vegetable fats. Unfortunately, this parameter

Table 2 Percentages of fine bakery products that met the respective nutrient profiles (by categories and claim types)

	Choices Programme	Smart Choices Programme	FSA/OFCOM	LIM	FDA
Products with a healthier image					
All fine bakery wares (n = 238)	6%	16%	12%	10%	37%
Sweet (*n* = 175)	2%	7%	4%	4%	20%
Savoury (*n* = 63)	17%	41%	35%	27%	81%
Products with nutrition and/or health claims					
All fine bakery wares (n = 187)	7%	19%	16%	13%	43%
Sweet (*n* − 128)	2%	9%	5%	5%	25%
Savoury (*n* = 59)	19%	41%	37%	29%	83%
Products by claim type					
All claims (n = 238)	6%	16%	12%	10%	37%
Health and nutrition claims (*n* = 187)	7%	19%	16%	13%	43%
Health claims (*n* = 36)	25%	36%	25%	25%	53%
Nutrition claims (*n* = 151)	3%	15%	13%	10%	41%
Other claims (*n* = 51)	0%	8%	0%	0%	14%
Diet claim (*n* = 1)	0%	0%	0%	0%	0%
Recipe claim (*n* = 50)	0%	8%	0%	0%	14%

Abbreviations: FDA, Food and Drug Administration; FSA, Food Standard Agency.

Table 3 Changes in average nutrient contents (all products with claims versus products that meet the respective profiles only)

	Choices Programme	Smart Choices Programme	FSA/OFCOM	LIM	FDA
All fine bakery wares (n = 238)					
Energy	−24%	−14%	−16%	−17%	−10%
Saturated fatty acids	−83%	−65%	−80%	−81%	−58%
Fibre	+149%	+90%	+82%	+98%	+67%
Sweet (n = 175)					
Energy	−23%	−7%	−11%	−13%	−9%
Saturated fatty acids	−75%	−41%	−67%	−73%	−55%
Total sugars	−18%	−47%	−90%	−50%	−42%
Fibre	+110%	+63%	+79%	+105%	+100%
Savoury (n = 63)					
Energy	−17%	−10%	−9%	−11%	−2%
Saturated fatty acids	−71%	−60%	−70%	−69%	−25%
Sodium	−44%	−28%	−46%	−48%	−12%
Fibre	+73%	+41%	+25%	+36%	+10%

Abbreviations: FDA, Food and Drug Administration; FSA, Food Standard Agency.

could not be analysed in detail in the present study due to restricted data availability.

When applied to this category, four out of the five criteria defined by the Choices Programme model (energy, saturated fatty acids, added sugars and sodium) contributed to the non-eligibility of products. In the case of the Smart Choices Programme model, four criteria (total fat, saturated fatty acids, added sugars and one beneficial nutrient or food group) were again of high importance, whereas the FDA disqualified most products based on three criteria (total fat, saturated fatty acids and fibre) only.

Scoring models, as opposed to threshold models, represented unique challenges. The FSA/OFCOM and LIM models could not be directly analysed for key nutrient criteria, as the scoring approach they employ means that there is no pre-determined maximum amount for a nutrient. However, typically the contents of saturated fatty acids (total or added), sugars and sodium contributed significantly to exceeding overall scores. In the case of the FSA/OFCOM model, saturated fatty acids and total sugars were counted twice due to their additional impact on the overall energy content.

Potential reduction of critical nutrients in products with claims
In another analytical model it was calculated, to what extent the average contents of energy, saturated fatty acids, total sugars, sodium and fibre differed between those products that met each model and all products in the study (Table 3). The reductions in sugars were assessed for sweet products only, and sodium was only analysed for savoury items, based on the overall importance of these nutrients for each subcategory.

The differences in average contents were highest for saturated fatty acids and fibre, which were also the two most important disqualifying nutrients. The former were reduced between 50 and 80% and the latter increased between roughly two thirds and up to 150% when applying the different models.

In sweet items, total sugar contents were also noticeably reduced between 20 and 90% on an average. In savoury items, sodium was cut by roughly one-third to half in almost all models.

No substantial changes could be identified for energy in all models. In addition, the FDA model fell short of considerable changes for sodium and fibre levels in savoury items.

Overall, the Choices Programme model as the most restrictive model in terms of the number of qualifying products also showed the biggest differences in nutrient levels. However, other models with more eligible products still lead to a substantially better average nutritional composition of the qualifying products.

Inter-model comparison
Similarities between all the product ratings were compared, to determine the uniqueness of each model and the different approaches to nutrient profiling. Table 4 shows the levels of agreement between the models, that is, the number of products that were rated the same (eligible/eligible or non-eligible/non-eligible) by any two of the models in the study. Overall, all models but the FDA model showed substantial (60–80%) to almost perfect (>80%) concordance across all products. The highest levels of agreement were identified for the Choices Programme, FSA/OFCOM and LIM models, based on the low number of qualifying products overall. While the FDA model was still substantially in line with all the other models for sweet products (80% concordance), this figure dropped to only fair (<40%) or moderate (40–60%) agreement for savoury items (Table 4).

Table 4 Identical inter-model ratings for all products carrying claims

	Smart Choices Programme	FSA/OFCOM	LIM	FDA
All categories (n = 238)				
Choices programme	87%	92%	94%	68%
Smart Choices Programme	—	88%	87%	75%
FSA/OFCOM	—	—	96%	73%
LIM	—	—	—	71%
Sweet products (n = 175)				
Choices Programme	91%	95%	97%	79%
Smart Choices Programme	—	91%	90%	82%
FSA/OFCOM	—	—	98%	81%
LIM	—	—	—	81%
Savoury products (n = 63)				
Choices Programme	76%	83%	87%	37%
Smart Choices Programme	—	81%	79%	57%
FSA/OFCOM	—	—	92%	51%
LIM	—	—	—	43%

Abbreviations: FDA, Food and Drug Administration; FSA, Food Standard Agency.

No further statistical analyses were conducted on the generated data, due to the deterministic and non-random nature of the product ratings.

Discussion

The present study shows that the application of nutrient profiles to commercially available fine bakery wares with label claims can help to effectively identify products with a more favourable nutritional composition. The average contents of critical nutrients like saturated fatty acids, total sugars or sodium can be cut by half or more, the levels of favourable nutrients such as fibre can be doubled or more, always in comparison with all products that are currently marketed as healthier options. By applying such models, products can be selected that are suitable for carrying claims, carrying front-of-pack logos for the signposting of overall healthier product choices or being advertised to certain audiences only.

To provide meaningful results, the profiling models have to employ certain underlying principles.

The most effective nutrient criteria for categorising the items in this study according to their nutritional composition were the total fat, saturated fatty acids and fibre contents. Additionally, total or added sugars proved to be an important criterion for sweet products, while sodium was critical in savoury items.

As expected, the sugar content was often correlated with the total energy level. Leaving one of them out would have nevertheless allowed significantly more products to qualify. This shows that both the criteria are of importance for the overall results.

Total fat and saturated fatty acids levels were not correlatively linked in the evaluated products. Total fat as a nutrient parameter therefore cannot be left out completely also. It can, however, be indirectly covered through a total energy criterion. Total fat does not have a negative health impact other than its caloric value, provided saturated fatty acids are covered separately.

Instead of fibre, whole grain could also be regarded a nutritionally beneficial and therefore important composition parameter. In addition to fibre, it delivers a whole series of important micronutrients. Also, *trans*-fatty acids can be of importance for the selected range of products, based on the potential addition of partially hydrogenated vegetable fats. Both values, however, could not be analysed as part of this study, due to the restricted availability of compositional data.

