National Institute for Public Health
and the Environment
Ministry of Health, Welfare and Sport

Health aspects of the Dutch *diet*

Background report to 'What's on our plate? Safe, healthy and sustainable diets in the Netherlands.'

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Colophon

J.M.A. Boer (author), RIVM
E.J.M. Buurma-Rethans (author), RIVM
M. Hendriksen (author), RIVM
H.J. van Kranen (author), RIVM
I.E.J. Milder (author), RIVM
M.C. Ocké (author), RIVM
J. Verkaik-Kloosterman (author), RIVM
J. van Raaij (author), RIVM

Contact:
Jolanda Boer
jolanda.boer@rivm.nl

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National Institute for Public Health and the Environment
P.O. Box 1 | 3720 BA Bilthoven
The Netherlands
www.rivm.nl/en

Synopsis

Health aspects of the Dutch diet
Background report to 'What is on our plate? Safe, healthy and sustainable diets in the Netherlands.'

The health of the Dutch population can improve considerably if people adopt a healthier diet. If everyone eats enough fruit, vegetables and fish, and not too many saturated fatty acids, average life expectancy could increase by approximately six months. Similar health gains could be made if everyone was a healthy weight. However, the Dutch do not eat as healthily as they should and only a small section of the population follows the Dutch Dietary Guidelines (Richtlijnen Goede Voeding) issued by the Health Council of the Netherlands (Gezondheidsraad) in 2015. Approximately ten percent of 19-50 year olds achieve the guideline of eating 200 grams of vegetables per day, and approximately eight percent achieve the guideline of 200 grams of fruit. Furthermore, 54 percent of men and 46 percent of women are overweight, a higher percentage than a decade ago.

A healthy diet reduces the risk of overweight and chronic diseases, including cardiovascular disease, type 2 diabetes and some forms of cancer. There are a number of initiatives to encourage the Dutch to eat more healthily. The focus of these initiatives is to make it easier for consumers to choose healthier products. For example, the food industry has implemented various programmes to improve the composition of food products. In addition, programmes and guidelines have led to improvements in the food offered in schools, sports canteens and company canteens, although this is not yet the case everywhere.

Another example is the municipalities involved in the Young People at a Healthy Weight (Jongeren Op Gezond Gewicht, JOGG) programme, in which more than a hundred municipalities work with various partners (schools, shops, etc.) to enable children to grow up in an environment in which 'the healthy choice' is totally normal. In addition, the Netherlands Nutrition Centre (Voedingscentrum) provides consumers with independent and evidence-based information about eating healthily, for example through the Wheel of Five (Schijf van Vijf). The centre also offers tools for personal dietary advice, such as the Food Meter (Eetmeter).

This report is a background study for the report, "What is on our plate? Safe, healthy, and sustainable diets in the Netherlands" which was published on the 24th of January 2017. In this report, healthy, safety and sustainability aspects of food are integrated..

Keywords: food, nutrition, health, policy, nourishing framework, the Netherlands.

Publiekssamenvatting

Gezondheidsaspecten van het Nederlandse voedingspatroon
Achtergrondrapport bij 'Wat ligt er op ons bord? Gezond, veilig en duurzaam eten in Nederland'

De gezondheid van de Nederlandse bevolking kan aanzienlijk verbeteren als mensen gezonder eten. Als iedereen voldoende groente, fruit, vis, en niet te veel verzadigde vetzuren eet, kan de gemiddelde levensverwachting met ongeveer een half jaar toenemen. Als iedereen een gezond gewicht zou hebben, zou eenzelfde gezondheidswinst te behalen zijn. Nederlanders eten echter niet optimaal en slechts een klein deel van de bevolking eet volgens de Richtlijnen Goede Voeding van de Gezondheidsraad uit 2015. Zo haalt ongeveer 10 procent van de 19-50 jarigen de richtlijn om 200 gram groente per dag te eten en ongeveer 8 procent de richtlijn van 200 gram fruit. Ook heeft 54 procent van de mannen en 46 procent van de vrouwen overgewicht. Dit percentage was 10 jaar geleden lager.

