Evaluation of a front-of-pack nutrition label

Effects on consumer behavior,
product development and public health

Ellis Kroonenberg-Vyth

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General Introduction

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In this thesis, we evaluated the front-of-pack (FOP) nutrition label "Choices" in the Netherlands (in Dutch *'Ik Kies Bewust logo'*). The aim was to investigate the effects of the logo on consumer behavior, product development, and public health. This General Introduction introduces the research area of FOP labeling, describes the background of the Choices logo, and provides the aim and outline of this thesis.

Nutrient information on food products

Globally, dietary intakes of trans fatty acids (TFA), saturated fatty acids (SAFA), sodium and sugar exceed the recommendations (1). As a result, the prevalence of diet related chronic diseases, such as heart disease, obesity and diabetes, is increasing. Therefore, the World Health Organization's (WHO) Global Strategy on Diet, Physical Activity and Health recommended the private sector to limit the levels of TFA, SAFA, salt and free sugars in food products in order to reduce this prevalence (2). One way to help consumers reduce the intake of these nutrients is to improve the product composition; another is to motivate consumers to make healthier choices. Displaying information about the nutrient content on food products can both stimulate food manufacturers to develop healthier products and can help consumers make healthier choices at the point-of-purchase. The nutrient content is reflected in the nutrition facts panel on the back of packaged food products, expressed in relative and absolute quantification of nutrients (Figure 1). Nutrition facts panels have been mandatory in the US since 1990, in Canada since 2007, and in Australia and New Zealand since 2002 (3, 4). In Europe, mandatory regulations for nutrition facts panels have been adopted only very recently (July 2011) (5). It depends on the country which nutrients are listed, and whether they are expressed per 100 grams or per portion. A recent review concludes that nutrition facts panels are among the most prominent sources of nutrition information (3). One of the advantages compared with other sources of nutrition information (e.g. promotion folders or nutrition information provided by health professionals) is that the information on nutrition facts panels can be used in the point-of-purchase setting where actual purchasing decisions have to be made (6, 7). A disadvantage of the nutrition facts panel is that it can be difficult for consumers to understand, which may hamper its use (8). It is supposed that older consumers and consumers with lower levels of education and income experience particular difficulties – exactly those people with the greatest need to adopt healthier dietary patterns (3, 4, 8). It has therefore been suggested that interpretational aids may serve a useful function in getting consumers to use the nutrition facts panel more often and more effectively (8).

Voedingswaarde per 100 g	
energie	2045 kJ (485 kcal)
eiwit	6,5 g
koolhydraten	59 g
waarvan suikers	0,9 g
vet	25 g
waarvan verzadigd	3,0 g
onverzadigd	1,0 g
transvet	0,7 g
voedingsvezel	4,5 g
natrium	0,10 g
Een tacoschelp bevat 55 kcal.	
Gemiddelde energiebehoefte per dag:	
mannen	2500 kcal
vrouwen	2000 kcal

Figure 1. Nutrition facts panel (example from the Netherlands).

As a result, nutrition and health claims and FOP labeling formats are increasingly displayed on product packages. Nutrition and health claims convey information on food characteristics (e.g. “contains calcium”) and on the link between diet and health (e.g. “contributes to prevention of osteoporoses”). Current food packaging has given rise to a considerable number of debatable claims. There are indications that these claims increase consumers’ perception of the healthfulness of food products, whereas others state that these claims are misleading and confusing (9-11). Additionally, FOP labeling formats were developed as interpretational aids to supplement the nutrition facts panel back-of-pack. FOP labels help to distinguish “healthier” food options from less healthy options. They require less detailed nutritional knowledge than that needed for interpreting the traditional nutrients facts panel. In general, FOP

Table 1. Categorization of FOP labels proposed by the European Union funded project ‘FLABEL’.

FOP label category	Main characteristics	FOP label examples
Non-directive	Overall conclusion whether product is healthy is left to consumer.	Guideline Daily Amounts (GDA) NuVal
Semi-directive	Provide some direction, but leave final healthiness interpretation to consumer.	Traffic lights label Guiding Stars
Directive	Communicate overall healthiness; no interpretation needed by consumer.	Green Keyhole Pick the Tick Choices logo

labels have two aims. First, they aim to help consumers to make healthier choices. Second, FOP labels aim to stimulate food manufacturers to develop healthier products.

Categorization of front-of-pack (FOP) labels

Since the 1990s, many countries, food manufacturers, retailers and consumer organizations have developed their own FOP labels, with different designs and criteria. FOP labels can be categorized in three groups: “non-directive”, “semi-directive” and “directive” FOP labels, a categorization proposed by the European Union funded project “Food Labeling to Advance Better Education for Life” (FLABEL) (12). Table 1 illustrates the three categories and their main characteristics.

Non-directive FOP labels leave the overall conclusion as to whether the product is healthy or not to the consumer. An example of a non-directive label is the Guideline Daily Amounts (GDA), devised by the United Kingdom and widely used on food products by industries in other countries as well (13). This label shows the percentage of daily requirements of energy, total fat, saturated fat, sugar and salt that a serving of a particular food provides. Another example is the American NuVal system, a science-based nutrition index score displayed on supermarket shelves, which scores the relative healthiness of a food on a scale of one to 100 (14).

Semi-directive labels are labels which provide some guidance (for example by the

use of colors), but leave the final healthiness interpretation to the consumer. An example is the traffic light label, which also originates from the United Kingdom and is currently used on many food products in different countries (15). These labels rank total fat, saturated fat, sugar and sodium and code them with a color as high (red, "think before you eat"), medium (amber, "OK") or low (green, "go"), based on cut-points established by the Food Standards Agency (15). Another example is the American "Guiding Stars" symbol displayed on supermarket shelves, which expresses the relative healthiness of a food product by showing 1, 2 or 3 stars (16).

Finally, there are directive FOP labels, also called "health logos". They serve as a "health quality mark" and are present only on products with a relatively favorable nutrient composition. They communicate the overall healthiness of the food product and no interpretation by the consumer is needed. These labels provide an integrative assessment of a combination of nutrients, such as saturated fat, total fat, salt, added sugar, fiber and energy, based on pre-set product criteria. Directive FOP labels generally have category-specific criteria. Because the range of the intake of different nutrients is too great for one set of criteria to be created for all food products when foods are labeled with one "health quality mark", product grouping is needed (17, 18). Thus, the presence of a directive FOP label usually means "healthier product" within a predefined product group. Although there is much debate whether consumers choose within or across product groups, there is some evidence that FOP labels should be category-specific to be helpful in promoting healthier diets, but with a limited number of categories to avoid being confusing (18). Furthermore, it is supposed that systems that rely on one set of criteria for the entire food supply are less aimed at stimulating product reformulation compared with systems which have product group-specific criteria. Examples of directive FOP labels are the Green Keyhole Symbol in Sweden (19), the Heart Symbol in Finland (20), the Pick the Tick logo in Australia and New Zealand (4), the Healthier Choices Symbol in Singapore (21) and the Choices logo in the Netherlands (22).

In 2010, the Institute of Medicine from the United States published an overview of the FOP labeling systems internationally available, which describes the different designs, criteria and system developers (23). Food manufacturers, retailers, health organizations, and others developed their own symbols and systems, not without controversy. Concerns, particularly over nutrient criteria that vary widely and sometimes conflict among the many systems in the marketplace, and lack of conclusive effectiveness research on these labels have fueled current debate on the future use of FOP labels.

Research about front-of-pack (FOP) labeling

In recent years there has been vigorous international debate about the preferred format and potential impact of FOP nutrition labeling. Existing FOP labels use different criteria to categorize products as healthy or otherwise. Furthermore, they vary considerably in appearance (e.g. colors, sizes, placing on the package, expressions by numbers). Regulatory changes are currently being considered by the European Parliament (5) and regulatory bodies in Australia and New Zealand (24, 25). Also, the Institute of Medicine (IOM) and the Food and Drug Administration (FDA) in the

United States are currently conducting research in this area and preparing advice for the US government (23, 26). In this highly political debate, policy-makers, scientists, industry groups and consumer organizations are looking for literature evaluating FOP labels in order to make well-informed decisions (11, 27). As a result, a growing number of studies testing the effectiveness of the FOP labels have been published (science based and non-science based). Researchers study different aspects, such as (self-reported) consumer understanding and use of FOP labels (6, 19, 28-36), actual label use in real life shopping environments (37-45), and effects on reformulation (46-48), sales (16, 49, 50) and health outcomes (51-55). In this way, they aim to evaluate the usefulness, adoption, reach and impact of these labels. Obviously, for industry groups, effects on sales play an important role, as their primary aim is to sell their products. We will discuss the role of the different stakeholders, their conflicting interests and the role of science further in the General Discussion of this thesis.
Currently, the FOP studies published use different methodologies and different FOP labels for comparison (56). Therefore, we cannot draw any conclusions yet as to whether and how these labels influence public health. Do FOP labels actually help consumers to make healthier choices and do they stimulate product development? This thesis focused on answering these questions by evaluating the effectiveness of the directive FOP label "Choices" in the Netherlands.

Figure 2.
The directive FOP label 'Ik Kies Bewust'.

Choices Netherlands

The FOP label "Choices" (in Dutch *'Ik Kies Bewust logo'*; Figure 2) was developed by large food companies in the Netherlands. At the request of the Dutch Minister of Health, the Choices Foundation was created, with representatives from food industry, the Netherlands Nutrition Center, retail and catering organizations. The logo has appeared on a variety of products in the Netherlands since 2006 which are available in many supermarket chains and food service locations including railway stations and worksite cafeterias. The program aims to help consumers to make a favorable choice within each product category and should stimulate product innovation towards healthier products.

The initial product criteria of the Choices logo were based on the Nutrition Enhancement Program of Unilever, and on criteria of the Netherlands Nutrition Center (57). Subsequently, an independent committee of Dutch scientists has developed a new set of product criteria. This scientific committee periodically adjusts the criteria in order to continue encouraging food manufacturers to improve their products. The logo is assigned to products that contain lower levels of sodium, added sugar, SAFA, TFA and caloric content and increased levels of dietary fiber compared with similar products within the same product category. Basic product categories have been de-

fined which provide the essential and beneficial nutrients, and which are based on food-based dietary guidelines: vegetables and fruits, sources of carbohydrates, sources of proteins (meat, fish, eggs and meat substitutes), dairy products, oils and fats, and ready meals. Additionally, categories were identified which provide fewer essential nutrients but are consumed regularly and are consequently of interest for product innovation: soups, sauces, snacks and beverages.

Food companies pay a fee to join the Choices Foundation. These fees are used to cover the costs of communication regarding the logo, especially mass media communications to introduce and explain the meaning of the logo to consumers. Although any food manufacturer can join the Choices Foundation and opt to carry the logo on products that comply with the criteria, not all producers have joined. This means that not all products on the market complying with the Choices criteria carry the logo. In March 2011, 106 participants, including food manufacturers, retailers and caterers, joined the Foundation in the Netherlands, and the logo was assigned to approximately 5100 packaged products and 1500 fresh fruits and vegetables (58).

A year before the launch of the Choices logo, in 2005, another health logo was launched in the Netherlands. This logo was developed by the largest retailer in the country, was present on the retailer's own brands and was called *'Gezonde Keuze Klavertje'*. Its criteria were comparable with the Choices criteria. It was, however, confusing to have two health logos in one country. As a result, the government strongly advised that the two health logos should be combined (59). After two years of negotiations, the stakeholders agreed on a single national health logo in the Netherlands, and this was presented to the Minister of Health on the 1st of March 2011. The politics around this process and around FOP labeling in general are discussed further in the General Discussion of this thesis.

Choices International

Since 2008, the Choices International Foundation has secured the endorsement of local authorities, scientists, non-governmental organizations, and the food industry for the international roll-out of the Choices logo: the logo was launched in several countries in Europe (2008-2011) and in Israel (2011). Since 2010, the International Foundation has been exploring how to create local foundations in South America and Asia. The international Choices criteria are based on the Dutch criteria. However, the international roll-out has necessitated a complete re-evaluation of the criteria for further international applicability. Therefore, an independent scientific committee of experts in nutrition, food science, and consumer behavior from Europe, the United States and South Africa was established (60). They developed international nutrient criteria by redefining product groups as well as the full set of criteria. The final set of criteria is to be re-evaluated every three years in order to continue stimulating product innovations and to achieve population dietary intake aims.

Aim of this thesis

At the start of this thesis in September 2007, the Choices logo has been on the Dutch market for more than a year. Scientists, industry groups, the Dutch government and the Dutch Choices Foundation expressed a need to evaluate the logo's

effectiveness. Therefore, the aim of this thesis was to evaluate the effectiveness of the Choices logo on consumer behavior, product development, and public health in the Netherlands. This thesis describes five effectiveness studies, as illustrated by the scheme in Figure 3. “Effectiveness” was defined as effects of FOP labels on *consumer behavior, reformulation and health outcomes.* Consumer behavior was subdivided in effects on consumers’ *self reported understanding and use of FOP labels,* effects on consumers’ *observational use* and effects on *sales*. This subdivision was based on the designs and main outcomes of current FOP labeling studies. In addition to these five effectiveness studies, this thesis describes two more studies: an implementation evaluation and a review of methodologies used in earlier FOP label evaluation studies.

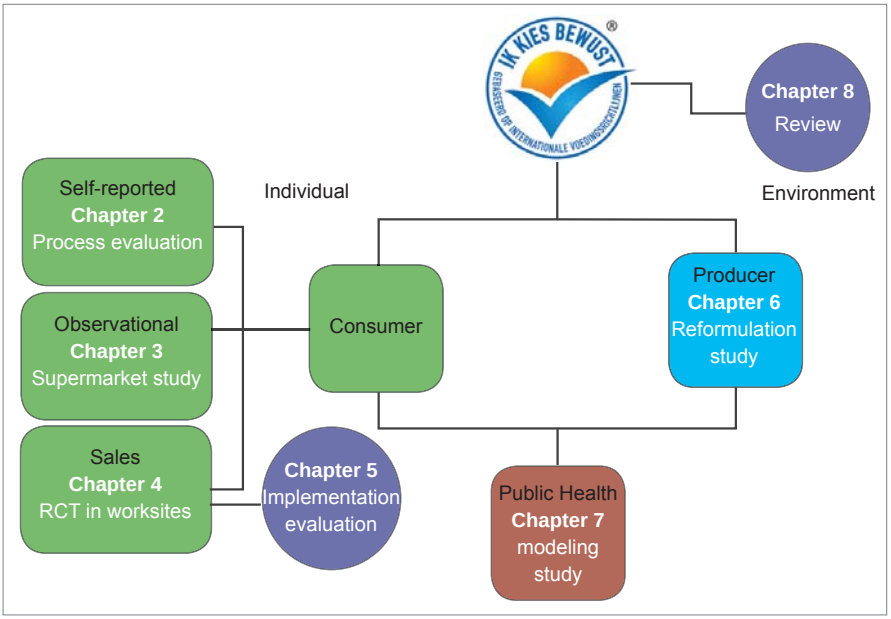
Research settings and methodologies

In the studies described in this thesis, we have used different methodologies and different research settings to evaluate the logo’s effectiveness. To evaluate its effectiveness on consumer behavior, we collected self-reported questionnaire data, conducted in-store observations, and collected observational sales data. Further, these consumer studies took place in different point-of-purchase settings where the logo is available, such as in supermarkets and worksite cafeterias. To evaluate the logo’s effectiveness on reformulation, we collected nutrient composition data provided by food manufacturers. Finally, to evaluate the effectiveness of the logo on public health, we performed a modeling study in which we used existing national food consumption (61) and food composition databases (62).

Outline of this thesis

Regarding the effectiveness of the Choices logo on consumer behavior, we conducted three studies. This thesis starts in **chapter 2** with a self-reported consumer study. We collected quantitative data from large consumer panels (n=2159) in combination with qualitative focus group interviews with 41 consumers a year after the introduction of the logo. The aim of this study was to evaluate the self-reported use and understanding of the logo. **Chapter 3** describes an observational consumer study (n=404), in which we used a combination of questionnaires and in-store product observations in nine supermarkets. Consumer characteristics were linked to reported use and actual use of the logo to gain insight in what types of consumers purchase logo products. **Chapter 4** describes our third consumer study, in which we measured sales data in 25 worksite cafeterias by conducting a randomized controlled trial. We investigated the effect of labeling vs. no labeling on employee’s food choices during lunch. **Chapter 5** does not describe a real effectiveness study, but an implementation evaluation study. A good implementation of an intervention is essential before being able to evaluate its effectiveness. Therefore, the implementation of Choices in worksite cafeterias was evaluated by collecting questionnaire data from 316 catering managers who had implemented the Choices logo in his or her cafeteria. **Chapter 6** describes an effectiveness study again, in which the effects of the Choices logo on reformulation and healthier product development were evaluated. We collected the nutrient composition data of 821 products; these data were provided by 47 food manufacturers who joined the Choices Foundation. The final effectiveness study, a modeling study, is described in **chapter 7**. The potential effect

Figure 3. The studies described in this thesis: five studies exploring the effects of front-of-pack (FOP) labeling (chapters 2, 3, 4, 6 and 7), an implementation evaluation (chapter 5) and a review of methodological aspects of FOP labeling research (chapter 8).



of consuming a diet complying with the Choices criteria on the cholesterol levels of the Dutch population was investigated. For the data analyses, we combined Dutch food consumption data with Dutch food composition data to calculate shifts in fatty acids intake. Afterwards, we used quotations from meta-analyses to calculate how blood lipids change when the composition of the diet changes. **Chapter 8** provides an overview of the methodological quality of current FOP labeling research. We describe the strengths and limitations of current labeling studies, and propose future research challenges. This thesis ends in **chapter 9** with a General Discussion, which discusses the studies' main findings, the studies' methodological strengths and limitations, and proposes recommendations for further research and practice. Finally, we relate the findings of this thesis research to the current international debate about front-of-pack labeling.

In conclusion, by using different outcome measures, different settings, different methods of data collection, and different research designs we aimed to gain insight into the effectiveness of the Choices logo on consumer behavior, product development, and on public health. I hope this thesis will contribute to the interesting research area and to the international debate about front-of-pack nutrition labeling.

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A front-of-pack nutrition logo: A quantitative and qualitative process evaluation in the Netherlands

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Abstract

Introduction: This study aimed to perform a quantitative and qualitative process evaluation of the introduction of the Choices logo, a front-of-pack nutrition logo on products with a favorable product composition, adopted by many food producers, retail and food service organizations, conditionally endorsed by the Dutch government, validated by scientists, and in the process of international dissemination.

Methods: An online questionnaire was sent to adult consumers four months after the introduction of the logo (n=1032) and one year later (n=1127). Additionally, seven consumer focus groups (n=41) were conducted to provide more insight into the questionnaire responses.

Results: Quantitative analyses showed that exposure to the logo had significantly increased. Elderly and obese reported to be more in need of a logo than younger and normal-weight respondents. Women perceived the logo more attractive and credible than men did. Further qualitative analyses indicated that the logo's credibility would improve if it became known that governmental and scientific authorities support it. Elderly indicated to need a logo due to health concerns. Consumers interested in health reported that they used the logo.

Conclusions: Further research focusing on specific target groups, forming healthful diets and health outcomes is needed to investigate the effectiveness of the Choices logo.

Introduction

The prevalence of chronic diseases related to diet, such as cardiovascular disease, cancer, obesity and diabetes, is increasing (1). In order to diminish this prevalence, the World Health Organization has recommended that consumers reduce their intake of sodium, sugar, saturated fatty acids and trans fatty acids (2). A front-of-pack nutrition logo on products that contain lower levels of these nutrients as compared to similar products within the same product category could help consumers to make healthy choices, thereby possibly reducing the intake of these nutrients. In addition, such a logo might stimulate food manufactures to improve their product composition (3-6).

The traditional Nutrient Facts Panel on the back of packaged food products provides extensive information about product composition, expressed in relative and absolute quantification of nutrients. However, many studies show that consumers have difficulties interpreting these food labels, especially older consumers and consumers with lower levels of education and income (7-9). Therefore, a simple front-of-pack nutrition logo that provides an overall representation of the key nutrient composition of a product could help consumers to choose products with a more favorable product composition (3, 10). Interpreting such a logo does not require detailed nutritional knowledge and thus could be useful for all consumer groups.

In order to help consumers to interpret the traditional nutrient fact box, many countries have developed their own front-of-pack nutrition labels. These labels differ in design and complexity. Complex labels can be found in the United Kingdom, such as the Guideline Daily Amount (GDA) and the Multiple Traffic Light system (11, 12). Both labels provide extensive information per nutrient relatively to the average recommended daily intake, and do not provide an integrative assessment of a combination of nutrients. Additionally, simpler logos exist, that serve as a “health quality mark” and are only present on products with a relatively favorable nutrient composition. The European Heart Network has published an overview of current “health quality marks” that are available globally (5). It shows that the product criteria and the authorities responsible for the introduction of different nutrition logos differ per country and even within an individual country, which may be confusing for consumers. In Sweden, the Swedish National Food Administration introduced the Green Keyhole in 1989, a nutrition logo on low-fat and high-fiber products. Research showed that the majority of the respondents understood its message. However, certain sub-groups had difficulties linking the meaning of the symbol to a healthy diet (13). In Finland, the Finnish Heart Foundation developed the Heart Symbol, a nutrition logo for products with low levels of fat and salt (14). Five years after its introduction, 82% of the adult population recognized the logo, and 42% of the adult population indicated that the logo had influenced their purchases (5). In Denmark, a logo on low fat products has been introduced. They intend to extend this logo with other nutrient criteria. In Canada, the Heart and Stroke Foundation developed the Health Check Symbol, based on their national nutrient criteria. In Australia and New Zealand, the respective Heart Foundations created the Pick the Tick logo, based on national criteria for fat, salt, energy, fiber and added sugar. Research showed that the Pick the Tick logo seemed to act both as a “nutrient signpost” for consumers, and to significantly influence product formulation (5, 6, 15). In the United States, a group of the largest food companies recently introduced the Smart Choices logo. The cri-

teria are derived from the national dietary guidelines. In the Netherlands, there are currently two of such nutrient sign post logos in use. One logo, the Healthy Choice Clover, is the initiative of the largest national supermarket chain and can only be found on the own brands in that chain's stores. The other logo is the Choices logo ("Ik Kies Bewust" logo, see Figure 1), introduced by a collaboration of different stakeholders, which can be found on a variety of brands in many supermarket chains and in many food service locations. The criteria of the Choices logo are based on international recommendations by the World Health Organization regarding saturated fatty acids, trans fatty acids, sodium and added sugar (16). The Choices nutrition logo has distinguished itself from other nutrition logos. One reason for this is that the logo is not supported by a single authority, but by a foundation of food manufacturers, retail and food service organizations, the Netherlands Nutrition Center, nutrition scientists, and conditionally endorsed by the Dutch Government. The other reason is that it is the only nutrition logo for which criteria were developed and are continuously monitored by an independent scientific committee of nutrition and food scientists. The logo is assigned to products that have a more favorable nutrient composition than alternatives within the same product category. Thereby the logo should stimulate consumers to make well considered food choices. However, no evaluation research among consumers has been published since the introduction of the Choices logo in the Netherlands. Therefore, the aim of this study was to perform a quantitative and qualitative process evaluation of the introduction of the Choices logo in the Netherlands.

Figure 1.
The 'Ik Kies Bewust' nutrition logo.

Methods

Design

Primarily, a quantitative process evaluation was performed via an online questionnaire that was completed four months after the introduction of the Choices logo, just before the first public advertisement campaign, and again one year later. To provide more in-depth insight into the perception of the Choices logo among consumers, an additional qualitative study was performed by means of seven focus group interviews after the second online questionnaire using different participants.

The Choices logo

The Choices logo is assigned to products with relatively low levels of saturated fatty acids, trans fatty acids, sodium and added sugar within their product category. Additionally, fibers and calories are taken into consideration. The Choices logo should facilitate consumers to make a favorable choice within each product category and should stimulate product innovation towards healthier products. Six main product categories have been defined that substantially contribute to the daily intake of es-

sential nutrients: vegetables and fruits, sources of carbohydrates, sources of proteins (meat, fish, eggs and meat substitutes), dairy products, oils and fats, and ready-to-eat dishes. Additionally, four categories were identified which provide fewer essential nutrients but are consumed regularly and are consequently of interest for product innovation: soups, sauces, snacks and beverages. Although the logo is open for all food manufacturers, not all producers have joined the foundation. In June 2008, over 100 food manufacturers have joined the foundation, and the logo has been assigned to around 2100 packaged products and 600 fresh fruits and vegetables. Mass media was developed to communicate the meaning of the Choices logo to consumers. Currently, the Choices International Foundation has secured the endorsement of local authorities, scientists, non-governmental organizations and industry to support the logo in 9 countries.

Participants

Participants were recruited via existing adult consumer panels, from a pool of 20.000 Dutch consumers willing to participate in market research. An online questionnaire was sent to a random sample of around 1400 consumers at two periods of time: four months after the introduction of the Choices logo (T0) and again one year later (T1). For T1, another sample of participants was recruited than for T0. At both times, participants consisted of representative samples of Dutch shoppers by age, region, size of household and size of residence. Inclusion criteria were age (>18 years old) and buying products in a supermarket at least once a week. Within a household, the person visiting a supermarket most often per week was asked to fill in the questionnaire. A total of 1032 respondents completed the questionnaire at T0 (response rate 61%) and 1127 respondents completed it at T1 (response rate 78%). Participants received some credits which could be exchanged for a gift coupon.

Additionally, seven focus group interviews (n=41) were conducted at T1. Participants were recruited through community centers, cultural centers, sports clubs, and supermarkets. Inclusion criteria were age (>18 years old) and buying products in a supermarket at least once a week. All focus groups included both men and women.

Conceptual framework

The Choices nutrition logo aims to help consumers to make healthy choices and change their food selection behavior. McGuire's Communication Persuasion Model is frequently used to describe behavioral change (17). This model describes successive steps that have to be followed before successful communication and the consequent behavioral change can occur: exposure, attention, liking, comprehension, cognitive elaboration, skill, acquisition, agreement, memory storage, retrieval, decision making, acting on a decision, cognitive consolidation and proselytizing. In the current process evaluation, the first steps of successful communication were included: *exposure, attention,* liking and *comprehension*. Additionally, other relevant concepts were examined, in agreement with other process evaluation studies (18-21). Concepts included were whether consumers felt they *needed* a logo, the *credibility* of the logo, and self-reported effects on *purchasing behavior*.

Questionnaire / Focus groups

All respondents provided information about background variables, such as age, gen-

der, body weight, height and level of education. Further, *exposure* to the Choices logo was measured by asking whether respondents were familiar with the logo or not (response categories 0= "no" or 1= "yes") and the perceived *need* for a logo (response categories ranging from 1= "totally not needed" to 5= "strongly needed") was measured both at T0 and T1. On basis of reported body weight and height data, the Body Mass Index (BMI) was calculated (kg/m^2). Educational level was divided into three categories: a low educational level (primary school or basic vocational education), a medium level (secondary vocational education or high-school degree) or a high educational level (higher vocational education or university degree). Only at T1, further questions about the logo were asked to respondents who indicated being exposed to the logo at that time (n=996), all measured with a five-point Likert scale. *Attention and purchasing behavior* were measured by asking how often respondents

Table 1. Main interview topics discussed during focus group discussions.

Interview topic	Main aspects to discuss
Exposure	Familiarity with the Choices logo Places where the logo has been seen
Need	Feeling a need for a nutrition logo
Attention	Attention to nutrition logos in the supermarket Attention to the Choices logo in the supermarket
Liking	Attractiveness of the Choices logo Design of the Choices logo: colors, size, and format Eye-catchingness of the Choices logo
Comprehension	Meaning of the Choices logo Criteria of the Choices logo
Credibility	Credibility of the Choices logo Supporting authority for the Choices logo Importance of support by an independent authority
Purchasing behavior	Buying products with the Choices logo due to the logo Intention to buy (more) products with the Choices logo

paid attention to or bought products with the logo (response categories ranging from 1= "never" to 5= "always"). Further, respondents were asked to what extent they agreed that the logo is attractive, eye-catching and useful *(liking),* and credible *(credibility)* (response categories ranging from 1= "totally disagree" to 5= "totally agree"). For the analyses at T1, BMI was divided into three categories: BMI<25 (healthy body weight), BMI 25-30 (overweight) and BMI>30 (obese). Age was divided into two categories: <50 years old and >50 years old.

Table 1 shows the main interview topics discussed in the focus groups. The same concepts that were measured in the quantitative study were discussed, with the addition of *comprehension*, because qualitative research was supposed to provide the most accurate insight into how the logo was understood. The seven focus groups were conducted by a three-member project team (EV, SM, ZM). The moderators (EV, SM) used moderation techniques developed by Morgan and Krueger (22). One

moderator per focus group guided the interview, and two independent observers asked participants to explain any unclear statements, in order to acquire more complete data. Participants completed a brief demographic questionnaire at the beginning of the interview. At first, participants were asked to briefly discuss their opinions about nutrition information in the supermarket in general. Next, the Choices nutrition logo was introduced and the concepts mentioned before were discussed. Products from different product categories with the nutrition logo were used to illustrate the discussion topics. After the interview, participants received a small gift for participation.

Analyses

Descriptive analyses were used to report the demographic variables of the participants. The χ^2 test and t test were used to test for differences in *exposure* and *need* between T0 and T1. For the next analyses at T1, associations between demographic variables (gender, educational level, BMI and age) and *exposure* to the logo were analyzed using multiple logistic regression analyses (exposure to the logo dichotomous). The results are presented as odds ratios (OR) with 95% confidence intervals (CI). Univariate analysis tests (t tests, ANOVA) were used to examine significant differences in *need, attention, liking, credibility* and *reported purchasing behavior* between subgroups, based on gender, educational level, BMI and age. Bonferroni adjustment for multiple comparisons was applied. Statistical analyses were performed by the SPSS 15.0 statistical package (SPSS, 2006), using a significance level of 0.05.

Responses from each focus group were recorded and transcribed verbatim. Transcripts were analyzed deductively using the "Framework approach" (23). Codes were based on the concepts mentioned before. Data analyses were conducted by the three project members. The different analyses were systematically compared, and combined into one analysis. Data were analyzed using Atlas.ti 5.2.

Results

The quantitative research population consisted of 1032 participants at T0 and 1127 at T1, the majority of whom were women (80.8 % and 86.5 %, respectively). At T0, mean age (±SD) was 46.4 (±13.2) years old and mean BMI (± SD) was 25.6 (± 5.1) kg/m2. At T1, mean age (±SD) was 49.1 (±15.0) years old and mean BMI (± SD) was 25.4 (± 4.5) kg/m2. At both T0 en T1, men were significantly higher educated than women ($P < 0.01$). Also, men were significantly higher educated at T1 than at T0 ($P < 0.01$). Further, no significant differences were detected.

A total of 41 consumers (16 men, 25 women) participated in the focus group interviews. The mean age was 46 years old (range 20-83). The mean BMI was 23.0 kg/m² (range 17.7-27.7). Participants reported that they visit a supermarket three times a week on average. Seven participants had a low educational level, 12 participants had a medium educational level and 22 participants had a high educational level.