When looking at the reference bases of nutrient profiling models, it became obvious that a limit on the total energy content is necessary when using energy related thresholds for other critical nutrients (such as x% of sugars per 100 kcal). Otherwise, the mere addition of calories would allow for higher contents of nutrients unfavourably linked to health.

Finally, the results of this study confirm that it is possible to evaluate all fine bakery wares against the same set of nutrient criteria. They can be included in an even broader food group, as none of the models with a generic 'snacks' category or even an across-the-board approach generated anomalies in the results.

Further research is needed to fully understand the potential impact of nutrient profiling of bakery wares on the dietary intake of nutrients linked to health. For this, product specific analyses like in the present study need to be linked to a detailed intake data of the same products. Also, the effectiveness of any application of nutrient profiles needs to be fully understood, that is, their ability to significantly change consumer behaviour in the long term.

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Conclusions

Nutrient profiles can be applied to identify fine bakery wares with a significantly better nutritional composition than the average range of products positioned as healthier. Important nutrient parameters to take into account include energy, saturated fatty acids, sugars, sodium and fibre. Different nutrient criteria sets for subcategories of fine bakery wares do not seem necessary.

Conflict of interest

The authors declare no conflict of interest.

Acknowledgements

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CORRIGENDUM

Fine bakery wares with label claims in Europe and their categorisation by nutrient profiling models

J Trichterborn, G Harzer and C Kunz

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Correction to: *European Journal of Clinical Nutrition* (2011) 65, 307–312; doi:10.1038/ejcn.2010.275

Since the publication of this paper, the authors have been made aware that 'SAIN,LIM' is the correct spelling of one of the nutrient profiling models mentioned in the study. In addition, the most recent version of the model contains 5 basic and 4 optional positive nutrient criteria and not 15 as mentioned in the text and in Table 1 (Darmon *et al.*, 2009). The corrected Table 1 and the corresponding reference to the model are shown below. These errors do not have any impact on the results of the study, as the positive criteria were not applied.

The authors would like to apologise for any inconvenience caused.

Reference

Darmon N, Vieux F, Maillot M, Volatier JL, Martin A (2009). Nutrient profiles discriminate between foods according to their contribution to nutritionally adequate diets: a validation study using linear programming and the SAIN,LIM system. *Am J Clin Nutr* **89**, 1227–1236.

Table 1 Overview of chosen nutrient profiling models and their key parameters

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Number of (sub)categories	$1+22$	$1+19$	1^f	1	1
Calculation approach	T	T	S	S	T
Number of nutrients (negative/positive)	(4/1)	(6/1 out of 7)	(4/3)	$(3/5+4)$	(4/1 out of 6)
Reference value	100 g/kcal	One serving/100 kcal	100 g	100 g/kcal	One serving

Abbreviations: ADV, advertising; CL, claims; FDA, Food and Drug Administration; FOP, front-of-pack; FSA, Food Standards Agency; S, scoring; T, threshold.
[a]Positive front-of-pack signposting.
[b]Advertising regulations.
[c]Claims regulation.
[d]Proposed for this purpose.
[e]In this study, only the LIM criteria could be applied (see Results).
[f]Model distinguishes between foods and drinks.

6. The potential impact of nutrient profiles on dairy-related energy and nutrient intake in German children and adolescents

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Running title: Nutrient profiling and dairy nutrient intake

.

ORIGINAL ARTICLE

The potential impact of nutrient profiles on dairy-related energy and nutrient intake in German children and adolescents

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Background/Objectives: To evaluate the potential impact of nutrient profiling-based dairy product choices on energy and nutrient intake in German children and adolescents.

Subjects/Methods: Consumption data were obtained from product-specific dietary records in the DONALD Study (Dortmund Nutritional and Anthropometric Longitudinally Designed Study). We compared actual intake data with intake data that were calculated based on the assumption that participants exclusively consumed products that met the criteria of selected nutrient profiling models.

Results: For most profiling models, the percentage of compliant products was unrelated to the percentage of the participants' dairy consumption rated eligible. The participants' intake of energy, saturated fatty acids (SAFA), sodium, calcium and vitamin D would be reduced significantly ($P < 0.0001$) if only qualifying products were consumed. The impact on the participants' nutrient intake levels was not directly related to the impact on the product's nutrient content levels. Lower fat consumption was correlated with reduced vitamin D intake, and the models' disqualification of (semi-) hard cheeses had a negative impact on the calcium intake.

Conclusions: The evaluation of product-specific intake data was critical to understand the potential impact of any profiling scheme on nutrient intake. Selecting dairy products based on nutrient profiling could help reduce the intake of less-desirable nutrients, such as SAFA and sodium. However, models that are too restrictive might negatively impact calcium and vitamin D intake. Ultimately, the effectiveness of nutrient profiling models will be determined by the fact whether or not complying foods are consumed.

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Introduction

Nutrient profiling models allow the categorisation of foods according to their nutritional composition. Several authorities, health organisations, food manufacturers and retailers therefore apply such schemes to guide consumers' choices towards healthier options and, ultimately, a more balanced diet (Nijman *et al.*, 2007; Choices International Foundation, 2010; FDA, 2010; Livsmedelverket Swedish National Food Administration, 2010; OFCOM, 2010).

Townsend (2010) recently suggested a multi-level conceptual framework for the validation of such models. Previous studies have mainly focused on how foods were categorised as either qualifying or non-qualifying items (Azais-Braesco *et al.*, 2006; Arambepola *et al.*, 2007; Quinio *et al.*, 2007; Scarborough *et al.*, 2007; Volatier *et al.*, 2007; Darmon *et al.*, 2009; Fulgoni *et al.*, 2009). Another way to validate these models is to evaluate the potential impact of a profiling-based intervention on daily nutrient intake. Such predictions were calculated for one profiling model mostly based on generic food composition and average dietary intake data of adults (Roodenburg *et al.*, 2009, 2011). The focus of the present study was on children and adolescents between 4 and 18 years, as an increasing number of regulatory interventions target changes in the dietary behaviour of this subgroup of the population. At the same

time, our aim was also to compare the potential impact of various profiling models with different underlying principles in one study and to evaluate individual consumption data on commercially available products. Owing to the complexity of the data, the analysis was limited to dairy products, which are of particular importance in the diet of children and adolescents.

Materials and methods

General description of the data assessment
We first determined the standard dairy consumption pattern of German children and adolescents. Second, we evaluated all consumed products against five nutrient profiling models (Table 1) to understand the impact of their categorisation into qualifying and non-qualifying items at the product level. Finally, we calculated the potential impact on the intake of energy, saturated fatty acids (SAFA), sodium, calcium and vitamin D based on the assumption that only products that met the models were consumed.

Study sample and dietary survey
The data were obtained as part of the DONALD Study (Dortmund Nutritional and Anthropometric Longitudinally Designed Study), an open cohort study that has been run by the Research Institute of Child Nutrition (Forschungsinstitut

für Kinderernährung, FKE) since 1985. Specifically, we used 3-day weighed dietary records obtained through intake recording by the participants or their parents. Additional details of the DONALD methods have been published (Kersting et al., 1998; Kroke et al., 2004). All examinations and assessments were performed with parental and, later on, with the children's written consent. The study was approved by the ethical committee of the Rheinische Friedrich-Wilhelms-University Bonn.

The DONALD participants generally have an above-average socioeconomic status, which is a potential weakness of this study. However, the dietary habits identified are similar to the results of the EsKiMo Study, a module of the representative German children and adolescent health survey KiGGS conducted from 2005 to 2006 (Mensink, 2007; Mensink et al., 2007).