Een gezond voedingspatroon vermindert het risico op overgewicht en chronische ziekten, waaronder hart- en vaatziekten, diabetes type 2 en sommige soorten kanker. Met verschillende initiatieven worden Nederlanders gestimuleerd om gezonder te eten. De focus daarvan is dat het consumenten gemakkelijker wordt gemaakt om voor gezonde producten te kiezen. Zo heeft de levensmiddelenindustrie diverse programma's uitgevoerd om de samenstelling van hun producten te verbeteren. Ook hebben programma's en richtlijnen ervoor gezorgd dat het aanbod van voedsel in school, sport- en bedrijfskantines is verbeterd, alleen is dat nog niet overal het geval.

Een ander voorbeeld is de ruim honderd zogeheten JOGG-gemeenten (Jongeren Op Gezond Gewicht). Hierin werken gemeenten samen met verschillende partners (scholen, winkels, enzovoort) om kinderen te laten opgroeien in een omgeving waarin 'de gezonde keuze' de normaalste zaak van de wereld is. Daarnaast geeft het Voedingscentrum consumenten wetenschappelijk onderbouwde en onafhankelijke informatie over gezonde voeding, bijvoorbeeld via de Schijf van Vijf. Ook bieden zij hulpmiddelen voor persoonlijk voedingsadvies, zoals de eetmeter.

Dit rapport is een achtergrondstudie voor de rapportage 'Wat ligt er op ons bord? Gezond, veilig en duurzaam eten in Nederland' van het RIVM die op 24 januari 2017 is verschenen. Hierin worden de aspecten van gezond, veilig en ecologisch duurzaam voedsel geïntegreerd weergegeven.

Kernwoorden: voeding, gezondheid, beleid, nourishing framework, Nederland.

Contents

Summary

The background report "Health aspects of the Dutch diet" addresses various questions regarding the healthiness of the Dutch food consumption pattern.

This report shows that in the Dutch population substantial health gains can still be achieved by improving diet and by lowering body weight. Our diet is not optimal and a large part of the population is not following the Dutch dietary guidelines. The guidelines have recently been revised and are now based on the state of the art research available on the relationship between diet and the risk of disease (Chapter 2). At present, 75-91% of the adult population do not follow the guidelines for vegetables and 78-94% do not follow the guidelines for fruit. These percentages have not changed over the last decade (Chapter 3). Furthermore, in 2015 the prevalence of overweight (including obesity) was 54.4% among men (including 12.2% obesity) and 46.3% among women (including 15.1% obesity). The prevalence of overweight has not decreased over the past decade.

We have estimated what the health gains would be if the Dutch population followed the 2006 dietary guidelines for fruits, vegetables, fish, salt and saturated and trans fatty acids (Chapter 4). The expected health gains include a reduction in the average mortality rate by some 5,000 deaths per year (annual mortality rate in the Netherlands is about 140,000), a mean increase in life-expectancy of about 0.5 year and a mean increase in number of years lived in full health of around 0.7 year. The health gains that are anticipated for a strict scenario in which all people had a body mass index (BMI) below 25 kg/m^2 would be in the same order as for all of the dietary factors together (1). The health gains of more realistic body weight reduction scenarios are much lower (Chapter 4).

This report also summarizes what is being done to bridge the gap between the present situation and a situation in which the dietary and body weight guidelines are followed. Effective governmental, civil society and food industry policies and actions are essential to maintain or increase the healthiness of food environments and to facilitate the consumer make the right food choices. In 2013, the World Cancer Research Fund International published a systematic framework called 'NOURISHING', which brings together the key domains of actions and policy areas to effectively promote healthier eating (2). NOURISHING is based on the understanding that food policies to prevent obesity and diet-related non-communicable diseases should aim to improve dietary behaviours by improving the availability, affordability and acceptability of healthy diets and decreasing the availability, affordability and acceptability of unhealthy diets. This framework is consistent with and supportive of the list of policy options for countries included in the WHO's Global Action Plan for the Prevention and Control of Non-Communicable Diseases (2013-2020) (3). In this Report, we used the NOURISHING framework to highlight the policy areas and actions aimed at promoting healthier eating for the Dutch situation (Chapter 5).