The *exposure* to the logo had significantly increased in one year: at T0, 33.4% of the population was familiar with the logo, compared to 88.4% at T1 ($P<0.01$). The mean score for *need* for a logo (±SD) was 3.67 (± 3.94) at T0 and 3.44 (± 0.90) at T1, a significant decrease (diff. = 0.23, 95% CI: 0.15; 0.30, $P<0.01$). Table 2 shows the associations between demographic variables and exposure for all respondents at T1 (n=1127). Men were less exposed than women, both before and after adjustment for

educational level, BMI and age (P<0.01). Further, logistic regression analyses showed that respondents more than 50 years old were less exposed to the logo than younger respondents, both before and after adjustment for gender, educational level and BMI (P<0.01). In general, participants of the focus groups stated to be familiar with the Choices logo at T1. The logo had been noticed on food products in supermarkets and in a television commercial. Other communication promoting the Choices logo, such as posters or flyers, seemed to be unknown among the participants. Older participants, especially men, indicated that they were not familiar with the logo. The reasons they mentioned for this were that they were not interested in on-package nutrition information, or that the logo had not yet attracted their attention.

The older age group was the group that reported to be in greater *need* of a logo than respondents less than 50 years old in the quantitative study at T1 (diff. = 0.20, 95% CI: 0.09; 0.30, P<0.01). Obese respondents reported to be in greater need of a logo than those with a healthy body weight (diff. = 0.23; 95% CI: 0.03; 0.44; P<0.05) at T1. The reason why some participants of the focus groups mentioned to feel a need for a nutrition logo was because of diet-related health problems, such as diabetes or cardiovascular disease. Older participants especially indicated that they were suffering from these types of diseases. A comprehensible nutrition logo could help them to make the right food choices regarding their health:

> *A good, visible nutrition logo makes it easy to make the right food choice for my heart.*

The explanation given why participants felt they did not need a nutrition logo was that they did not understand the advantages of a new logo in addition to the overwhelming number of quality logo's currently in use, such as health, safety, organic and ecological logos.

Respondents of the focus groups came up with

Table 2. Associations between demographic variables and exposure to the logo after adjustment for gender, educational level, BMI and age (odds ratios (OR) with 95% confidence intervals (CI)) at T1.

	Total (n=1127)	Men (n=152)	Women (n=975)	BMI<25 (n=628)	BMI 25-30 (n=359)	BMI>30 (n=140)	Education Low (n=362)	Education Medium (n=444)	Education High (n=321)	Age<50 (n=612)	Age>50 (n=515)
Exposure (%)	88.4	81.6	89.4	87.3	89.7	90.0	86.2	91.7	86.3	94.3	81.4
OR	-	0.52**	1.0 (ref)	1.0 (ref)	1.34	1.31	1.0 (ref)	1.41	0.80	1.0 (ref)	0.26**
95% CI	-	0.32-0.84	-	-	0.87-2,05	0.70-2.43	-	0.88-2.25	0.50-1.28	-	0.17-0.39

**P < 0.05 **P < 0.01 (ref): reference category*

many different explanations for the meaning of the Choices logo. The explanations frequently mentioned could be related to product quality, such as: healthy product, safe product, natural product or organic product. More detailed explanations mentioned could be linked to a healthy product composition: less fat, less sugar, good mix of ingredients or fewer calories. However, not all respondents were able to explain the meaning of the logo completely. The diversity of product categories carrying the logo appeared to be somewhat confusing: fresh vegetables, snacks, dressings, soups, dairy products:

Why do they put the same logo on fresh vegetables and snacks?

Table 3 shows mean scores (±SD) for respondents of the quantitative study who

Table 3. Mean scores (± SD) (range 1-5) of subgroups exposed to the logo at T1. Only significant differences are listed.
Note: BMI not significant, thus not shown.

	Total	Men	Women	Education			Age<50	Age>50
	(n=996)	(n= 124)	(n=872)	Low (n=312)	Medium (n=407)	High (n=277)	(n=577)	(n=419)
Attention (1-5)	2.60 (±1.02)			2.71 (±1.00)		2.45 $^{L>H**}$ (±1.06)	2.53 (±1.03)	2.71** (±1.01)
Attractiveness (1-5)	3.80 (±0.99)	3.60 (±1.01)	3.83** (±0.88)	3.66 (±1.10)	3.88 $^{M>L**}$ (±0.85)	3.84 $^{H>L*}$ (± 0.85)		
Eye-catchingness (1-5)	3.72 (±0.96)	3.54 (±0.95)	3.74* (±0.96)		3.81 (±0.92)	3.62 $^{H<M*}$ (±0.95)		
Usefulness (1-5)	3.42 (±1.06)							
Credibility (1-5)	3.75 (±0.99)	3.49 (±1.06)	3.79** (±0.97)					
Reported purchasing behavior (1-5)	2.75 (±0.98)	2.53 (±0.98)	2.79** (±0.97)					

**P < 0.05   **P < 0.01*

were exposed to the logo at T1 (n=996). The table lists significant relationships only. The mean score for *attention* was 2.60 (±1.02), with respondents with a low educational level paying more attention to the logo than respondents with a high educational level (diff. = 0.25, 95% CI: 0.05; 0.45, P<0.01). Also, respondents who were more than 50 years old reported that they paid more attention to the logo than younger respondents (diff. = 0.18, 95% CI: 0.06; 0.31, P<0.01). In the qualitative study, it appeared that especially female participants who were interested in health paid attention to the Choices logo. They indicated that they compared the composition of the products with and without a logo in order to make a healthy choice. Possible explanations for not paying attention to the logo were unfamiliarity, habitual behavior or lack of time:

I run through the supermarket like a race car and buy what I see at first sight.

The quantitative analyses showed that women *liked* the logo more than men: they perceived the logo as being more attractive (diff. = 0.23, 95% CI: 0.06; 0.40, P<0.01) and eye-catching (diff. = 0.20, 95% CI: 0.02; 0.38, P<0.05) than men did. Respondents with a medium and high educational level perceived the logo as being more attractive than respondents with a low educational level (diff. = 0.23, 95% CI: 0.07; 0.39, P<0.01 and diff. = 0.18, 95% CI: 0.01; 0.36, P<0.05, respectively). Further, respondents with a medium educational level perceived the logo to be more eye-catching than highly educated respondents (diff. = 0.18, 95% CI: 0.00; 0.36, P<0.05). Female respondents of the focus groups especially indicated to like the logo:

It is fresh and sparkling, and because of the orange, it looks fruity.

Men appeared to be somewhat indifferent to it. The criticisms mentioned were related to the design of the logo: its colors, size and location differ among products, and some respondents considered the logo to be far too small, and dominated by the other colors on the package.

The mean score for *credibility* was 3.75 (±0.99), with women perceiving the logo as being more credible than men (diff. = 0.30, 95% CI: 0.11; 0.48, P<0.01). Factors that may contribute to the logo's credibility, according to the focus groups, were that the logo is perceived to be supported by independent authorities, such as the Netherlands Nutrition Center, the Dutch government, the Food and Consumer Product Safety Authority, or the European Union. Factors that might negatively influence the logo's credibility were that participants had the impression that the logo is only present on high-quality brands of processed foods and the perception that the food industry had developed the logo only for its own benefit:

It seems to be one of those marketing stunts!

In the quantitative study, women reported that they buy more products with the logo than men reported (diff. = 0.25, 95% CI: 0.07; 0.44, P<0.01). Participants of the focus groups with an interest in health especially reported that they used the logo for making a choice between products within a product category. Other respondents indi-

cated that they do not intentionally buy products with a logo, because their purchasing decisions appeared to be generally guided by a familiar brand or a low price.

Discussion

This study aimed to perform a quantitative and qualitative process evaluation of the introduction of the Choices logo, a front-of-pack nutrition logo on products with a favorable product composition. The exposure to the Choices logo had increased significantly after one year. This could partly be explained by communication campaigns which started during the year and by the increased visibility of the logo in supermarkets and in other public places, due to an increasing number of participating organizations. However, the qualitative study indicated that the logo's meaning appeared to be not totally clear to some consumers. These findings are in agreement with a review of the Pick the Tick logo used in Australia and New Zealand (15), that shows that it takes some years of communication before a real understanding of the meaning of a nutrition logo can be created. Nevertheless, the finding that the majority of consumers was familiar with the Choices logo only 1,5 year after its introduction can be considered as a major achievement for the introduction of a new brand.

We found several significant differences in need, attention, liking, credibility and reported purchasing behavior between subgroups. Although these were rather minor differences, they indicate interesting trends which require further investigation.

We found that especially elderly and obese people expressed the need for a logo. The older adults generally have a higher chance of suffering from diet-related health problems, such as diabetes or cardiovascular disease, and therefore demonstrate a higher need for a health related logo (4, 11, 24), which has been supported by our findings as well. The older age group was also the same group that appeared to be less familiar with the Choices nutrition logo than younger respondents, although a large majority of the elderly still appeared to be familiar with the logo. Nevertheless, on-package nutrition information, such as a nutrition logo, might be too small to be noticed by the elderly (25). This factor stresses the importance of a good, visible design, a logo that is uniform in terms of size, location and colors, as previously recommended in the literature (3, 9, 25, 26). Further, obese people might be particularly sensitive to nutrition information that could help them to lose body weight (13), explaining their increased need and substantial familiarity with the Choices logo. To our knowledge, there are hardly studies that focus on the perception of nutrition logos by specific target groups, such as the elderly or obese people, thus forming a challenge for further research and communication campaigns.

Respondents with a low educational level reported paying more *attention* to the logo than more highly educated respondents. As many studies have indicated the difficulty of communicating nutrition education to people with lower levels of education (27, 28), this finding could be valuable and should be investigated in further research. The qualitative findings that habitual purchasing behavior and time pressure play a role in whether or not consumers are paying attention to the logo are in agreement with other studies (4, 24, 26, 29) and could also be of interest for further research regarding the Choices logo .

The mean score for the *credibility* of the logo was rather high. Nevertheless, our qualitative study indicated that the authority supporting the logo was not totally clear

to consumers, resulting in mixed feelings regarding the logo's trustworthiness. The literature shows that consumers' trust in nutrition information on food labels would increase if there is " a clear trustworthy sender" (4, 9, 26, 30). Health professionals, scientists and independent (consumer) organizations are the most trusted information sources for nutrition information, whereas industry is usually perceived as less trustworthy (21, 31). This emphasizes the importance of correcting the potential misconception that the Choices nutrition logo is supported only by industry.

Women *liked* the logo more than men, and women also *reported to buy more products with the Choices logo* than men. These findings are not surprising: women are generally more interested in health, food and nutrition information than men (4, 8, 11, 24, 30). Currently, the Choices logo seems to mainly play a role in the reported purchasing behavior among people who are interested in health. It is important to realize this, as the Choices logo aims to stimulate a favorable eating pattern among all consumers. However, one should realize that behavior change is a complex process, and a nutrition logo could be one of the factors that might influence behavior change. Further, one could question whether reported purchasing behavior correctly reflects actual label use, as discussed in earlier research (32). Yet there is a lack of studies investigating the role of nutrition logos in guiding buying decisions in real-life settings, such as supermarkets or other places outside the home (4, 9, 15, 29, 33), offering challenges for further research on the actual label use of the Choices logo. Additionally, the possible stimulating effect of the logo on product development towards healthier products could be interesting to investigate. The increased availability of healthy products could be favorable for the dietary pattern of all consumers, including those consumers not interested in health.

A limitation of this study could be the possibility that people who are interested in nutrition research were more willing to participate in both the quantitative and the qualitative study. Also, one could question whether participants were inclined to give socially desirable answers (34). Therefore, one should be careful when extrapolating the results to the general population. Nevertheless, this unique combination of quantitative and qualitative analyses provides initial insights into the perception of the Choices nutrition logo among consumers, which are used to formulate useful recommendations for further research and communication regarding the logo.

Conclusions

Consumers' exposure to the Choices logo has increased significantly in one year. To further increase consumer's comprehension and use of the logo, product criteria and the support provided by independent authorities should be clarified more extensively. Further research focusing on specific target groups, on actual food choice and on health outcomes of consumption of Choices products is needed to investigate the effectiveness of the Choices logo in real-life settings.

Conflicts of interest and authors' affiliations

Gerda Feunekes works at the Unilever Food and Health Research Institute, one of the participating food companies in the Choices programme. Léon Jansen is secretary of the International Scientific Committee of the Choices International Foundation and works at Schuttelaar & Partners, a consultancy firm that operates as the Foundation's Secretariat.

Hans Verhagen works at the RIVM and was requested by the Dutch Ministry of Health, Welfare and Sports (MinVWS) to actively participate in the project group in order to assure agreement on the quality, however leaving the responsibility for the project with the Choices Foundation; the RIVM is an agency of the MinVWS. The other authors have no conflicts of interest. Marcel Temminghoff is employed by GfK Panel Services Benelux B.V., the Netherlands. Johannes Brug is employed by the Department of Epidemiology and Biostatistics, EMGO Institute for Health and Care Research, VU University Medical Center, Amsterdam, the Netherlands. The other authors are employed by the Department of Health Sciences and the EMGO Institute for Health and Care Research, VU University Amsterdam, the Netherlands.

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3

Actual use of a front-of-pack nutrition logo in the supermarket: Consumers' motives in food choice

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Abstract

Introduction: A front-of-pack nutrition logo on products with relatively favorable product compositions might help consumers to make more healthful choices. Studies investigating actual nutrition label use in point-of-purchase settings are scarce.

Methods: This study investigates the use of the “Choices” nutrition logo in nine Dutch supermarkets. Adults (n=404) completed a validated questionnaire about motivation for food choice and their purchased products were scored for the Choices logo after they had done their shopping.

Results: Of the respondents, 62% reported familiarity with the logo. The motivations for food choice that were positively associated with actually purchasing products with the logo were attention to “weight control” and “product information”. The food choice motive “hedonism” was negatively associated with purchasing products with the logo.

Conclusions: This is the first study to investigate actual use of the Choices logo. In order to stimulate consumers to purchase more products with a favorable product composition, extra attention should be paid to hedonistic aspects such as the tastefulness and the image of healthy products.

Introduction

The high levels of trans fatty acids, saturated fatty acids, salt and sugars in the European diet are associated with a higher risk of diet-related chronic diseases (1). In order to encourage consumers to adopt more healthful eating habits insight into which motives influence consumer food choices is necessary (2). Different motives have been identified such as taste, mood, convenience, price, weight control, habitual behavior and pleasure (2-5). Health motives may also influence food choices (6, 7).

However, interpreting the overload of nutritional information currently available appears to be a difficulty for consumers trying to make healthy food choices (8, 9). A front-of-pack nutrition logo on products with a favorable product composition as compared to similar products within the same product category could help consumers to make healthy choices, thereby possibly reducing the prevalence of diet-related chronic disease (9-12).

Many countries have developed their own front-of-pack nutrition logos, which vary in design and complexity. One of the front-of-pack nutrition logos currently available in the Netherlands is the Choices logo (*'Ik Kies Bewust'* logo, see Figure 1). This logo has been introduced by a collaboration of various partners, and can be found on a variety of brands in many supermarket chains, worksite cafeterias and other food service locations across the Netherlands. The logo is assigned to products that contain lower levels of sodium, added sugar, saturated fatty acids and trans fatty acids and energy and increased levels of fiber as compared to similar products within the same product category.

Table 1 shows the number of available products carrying the Choices logo per product category. The items are mutually exclusive. The logo is supported by a foundation of food manufacturers, retail and food service organizations, nutrition scientists, and is conditionally endorsed by the Dutch Government. The criteria of the Choices logo have been developed by an independent scientific committee of nutrition and food scientists. A detailed background to the Choices logo has been described elsewhere (13, 14). Earlier research showed that consumers were largely familiar with the Choices logo one year after its introduction. Women perceived the logo to be more credible and attractive than did men. Furthermore, consumers more interested in health were more likely to report that they used the logo when shopping for food (13).

However, until now, the actual use of the Choices logo has not been investigated in real life settings such as supermarkets. Only a few studies have

Product category	Number of available logo products
Fruits and vegetables	703
Sources of carbohydrates	183
Sources of proteins	277
Dairy products	285
Oils and fats	202
Ready-to-eat dishes	65
Soups	355
Sauces	199
Snacks	195
Beverages	333
Remaining products	102

Table 1. Number of available products carrying the Choices logo per product category.

Figure 1.
The 'Ik Kies Bewust' nutrition logo.

investigated the use of a nutrition logo in the supermarket itself (15-17). In general, there is a large need for studies in which the use of nutrition labels is investigated in point-of-purchase settings (8, 9, 13, 18-20).

The aim of this study is to provide insights into the use of the Choices logo in the supermarket. Reported logo use was explored by a questionnaire and actual logo use was investigated by verifying actual product purchases after participants had done their shopping. Also, the motives for choice of food of consumers, both health and other food choice motives, were explored. It was investigated whether or not a relationship exists between:

1. Demographic variables of consumers and familiaritywith, and actual use of the Choices logo
2. Reported logo use and actual logo use
3. Motives for food choice and logo use

Methods

Design and participants

A total of 1089 consumers were asked to participate in the supermarket setting, after they had done their shopping, of which 404 participants were willing to cooperate (response rate 37%). Inclusion criteria were age ≥18 years old and having a shopping basket or cart with products after finishing shopping. The main reason for refusing to participate was lack of time. Participants were recruited in nine supermarkets of various sizes all belonging to the C1000 supermarket chain, one of the largest supermarket chains in the Netherlands. The supermarkets were located in different socio-economic areas spread over six different cities in the western part of the Netherlands. Data collection took place from Monday till Saturday including evening hours across a three week time period. While participants were completing a questionnaire, four trained research assistants counted the products the participants had just bought and whether the products were carrying the Choices logo or not. All participants gave informed consent.

Questionnaire

The questionnaire started with questions about age, gender, body weight, height, level of education and frequency of shopping in a supermarket. Next, the questionnaire included the Dutch version of the Food Choice Questionnaire (FCQ), a generally used instrument for measuring motives related to food choice, developed by Steptoe et al. (2). The FCQ has been validated and has been found to be reliable, consistent and stable over time (2, 21-23). The FCQ measures nine motivations identified as being related to food choices, namely: *health, mood, convenience, sensory appeal, natural content, price, weight control, familiarity* and *ethical concern*.

The FCQ begins with the sentence “It is important to me that the food I eat on a typical day…” and is then followed by a total of 36 statements covering the nine food choice motives measured by the FCQ, all measured using a four-point Likert scale. For example, for an item concerning the *weight control* motive: “It is important to me that the food I eat on a typical day helps me to control my weight” (response categories ranging from 1= “not at all important” to 4= “very important”). As ethical concerns related to environmental and political issues was not considered to provide useful information related to the Choices logo, this motive was omitted. Three additional motives of potential interest regarding the Choices logo were included in the questionnaire: two derived from the food-related lifestyle instrument (FRL), a questionnaire extensively tested and shown to be stable across cultures and over time (3, 5): *importance of product information* and *use of a shopping list*. Further, the food choice motive importance of pleasure (hedonism) was added (7). Each of the last three motives was measured by three statements on a seven-point Likert scale. For example, “I compare labels to select the most nutritious food” (response categories ranging from 1= “totally disagree” to 7= “totally agree”). The last part of the questionnaire included three questions about the Choices logo, concerning familiarity with the logo (“Do you know the Choices logo”; response categories “yes” or “no”) and the use of the Choices logo (“Did you buy products with the Choices logo today intentionally”; response categories “yes” or “no” and “How often do you purchase products with the Choices logo intentionally”; response categories ranging from 1= “never” to 5= “always”).

Product observations

Product selections were verified by the trained research assistants after the participants had done their shopping. All products the participants had just bought in the supermarket were scored. The products were classified into the product categories for which the Choices criteria have been defined: fruits and vegetables, sources of carbohydrates, sources of proteins (meat, fish, eggs and meat substitutes), dairy products, oils and fats, ready-to-eat dishes, soups, sauces, snacks, beverages, and remaining products. The research assistants classified each product in the right product category and noted whether it was carrying the Choices logo or not.

Calculations

From self-reported body weight and height, Body Mass Index (BMI) was calculated (kg/m^2). BMI was divided into three categories: BMI <25 (healthy body weight), BMI 25-30 (overweight) and BMI >30 (obese). Educational level was divided into three categories: a low educational level (primary school or basic vocational education), a medium educational level (secondary vocational education or high-school degree) or a high educational level (higher vocational education or university degree), corresponding to the commonly used classification in the Netherlands (24). Self-reported frequency of buying products with the Choices logo was also divided into three categories: “never or seldom”, “sometimes”, and “often or always”.

A mean score (range 1-4) was calculated for each motive included in the FCQ (2, 22), and for i*mportance of product information, shopping list* and *importance of pleasure* (range 1-7) (5). The numbers of observed products purchased with the logo were added up, both for the whole study population and per person. The variables

are expressed as absolute numbers (number of actual purchased products with logo) and as a proportion (% actual purchased products with logo of total number of purchased products). Additionally, the same variables were calculated excluding fresh fruits and vegetables, because although all fruits and vegetables comply to the criteria for having the logo, many fresh fruits and vegetables are not labeled as such.

Statistics

Demographics, familiarity and actual logo use. Descriptive analysis was used to report the demographic variables of the participants. Chi-square tests, t-tests and ANOVA (using Bonferroni adjustment for multiple comparisons) were used to test for differences in familiarity with the logo and actual logo use according to gender, BMI and educational level.

Reported logo use versus actual logo use. T-tests were used to explore differences in actual logo use between respondents who did and who did not report purchasing products with the choices logo intentionally.

Food choice motives and logo use. The reliability of the food choice motives was tested using Cronbach's alpha. ANOVA was used to examine significant differences in the food choice motives according to reported use of the Choices logo. Bonferroni adjustment for multiple comparisons was applied. A backward selection procedure was furthermore used to obtain the best linear regression model, using reported logo use and proportion of products with the logo as the dependent variables. The independent variables tested were age, gender, BMI, educational level, and the food choice motives. Store was also included as an independent variable to adjust for the possible clustering effect of store.

Statistical analyses were performed using the SPSS 15.0 statistical package (SPSS, 2006), adopting a significance level of 0.05. For the linear regression model an exclusion P-value of 0.10 was used.

We performed all analyses using both the proportion variable *including* and *excluding* fresh fruit and vegetables to be able to check for any bias. As we found no differences in all results between the two variables, we only discuss both proportion variables in the first paragraph of the results section. In the rest of this article we report the proportion variable including fresh fruit and vegetables.

Results

Demographics, familiarity and actual logo use

The research population consisted of 404 consumers; 79.2% women; mean age (± SD) 50.0 years old (± 14.2, range 18-84 y). Table 2 shows familiarity with the Choices logo and the proportion of purchased products with a logo of the total number of purchased products (both including and excluding fresh fruit and vegetables) for subgroups based on gender, BMI and educational level. Sixty-two percent of the total population reported familiarity with the logo. Women were more familiar with the logo than men ($p<0.01$). Familiarity was significantly different between the different levels of education ($p<0.01$). Furthermore, participants with a high and a low educational level purchased relatively fewer products with the logo than did participants with a medium educational level, both including and excluding fresh fruit and vegetables (all p-values <0.01). No other significant differences were found.

Table 2. Familiarity and actual purchasing behavior of the study population.

	Familiarity with logo (%)	% Actual purchased products with logo of total number of purchased products: mean (SD)	% Actual purchased products with logo of total number of purchased products: mean (SD) *without fresh fruit and vegetables*
Total (n=404)	62.0	18.0 (15.2)	16.6 (16.2)
Men (n=84)	35.4	17.4 (15.4)	16.0 (16.1)
Women (n=320)	68.9 **	18.2 (15.2)	16.8 (16.2)
BMI			
< 25 (n=201)	64.3	18.9 (14.5)	17.5 (15.8)
25 – 30 (n=135)	54.9	17.1 (15.8)	15.6 (16.5)
> 30 (n=61)	68.9	16.3 (16.4)	15.7 (16.8)
Educational level			
low (n=130)	52.0	16.0 (15.3)	14.9 (17.4)
medium (n=147)	66.0	21.5 (16.4) M>L**	20.6 (16.7) M>L**
high (n=123)	68.0 *	15.9 (12.6) H<M**	13.5 (13.0) H<M**

* $p < 0.05$ ** $p < 0.01$

Product observations

Figure 2 provides insight into the product observations made for every product category. A total of 7281 products were scored. Most products carrying the logo (expressed as a percentage of the total number of products scored within a product category) were found to be in the category of dairy products (42.2%), followed by oils & fats (41.8%), vegetables and fruits (33.4%) and soups (30.3%).

Figure 2. Total number of purchased products with and without the logo per product category.

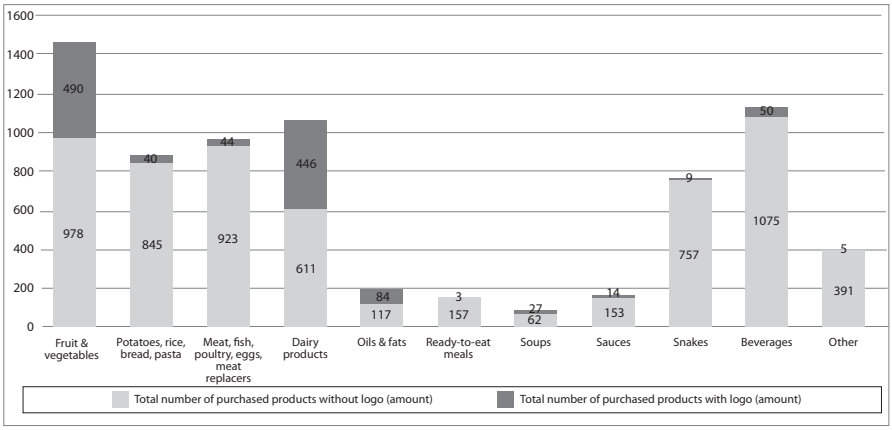

Table 3. Reported and actual logo use (mean (SD)) of all participants who are familiar with the logo.

n=246	Reported purchasing products with logo (n=72)	Reported not purchasing products with logo (n=174)
Number of actual purchased products with logo (range: 0-20)	3.96 (2.85) *	2.77 (2.53)
Actual purchased products with logo as % of total number of purchased products (range: 0-100)	23.65 (16.99) *	17.19 (13.82)

** p< 0.01*

Reported logo use versus actual logo use

Table 3 shows that participants who reported to intentionally purchase products with the logo, also actually purchased more products with the logo than participants who reported not purchasing products with the logo intentionally (both absolute and as a proportion of total products bought; p<0.01).

Food choice motives and reported logo use

Table 4 shows the mean scores (± SD) of the total population (n=404) for each of the food choice motives, and the food choice motives separately calculated for different levels of reported logo use (of those familiar with the logo, n=247). Further, the Cronbach's alphas of the food choice motives are listed. The more often participants reported purchasing products with the logo, the higher they scored on the food choice motives *product information, health*, and *weight control* (all p-values <0.01). Also, participants who reported "often or always" purchasing products with the Choices logo had a higher mean score on mood (important that food makes them feel good), *natural content and familiarity with food* than participants who reported "never or seldom" purchasing products with the logo (all p-values <0.01).

It can be concluded from the regression analyses that the food choice motives positively associated with reported logo use were *weight control* (β = 0.26, 95% CI: 0.09; 0.43, p = 0.002), *familiarity* (β = 0.25, 95% CI: 0.08; 0.42, p = 0.004) and *product information* (β = 0.31, 95% CI: 0.23; 0.38, p = 0.000). *Shopping list* was negatively associated with reported logo use (β = -0.08, 95% CI: -0.13; -0.02, p = 0.007).

Food choice motives and actual logo use

Food choice motives positively associated with actual purchasing of products with the logo were *weight control* (β = 3.05, 95% CI: 0.56; 5.54, p = 0.017) and *product information* (β = 1.80, 95% CI: 0.68; 2.92, p = 0.002). The food choice motive *hedonism* was negatively associated with purchasing products with the logo (β = -2.53, 95% CI: -4.55; -0.51, p = 0.01).

Table 4. Food choice motives of the complete study population (n=404), and food choice motives related to reported logo use of those being familiar with the logo (n=247) (mean (SD)) (significant relationships only), and Cronbach's alphas.

	Total (n=404)	Reported logo use: never, seldom (1) (n=57)	Reported logo use: some-times (2) (n=114)	Reported logo use: always (3) (n=76)	Cronbach alpha
Health (1-4)	3.13 (0.45)	2.94 (0.41)	3.14 $^{2>1*}$ (0.40)	3.33 $^{3>2,\ 3>1*}$ (0.43)	0.76
Mood (1-4)	2.52 (0.63)	2.27 (0.53)	2.50 (0.63)	2.68 $^{3>1*}$ (0.63)	0.83
Convenience (1-4)	2.86 (0.59)				0.75
Sensory appeal (1-4)	3.14 (0.50)				0.66
Natural content (1-4)	2.88 (0.64)	2.64 (0.64)	2.89 (0.57)	3.12 $^{3>1*}$ (0.64)	0.77
Price (1-4)	3.00 (0.61)				0.69
Weight control (1-4)	2.99 (0.66)	2.70 (0.56)	3.03 $^{2>1*}$ (0.61)	3.29 $^{3>1*}$ (0.64)	0.80
Familiarity with food (1-4)	2.40 (0.58)	2.13 (0.55)	2.34 (0.60)	2.56 $^{3>1*}$ (0.59)	0.57
Product information (1-7)	4.44 (1.48)	3.70 (1.45)	4.60 $^{2>1*}$ (1.17)	5.60 $^{3>2,\ 3>1*}$ (1.22)	0.83
Shopping list (1-7)	4.87 (1.83)				0.86
Hedonism (1-7)	4.90 (0.79)				0.60

**p< 0.01*

Discussion

Studies investigating the role of nutrition logos in guiding buying decisions in point-of purchase settings such as supermarkets are scarce (8, 9, 13, 16, 18-20). This is the first study to investigate in the supermarket the actual use of the Dutch Choices logo, a front-of-pack nutrition logo on products with a favorable product composition.

Familiarity and logo use

Familiarity with the Choices logo in this study was lower than reported in our earlier research, in which 88.4% of the population was familiar with the logo (13). This can be explained by the fact that, in contrast to our previous study, we did not use an image of the logo in the questionnaire. Nevertheless, 62% of the study population

reported being familiar with the logo, more so among women and more highly educated participants. This is in line with results from earlier studies investigating nutrition logos (9, 25-29).

Product observations

The product observations from this study showed that most products bearing the logo were found to be in the category of dairy products followed by oils and fats, vegetables and fruits and soups. These findings are not surprising, as large food manufactures producing products for these product categories are joining the Choices Foundation, resulting in a large availability of the logo in these product categories. As the Choices logo aims to stimulate a large availability of healthy products in *all* product categories, food manufactures producing products for other categories should be stimulated to produce healthier products as well. Snacks, sauces and beverages largely contribute to the intake of calories, salt, added sugar and saturated fatty acids in the Netherlands (30, 31) and could therefore be important categories for product innovation.

Reported logo use versus actual logo use

Participants who reported having intentionally purchased products with the logo, had indeed purchased more products with the logo than participants reporting not having done so. However, we observed that 17% of the food purchases of participants who reported not to purchase products with the logo, representing 71% of the participants, did carry the logo. This finding suggests that consumers often purchase products with the logo *unintentionally*, which is supported by earlier research using self-reported data (13). Although the Choices logo aims to intentionally facilitate consumers in making healthy choices, the increased availability of healthier products might help to improve the dietary pattern of both intentional and unintentional shoppers.