In total, intake data from 2208 dietary records from 584 participants (295 boys and 289 girls) aged 4–18 years were analysed, covering all DONALD participants between 2003 and 2008.

Selection of food and beverage subcategories
Product composition data were obtained from LEBTAB, a database which is continuously updated with any new product mentioned in the DONALD dietary records (Sichert-Hellert et al., 2007). Energy and nutrient contents of basic food items (currently more than 1200) are taken from

Table 1 Overview of chosen nutrient profiling models and key parameters (Choices International Foundation, 2009; Darmon et al., 2009; FSA, 2009; Livsmedelverket Swedish National Food Administration, 2009; FDA, 2010)

	Swedish Keyhole	Choices Programme	FSA/OFCOM	SAIN, LIM	FDA
Objective of current use	FOP[a]	FOP[a]	ADV[b]	CL[c,d]	CL[c]
Number of (sub-) categories	25	1 + 22	1[e]	1	1
Calculation approach	T	T	S	S	T
Number of nutrients (negative/positive)	(5/1)	(4/1)	(4/3)	(3/5 + 4)	(4/1 out of 6)
List of nutrients	Total fat	Energy[f]	Energy	SAFA	Total fat
	SAFA[f]	Total fat[f]	SAFA	Added sugars	SAFA
	Total sugars	SAFA	Total sugars	Sodium	Cholesterol
	Refined sugars[f]	Trans fatty acids	Sodium	Protein	Sodium
	Sodium	Added sugars	Fruits, vegetables and nuts	Fibre	One out of:
	Fibre[f]	Sodium	Fibre	Vitamin C	Vitamin A
		Fibre[f]	Protein	Calcium	Vitamin C
				Iron	Iron
				Optional:	Calcium
				Vitamin D	Protein
				Vitamin E	Fibre
				α-Linoleic acid	
				Monounsaturated fattty acids	
Reference value	100 g/kcal[f]	100 g/kcal[f]	100 g	100 g/kcal	One serving

Abbreviations: ADV, advertising; CL, claims; FDA, Food and Drug Administration; FOP, front-of-pack; FSA, Food Standards Agency; OFCOM, Office of Communications; SAFA, saturated fatty acids; T, threshold; S, scoring.
[a]Positive FOP signposting.
[b]Advertising regulations.
[c]Claims regulation.
[d]Proposed for this purpose.
[e]Model distinguishes between foods and drinks.
[f]Parameter not defined for the products analysed in this study.

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standard food composition databases, primarily from Germany (Souci et al., 2000). If no data can be found, nutrient contents are imputed from similar foods. No missing values are allowed. For commercial products (currently more than 10 800 complex, multi-component products not prepared at home and bought as such) nutrient composition is estimated by simulating a recipe based on the labelled ingredients, which are usually basic foods. Added sugars are handled like other nutrients following the definition of the US Department of Agriculture ('sugars and syrups added to food during processing' (USDA, 2011)).

Dietary consumption data were calculated from the individual means of the three recorded days. Starting with the products with the highest daily consumption levels (in grams), a subset of items was selected so that their accumulated intake represented >95% of the total dairy consumption. At the same time, these products represented >95% of the consumption of each selected subcategory in LEBTAB (Table 2). All items typically used as recipe ingredients, such as cream, were excluded. For further data processing, 307 identified products were recategorised into two main groups ('Cheeses' and 'Other dairy products') and four more-specific subgroups ('Fresh cheeses', '(Semi-) hard cheeses', 'Dairy drinks' (including milk) and 'Dairy desserts'). SAS procedures (version 9.1.3, Statistical Analysis System, Cary, NC, USA) were used for the data analysis.

Application of nutrient profiling models

We evaluated all products against five profiling schemes that are applicable to majority of the foods and drinks, including dairy products (Table 1). The selected profiling models cover both threshold and scoring algorithms. Threshold models set minimum and maximum levels for positive and negative nutrients, respectively. Scoring models allocate points to the nutrient levels in a product, and a final score is calculated as

the sum of these points. All models included criteria on fat (total fat or SAFA), sugars (total or added sugars) and sodium. In addition, some of the models define additional positive (protein, fibre and fruits and vegetables) or negative (energy, trans fatty acids and cholesterol) criteria (see Supplementary Information for further details on the criteria applied in this study).

Product categorisation, food choice scenarios and correlated nutrient intake

For each nutrient profiling model, we assessed the percentage of items that met all criteria ('eligible products') and determined the average proportion of reported consumption they represented. In addition, we compared the nutrient content of the eligible products with that of all products in the study.

For the analysis of the potential impact of the profiling models on energy and nutrient intake, we assumed that participants only consumed eligible products. To simulate this, we kept the total consumption levels (in grams) in each DONALD record the same but replaced the consumption of non-eligible products by proportionally increasing the consumption of eligible products reported in the record. This simulation was performed for each profiling model and within groups of similar product choices, that is, within the subcategories of Dairy drinks, Dairy desserts and Cheeses. Based on this simulated scenario, median intakes of energy, SAFA, sodium, calcium and vitamin D were calculated for each profiling model and compared with the equivalent standard intake reported in the DONALD Study.

Statistical analysis

In both main product groups, distribution plots were non-normal for the majority of nutrient content levels and

Table 2 Product categorisation in LEBTAB, including number of items per category, corresponding mean daily consumption and number of items analysed in this study

	Number of all consumed items (mean daily consumption)	Number of analysed items (mean daily consumption)	Level of consumption represented by the analysed items (%)
All dairy products	509 (242 g)	307 (234 g)	96.8
Cheeses	97 (23 g)	35 (22 g)	95.9
Fresh cheese (preparations)	71 (10 g)	24 (9 g)	95.1
(Semi-) hard cheese	26 (13 g)	11 (13 g)	96.6
Other dairy products	412 (219 g)	272 (212 g)	96.8
Fresh Milk[a]	12 (135 g)	3 (132 g)	97.9
Milk drinks, sweetened[a]	43 (15 g)	26 (14 g)	95.3
Milk preparations[b]	203 (30 g)	135 (28 g)	95.0
Yoghurt[b]	18 (20 g)	8 (19 g)	95.7
Milk products, pro-/pre-/symbiotic[c]	71 (10 g)	51 (10 g)	95.1
Milk products, fortified[c]	65 (9 g)	49 (8 g)	95.3

[a]Categorised as 'Milk/dairy drinks' in this study.
[b]Categorised as 'Dairy desserts' in this study.
[c]Categorised as 'Milk/dairy drinks' or 'Dairy desserts' in this study. All items typically used as ingredients, such as cream, were excluded from the data analysis.

consistently non-normal for nutrient intake levels. We therefore evaluated median values. In addition, we assessed the mean values for calcium levels in Cheeses to better illustrate differences in the effects of the models.

Differences in nutrient content levels of all reported versus eligible Other dairy products were tested for significance using the unpaired Student's *t*-test for normally distributed energy levels and the Mann–Whitney *U*-test for non-normally distributed levels of all other nutrients. Differences in nutrient content levels of Cheeses could not be significance tested due to the low number of eligible items. Differences between reported and simulated nutrient intake from both main product groups were assessed using the Wilcoxon signed-rank test. All tests were two-tailed and performed with $\alpha = 0.05$.

Results

Proportion of eligible products
The first part of Table 3 shows the percentages of products rated eligible by model and product subcategory. The Swedish Keyhole and Choices Programme models were the most restrictive overall, with <20% of all products qualifying. The other models classified between 27 and 55% of the products as eligible. Although the numbers of eligible products were similar when looking at Other dairy products

only, the Choices Programme model allowed by far more Cheeses to qualify than all other models. Together with the Swedish Keyhole model, it was the only model that qualified some (Semi-) hard cheeses.