The starting point for many actions is that the healthy choice should be the easy choice. Because of the actions taken by the food industry to improve the composition of their food products, the sodium levels have been reduced in several product groups, like canned vegetables and legumes, and bread flour. Yet important steps still have to be taken because comparable foods have a wide range in levels of sodium and saturated fatty acids. Food quality is also improved by various fortification practices. Mandatory or encouraged fortification with nutrients, driven by a significant public health need, is very successful in improving nutrient intake, contrary to voluntary fortification. Regular and consistent nutritional education is a requisite for a successful supplementation advice. The current intake of supplements among the Dutch population does not contribute substantially to decreasing the proportion of people with inadequate intakes.

In recent years, several programmes have been implemented to improve the food environment, especially in schools. Programmes and guidelines for healthier school, company and sports canteens have indeed led to positive changes in the food assortment, but many canteens do not comply with even the most lenient variant of these guidelines, i.e. that a healthier option is available in each product category. An example of an integrated approach in the community setting is the JOGG approach (Youth at a Healthy weight). In December 2016 there were 114 municipalities (~30%) participating in JOGG. The programme is especially active in deprived neighbourhoods. Local studies suggest that the prevalence in childhood obesity has decreased in some JOGG-communities. But from the studies it is not possible to determine to what extent the JOGG approach contributed to these trends.

The Netherlands Nutrition Centre (Voedingscentrum) provides consumers with scientifically sound, independent information on healthy, safe and sustainable food choices. They are the authority for population-based and subgroup-based advice. They developed the food-based guidelines ‘Wheel of Five’, which is well-known in the Netherlands. In addition, they have developed more personalized nutritional aids such as the ‘eetmeter’. There are numerous other ‘food-based tools’ such as apps that are available to the public, but their value for improving diets is still largely unknown. In addition, nutrition advice provided in health care settings is an appropriate option for providing personalized nutrition advice. No appropriate options are yet available for obtaining personalized nutrition advice that is based on genetic information, although there are promising developments. Research has shown that personalized nutrition advice may be more effective in improving dietary behaviour than conventional population-based advice.

1 Introduction

Healthy and unhealthy diets have been receiving considerable attention for quite some time now. In 2004 RIVM, the National Institute for Public Health and the Environment in the Netherlands, published the report "Ons eten gemeten. Gezonde voeding en veilig voedsel in Nederland" (4) (followed by the English translation in 2006 "Our food, our health. Healthy diet and safe food in the Netherlands" (1)). At the time, the report was responding to the urgent need for integrated information on a healthy diet and safe food. Such integrated information was needed to assist in formulating priorities for policies in the fields of health protection and health promotion (4). The past decennium, much new knowledge on healthy diets and safe foods has been generated. Furthermore, food has increasingly become an issue in public debate, in part because of the sustainability aspects of food production, food supply and food consumption.

In 2014, the Dutch Scientific Council for Government Policy (WRR) published a report that explored the consequences of the large global challenges we are facing regarding ecological sustainability, public health and the robustness of the food supply for the Netherlands (5). The Council concluded that it was time for an explicit food policy. Such a policy should take into account the diversity of values in relation to food, the relationship between production and consumption, and the changing power relationships in the food system. The Dutch government can identify with the WRR recommendations and agrees that modifications of the food system are necessary to guarantee that sufficient amounts of safe and healthy foods are produced in a sustainable way (6) in the long term.