Food choice motives and logo use

We found that those participants who reported paying considerable attention to their weight and also those who reported looking at nutrition information on food packages both stated that they purchase and do actually purchase more products with the Choices logo. To our knowledge, there is only one study that has investigated the predictors of the actual use of a nutrition logo by collecting grocery store receipts (17). They found that participants who report limiting their fat intake purchased more products with a nutrition logo. These findings suggest that health conscious and weight conscious people purchase more products with a nutrition logo, in agreement with studies using self-reported data (9, 13, 19, 20). However, based on our observational data, we are not able to conclude whether health conscious and weight conscious participants purchase logo products due to the logo, or due to another reason. Future research should make use of innovative research techniques such as eye-tracking to study whether consumers purchase logo products due to the logo. The eye-tracking method measures eye-movements to investigate which product characteristics are noticed when standing before the shelves in the supermarket. A disadvantage of this method is that participants have to wear an eye-tracking apparatus when walking trough the supermarket, possibly biasing the results. Also, eye-

movements could be unconscious, hampering the interpretation of the data. Other research types such as qualitative research by means of interviews could further provide more in-depth insights in why consumers purchase logo products.
Although we cannot attribute product purchases to the logo, we can conclude that health conscious participants purchase more products with a healthier product composition. However, the Choices logo aims to stimulate a favorable eating pattern among all consumers. Those consumer groups that need to improve their dietary pattern should be reached in particular, such as people with lower levels of education or a high BMI. However, these consumers appear to be precisely the ones that are difficult to reach through nutrition education (30, 32). Future communication around the logo should be focusing on these specific target groups in order to help them to improve their dietary pattern.
Furthermore, the finding that making a shopping list was negatively associated with reported logo use is interesting. Possibly, a shopping list helps to focus on specific products during shopping and makes a consumer less susceptible to on-package and in store nutrition information.
The finding that the higher enjoyment of the taste of food (hedonism) is rated, the fewer products with the logo are actually bought, can be explained by earlier studies: consumers seem to prefer foods that they perceive as unhealthy because they assume that such food tastes better and will give them more pleasure (33, 34). Thus, if one would like to motivate hedonists to adopt a healthier dietary pattern by purchasing healthier products, extra attention should be paid to the perceived tastefulness and image of healthy products.

A limitation of this study is the low response rate. Because consumers were asked to participate in the study after having paid at the cash desk in the supermarket, many consumers wanted to go home and indicated that they had no time to participate. However, by asking the consumers after having paid, we did not influence purchasing decisions, which was essential for the validity of the data of this study. Moreover, by measuring during both weekend days and evening hours, we tried to create a study population that is as representative as possible. Another limitation is that the food choice motive hedonism was measured by self developed items based on earlier research (7). The Cronbach's alpha of hedonism, together with some other food choice motives, was below 0.7, which is usually considered minimally acceptable. It would be recommended to validate these scales in future studies linking food choice motives to purchasing behavior.
Also, not all products that comply with the Choices criteria currently bear the Choices logo, because producers join the Choices foundation on a voluntary basis. We tried to correct for this by choosing one of the largest supermarket chains of the Netherlands and one that has joined the Choices foundation. Nevertheless, by only choosing C1000 store chains, the results of this study were limited to only one store chain and one should be careful when extrapolating the results to the general population. Another limitation is that inter-observer reliability was not assessed. Although the observers worked in pairs of two persons and both persons checked which products a participant just bought and whether the products were carrying a logo or not, testing inter-observer reliability would have added extra value to the quality of the collected data. A final limitation is that this study provides information about logo use

based on only one shopping occasion, rather than about habitual shopping habits. Consequently, we recommend future studies to follow participants' food purchases over time to get more insight in the role of habitual purchasing behavior, for example by asking them to scan all their food purchases for some weeks with a scanner.

There are hardly any studies that go beyond studying self-reported use of nutrition logos. Notwithstanding, these are frequently cited to support the existence of current nutrition logos (9, 15-17). This is the first study that has investigated the actual use of the Choices logo in the point-of-purchase setting. The innovative methodology used in this study, a combination of self reported data and real life observations, provide unique first insights into the actual use of the Choices nutrition logo and the related food choice motives of consumers. These insights can be used for tailoring health communication around the logo to subgroups of consumers, thereby possibly improving their dietary pattern (13, 35). Further intervention studies in point-of-purchase settings are needed to investigate the effectiveness of the Choices logo on food choices and health behavior.

Conclusions

The Choices logo seems to mainly play a role in the actual food purchases of people who are health conscious and weight conscious. 'Hedonism' or pleasure appears to be negatively associated with purchasing products with the logo. Thus, in order to stimulate all consumers to purchase more products with a favorable product composition, extra attention should be paid to the tastefulness and the image of healthy products.

Conflicts of interest and authors' affiliations

There were no conflicts of interest. Johannes Brug is employed by the Department of Epidemiology and Biostatistics, EMGO Institute for Health and Care Research, VU University Medical Center, Amsterdam, the Netherlands. The other authors are employed by the Department of Health Sciences and the EMGO Institute for Health and Care Research, VU University Amsterdam, the Netherlands.

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4

Influence of placement of a nutrition logo on cafeteria menu items on lunchtime food choices at Dutch worksites

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Abstract

Introduction: This study investigates the effectiveness of labeling foods with the Choices nutrition logo on influencing cafeteria menu selection and the behavioral determinants of menu choices in worksite cafeterias in the Netherlands.

Methods: A cluster randomized controlled trial was conducted. Intervention cafeterias (n=13), where the Choices logo was used to promote healthier eating for a three-week period, were compared with control cafeterias (n=12), which offered the same menu without the logo. Sales data were collected daily for nine weeks, from March to May 2009. Additionally, employees from one intervention and one control company completed an online questionnaire at baseline and after the intervention (n=368) in which the behavioral determinants of food choice (attitude, self-efficacy and intention) and logo use were measured. Generalized estimating equation (GEE) analyses, chi-square tests, t-tests and linear regression analyses were performed.

Results: No nutritionally meaningful intervention effects were found in the sales of sandwiches, soups, snacks, fruit and salads. Also, no significant differences in behavioral determinants were found. An “intention to eat healthier” and “paying attention to product information” were positively associated with self-reported consumption of foods with the Choices logo at lunch.

Conclusions: The intervention did not have a significant impact on employees’ lunchtime food choices. Labeling healthy choices might be useful for health-conscious employees in the volitional phase of behavior change. Further research should focus on the possible health benefits of menu reformulation in the catering sector.

Introduction

The World Health Organization recommends that consumers reduce their intake of sodium, sugar, saturated fats and trans fats in order to reduce the prevalence of diet-related chronic diseases, which are increasing worldwide (1). Because food consumption during lunch appears to contribute significantly to the intake of these substances, the worksite cafeteria could be a strategically important venue in which to expose individuals to healthy food choices (2–4). Therefore, the Choices nutrition logo was introduced in several large catering organizations in the Netherlands in 2006.

The Choices nutrition logo is found on a variety of brands in many supermarket chains and food service locations in the Netherlands, including worksite cafeterias. The logo is assigned to products that meet the determined criteria for sodium, added sugar, saturated fats, trans fats, fiber and calories. These criteria were developed by an independent scientific committee of experts in nutrition, food science and consumer behavior from Europe, the United States, South America and Asia. Choices products must meet all of the nutritional criteria determined for their category. The Choices logo can be compared with nutrition scoring systems in the United States, such as NuVal, a science-based nutrition index score that is designed to help consumers purchase healthier products, or the Smart Choices program, a front-of-pack nutrition symbol that looks similar to Choices, although the systems are not related (5, 6). Detailed background information for the Choices logo has been given elsewhere (7).

The catering sector is different from supermarkets because cafeterias are allowed to assign the Choices logo to freshly prepared products, such as sandwiches with self-prepared sandwich filling (Figure 1). Catering managers are trained to prepare these products with reduced levels of sodium, sugar, saturated fats, trans fats and calories, and with increased fiber content. By both increasing the availability of healthy foods and labeling these products with the Choices logo, caterers try to facilitate employee selection of healthier foods in worksite cafeterias.

The labeling of healthier items in the food service sector may influence behavior, promoting a healthier dietary pattern (8, 9). Earlier studies exploring the effect of labeling in worksite cafeterias suggest some positive benefits, whereas other studies show only modest effects on sales data or consumer behavior (8, 10–13). There is a general need for high-quality studies investigating the potential benefits to nutrition education of implementing healthy menu logos in point-of-purchase settings, such as worksite cafeterias (6, 14, 15). Therefore, this study aimed to investigate the effectiveness of the Choices logo on influencing cafeteria menu selection and on the behavioral determinants (attitude, self-efficacy and intention) of menu choice by conducting a randomized controlled trial in worksite cafeterias in the Netherlands.

Methods

Participants

A cluster randomized controlled trial was conducted in the Netherlands from March to May 2009. The power calculation was based on the main outcome measure: the sales data. With the assumption of a standard deviation of 10%, a sample of twelve intervention and twelve control worksite cafeterias was estimated to provide 80% power at a 5% level of significance to detect a 12% increase in sales between the

Figure 1. Choices sandwiches labeled with the Choices logo.

intervention and the control group. Twenty-five worksite cafeterias (including one more worksite than in the power calculation in case another dropped out) in Dutch companies employing office workers with mainly sedentary jobs were recruited in collaboration with the leading catering organization in the Netherlands. At the onset of the study the companies (employing 120-2000 workers) had not yet implemented the Choices logo system. Randomization was stratified by company size (companies >500 employees and companies <500 employees). Seven worksites with more than 500 employees were blindly allocated to either the intervention group or the control group. The remaining 18 cafeterias were randomized similarly. Treatment assignment codes were available to the research staff during the study in order to check for compliance. The study protocol was approved by the Scientific Ethics Committee of VU University.

The Choices intervention

All the cafeterias were trained to offer exactly the same sandwiches and soups every day (one freshly prepared Choices sandwich, one regular sandwich, one Choices soup and one regular soup) during the research period, essentially for comparison of the sales data among the cafeterias. The prices of the Choices products and the regular products were the same. Additionally, the cafeterias were allowed to offer their regular products, such as dairy products, desserts and hot meals, but were not permitted to offer sandwiches or soups not listed on the menu.

The three-week menu cycle was repeated three times during the nine-week research period: the baseline, intervention and post-intervention periods. During the intervention period, the intervention cafeterias were asked to place the Choices logo next to the freshly prepared Choices sandwiches and soups as well as the fresh fruit basket (it is permissible to assign the logo to fresh fruit, as described elsewhere (7). However, it is not permissible to assign the logo to the salad bar, because not all (processed) salads comply with the Choices criteria). Further, menus explaining the meaning of the Choices logo focused employees' attention on the logo and aimed to

help them make healthy lunch choices. The control cafeterias did not use labels or any other communication about the logo. During the baseline and post-intervention periods, no Choices menu labeling was used in either the intervention or the control cafeterias. Each week four trained research assistants telephoned, e-mailed and visited all the cafeterias to check for compliance.

Data collection

Sales. The sales of sandwiches and soups and the number of employees lunching in the cafeteria were registered daily for the entire nine weeks (March to May 2009). Also, sales for fried snack foods, fruit and salads were collected to see whether the intervention had any effect on the sales of these other product categories.

Questionnaires. Additionally, to gain insights into the behavioral determinants of food choice, the employees at two worksites (the largest worksites for both the intervention group and the control group) were asked to complete an online questionnaire at baseline and after the intervention. The questionnaires assessed the presumed behavioral determinants of food choice, derived from the Theory of Planned Behavior (16, 17). Attitude (e.g. “How satisfied are you with the healthy products offered in the cafeteria?”); self-efficacy (e.g. “Do you consider yourself to be able to choose healthy foods in your worksite cafeteria?”) and intention (e.g. “Do you intend to eat healthier in the coming month?”) were measured by two items each, with all items measured on a five-point Likert scale. Further, self-reported demographic variables were collected, such as age, gender, body weight, height, level of education and frequency of lunching in the worksite cafeteria.

In the second questionnaire, completed in the same two worksites during the post-intervention period, the respondents were also asked about their familiarity with the Choices logo (in “yes” or “no” response categories) and whether they used the logo to make a healthy choice during lunch (in response categories ranging from one=“never” to five=“always”). Further, the questionnaire included three food choice motives measured by three statements, each measured on a seven-point Likert scale: “weight control,” “importance of product information” and “importance of pleasure in eating” (18–20). In earlier research these food choice motives were found to be significant predictors of the selection of foods with the Choices logo (14).

Statistics

Sales. Missing data (3.9% of the data was missing) were accounted for with the multiple imputation method for missing data, a statistical method to estimate missing data by multiple sampling (21, 22). Zeros were added to the data set where no sale took place. Generalized estimating equation (GEE) analyses were carried out, with the worksite as the unit of analysis (subject variable) (n=25) (23). The week was used as the within-subject variable and sales data per product category per week were used as the dependent variables. Intervention (one=intervention, zero=control) was used as the between-subject factor and the baseline sales score was added to the model as a covariate. To study whether the effect of the intervention on sales data was time dependent, the interaction between the intervention and the week was explored.

Questionnaires. The body mass index (BMI) was calculated (kg/m2) from self-reported body weight and height. A mean score was calculated for each of the food choice

motives (range, one to seven) and for each of the behavioral determinants (range, one to five). Chi-square tests and t-tests were used to test for differences in demographic variables between the intervention and control employees at baseline. After the intervention, T-tests were used to explore significant differences in the difference scores of the behavioral determinants of food choice between the intervention and the control participants. Finally, for the intervention group a backward selection procedure was used to obtain the best linear regression model for reported consumption of products with the Choices logo during lunch (dependent variable). The model started with all the independent variables (baseline intention, gender, BMI, age, educational level, frequency of lunching at the cafeteria and the three food choice motives) and tested them one by one for statistical significance, deleting any that were not significant.

All the statistical analyses were performed with the Statistical Package for the Social Sciences (SPSS version 17.0, 2009, Chicago, IL), and a significance level of 0.05 was adopted. For the backward selection procedure an exclusion P-value of 0.10 was used.

Table 1. Change in cafeteria sales (b, 95% CI) at worksites with the Choices program compared to control worksites[1].

Product category	b (95% CI) *Intervention period*	P-Value	b (95% CI) *Intervention plus post-intervention period*	P-Value
Proportion Choices bread	-0.006 (-0.060; 0.047)	0.815	0.004 (-0.038; 0.048)	0.832
Proportion Choices soups	0.011 (-0.028; 0.050)	0.583	0.023 (-0.122; 0.167)	0.759
Snacks[a]	0.368 (-2.105; 2.840)	0.769	1.065 (-0.898; 3.028)	0.284
Salads[a]	1.163 (-0.378; 2.705)	0.139	0.859 (-0.503; 2.222)	0.216
Fruits[a]	1.159 (0.454; 1.864)	0.001**	1.045 (0.406; 1.685)	0.001**

[1] The betas represent the differences between the mean sales at the intervention worksites and the mean sales at the control worksites. The betas were calculated separately for the intervention period (second column; weeks four to six of the complete study period of nine weeks) and the intervention plus post-intervention period (fourth column; weeks four to nine of the complete study period of nine weeks).

[a] Units sold per 50 lunching employees

*** P< 0.01*

Results

Sales

In table 1, the data show a significant effect on fruit sales to the intervention group compared with the control group during the intervention period (b=1.159, 95% CI: 0.454; 1.864, p=0.001). This effect represents one cup of fruit per 50 employees per week. This change continued during the post-intervention period (b=1.045, 95% CI: 0.406; 1.685, p=0.001). No significant differences in sales were found in the other

product categories. No interaction was detected between the intervention and the week.

Questionnaires

A total of 1014 questionnaires were completed in the two worksites at baseline (response rate, 48.0%) and 368 in the post-intervention period (response rate, 36.3%), resulting in a sample population of 368 consumers, of which 232 were in the intervention group and 136 in the control group. A total of 54.3% were women; the mean age (±SD) was 39.2 years (±9.9 years) and the mean BMI was 24.0 kg/m2 (±3.5). The majority had a relatively high level of education and frequently ate lunch in the worksite cafeteria (four to five times per week). No significant differences in the baseline characteristics (age, BMI, educational level and frequency of lunching in the cafeteria) were detected between the intervention group and the control group.

Table 2 shows the mean scores for the determinants of behavior. No significant differences were found in the difference scores (post-intervention minus baseline) between the intervention and control groups. Further analyses within the intervention group showed that, at baseline, 66% had a low intention to eat healthier. A total of 56% of the intervention group had noticed information about healthier eating and 82% indicated that they were familiar with the Choices logo. The regression analyses showed that the best predictors of reported consumption of foods with the logo during lunch were "intention at baseline" and "importance of product information" (b=0.201, 95% CI: 0.085; 0.343, p=0.006 and b=0.170, 95% CI: 0.094; 0.245, p=0.000, respectively).

Table 2. Mean changes to the determinants of behavior change at worksites with the Choices program versus traditional food service sites (control sites).

	Baseline Mean (SD)	Post-intervention Mean (SD)	Difference Mean (SD)
Self-Efficacy (1-5) [a]			
Intervention	3.63 (0.76)	3.59 (0.76)	-0.04 (0.62)
Control	3.89 (0.67)	3.89 (0.56)	0.01 (0.57)
Intention (1-5) [a]			
Intervention	3.25 (0.89)	3.22 (0.86)	-0.04 (0.77)
Control	2.98 (0.83)	2.92 (0.83)	-0.06 (0.69)
Attitude (1-5) [a]			
Intervention	3.11 (1.03)	3.17 (0.94)	0.06 (0.79)
Control	3.48 (0.83)	3.51 (0.82)	0.04 (0.69)

[a] *Self-Efficacy, Intention and Attitude were measured by two items each on a five-point Likert scale. Example of Self-Efficacy measurement: "Do you consider yourself to be able to choose healthy foods in your worksite cafeteria?" Example of Intention measurement: "Do you intend to eat more healthily in the coming month?" Example of Attitude measurement: "How satisfied are you with the healthy products offered in the cafeteria?"*

Discussion

This study investigated the effectiveness of labeling with a nutrition logo on cafeteria menu selection and behavioral determinants (attitude, self-efficacy and intention) of this choice by conducting a randomized controlled trial in worksite cafeterias in the Netherlands. No nutritionally meaningful intervention effects were observed for the sales of sandwiches, soups, snacks, fruit and salads. Further, no significant differences in behavior determinants between the intervention and control groups were found. The best predictors of reported lunchtime consumption of products with the Choices logo after the intervention were "intention at baseline" and "product information."

A possible explanation for the intervention's lack of impact is that the majority of the intervention population had a low intention to eat healthier at baseline. Common behavior theories argue that consumers first have to be motivated to change their behavior before they actually undertake action to change it (16, 17). Individuals then shift from the "motivational phase" to the "volitional phase," as defined by Renner and Schwarzer (24). In the Transtheoretical Model of Behavior Change (25), this is described as a changing from the "contemplation phase" to the "preparation and action" phase. However, if consumers have no interest in healthier eating, they might not be motivated to pay attention to or use health information such as nutrition labeling (15). Labeling might be an intervention that suits the volitional phase of behavior change rather than the motivational phase. The findings of this study reveal that the intervention group participants who had an intention to eat healthier at baseline (volitional phase) and the participants who reported paying attention to nutrition information on food packages stated that they used the Choices logo to make a healthy choice during lunch. Unfortunately, no consumption data were available to support these findings, because the sales data were collected per cafeteria, and not per person. Nevertheless, these results suggest that health-conscious consumers may use the Choices logo to make a healthy choice, in agreement with previous supermarket research showing that health-conscious consumers bought more products with the Choices logo (14). The challenge, however, is to investigate how to improve the dietary pattern of *all* consumers. Consumer research in the United States on the NuVal system, a nutrition label on packaged foods that ranks foods on a scale of one to 100, shows that consumers prefer a nutrition logo combined with an education program (6). It would be interesting to investigate the effectiveness of combining nutrition logos with tailored health education to motivate vulnerable consumer groups to improve their diet (8, 15, 26).

Study limitations

This study focused primarily on office workers with sedentary jobs in the Netherlands. This homogeneous population is different from populations in other countries, such as the United States, which has a multiethnic workforce that eats a wide variety of foods. Further research is needed to be able to extrapolate these results to other populations. Secondly, although the questionnaire was based on validated concepts, this specific survey was not validated. Validation in future studies is recommended. Finally, although randomization was stratified by company size, it cannot be concluded that the randomization process was effective and ensured equal distribution of other possible confounding variables across the intervention and the control worksites, such as the percentage of male/female employees, mean age and

mean weight. Due to practical limitations, these data were not collected, but it is recommended that these data be collected in future studies in order to interpret the study findings more appropriately.

Practical applications

This study shows that labeling foods with a nutrition logo alone did not have a significant impact on employees' food choice during lunch. It is assumed that more extensive health education is needed to influence food choice at lunch. Worksites should ask for the help of health professionals to motivate their employees to eat healthier, for example by performing health checks or by using the "Motivational Interviewing" counseling style, a client-centered, directive approach to enhance intrinsic motivation by working with and resolving ambivalence (27). Also, more detailed explanation of the meaning of a nutrition logo is needed. Catering managers should explain the meaning of the logo to their employees, the nutrient criteria, and how the labeling makes healthy products more recognizable. Previous research shows that the correct use of the Choices logo appears to be dependent on an accurate explanation that the Choices logo is found on healthy choices within a specific product category (7).

Furthermore, this study focused on labeling, and did not explore the health benefits of menu reformulation in the catering sector in order to meet the Choices guidelines, which could be an efficient way to improve the diet of both health-conscious and non-health-conscious employees (14, 28). Research shows that the Choices logo has influenced food manufacturers and caterers to reformulate existing products and develop new products with a healthier product composition, especially where sodium and dietary fiber are concerned (29). A worksite cafeteria with a menu limited to products with reduced levels of sodium, sugar, trans fats and saturated fats could have a great impact on healthy eating (30).

Conclusions

Labeling healthy choices in worksite cafeterias could be useful to health-conscious employees in the volitional phase of behavior change. Further research should investigate how to improve the dietary pattern of non-health-conscious employees, for example by combining nutrition logos with tailored health education via innovative technologies such as cell phones. Secondly, further research should focus on the possible health benefits of menu reformulation in the catering sector so that more healthy products are offered. It would be interesting to investigate how different partners, including chefs, marketing directors and food companies, could cooperate most effectively to create a significant impact on the health of corporate employees.

Conflicts of interest and authors' affiliations

Annet Roodenburg is seconded at the VU University Amsterdam and employed by Unilever R&D, the Netherlands. The other authors have no conflicts of interest. Johannes Brug is employed by the Department of Epidemiology and Biostatistics, EMGO Institute for Health and Care Research, VU University Medical Center, Amsterdam, the Netherlands. The other authors are employed by the Department of Health Sciences and the EMGO Institute for Health and Care Research, VU University Amsterdam, the Netherlands.

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5

A nutrition labeling intervention in worksite cafeterias: An implementation evaluation across two large catering companies in the Netherlands

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Abstract

Introduction: By both increasing the availability of healthy foods and labeling these products with the Choices logo, caterers may facilitate employees to make a healthier choice in their worksite cafeterias. The aim of this study was to explore which attributes influence the implementation of the Choices logo in worksite cafeterias in the Netherlands.

Methods: Questionnaires were completed by catering managers of 316 cafeterias of two large caterers in the Netherlands (response rate 49.8 %). Attributes from the Diffusion of Innovations Theory were used to investigate whether they could predict implementation.

Results: Compatibility (consistency with the beliefs of the catering manager; OR = 1.52), voluntariness (perception of the implementation as voluntary; OR = 0.50), result demonstrability (ability to communicate the implementation; OR=1.52) and complexity in the sense of time (time needed for implementation; OR = 0.70) were the best predictors for the frequency of offering fresh Choices products (all significant). For the frequency of using Choices promotion materials, voluntariness (OR = 0.54), result demonstrability (OR=1.51), and relative advantage (perceived advantage of the implementation; OR=1.44) were the best predictors (all significant).

Conclusions: This study provides unique insights in which perceived attributes influence the implementation of a nutrition logo in worksite cafeterias. In order to increase the implementation, the Choices logo should be consistent with catering managers' ideas about healthy food, the workload of implementing the logo should be limited and it could be recommended to incorporate the logo in the health policy of the caterer.

Introduction

Nowadays, many people eat out-of-home meals during lunch (1). In the United States, 25.3% of out-of-home lunches are consumed in worksite cafeterias (2). In the Netherlands, 35-40% of employees have their lunch in worksite cafeterias (3). Out-of-home eating has been associated with large portion sizes (1). Large portions have been related to a high energy intake, which has been associated with diet-related chronic diseases (4). These findings stress the importance of offering healthy lunches in worksite cafeterias. There are several strategies to make worksite cafeterias healthier. A systematic review investigating the effectiveness of worksite health promotion programs using environmental modifications indicated the potential to improve dietary behavior in worksite cafeterias by using strategies such as increasing the availability of healthy products, promotional materials, efficient food placement, and food labeling (5).

In 2006, a new front-of-pack nutrition logo was introduced in the Netherlands, the Choices nutrition logo, introduced by a foundation of food manufacturers, retail and food service organizations, the Netherlands Nutrition Center, nutrition scientists, and conditionally endorsed by the Dutch Government. The logo is assigned to products that qualify for criteria of sodium, added sugar, saturated fatty acids, trans fatty acids, fiber and energy, based on international recommendations by the World Health Organization (WHO). Logo products inform healthier food choices within their respective product category. The logo can be found on a variety of food products in different supermarket chain stores, and in several food service locations. One of the aims of the logo is to stimulate consumers to make healthier food choices. Earlier of our studies showed that consumers were largely familiar with the logo one year after its introduction and consumers more interested in health purchased most logo products (6, 7). A detailed background of the logo has been described elsewhere (6). Since 2008 the Choices logo has been implemented in worksite cafeterias operated by several commercial catering companies in the Netherlands. After following a training course, the catering manager of the worksite cafeteria is supposed to increase the availability of healthy food choices and implement the logo in his/her worksite cafeteria. Additional to pre-packaged products, the worksite cafeteria may offer freshly prepared products which comply with the Choices criteria, such as Choices sandwiches and salads. It is interesting to mention that we found that the logo has influenced food manufacturers and caterers to reformulate existing products and develop new products with a healthier product composition especially where sodium and dietary fiber are concerned (8). Further, the catering managers are allowed to use promotion materials, such as labeling in their worksite cafeterias (see Figure 1). By both increasing the availability of healthy foods and labeling these

Figure 1. Freshly prepared Choices sandwiches labeled with the Choices logo

products with the logo, the caterer may facilitate employees to make a healthier choice in their worksite cafeterias.
The implementation of the logo in worksite cafeterias has not been evaluated yet, because it is a relatively new labeling system which is implemented on a voluntary basis. It is of interest to investigate which perceived attributes influence the implementation of the logo in worksite cafeterias in order to be able to increase its implementation. Therefore, this study investigated the degree of implementation and which perceived attributes influence the degree of implementation of the Choices logo in worksite cafeterias in the Netherlands.

Methods

Design and population

A cross-sectional quantitative design was used. Catering managers were recruited from the two largest catering companies in the Netherlands who joined the Choices Foundation. These two caterers have a market share of 52 % of the Dutch catering market. In 72% of their workplaces, the Choices logo has been introduced. Questionnaires were sent by e-mail or post to the managers of 634 catering sites located in different areas of the Netherlands in March 2009. A total of 316 (49.8%) questionnaires were returned. The study protocol of the study was approved by the Scientific Ethics Committee of the VU University Amsterdam.

Questionnaire and calculations

Perceived attributes of the program. A theory frequently used for studies investigating the implementation of innovations is the Diffusion of Innovations theory (9). Exploring the implementation of the Choices logo as an innovation according to this theory may provide useful insights which can be used to improve its implementation. Rogers identifies the following attributes related to program diffusion: *relative advantage* (the degree to which the implementer sees the innovation as an advantage), *compatibility* (the degree to which the innovation is consistent with the ideas and opinions of the implementer), *complexity* (the degree to which the innovation is difficult to work with), *trialability* (the degree to which the implementer can experience the innovation before implementation) and *observability* (the degree to which the results of the innovation are visible to the implementer). In this study we included all these attributes except observability, because Moore and Benbasat found a more valid way of including observability by measuring the attribute *result demonstrability* (the degree to which the implementer is able to measure, observe and communicate the results of the innovation) (10). Additionally, we also measured *voluntariness* (the degree to which the implementer perceives the implementation as voluntary) and the *knowledge* of the catering manager about the meaning and use of the Choices logo in worksite cafeterias. The questionnaire for this study was based on the questionnaire of Moore and Benbasat (10) and Pankratz and colleagues (11). Although these questionnaires are not related to food labeling, they measure the above mentioned attributes which form the theoretical framework of this study. Therefore, these questionnaires were used. The operationalization of the attribute *relative advantage* was based on the study in worksite cafeterias by Steenhuis and colleagues (12).

Respondents. The questionnaire measured the age, gender and educational level of

the catering managers. Educational level was divided into three categories: a low educational level (primary school or basic vocational education), a medium level (secondary vocational education or high-school degree) or a high educational level (higher vocational education or university degree), corresponding to the commonly used classification in the Netherlands (13). Further, the catering managers reported how many employees worked in their cafeteria, how many users their cafeteria had, whether they had followed a Choices training course (yes/no), who decided that he/she had to follow this training (respondent/other), and when this training was followed.

Degree of implementation. We developed two measures to assess the implementation of the logo in the worksite cafeterias. The frequency of offering freshly prepared Choices products was defined as a measure for implementation (How often do you offer freshly prepared Choices products in your worksite cafeteria?), measured on a five-point Likert scale (never = 1, always = 5). This measure was divided into two categories: low frequency implementers (LOI; score 1 – 3) and high frequency implementers (HOI; score 4 – 5). The second measure was defined as promotion of the logo and included five questions about the frequency of using Choices promotion materials (e.g. How often do you place Choices signs in front of freshly prepared Choices products in your worksite cafeteria?), all items were measured on a five-point Likert scale (never = 1, always = 5). A mean score was calculated and this measure was also divided into two categories: low promotion implementers (LCI; score 1.0 – 3.0) and high promotion implementers (HCI; score 3.1 – 5.0).

Attributes influencing implementation. We measured all perceived attributes of the program on a five-point Likert scale (strongly disagree = 1, strongly agree = 5). The attribute complexity was subdivided into three categories: complexity of working with the Choices recipes for freshly prepared products (four items), complexity of working with the Choices signs for freshly prepared products (three items), and complexity in the sense of time (two items). For example, an item of the attribute complexity of working with the Choices recipes for freshly prepared products was: “In general, I think the Choices recipes are easy to use.” Additionally, compatibility (two items), trialability (one item), voluntariness (three items), result demonstrability (three items), relative advantage (three items), and knowledge about the meaning and use of the logo (three items) were measured in a similar way. Mean scores were calculated per attribute. The reliability of the attributes was tested using Cronbach’s alpha, with the lowest alpha being 0.58 (result demonstrability and complexity of working with the Choices signs for freshly prepared products) and the highest alpha 0.87 (knowledge about the meaning and use of the logo). Please see appendix I for the complete description of all items.

Statistical Analyses

Respondents and degree of implementation. Descriptive analyses were used to report demographic data of the participants and the worksite cafeterias, and the degree of implementation. Chi- square tests were used to test for differences in high and low implementers for the two implementation measures (frequency and promotion) according to gender, education, and who made the decision to follow a Choices

training course. T-tests were used to test for differences in high and low implementers for the two measures (frequency and promotion) according to age.

Attributes influencing implementation. T-tests were used to examine significant differences in the attributes influencing implementation between high and low implementers for each of the two measures (frequency and promotion). A backward selection procedure was used to obtain the best logistic regression model, using the frequency implementation measure and the promotion implementation measure as the dependent variables. The independent variables tested were the perceived attributes of the program. Statistical analyses were performed in SPSS 15.0 (SPSS, 2006) statistical package using a significance level of 0.05. For the prediction model an exclusion p-value of 0.10 was used.