Proportions of total reported consumption represented by eligible products
The second part of Table 3 shows what percentages of the total consumption (in grams) were represented by eligible items. The nutrient profiling models classified an average of between 6 and 59% of the total consumption of each participant as favourable, which in some cases differed from the proportions of eligible products. For example, the Choices Programme model rated on average 17% and the SAIN,LIM model 27% of all products eligible, but these represented 35% and 59% of the participants' consumption, respectively. In contrast, the Swedish Keyhole model rated one third of all Dairy drinks eligible, but these represented only 3% of participants' consumption.

Impact of the nutrient profiles on energy and nutrient contents
Table 4 shows the potential impact of each profiling model on energy and nutrient contents.

Cheeses rated eligible by the profiling models showed considerably lower median contents of all nutrients, except

Table 3 Proportion of products meeting the respective nutrient profiles and the respective ratio of represented consumption

Proportion of dairy products meeting the nutrient profiles[a]

	n	Swedish Keyhole (%)	Choices Programme (%)	FSA/OFCOM (%)	SAIN,LIM (%)	FDA health claims (%)
All Products	307	14.0	17.3	55.4	26.7	45.9
Cheeses	35	14.3	40.0	20.0	17.1	25.7
Fresh cheeses	24	16.7	45.8	29.2	25.0	37.5
(Semi-) hard cheeses	11	9.1	27.3	0.0	0.0	0.0
Other dairy products	272	14.0	14.3	59.9	27.9	48.5
Milk/dairy drinks	89	33.7	30.3	40.4	58.4	82.0
Dairy desserts	183	4.4	6.6	69.4	13.1	32.2

Average proportion of consumption (in grams) represented by eligible products[b]

	Mean reported consumption (g)	Swedish Keyhole (%)	Choices Programme (%)	FSA/OFCOM (%)	SAIN,LIM (%)	FDA health claims (%)
All Products	234	6.2	34.8	49.8	59.0	41.5
Cheeses	22	17.0	33.0	17.5	14.8	19.7
Fresh cheeses	9	35.2	66.7	46.7	39.5	52.6
(Semi-) hard cheeses	13	5.8	14.0	0.0	0.0	0.0
Other dairy products	212	3.6	35.2	57.1	68.1	46.1
Milk/dairy drinks	162	3.2	45.9	52.9	89.1	53.0
Dairy desserts	50	3.9	14.0	70.2	25.2	33.8

Abbreviations: FDA, Food and Drug Administration; FSA, Food Standards Agency; OFCOM, Office of Communications.
[a]Number of eligible items/number of all items.
[b]Measured intake of eligible items/measured intake of all items.

Table 4 Potential impact of the nutrient profiles on mean energy/nutrient content and median intake

	Energy (kJ/100 g)	SAFA (g/100 g)	Sodium (mg/100 g)	Calcium (mg/100 g)	Vitamin D (μg/100 g)
			Median contents[a]		
Cheeses					
Median content of all products	975	10.1	432	99	0.337
Mean content of products rated eligible by					
Swedish Keyhole	420 (−56.9%)	2.2 (−78.3%)	230 (−46.8%)	95 (−3.6%)	0.090 (−73.3%)
Choices Programme	786 (−19.4%)	8.3 (−18.3%)	429 (−0.8%)	95 (−3.6%)	0.306 (−9.2%)
FSA/OFCOM	420 (−56.9%)	2.2 (−78.3%)	230 (−46.8%)	95 (−3.6%)	0.085 (−74.8%)
SAIN,LIM	377 (−61.4%)	1.8 (−82.5%)	230 (−46.8%)	95 (−3.6%)	0.064 (−81.2%)
FDA health claims	420 (−56.9%)	2.2 (−78.3%)	230 (−46.8%)	95 (−3.6%)	0.090 (−73.3%)
Other dairy products					
Median content of all products	431	1.8	44	104	0.053
Mean content of products rated eligible by					
Swedish Keyhole	184 (−57.4%)*	0.1 (−96.7%)*	49 (+11.3%)	105 (+1.4%)	0.001 (−98.1%)*
Choices Programme	182 (−57.8%)*	0.1 (−95.5%)*	49 (+13.4%)**	114 (+9.6%)****	0.001 (−98.1%)*
FSA/OFCOM	423 (−1.9%)	1.7 (−2.1%)	45 (+3.2%)	105 (+1.0%)	0.051 (−3.8%)
SAIN,LIM	252 (−41.6%)*	0.2 (−86.4%)*	48 (+9.2%)***	114 (+9.5%)*****	0.007 (−86.8%)*
FDA health claims	307 (−28.8%)*	0.8 (−57.6%)*	45 (+2.1%)	106 (+1.5%)	0.024 (−55.7%)*

	Energy (kJ)	SAFA (g)	Sodium (mg)	Calcium (mg)	Vitamin D (μg)
			Median intake[b]		
Cheeses					
Median measured intake from all products	161	1.8	57	66	0.053
Median potential intake based on					
Swedish Keyhole	66 (−65.6%)*	0.3 (−82.3%)*	25 (−52.2%)*	27 (−71.9%)*	0.010 (−75.2%)*
Choices Programme	101 (−43.7%)*	0.8 (−54.3%)*	31 (−27.3%)*	26 (−69.6%)*	0.026 (−41.3%)*
FSA/OFCOM	57 (−71.4%)*	0.2 (−87.4%)*	18 (−66.4%)*	14 (−85.8%)*	0.006 (−85.4%)*
SAIN,LIM	52 (−74.1%)*	0.1 (−91.4%)*	21 (−61.1%)*	14 (−85.8%)*	0.005 (−89.3%)*
FDA health claims	63 (−67.4%)*	0.3 (−83.0%)*	21 (−54.9%)*	20 (−79.2%)*	0.008 (−80.2%)*
Other dairy products					
Median measured intake from all products	537	2.8	86	205	0.087
Median potential intake based on					
Swedish Keyhole	345 (−32.9%)*	0.2 (−94.4%)*	87 (+2.8%)*	184 (−13.5%)*	0.003 (−96.5%)*
Choices Programme	346 (−34.1%)*	0.7 (−73.1%)*	90 (+6.1%)*	202 (0.0%)*	0.019 (−76.5%)*
FSA/OFCOM	494 (−3.0%)*	1.8 (−13.8%)*	86 (0.0%)*	204 (0.0%)*	0.053 (−16.7%)*
SAIN,LIM	431 (−12.8%)*	1.9 (−7.1%)*	87 (0.0%)*	211 (0.0%)*	0.058 (−5.7%)*
FDA health claims	459 (−8.4%)*	1.3 (−50.2%)*	87 (+2.4%)*	196 (−0.6%)*	0.042 (−46.1%)*

Abbreviations: FDA, Food and Drug Administration; FSA, Food Standards Agency; OFCOM, Office of Communications; SAFA, saturated fatty acids.
[a]The percentages show the differences between the average nutrient content of the products rated as eligible by the models out of all the products in the study; Tested for significance using unpaired Student's *t*-test (energy) and Mann–Whitney *U*-test (all other nutrients).
[b]The percentages show the differences between the simulated nutrient intakes based on the assumption that only eligible items are consumed and the total measured intake (full replacement of non-eligible items with eligible items on a weight basis); tested for significance using Wilcoxon signed-rank test.
*-*****All the *P*-values are <0.05 (**P*<0.0001; ***P*=0.019; ****P*=0.013; *****P*=0.050; ******P*=0.002).

calcium, compared with all Cheeses in the study. For calcium, reductions could only be illustrated by looking at mean values (Table 5), as the distribution of products and therefore the median values of calcium contents were skewed towards items with lower calcium levels.