The knowledge synthesis "Safe, Healthy and Sustainable Diets" that RIVM started in 2014 fits in very well with the WRR report and the Cabinet response, but focuses on the Dutch food consumption pattern. It aims to give coherent answers to various questions regarding Dutch food consumption. How safe, healthy and sustainable is our current food consumption pattern? What are the scenarios for future food consumption patterns and these patterns safeness, healthiness and sustainability? With what measures and to what extent can our food consumption patterns become safer, healthier and more sustainable? And on what aspects do these three goals conflict or coincide? The knowledge synthesis is one of the cross-cutting themes of the strategic programme 2015-2018 of RIVM. The programme focuses on issues that may have an impact on our future health and environment. In this way, RIVM is preparing for tomorrow's issues.

As part of the knowledge synthesis "What's on our plate? Safe, Healthy, and Sustainable food in the Netherlands", various reports are prepared. As shown in Figure 1.1, there are five background reports that underpin the final integrative report with key messages. The present background report "Health aspects of the Dutch diet" describes various topics regarding the healthiness of the Dutch food consumption pattern.

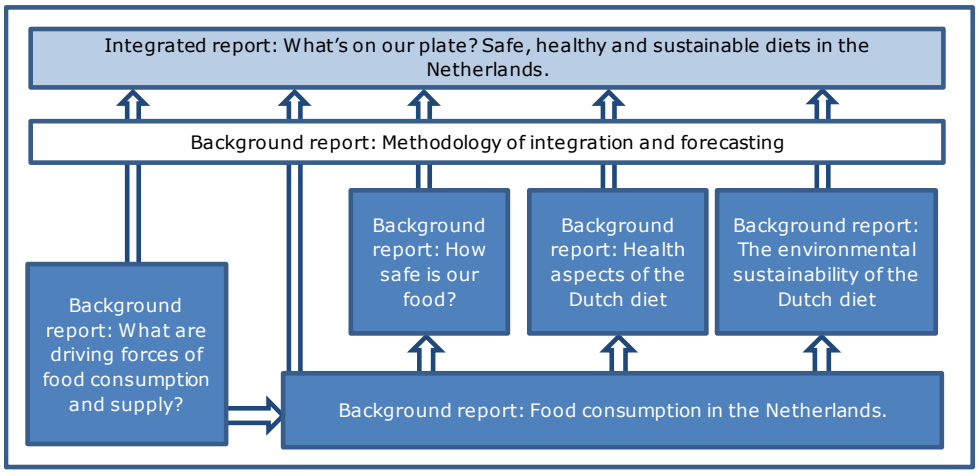

Figure 1.1. The various reports of the knowledge synthesis "Safe, Healthy, and Sustainable Diets" and their Interrelationships.

This background report deals with the healthiness of the Dutch diet; yet what is meant by healthiness? The traditional WHO definition of health 'Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity' was first set out in 1948. At the time, morbidity mainly featured infectious diseases. Today, chronic diseases are much more prevalent. Maintaining the traditional definition in today's situation means that almost everybody, to some extent, could be considered ill. So the need for a more dynamic description of health that highlights the human capacity for resilience and for coping with new situations is increasingly being felt. For this reason, a new concept of health was introduced in 2011: 'Health as the ability to adapt and to self-manage in the face of social, physical and emotional challenges' (7). Such a concept needs further operationalization for use in daily practice and for monitoring purposes. Recently, in an exploratory study, the support for the new concept of health was evaluated and indicators of health were developed in order to make the concept measurable, but validation studies must still be performed (8). Additionally, for the development of guidelines for a healthy diet, scientific evidence comes mostly from studies that investigate diet-disease relationships. So, for the moment, we will also relate the healthiness of the diet to the capacity to prevent or reduce diseases.

This report first describes the association between diet and diseases (Chapter 2). These associations lie at the foundation of guidelines for a healthy diet and are needed to perform health impact calculations.

Subsequently, this report describes the healthiness of the Dutch diet by comparing the actual food consumption of the Dutch population and various subgroups within the population with guidelines for a healthy diet (Chapter 3). Chapter 3 also focuses on what the Dutch consumer's perception is of a healthy diet.

