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# Impact of foods with health logo on saturated fat, sodium and sugar intake of young Dutch adults

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## Abstract

*Objective:* Health logos are introduced to distinguish foods with 'healthier' nutrient composition from regular foods. In the present study, we evaluated the effects of changed food compositions according to health logo criteria on the intake of saturated fat, sugar and sodium in a Dutch population of young adults.
*Design:* Foods in the Dutch food composition table were evaluated against nutrient criteria for logo eligibility. Three replacement scenarios were compared with the nutrient intake 'as measured' in the Dutch consumption survey. The foods not complying with health logo criteria were replaced either by 'virtual' foods exactly complying with the health logo criteria, with real 2007 market shares (scenario I) and 100 % market shares (scenario II), or by existing similar foods with a composition that already complied with the health logo criteria (scenario III).
*Results:* The percentage reduction in nutrient intake with the current 2007 market shares of 'health logo foods' was −2·5 % for SFA, 0 % for sodium and −1 % for sugar. With a 100 % market share these reductions would be −10 % for SFA, −4 % for sodium and −6 % for sugar. This may lead to a reduction of −40 % for SFA, −23 % for sodium and −36 % for sugar in the most optimal replacement scenario.
*Conclusions:* With 'health logo foods', available in 2007 and current consumption patterns, small reductions can be achieved for SFA and sugar. For additional reductions, lowering the fat/sodium content of meat (products) towards health logo criteria and drinks without sugar towards limits far below health logo criteria would be the most effective reformulation strategy.

**Keywords**
Reformulated food
Health Logo
Intake
Nutrient
Impact assessment

In 2004, WHO adopted its Global Strategy on Diet, Physical activity and Health as part of the global strategy to reduce chronic diseases[1]. The private sector was encouraged to limit the levels of *trans* fatty acids and SFA, salt and free sugars of existing foods. This so-called reformulation of foods is considered among the key options to achieve population nutrient goals, since a large part of the foods that we eat is industrially processed. Food reformulations by industries may be stimulated by labelling initiatives like health logos[2]. Health logos give producers an incentive to produce healthier foods. On the other hand, health logos may help consumers to choose, within food categories, for a healthy alternative.

In May 2006, the Choices ('Ik Kies Bewust') health logo was introduced in The Netherlands by food producers. This logo was based on international dietary guidelines for healthy nutrition[3]. To be able to carry this health logo, the nutrient composition of foods has to comply with criteria for maximum levels of (among others) saturated fat, added sugars and sodium[4]. Food groups to which the logos are applied are non-processed (such as fresh vegetables and fruits) as well as industrially processed foods. The latter include already reformulated foods (such as skimmed milk) and recently reformulated foods (e.g. a zero-fat and low-sugar custard). Reformulation means a change in food composition to reduce the 'unhealthy' components (e.g. SFA, *trans* fatty acids, sugar, salt) and retain the 'healthy' components (e.g. PUFA and fibre) compared to the regular variant[5]. The foods are either marketed as a new food variant (e.g. a reduced-fat and reduced-salt cheese) or as a replacement of an existing food (e.g. the same brand of soup with less salt).

When reformulated foods with health logo indeed lead to healthier alternatives with respect to food composition,

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beneficial effects on nutrient intake of the Dutch population are expected. To evaluate the impact on intake, not only the composition of the foods but also consumption patterns must be taken into account. In the present study, we evaluated the effects of changed food compositions according to health logo criteria on the intake of saturated fat, sugar and sodium in a Dutch population of young adults, taking into account current market shares.

## Experimental methods

### *Study design and replacement scenarios*

The intake of SFA, sodium and sugar (key nutrients under study) in the baseline situation was calculated from the Dutch National Food Consumption Survey 2003[6] (described below). Then it was evaluated whether the composition of foods that were consumed complied with the health logo criteria (see under Food composition). In three replacement scenarios, the foods that did not comply with the health logo criteria were replaced either by 'virtual' foods that had the key nutrient level similar to the health logo criteria (scenarios I and II) or by existing similar 'real' foods (from the Dutch food composition table, NEVO[7]) with an overall composition that already complied with the health logo criteria (scenario III). Scenarios I and II enabled us to evaluate the health logo criteria and scenario III to estimate the potential (maximum) shift in intake, while staying as close as possible to habitual eating habits. For all foods, replacements were based on the quantity of the food originally consumed, i.e. the amount (in g) of the original food consumed was replaced by exactly the same amount of the alternative food.

Scenarios I and II only took into account food groups for which market share information was available (see under Market share). Food groups were non-alcoholic drinks, processed fruit and vegetables, cheese, dairy and dairy products, soya foods, prepared meals, soup, fats (baking and spreading), fat-based sauces and water-based sauces. Scenario III took into account all food groups. Additional food groups included in this scenario were potatoes prepared, rice, pasta, noodles, bread, cereal and cereal products, meat and poultry (products), fish, meat replacers and sweet and sugary snacks.