All profiling schemes except the Food Standards Agency model led to median levels of energy, SAFA and vitamin D in eligible Other dairy products that were significantly lower (*P*<0.0001) than in all products in the study. Differences in median sodium and calcium levels were minor across all models.

Potential impact of the nutrient profiles on energy and nutrient intakes

The median intake of all key nutrients from Cheeses was reduced significantly (*P*<0.0001) by all profiling models, when assuming consumption of only eligible products (Table 4). Reduction levels were similar across all models with the exception of the Choices Programme model, which had a lower, yet still-noticeable, impact on energy and key nutrient intake from Cheeses. Other dairy products contributed significantly less energy, SAFA, calcium and vitamin D (*P*<0.0001) in most profiling models,

Table 5 Potential impact of the nutrient profiles on mean calcium contents in cheeses

Cheeses	Calcium (mg/100 g)	Difference compared to all products (%)
Mean content of all products	337 (±359)	
Mean content of products rated eligible by		
Swedish Keyhole	205 (±239)	(−39.4)
Choices Programme	228 (±274)	(−32.3)
FSA/OFCOM	95 (±7)	(−71.8)
SAIN,LIM	95 (±8)	(−71.8)
FDA health claims	155 (±179)	(−54.1)

Abbreviations: FDA, Food and Drug Administration; FSA, Food Standards Agency; OFCOM, Office of Communications.

but changes in the intake levels of sodium and calcium were small.

The reductions in the simulated median intake differed significantly from the reductions in the average nutrient contents of the products (Table 4). This difference was based on the fact that within the group of eligible items, products were consumed in different amounts. The SAIN,LIM model had a significant impact on the median energy (−42%), SAFA (−86%) and vitamin D (−87%) content levels of Other dairy products ($P<0.0001$), but the potential impact on the median intakes was rather small (−13%, −7% and −6%, respectively ($P>0.0001$)). In contrast, median intake reductions ($P<0.0001$) for energy (−44%), SAFA (−54%) and sodium (−27%) from Cheeses were much higher than median content reductions (−19%, −18% and −1%, respectively) for the Choices Programme model.

Discussion

The findings of the present study confirm that the application of nutrient profiling models could potentially reduce the dietary intake of SAFA and sodium from dairy products in German children and adolescents. At the same time, however, intake of calcium and vitamin D could potentially be reduced. The number of eligible items within the category of dairy products and its subcategories highly depends on the nutrient profiling model applied. Some of the models only qualify a relatively small number of items, but consumption levels represented are high or *vice versa*. The application of a profiling model can also lead to a selection of products with average nutrient levels that differ considerably from the average levels in the original set of products, but the potential impact on median nutrient intake would be only moderate or *vice versa*. This indicates that differences in the individual consumption levels of qualifying items have a major role when evaluating the impact on nutrient intake.

Townsend (2010) pointed out the importance of validating nutrient profiling models against independent and consistent standards and outlined a multi-level conceptual framework for this purpose. Previous studies mainly focused on how the categorisation of foods as eligible or non-eligible by the models compared with the judgments of nutrition experts (Azais-Braesco *et al.*, 2006; Scarborough *et al.*, 2007), measures of diet quality (such as dietary patterns or index foods linked to health) (Quinio *et al.*, 2007; Volatier *et al.*, 2007; Fulgoni *et al.*, 2009) or compatibility with general nutrition recommendations (Arambepola *et al.*, 2007; Darmon *et al.*, 2009). The advantages and limitations of these approaches were recently discussed by Roodenburg *et al.* (2011).

Roodenburg *et al.* (2009) and Roodenburg *et al.* (2011) applied an alternative validation approach by predicting the potential effect of the Choices Programme on nutrient intake in various countries. Like most of the previous studies, these assessments were conducted mostly based on compositional data from generic food database items and on average adult intake data. This approach allowed for the assessment of the potential impact of the Choices Programme across the whole diet and across a large proportion of the population. The aims of the present study were to apply a similar approach, but to compare various profiling models, achieve a high level of data accuracy by assessing all commercially available and branded products consumed by each participant instead of average consumption of generic items, and focus specifically on children and adolescents. To reduce the complexity of the data analysis, dairy products were chosen as a model category.

The results show the importance of taking product-specific intake data into account to fully understand the potential impact of the application of nutrient profiles. First and foremost, the impact of a profiling model on nutrient intake depends on how products are categorised into qualifying and non-qualifying items. However, it is not sufficient to evaluate the number of qualifying products or the potential impact on nutrient levels. The frequency of consumption of the products has to be taken into account to determine the potential impact on nutrient intake.

Dairy products contribute considerably to the daily intake of SAFA and sodium, both of which are consumed in excess by German children and adolescents (Mensink *et al.*, 2007). The consumption of products rated eligible by the profiling models only could effectively help children and adolescents eat reduced amounts of SAFA and sodium while maintaining general consumption habits.

Dairy products are also important sources of calcium, the average intake of which barely meets the recommendations for many age groups, and vitamin D, the intake of which falls considerably short of the recommended levels for children and adolescents of all ages (Alexy and Kersting, 1999; Holick, 2007; Mensink *et al.*, 2007; Kersting and Bergmann, 2008). The intake of these nutrients could also be highly impacted by the application of nutrient profiles.

The results show that the exclusive consumption of eligible items could have a bigger impact on nutrient intake

from cheeses (decreased intake of SAFA, sodium, calcium and vitamin D) than from other dairy products (intake of sodium and calcium would remain stable). Especially (Semi-) hard cheeses are important contributors to the dietary intake of calcium, but contain significant amounts of sodium at the same time. The intake of fat-soluble vitamin D would be reduced from both categories, as contents are reduced when milk is skimmed and most German products are not fortified to make up for this loss.

Differences in the underlying principles of the models' calculation algorithms did not lead to specific differences in the potential impact on nutrient intake. Future research could help to achieve more balanced results by simulating varying combinations of these principles.

In our study, we assumed that the consumption of non-eligible products would be replaced by eligible items on a weight basis. This approach follows general dietary recommendations, for example, participants consume one glass of reduced-fat milk instead of full-fat milk, and seemed most appropriate for the evaluation of one category only. An alternative calculation that assumes consumption would increase to compensate for reduced energy intake is another way to assess the potential impact and is especially important when assessing a whole diet, as increases in energy intake would likely come from multiple food categories. Therefore, future research should focus on studies that show whether potential applications of nutrient profiling (such as the regulation of advertising and claims or front-of-pack signposting of healthier options) can guide consumer choice across categories. Such data would also help elucidate whether the potential decreases in intake of calcium and vitamin D from dairy products could be compensated for by higher intake of these nutrients from other foods.

Despite these limitations, the results of this study show the necessity of defining any nutrient profiling model, such that reductions in the intake of nutrients negatively linked to health are achieved without jeopardising the intake of positive nutrients, particularly those that are not consumed in sufficient amounts. Without fortification and accounting for existing consumption habits, a more balanced impact can only be achieved for dairy products by allowing some hard and semi-hard cheeses to qualify and by avoiding excessively restrictive fat thresholds for dairy products other than cheeses. Important parameters to take into account include the differences in the intrinsic nutritional composition and typical serving sizes between cheeses and other dairy products.

Ultimately, the effectiveness of any nutrient profiling model depends on the effectiveness of the application it is used for. When regulating food advertising or food labelling, the categorisation of single products by nutrient profiling can have a measurable impact on a population's diet if consumer behaviour responds accordingly. Additionally, food manufacturers can be incentivised to reformulate their products if product eligibility is achievable without compromising too much on important drivers of consumer preference such as taste and price.