The report describes the health impact of following or neglecting dietary guidelines as well, including following or neglecting weight maintenance guidelines (Chapter 4). To place such health impact calculations in

perspective, Chapter 4 also includes the observed trends in NCDs over the past decade.

In Chapter 5 we highlight the policy areas and actions aimed at promoting healthier eating in the Dutch situation. These include effective governmental, civil society and food industry policies and actions, which are essential to maintain or increase the healthiness of food environments and to help the consumer make the right food choices. We use the 'NOURISHING' framework to structure this chapter. In 2013, the World Cancer Research Fund International published this systematic framework, which brings together the key domains of actions and policy areas to effectively promote healthier eating (2). NOURISHING is based on the understanding that food policies to prevent obesity and diet-related non-communicable diseases (NCDs) should aim to improve dietary behaviour by improving the availability, affordability and acceptability of healthy diets and decreasing the availability, affordability and acceptability of unhealthy diets. The framework NOURISHING is consistent with and supportive of the list of policy options for countries included in the WHO's Global Action Plan for the Prevention and Control of Non-Communicable Diseases (2013-2020) (3).

Abbreviations used are listed in Appendix 1.

Chapters 2 to 5 each end with a summary of key findings. The key findings of this background report will be used as input for the integration of food safety, healthiness and sustainability (see Figure 1.1).

2 Relation between diet and disease

A healthy diet helps to protect against malnutrition in all its forms, including non-communicable diseases (NCDs), such as diabetes, heart disease, stroke and cancer. Healthy dietary practices are important from very early in life onwards. A healthy diet during pregnancy is essential for normal growth and development of the foetus, while breastfeeding fosters healthy growth in infants and may have longer-term health benefits (9). It is also important to know whether or not the perception of the consumer concerning a healthy diet is in line with the scientific knowledge about the relationship between diet and disease. For this reason, the consumer's perception of a healthy diet is described in this chapter.

2.1 Diet and pregnancy

The quality of daily food intake is an important factor for the health of mother and child (10). Long-term vitamin B6 deficiency before pregnancy may cause nausea and vomiting, while anaemia is frequently responsible for tiredness. Therefore, optimal preconception nutrition, with iron supplementation when necessary, may reduce tiredness during pregnancy, especially during the first trimester. Maternal vitamin D deficiency has been associated with an elevated risk of gestational diabetes mellitus and pre-eclampsia, a condition associated with an increase in maternal and perinatal morbidity and mortality (11). Low prenatal and perinatal maternal vitamin D concentrations can affect the function of other tissues, which may lead to a greater risk of multiple sclerosis, cancer, insulin-dependent diabetes mellitus, and schizophrenia later in the child's life. While there is some indication that vitamin D supplementation could reduce the risk of pre-eclampsia and increase a baby's length and head circumference at birth, further rigorous randomized trials are required to confirm these effects.

Adequate preconception folic acid has been associated with a decreased risk of neural tube defects in the foetus and supplementation with folic acid, alone or in combination with vitamins and minerals, prevents them (12). Docosahexaenoic acid (DHA) and iodine have a well-established role in the development of the central nervous system in the foetus during pregnancy (13). Maternal iodine deficiency during pregnancy impairs early brain development in the foetus, with consequent physical and mental retardation and lower cognitive and motor performance in later life. Fish is rich in DHA and iodine, and EFSA concluded that consumption of about 1-2 servings of seafood per week and up to 3-4 servings per week during pregnancy has been associated with better functional outcomes for neurodevelopment in children compared to no consumption.