Table 1: Demographic variables of the catering managers.

Demographics	Total (n = 316)	LFI[1] (n=157)	HFI [1] (n=145)	LPI[1] (n=137)	HPI[1] (n=158)
Gender (% women)	76.7	75.4	77.9	76.3	77.9
Who decided to follow Choices training: manager him/herself or others (% other)	88.2	84.7	91.3	85.1	90.3
Education (%)					
Low	49.0	44.6	53.0	46.9	50.7
Medium	43.5	45.5	41.8	42.5	44.2
High	7.5	9.9	5.2	10.6	5.1
Age (mean) (SD)	45.6 (10.3)	44.7 (10.8)	46.5 (9.8)	46.0 (10.6)	45.6 (10.0)

[1] LFI: Low Frequency Implementer, HFI: High Frequency Implementer, LPI: Low Promotion Implementer, HPI: High Promotion Implementer

**p<0.05, ** p<0.01*

Results

Respondents and degree of implementation

The research population consisted of 316 managers. Table 1 shows the demographics of the catering managers. In almost all worksite cafeterias there were fewer than ten employees working in the cafeteria (86.4%) and fewer than 200 cafeteria users a day (71.2%). Most worksite cafeterias implemented the logo between six months and a year ago (55.0%), followed by under six months ago (27.0%). A total of 53.6 % of the worksite cafeterias had a high promotion implementation. The percentage of cafeterias with a high frequency implementation was slightly lower (48.0%). A total of 34.2% had both a high frequency and a high promotion implementation. No significant differences in demographics were detected between managers from low and high implementation cafeterias.

Attributes influencing implementation

Table 2 shows the mean scores of the perceived attributes of the program for all participants, as well as separate means for high and low promotion implementers, and high and low frequency implementers. For both implementation measures high implementers had significantly higher scores on relative advantage, compatibility, trialability, and result demonstrability than low implementers; and high implementers had significantly lower scores on complexity and voluntariness than the low implementers. High frequency implementers had higher scores on knowledge about the meaning and use of the logo than low frequency implementers. The logistic regression analyses (with the two implementation measures as the dependent variables and the perceived attributes of the program as the independent variables) showed

Table 2: Attributes influencing implementation, subdivided into low and high frequency implementation, and low and high promotion implementation (mean scores (SD)).

Attributes[1]	Total (n=316)	LFI[2] (n=157)	HFI[2] (n=145)	LPI[2] (n=137)	HPI[2] (n=158)
Relative advantage	3.2 (0.87)	3.12 (0.83)	3.35* (0.90)	3.07 (0.87)	3.38** (0.86)
Compatibility	3.4 (0.97)	3.18 (0.92)	3.69** (0.94)	3.27 (0.93)	3.59** (0.98)
Trialability	3.6 (1.26)	3.3 (1.29)	3.85** (1.18)	3.23 (1.30)	3.84** (1.17)
Complexity signs	2.3 (0.91)	2.52 (0.90)	2.07** (0.87)	2.54 (0.85)	2.10** (0.92)
Complexity recipe	2.6 (0.96)	2.83 (0.95)	2.29** (0.90)	2.78 (0.93)	2.40** (0.96)
Complexity of time	2.8 (1.15)	3.16 (1.09)	2.41** (1.09)	3.11 (1.08)	2.51** (1.15)
Voluntariness	2.5 (1.08)	2.88 (1.04)	2.09** (0.98)	2.86 (1.03)	2.19** (1.04)
Result demonstrability	3.8 (0.81)	3.52 (0.77)	3.98** (0.79)	3.55 (0.78)	3.92** (0.81)
Knowledge about the Choices logo	4.6 (0.8)	4.5 (0.9)	4.8* (0.7)	4.5 (0.9)	4.7 (0.8)

[1] All attributes were measured on a five-point Likert scale (strongly disagree = 1, strongly agree = 5); please see appendix I for the complete description of all items.

[2] LFI: Low Frequency Implementer, HFI: High Frequency Implementer, LPI: Low Promotion Implementer, HPI: High Promotion Implementer

**p < 0.05, ** p < 0.01*

that compatibility (OR = 1.52, 95% CI: 1.10; 2.11, p=0.012), voluntariness (OR = 0.50, 95% CI: 0.38; 0.66, p<0.001), result demonstrability (OR=1.52, 95% CI: 1.04; 2.22, p=0.031) and complexity in the sense of time (OR = 0.70, 95% CI: 0.53; 0.91, p=0.009) were the best predictors for a high frequency implementation. For a high promotion implementation voluntariness (OR = 0.54, 95% CI: 0.41; 0.69, p<0.001), result demonstrability (OR=1.51, 95% CI: 1.07; 2.13, p=0.021), and relative advantage (OR=1.44, 95% CI: 1.04; 2.01, p=0.03) were the best predictors.

Discussion

The aim of this study was to investigate the degree of implementation and which perceived attributes influence the degree of implementation of the Choices logo in worksite cafeterias in the Netherlands. A total of 34.2 % of the worksite cafeterias had both a high frequency and a high promotion implementation. Voluntariness (the degree to which the catering manager perceives the implementation as voluntary) and complexity in the sense of time (the degree to which the catering manager perceives the implementation of the logo as time consuming) appeared to be the most important predictors for a low implementation. Result demonstrability (the degree to which the catering manager is able to observe and communicate the results of implementing the logo), relative advantage (the degree to which the catering manager perceives the implementation of the logo as an advantage for his/her cafeteria), and compatibility (the degree to which the implementation of the logo is perceived to be compatible with the way catering managers like to work and their ideas about healthy food) appeared to be the most important predictors for a high implementation.

A systematic review shows that implementation data are essential to evaluate the impact of intervention programs on program outcomes in different research areas and different settings, such as tobacco use prevention, alcohol use prevention, health promotion at schools, at workplaces and at home (14). Positive implementation results have been reported with implementation levels around 60%. In our study, the worksite cafeteria was the setting to evaluate. It was found that around one third of the worksite cafeterias had reached a high implementation level. One could question whether this is high or low. This is the first implementation evaluation of the Choices logo in worksites and there are no appropriate studies to compare with. Taking into account that the Choices logo is a relatively new labeling system implemented on a voluntary basis, an implementation level of one third is considered as a good starting point. Nevertheless, compared with the findings of Durlak and DuPre, our result stresses the importance of investigating which attributes influence the implementation of the logo in worksite cafeterias in order to further increase its implementation.

The finding that the attribute *voluntariness* (the degree to which the catering manager perceives the implementation of the logo as voluntary) appeared to be a predictor of a lower implementation of the logo in worksite cafeterias in the Netherlands is considered a little remarkable: involuntary strategies are not frequently used to increase the implementation of programs, because implementers may not feel dedicated to the program in such a situation (14, 15). In our study, however, it appears that the relation between voluntariness and the implementation of the logo might be

interpreted from a different point of view. Catering managers indicated that they offer Choices products because they are obliged to do this owing to the policy of their caterer. Therefore, it is supposed that by incorporating the Choices logo in the (health) policy of the caterers, the implementation of the logo could further be increased.

Nevertheless, although the logo's implementation might increase because of the caterer's policy, our results show that *compatibility* was important as well. Using the logo has certainly to be compatible with the way catering managers like to work and their ideas about healthy food, in agreement with earlier research (14). It is supposed that the more the logo will be compatible with the manager's ideas about healthy food, the more the managers will be able to communicate the advantages of using the logo in their worksite cafeterias. Therefore, it is not surprising that *result demonstrability* (the degree to which the catering manager is able to observe and communicate the results of implementing the logo) and *relative advantage* (the degree to which the catering manager perceives the implementation of the logo as an advantage for his/her cafeteria) appear to be important predictors of the implementation of the logo as well. Earlier research concludes that innovations with a clear, visible advantage are more easily implemented (16). The advantage mentioned by catering managers related to the logo was that using the Choices signage makes healthy products more recognizable for their visitors. However, we should note that it is not clear yet whether the logo actually stimulates healthier food purchases. Our randomized controlled trial in worksite cafeterias did not show an effect of labeling with the logo on lunchtime food purchases (17).

The finding that *complexity in the sense of time* proved to be a predictor of the frequency implementation is in accordance with other studies: time seems to be a frequently mentioned barrier to implementation (17-21). In this study, the main time-consuming element appears to be the weighing of the ingredients for the preparation of the fresh Choices products, as indicated by the catering managers. To solve this obstacle, one could think of alternative ways of weighing the ingredients instead of using a scale, for example by providing catering managers with cups with pre-defined portion sizes, or by using standard portion sizes from pre-packaged foods in the Choices recipes.

There are a few limitations of this study that should be discussed. First, we only used two caterers from whom to recruit participants. Although we included the two largest catering companies in the Netherlands who joined the Choices Foundation with a market share of 52%, future studies should include more caterers to create more insight in the implementation of the logo. Secondly, the catering managers might have provided socially desirable answers, or the participating managers might work in the worksites with the highest implementation levels. Those implementing the program most could have been more inclined to complete the questionnaire and to share their implementation experiences than those with a relatively low implementation. Consequently, we possibly found a higher implementation level than there actually was. Thirdly, although the questionnaire was based on validated attributes, this specific survey was not validated. The Cronbach's alphas of result demonstrability

and complexity of working with the choices signs were below 0.7, which is usually considered minimally acceptable. Validation in future studies is recommended. Fourthly, this study did not investigate whether the impact of the Choices intervention can be related to the extent of implementation, possibly interesting for future studies. Finally, the frequency implementation measure was defined by the frequency of offering *any* freshly prepared Choices products. No information was collected on the quantity of the products that were offered. Therefore, a cafeteria that offered only one freshly prepared Choices product has received the same score as one that offered for example ten freshly prepared Choices products. Future studies should collect more detailed information about the quantity and the type of Choices products which were offered in order to assign a relatively higher implementation score to cafeterias offering a large amount of Choices products.

Conclusions

Despite these limitations, this study provides unique insights in which perceived attributes influence the degree of implementation of a nutrition logo in worksite cafeterias. In order to increase the implementation, the Choices logo should seek to ensure that it is in-line with catering managers' ideas about healthy food. The workload of implementing the logo should be limited, in order to avoid the implementation taking up too much time. Further, catering managers should be able to perceive and communicate the advantages of implementation, such as that using labeling makes healthy products more recognizable for the worksite visitors. It could be recommended to incorporate the logo in the health policy of the caterer in order to increase the implementation.

Conflicts of interest and authors' affiliations

There were no conflicts of interest. The authors are employed by the Department of Health Sciences and the EMGO Institute for Health and Care Research, VU University Amsterdam, the Netherlands.

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APPENDIX I

Questionnaire measuring the perceived attributes of the Choices program (all measured on a five-point Likert scale; strongly disagree = 1, strongly agree = 5)[1].

Complexity of working with the Choices recipes for freshly prepared products

1. I have to think carefully when using the Choices recipes for freshly prepared products.
2. In general, I think it's easy to use the Choices recipes in my worksite cafeteria.
3. It was easy to learn how to prepare fresh Choices products.
4. It was difficult to teach my employees how to use the Choices recipes when preparing fresh Choices products.

Complexity of working with the Choices signs for freshly prepared products

1. I have to think carefully when using the Choices signs for freshly prepared products.
2. In general, I think it's easy to use the Choices signs in my worksite cafeteria.
3. It was difficult to teach my employees how to use the Choices signs for fresh Choices products.

Complexity in the sense of time

1. The introduction of the Choices logo takes more time than I actually have.
2. Using the Choices logo in my worksite cafeteria takes little time.

Compatibility

1. Using the Choices logo in my worksite cafeteria is compatible with the way I like to work.
2. Using the Choices logo in my worksite cafeteria is consistent with my ideas about healthy food.

Trialability

1. I had enough time to practice with using the Choices logo during the Choices training.

Voluntariness

1. My supervisor did not oblige me to introduce the Choices logo in my worksite cafeteria.
2. I am voluntary using the Choices logo in my worksite cafeteria.
3. My supervisor expects me to use the Choices logo in my worksite cafeteria.

Result demonstrability

1. I am able to explain the consequences of using the Choices logo in my worksite cafeteria to others.
2. The results of using the Choices logo are clear to me.
3. It's difficult for me to explain why I'm using the Choices logo in my worksite cafeteria.

Relative advantage

1. It's an advantage of the Choices logo that healthy products become more recognizable for the worksite visitors.
2. My worksite visitors are more aware of healthy eating, because my worksite uses the Choices logo.
3. It's an advantage of the Choices logo that the sales of Choices products increase.

Knowledge about the meaning and use of the Choices logo

1. I know why some products are carrying the Choices logo and others are not.
2. I know where to place the Choices signs in my worksite cafeteria.
3. I know how to prepare fresh Choices products.

[1]All items are based on the validated questionnaires of Moore and Benbasat (10), Pankratz and colleagues (11) and Steenhuis and colleagues (12). All items were translated from Dutch.

6

Front-of-pack nutrition label stimulates healthier product development: A quantitative analysis

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Abstract

Introduction: In addition to helping consumers make healthier food choices, front-of-pack nutrition labels could encourage companies to reformulate existing products and develop new ones with a healthier product composition. This is the largest study to date to investigate the effect of a nutrition logo on the development of healthier products by food manufacturers.

Methods: A total of 47 food manufacturers joining the Choices Foundation in the Netherlands (response: 39.5%) indicated whether their Choices products were newly developed, reformulated or already complied with the Choices criteria and provided nutrient composition data for their products (n=821; 23.5% of the available Choices products in August 2009).

Results: Most products carrying the logo as a result of reformulation and new product development were soups and snacks. Sodium reduction was the most common change found in processed meats, sandwiches, soups and sandwich fillings. Dietary fiber was significantly increased in most newly developed Choices product groups; for example, in fruit juices, processed meats, dairy products, sandwiches and soups. Saturated fatty acids and added sugar were significantly decreased both in reformulated and newly developed dairy products. Caloric content was significantly decreased only in reformulated dairy products, sandwich fillings and in some newly developed snacks.

Conclusions: The results indicate that the Choices logo has motivated food manufacturers to reformulate existing products and develop new products with a healthier product composition, especially where sodium and dietary fiber are concerned.

Introduction

The World Health Organization recommends limiting the intake of sodium, sugar, saturated fatty acids (SAFA) and trans fatty acids (TFA) in order to reduce the prevalence of diet-related chronic diseases (1). The food industry, retailers and catering organizations can help consumers make healthy choices by offering products with reduced levels of these nutrients. Food reformulation and the development of new products with a favorable nutrient composition could assist with this.

A front-of-pack nutrition label can encourage food manufacturers to reformulate their products and develop new products with a favorable composition which would carry the label. Many countries have developed their own labels; for example, there is the Green Keyhole Symbol in Sweden (2), the Heart Symbol in Finland (3), the Multiple Traffic Light system and the Guideline Daily Amount in the United Kingdom (4), the Pick the Tick logo in Australia and New Zealand (5), and the Nuval system (6), the Guiding Stars symbol (7), and the Smart Choices program in the United States (8). Although these nutrition labels have different designs and different product criteria, they generally have the same two aims: to help consumers make healthier food choices and to encourage food manufacturers to develop healthier products.

In the Netherlands the Choices nutrition logo has been found on a variety of products since 2006, available in many supermarket chains and food service locations including railway stations and worksite cafeterias. The criteria for the Choices logo were developed and are periodically adjusted by an independent scientific committee of experts in food and consumer behavior. The logo is assigned to products that contain lower levels of sodium, sugar, SAFA and TFA and caloric content and increased levels of dietary fiber compared with similar products within the same product category. A detailed background of the Choices logo has been described elsewhere (9, 10).

Research indicates that the people who are health-conscious not only reported to purchase but also actually purchased more logo products (10, 11). The increased availability of healthier products, such as those carrying the logo, can be an efficient way to improve the diets of all consumer groups, whether or not they identify as health-conscious consumers. To date, only one study has evaluated the impact of a front-of-pack nutrition label on healthier product development (12). This study, conducted in New Zealand, found that the Tick logo effectively influenced the food industry to reduce sodium levels in breakfast cereals, breads and margarines. In the Netherlands, it is assumed that the Choices logo has provided a clear incentive to companies, driving food reformulation and development in a healthier direction. Evidence for this, however, is lacking. Therefore, the aim of this study is to investigate the effect of the Choices logo on product reformulation and the development of new products with a favorable product composition. The following research questions were formulated:

- In which product groups are the most products reformulated or newly developed to comply with the Choices criteria?;
- Which nutrients have been changed in the reformulation process to comply with the Choices criteria and how much have these nutrients changed?; and
- What is the difference between the product compositions of newly developed Choices products and reference products that do not carry the logo?

Methods

Data collection

Between May 2007 and August 2009 all of the food manufacturers participating in the Choices program in the Netherlands (n=119) were approached via email and phone and asked to participate in the study; 47 were willing to participate (response rate: 39.5%; main reason for non-response was lack of time). Participants were asked to complete an electronic questionnaire about their products carrying the Choices logo. First, they were asked to list the names of their Choices products and the corresponding product groups, as defined in the Choices program: vegetables and fruits (fresh, processed or juices), carbohydrates (processed or unprocessed potatoes, bread or grain products), proteins (meat, fish, eggs or meat substitutes (fresh or processed), dairy products, cheese products), oils and fats, ready-to-eat dishes, sandwiches, soups, sauces (water-based, emulsions or other sauces), snacks, beverages and other products (the background of the product groups has been explained elsewhere (10)). Furthermore, the food manufacturers were asked why each product had obtained the Choices logo. The following answer categories were provided:

a) Product already existed on the market and complied with the Choices criteria;
b) Existing non-complying product was reformulated to comply with the Choices criteria; or
c) A new product was developed that complied with the Choices criteria.

Additionally, for each Choices product manufacturers were asked to provide the product composition for energy density (kcal/100 g), SAFA (g/100 g), TFA (g/100 g), added sugar (g/100 g), sodium (mg/100 g), dietary fiber (g/100 g) and, if applicable, portion size (g). Food companies that had reformulated their products were asked to provide data on both pre-reformulation product composition and current (Choices-compliant) product composition. The companies returned product information on 878 products. Product information for 57 of these products was incomplete or the product was not available on the Dutch market, resulting in 821 useable products for further calculations and analyses. Because food manufacturers are allowed to assign the logo to fresh fruits and vegetables without changing their product composition, no data about fresh fruits and vegetables were collected. The study's protocol was approved by the Scientific Ethics Committee of VU University Amsterdam before the start of data collection and all food manufacturers provided written approval to use their data for scientific purposes.

Statistical analysis

All products. Descriptive analysis was used to report the total number of products per product group which were reported to be newly developed, reformulated or already compliant with the Choices criteria.

Reformulated products. To estimate the effect of reformulation paired sample t-tests were used to explore differences in product composition per product group before and after reformulation. Product groups containing less than five reformulated prod-

ucts were considered to constitute too small a sample and consequently omitted from the analyses (e.g. beverages, ready-to-eat meals, water-based sauces, oils and fats).

Newly developed products. There is no pre-reformulation product composition reference for newly developed Choices products. Therefore, it was decided to use the same reference products for the analyses of the newly developed products that were used for the analyses of the reformulated products. For example, the mean product composition of the 68 pre-reformulated soups was used as the reference for the 21 newly developed Choices soups. In this case we assume that soups have a general pre-Choices product composition represented by the group of 68 soups. Independent sample t-tests were conducted to explore the differences in product composition between newly developed Choices products and reference products. Product groups containing less than five newly developed products and product groups lacking reference products were omitted from the analyses (e.g. potatoes, bread, cheese products, ready-to-eat meals, sauces, oils and fats).
Because most newly developed Choices products seemed to be snacks, extra analyses were conducted to determine their product composition. The snacks were divided into subgroups based on product type (fruit drink snacks, licorice, non-dairy ices, ice creams and savories) and their caloric content per portion was compared with the caloric content of reference products derived from the Dutch Food Composition Database (13), using one-sample t-tests. Subgroups containing less than five snacks were omitted from the analyses (peppermints). All statistical analyses were performed with the Statistical Package for the Social Sciences (SPSS version 17.0, 2009, Chicago, IL), and a significance level of 0.05 was adopted.

Results

All products

A total of 47 companies participated in the study, including one retailer and two caterers. Data were collected on 821 products, which was 23.5% of the total number of Choices products available on the market in August 2009 (excluding fresh fruits and vegetables). A total of 417 products were found to be existing products that complied with the Choices criteria; 168 products had been reformulated; 236 products were newly developed to comply with the Choices criteria. The number of Choices products produced by each company ranged from one to 300.
Figure 1 shows the total number of Choices products per product group, subdivided into existing compliant, reformulated and newly developed Choices products. Most products carrying the logo as a result of reformulation were soups (n=68), followed by sandwiches (n=16), other products (n=15) and processed meat (n=11). Most products carrying the logo as a result of new product development were snacks (n=50), followed by processed fruits and vegetables (n=32), fruit juices (n=32), drinks (n=21) and soups (n=21).

Reformulated products

Table 1 shows the product composition per product group before and after reformulation. Fiber levels in fruit juices were found to be significantly increased to obtain the Choices logo ($p<0.05$). Sodium levels and SAFA were significantly reduced in the

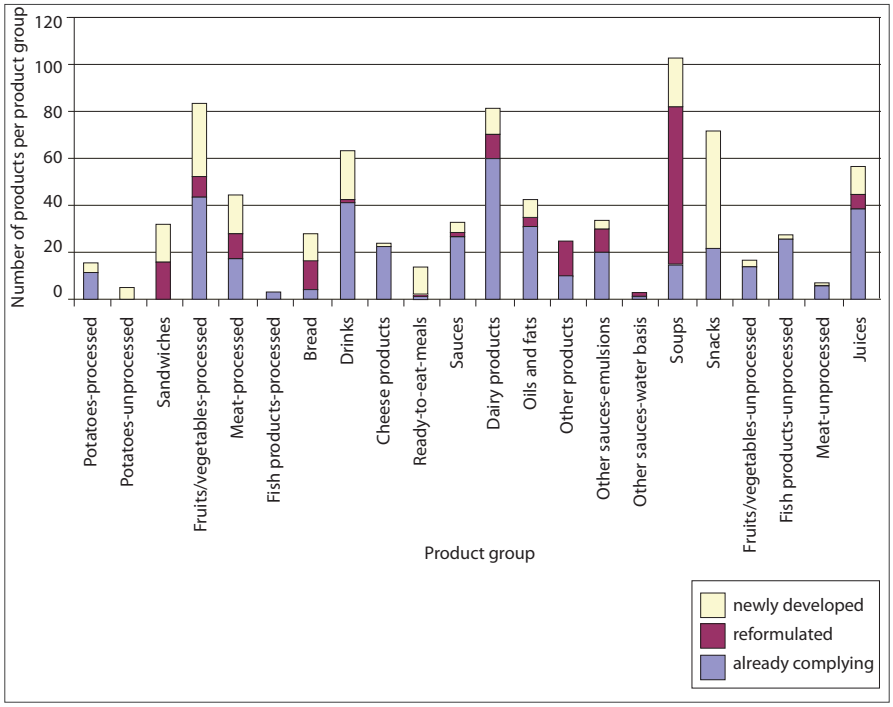
Table 1. Mean (SD) nutrient content of reformulated products (Reform) and the pre-reformulation products (Previous) per product group[1].

Product Category	SAFA[a] Previous (g/100 g)	SAFA[a] Reform (g/100 g)	TFA[b] Previous (g/100 g)	TFA[b] Reform (g/100 g)	Added Sugar Previous (g/100 g)	Added Sugar Reform (g/100 g)	Sodium Previous (mg/100 g)	Sodium Reform (mg/100 g)	Fiber Previous (g/100 g)	Fiber Reform (g/100 g)	Energy Previous (kcal/ 100 g)	Energy Reform (kcal/ 100 g)
Fruit juices (n=6)	-	-	-	-	-	-	1.67 (0.52)	1.67 (0.52)	0.15 (0.12)	0.23* (0.18)	40.50 (3.62)	38.83 (5.49)
Processed meats (n=11)	3.09 (2.46)	1.75* (0.71)	0.081 (0.163)	0.022 (0.031)	1.69 (0.95)	1.00 (0.82)	1017.82 (175.74)	834.55** (56.63)	0.07 (0.13)	0.14 (0.19)	242.82 (210.81)	237.73 (216.64)
Dairy products (n=10)	1.26 (0.52)	0.88* (0.27)	-	-	5.74 (5.49)	1.46* (2.35)	50.30 (15.94)	52.80 (14.76)	–	0.18 (0.57)	57.10 (17.12)	51.20* (10.77)
Sandwiches (n=16)	1.87 (1.76)	1.26 (0.86)	0.111 (0.207)	0.044 (0.053)	0.29 (0.68)	0.33 (0.82)	470.99 (295.55)	273.02* (96.34)	2.40 (1.04)	3.64** (0.86)	198.71 (61.44)	179.18 (28.76)
Soups (n-68)	0.58 (0.48)	0.58 (0.48)	0.016 (0.019)	0.016 (0.019)	0.69 (0.71)	0.69 (0.71)	372.42 (47.91)	322.01** (32.11)	0.30 (0.44)	0.30 (0.44)	41.02 (18.46)	41.02 (18.46)
Sauces emulsions (n=10)	2.54 (1.29)	2.77 (1.46)	0.253 (0.281)	0.168 (0.095)	6.12 (1.84)	5.31* (1.70)	0.71 (0.08)	0.69 (0.07)	1.51 (2.41)	1.51 (2.41)	220.00 (77.60)	215.00 (75.61)
Sandwich filling(n=8)	2.50 (0.53)	1.59** (0.73)	0.025 (0.004)	0.015** (0.005)	5.69 (2.01)	6.06 (2.21)	668.50 (311.29)	406.50* (117.84)	1.05 (0.46)	0.92 (0.62)	293.63 (53.36)	206.75** (49.86)

[1] Paired sample t-tests were used to explore differences in product composition per product group before and after reformulation.

*[a] SAFA: saturated fatty acids [b] TFA: trans fatty acids *p< 0.05 ** p< 0.01*

Figure 1. Total number of products per product group that were newly developed, reformulated or already compliant with the Choices criteria.



processed meats (p<0.01 and p<0.05, respectively). In dairy products, SAFA, added sugar and calories were found to be significantly reduced because of the logo criteria (all p<0.05). Sodium levels in sandwiches were significantly reduced (p<0.05), and fiber levels were increased (p<0.01). Sodium was also significantly decreased in soups (p<0.01). In sauces (emulsions), added sugar was decreased (p<0.05). For sandwich fillings, SAFA (p<0.01), TFA (p<0.01), sodium p<0.05) and calories (p<0.01) were found to be decreased to obtain the logo.

Newly developed products

Table 2 shows the product composition of the newly developed Choices products per product group (mean (SD)) compared with the reference products. The fiber levels in the fruit juices were found to be significantly higher compared to the reference products (p<0.05). For processed meats, sodium levels were found to be significantly lower and fiber levels higher (all p<0.01). In dairy products, SAFA (p<0.01) and added sugar (p<0.01) were significantly lower and fiber levels were higher (p<0.05) than the reference product compositions. Fiber levels were also significantly higher in sandwiches, but added sugar levels were also found to be higher (all p<0.05). For soups, sodium was significantly lower and fiber was higher (all p<0.01). For all product groups, caloric values were found to be unchanged.

Figure 2 shows the caloric content per portion of newly developed Choices snacks compared with the reference snacks selected from the Dutch Food Composition Database (13). The caloric content of all subgroups of Choices snacks was found to

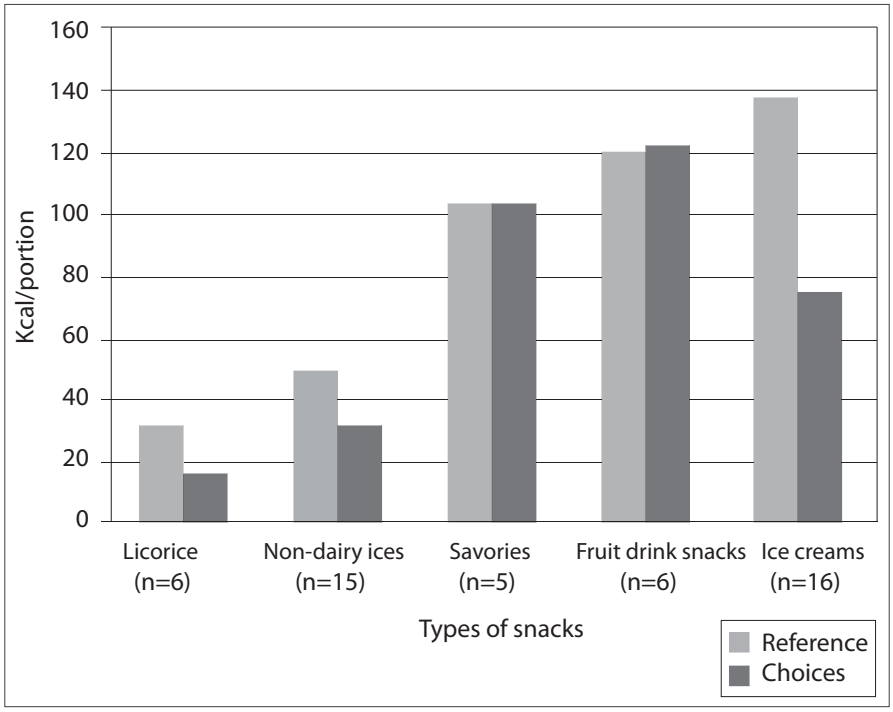
Table 2. Product composition of newly developed Choices products (New) per product group (mean (SD)) compared with reference products (Ref)[1].

Product Category	SAFA[a] Ref (g/100 g)	SAFA[a] New (g/100 g)	TFA[b] Ref (g/100 g)	TFA[b] New (g/100 g)	Added Sugar Ref (g/100 g)	Added Sugar New (g/100 g)	Sodium Ref (mg/100 g)	Sodium New (mg/100 g)	Fiber Ref (g/100 g)	Fiber New (g/100 g)	Energy Ref (kcal/ 100 g)	Energy New (kcal/ 100 g)
Fruit Juices (Ref: n=6, New: n=12)	-	-	-	-		2.13 (3.45)	1.67 (0.52)	2.58 (1.51)	0.15 (0.12)	0.40* (0.23)	40.50 (3.62)	43.00 (9.82)
Processed meat (Ref: n=11, New: n=17)	3.09 (2.46)	1.67 (0.73)	0.081 (0.163)	0.044 (0.043)	1.69 (0.95)	1.08 (1.10)	1017.82 (175.74)	626.04** (242.95)	0.07 (0.13)	0.41* (0.45)	242.82 (210.8)	191.02 (188.65)
Dairy products (Ref: n=10, New: n=11)	1.26 (0.52)	0.15** (0.18)	-	-	5.74 (5.49)	- **	50.30 (15.94)	46.09 (10.90)	-	0.52* (0.63)	57.10 (17.12)	63.45 (35.74)
Sandwiches (Ref: n=16, New: n=16)	1.87 (1.76)	2.08 (0.98)	0.111 (0.207)	0.095 (0.073)	0.29 (0.68)	1.80* (2.11)	470.99 (295.55)	358.97 (76.30)	2.40 (1.04)	3.19* (0.78)	198.71 (61.44)	209.25 (37.76)
Soups (Ref: n=68, New: n=21)	0.58 (0.48)	0.41 (0.34)	0.016 (0.019)	0.036 (0.026)	0.69 (0.71)	0.54 (0.52)	372.42 (47.91)	279.57** (63.40)	0.30 (0.44)	0.77** (0.60)	41.02 (18.46)	42.47 (21.34)

[1] The product composition of the reformulated products before reformulation was used as the reference. Independent sample t-tests were conducted to explore the differences in product composition between newly developed Choices products and reference products

*[a] SAFA: saturated fatty acids [b] TFA: trans fatty acids *p< 0.05 ** p< 0.01*

Figure 2. Caloric content of the subgroups of newly developed Choices snacks compared with reference snacks[1].