Conclusions

The evaluation of product-specific intake data was critical to understand the potential impact of any profiling scheme on nutrient intake. Selecting dairy products based on nutrient profiling could help reduce the intake of SAFA and sodium from dairy products. However, models that are too restrictive could negatively impact calcium and vitamin D intake. The eligibility of (Semi-) hard cheeses and vitamin D fortification, among other potential options, could help to minimise these effects.

Conflict of interest

Jan Trichterborn and Gerd Harzer are employed by Kraft Foods R&D Inc.

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7. List of publications

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Trichterborn J (2009) (Funktionelle) Lebensmittel und Health Labelling. In: Marauhn, T., Ruppel, N. (Hrsg.) Vom Arzneimittel zum Lebensmittel: Zur Abgrenzung von Arznei- und Lebensmitteln im europäischen und deutschen Recht. Tübingen: Mohr Siebeck (in German).

Trichterborn J, Harzer G, Kunz C (2011) Fine bakery wares with label claims in Europe and their categorisation by nutrient profiling models. *Eur J Clin Nutr* **65**, 307-312.

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**, 1032-1038.

Trichterborn J, Drossard C, Kersting M, Harzer G, Kunz C (2012) The potential impact of nutrient profiles on the dairy related energy and nutrient intakes in German children and adolescents. *Eur J Clin Nutr* **66**, 466-473.

8. Appendix A: Energy and nutrient intake from cheeses and other dairy products in German children and adolescents

Table 8.1 Distribution of DONALD participants 4-18 years between 2003 and 2008 in the analysed sample (numbers and percentages)

	Male	Female	SUM
4-6 years	276	264	540
	12.5%	**12.0%**	**24.5%**
7-9 years	237	231	468
	10.7%	**10.5%**	**21.2%**
10-12 years	203	219	422
	9.2%	**9.9%**	**19.1%**
13-14 years	126	133	259
	5.7%	**6.0%**	**11.7%**
15-18 years	268	251	519
	12.1%	**11.4%**	**23.5%**
SUM	1110	1098	2208
	50.3%	**49.7%**	**100.0%**

Table 8.2 Product categorisation, including number of all items per category, corresponding mean daily consumption and number of items selected in this study

	Number of all consumed items (Mean daily consumption)	Number of analysed items (Mean daily consumption)	Level of consumption represented by the analysed items
ALL DAIRY PRODUCTS	509 (242g)	307 (234g)	96.8%
CHEESES	97 (23g)	35 (22g)	95.9%
(Semi-) Hard Cheese	26 (13g)	11 (13g)	96.6%
Fresh Cheese (Preparations)	71 (10g)	24 (9g)	95.1%
OTHER DAIRY PRODUCTS	412 (219g)	272 (212g)	96.8%
Fresh Milk	12 (135g)	3 (132g)	97.9%
Milk Preparations	203 (30g)	135 (28g)	95.0%
Yoghurt	18 (20g)	8 (19g)	95.7%
Milk Drinks, sweetened	43 (15g)	26 (14g)	95.3%
Milk Products, pro-/pre-/ symbiotic	71 (10g)	51 (10g)	95.1%
Milk Products, fortified	65 (9g)	49 (8g)	95.3%

All items used as ingredients, such as cream, were excluded from the data analysis.

Table 8.3   Dairy products in this study and their mean daily consumption by product group, age and sex

	4-6 yrs		7-9 yrs		10-12 yrs		13-15 yrs		15-18 yrs		AVG
	boys	girls	boys	girls	boys	girls	boys	girls	boys	girls	
MEAN CONSUMPTION LEVELS IN GRAMS PER DAY											
All Dairy Products (n=307)	**239**	**197**	**248**	**197**	**272**	**206**	**282**	**211**	**303**	**195**	**234**
Cheeses (n=35)	13	12	17	17	24	22	26	26	38	28	22
Fresh Cheeses (n=24)	*6*	*5*	*8*	*7*	*10*	*10*	*9*	*13*	*15*	*11*	*9*
(semi) Hard Cheeses (n=11)	*7*	*7*	*9*	*10*	*14*	*12*	*17*	*13*	*24*	*17*	*13*
Other dairy products (n=272)	226	185	232	180	248	184	256	186	265	167	212
Milk/ Dairy Drinks (n=89)	*176*	*139*	*180*	*135*	*200*	*135*	*183*	*138*	*208*	*127*	*162*
Dairy Desserts (n=183)	*50*	*46*	*51*	*45*	*48*	*49*	*73*	*47*	*57*	*40*	*50*

Table 8.4   Energy, protein, carbohydrate and fat intake from the total diet and dairy products per sex and age group (means ± SD)

	Boys					Girls				
	4-6 yrs	7-9 yrs	10-12 yrs	13-15 yrs	15-18 yrs	4-6 yrs	7-9 yrs	10-12 yrs	13-15 yrs	15-18 yrs
Energy RV (in kJ)	*6280*	*7955*	*9630*	*11304*	*12979*	*5862*	*7118*	*8374*	*9211*	*10467*
Total dietary intake	*5739 ± 1053*	*7160 ± 1327*	*7984 ± 1538*	*9344 ± 2075*	*10453 ± 2536*	*5322 ± 1058*	*6296 ± 1180*	*7074 ± 1313*	*7497 ± 1519*	*7567 ± 1845*
in % RV	91.4%	90.0%	82.9%	82.7%	80.5%	90.8%	88.5%	84.5%	81.4%	72.3%
Total intake from dairy	*814*	*679*	*874*	*736*	*983*	*679*	*874*	*736*	*983*	*757*
in % RV	13.0%	11.0%	10.2%	9.4%	9.1%	11.6%	10.3%	9.0%	8.8%	7.6%
From Cheeses	2.2%	2.2%	2.7%	2.5%	3.3%	2.3%	2.6%	2.6%	2.9%	2.9%
From Other dairy products	10.8%	8.8%	7.5%	6.9%	5.8%	9.3%	7.7%	6.4%	5.9%	4.6%
Protein RV (in g)	*18.0*	*24.0*	*34.0*	*46.0*	*60.0*	*17.0*	*24.0*	*35.0*	*45.0*	*46.0*
Total dietary intake	*43.2 ± 10.1*	*53.9 ± 12.1*	*61.3 ± 13.5*	*73.6 ± 20.0*	*87.4 ± 26.8*	*39.2 ± 8.7*	*46.6 ± 9.2*	*55.7 ± 12.1*	*58.9 ± 13.7*	*58.9 ± 15.1*
in % RV	239.9%	224.4%	180.2%	160.0%	145.6%	230.8%	194.4%	159.0%	130.8%	128.1%
Total intake from dairy	*10.1*	*10.8*	*12.9*	*13.6*	*16.3*	*8.6*	*9.3*	*10.1*	*10.7*	*10.8*
in % RV	56.0%	45.2%	37.8%	29.5%	27.2%	50.4%	38.7%	28.9%	23.7%	23.4%
From Cheeses	13.5%	13.0%	13.4%	11.0%	12.6%	13.7%	13.5%	11.3%	10.3%	11.4%
From Other dairy products	42.5%	32.2%	24.4%	18.5%	14.6%	36.6%	25.2%	17.5%	13.4%	12.0%
Carbohydrates RV (in g)[1]	*187.5*	*237.5*	*287.5*	*337.5*	*387.5*	*175.0*	*212.5*	*250.0*	*275.0*	*312.5*
Total dietary intake	*182.0 ± 39.2*	*228.2 ± 49.8*	*249. ± 56.2*	*295.4 ± 71.4*	*319.6 ± 90.2*	*168.3 ± 37.6*	*198.2 ± 46.3*	*218.4 ± 47.5*	*235.2 ± 55.6*	*238.7 ± 64.4*
in % RV*	97.1%	96.1%	86.7%	87.5%	82.5%	96.2%	93.3%	87.4%	85.5%	76.4%
Total intake from dairy	*18.2*	*19.7*	*19.1*	*21.5*	*21.2*	*15.0*	*15.1*	*15.5*	*15.4*	*13.3*
in % RV*	9.7%	8.3%	6.7%	6.4%	5.5%	8.6%	7.1%	6.2%	5.6%	4.3%
From Cheeses	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.2%	0.1%
From Other dairy products	9.6%	8.2%	6.5%	6.3%	5.3%	8.5%	7.0%	6.1%	5.5%	4.1%
Total Fat RV (in g)[2]	*58.3*	*73.9*	*89.4*	*105.0*	*120.6*	*175.0*	*212.5*	*250.0*	*275.0*	*312.5*
Total dietary intake	*52.0 ± 12.6*	*64.4 ± 15.9*	*73.6 ± 17.7*	*83.6 ± 24.4*	*93.1 ± 27.3*	*48.8 ± 13.5*	*58.1 ± 13.9*	*65.8 ± 17.0*	*68.0 ± 17.8*	*67.7 ± 22.7*
in % RV*	89.2%	87.2%	82.3%	79.6%	77.2%	89.7%	87.9%	84.6%	79.5%	69.7%
Total intake from dairy	*9.0*	*9.6*	*11.9*	*12.6*	*14.5*	*7.5*	*8.7*	*8.7*	*9.8*	*10.3*
in % RV*	15.5%	13.0%	13.3%	12.0%	12.0%	13.9%	13.1%	11.2%	11.5%	10.6%
From Cheeses	4.2%	4.2%	5.3%	4.9%	6.4%	4.4%	5.2%	5.0%	5.6%	5.8%
From Other dairy products	11.3%	8.8%	8.0%	7.1%	5.6%	9.4%	8.0%	6.2%	5.8%	4.8%