2.2 Health effects of breastfeeding

Breastfeeding has a beneficial effect on the health of both the child and the mother compared with formula feeding. Recently, RIVM updated a systematic review on the health effects (14). There is convincing evidence that breastfed infants run a lower risk of contracting gastrointestinal and respiratory tract infections, as well as otitis media in early childhood. The beneficial effect is maintained after breastfeeding is

stopped. Breastfeeding may also protect children against obesity, asthma and wheezing, with stronger effects seen in young children than in older children. The evidence for these associations was classified as probable. There is possibly also a protective effect with respect to childhood cancers in general, leukaemia, inflammatory bowel disease, Crohn's disease, ulcerative colitis, diabetes mellitus type 1 and type 2 and sudden infant death syndrome.
Breastfeeding probably provides the mother with a lower risk of diabetes mellitus type 2, rheumatoid arthritis and hypertension. Breastfeeding also possibly lowers their risk of ovarian cancer, postpartum weight retention and hip fractures.

2.3 Underweight, overweight and obesity

Energy intake needs to balance energy expenditure. A low energy intake relative to expenditure leads to underweight. When energy intake exceeds energy expenditure, the excess energy is stored in the body primarily as fat mass. When fat accumulation is abnormal or excessive, a person becomes overweight or obese. Overweight and obesity, often measured by a high body mass index (BMI, see Textbox 2.1), is an established risk factor for multiple health problems, including cardiovascular diseases, many types of cancer, musculoskeletal disorders and type 2 diabetes in particular (15).

Textbox 2.1. Underweight, overweight and obesity (16).

Overweight and obesity are defined as abnormal or excessive fat accumulation that may impair health. Body mass index (BMI) is a simple index of weight-for-height that is commonly used to classify overweight and obesity. It is defined as a person's weight in kilograms divided by the square of his height in meters (kg/m^2). BMI provides the most useful population-level measure of overweight and obesity, as it is the same for both sexes and for all ages of adults. Yet it should be considered a rough guide because it may not correspond to the same degree of fatness in different individuals.

Classification in adults:
Underweight: BMI<18.5 kg/m^2
Normal weight: BMI 18.5-24.99 kg/m^2
Overweight: BMI 25-29.99 kg/m^2
Obesity: BMI≥30 kg/m^2

Prevalence of underweight

The prevalence of underweight in the Netherlands is low in adults. In contrast, the prevalence is 8% in children aged 4-12 years and 5.5% in 16-20 year-olds (Figure 2.1). A recent study among children in Amsterdam showed that the prevalence of underweight may increase. In 2013, a higher prevalence (7.8% in boys and 7.0% in girls) was observed among schoolchildren than in 2009 (5.4% and 6.3%, respectively) (17). Because little is known about the determinants and health consequences of underweight in children, it is unclear whether this is a serious development or not.

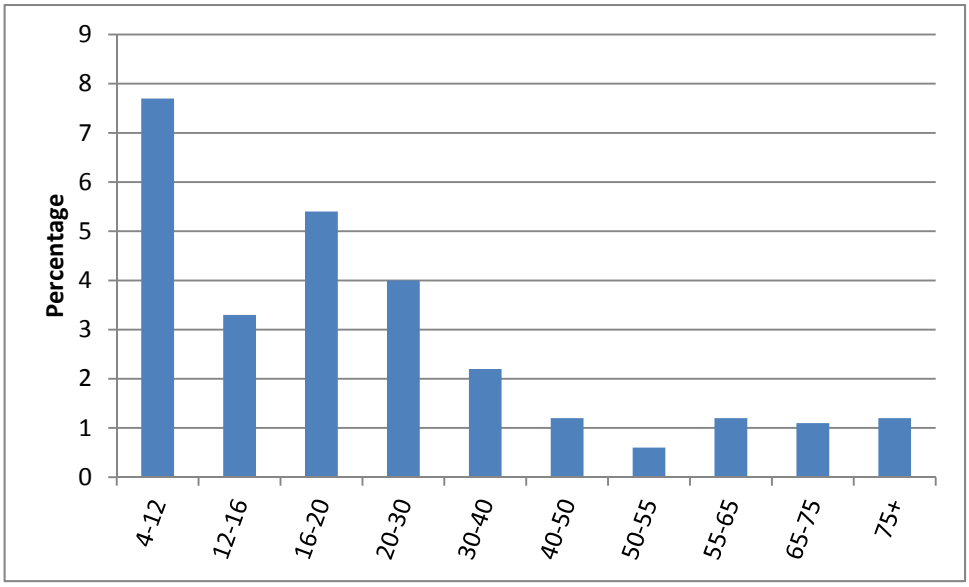

Figure 2.1. Prevalence of underweight according to age, 2013. Source: CBS statline.