The outcome variable is expressed as usual (long-term) nutrient intake. This was calculated from daily intake data using a statistical model provided in the Monte Carlo Risk Assessment (MCRA) program[8]. Inputs were food consumption data, food composition data and market share information.

### *Food composition*

Food composition data were derived from the Dutch food composition table (NEVO 2006[7]). Food groups usually contain multiple foods (NEVO food codes), e.g. the group non-alcoholic drinks contains seventy-three codes. Each food consumed was compared with the nutrient health logo criteria for one nutrient at the time. Nutrient composition of the health logo complying and non-complying foods was evaluated for SFA, added sugar and sodium. For these nutrients the criteria apply directly. In Table 1, the average nutrient content of non-complying foods is given in the column under baseline, the nutrient-specific health logo criteria are in the column of replacement scenarios I and II and the average content of complying foods is in the column of replacement scenario III.

Added sugar is mainly not reported in the food composition tables; total mono- and disaccharides are reported instead. To calculate the added sugar content, the average mono- and disaccharide content of a food without added sugar (e.g. natural yoghurt) was calculated and subtracted from the total mono- and disaccharide content of similar foods (e.g. yoghurt with strawberries) to derive the added mono- and disaccharide concentration.

For the composition of the 'health logo foods' in scenarios I and II it was assumed that the concentrations are at the upper level of the criteria (see Table 1). It could be that the concentration of one nutrient was lower than this upper level and the concentration of another nutrient exceeded the criterion for maximum concentration. Then, only the nutrient exceeding the criterion was replaced by the upper level of health logo criteria. This applies for a low-fat cheese complying with the saturated fat criterion of the health logo, but exceeding the sodium content criterion. In this case, only the sodium level was changed. In scenario III, the non-complying food was replaced by a similar complying food from the Dutch food composition table[7]. In a few cases, it was not possible to find a complying replacement food. In these cases, the food was either not replaced (e.g. egg) or replaced by an alternative better complying with the criteria. This applied to chocolate, which was replaced by sugar-free chocolate, one pizza, one quiche and a bouillon and mustard. In addition, for scenario III, composition data (label information) of four new foods with the health logo stamp (peanut butter, cheese spread, fruity ice cream and biscuits) were added to the composition database and used as replacement foods[9].

### *Market share*

In five major supermarkets, all foods with a Choices health logo were identified by European Article Number (EAN) codes by Information Resources Incorporated (IRI), a marketing research bureau, at the beginning of 2008. In each food category, purchases (in €) of these particular foods were combined to a 'Choices purchase', based on scanning data of their EAN codes in 2007. The percentage of market share (based on €) of foods with a Choices logo, as measured in 2007, was then calculated against the total purchases in each food category (e.g. cheese, fats, soups). In the present study, we did not take into account brand loyalty; e.g. we do not know from the

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purchases data whether this is a one-time or regular purchase. In scenario I, consumption amounts were linked randomly with health logo or non-health logo nutrient levels of the product, with probabilities proportional to market shares.

### *Food consumption*

Food consumption data of the 2003 food consumption survey in Dutch young adults were used (http://www.rivm.nl/vcp/onderzoeken/jong_volwassenen/index.jsp).

The aim of the Dutch food consumption survey was to assess the dietary consumption of men and women aged 19–30 years. The participants were members of consumer panels. The participants were considered to be representative of Dutch young adults in terms of sex, age, level of education and region of residence. Diet was assessed in a representative sample of 750 young adults by two telephone 24 h recalls, by trained dietitians. A 7–14 d time interval was set between the first and second interviews. The second interview was conducted on a different day of the week from the first.

During a 24 h recall the participants reported the types and quantities of all foods and beverages that were consumed during the preceding day. To obtain a standardized 24 h recall interview, the validated software package EPIC-SOFT (International Agency for Research on Cancer, Lyon, France) was used[10]. EPIC-SOFT is designed for uniform data collection in the ten countries participating in the European Prospective Investigation into Cancer and Nutrition[10]. The software allows one to obtain a very detailed description and quantification of foods, recipes and supplements consumed. Quantification of the consumed foods is supported by a picture book that comprises photographs of foods in different portion sizes. Current food composition data of 2006[7] as well as health logo nutrient composition (Table 1) were linked to food consumption data. Linkage was developed previously by the Institute for Public Health and the Environment (Bilthoven, The Netherlands). The food categorization is based on the categorization of the NEVO table.

### *Intake assessment*

The intake of nutrients from a certain food at the interview days was estimated by:

$$y_{ij} = \sum_{k=1}^{K} 10 \cdot c_{jk} \cdot x_{ik}$$

where $y_{ij}$ is the intake of a certain nutrient $j$ by individual $i$ (g/d); $x_{ik}$ is the consumption of a certain food $k$ by individual $i$ (kg/d); and $c_{jk}$ is the concentration of nutrient $j$ in food $k$ or the corresponding health logo criteria value (g/100 g). To estimate the total intake per day, individual daily intakes of the nutrient from different food groups were summed over the $K$ foods involved.