[1] **recalculated from energy related RV (min 50% of energy)**

[2] **recalculated from energy related upper RV (max. 35% of energy)**

Table 8.5   Intake of other nutrients from the total diet and dairy products per sex and age group

	Boys					Girls				
	4-6 yrs	7-9 yrs	10-12 yrs	13-15 yrs	15-18 yrs	4-6 yrs	7-9 yrs	10-12 yrs	13-15 yrs	15-18 yrs
Saturated Fatty Acids RV (in g)[1]	*16.7*	*21.1*	*25.6*	*30.0*	*34.4*	*15.6*	*18.9*	*22.2*	*24.4*	*27.8*
Total dietary intake	*23.7 ± 6.7*	*28.8 ± 8.1*	*32.4 ±8.3*	*36.3 ± 11.9*	*40.0 ± 12.9*	*21.9 ± 6.5*	*26.0 ± 6.9*	*28.6 ± 8.0*	*30.2 ± 8.4*	*29.4 ± 10.7*
in % RV	142.2%	136.4%	126.6%	120.9%	116.0%	140.7%	137.5%	128.6%	123.4%	105.9%
Total intake from dairy	*5.3*	*5.7*	*7.1*	*7.5*	*8.8*	*4.5*	*5.2*	*5.2*	*5.9*	*6.2*
in % RV	31.9%	26.8%	27.6%	25.1%	25.4%	28.7%	27.4%	23.4%	24.0%	22.4%
From Cheeses	9.2%	9.2%	11.7%	10.9%	14.2%	9.8%	11.4%	11.0%	12.3%	12.9%
From Other dairy products	22.7%	17.6%	15.9%	14.3%	11.2%	19.0%	16.0%	12.4%	11.7%	9.5%
Fibre RV (in g)	*15.0*	*19.0*	*23.0*	*27.0*	*31.0*	*14.0*	*17.0*	*20.0*	*22.0*	*25.0*
Total dietary intake	*14.2 ± 3.7*	*18.3 ± 5.1*	*19.3 ± 5.5*	*22.6 ± 7.6*	*24.8 ± 8.6*	*13.6 ± 3.7*	*16.1 ± 4.5*	*18.2 ± 4.6*	*18.4 ± 5.2*	*19.6 ± 5.9*
in % RV	94.8%	96.5%	83.7%	83.6%	79.9%	96.8%	94.6%	91.1%	83.9%	78.2%
Total intake from dairy	*0.3*	*0.5*	*0.3*	*0.4*	*0.4*	*0.2*	*0.3*	*0.3*	*0.3*	*0.2*
in % RV	1.9%	2.4%	1.2%	1.6%	1.3%	1.6%	1.7%	1.5%	1.4%	1.0%
From Cheeses	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%
From Other dairy products	1.9%	2.3%	1.2%	1.5%	1.3%	1.6%	1.7%	1.5%	1.3%	0.9%
Sodium RV (in mg)	*410*	*460*	*510*	*550*	*550*	*410*	*460*	*510*	*550*	*550*
Total dietary intake	*1464 ± 478*	*1976 ± 629*	*2244 ± 720*	*2698 ± 863*	*3213 ± 1069*	*1374 ± 388*	*1743 ± 615*	*2093 ± 646*	*2208 ± 631*	*2267 ± 795*
in % RV	357.0%	429.6%	440.0%	490.5%	584.2%	335.2%	378.9%	410.5%	401.5%	412.2%
Total intake from dairy	*157*	*176*	*211*	*233*	*278*	*141*	*158*	*174*	*189*	*198*
in % RV	38.4%	38.3%	41.5%	42.4%	50.5%	34.5%	34.3%	34.1%	34.4%	36.1%
From Cheeses	12.4%	13.8%	17.9%	19.9%	27.4%	12.3%	15.3%	16.2%	18.2%	21.5%
From Other dairy products	26.0%	24.5%	23.6%	22.5%	23.2%	22.1%	19.0%	17.9%	16.2%	14.6%
Calcium RV (in mg)	*700*	*900*	*1100*	*1200*	*1200*	*700*	*900*	*1100*	*1200*	*1200*
Total dietary intake	*684 ± 239*	*821 ± 304*	*927 ± 311*	*1082 ± 450*	*1244 ± 540*	*615 ± 202*	*703 ± 216*	*813 ± 258*	*866 ± 260*	*879 ± 329*
in % RV	97.7%	91.2%	84.3%	90.2%	103.6%	87.9%	78.1%	73.9%	72.2%	73.2%
Total intake from dairy	*322*	*345*	*406*	*428*	*508*	*275*	*294*	*312*	*326*	*332*
in % RV	46.0%	38.3%	36.9%	35.7%	42.3%	39.3%	32.7%	28.3%	27.2%	27.7%
From Cheeses	8.7%	8.7%	10.8%	11.5%	16.9%	8.7%	9.7%	9.2%	9.6%	11.7%
From Other dairy products	37.3%	29.6%	26.0%	24.2%	25.4%	30.5%	23.0%	19.1%	17.6%	15.9%
Vitamin D (in µg)	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*
Total dietary intake	*1.634 ± 1.359*	*1.617 ± 1.016*	*1.971 ± 1.383*	*2.358 ± 2.157*	*2.685 2.042*	*1.420 ± 0.986*	*1.750 ± 1.815*	*1.781 ± 1.803*	*1.951 ± 1.461*	*1.889 ± 1.538*
in % RV	32.7%	32.3%	39.4%	47.2%	53.7%	28.4%	35.0%	35.6%	39.0%	37.8%
Total intake from dairy	*0.200*	*0.211*	*0.269*	*0.284*	*0.345*	*0.167*	*0.196*	*0.195*	*0.230*	*0.241*
in % RV	4.0%	4.2%	5.4%	5.7%	6.9%	3.3%	3.9%	3.9%	4.6%	4.8%
From Cheeses	1.1%	1.4%	2.3%	2.3%	3.8%	1.1%	1.6%	1.8%	2.2%	2.7%
From Other dairy products	2.9%	2.8%	3.1%	3.4%	3.1%	2.3%	2.3%	2.2%	2.4%	2.1%

[1] **recalculated from energy related RV (10% of energy)**

9. Appendix B: Applied nutrient profiling models

Table 9.1   **Relevant profiling criteria Swedish Keyhole model (Thresholds per 100g)**

	Total Fat (g)	Total Sugars (g)	Sodium (mg)
Milk and corresponding fermented products	≤0.7	-	-
Flavoured fermented milk products	≤0.7	≤9.0	-
Fresh cheese and corresponding flavoured products	≤5.0	-	≤350
Other cheese and corresponding flavoured products	≤17.0	-	≤500
Snacks	No criteria defined		

Table 9.2   **Relevant profiling Criteria Choices Programme model (Thresholds per 100g)**

	Sat Fat (g)	Trans Fat (g)*	Added Sugars (g)	Sodium (mg)
Milk (-products)	≤1.4	≤0.1	≤5.0	≤100
Cheese (-products)	≤15.0	≤0.1	≤0.0	≤900
Snacks	≤1.1	≤0.1	≤20.0	≤400
	Energy: max. 110kcal/serving			

*excl. TFA from ruminant origin

Table 9.3   Details of FSA/OFCOM model

I. Work out total 'A' points

A maximum of ten points can be awarded for each nutrient.

Total 'A' points = (points for energy) + (points for saturated fat) + (points for sugars) +(points for sodium)

The following table indicates the points scored, depending on the amount of each nutrient in 100g of the food or drink:

Points	Energy (kJ)	Sat Fat (g)	Total Sugar (g)	Sodium (mg)
0	≤ 335	≤ 1	≤ 4.5	≤ 90
1	>335	>1	>4.5	>90
2	>670	>2	>9	>180
3	>1005	>3	>13.5	>270
4	>1340	>4	>18	>360
5	>1675	>5	>22.5	>450
6	>2010	>6	>27	>540
7	>2345	>7	>31	>630
8	>2680	>8	>36	>720
9	>3015	>9	>40	>810
10	>3350	>10	>45	>900

If a food or drink scores 11 or more 'A' points then it cannot score points for protein unless it also scores 5 points for fruit, vegetables and nuts.

II. Work out total 'C' points

A maximum of five points can be awarded for each nutrient/food component.

Total 'C' points = (points for % fruit, vegetable & nut content) + (points for fibre [either NSP or AOAC]) + (points for protein)

The following table indicates the points scored, depending on the amount of each nutrient/food component in 100g of the food or drink:

Points	Fruit, Veg & Nuts (%)	NSP Fibre ' (g)	Or AOAC Fibre ' (g)	Protein (g)
0	≤ 40	≤ 0.7	≤ 0.9	≤ 1.6
1	>40	>0.7	>0.9	>1.6
2	>60	>1.4	>1.9	>3.2
3 -		>2.1	>2.8	>4.8
4 -		>2.8	>3.7	>6.4
5*	>80	>3.5	>4.7	>8.0

III. Work out overall score

If a food scores less than 11 'A' points then the overall score is calculated as follows:

Total 'A' points (energy + saturated fat + sugars + sodium)

Minus

Total 'C' points (fruit, veg and nuts + fibre + protein)

If a food scores 11 or more 'A' points but scores 5 points for fruit, vegetables and nuts then the overall score is calculated as follows:

Total 'A' points (energy + saturated fat + sugars + sodium)

Minus

Total 'C' points (fruit, veg and nuts + fibre + protein)

If a food scores 11 or more 'A' points, and less than 5 points for fruit, vegetables and nuts, then the overall score is calculated as follows :

Total 'A' points (energy + saturated fat + sugars + sodium)

Minus

Points for fibre + points for fruit, vegetables and nuts (not allowed to score for protein)

A **food** is classified as 'less healthy' where it scores **4 points or more**.

A **drink** is classified as 'less healthy' where it scores **1 point or more**.

Figure 9.1   Details of SAIN,LIM model

$$SAIN = \frac{\sum\limits_{p=1}^{p=5} ratio_{ip}}{5} \, x100 \qquad \text{with} \qquad ratio_{ip} = \left[\frac{nutrient_{ip}}{RV_p}\right] \times \frac{100}{E_i}$$

$nutrient_{ip}$ quantity (in g, mg or µg) of the positive nutrient p in 100g of the food i
RV_p daily recommended value for nutrient p
E_i energy content of 100g of food i (in kcal/100g)

Recommended values (RV) used for calculation

Basic positive nutrients
Protein 65g
Fibre 25g
Vitamin C 110m
Calcium 900mg
Iron 12.5mg
Optional positive nutrients
Vitamin D 5µg
Vitamin E 12mg (for foods with > 97% of energy from lipids)
-Linoleic Acid 1.8g (for foods with > 97% of energy from lipids)
Monounsaturated fatty acids 44.4g (for foods with > 97% of energy from lipids)

Up to 2 optional nutrients can replace basic nutrients in the $SAIN_i$ algorithm if their ratios are higher.

———————————————————

$$LIM = \frac{\sum\limits_{l=1}^{l=5} ratio_{il}}{3} \qquad \text{with} \qquad ratio_{iL} = \left[\frac{nutrient_{iL}}{MRV_l}\right] \times 100$$

$nutrient_{il}$ quantity (in g or mg) of limited nutrient l in 100g of the food i
MRV_l daily maximal recommended value for nutrient l

Maximal recommended values (MRV) used for calculation

Saturated Fatty Acids 22g
Added sugars 50g
Sodium 3153mg

———————————————————

ELIGIBLE: All products with SAIN ≥ 5 and LIM < 7.5 (SAIN,LIM class 1)

Table 9.4   Relevant profiling criteria FDA model (Thresholds per Reference Amount Customarily Consumed (RACC)*)

	Total Fat (g)	Sat Fat (g)	Cholesterol (mg)[a]	Sodium (mg)	Protein, Calcium OR Fibre
All Products	≤13	≤4	≤60	≤480	≥10%DV

*RACCs applied in this study include those for Cheese (30g), Milk/ Milk based drinks (240mL), Yogurt (225g) and Biscuits/ Crackers (50g)

**Daily Values (DVs) applied in this study: Protein 50g, Calcium 1000mg, Fibre 25g

[a]Cholesterol content only applied when available

Table 9.5   Relevant profiling criteria Smart Choices Program (Thresholds per serving)

	Energy (kcal)	Total Fat(g)	Sat Fat (g)	Trans Fat (g)[a,b]	Cholesterol (mg)[a]	Added Sugars (g)	Sodium (mg)	Nutrients/ Food Groups to encourage
Milk, dairy products and dairy substitutes	N/A	≤3	≤2	0	≤60	≤25 E%[c]	≤240	≥10% DV calcium or ½ cup low-fat milk products
Cheese and cheese substitutes	N/A	≤3	≤2	0	≤60	≤12	≤240	
Snack foods and sweets	≤160	≤35 E%[c] or 3[d]	≤10 E%[c] or 1[d]	0	≤60	≤25 E%[c] or 6[d]	≤240	≥10% DV fibre or ½ serving (8 grams[d]) whole grains

[a]criterion could not be applied as no data available

[b]naturally occurring TFA excluded

[c]% energy from nutrient

[d]if product contains ≤100 kcal per serving

Acknowledgments