Prevalence of overweight and obesity

Since the 1980s, the prevalence of overweight and obesity has increased sharply in the Netherlands, both in men and in women and at all educational levels (Figure 2.2) (18). The increase in the prevalence of overweight was highest in Dutch adults with a mid-high and high level of education. The increase in obesity, however, was lowest in these groups.

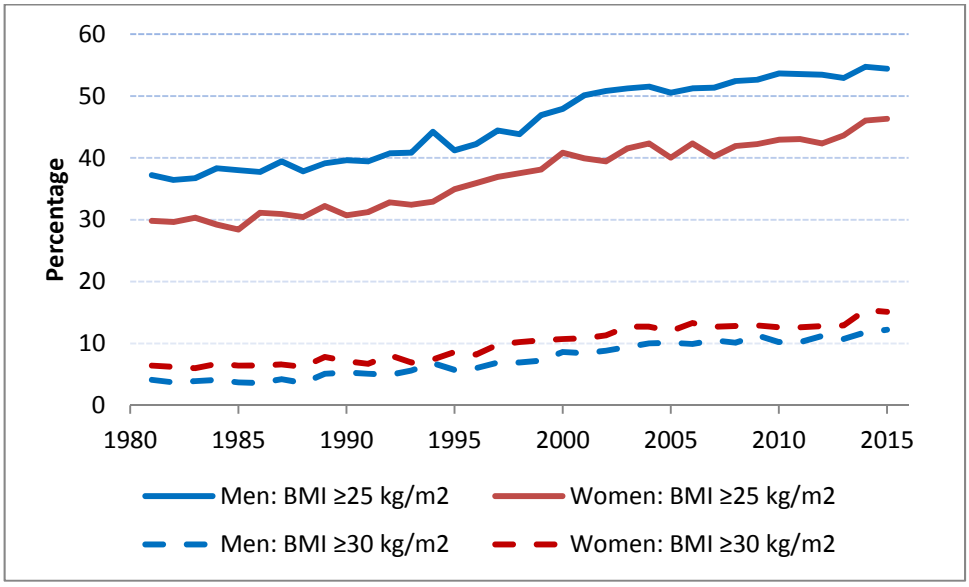

Figure 2.2. Percentage of adults aged 20 years and over with overweight (including obesity) and obesity from 1981-2015. Source: www.volksgezondheidenzorg.info.

In 2015, about half (50.3%) of the Dutch adult population was overweight or obese, with 13.7% being obese. The prevalence of overweight and obesity was higher among men (54.4%) than among women (46.3%). In contrast, obesity was more prevalent among women (15.1%) than among men (12.2%). The prevalence of overweight and obesity increases with age. Among men, the prevalence decreases after the age of 75 (Figure 2.3).

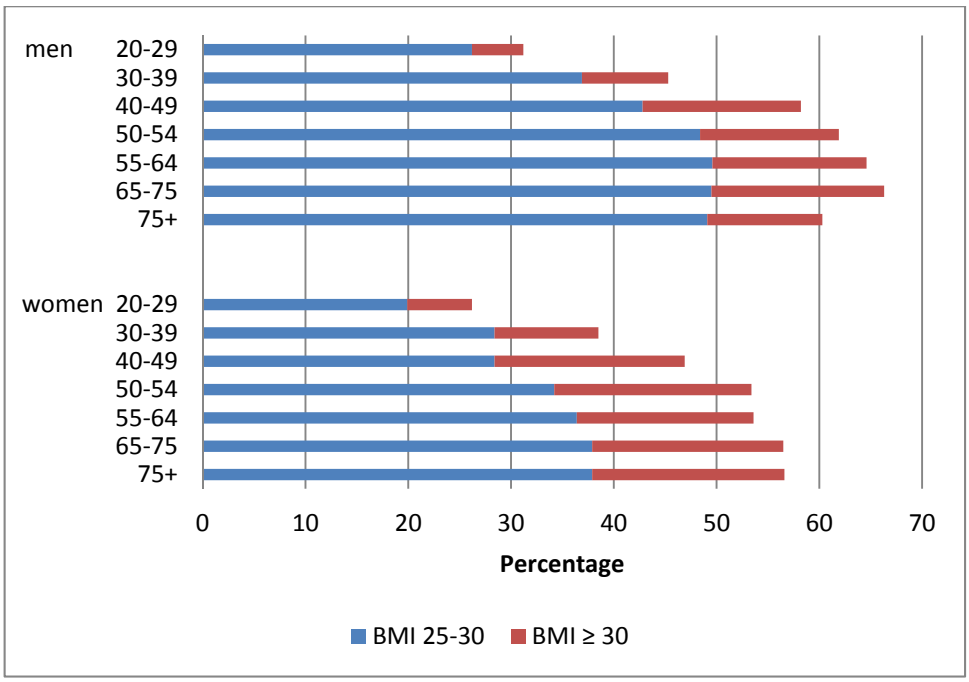

Figure 2.3. Prevalence of overweight and obesity according to age in adults, 2015. Source: www.volksgezondheidenzorg.info.

Adults with a low level of education more often have overweight or obesity (64%) than adults with a high level of education (40%, Figure 2.4) (18). Recent data from the HELIUS study showed that the percentage of participants with overweight or obesity is also higher among Dutch adults from Turkish, Moroccan, Surinamese and Hindu origin. While the prevalence of obesity was 8% among participants from Dutch origin, the prevalence ranged from 17 to 27% among men and 30 to 40% among women in the groups with a non-Western origin (19).

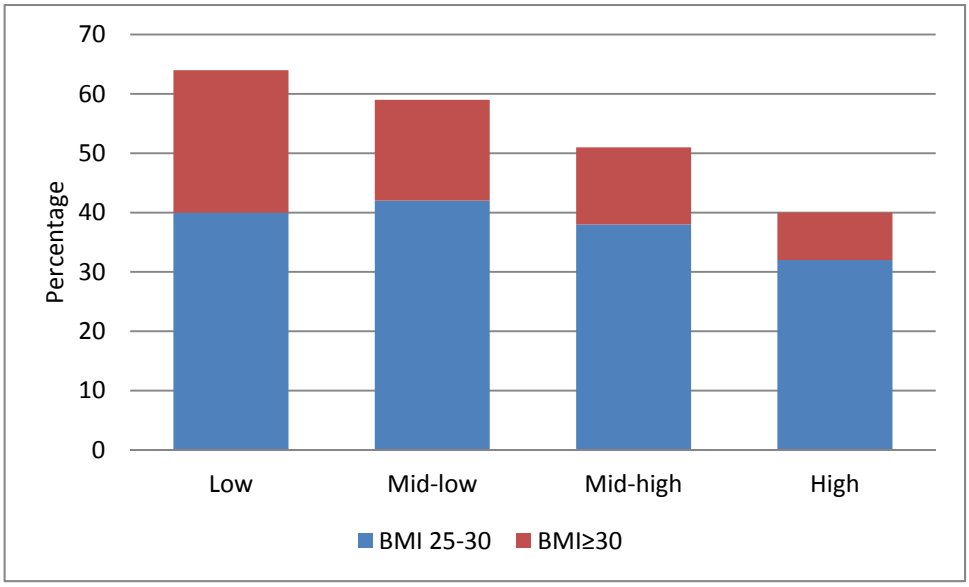

Figure 2.4. