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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 where 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-
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 stimulating 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, Hor- gen 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 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-
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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