Intake was assessed at baseline and in the three replacement scenarios. In scenario I, health logo concentration criteria and current market shares were applied. It should be noted that monetary market shares (percentage of €) were used as an approximation for weight market shares (percentage of kg). In scenario II, a 100 % market share scenario was evaluated in which all foods that could be reformulated towards the health logo criteria were replaced by maximal concentrations of the health logo criteria (Table 1). Scenario III took into account the actual composition of health logo foods. The replacement scenarios give insight into the current and potential effects of reformulated health logo foods on the habitual intake of saturated fat, sugar and sodium, respectively.

For nutrient analysis the 'habitual or usual' intake is of most interest. Usual intake is defined as the long-term average intake of a person. The usual intake distribution was estimated with the Nusser method[11], implemented as the Iowa State University Foods method in the MCRA program (https://mcra.rivm.nl/). Several statistical methods are available to estimate 'usual' intake distributions. These statistical procedures adjust for within-person or day-to-day variability, using a model assuming that usual intake after some transformation is normally distributed. The Nusser method[11] applies a flexible transformation of the data to obtain approximately normally distributed values.

For SFA and sodium, the median of usual intake distributions was compared with population nutrient intake goals as reported by the WHO/FAO[12]. A population nutrient intake goal represents the population's 'average' intake that is judged to be consistent with the maintenance of health in a population. The population nutrient intake goal for SFA is below 10 % of total energy (below 25·9 g/d in the population of young adults with average energy intake in this population of 9740 kJ/d (2328 kcal/d)). For sodium the population intake goals as reported by the WHO/FAO[12] is below 2 g/d. Since the calculated sodium intake did not take into account added salt during cooking and on certain foods such as boiled eggs and roast beef, we did not compare the intake calculated with this recommendation for sodium. For the evaluation of foods against the health logo criteria for sugar, estimates for added sugar were used. The calculations of the outcome variables (usual intakes) have been based on the original food composition data[7] and are therefore given for total sugar only and not evaluated with recommended levels.

## Results

### *Food composition*

Table 1 shows the nutrient levels of food groups according to the Dutch food composition table[7]. Note that the compositions represent an average composition over multiple food codes. The average values shown, therefore, give a crude estimate of the composition. Table 1 shows, per nutrient (saturated fat, sodium and total sugar),

**Table 1** Average nutrient composition of foods that were replaced by foods complying to health logo criteria in replacement scenarios I and II (maximum levels according to health logo criteria) and scenario III (actual composition)

| | | | SFA | | | | Sodium | | | | Total sugar | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Baseline | | Replacement | | Baseline | | Replacement | | Baseline | | Replacement | |
| | | | Non-complying foods | | Scenarios I and II† | Scenario III | Non-complying foods | | Scenarios I and II† | Scenario III | Non complying foods | | Scenarios I and II† | Scenario III |
| Product group | Type | *n** | *n* | g/100 g | g/100 g | g/100 g | *n* | mg/100 g | mg/100 g | mg/100 g | *n* | g/100 g | g/100 g | g/100 g |
| Food groups for which health logo foods were available in 2007 (included in scenarios I, II and III) | | | | | | | | | | | | | | |
| Non-alcoholic drinks‡ | Fruit and vegetable juice | 29 | | | | | | | | | 24 | 10·8 | 8·0 | 8·0 |
| | Drinks other than fruit juice | 44 | | | | | | | | | 20 | 10·9 | 8·0 | 2·2 |
| Fruit | Processed | 3 | | | | | | | | | | | | |
| Fruit | Canned with syrup | 8 | | | | | | | | | 8 | 15·7 | 9·0 | 10·5 |
| Vegetables | Processed | 30 | | | | | 16 | 295 | 120 | 36 | 9 | 6·6 | 2·3 | 2·1 |
| Cheese | | 42 | 20 | 19·9 | 15·0 | 13·0 | 19 | 1158 | 900 | 741 | | | | |
| Dairy and dairy products | Milk | 6 | 2 | 2·4 | 1·4 | 0·4 | | | | | | | | |
| | Dairy desserts | 55 | 29 | 3·2 | 1·4 | 1·0 | 1 | 195 | 120 | 46 | 36 | 15·3 | 9·0 | 4·7 |
| | Dairy drinks | 30 | 2 | 1·8 | 1·4 | 0·4 | | | | | 19 | 12·0 | 9·0 | 5·0 |
| | Coffee creamer | 9 | 5 | 16·4 | 1·4 | 0·0 | 2 | 230 | 120 | 60 | 6 | 12·0 | 9·0 | 5·5 |
| Soya products, soya drinks | | 11 | 1 | 5·6 | 5·3 | 0·7 | | | | | 1 | 9·3 | 3·3 | 0·7 |
| Prepared meals | | 27 | 12 | 4·4 | 3·1 | 3·4 | 11 | 714 | 425 | 420 | | | | |
| Soup | | 21 | 1 | 1·5 | 1·4 | 0·6 | 9 | 404 | 350 | 225 | 3 | 10·9 | 7·0 | 1·0 |
| Fat§ | | 33 | 12 | 35·3 | 22·1 | 12·8 | 1 | 1366 | 1040 | 136 | | | | |
| Sauces – fat based | | 73 | 32 | 13·4 | 8·5 | 5·6 | 5 | 775 | 750 | 286 | 14 | 9·9 | 6·2 | 2·0 |
| Sauces – water based | | 17 | 3 | 2·5 | 1·4 | 0·3 | 9 | 1294 | 750 | 417 | | | | |
| Food groups for which health logo foods were not available in 2007 (included in scenario III) | | | | | | | | | | | | | | |
| Sources of carbohydrates | Potatoes prepared | 23 | 5 | 2·5 | 1·4 | 0·5 | 1 | 466 | 120 | 29 | 22 | 2·3 | 0·0 | 1·3 |
| | Bread | 43 | 11 | 3·6 | 1·4 | 0·4 | 29 | 569 | 500 | 480 | 9 | 19·6 | 8·8 | 6·5 |
| | Cereal and cereal products | 32 | 2 | 2·4 | 1·4 | 0·5 | 12 | 566 | 120 | 13 | 19 | 15·5 | 3·3 | 3·0 |
| Meat, fish, poultry, eggs and meat replacers‖ | | | | | | | | | | | | | | |
| | Meat, poultry (fresh) | 82 | 50 | 5·8 | 3·1 | 1·4 | 23 | 847 | 120 | 357 | | | | |
| | Meat, poultry (processed) | 34 | 30 | 8·9 | 4·1 | 1·6 | 12 | 1449 | 900 | 373 | | | | |
| | Fish (fresh)§ | 25 | 6 | 2·4 | 2·1 | 2·2 | 18 | 540 | 120 | 157 | | | | |
| | Fish (processed) | 5 | 2 | 3·9 | 3·7 | 1·7 | 1 | 493 | 450 | 372 | | | | |
| Snacks¶ | | | | | | | | | | | | | | |

*Number of products (food codes) in this food group.
†Average health logo criteria.
‡Health logo criterion for energy is converted into total sugar content.
§Health logo criterion for SFA is expressed as maximum of 30 % of total fat content, each food was evaluated accordingly.
‖Health logo criterion for SFA is expresssed as maximum of 13 % of total energy content, each food was evaluated accordingly.
¶Only two replacers possible, compositions highly variable and not given.

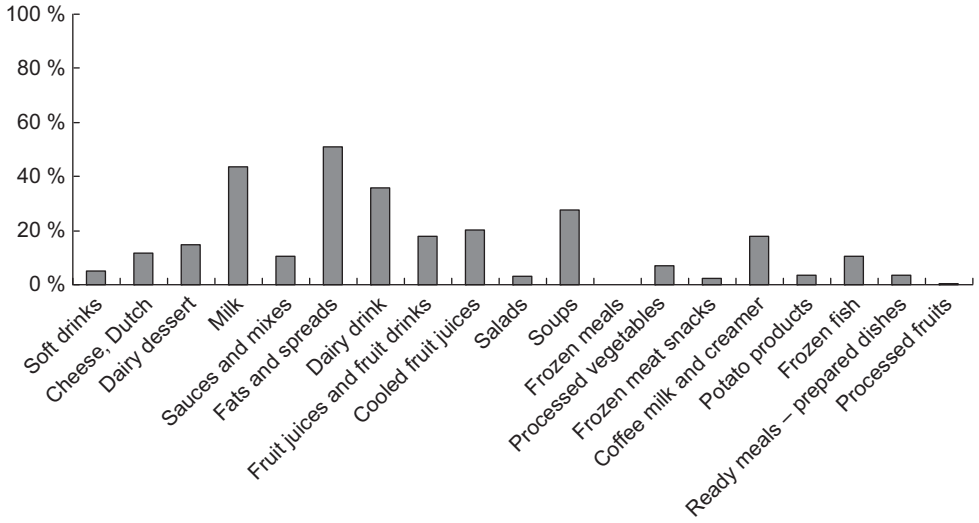


**Fig. 1** Market shares (based on Euros) of food purchases with a (Choices) health logo in 2007, as a percentage of the total purchases in each food category in 2007

the total number of food codes per group, the number of foods not complying with the nutrient-specific criteria, the average nutrient composition of the non-complying foods, the maximum nutrient levels according to health logo criteria (assumed in scenarios I and II) and the composition of the most favourable composed foods within each group (used in scenario III).

For SFA, by complying with the health logo criteria, major compositional shifts can be achieved for cheeses, dairy products, prepared meals, fats and fat-based sauces (scenarios I, II and III); e.g. by replacing solid baking or frying fats, full-fat dairy by low-fat alternatives and dairy products. In addition, a major SFA reduction might be achieved by choosing other types of meat (scenario III).

For sodium, processed vegetables, cheese, soups, prepared meals and water-based sauces are the main food categories not complying with the sodium criteria for which healthier formulated foods are available (scenarios I and II). For processed vegetables, complying with the health logo criteria (scenarios I and II) would mean a 59% reduction of sodium, for prepared meals and water-based sauces around 40% and for soups and cheese on average 20% sodium reduction. Major sodium reduction, in addition, could be achieved in bread, processed meat and fish (scenario III).

With respect to reducing added sugar contents, reformulating canned fruits with syrup, processed vegetables, non-alcoholic drinks, dairy products and fat-based sauces may induce major changes in sugar content (scenarios I, II and III). In scenarios I and II, complying with the health logo criteria means a 42% reduction in total sugar for canned fruits in syrup, around one-third reduction of total sugar in dairy desserts and dairy drinks. The average reduction in sugar content of non-alcoholic drinks other than fruit juice would be 27%. The actual average total sugar content of non-alcoholic drinks other than fruit juice complying with the health logo criteria is only 2·2 g/100 g, thus allowing for a potential reduction by 80%.

### *Market share of health logo foods*

Purchases of health logo and non-health logo foods in the different food categories are shown in Fig. 1. In five major supermarkets, 734 foods were identified as carrying a Choices health logo in 2007. The largest shares of health logo foods were found for fats and spreads (51%), milk (43%), dairy drinks (36%) and soups (28%). Low health logo market shares were found for soft drinks (5%), prepared salads (3%), prepared (3%) and frozen meals (0%).

### *Intake assessments*

Table 2 and Fig. 2 show the results of the intake assessments for saturated fat, sodium and total sugars. In this population of young adults, the median usual intake of SFA at baseline (i.e. without replacing the non-complying foods) was estimated at 32 (95% CI 31, 33) g/d (see Table 3). The estimated average population nutrient intake goal is not more than 25·9 g/d (10% of energy; average energy intake in this population of 9740 kJ/d (2328 kcal/d)), and is met by 26%. Major sources of SFA were dairy products (13%), cheese (18%) and meat products (20%).

Figure 2a compares the saturated fat intake distributions for the three replacement scenarios. With the health logo criteria (scenario II) within available food categories, the intake in scenario II is 3·2 g of SFA (or 10%) lower than in the baseline situation (see Table 3 and Fig. 2a). In all, 37% of the Dutch young adults, instead of 26%, comply with the population nutrient intake goal for SFA. In this scenario, SFA intake from cheeses and fats and oils is around 4% and dairy is 3% lower than in the baseline

**Table 2** Usual nutrient intake in three replacement scenarios compared with the baseline situation (Dutch National Food Consumption Survey – 2003)

| | Baseline situation and replacement scenarios | Median (g/d) | 95 % CI | Percentage reduction (compared with baseline situation) | Percentage according to population nutrient intake goal |
|---|---|---|---|---|---|
| SFA* | | | | | |
| As measured | Baseline | 31·9 | 31·0, 32·9 | | 25·7 |
| Available health logo foods, health logo criteria, current market share | I | 31·1 | 30·1, 32·0 | −2·5 | 27·9 |
| Available health logo foods, health logo criteria, 100 % market share | II | 28·7 | 27·7, 29·6 | −10·0 | 36·8 |
| All foods consumed, actual compositions, 100 % market share | III | 19·0 | 18·6, 19·6 | −40·4 | 84·0 |
| Sodium | | | | | |
| As measured | Baseline | 2·864 | 2·783, 2·945 | | |
| Available health logo foods, health logo criteria, current market share | I | 2·852 | 2·782, 2·947 | −0·4 | |
| Available health logo foods, health logo criteria, 100 % market share | II | 2·745 | 2·670, 2·827 | −4·1 | |
| All foods consumed, actual compositions, 100 % market share | III | 2·214 | 2·160, 2·294 | −22·7 | |
| Total mono- and disaccharides | | | | | |
| As measured | Baseline | 138·6 | 134·3, 142·3 | | |
| Available health logo foods, health logo criteria, current market share | I | 137·5 | 133·7, 141·4 | −0·8 | |
| Available health logo foods, health logo criteria, 100 % market share | II | 129·7 | 125·4, 134·2 | −6·4 | |
| All foods consumed, actual compositions, 100 % market share | III | 88·5 | 85·8, 91·6 | −36·2 | |

*Population nutrient intake goal of ≤10 % of daily energy intake; in the DNFCS study population, this means SFA ≤ 25·9 g/d.

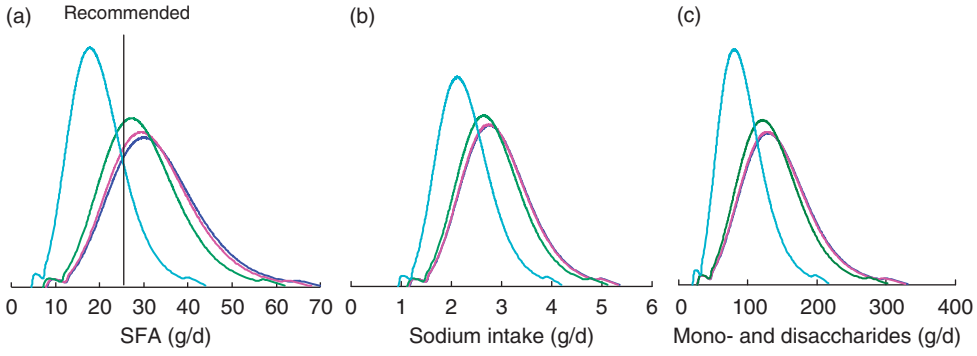


**Fig. 2** (a–c) Nutrient intake in the baseline situation (—) and three replacement scenarios; replacement scenario I (—; health logo criteria and current market share), replacement scenario II (—; health logo criteria and 100 % market share) and replacement scenario III (—; actual compositions, 100 % market share). See the text for further description of the scenarios. In Figs 2b and c, the baseline situation and the replacement scenario I overlap

situation (Table 3). With the current purchase behaviour (scenario I), the reduction is estimated to be only 2·5 % (SFA reduction of 0·8 g/d) compared with the reference intake. Would all non-complying foods be replaced by similar foods complying with the health logo criteria, a major decreased SFA intake of 12·9 g/d (40 % reduction) would be achieved. In scenario III, 84 % of young adults would be below the population nutrient intake goal; lower-saturated-fat meat products are responsible for the major part of the reduction (SFA intake from meat is 14·5 % lower than in the baseline situation). Intake of fats and oils, cheeses and dairy products contributes less and is 6–7 % lower than in the baseline situation (Table 3).

The estimated usual intake of sodium in the study population, at baseline, was 2·9 (95 % CI 2·8, 2·9) g/d. The main sources of sodium are bread (27 %), meat (products; 17 %) and cheese (9 %). For sodium, in a 100 % market share scenario (scenario II), sodium reduction expected is 0·1 g/d (4 % reduction; see Table 2 and Fig. 2b). The intake in this scenario is not significantly different from the intake in the baseline situation. With the current market share sodium intake is similar to the reference intake.

**Table 3** Average percentage reduction of SFA, sodium and sugar intake in different food groups in replacement scenarios II and III compared with baseline situation

| | Percentage reduction of SFA | | | Percentage reduction of sodium | | | Percentage reduction of sugar | |
|---|---|---|---|---|---|---|---|---|
| Food groups | Scenario II | Scenario III | Food groups | Scenario II | Scenario III | Food groups | Scenario II | Scenario III |
| Cheese | −3·9 | −7·1 | Fats, oils and savoury sauces | −1·5 | −1·2 | Non-alcoholic drinks | −3·7 | −21·1 |
| Fats, oils, savoury sauces | −3·7 | −6·1 | Prepared meals | −1·2 | 0·0 | Dairy and dairy products | −2·4 | −6·2 |
| Dairy and dairy products | −2·7 | −6·0 | Cheese | −0·6 | −2·0 | Fruit (processed) | −0·4 | −0·3 |
| Prepared meals | −0·1 | −0·4 | Soups | −0·5 | −2·0 | Vegetables (processed) | −0·1 | −0·3 |
| Meat (products) | | −14·5 | Vegetables (processed) | −0·4 | −1·0 | Sugar, sweets | | −6·5 |
| Nuts, seeds and snacks | | −3·4 | Dairy and dairy products | −0·1 | 0·0 | Biscuits, pie and cake | | −5·2 |
| Biscuits, pie and cake | | −2·4 | Meat (products) | | −8·2 | Bread | | −1·0 |
| Bread | | −2·0 | Nuts, seeds and snacks | | −2·3 | Cereal and cereal products | | −0·6 |
| Potatoes | | −1·3 | Bread | | −2·3 | Fats, oils and savoury sauces | | −0·4 |
| Fish | | −0·4 | Spices and herbs | | −2·3 | Meat (products) | | −0·2 |
| Cereal and cereal products | | −0·4 | Fish | | −0·6 | Spices and herbs | | −0·2 |
| Non-alcoholic drinks | | −0·3 | Potatoes | | −0·4 | Prepared meals | | −0·2 |
| Savoury sandwich toppings | | −0·2 | Biscuits, pie and cake | | −0·3 | Savoury sandwich toppings | | −0·1 |
| Soups | | −0·2 | Pulses | | −0·3 | Soya and vegetarian products | | −0·1 |
| Spices and herbs | | −0·2 | Savoury sandwich toppings | | −0·2 | Pulses | | −0·1 |
| Fruit (processed) | | 0·0 | Sugar and sweets | | −0·2 | Meal supplements | | −0·1 |
| Pulses | | 0·0 | Cereal and cereal products | | −0·2 | Various | | 0·0 |
| Various | | 0·0 | Fruit (processed) | | 0·0 | Cheese | | 0·0 |
| Eggs | | 0·0 | Soya and vegetarian products | | 0·0 | Fish | | 0·0 |
| Vegetables (processed) | | 0·0 | Various | | 0·0 | Eggs | | 0·0 |
| Soya and vegetarian products | | 0·0 | Non-alcoholic drinks | | 0·0 | Nuts, seeds and snacks | | 0·0 |
| Meal supplements | | 0·0 | Meal supplements | | 0·0 | Potatoes | | 0·0 |
| Sugar and sweets | | 0·0 | Eggs | | 0·0 | Soups | | 0·0 |

In scenario III, when all non-complying foods are replaced with foods complying with health logo criteria, sodium intake reduced by 23 % to 2·2 g/d. The main contributors to this reduction are meat (products; 8·2 % lower intake from meat products compared with the reference situation), bread, cheese, nutty and savoury snacks and herbs (2·3 % lower intake compared with the reference situation; Table 3).

The usual intake at baseline of mono- and disaccharides in this population of young adults is 138·6 (95 % CI 134·3, 142·3) g/d. The main sources of mono- and disaccharides are non-alcoholic drinks (31 % of total sugar intake of which 21 % lemonades and soft drinks), sugar and sweets (21 %) and dairy products (18 %).

For sugar, the reduction possible at the moment by following the criteria for available health logo foods (in a 100 % market share scenario II) is 8·9 g of sugar (6 % reduction; see Table 3 and Fig. 2c). More than half of this reduction is accounted for by replacing full-sugar drinks with the health logo variant (3·7 % lower sugar intake compared with the baseline situation), around one-third by choosing low-sugar dairy instead of regular dairy. Taking into account the current market share of health logo foods in this category (scenario I), sugar reduction is not significant and is limited to 1 g/d. In scenario III, where all non-complying foods are replaced by complying foods with actual compositions, the estimated intake of sugars would be 88·5 (95 % CI 85·8, 91·6) g/d, a reduction of 36 % compared to the reference intake. The main contributors to this reduction are non-alcoholic drinks, responsible for half of the reduction, and sweets, sweet snacks and dairy products (5–6 % lower intake compared with baseline situation; Table 3).

## Discussion

The present study evaluated the effects on nutrient intake by consuming foods complying with health logo criteria instead of non-complying foods. The study estimated the potential benefits based on the health logo criteria applied, the foods available and their current market shares. Although the study applies to the Dutch situation, the methodology used can be used in broader settings, e.g. for evaluating the potential impact of certain reformulated foods, or potential impact of proposed nutritional profiles on nutrient intake in different populations. As exemplified in Figs 2a–c the estimation of usual intake distributions, rather than point estimates, allows an assessment of the estimated impacts of reformulation respective to the background of inter-individual variation that always exists. It also allows conclusions for the tails of the intake distribution (consumers with low and high intakes) in addition to those for the 'average' consumer.

### *Food composition*

The foods complying with health logo criteria provided considerable 'compositional' gains for SFA (mainly in the food category of fats, fat-based sauces and cheese), sugar (mainly in the food category of canned fruits with syrup and dairy desserts) and sodium (mainly for prepared dishes, water-based sauces). Actual compositions are, as expected, lower than the criteria values to a more or lesser extent. In the comparison of food composition data with health logo criteria, we noticed the importance of evaluating more nutrients at the time. Complying with one nutrient a limit does not automatically mean that the food is also complying with the other nutrient criteria. Current food composition data[7] indicate that low-fat cheeses contained, on average, much more salt than the regular high-fat cheeses and low-fat dairy dessert contains more sugar than the regular variant. A similar concern was reported before for foods in which *trans* fatty acids were lowered, but replaced for SFA[13].

### *Impact assessment*

Saturated fat intake estimated in scenario II (100 % market share) is reduced significantly. Major food groups responsible for this reduction were fats and oils, cheese and dairy products. 'Health logo foods' were, however, not found for major contributors of SFA intake as meat and meat products. Adding these foods and actual compositions of possible replacements would potentially further lower SFA intake 4-fold as is shown in scenario III. This scenario would mean changing, in addition, the type of meat towards leaner variants. A recent study on the impact of replacing foods high in saturated fat by low-saturated-fat alternatives showed similar reductions as in scenario III. Schickenberg *et al.*[14] replaced the individual's three main contributors of saturated fat intake by similar low-saturated-fat foods. SFA intake was reduced by 13 g or 5 % of total energy intake. The main foods replaced were cheeses, meat (products), milk, baking fat and margarines. These foods were replaced by foods with very low-saturated fat content; e.g. a cheese with 10 % rather than 48 % fat in solids. It is, however, questionable whether enough people would choose such a food, as was noted by the authors themselves. Market share information used in the present study showed that around 12 % of total cheese purchases consist of low-fat cheese. In scenario III, cheese with 30 % fat in solids was used as a replacement for a high-fat cheese. To achieve the reductions calculated in the third scenario asks for a major shift towards meats containing less (saturated) fatty acids. In addition, more effort is needed for the groups meat and meat products to produce tasty alternatives (taking into account the salt content) and to tease consumers to buy lower- instead of similar high-saturated-fat foods.

The lack of a clear reduction of sodium in scenario II is due to the fact that the largest contributors to sodium intake (bread and bread products and meat products) are not included in this scenario. No health logo foods were available and/or bread and meat products with lower salt content were not labelled by health logos at the time

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of the study. Including replacements for meat and bread (scenario III), the estimated sodium reduction would be 23 %/d. Choosing lower-sodium meat products provides the largest gain followed by lower-salt bread. It is still debated, however, whether sodium reformulations, especially in bread, should be made public by labelling initiatives like health logos[2,15,16], because of the possible effects on taste. The results of scenario III confirm the simulation studies from Finland[17]. Intake of salt was very high in Finland[18] but has decreased in recent years through combined policy, industry and educational actions. Pietinen *et al.*[17] calculated that if the Finnish population would choose low-salt bread, cheese, meat and fish products, margarines and cereal, salt intake would be reduced by 1·2 g/d. Choosing, in addition, lower-salt prepared meals, salt intake could be further reduced by 2 g/d (equivalent to 0·8 g sodium per day)[17]. In The Netherlands, sodium reformulations have just started via the task force of salt reduction[19] and are also stimulated from an international perspective[20]. Both scenario analyses for saturated fat as well as sodium intakes show that it is possible to reduce, with a limited number of currently available foods that could be labelled by a health logo.

For sugar, lemonades and soft drinks, the main foods contributing to sugar intake, are labelled with a health logo. With the current criteria (scenario II) a small but significant sugar reduction may be achieved. Since the major sugar contributors are covered by the health logo products, further improvements of estimated intakes into the direction of scenario III may only be achieved by narrowing the current health logo criteria for sugar. The current limit for soft drinks is set at 134 kJ/100 ml (32 kcal/100 ml; or 8 g mono- and disaccharides/100 ml), whereas the actual sugar content of major low-sugar soft drinks is below 2 g/100 ml. There is no consensus[23], but re-evaluating the current limits is especially worthwhile because evidence suggests that full-sugar soft drinks contribute to overweight, diabetes and CVD[21,22]. Added sugar, in addition, remains a difficult nutrient to evaluate. A large diversity in methodologies and definitions is used to evaluate added sugar intake and the inclusion or exclusion of fruit juices. According to the WHO guidelines[12], the term 'free sugars' refers to all mono- and disaccharides added to foods by the manufacturer, cook or consumer, plus sugars naturally present in honey, syrups and fruit juices. As the definition of free sugars[12], as set by the WHO, was found difficult to work with, it was decided to evaluate products on their level of added sugars: unlike free sugar, the amount of added sugar can be adjusted by industry.

### *Limitations of the study*

The limitations can be related to the type of data the calculations are based on. For a more accurate estimation of impact, further efforts must be made to ensure and update the composition, purchase as well as consumption data.

Composition data were derived from the most recent Dutch food composition table[7]. In this table, foods are grouped in food codes according to composition and provide information on average composition. Compositional gains and intake estimates calculated may be crude. On the other hand, criteria values for health logos are also given in broad product categories.

Large differences were noted between food categories for the market share of health logo products. Health logo labelling is voluntary and is initiated by a few large companies. Not all companies choose to market products lower in saturated fat, sugar and sodium by applying health logos. For some product categories this means 'underlabelling'. The market share for 2007, in addition, is just a snapshot; the market for foods and the availability of foods with health logos change rapidly. In the category of soft drinks, labelling was rather low. Recent reports, however, show that the market share of soft drinks without sugar, complying with the Choices health logo criteria but not carrying one, has increased rapidly[24]. This would affect usual intake estimates in the first scenario. Intake estimates of the third scenario estimate would not be affected.

Many studies, in addition, show that dietary surveys relying on self-reported consumption data are prone to errors of recall[25]. The degree of under-reporting may vary according to the type of food (e.g. snacks, confectionery, sweetened hot drinks and soft drinks are often forgotten) and across income, age groups and household types[26]. In addition, the intake data for sodium do not take into account the level of added salt.

In the intake assessments, it was assumed that a person would replace a non-complying food for a similar complying food, and would not eat more of it. Consumers, however, have difficulties in understanding the message of the health logo[27] and acting accordingly.

Whether health logos effectively change consumer behaviour should be investigated further. The effectiveness of health logos depends on how the message is communicated to the consumer and whether the consumer makes appropriate behavioural changes. These aspects should be further evaluated, because in the end this will determine the impact of health logo foods on intake. For a more accurate estimation of impact, further efforts must be made to ensure and update the composition and market share information as well as consumption data.

## Conclusions

The present study quantified the possible impact of reformulation and labelling initiatives on nutrient intake via three replacement scenarios. The percentage reduction with the current market shares of health logo foods was −2·5 % for SFA, 0 % for sodium and −1 % for sugar.

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Reductions of −40 % for SFA, −23 % for sodium and −36 % for sugar may be reached in the most optimal replacement scenario. For additional reductions, lowering the fat/sodium content of meat (products) towards health logo criteria and drinks without sugar towards limits far below health logo criteria would be the most effective strategy.

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