[1] The subgroups of Choices snacks and their selected reference products, derived from the Dutch Food Composition Database (2006) and portion sizes, were the following:
Choices: licorice – reference: licorice average (10 g)
Choices: non-dairy ices – reference: non-dairy ices (53 g)
Choices: savories – reference: prepared croquette (44 g)
Choices: fruit drink snacks – reference: fruit 2/day (200 ml)
Choices: ice creams – reference: vanilla ice cream (72 g)

be significantly lower than the reference snacks, with the exception of fruit drink snacks and savory snacks, which remained the same.

Discussion

To the best of our knowledge, this is the largest study to date to investigate the effect of a front-of-pack nutrition label on the development of healthier food products. Our data showed that most products carrying the logo as a result of reformulation and of new product development were soups and snacks, respectively. Sodium was the nutrient reformulated in the most products groups, namely in processed meats, sandwiches, soups and sandwich fillings. Dietary fiber was significantly higher in most newly developed Choices product groups when compared with reference products, namely in fruit juices, processed meats, dairy products, sandwiches and soups.

The finding that sodium is an important nutrient for reformulation is in agreement with a study from New Zealand that showed that the Pick the Tick logo effectively reduced the sodium content in a relatively small sample of food products (12). In addition to a reduction in sodium, our study showed that the Choices logo also led to an improvement in the other nutrients with defined Choices criteria. For example, SAFA and added sugar were significantly decreased in both reformulated and newly developed dairy products. Dietary fiber was increased, also in product groups for which no fiber criteria were defined, such as processed meats and dairy products, possibly due to technological reasons. Newly developed Choices sandwiches, however, had a significantly higher sugar content than reference sandwiches, possibly to compensate for changes in other nutrients; this change deserves attention from a health perspective. Further, we only found significant reductions in the caloric content of dairy products and sandwich fillings after reformulation, and reductions in the caloric content of some newly developed snacks compared with reference snacks. The lack of major reductions in energy density is somewhat disappointing because a high intake of energy-dense food products is one of the major contributors to the prevalence of obesity (1). Nevertheless, even small changes in calories can have a far-reaching public health impact. Roodenburg and colleagues showed a potential reduction in nutrient intakes, including calories, with the consumption of a diet complying with the Choices criteria, indicating their potential impact on energy balance (14). This study is further discussed below.

Most newly developed Choices products were found in the category of snacks. Although the consumption of a limited number of snacks is promoted in the Netherlands, around 30% of a person's daily energy intake comes from food consumption between meals, and the greater part of that amount is snacks (15). Our study showed that Choices snacks generally have a lower caloric content than regular snacks. Other nutrients were found to be changed in positive directions as well, such as decreased levels of SAFA in ice creams (milk-based) and decreased levels of sodium in licorice. This stresses the importance of further encouraging food manufacturers to develop healthier snacks. It has been debated whether it is justifiable to assign a health logo to snacks since the logo could stimulate snack consumption, which could constitute a negative side effect of the logo. Steenhuis and colleagues, however, showed that the use of the Choices logo had no negative side effects on the consumption of a chocolate mousse cake among females in a university community when they compared a cake with the logo to the same cake without it (16). Nevertheless, it is of interest to note that the chocolate mousse cake was not perceived as healthy in that study. Other research indicates that the perception that a snack food was healthy did increase the actual intake of the food (17).

Our study does have some limitations. First, one could question whether our data can be considered a representative sample of the total number of Choices logo products available on the market. By collecting data from food manufacturers representing different types of industries, including multinationals, medium and small enterprises, retailers and caterers, we tried to create a sample that was as representative as possible and we did collect data from all product groups. Nevertheless, we did not collect enough data to be able to analyze all product groups, such as breads for example. Future research should try to include data on the product reformulation of breads because this category is the major source of sodium intake in the Nether-

lands and, therefore, is regarded as an important product for reformulation (18). Secondly, it should be noted that some nutrients in quite a few product groups had a large standard deviation, due to the large variety of products within those product groups. Thirdly, the reference values for the newly developed Choices products could have been selected differently. It is possible that the food manufacturers developed new Choices products (for example, mango yogurt) based on existing non-Choices products (for example, strawberry yogurt) which were only slightly different from the Choices guidelines (for example, less sugar was added to the mango yogurt than to the strawberry yogurt, making the mango yogurt compliant with the Choices criteria). It could be useful for future food reformulation studies to ask food manufacturers more extensive questions about the composition development of newly introduced products. In this way, more valid reference values could be obtained (in this example the strawberry yogurt would have been the reference product for the newly developed Choices mango yogurt).

Finally, we collected data on a voluntary basis and all nutrient composition data were self-reported by the food manufacturers. The response rate was quite low and it is possible that only motivated food manufacturers participated in our research, especially those manufacturers that had significantly improved their products. Unfortunately, no data were collected about how many unhealthy products, or those not meeting the Choices criteria were introduced during the same time frame, to be able to evaluate the overall picture of the food supply. Nevertheless, the finding that motivated food manufacturers improved their products can be considered a positive starting point for the improvement of the availability of healthy products for consumers. It would be interesting for further research to explore why some food manufacturers are motivated to improve their products and others are not, and which aspects of company policies play a role in these decisions.

Despite these limitations, this is the largest study to date to explore the impact of a front-of-pack nutrition label on the development of healthier food products. Whether all significant changes can be considered nutritionally relevant remains to be determined. No consumption data and sales data were collected for this study. Consequently, we are only able to relate our findings to individual product groups and cannot make statements about the actual impact of the Choices logo on a population's health outcomes. Nevertheless, consuming a Choices-compliant diet could potentially lead to substantial improvements in nutrient intake, as reported by Roodenburg and colleagues (14). In this study, the researchers combined food composition data and food consumption data and calculated the usual nutrient intake distributions in the Dutch population of young adults. Additionally, food products not complying with the Choices criteria were replaced by products that did comply. As a result, nutrient intakes for energy, total fat, SAFA, TFA, sodium, and total sugar decreased and fiber intake increased (these are the nutrients included in the Choices criteria). Additionally, positive changes were found for protein, total carbohydrate, PUFAs, MUFAs, calcium, iron and folic acid (nutrients not included in the Choices criteria). The challenge now is how to investigate the actual effect of the Choices logo by combining reformulation data with intake data and sales data. Consequently, possible health gains can be estimated, such as the prevalence of cardiovascular disease, life expectancy and health care costs. For example, in the United States, the Coronary Heart Disease Policy Model has been used to estimate the cost-effec-

tiveness of a population-wide dietary salt reduction (19). In future studies, using such a model could be helpful in estimating the impact of a front-of-pack nutrition logo on a population's health outcomes.

Conclusions

This study indicates that the Choices logo has influenced food manufacturers to reformulate existing products and develop new products with a healthier product composition, especially where sodium and dietary fiber are concerned. Future studies should combine innovation data with consumption data and sales data to explore the impact of the Choices logo on a population's health outcomes.

Conflicts of interest and authors' affiliations

Annet Roodenburg is seconded at the VU University Amsterdam and employed by Unilever R&D, the Netherlands. The other authors have no conflicts of interest. Johannes Brug is employed by the Department of Epidemiology and Biostatistics, EMGO Institute for Health and Care Research, VU University Medical Center, Amsterdam, the Netherlands. The other authors are employed by the Department of Health Sciences and the EMGO Institute for Health and Care Research, VU University Amsterdam, the Netherlands.

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7

Consuming a diet complying with front-of-pack label criteria may reduce cholesterol levels: A modeling study

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Abstract

Introduction: Front-of-pack nutrition labels can help consumers to make healthier choices and stimulate healthier product development. This is the first modeling study to investigate the potential impact on cholesterol levels of consuming a diet consisting of products that comply with the criteria for a 'healthier choice logo'.

Methods: National food consumption and food composition data were used to estimate the nutrient intake of the Dutch adult population (18-70 years old) before and after replacing foods that did not comply by foods that did comply with the Choices front-of-pack label criteria. Different scenarios were established. The difference in cholesterol levels in the Dutch population was assessed before and after replacement by means of equations from meta-analyses that calculate how blood lipids change when diet composition changes.

Results: After replacing non-complying products with products which comply with the label's criteria (maximum scenario), saturated fatty acids intake reduced from 14.5 to 9.8 energy%. Trans fatty acids reduced from 0.95 to 0.57 energy%. The average predicted changes in LDL and total cholesterol levels were -0.25 and -0.31 mmol/l, respectively. Because HDL cholesterol levels reduced as well (-0.05 mmol/l), overall, the result was a slightly positive change in the total cholesterol/HDL ratio (-0.03).

Conclusions: Our findings suggest that the consumption of foods complying with the criteria for a front-of-pack label may contribute moderately to cardiovascular risk reduction via influencing blood lipids. These findings were independent of other potential effects on related health outcomes.

Introduction

The World Health Organization recommends limiting the intake of sodium, sugar, saturated fatty acids (SAFA) and trans fatty acids (TFA) in order to reduce the prevalence of diet-related chronic diseases (1). Front-of-pack nutrition labels are tools that can assist with this. They aim to help consumers to make healthier choices and can encourage food manufacturers to develop healthier products. Many countries, food manufacturers, retailers and consumer organizations have developed their own labels, with different designs and criteria (2, 3).

In the Netherlands, since 2006, the front-of-pack label 'Choices' has been present on a variety of food products in supermarket chains and food services. An independent international scientific committee developed the label's criteria. Products that contain lower levels of sodium, sugar, SAFA, TFA and energy and increased levels of dietary fiber compared with similar products within the same product category can obtain the label. The detailed background of the label has been described elsewhere (4, 5). We found that health-motivated consumers not only reported purchasing but also actually purchased more labeled products (5, 6), although our randomized controlled trial in worksite cafeterias did not show an effect of labeling on lunchtime food purchases (7). We also found that the label has caused food manufacturers to reformulate existing products and to develop new products with a healthier nutrient composition (8).

It is hypothesized that an increased availability of reformulated products due to front-of-pack labels will eventually contribute to better nutrient intake and subsequently a healthier population. Earlier studies combined food consumption data with food composition data in order to explore the potential impact of the Choices criteria on a population's nutrient intake. They found that consuming a diet which complies with the label's criteria can potentially lead to substantial improvements in nutrient intake (9, 10). However, these studies only calculated the nutrient intake for the Dutch population of young adults. Furthermore, nutrient intake was the outcome measure, and these studies did not model the potential impact on health-related risk factors. One other study did model the effects of a front-of-pack label on health-related risk factors and assessed its cost-effectiveness. Sacks and colleagues assumed that health outcomes could be modeled via a change in body weight, and found that traffic light labeling is likely to be an excellent value-for-money obesity prevention measure (11). To the best of our knowledge, no studies have yet calculated the effect of consuming a diet which is compliant with the criteria of a front-of-pack label on a specific cardiovascular risk factor, such as cholesterol levels. There is a large body of evidence on the association between one's intake of different fatty acids and cholesterol levels and subsequently with coronary heart disease (CHD) (12-14). Therefore, this study aimed to model the potential impact of consuming a diet which is compliant with the Choices criteria on cholesterol levels for the total Dutch adult population.

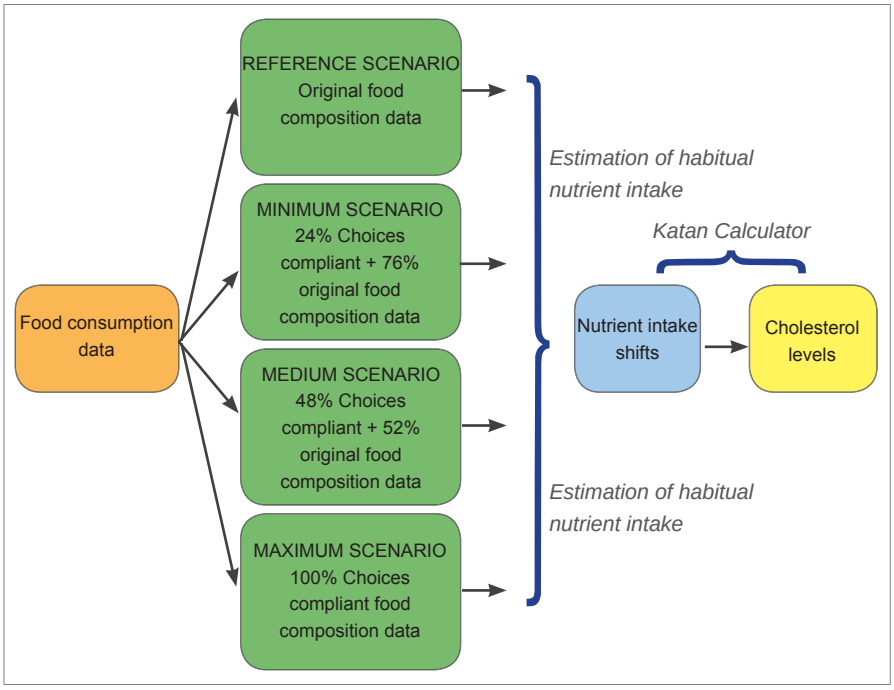
Methods

First, we developed four different nutrient intake scenarios for the Dutch adult population (18-70 years). Second, we calculated the nutrient intake distribution in the population for each of the scenarios. Third, we estimated the effect of shifts in several fatty acids on average cholesterol levels. Figure 1 illustrates the design of this study. Please note that this study focused on modeling the effects on cholesterol levels. It did not investigate other potential effects on related intermediaries and health outcomes, such as BMI, blood pressure, stroke, diabetes and cancer.

Food consumption data

We used data from the Dutch National Food Consumption Survey 1997-1998 (15). These data are currently the most recent food consumption data available for the total population of the Netherlands. The survey was conducted among 6250 Dutch participants aged > 1 year old. This group is considered to be representative in terms of sex, age, level of education and place of residence for the general Dutch population. Trained dieticians instructed the participants to keep a two-day-diary. In the present study, we focused on the adult population aged 18-70 years old (n=4336).

Figure 1. Study design



Food composition data

We also used food composition data from the Dutch food composition database (16) for the following nutrients: SAFA (expressed as percentage of total energy intake (en%)), trans fatty acids (TFA; en%), sodium (g), energy (kcal) and fiber (g) (the Choices nutrients) and monounsaturated fatty acids (MUFA; en%), polyunsaturated fatty acids (PUFA; en%), protein (en%) and cholesterol (mg) (needed for calculating the effects on cholesterol) (17). Added sugar (en%) was estimated based on imputation of the mean value for comparable products within the same product group. Foods were scored according to the Choices criteria for each food group. Alcoholic beverages and special diet products were excluded as there are no Choices criteria for these product groups. Foods were compliant with the front-of-pack label if they met all of the criteria for each nutrient (SAFA, TFA, sodium, energy and fiber). The scoring resulted in 516 products that complied with the label's criteria, 999 non-compliant products, and 57 which could not be scored due to missing nutrient data.

Replacement procedure

All consumed products which did not comply with the Choices criteria were replaced by products complying with the criteria and which were available in the Dutch food composition database. We only replaced products within the defined Choices product groups, as the program assumes that consumers choose products within certain product groups. If we found no similar product suitable for replacement, the product was not replaced (which was the case for 36% of the non-compliant products). Products that already complied were not replaced. Three trained investigators (ELV, MAHH, AJCR) systematically compared all of the replacements.

Reference scenario

We combined the Dutch food consumption data with data from the Dutch food composition database in order to estimate the nutrient intake of the Dutch adult population aged 18-70 years old. This reference scenario was compared to each of the three scenarios explained below.

Minimum scenario

We estimated the nutrient intake of the Dutch population if 24% of the population replaced their food with products which complied with the label's criteria. This was based on our supermarket observations which showed that 24% of consumers' supermarket purchases consist of labeled products (6). If 24% of a population's intake comes from products complying with the label's criteria, it was assumed that it would be possible to calculate the population's nutrient intake as if 24% of the population ate only products complying with the label's criteria.

Medium scenario

We assume that the current trend for innovation and healthy behavior will continue, due to the increasing interest of food manufacturers in product reformulation and the increasing health education of consumers. Therefore, we also performed calculations for a scenario in which 48% of the population replaced their food products with products which complied with the label's criteria (twice the minimum scenario).

Maximum scenario
We finally performed calculations in which 100% of the population replaced their food products with products which complied with the label's criteria.

Analyses
Nutrient intake. The habitual intake for all nutrients was calculated based on the two-day diaries, correcting for within-individual variation (e.g., day-to-day correlation and interview sequence), using the Iowa State University (ISU) method (SIDE/IML version 1.11, 2001; Iowa State University, Ames, IA, USA) for the reference and the maximum scenarios. In order to take into account the uncertainty regarding which subjects will actually replace their food products with compliant food products in the minimum and medium scenarios, a probabilistic procedure was applied. A random sample was drawn from the study population, corresponding to the proportion of the study population who would substitute their food products with products which complied with the label's criteria (24% and 48%). We assumed that the subjects who were not selected (76% and 52%) continued to consume their regular foods. This sampling procedure was repeated 100 times. For each sample, habitual nutrient intake was calculated. The results presented are the median values for all of the samples. We compared the median intake to the recommended intake levels developed by the Health Council of the Netherlands (18) and, if these data were not available, to the recommendations of the WHO (19). Additionally, insight in the contribution of nutrients by various product groups was obtained to investigate which product groups contributed most to the changes in nutrient intakes. First, the relative reduction per product group for each individual was calculated, and subsequently, the distribution of changes was derived for the whole population per food group.
Cholesterol. In order to calculate the effects of the shift in nutrient intake on cholesterol levels, we used the Katan Calculator, an online tool (www.katancalculator.nl) that calculates how blood lipids change when the subject's diet composition changes (17) This online tool is based on high-quality scientific data (13, 20-22). Body weight is assumed to remain constant in this calculation tool, because changes in body weight may also influence cholesterol levels and otherwise would bias the outcomes of the calculations. The minimum, medium and maximum scenarios were compared with the reference scenario using the different SAFA, TFA, MUFA, PUFA, protein and cholesterol intake values as the input. The outcomes recorded were changes in LDL, HDL, total cholesterol and in the ratio total cholesterol/HDL.

Results

Nutrient intake
Table 1 shows the median (5th percentile; 95th percentile) habitual intake of the different nutrients for the four scenarios for the total adult population (18-70 years old). The nutrients SAFA, TFA, sodium, added sugar and energy (which were used as criteria in the replacement procedure) showed reductions for all scenarios, while fiber levels increased. When looking at the other nutrients, increases in the subjects' intake were shown for PUFA, protein and cholesterol, and a decrease was found for MUFA. The probability approach for the minimum and medium scenario showed median intake estimates (P5 and P95 of the 100 iterations) ranging between 13.27 to 13.35 en% for SAFA and 0.84 to 0.85 en% for TFA in the minimum scenario; and

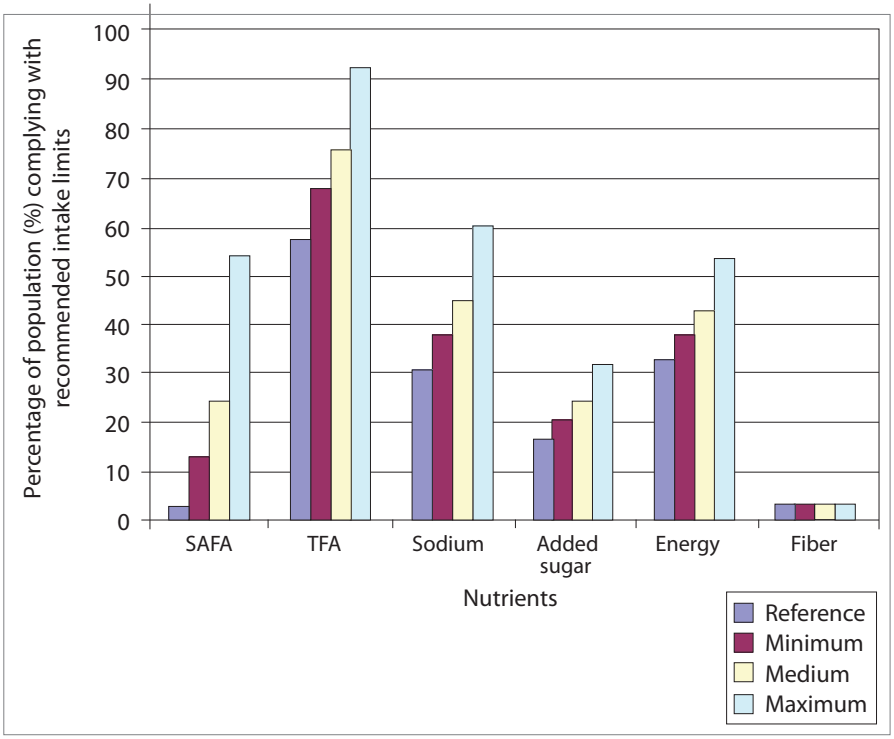
Table 1. Median (5th percentile; 95th percentile) habitual intake of different nutrients in the different scenarios among the total Dutch adult population.

Nutrients	Reference	Minimum[1]	Medium[1]	Maximum	Rec[a]
SAFA[2] (en%)	14.5 (10.5; 18.7)	13.3 (8.6; 18.6)	12.1 (7.6; 17.8)	9.8 (7.3; 12.8)	<10
TFA[2] (en%)	0.95 (0.59; 1.49)	0.8 (0.4; 1.5)	0.7 (0.3; 1.4)	0.57 (0.29; 1.09)	<1
MUFA[2] (en%)	11.5 (8.9; 14.6)	11.4 8.5; 14.7)	11.2 (8.2; 14.6)	10.7 (7.6; 14.5)	MUFA + PUFA: 8 - 38
PUFA[2] (en%)	6.9 (4.5; 10.4)	7.1 (4.6; 10.4)	7.2 (4.8; 10.5)	7.5 (5.2; 10.4)	MUFA + PUFA: 8 - 38
Protein (en%)	15.3 (11.5; 20.3)	16.2 (11.7; 22.4)	17.1 (12.2; 23.9)	19.3 (14.6; 25.3)	<10
Cholesterol (mg)	227.0 (132.4; 376.8)	214.7 (122.5; 362.6)	202.7 (115.2; 344.3)	178.9 (108.2; 288.8)	<300
Sodium (g)	2.8 (1.7; 4.4)	2.6 (1.5; 4.2)	2.5 (1.4; 4.0)	2.2 (1.3; 3.5)	<2.4
Added sugar (en%)	18.8 (5.0; 39.2)	17.5 (4.2; 37.8)	16.2 (3.6; 36.1)	13.7 (2.7; 31.3)	<10
Energy (kcal)	2241 (1402; 3357)	2171 (1342; 3279)	2100 (1296; 3187)	1956 (1226;2924)	<2000
Fiber (g)	20.7 (11.7; 33.1)	21.0 (12.0; 33.3)	21.3 (12.4; 33.5)	22.0 (13.2; 33.8)	30-40

[1] Median of multiple sampling (100 times)
[2]SAFA: saturated fatty acids; TFA: trans fatty acids; MUFA: monounsaturated fatty acids; PUFA: polyunsaturated fatty acids
[a] Rec: Recommended daily intake (upper limit) for SAFA, TFA, sodium, energy, fiber, MUFA, PUFA and protein as recommended by the Dutch Health Council (18). There are no recommendations for added sugar and cholesterol in the Netherlands; therefore, the recommendations for these nutrients were based on WHO recommendations (added sugar recommendations are for free sugars) (19).

12.04 to 12.13 en% and 0.74 to 0.76 en% for SAFA and TFA respectively in the medium scenario. The other nutrients showed similar narrow ranges.
The last column of Table 1 shows the recommended daily intakes. Figure 2 illustrates the percentage of the total adult population who complied with the recommendations for the nutrients used in the replacement procedure. It is shown that 54.0% of the population complied with the recommendations for SAFA in the maximum scenario, 60.2% for sodium and 53.3% for energy. For TFA, the reference median intake already complied with the recommendation of <1 en%. It is shown that for

Figure 2. Percentage of total adult population complying with recommendations for SAFA, TFA, sodium, added sugar, energy and fiber in the different scenarios[1].



[1]Recommended daily intake (upper limit) for SAFA, TFA, sodium, energy and fiber as recommended by the Dutch Health Council (see Table 1 for values) (18). There is no recommendation for added sugar; therefore this recommendation was based on WHO recommendations (19).

added sugar, 32.2% of the population complied with the recommendations in the maximum scenario, but that only 3.8% complied with the recommendations regarding fiber.

Table 2 shows the five product groups which contributed most to changes in SAFA and TFA median intakes (two nutrients of importance regarding cholesterol levels), the number of non-complying products which were replaced by complying products from the food composition table, and some replacement examples that are responsible for the changes. The table illustrates that replacing cheese products and processed meats contributed most to the SAFA reduction when comparing the maximum scenario with the reference intake. Replacing oils, fats and fat containing spreads caused the largest reduction in TFA intake.

Table 2. The five product groups which contributed most to the changes in SAFA and TFA median intakes, the number of non-complying products which were replaced by complying products from the Dutch food composition table (2006), and some replacement examples responsible for the changes.

Product group	P50 change (%) SAFA[1]	P50 change (%) TFA[1]	Number of products replaced (total number of non-complying products)	Product example	Replaced by
Bread	-10.3	-25.9	33 (42)	All types of cracker All types of bread Bread without gluten	Light crackers Tarvo bread NOT REPLACED
Processed meat, meat products and meat substitutes	-57.3	-50.8	96 (156)	All types of processed beef products Organ meats, croquettes, sausages	Beefsteak (pre-prepared) NOT REPLACED
Dairy products	-38.2	-34.7	77 (142)	Full-fat yoghurt Fall-fat fruit yoghurt Creamers, crème fresh	Low-fat yoghurt Low-fat fruit yoghurt NOT REPLACED
Oils, fat and fat-containing spreads	-36.9	-87.1	43 (55)	All types of butter	Low-fat margarine
Cheese (products)	-61.4	-61.4	44 (59)	All types of regular cheese All types of cheese spread Special cheeses	Low-fat cheese Low-fat cheese spread NOT REPLACED

[1]Percentage of changes in saturated fatty acids (SAFA) and trans fatty acids (TFA) median (P50) intakes when comparing the median intakes of the maximum scenario with the reference scenario per product group.

Cholesterol

Table 3 shows the effects of the different scenarios on the cholesterol level of the total adult population. It is shown that LDL and total cholesterol levels reduced slightly when the minimum, medium and maximum scenarios were compared with the reference scenario. HDL was found to be reduced as well, resulting in a small change in the total/HDL ratio.

Table 3. Effect of scenarios on cholesterol levels for total Dutch adult population, using Katan Calculator (17) (Input: P50 of SAFA, MUFA, PUFA, TFA, cholesterol, protein; minimum, medium and maximum scenario compared with reference scenario). [1]

Scenario	Minimum	Medium	Maximum
Change LDL (mmol/l)	-0.07	-0.13	-0.25
Change HDL (mmol/l)	-0.01	-0.03	-0.05
Change total chol. (mmol/l)	-0.08	-0.16	-0.31
Change Total/HDL Ratio	-0.01	-0.02	-0.03

[1] SAFA: saturated fatty acids; TFA: trans fatty acids; MUFA: monounsaturated fatty acids; PUFA: polyunsaturated fatty acids.

Discussion

This is the first study that has investigated the potential impact of consuming a diet which complies with the criteria for the Choices logo, a front-of-pack 'healthier choice' logo, on cholesterol levels by conducting a modeling study. Our findings show that when all foods that can be replaced by foods that comply with the criteria for the Choices front-of-pack label are replaced (maximum scenario), population cholesterol levels are likely to reduce slightly.

Nutrient intake

Whereas the minimum and the medium scenario reveal a small move in nutrient intake towards the recommendations, the median intakes reached the recommended levels for the nutrients SAFA, sodium and energy in the maximum scenario only. However, sodium intake will be higher in reality, because added sodium was not taken into account. If one aims to achieve the recommended levels for the total population, these findings show that these scenarios are just a starting point from which to further stimulate food reformulation and healthy food choices. A more positive effect on intake and consequently on public health could be achieved by applying more stringent logo criteria for nutrient levels in each food group. With regard to added sugar and fiber, the intakes in the maximum scenario are still far from the recommendations, stressing the importance of paying extra attention to these nutrients.

Cholesterol and CHD

In all scenarios, a small reduction in mean cholesterol levels was predicted, which may result in a reduction of the risk of CHD. Interestingly, there is a large body of evidence regarding the negative health effects of excessive SAFA intake on cholesterol levels and CHD, and the positive effects of replacing SAFA with PUFA (12-14). Therefore, it is recommended that a shift towards greater PUFA consumption in place of SAFA would significantly reduce rates of CHD (14). In our scenarios, we did find a reduction in SAFA, but we did not find a large increase in PUFA. It would be interesting to further explore the possibilities for product reformulation by food manufacturers, and the technological feasibility of (partly) replacing SAFA with PUFA.

Furthermore, while some review studies use total cholesterol as a marker to predict CHD and others use LDL cholesterol levels, the total/HDL cholesterol ratio appears to be one of the strongest predictors of CHD risk, although the precise role of HDL in relation to CHD is not yet clear (23, 24). Epidemiological studies suggest that a one unit change in total/HDL cholesterol is associated with a 53% change in the risk of myocardial infarction (MI) (25), which could be translated to an MI risk reduction of 1.59% for our maximum scenario. Although this is a very small risk reduction on an individual level, it may be substantial on a population level. As Rose states in his book 'The strategy of preventive medicine' (26): *When many people each receive a little benefit, the total benefit may be large.* This can be explained by the fact that those people who are slightly above the centre of the population distribution will move to a lower risk. For an individual, the risk reduction may be negligible, but collectively, on a population level, the effect is large. Browner and colleagues modeled that if Americans reduced their fat intake from 37 en% to 30 en%, the risk of CHD in elderly people may be reduced by 5% (27). At a population level, the researchers translate this risk reduction to 60 million years of additional life for the American population. However, on an individual level, this means a possible gain of three or four months in life expectancy. These benefits will be greater for high-risk groups, but may equal zero for someone with no risk factors. We did not differentiate between high-risk groups in our study, which could be an interesting topic for future studies. The risk of CHD obviously depends on many other risk factors as well such as prior coronary events, blood pressure, glucose tolerance, inflammatory markers, body mass index, physical activity, age and total dietary pattern (24, 28).

Study limitations

Scenario modeling has its inherent limitations, especially because of its many assumptions. In the first place, what foods may be replaced by which alternatives is theoretical; we attempted to tackle this to some extent by using three independent researchers to decide upon likely replacements. Second, we assumed that people would eat as much of the replacement foods as they ate of their traditional choice. It may be that people will eat more of products they perceive to be healthier. Provencher and colleagues showed that the perception that a cookie was healthy increased the actual intake of the food (29). Nevertheless, Steenhuis and colleagues showed no increased intake when comparing the consumption of a cake with the Choices logo to the same cake without it (30) (note that this cake was not perceived as healthy). These studies focused on only one product and therefore further research is required regarding overall dietary patterns. A third limitation is that the minimum

scenario was based on a single study that may not be fully representative of the population at large (6). The assumption that 24% of adults would change to a diet that is fully compliant with the label's criteria may thus be too optimistic, although we currently have no evidence about what would be a more realistic scenario. Future studies could explore what percentage of compliant products is typical for an average consumer, and include this percentage in more realistic scenario calculations (for example 24% of the population consuming a diet with 10% of products that are compliant). However, if lower than 24% is more realistic than the present 'minimum' scenario, then the effects on nutrient intakes and subsequently on cholesterol levels will be even smaller. Fourth, the available national representative food consumption data used were based on self-reports, and were somewhat outdated.

Future research

In spite of these limitations, this study provides unique initial insights into the potential effects of consuming a diet which complies with the criteria for a front-of-pack label on cholesterol levels. This study focused on modeling the effects on cholesterol levels. It did not examine other potential effects on related intermediaries and health outcomes, such as BMI, blood pressure, stroke, diabetes and cancer, which are obviously interrelated. Therefore, it would be interesting for future modeling studies to develop a model which takes other intermediaries and health outcomes into account.

Further, we realize that modeling studies are limited by the fact that all outcomes are potential outcomes. Further research should therefore also focus on actual health outcomes in real-life settings. Ireland and colleagues showed that nutrition education about the front-of-pack symbol Pick the Tick (from Australia and New Zealand) significantly decreased urinary sodium excretion (31). We recommend that future studies follow, for example, a cohort of consumers consuming a diet which complies with the criteria for a front-of-pack label and to measure biomarkers, such as blood lipid levels and urinary sodium excretion.

Conclusions

Our findings suggest that the consumption of foods which comply with the criteria for a front-of-pack label may contribute moderately to cardiovascular risk reduction via influencing blood lipids. These findings did not take into account other potential effects on related intermediaries and health outcomes, such as blood pressure, BMI, stroke, diabetes and cancer. Further research should focus on biomarkers in real-life settings in order to investigate the real public health impact of front-of-pack nutrition labels on our society.

Conflicts of interest and authors' affiliations

Annet Roodenburg is seconded at the VU University Amsterdam and employed by Unilever R&D, the Netherlands. Hans Verhagen works at the National Institute for Public Health and the Environment (RIVM), the Netherlands. He was requested by the Dutch Ministry of Health, Welfare and Sports (MinVWS) to actively participate in the project group in order to assure agreement on the quality, however leaving the responsibility for the project with the Choices Foundation; the RIVM is an agency of the MinVWS. Rest of the authors declare no conflicts of interest. Marieke Hendriksen

and Joop van Raaij are also employed by the RIVM. Ellis Vyth, Ingrid Steenhuis and Jacob Seidell are employed by the Department of Health Sciences and the EMGO Institute for Health and Care Research, VU University Amsterdam, the Netherlands. Johannes Brug is employed by the Department of Epidemiology and Biostatistics, EMGO Institute for Health and Care Research, VU University Medical Center, Amsterdam, the Netherlands.

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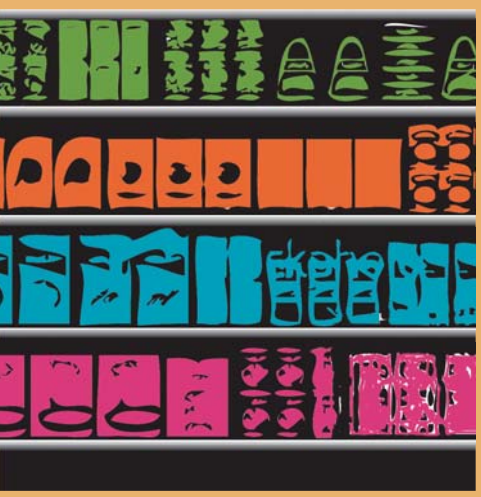

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Methodological quality of front-of-pack labeling studies: A review and identification of research challenges

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Abstract

Introduction: Evaluations of the effects of front-of-pack (FOP) labeling vary in their methodologies and rigor. This is the first review that evaluates the methodological quality of current FOP labeling research.

Methods: Peer-reviewed articles were identified using a computerized search of the databases PUBMED and the Web of Science (ISI) from 1990 to February 2011; reference lists from key published articles were additionally used to identify published studies. Study quality of the 31 included studies was assessed. Studies were subdivided in self-reported consumer studies (n=11), observational consumer studies (n=9), sales (n=3), reformulation (n=3), and health outcomes (n=5).

Results: Observational consumer studies had a higher quality than self-reported consumer studies. Sales studies make use of large databases in real life settings, but lack control groups. There is a lack of a validated methodology for measuring FOP label use in real life settings. Regarding reformulation, the challenge is to collect large samples of chemically analyzed food composition data. Modeling studies can provide interesting insights in the potential population health effects of FOP labels, but are based on theoretical assumptions. Only one study used biomarkers to assess the health effects of a FOP label in a real life setting.

Conclusions: Few methodologically sound FOP labeling studies are presently available. The highest methodological quality and public health relevance is achieved by measuring health effects of FOP labels by using biomarkers in a longitudinal randomized controlled design in a real life setting. Future research challenges are discussed.

Introduction

Front-of-pack (FOP) nutrition labels are present on food products worldwide (1-4). Most labels are assigned to products which have reduced levels of saturated fat, sugar, salt and calories. The World Health Organization recommends limiting the intake of these nutrients to reduce the prevalence of diet-related chronic diseases (5). Although the present FOP labels have different designs, different product criteria and different developers, they generally have the same two aims: to assist consumers in making healthier food choices and to stimulate food manufacturers to produce healthier products.

In recent years there has been an international debate about the preferred format and potential impact of front-of-pack nutrition labeling. Regulatory changes are currently being considered by the European Parliament (6, 7) and regulatory bodies in Australia and New Zealand (8, 9). The Institute of Medicine (IOM) and the Food and Drug Administration (FDA) in the United States are also currently conducting research in this area (1, 10). In this highly political debate, policy makers, scientists, industry groups and consumer organizations are looking for evidence-based information on the effects of FOP labels to support their policy (7, 11, 12). As a result, more and more studies testing the effectiveness of the FOP labels are published. Researchers study different aspects, such as (self-reported) consumer understanding, liking and use of FOP labels (13-23), observational label use (24-32), and effects on reformulation (33-35), sales, (36-38) and health outcomes (39-43). In this way, they aim to evaluate the impact of the labels on the health of our society. Until now, there is no consensus about the actual (health) effects of different FOP labels, neither is there consensus about the optimal format to guide consumers' food purchases.

Thus, many studies have investigated whether or not FOP labels are effective in changing consumers' food choices and improving public health. However, to the best of our knowledge, no overview has been published regarding the methodological quality of these studies. Studying methodological issues is important because good scientific studies can provide reliable evidence about the effectiveness of FOP labels. Some studies already did identify some methodological limitations, for example that self-reported data do not accurately reflect actual FOP label use (23, 26, 28). Consequently, more studies started to make use of observational data, such as in-store observations (25, 26, 29, 32), eye-tracking (27, 31), or collecting supermarket sales data (36, 37). However, do these data accurately reflect real food purchases resulting from FOP labels, or do other factors bias the results? How do we study the effectiveness of FOP labels in the best way, and which outcome measures are most relevant for public health? In considering these questions, this study aimed to provide a review of the methodological quality of current FOP labeling research. We discuss the strengths and limitations of the current studies and propose future research challenges.

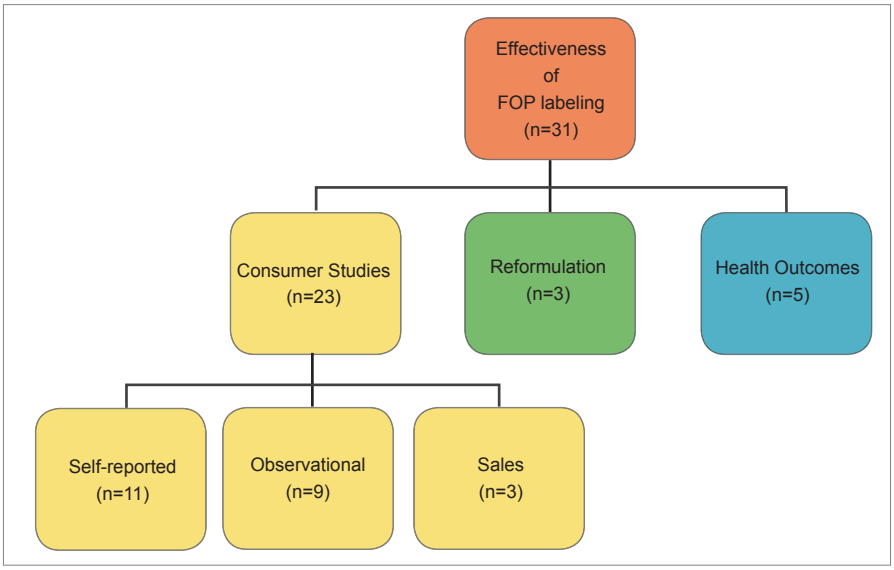
Methods

Structure of this overview

"Effectiveness" was defined as the measure of impact of FOP labels on *consumer behavior, reformulation*, and *health outcomes*. Consumer behavior was subdivided in effects on consumers' *self reported understanding and use* of FOP labels, effects

on consumers' *observational use* and effects on *sales*. See Figure 1 for a schematic representation of this subdivision, which was based on the designs and main outcomes of the studies.

Figure 1. Structure of this review: schematic representation of the subdivision based on the designs and main outcomes of the studies.



Search strategy

Peer-reviewed articles were located using a computerized search of the databases PUBMED and the Web of Science (ISI) from 1990 to February 2011. We used the following keywords: "front of pack," "nutrition logo," "nutrition label," "nutrition symbol," "on package nutrition information," and "health logo." Also, we used the names of all current existing FOP labels as key words, for example: Traffic Light, Guiding Stars, Canada's Health Check, AHA Heart Check, NuVal, Green Keyhole, Choices logo, Guideline Daily Amount (GDA), Finnish Heart Symbol, and Pick the Tick (1, 3). In addition, we reviewed the reference lists from key published articles and nutrition reviews for relevant articles.

Inclusion and exclusion criteria

We included studies that evaluated the effectiveness of existing FOP labels actually in use. Studies investigating the nutrition facts panel and other back-of-pack information, health claims, calorie labeling, general on-package nutrition statements (e.g. "low salt" or "healthy food"), the general term "FOP labels" without mentioning the name of any specific FOP label, or self-developed health logos (e.g. a tick with the text 'healthy choice' developed by researchers and tested in a specific study design) were excluded. Further, FOP labeling studies that had no clear effectiveness measure on consumer behavior or product development, and studies belonging to larger studies or that did not contain original research were excluded, such as overview articles, review articles, reports of penetration of FOP labels and editorials.

Quality score

The quality of the included studies was assessed by two independent researchers (ELV and HEB) by using the quality assessment tool developed by Sirriyeh et al. (44). This tool is applicable to diverse research designs, including quantitative, qualitative and mixed designs and enables comparison among a diverse range of studies. The tool consists of 16 criteria. Each research paper was awarded a score on a scale from 0 to 3 for each of the criteria. Discussion following the independent scoring of papers resolved any differences in agreement by the two researchers. The sum of the scores provided a quality score per paper, and this score was expressed as a percentage of the maximum score possible (range 0-100%).

Results

The initial search generated a total of 622 citations, of which 122 titles appeared to meet the inclusion criteria and were reviewed. After reading the abstracts and/or full text articles, 31 studies met the inclusion criteria and were included. Table 1 lists the characteristics of these 31 studies. We found 11 self-reported consumer studies, 9 objective consumer studies, 3 sales studies, 3 studies focusing on reformulation, and 5 studies focusing on health outcomes. The last column of Table 1 shows the quality scores (%) per paper. Table 2 lists the main items identified to contribute to a high and a low quality scoring, which are discussed per subheading below.

Self reported consumer studies

The earliest studies evaluating effects of FOP labels, of which we found 11 studies (13-23), use consumer surveys. The outcome measures of these studies are based on self-reported data. Consumer studies using questionnaires generally aim to provide insight toward the understanding and use of FOP labels, and to explore any differences in perception between consumer groups (high/low educated, normal weight/obese, men/women etc.). Most of the studies compare different FOP labeling formats and try to identify which format guides consumers best in making healthier food choices (13, 15-18, 21, 22). The mean quality score of these studies was 48.8% (range 35.7% - 62.5%). A criterion on which the studies scored high in general was a “representative population sample of considerable size”: 9 of the 11 studies used large, well-balanced consumer panels consisting of 400 up to 2200 consumers (13-15, 17-20, 23). Criteria on which most studies received low scores were the “explanation for choice of data collection tools” and the “fit between research question and method of data collection”: many different tools were used to measure “use” and “understanding,” such as labeling tasks with photos, choice cards, computer tests, and comparing mock packages (13-16, 18). How well do these experimental self-reported data reflect actual understanding and use in real life shopping environments? A critical reflection on the chosen tools in the limitations sections was generally lacking. Also, the studies scored poorly with regard to validity of the measurement tools: although one study referred to some pretested scales (13), none of the used questionnaires were validated.

Only two studies used focus group interviews (22, 23). These qualitative group interviews were used to provide more in-depth insights as to how consumers understand and use FOP labels while, for example, showing some product packages.

Table 1. Study characteristics of front-of-pack (FOP) labeling studies included in this review (n=31) and their quality scores.

Type of study	First auther, year (reference number)	Type of existing FOP label	Subjects (n)	Setting	Study design/ control group	Main outcome measure(s)	Type of data collected	Authors' conclusions	Quality score [1]
Self-reported consumer studies	Andrews, 2011 (13)	Smart Choices, traffic lights – GDA	US consumers (520)	Online survey, mock packages in questionnaire	Cross sectional	Healthiness perception, nutrient use, purchase intentions	Self-reported questionnaire data	Smart Choices can lead to positive and potentially misleading nutrient and healthiness evaluations when compared to traffic lights-GDA or no FOP.	54.8%
	Balcombe, 2010 (14)	Traffic lights	UK consumers (477)	Experimental setting with choice cards in questionnaire	Cross sectional	Understand-ing of traffic lights	Questionnaire data	Consumers prefer to reduce any nutrient with red light; differ-ent consumer groups respond differently to traffic lights.	52.4%
	Borgmeijer, 2009 (15)	Traffic lights, GDA	Consumers (420)	Experimental setting, tasks with photos with labeled foods	Randomized experimental design: 4 labe-ling groups and 1 control group	Identification of healthier food in pair-wise com-parisons and daily food selection	Photo selec-tions by inter-viewer	Most correct identi-fications of healthier foods with traffic lights; envisaged daily food consumption did not dif-fer among conditions.	45.2%
	Feunekes, 2008 (16)	Traffic lights, Wheel of Health (+ fake labels)	Consumers from 4 Euro-pean countries (1630)	Online questionnaire	Cross sectional	Consumer friendliness and usage intention	Self-reported questionnaire data	Simpler labeling formats more appropriate to make quick purchase decisions.	40.5%

Type of study	First auther, year (reference number)	Type of existing FOP label	Subjects (n)	Setting	Study design/ control group	Main outcome measure(s)	Type of data collected	Authors' conclusions	Quality score [1]
Self-reported consumer studies *(continued)*	Gorton, 2009 (17)	Traffic lights, GDA	New Zealand shoppers (1525)	25 supermarkets	Cross sectional	Understand-ing and use of different FOP labels	Questionnaire data	High reported use of labels; traffic lights showed high under-standing across ethnic and income groups.	59.5%
	Kelly, 2009 (18)	Traffic lights, GDA	Australian consumers (790)	Experimen-tal setting, choice tasks with mock packages	Cross sectional	Consumer ability to compare the healthiness of labeled products	Question-naire data + interviews about the choice tasks	Traffic lights were most effective in assisting consumers to identify healthier foods.	47.6%
	Larsson, 1996 (19)	Keyhole	Swedish women (616)	Experimental setting	Cross sectional	Knowledge of Keyhole and relation to dietary fibre and fat intake	Questionnaire data + 24h recall	Most women under-stood meaning of Key-hole, but no difference in total fat or fiber intake between less and more knowledge.	50.0%
	Larsson, 1999 (20)	Keyhole	Swedish participants (1591)	Experimental setting	Cross sectional	Knowledge of Keyhole and relation to dietary behavior	Questionnaire data + food frequency questionnaire	Higher intake of Key-hole low-fat foods in people with knowledge about Keyhole, but this counted not for less educated ones.	50.0%

Type of study	First auther, year (reference number)	Type of existing FOP label	Subjects (n)	Setting	Study design/ control group	Main outcome measure(s)	Type of data collected	Authors' conclusions	Quality score [1]
Self-reported consumer studies *(continued)*	Moser, 2010 (21)	GDA, traffic lights	Consumers from Germany (147) and Belgium (128)	Consumer surveys (face to face interviews + self-administered questionnaires	Cross sectional	Understanding and preference	Self-reported survey data	German consumers prefer traffic lights, while Belgium consumers prefer GDA. Socio-demographics also play an important role.	35,7%
	Signal, 2008 (22)	Pick the Tick, traffic lights	Maori, Pacific and low-income New Zealanders (158)	Focus groups interviews	Cross sectional	Understanding and use of different labeling systems	Qualitative focus groups	Lack of use of nutrition labels due to lack of time, lack of understanding, shopping habits and absence on low-cost foods.	38.1%
	Vyth, 2009 (23)	Choices	Dutch consumers (2200)	Online questionnaires + focus group interviews	Cross sectional design on two different times	Exposure, and reported logo use	Self-reported questionnaire data + qualitative focus groups	Exposure to logo increased over time; health-interested consumers use Choices logo.	62.5%
Observational consumer studies	Bialkova, 2010 (24)	Choices, GDA	Dutch young adults (24)	Experimental setting, visual search tasks on computer	Cross sectional	Determinants of consumer attention to labels	Reaction time, accurate answers on tasks	Display size, color, familiarity, and location are key determinants of consumer attention.	64.3%

Type of study	First auther, year (reference number)	Type of existing FOP label	Subjects (n)	Setting	Study design/ control group	Main outcome measure(s)	Type of data collected	Authors' conclusions	Quality score [1]
Observational consumer studies *(continued)*	Grunert, 2010 (25)	GDA	Shoppers from 6 European countries (11781)	14 major retailers in 6 countries	Cross sectional	Use and understanding of nutrition information	In-store observations, in-store interviews and questionnaires	Understanding higher than use, possibly due to lack of motivation. Considerable national differences in both understanding and use.	69.0%
	Grunert, 2010 (26)	GDA, traffic lights, traffic lights + color coded GDA	UK shoppers (2019)	3 major UK retailers	Cross sectional	Use and understanding of FOP nutrition information	In-store observations, in-store interviews and questionnaires	Understanding was high; actual use lower; usage was related to interest in healthy eating and understanding to nutrition knowledge.	76.2%
	Jones, 2007 (27)	Traffic lights	UK participants from university setting (92)	Experimental setting, labeling tasks on computer	Cross sectional	Perceived healthiness of nutrition label and the areas of label examined	Eye movements + healthiness ratings	Traffic lights helped to pay attention to important nutrients and improved accuracy of healthiness ratings compared to standard label.	50.0%
	Rayner, 2001 (28)	Logos from Tesco, Sainsbury and Pick the Tick	Shoppers from UK and Australia (44)	Supermarket	Cross sectional, thinking aloud 2 times: shopping normally and shopping healthily	Reported use and actual use of FOP	Qualitative data from thinking aloud + quantitative interviews + cash receipts	Only Tesco shoppers rarely used FOP label. Shoppers claim to use FOP labels, although thinking aloud revealed hardly actual use.	75.0%

Type of study	First auther, year (reference number)	Type of existing FOP label	Subjects (n)	Setting	Study design/ control group	Main outcome measure(s)	Type of data collected	Authors' conclusions	Quality score [1]
Observational consumer studies *(continued)*	Reid, 2004 (29)	Canada's Health Check symbol	Canadian shoppers (200)	Supermarket	Cross sectional	Number of Health Check products purchased by shoppers	Grocery receipts + questionnaire data	Shoppers purchasing Health Check products had lower fat intake; logo awareness related to use and to interest in healthy foods.	73.8%
	Steenhuis, 2010 (30)	Choices	Female consumers from university setting (36)	Experimental lab-setting, taste experiment	Cross-over design with 2 conditions: logo and no-logo	Weighed consumption of chocolate cake	Consumption data + questionnaire data	Use of logo did not increase consumption and no effect on taste rating.	69.0%
	Visschers, 2010 (31)	General FOPs on breakfast cereals in Swiss	Swiss students (32)	Experimental setting, food choice task on computer	Between-subjects design, respondents randomized over 2 conditions: health or taste motivation	Eye movements	Eye movements + questionnaire	66% perceived nutrition label and/or FOP. Health motivation and package design direct consumer's attention towards on package nutrition information.	71.4%
	Vyth, 2010 (32)	Choices	Dutch consumers (404)	Nine supermarkets	Cross-sectional	Proportion of purchased logo products	Product observations + questionnaire data	Health-interested consumers purchase most logo products; hedonists purchase least logo products.	69.0%

Type of study	First auther, year (reference number)	Type of existing FOP label	Subjects (n)	Setting	Study design/ control group	Main outcome measure(s)	Type of data collected	Authors' conclusions	Quality score [1]
Sales	Sacks, 2009 (36)	Traffic lights	Supermarket store chains of 1 retailer (over 1000) in UK	One retailer	Natural experiment with measurements during 8 weeks	Sales of 6 ready meals and 12 sandwiches	Sales data	Introduction of traffic lights had no effect on relative healthiness of consumer purchases	66.7%
	Sutherland, 2010 (37)	Guiding Stars	Supermarket chain stores in US (168)	One store chain	Natural experiment with 3 measurements in 2 years	Proportion of food items with star-rating	Sales data	Proportion of purchased star-items increased at 1- and 2-y follow-up.	59.5%
	Vyth, 2011 (38)	Choices	Dutch worksites (25) and employees (368)	Worksite cafeterias	Randomized controlled trial with 1 labeling and 1 control condition for 9 weeks	Proportion of Choices sandwiches and soups	Sales data + questionnaire data	No effect on sales when comparing logo to non-logo cafeterias; health-interested employees report to use logo.	83.3%
Reformulation	Vyth, 2010 (33)	Choices	Dutch Choices products (821)	47 Food manufacturers	Cross sectional	Reason of logo assignment and nutrient composition data	Data provided by food manufacturers	Choices had stimulated healthier product development, especially regarding sodium and dietary fiber.	69.0%

Type of study	First auther, year (reference number)	Type of existing FOP label	Subjects (n)	Setting	Study design/ control group	Main outcome measure(s)	Type of data collected	Authors' conclusions	Quality score [1]
Reformulation *(continued)*	Williams, 2003 (34)	Pick the Tick	Tick products from Australia (12)	1 Food manufacturer	Cross sectional	Sodium content before and after (re) formulation	Chemical analyses + data provided by food manufacturer	Tick influenced food manufacturer to remove 235 tonnes of salt from breakfast cereals.	26.2%
	Young, 2002 (35)	Pick the Tick	Tick products from New Zealand (23)	Food manufacturers	Cross sectional	Sodium content before and after (re) formulation	Chemical analyses + data provided by food manufacturers	Tick influenced food companies to exclude 33 tonnes of salt trough (re)formulation of breads, breakfast cereals and margarines.	50.0%
Modeling and health outcomes	Ireland, 2010 (39)	Pick the Tick	Adult Australian consumers (49)	Real life setting, free living	One group randomized to Tick products and others to low salt foods for 8 weeks	Sodium excretion	24h urine samples	Simple dietary education was effective in reducing sodium intake in free-living individuals in a short time study.	88.1%
	Roodenburg 2011 (40)	Choices	Intake data from 7 countries	Virtual setting, modeling	Comparisons of typical daily menus with Choices daily menus	Nutrient intakes	Food composition + food consumption data combined	Replacing typical daily menus by Choices m menus can potentially lead to improved nutrient intakes towards recommendations.	69.0%

Type of study	First auther, year (reference number)	Type of existing FOP label	Subjects (n)	Setting	Study design/ control group	Main outcome measure(s)	Type of data collected	Authors' conclusions	Quality score [1]
Modeling and health outcomes *(continued)*	Roodenburg, 2009 (41)	Choices	Dutch young adults (750)	Virtual setting, modeling	Evaluation of different Choices compliant scenarios	Nutrient intakes	Food composition + food consumption data combined	Replacing foods by Choices compliant foods can potentially lead to improved nutrient intakes.	59.5%
	Sacks, 2010 (42)	Traffic lights	Australian adult population	Virtual setting, modeling	Evaluation of traffic lights and junk food tax scenario	Weight reduction, DALY's averted and costs	Data from national nutrition survey + costing data	Traffic lights labelling and junk food tax are highly cost-effective as obesity prevention measures.	69.0%
	Temme, 2010 (43)	Choices	Dutch young adults (750)	Virtual setting, modeling	Evaluation of different Choices scenarios by using market shares	Nutrient intakes	Food composition + food consumption data combined	With Choices foods available in 2007, SAFA and sugar intake can be slightly reduced.	69.0%

[1] The quality of the 31 included studies was assessed by two independent researchers by using the quality assessment tool developed by Sirriyeh et al. (44). The tool consists of 16 criteria. Each research paper was awarded a score on a scale from 0 to 3 for each of the criteria. Discussion following the independent scoring of papers resolved any differences in agreement by the two researchers. The sum of the scores provided a quality score per paper, range: 0-100% (with 100% the maximum score possible).

Table 2. Main items contributing to higher and lower quality scores.

Type of FOP labeling studies	*Contributing to higher quality score*	*Contributing to lower quality score*
Self-reported consumer studies	Large population samples	Self-reported data No validated methodology No validated questionnaires
Observational consumer studies	Objective way to measure FOP label use Real-life setting	Difficult to link observational data to actual FOP label use (not able to assess causal relationships) No validated methodology No validated questionnaires
Sales	Large amounts of objective data collected before and after introduction of FOP label Real-life setting Longitudinal design	If lack of a control group, not able to attribute sales affect to FOP label alone
Reformulation	Nutrient composition data collected before and after introduction of FOP label	Small sample sizes Self-reported data by food manufacturers
Health Outcomes	Modeling uses large databases on a population level Use of biomarkers in longitudinal design in real-life	Modeling based on many theoretical assumptions

Observational consumer studies

We found 9 studies which used observational methods to measure FOP label understanding and use (24-32). Self-reported data appear to over-estimate actual FOP label use in real life settings (26, 28, 32), stressing the importance of collecting more objectively assessed behavioral data. The mean quality score of these studies was 68.6% (range 50.0% - 76.2%). A criterion on which the studies in general scored high was a “clear description for the choice of data collection tools”: different observational data were collected, such as product observations in supermarkets (25, 26, 32), collection of grocery receipts (29), reaction time records when doing a computer task (24), tracking eye-movements when doing computer labeling tasks (27, 31), thinking aloud data (shoppers were asked to “think aloud” during their shopping trip, and the conversations were recorded on tape) (28), and food consumption data (30). Five studies were conducted in the real life supermarket setting (25, 26, 28, 29, 32), leading to a higher quality score because actual supermarket observations better reflect actual shopping behavior than studies conducted in experimental settings (26, 32).

However, most of these studies struggled with the question of how accurately observational data really reflect actual FOP label understanding and use, and identified this in their study limitations. As stated by Grunert et al. (26), even though shoppers

may have looked at nutrition information in-store, this does not necessarily mean that this information had an impact on their choice. Or, looking at the observational data of Vyth et al. (32), and Reid et al. (29), neither of the studies are able to conclude whether health-conscious participants purchase FOP labeling products due to the logo or due to another reason. Also, the eye-tracking studies report that their results do not indicate whether respondents understood the information they perceived correctly, hampering the interpretation of the data (27, 31). The studies stress the importance of conducting more longitudinal studies in which causality can be assessed. Further, although most studies used some validated items from prior research, e.g. the food choice questionnaire (32), the dietary restraint scale (30), questions to assess the use of food package information (29), or an instrument measuring nutritional knowledge (25, 26), none of the used measurement tools and questionnaires reported being validated for the specific research purpose.

Sales studies

Only two studies have been published which collected supermarket sales data before and after the introduction of a FOP label to study whether the FOP label influences sales. These studies had a quality score of 66.7% (36) and 59.5% (37). Both scored high on "rationale for choice of data collection tools": both studies collected a large amount of objective longitudinal sales data from real-life supermarket chain stores. The study by Sacks et al. scored lower on "representative sample of products" than Sutherland et al. because Sacks et al. only collected sales data from 6 ready meals and 12 sandwiches, whereas Sutherland et al. looked at all products with the Guiding Stars symbol (36, 37). Further, both studies scored low on "fit between research question and method of data collection": both studies had no control group. The change in sales could have occurred due to new product and package introductions, possibly in combination with the FOP label or other on-package nutrition information such as "low fat" or "light" statements, effects of price discounts, product group promotions, and/or product life-cycles (45). Sutherland et al. do not discuss this limitation, but Sacks et al. discuss that attributing the observed increase in sales to the introduction of the FOP labels is not completely possible, as the products examined were also reformulated at the time the labels were introduced, and the product packaging and manufacturer was changed (36).

One other study measured changes in sales after the introduction of a FOP label, but in worksite cafeterias, not in supermarkets (38). This randomized controlled study in 25 worksites measured objective sales data, consisted of a sample of reasonable size, and did include a control group in the longitudinal design, which makes it possible to link any change in sales to the label (quality score 83.3%).

Reformulation

Only three studies have been published that evaluated the effects of FOP labels on product development (33-35). The mean quality score of these studies was 48.4% (range 26.2% - 69.0%). Young and Swinburn (35), and Vyth et al. (33) scored high for example on a "clear description of the procedure for data collection" (data provided by food manufacturers) and "clear explanation for choice of data collection tools" (nutrient composition data before and after assignment of the FOP labels). Clear explanations for these items were lacking in the study by Williams et al. (34).

Low scores were assessed for the sample size of Young and Swinburn, and Williams et al.: these were quite small (23 and 12 products respectively), while the sample of Vyth et al. was larger (821), but still not exhaustive. Further, only Vyth et al. had a clear limitations section. An important limitation mentioned was that most data were self-reported by the food manufacturers.

Health outcomes

Epidemiological modeling is a way to investigate potential effects of FOP labels on nutrient intakes and health outcomes. We found 4 studies that evaluated the effects of FOP labels by modeling (40-43). The mean quality score of these studies was 66.6% (range 59.5% - 69.0%). These studies scored high for example on “fit between research question and method” and “representative sample size”: they estimate the effects of FOP labels on nutrient intakes and health outcomes based on national databases with population data instead of small consumer groups. Nevertheless, these studies scored low on “validity of the measurement tools”, mainly caused by the fact that modeling studies are based on so many highly selective assumptions. Assumptions in these 4 studies were related for example to compensation behavior, food replacement procedures, scenario development, costs estimations, and the associations between nutrients and health from limited literature sources. Only one studied the actual effects of FOP labels on biomarkers in the real life setting (39). Ireland et al. reached the highest quality score of all studies in this overview (88.1%). This high score is for example due to its longitudinal design with free living individuals in the real life setting, and due to its validated measurement tools: they used the biomarker “24h urinary sodium excretion”, which is considered the most reliable method of assessing sodium intake compared to more subjective measures such as dietary recall methods (46).

Discussion

This is the first study that provides an overview of the methodological quality of current FOP labeling research. Based on the quality assessments, we now identify some challenges for future research. Table 3 lists these research challenges which are discussed per subheading below. We start with the least relevant and we end this overview with the most relevant research challenge from a public health perspective. Public health relevance is illustrated by Figure 2. The upper part of this figure is based on the theoretical framework for studying consumer responses to nutrition labeling, developed by Grunert and Wills (47). Figure 2 is further clarified in the subheadings below.

Self-reported consumer studies

Self-reported consumer studies provide interesting initial insights into the understanding and intention of FOP label use. Providing a questionnaire to a consumer panel is considered a relatively easy, quick, and inexpensive way to collect research data. However, the relatively low quality scores of these studies and their relatively low public health relevance (see Figure 2) make them scientifically less interesting and the results should be used with caution with regard to policy recommendations. Whether these experimental self-reported data reflect actual use in real life shopping environments is highly questioned (26, 28, 32, 36).

Table 3. Methodological challenges for future FOP labeling research.

Type of FOP labeling studies	*Methodological challenges*
Self-reported and observational consumer studies	Develop a validated methodology and a validated questionnaire to measure FOP label usage in real life settings
Sales	Introduce FOP label in half of the chain stores and compare sales of labeled stores with sales of non-labeled stores Collect individual purchase data and dietary intake data
Reformulation	Collect (chemically analyzed) food composition data, right from the start of the introduction of a FOP label Also collect data about unhealthy product introductions to evaluate the overall picture of the food supply
Health Outcomes	Collect updated food consumption and food composition data for modeling studies Measure health effects of FOP labels in real life settings by using biomarkers

Observational consumer studies

Observational consumer studies have higher quality scores and higher public health relevance than self-reported consumer studies (see Figure 2). Although observational studies lack the ability to assess causality, these studies better reflect actual behavior in real life settings, in which consumers are influenced by many food choice motives, such as price, taste, time and convenience (48). Nevertheless, in both self-reported and observational consumer studies, we identified a lack of a validated methodology and of a validated questionnaire to measure FOP label use, forming a challenge for future FOP labeling research.

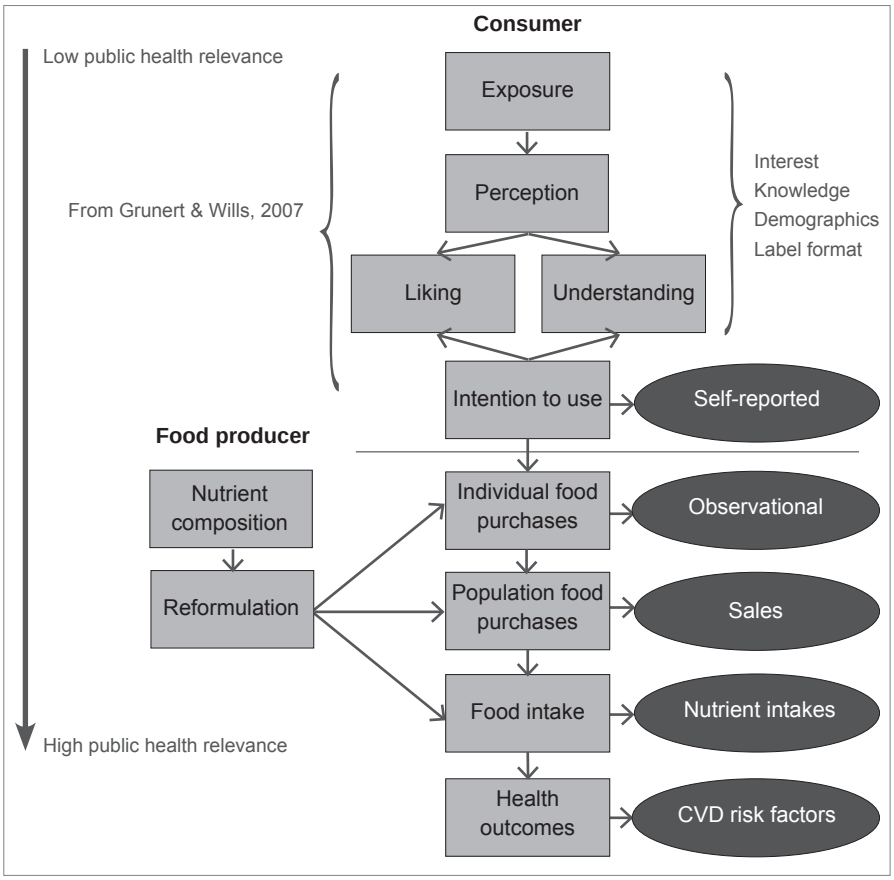
Sales

This type of research is considered to be of higher public health relevance than small-scale consumer studies because of its large objective databases. Inclusion of a control group is essential to attribute the sales effect to the introduction of the FOP label alone. Regarding the study of Sutherland et al. (37), it would have been interesting if, for example, the FOP label had been introduced in half of the chain stores and in the other half 6 months later. Then, one could compare the sales of the labeled stores with the sales of the non-labeled stores (while keeping all other factors equal). However, sales databases are quite crude and cannot be used to reflect individual food intake (36, 38), explaining their lower public health relevance compared to studies measuring food intake and health outcomes (Figure 2). This stresses the importance of also collecting individual dietary intake data.

Reformulation

Although the reformulation studies had a relatively low quality score due to methodological weaknesses, they have a relatively high public health relevance: reformulation can increase the availability of healthier products and consequently has a

Figure 2. Schematic representation of the public health relevance of front-of-pack labeling studies.



large impact on all consumer groups without the necessity of changing behavior (33). The challenge is to collect objective food composition data. Ideally, we consider these data not to be self-reported data by food manufacturers, but chemically analyzed data. It is recommended to collect these reformulation data from the start of the introduction of a FOP label, because afterwards it can be difficult to retrieve. Also, it is likely the case that especially those manufacturers that participated in the reformulation studies are the ones that had significantly improved their products. Therefore, it is recommended to also collect data regarding how many unhealthy products were introduced in the same time frame to be able to evaluate the overall picture of the food supply.

Health outcomes

What are the effects of FOP labeling on health outcomes? Modeling studies provide some potential insights. If updated food consumption and food composition data are available, these studies can provide interesting insights into the potential effects of FOP labels on nutrient intakes and health (40, 42, 43). Although, the most relevant

question from a public health perspective remains, as illustrated by Figure 2: what are the actual effects of FOP labels on a population's health? We consider the most interesting research challenge to be measuring health effects of FOP labels in real life settings by using biomarkers that are good predictors of disease risk.

Study limitations

First, this study is limited by the fact that it is not a systematic review. Nevertheless, it is unlikely that the studies we missed would have had a major impact on our conclusions.

Second, the quality assessments can be discussed. Although many validated quality assessment tools are currently available, they are largely limited to the assessment of studies with a specific research design: 50-60 tools are currently available to assess randomized controlled trial quality, along with a range of other tools for other single research designs (49, 50). Because FOP labeling studies are found to deal with diverse research methods and designs, we choose the tool of Sirriyeh et al. (44), which is able to evaluate overall quality of different designs. This tool is limited in that it relies on the researcher's knowledge and expertise to enable fair and consistent assessments to be drawn. Nevertheless, we tackled this limitation by assessing the quality scores by two independent researchers. Large-scale validation of the tool is still needed (44).

The research challenge for the coming years

The two studies with the highest quality scores (38, 39) have interesting methodological characteristics in common. Both have a longitudinal randomized design and use observational methods to measure the effects of FOP labels in real life settings. Inclusion of a control group enables the ability to attribute the effect to the FOP label alone. Although there is no single, universally accepted hierarchy of evidence, there is broad agreement that randomized controlled longitudinal research designs in real life settings are providing one of the highest forms of scientific evidence (51). When we further take the public health relevance of FOP labeling studies into account, we consider measuring health effects of FOP labels in real life settings by using biomarkers as the research challenge for the coming years. It would be interesting to develop a randomized controlled longitudinal design, in which one group of consumers is educated about FOP labels, and have it explained to them that FOP labels can assist them to make healthier food choices, while the other group is not given any information. The main outcome measures can be changes in urinary sodium excretion, blood pressure and blood lipids.

Conclusions

Evaluations of FOP labels vary greatly in methodological rigor, and few methodologically sound studies are presently available. Highest methodological quality and public health relevance is achieved through measuring health effects of FOP labels by using biomarkers in a longitudinal randomized controlled design in a real life setting. We hope our research recommendations will challenge future researchers to further contribute to the interesting research area of front-of-pack labeling.

Conflicts of interest and authors' affiliations

Annet Roodenburg is seconded at the VU University Amsterdam and employed by Unilever R&D, the Netherlands. The other authors have no conflicts of interest. Johannes Brug is employed by the Department of Epidemiology and Biostatistics, EMGO Institute for Health and Care Research, VU University Medical Center, Amsterdam, the Netherlands. The other authors are employed by the Department of Health Sciences and the EMGO Institute for Health and Care Research, VU University Amsterdam, the Netherlands.

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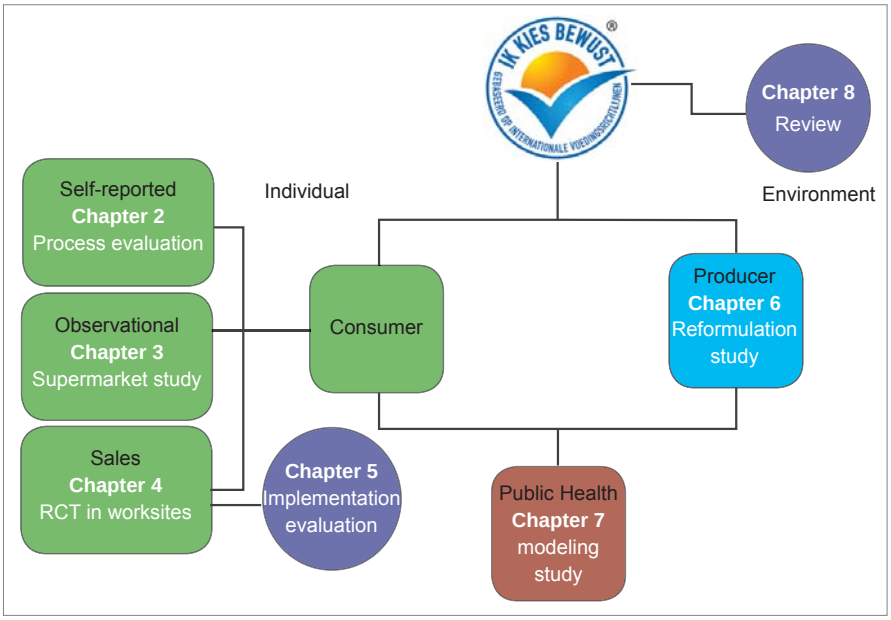
9 General discussion

Outline

The aim of this thesis was to evaluate the effectiveness of the front-of-pack nutrition label "Choices" on consumer behavior, product development, and on public health. First, I will discuss the main findings of the studies we conducted. Subsequently, I will discuss the studies' methodological strengths and limitations, reflect on our findings and propose recommendations for further research and practice. Finally, I will relate the findings of my thesis research to the current international debate about front-of-pack labeling.

Figure 1. The studies described in this thesis: five studies exploring the effects of front-of-pack (FOP) labeling (chapters 2, 3, 4, 6 and 7), an implementation evaluation (chapter 5) and a review of methodological aspects of FOP labeling research (chapter 8).



Summary of the main findings

This thesis described five studies exploring the effects of front-of-pack (FOP) labeling, an implementation evaluation and a review of methodological aspects of FOP labeling research. These different studies are interrelated as illustrated in Figure 1. The studies focused predominantly on one FOP label developed in the Netherlands and rolled-out internationally; the *'Ik Kies Bewust'* logo (internationally called "Choices" – the name which was used throughout this thesis). This thesis started with a General Introduction in **chapter 1**, in which the research area of FOP labeling was introduced. FOP labeling formats were developed as interpretational aids to the more complicated nutrition facts panel on food products back-of-pack, which provides nutrient information about a food product. FOP labels aim to facilitate consumers to make healthier food choices and should stimulate product innovation toward healthier products. The FOP label "Choices" was initiated by large food companies

from the Netherlands in 2006. The logo is assigned to products that contain lower levels of sodium, added sugar, saturated fatty acids and trans fatty acids and caloric content and increased levels of dietary fiber compared with similar products within the same product category. The Dutch criteria were developed by an independent committee of Dutch scientists. The Choices logo is currently rolled-out internationally.

Regarding the effectiveness of Choices on consumer behavior, we conducted three studies. **chapter 2** described a study among consumers using self-reported questionnaire data and focus group interviews. The quantitative analyses showed that the exposure to the logo was generally high. Elderly and obese respondents reported to be more in need of a logo than younger and normal-weight individuals. Also, women perceived the logo as more attractive and credible than men did. Further, consumers reporting to be interested in health issues, more often reported that they used the logo than consumers less interested in health. The qualitative analyses showed that accurate explanation that the Choices logo is found on healthier choices within a specific product category appeared to be essential for the understanding of the logo. Also, it appeared that the credibility of the logo would improve if it became known that governmental and scientific authorities support it. In **chapter 3** we described the second study conducted among consumers, in which we used a combination of questionnaire-derived data and in-store product observations. From this study it appeared that consumers already interested in health issues purchased more logo products than less health-interested consumers, and that consumers who scored high on a hedonistic scale included in the questionnaire, purchased logo products less often than consumers who scored high on this scale. In **chapter 4** we described the third study among consumers, in which sales data were obtained from worksite cafeterias. Data from worksites where the logo had been introduced were compared to worksites were the logo had not been introduced. All worksites offered the same prescribed menu. No nutritionally meaningful intervention effects were observed for the sales of sandwiches, soups, snacks, fruit, and salads. Again, employees who expressed an interest in health issues at baseline more often reported to use the logo to make food choices during lunch in the cafeteria. In **chapter 5** the evaluation of the implementation of the Choices logo in worksite cafeterias is described. We found that in order to increase the implementation, the logo should be consistent with catering managers' ideas about healthy food, the workload of implementing the logo should be limited and it could be recommended to explicitly incorporate the use and dissemination of the logo in the health policy of the caterer. In **chapter 6** another effectiveness study is described, but now the focus was on the effects of the Choices logo on reformulation and healthier product development among food producers. Nutrient composition data of 821 products were analyzed and the results indicated that the introduction and dissemination of the Choices logo had stimulated healthier product development, especially where sodium and dietary fiber are concerned. The final study exploring effects of the logo was a modeling study and is described in **chapter 7**. We showed that consuming a diet complying with the Choices criteria will most likely result in a slight decrease in serum cholesterol levels and, consequently, may thus contribute to cardiovascular risk reduction. In **chapter 8** a review of FOP labeling studies is presented which provides an overview of the methodological quality of current FOP labeling studies. We found that evaluations of FOP

labeling studies have varied greatly in methodological rigor and few methodological sound studies are presently available. Because measuring the effects of FOP labels on health outcomes is highly interesting from a public health perspective and has hardly been studied before, we concluded our review with the recommendation that measuring health effects of FOP labels in real life settings by using biomarkers would be the research challenge for the coming years.

Methodological issues

Strengths

The strengths of this thesis are that we used different outcome measures, different ways of data collection, different real life point-of-purchase settings, and different research designs to evaluate the effectiveness of the Choices logo. In this way, we tried to gain insight in the effectiveness of the Choices logo as complete as possible. First of all, we used a high diversity of outcome measures to study the effects of the Choices logo on different levels: consumer behavior, product development and public health. The self-reported understanding and use of the Choices logo were studied in chapter 2 and 5, the observational use of the logo in chapter 3 and 4, the effects of the logo on reformulation and healthier product development in chapter 6, and the potential effects of consuming a Choices compliant diet on cholesterol levels in chapter 7.

A second strength is that we used different ways of data collection. Large consumer panels (n=2159) and qualitative focus group interviews (n=41) were used in chapter 2, questionnaire data (n=404) combined with in-store product observations were collected in chapter 3, sales data from 7 product groups in chapter 4, questionnaire data in chapter 5, nutrient composition data of 821 products from 47 food manufacturers in chapter 6, and existing national food consumption and food composition databases were used in chapter 7.

A third strength is that we used different point-of-purchase settings for our consumer studies, such as 9 supermarkets in chapter 3 and 25 worksite cafeterias in chapter 4.

Fourth, we used a high diversity of research designs in this thesis. We combined observational research, natural experiments and modeling. Finally, to the best of our knowledge, we are the first that provided an overview of the methodological quality of current FOP labeling studies (chapter 8).

Limitations

This thesis also has some limitations which are related to the study designs, study populations, and measurements. First, regarding the study designs, some of our studies were cross-sectional studies without a control group, which makes it not possible to link our findings to the Choices logo alone. However, this is not a specific limitation of this thesis, but a general limitation of cross-sectional studies: there is broad agreement that randomized controlled longitudinal research designs in real life settings are providing one of the highest forms of scientific evidence (1). Our sales study in worksite cafeterias described in chapter 4 had a randomized longitudinal design including a control group, which makes it possible to link any changes in sales to the label. Further, although modeling studies are limited by the many theoretical assumptions needed in this type of research, our modeling study in chapter 7 is one of the first studies to indicate the potential effects of a FOP label on

public health.
A second limitation was that it was difficult to recruit representative study populations. As a result, consumers and catering managers interested in nutrition - and food manufacturers interested in Choices - may have been overrepresented in our studies. This may have led to an over-estimation of the found effects. This is also a general limitation of nutrition and public health research and hard to avoid.
Third, the limitations of our measurements should be discussed. Self-reported questionnaire data, which were collected in chapter 2 and 3, may not accurately reflect objective label use: most of the times self-reported data over-estimate actual label use in real life settings (2-4). Generally, in self-reported consumer studies, social desirable answers are inevitable. Nevertheless, in order to correct for this and to assess the use of the Choices logo more objectively, we also collected more observational data, such as in-store observations in chapter 3 and sales data in chapter 4.

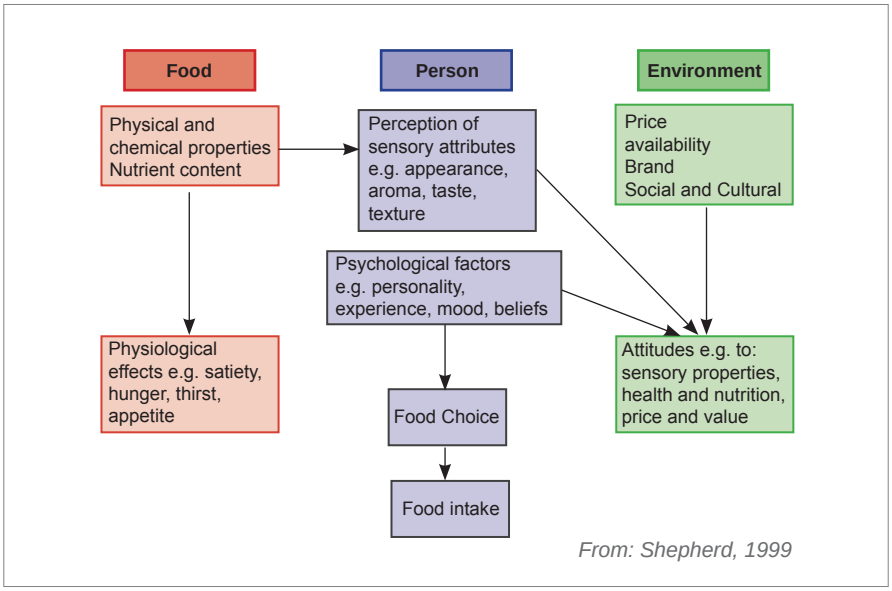
Reflection and interpretation

I will now reflect on and interpret our findings regarding consumer behavior, product development and public health.

Consumer behavior

In our consumer studies (4-6), we found that the familiarity with Choices was generally high in the Netherlands, but actual use in real life settings was low. Many studies investigated the use of different FOP labels using different methodologies and different settings and most of them suffer from methodological weaknesses (7). It is not known whether FOP labels alone influence food choices and intake. Earlier studies focused on food labeling in general in several settings including worksites, restaurants and universities. Some studies suggest some positive benefits of labeling, whereas other studies show only modest effects on sales data or consumer behavior (8-12). Regarding the labeling format, there is no consensus whether prescriptive (positive) labeling, such as promoting a broad range of healthy products with a healthy sign, is more effective than descriptive labeling, such as providing caloric information or Guideline Daily Amounts (GDA) (9, 12). This lack of consensus is not surprising, because food choice is a complex research area and labeling is only one aspect of food choice. Shepherd identifies three levels of factors affecting food choice and intake (Figure 2) (13). First, factors related to the food itself influence food choice, such as the physical and chemical properties, nutrient content, and physiological effects such as satiety, hunger, thirst and appetite. Secondly, personal factors affect food choice, such as sensory attributes (appearance, taste, texture) and psychological factors (personality, experience, knowledge, parental influences, beliefs about taste and health). Thirdly, economic and environmental factors affect food choice, such as food prices, availability, other on-package information, portion sizes, brands, social and cultural factors. In this complex area of food choice, what is the role of FOP labeling? We do know that the most important food choice motives are price, taste and convenience, generally more important than health (13-15). In light of the complex area of behavioral change and the many behavioral change theories currently available (16-18), one cannot expect that a FOP label alone is able to change behavior of consumers.

Figure 2.The three levels of factors affecting food choice and intake as identified by Shepherd (1999).

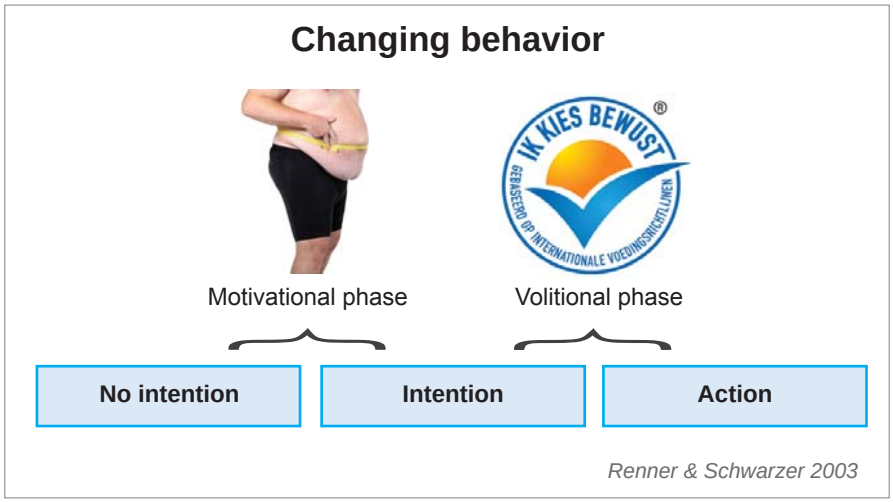


Our studies consistently indicate that health motivated consumers - consumers who expressed an explicit interest in health issues - use the logo more frequently than other consumers (4-6). This finding is in agreement with other front-of-pack labeling studies, in which it is found that consumers with a health motivation make most use of FOP labels (2, 19, 20). Logically, these consumers are also the ones who use on-package nutrition information most (21). As discussed in chapter 4, health interested consumers are most probably in the so-called volitional phase of behavior change as identified by Renner and Schwarzer (18). These are always the first to adopt changes. They intend to eat healthier and are looking for tools to change their intention into action. A FOP label as the Choices logo may serve as such a tool. It is also possible that these health-interested consumers already eat healthy. However, the majority of consumers do not have a strong motivation to change to a more healthy diet. They are still in the so-called motivational phase which comes before the volitional phase (18), as illustrated in Figure 3. Especially consumers with relatively lower levels of education and a higher BMI have been found to be in this phase - those for whom dietary change would be most beneficial (22). No FOP labeling studies are currently focusing on these consumer groups alone and how to motivate them to eat healthier.

Product development

Currently, product innovation intended to develop healthier products is a “hot topic”. For example, all around the world, salt reducing strategies and taskforces have been created, aiming to stimulate food manufacturers to develop products with less salt (23), in order to prevent high blood pressure, an important risk factor of cardiovascular disease risk (24). Other initiatives have focused on eliminating trans fats, replacing saturated fats by unsaturated fats, and reducing the sugar content of food prod-

Figure 3. The stages of behavioral change as identified by Renner & Schwarzer (2003).



ucts (25). Especially, eliminating trans fats from foods has an important history in the Netherlands. Two well-known scientists from the Netherlands, Mensink and Katan, showed in 1990 that trans fats reduce high- and increase low-density lipoprotein cholesterol (26). Triggered by many more scientific studies and media events, Unilever decided to remove trans fats from retail spreads, such as margarines, from 1994. This further triggered manufacturers worldwide to follow this initiative over the next 14 years (27). This example shows the important role food companies can play in healthier product development. Additionally, legislation may have played a role in stimulating healthier product development, which is further discussed in the practice recommendations below.

By stimulating food manufacturers to develop healthier products, the availability of healthier products will increase for all consumer groups, both the health motivated and non health motivated ones, including the people with relatively lower levels of education and high BMI. In chapter 6 we found that a FOP label such as Choices is an effective tool to stimulate food manufacturers to develop healthier products. I consider this one of the most important findings of this thesis. A FOP label can serve as a “reward” for producers for their product innovation efforts. Stimulating healthier product development has probably a larger public health impact than just influencing consumer behavior by FOP labels. Obviously, one needs to do both: if food manufacturers develop healthier products, consumers will have to buy these products. Nevertheless, changing consumer behavior is complex and may take much time and effort. By increasing the availability of healthier products in combination with other marketing techniques, such as easy preparation techniques, a low price and a good taste, one may stimulate consumers to actually purchase these healthier products. As a result, higher sales will further stimulate the food industry to develop healthier products.

Public Health

In chapter 7 we found that consuming a diet complying with FOP label criteria such as the Choices criteria may positively influence cholesterol levels. Although these scenario calculations can be relevant for policy makers, for example by translating cardiovascular risk reduction to reduced health care costs, modeling studies remain limited by the fact that they are based on so many theoretical assumptions, as described in the limitations before. In chapter 8 we concluded that measuring health effects of FOP labels in real life settings by using biomarkers will be the research challenge for the coming years. To the best of our knowledge, only one study assessed the effects of consuming FOP labeled products with biomarkers of intake: Ireland and colleagues showed that nutrition education about Australia's and New Zealand's Pick the Tick logo significantly decreased urinary sodium excretion in a real life setting (28). The next step is to assess the effects of such an intervention on cardiovascular risk factors, such as blood pressure and cholesterol levels.

Recommendations for research and practice

Based on our findings and reflections, I now formulate some recommendations for future research and practice regarding FOP labeling.

Methodological challenges

I will first discuss the methodological challenges for future FOP labeling research. These are more extensively discussed in chapter 8. In both our self-reported and observational consumer studies, we identified a lack of a validated methodology and of a validated questionnaire to measure FOP label use. This is a first challenge for future FOP labeling research. Secondly, regarding reformulation studies, it is likely the case that especially those manufacturers that participated in the reformulation studies are the ones that had significantly improved their products. Therefore, it is recommended to also collect data regarding how many unhealthy products not complying with the Choices criteria were introduced in the same time frame to be able to evaluate the overall picture of the food supply. It is further recommended to collect the reformulation data from the start of the introduction of a FOP label, because afterwards it can be difficult to retrieve. Finally, we consider the most interesting research challenge to be measuring health effects of FOP labels in real life settings. One could for example measure biomarkers of intake, such as urinary sodium excretion as a marker for sodium intake, and blood lipids as a marker for saturated fat intake. However, it is important to note that for example for added sugar, no biomarker exists. Additionally to measuring biomarkers of intake, it would be interesting to assess the effects of FOP labels on health outcomes by measuring cardiovascular risk factors, such as for example blood pressure and cholesterol levels. This type of study may answer the most important research question from a public health perspective: what is the impact of FOP labels on health.

Combine FOP labels with pricing strategies

It would be interesting to combine FOP labeling with pricing strategies, for example to investigate whether consumers purchase more FOP labeled products when these products are cheaper. It would especially be interesting to focus this type of research on consumer groups with relatively lower levels of education and a higher BMI –

those who need it most to eat healthier (29). Waterlander et al. showed that a 25% discount on fruits and vegetables was significantly associated with higher total fruit and vegetables purchases in a virtual supermarket (30). Nederkoorn et al. found that a tax on high energy dense foods causes people to buy less calories in an online web shop, especially less calories from carbohydrates (31). No earlier studies combined existing FOP labels with price reductions. However, there are some studies that combined price reductions with health messages or health signage. French et al. found that labels promoting low-fat snacks combined with price reductions in vending machines in worksites and in secondary schools had a higher effect on sales than price reductions alone, although the effect was small (32). However, Horgen and Brownell found that adding a health message to price reductions was less effective regarding sales than price reductions alone in a restaurant setting (33). This is explained by the fact that people may assume that foods promoted as healthy will not taste good, diminishing the pricing effect (34). This is in agreement with our findings from chapter 3, in which hedonists purchased the least Choices products, probably because hedonists assume that unhealthy foods taste better and give them more pleasure (4). Perhaps, the message that "healthy products can also be tasty" should be stressed.

Explore the effects of FOP labels in restaurants

Since 2010, calorie labeling is mandatory in restaurants with more than 20 locations in some states of the United States, although it it is not clear yet whether this affects consumer food choices (11, 12). Regarding FOP labels, we have been involved in a study evaluating the effects of the Choices logo on menu choices in a restaurant setting, which has not been published yet (the abstract was presented in a conference in Amsterdam (35)). It was found that visitors interested in health were most likely to choose a menu item labeled with the Choices logo from the menu card. These findings are in agreement with our findings from chapter 2 and 3 that health interested consumers are those who may use the Choices logo. In light of the current international debate about menu labeling, it is of interest to further explore the effects of FOP labeling in the restaurant setting.

Investigate compensation behavior

Consumers may eat and drink more of FOP labeled products than of non-FOP labeled products because they think it is justified to consume more of these products. This stresses the importance of gaining insight in compensation behavior. Sales data are considered too crude to explore such individual compensation behaviors and other potential negative side effects. Therefore, collecting actual food choice and eating behavior data from individual consumers is needed. It may be that people will eat more of products they perceive to be healthier. Provencher et al. showed that the perception that a cookie was healthy indeed resulted in increased intake (36). Wansink and Chandon found that low-fat labels on snacks increased overall consumption, and especially had a dramatic effect on the amount consumed by overweight consumers (37). There is only one study that investigated compensation behavior related to a specific FOP label. In our study among women in a university setting we found no increased intake when comparing the consumption of a cake with the Choices logo to the same cake without it (38). However, this cake was not

perceived as healthy in this study, neither with nor without the logo. Also, the studies described above focused on snack products only. Therefore, further research is required regarding the effects of FOP labels on overall dietary patterns. Making use of consumer panels who daily scan their products, in combination with dietary intake data and/or biomarkers would be interesting. By linking food purchases with a FOP label to dietary intakes, one could investigate whether FOP labels cause compensation behavior as a negative side-effect.

Make FOP labeling mandatory

Legislation can play a stimulating role in healthier product development. For example, in many countries trans fats have to be labeled now, such as in the United States from January 2006, which stimulated food industry to reduce them (27). Recently, in the Netherlands, the government is also considering legislation to eliminate trans fats from foods (39), although new labeling regulation developed by the European Union does not permit to label trans fats (40). Regarding FOP labeling formats, food manufacturers are still allowed to voluntary display them, both in the Netherlands and internationally. This is confusing for consumers. For example, one tomato soup complying with a health logo's criteria may carry the logo, while another tomato soup may not carry the logo, although it also complies with the criteria. The soup without the logo may even contain less sodium than the soup with the logo. Therefore, we would recommend governments to make FOP labeling mandatory for food manufacturers, both to remove confusion and to further stimulate healthier product development.

Introduce financial incentives to further stimulate product innovations

In general, governments leave healthy eating to the responsibility of the consumer, as also described in the recent health policy report of the Dutch Ministry of Health, Welfare and Sport (39). In light of the current obesogenic environment, I think that governments should take their responsibility in further stimulating healthier product development. For example, governments can provide food companies with financial incentives if, for example, 80% of their products comply with the criteria of a front of pack label. When considering this kind of subsidies, it is especially important to take into account the small and medium enterprises (SME's). These SME's may especially be motivated to develop healthier product due to competition, but have lack of money to innovate. A total of 99% of all companies in the Netherlands are SME's; they are responsible for 58% of the revenue and provide employment to 60% of the Dutch population (41). These numbers stress the importance of paying attention to the product innovation efforts of these companies.

International debate about front-of-pack nutrition labeling

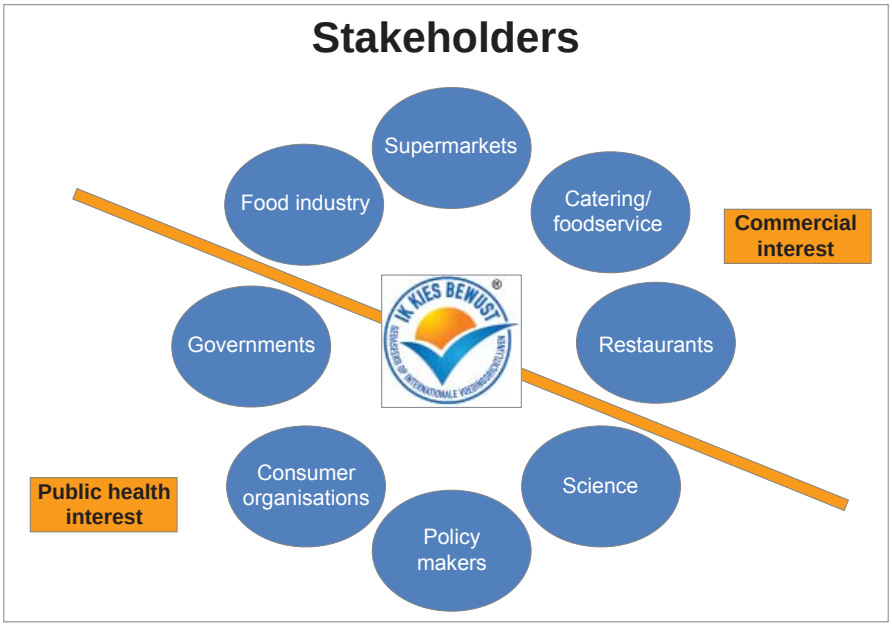
Finally, I will reflect on our findings in the context of the international debate about front-of-pack labeling which is currently going on.

Stakeholders

A vigorous international debate about the preferred format and potential impact of FOP labeling is currently going on. In this highly political debate, policy makers, scientists, the food industry and consumer organizations have their own interests (42-

45). Policy makers want to ensure that consumers can make well-informed food choices, while also supporting innovations and a fair competition in the food industry. Scientists are concerned with aspects relating to credibility and public health. The food industry is using FOP labels in its marketing to create a healthy image and thereby aims to sell (more of) its products. Consumer organizations want to protect consumers from being misled or confused, while they also want to encourage and facilitate healthy food choices. Figure 4 illustrates the main stakeholders involved in the international debate. In the next sections, I will reflect on how the different stakeholders act in the FOP labeling debate, illustrated by the most important discussions taking place internationally.

Figure 4. The main stakeholders involved in the international debate about front-of-pack labeling.



The Netherlands

One year before the launch of the Choices label, in 2005, another health logo was launched in the Netherlands. This logo was developed by the largest retailer of the Netherlands and was called *'Gezonde Keuze Klavertje'*. So, two health logos existed in the Netherlands, with similar criteria and similar aims. It appeared to be confusing to have two different health logos in one country. As a result, a debate developed between all stakeholders. Consumer organizations favored traffic lights. Some industry groups preferred the Choices logos. The large retailer preferred its own health logo. Obviously, different interests played a role. Finally, the government strongly advised the two health logo's to merge (46). After two years of negotiations, the stakeholders agreed upon one national health logo in the Netherlands. On the first of March 2011, the new logo was offered to the Minister of Health. Currently, there

are negotiations whether the new Dutch health logo can be considered as a nutrition claim in the legislation.

Europe

In Europe, there is ongoing debate between governments, industry groups and consumer organizations about what is the "best" FOP labeling format (45). Consumer organizations generally favor traffic lights labels. They share the opinion that consumers understand this label best, because of the color coding. These statements are supported by studies of limited methodological quality (43, 47-51). Nevertheless, these studies are eagerly used in the media to influence policy makers and the public opinion. However, "negative" labels, such as traffic lights with red labels on relatively unhealthy products, meaning "do not eat me" are not liked by the industry and by retailers (52). Food manufacturers like to create a positive healthy image and prefer GDA's or health logos. Their preference for health logos is not supported by studies in real life settings, but only by self-reported data (53, 54) or by studies in experimental settings (55).

In order to avoid an overload of different labeling systems in Europe which mislead and confuse consumers, the European parliament was considering mandatory FOP label legislation for all European member states (56). However, in July 2011, they voted in favor of new labeling legislation, which requires mandatory display of the nutrition facts panel, but which has no front-of-pack requirement for nutrition labeling. Additionally, the European parliament is considering a nutrient profiling system in the EU as part of the claims regulation. "Nutrient profiling" is defined as the science of classifying or ranking foods according to their nutritional composition for reasons of preventing disease and promoting health (57). The World Health Organization (WHO) is currently developing a basic nutrient profiling guideline that can be used for different applications in different countries, such as FOP labels. This system might be useful for the European debate.

What is the role of lobbying by different stakeholders, such as industry groups and consumer organizations, in these debates? It is estimated that the food industry spent no less than € 1.0 billion lobbying against the European Union's adoption of traffic lights (58). Is this debate really about the consumer and public health? I think these questions would be highly interesting to explore.

Australia and New Zealand

In Australia and New Zealand, a similar debate is taking place as in Europe: the health sector is generally supportive for traffic lights, while food manufacturers favor GDA's and health logos (59, 60). In March 2011, a review was launched at the request of the Australian government, which recommends voluntary traffic lights labeling (61). In April 2011, a report was published by the Public Health Association of Australia, which proposes a combination of the traffic lights system and GDA's (62). It would be interesting to compare the FOP labeling debates in Europe and Australia and to explore how the power of different stakeholders differs between these continents.

Asia

Countries in Asia have also been following Europe's "traffic lights versus GDA's"

debate closely. Regulatory developments are evolving rapidly. Korea became the first country in Asia to implement voluntary traffic light labeling starting January 2011 on the FOP of children's food. In May 2011, Thailand became the first country worldwide to make GDA labels mandatory on five snack categories: potato crisps, popcorn, biscuits, crackers and cream-filled wafers. While the Thai FDA was under pressure to combine the GDA's with traffic light colors, it decided not to do this. Health logos are also gaining ground in Asia. Malaysia announced in 2009 the re-introduction of a voluntary Healthier Choice symbol. However, the program was put on hold, because it was incompatible with the Healthier Choice symbol from Singapore. Meanwhile, Thailand and the Philippines also introduced their own health logos in April 2009 and December 2010, respectively (63).

United States

In the United States, the Institute of Medicine (IOM) and the Food and Drug Administration (FDA) are currently evaluating existing FOP labeling systems following the failure of a multi-stakeholder initiative - the Smart Choices Program - led by the food industry (not related to the Choices logo from the Netherlands). It failed due to criticism by prominent scientists and the media that its nutrient criteria allowed high sugar and high fat products to carry a healthy choice label (53, 64). As a response, the IOM published an overview about FOP labeling systems internationally available (65). They conclude that different stakeholders developed their own symbols and systems, not without controversy. Nutrient criteria are diverse and sometimes conflict among the many systems in the marketplace. The IOM is currently working on the second part of their research to be published in the autumn of 2011, in which they review the effectiveness of all FOP labeling systems internationally available. Meanwhile, in January 2011, two major food-industry trade associations announced a new and voluntary FOP labeling system for the United States, quite similar to GDA's. Why would the industry not wait for the recommendations of the IOM? According to Brownell and Koplan, two well-known scientists from the US, probably so that the industry can preempt the imposition of an alternative system, such as traffic lights labels (58).

This thesis in light of the international FOP labeling debate

Which format works best to guide consumers make healthier choices? As different studies use different designs, different formats and different methods (7), we are not able to conclude which format works best. It is important to keep in mind that the consumer does not exist: consumer groups react differently on FOP labels, depending on their age, gender, health status and nutrition interest (2, 6, 21, 66). This thesis evaluated the effectiveness of one specific FOP label, the Choices label. One can take this label as an example for input in the international debate about FOP labeling. I have concluded that we should focus on the producer if we aim to achieve considerable public health impact of FOP labels. However, most of the global discussions about FOP labeling are focusing on the consumer. Most scientific studies are exploring consumer behavior (7). Therefore, I would recommend changing this focus to the producer. A directive label such as Choices can stimulate healthier product development as described in chapter 6. Although this was only one study with a selective sample of food manufacturers, it is considered as a good starting point to

further explore the effectiveness of FOP labels on healthier product development. The feasibility of mandatory FOP labeling, and the effectiveness of providing financial incentives to companies whose products comply with FOP label criteria, are highly interesting to explore further, as recommended before. Semi-directive and directive labels (e.g. traffic lights, health logos) might be more suitable to stimulate product innovations than non-directive labels (e.g. GDA's), because these labels provide the food manufacturers with some direction to strive for.

Obviously, in order to keep food manufacturers motivated to develop healthier products and use FOP labels, the consumer also plays an important role. If sales do not increase, food manufacturers will stop producing healthier products. However, we cannot expect that a FOP label alone is able to change food choices and influences sales. I think we should see the FOP label as just one part of the whole picture to influence food choice behavior. If food manufacturers combine the development of new products complying with FOP label criteria with attractive product packaging, a low price, a good taste, and if the food manufacturer has a reliable image, consumers may purchase these healthier products and sales will increase.

In fact, the FOP labeling discussion is in essence about the question: how do we categorize foods as "healthier"? Categorizing foods as healthier can help the health claims regulations to prevent misleading nutrient information to consumers. Categorizing foods as healthier can help governments to subsidize healthier foods and to put a tax on relatively unhealthy foods. Categorizing foods as healthier can help to regulate food marketing to children, for example by prohibiting marketing of unhealthy foods to children under 12 years old. In conclusion, categorizing foods as healthier can help promoting public health.

General conclusions

This thesis showed that the familiarity with the Choices logo was generally high in the Netherlands, but actual use in real life settings was low. Health-interested consumers reported to use the Choices logo to make healthier food choices. Furthermore, this thesis found that a directive FOP label such as Choices was shown to be an effective tool to stimulate food manufacturers to develop healthier products.

I have concluded that we should mainly focus on the producers and increase the availability of healthier products if we aim to achieve public health impact of FOP labels. However, if sales do not increase, food manufacturers will stop producing healthier products. Therefore, a FOP label should be considered as one part of the bigger picture: if food manufacturers combine the development of new FOP labeled products with other marketing techniques, such as attractive product packaging, a low price, and a good taste, then consumers may purchase the healthier products and sales will increase. Increased sales may result in a positive effect on public health, provided that consumers eat products complying with FOP label criteria instead of regular products. Our scenario calculations showed that consuming a diet complying with the Choices criteria may positively contribute to cardiovascular risk reduction by influencing blood lipids. Yet, the most important question for all stakeholders - scientists, policy makers, food industry and consumer organizations - is: what are the actual effects of FOP labels on the health of our society? Answering this question will be essential for the future of FOP labels.

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Summary

General Introduction

This thesis evaluated the effects of a front-of-pack (FOP) nutrition label in the Netherlands: the 'Ik Kies Bewust' logo (internationally called "Choices" logo). The aim was to evaluate the effects of the Choices logo on consumer behavior, product development, and on public health. This thesis starts with a General Introduction in **chapter 1**, in which the research area of FOP labeling is introduced. FOP labels aim to facilitate consumers to make healthier food choices and should stimulate product innovation towards healthier products. The FOP logo Choices is assigned to products that contain lower levels of sodium, added sugar, saturated fatty acids and trans fatty acids and caloric content and increased levels of dietary fiber compared with similar products within the same product category. The Choices logo is currently rolled-out internationally.

Summary of the main findings

Regarding the effectiveness of the Choices logo on consumer behavior, we conducted three studies. **chapter 2** describes a study among consumers using self-reported questionnaire data (n=2159) and focus group interviews with 41 consumers. The analyses showed that the exposure to the logo was generally high. Consumers reporting to be interested in health issues, more often reported that they used the logo than consumers less interested in health. Further, accurate explanation that the Choices logo is found on healthier choices within a specific product category appeared to be essential for the understanding of the logo. **chapter 3** describes the second study conducted among consumers (n=404), in which we used a combination of questionnaires and in-store product observations in 9 supermarkets. From this study it also appeared that consumers already interested in health issues purchased more logo products than less health-interested consumers, and that consumers who scored high on a hedonistic scale included in the questionnaire, purchased logo products less often than consumers who scored low on this scale. In **chapter 4**, a third study among consumers is described, in which we measured sales data in 25 worksite cafeterias by conducting a randomized controlled trial. We investigated the effect of labeling versus no labeling on employee's food choices during lunch. No nutritionally meaningful intervention effects were observed for the sales of sandwiches, soups, snacks, fruit, and salads. Again, employees who expressed an interest in health issues more often reported to use the logo to make food choices during lunch in the cafeteria. In **chapter 5** the implementation of the Choices logo in worksite cafeterias was evaluated by collecting questionnaire data from 316 catering managers. We found that in order to increase the implementation, the logo should be consistent with catering managers' ideas about healthy food, the workload of implementing the logo should be limited and it could be recommended to explicitly incorporate the logo in the health policy of the caterer. In **chapter 6** the effect of the Choices logo on reformulation and healthier product development among food producers has been investigated. We collected nutrient composition data of 821 products; these data were provided by 47 food manufacturers joining the Choices foundation. The results indicate that the Choices logo has stimulated healthier product development, especially where sodium and dietary fiber are concerned. In **chapter 7** the potential effects of consuming a diet complying with the Choices criteria on cholesterol levels of the Dutch population has been investigated in a modeling study.

We showed that consuming a diet complying with the Choices criteria will most likely result in a slight decrease in serum cholesterol levels. Finally, in **chapter 8** we present a review of the methodological quality of current FOP labeling studies. We found that evaluations of FOP labeling studies have varied greatly in methodological rigor and few methodologically sound studies are presently available. Measuring health effects of FOP labels in real life settings by using biomarkers would be the research challenge for the coming years.

General Discussion

This thesis is completed with a General Discussion in **chapter 9**. Generally, our studies show that the familiarity with the Choices logo is high in the Netherlands. However, actual use of the logo in real life settings is low, except for health-motivated consumers: they reported to use the Choices logo to make healthier food choices. Furthermore, this thesis shows that a FOP label such as Choices can be an effective tool to stimulate food manufacturers to develop healthier products. We have concluded that we should mainly focus on the producers and continue stimulating them to increase the availability of healthier products if we aim to achieve public health impact of FOP labels. In this way, we may reach all consumer groups – both the health-motivated and the non-health motivated ones.

Based on this thesis, we have formulated some recommendations for research and practical implementation. First, we recommend future studies to measure health effects of FOP labels in real life settings by using biomarkers of intake and cardiovascular risk factors in a longitudinal randomized controlled design. Secondly, it would be interesting to combine FOP labeling with other marketing techniques, such as pricing strategies, for example to investigate whether consumers purchase more FOP labeled products when these products are cheaper. Thirdly, investigating the effects of FOP labels in other settings, such as restaurants, would be interesting. Fourthly, investigating compensation behavior is highly recommended. Consumers may eat and drink more of FOP labeled products than of non-FOP labeled products because they think it is justified to consume more of these products. Finally, we would recommend governments to introduce some form of regulation regarding FOP labeling. Making FOP labeling mandatory may remove confusion. Additionally, providing food companies with financial incentives, for example, if 80% of their products comply with the criteria of a FOP label, may further stimulate healthier product development.

General conclusions

FOP labeling has a wider scope than only public health: it is about lobbying, conflicting interests and money. A vigorous international debate about the preferred format and potential impact of FOP labeling is currently going on. In this highly political debate, policy makers, scientists, the food industry and consumer organizations have their own interests. I have concluded that we should mainly focus on the producer if we aim to achieve considerable public health impact of FOP labels. Obviously, in order to keep food manufacturers stimulated to develop healthier products and use FOP labels, the consumer plays an important role as well. If consumers do not purchase healthier products and sales do not increase, food manufacturers will stop producing these products. Therefore, a FOP label is just one part of the bigger pic-

ture: if food manufacturers combine the development of new FOP labeled products with other marketing techniques, such as attractive product packaging, a low price, and a good taste, and if the food manufacturer has a reliable image, then consumers may purchase the healthier products and sales will increase. Increased sales may result in a positive effect on public health, provided that consumers eat products complying with FOP label criteria instead of regular products. Our scenario calculations showed that consuming a diet complying with the Choices criteria may positively contribute to cardiovascular risk reduction by influencing blood lipids. Yet, the most important question for all stakeholders - scientists, policy makers, food industry and consumer organizations - is: what are the actual effects of FOP labels on the health of our society? Answering this question will be essential for the future of FOP labels.

Samenvatting

Algemene Introductie

In dit proefschrift is het gezondheidslogo “Ik Kies Bewust” geëvalueerd. Doel van de evaluatie was om het effect van het logo te onderzoeken op consumentengedrag, productontwikkeling en gezondheid van de Nederlandse bevolking. Hoofdstuk 1 begint met een algemene introductie over gezondheidslogo’s op productverpakkingen van voedingsmiddelen. Deze logo’s hebben twee doelen: consumenten helpen een gezondere keuze te maken, en producenten stimuleren om gezondere producten te ontwikkelen. Het Ik Kies Bewust logo staat op producten die minder natrium, toegevoegd suiker, verzadigd vet, transvet en calorieën bevatten, en meer voedingsvezel, vergeleken met vergelijkbare producten binnen dezelfde productgroep. Het Ik Kies Bewust logo wordt momenteel internationaal geïmplementeerd.

Onderzoeksresultaten

Om de effectiviteit van het Ik Kies bewust logo op consumentengedrag te onderzoeken, zijn drie studies gedaan. **hoofdstuk 2** beschrijft een consumentenonderzoek waarin gebruik is gemaakt van consumentenpanels (n=2159) en focusgroep interviews met 41 consumenten. De analyses laten zien dat de bekendheid met het logo groot is. Consumenten geïnteresseerd in gezondheid gaven aan het logo meer te gebruiken dan consumenten die in mindere mate geïnteresseerd zijn in gezondheid. Verder bleek het voor het begrip van het logo essentieel uit te leggen dat het logo op gezondere producten binnen een productgroep staat. **hoofdstuk 3** beschrijft een tweede consumentenonderzoek (n=404), waarin consumentenprofielen, onderzocht met behulp van vragenlijsten, gekoppeld zijn aan aankoopgedrag in 9 supermarkten. De resultaten laten zien dat consumenten geïnteresseerd in gezondheid de meeste producten met het logo gekocht hadden, en hedonisten de minste. **hoofdstuk 4** beschrijft het derde consumentenonderzoek. Verkoopcijfers zijn bijgehouden in een gerandomiseerd gecontroleerd onderzoek in 25 bedrijfsrestaurants. Bedrijfsrestaurants die hun producten labelden met het Ik Kies Bewust logo zijn vergeleken met restaurants zonder labels om het effect van het logo te onderzoeken op de lunchkeuzes van werknemers. Er werden geen effecten gevonden van het logo op de verkoopcijfers. Wel laten de resultaten opnieuw zien dat consumenten geïnteresseerd in gezondheid aangaven het logo te gebruiken. In **hoofdstuk 5** is de implementatie van het logo in bedrijfsrestaurants geëvalueerd door middel van een vragenlijstonderzoek onder 316 catering managers. Om de implementatie te optimaliseren, bleek dat catering managers een positieve houding moesten hebben ten opzichte van het logo en de tijdsinvestering voor implementatie moest minimaal zijn. Ook bleek het van belang voor de implementatie van het logo om dit in het gezondheidsbeleid van de cateraar op te nemen. **hoofdstuk 6** beschrijft een studie waarin ditmaal de focus op de producent ligt. Het effect van het logo op herformulering en gezondere productontwikkeling is onderzocht door data te verzamelen van de productsamenstelling van 821 producten; de data zijn geleverd door 47 producenten die deelnemen aan Stichting Ik Kies Bewust. De resultaten laten zien dat het logo producenten gestimuleerd heeft om gezondere producten te ontwikkelen, vooral wat betreft natriumreductie en toevoeging van voedingsvezel. In **hoofdstuk 7** is het potentiële effect van een voedingspatroon dat voldoet aan de Ik Kies Bewust criteria gemodelleerd. De berekeningen laten zien dat zo’n voedingspatroon het cholesterolgehalte van de Nederlandse bevolking zou kunnen laten dalen. Ten slotte

beschrijft **hoofdstuk 8** een overzicht van de methodologische kwaliteit van onderzoek naar gezondheidslogo's. Het meeste onderzoek blijkt van beperkte methodologische kwaliteit te zijn. De onderzoeksuitdaging voor de toekomst is het meten van het daadwerkelijke effect van gezondheidslogo's op de gezondheid, bijvoorbeeld door het meten van bloeddruk en cholesterol.

Algemene Discussie

Dit proefschrift wordt afgerond met een algemene discussie in **hoofdstuk 9**. In het algemeen laten onze onderzoeken zien dat de bekendheid met het Ik Kies Bewust logo groot is. Echter, het daadwerkelijke gebruik van het logo is laag, met uitzondering van consumenten die al geïnteresseerd zijn in gezondheid: zij geven in verschillende onderzoeken aan het logo te gebruiken om een gezondere keuze te maken. Verder laat dit proefschrift zien dat het Ik Kies Bewust logo producenten gestimuleerd heeft om gezondere producten te ontwikkelen. We concluderen dat de meeste gezondheidswinst van gezondheidslogo's te behalen valt door de focus te leggen op de producent en het aanbod van gezondere producten te vergroten. Op deze manier kunnen we zowel de in gezondheid geïnteresseerde als de minder geïnteresseerde consument bereiken.
In de algemene discussie formuleren we ook een aantal aanbevelingen voor onderzoek en praktijk. Ten eerste bevelen we aan om in de toekomst de daadwerkelijke effecten van gezondheidslogo's op de gezondheid te meten, bijvoorbeeld door het meten van bloeddruk en cholesterol. Ten tweede zou het interessant zijn om gezondheidslogo's te combineren met andere marketing technieken zoals prijsstrategieën. Men zou kunnen onderzoeken of consumenten meer logoproducten kopen als deze producten goedkoper worden. Ten derde wordt aanbevolen om het effect van gezondheidslogo's in andere settings te onderzoeken, bijvoorbeeld in de horeca. Ten vierde zien wij een grote behoefte om compensatiegedrag te onderzoeken. Het zou kunnen zijn dat men meer gaat eten van logoproducten dan van dezelfde producten zonder logo, omdat men denkt dat meer eten van een gezonder product niet zoveel kwaad kan. Ten slotte bevelen we overheden aan om meer regulering te ontwikkelen voor wat betreft gezondheidslogo's. Het verplicht maken van een gezondheidslogo kan verwarring wegnemen waarom producten met dezelfde productsamenstelling niet allemaal hetzelfde logo dragen. Verder zou het verschaffen van financiële beloningen, bijvoorbeeld wanneer 80% van de producten van een bedrijf voldoet aan logo criteria, gezondere productontwikkeling extra kunnen stimuleren.

Algemene Conclusie

Bij gezondheidslogo's gaat het over meer dan alleen gezondheid: het gaat over lobbyen, belangenverstrengeling en geld. Momenteel is er een hevig internationaal debat gaande over het optimale format en de mogelijke impact van gezondheidslogo's. In dit politieke spel hebben beleidsmakers, wetenschappers, de voedingsmiddelenindustrie en consumentenorganisaties ieder hun eigen belangen. Ik denk dat de meeste gezondheidswinst van gezondheidslogo's te behalen valt door de focus te leggen op de producent en het vergroten van het aanbod van gezondere producten. Uiteraard speelt de consument ook een belangrijke rol: als deze de gezondere producten niet koopt, stopt de producent met de verkoop. Ik denk daarom dat we gezondheidslogo's in een breder kader moeten plaatsen: wanneer een product met

gezondheidslogo gecombineerd wordt met andere marketing technieken, zoals een aantrekkelijke verpakking, een lage prijs en een goede smaak, en wanneer de producent een betrouwbaar imago heeft, is de kans groot dat de consument dit product koopt. Hogere consumptie van producten met gezondheidslogo kan resulteren in een gezondere bevolking, mits men niet meer van deze producten gaat eten dan van producten zonder logo. Onze modelleringstudie laat zien dat consumptie van een voedingspatroon dat voldoet aan de criteria van een gezondheidslogo effect kan hebben op het cholesterolgehalte. De vraag die nu rest voor alle partijen – wetenschappers, beleidsmakers, voedingsmiddelenindustrie en consumentenorganisaties – is: wat is de daadwerkelijke impact van gezondheidslogo's op de gezondheid van onze maatschappij? Het antwoord op deze vraag zal essentieel zijn voor de toekomst van gezondheidslogo's.

Epilogue

Final personal note: science communication and the Four Organs Theory

I will end this thesis by reflecting on what the essential four levels of science communication are. Science communication can be more effective by using these four levels. I will illustrate this by using the communication around a front-of-pack (FOP) label as an example. I have based my thoughts on the book "Don't be such a Scientist" by Randy Olson (1) and the classical Retorica (Ars Retorica) by Aristoteles how to persuade your audience (2).

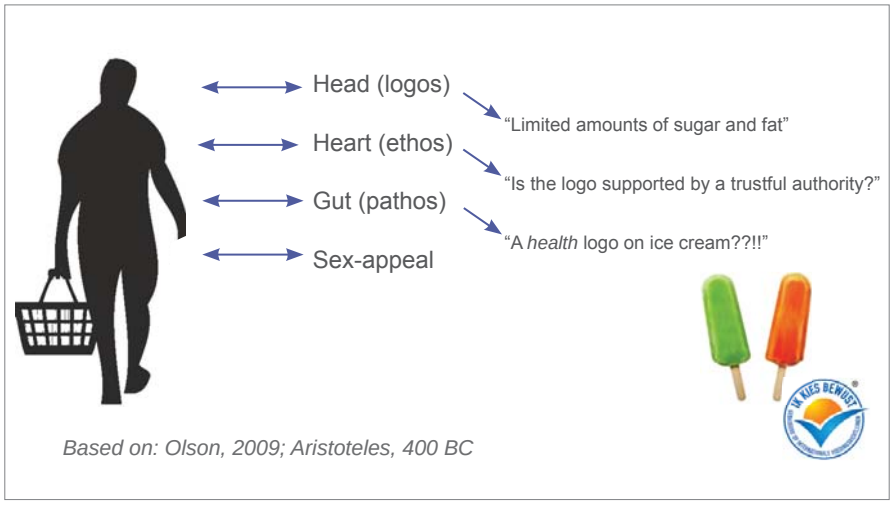
The Four Organs Theory of connecting with your audience

Science is rational. Science is based on principles of logic, argumentation and analysis. Scientists think with their heads, with their brains. They also communicate in this way. Aristoteles called this: "logos". By using scientific sound arguments, one is able to convince others. However, when communicating, it is important not only to communicate with your "head". There are three more levels essential to effectively communicate your message. First, there is the heart. The heart stands for belief, for love, and most importantly, for trust. Aristoteles used the word "ethos" for convincing an audience by showing authority and trust. Referring to one's own qualities is most effective to persuade others, according to Aristoteles. Secondly, there is the gut. The gut stands for feelings, emotions and impulsivity. People who trust their "gut instinct", generally did not think about this analytically. They rely on their "gut feeling". One can relate this level of communication to the Greek word "pathos". Using your emotions to convince your audience is using your pathos. Finally, there are the sex "organs" (not related to classical retorica), as a metaphore of someone's masculine or feminine expression. The power of them to connect to your audience and to persuade them of your message is enormous according to Olson. Think of Barack or Michelle Obama, who are using their masculinity and femininity in their communications.

A FOP label and the four levels of communication

Figure 1 illustrates this Four Organs Theory of connecting with your audience, related to a directive FOP label on ice cream. It shows the challenges around communicating the meaning of FOP labels. And it stresses the importance of communicating with all levels. When communicating with your head, your brains, it is easy to find scientific arguments why it is justified to put a FOP label on ice cream. This ice cream contains limited amounts of calories, less saturated fat and less added sugar than regular ice cream. This ice cream is obviously a healthier choice within its product group of ice cream. Additionally, ice creams are an interesting category for product innovations. When we go to the heart now, some critical questions arise. One may wonder which food manufacturer developed this product, which authority is supporting this FOP label and whether it can be trusted. This stresses the importance of a credible, trustable sender, which has sometimes been questioned regarding FOP labels in the past. When we go down to the gut now, some doubtful feelings may arise. A health label on ice cream? My "gut-feeling" indicates that it just does not feel right! Regarding the sex appeal, one may think of male or female role models promoting this ice cream. Journalists, industry groups and consumer organizations have frequently used the "heart" and "gut-feelings" especially in the past to promote or criticize FOP labels on snacks. Scientists should also become more aware of the use of these four levels of communication to convince others.

Figure 1. The Four Organs Theory of connecting with your audience, related to a front-of-pack label on ice cream.



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About the author

About the author

Ellis Lotte Vyth was born in Amsterdam, the Netherlands, on August the 4th, 1982 as daughter of Arno and Florry Vyth. She has one younger sister, Joline. After graduating the Vossius Gymnasium in Amsterdam in the year 2000, she studied Biology at the University of Utrecht. There, she discovered that she was fascinated by human biology in general and human nutrition in particular. Therefore, after completing her propaedeutics in 2001, she decided to study Human Nutrition at Wageningen University. While interested in human physiology, she discovered that she preferred communicating about human nutrition towards society, over lab research. For her internship, she worked 5 months at Schuttelaar & Partners, a consultancy company specialized in health and sustainability, located in The Hague. There she became interested in science communication in general as well as between different stakeholders. During that same period, the front-of-pack label Choices was launched; Schuttelaar & Partners was responsible for all logistics around the launch, and Ellis was involved in the start-up. She received her Master's degree in Human Nutrition in 2006.
In 2007, she was asked by Prof. Jaap Seidell to take up a PhD position to scientifically study and evaluate the Choices label at the VU University Amsterdam, Department of Health Sciences. In September 2007, she started her PhD and she finished her thesis in August 2011 before going with maternity leave. During those 4 years, Ellis closely collaborated with food producers, governmental organizations, retailers, catering organizations, consumer organizations and nutrition networks. Ellis wrote 7 international scientific articles as 1st author and 4 Dutch publications. She gave presentations at many national and international conferences and meetings. Currently, Ellis works as a postdoctoral researcher, further deepening her expertise in the area of nutrition labeling and nutrient profiling. She is also developing and giving trainings about science communication, presenting yourself and your key-message and visualizing science. In her future career, she would like to continue fulfilling an intermediate function between nutrition and health sciences and society by transferring scientific knowledge via seminars and trainings.

Ellis is married to Robin Kroonenberg and on the 21st of September 2011 their beautiful son Jona was born.

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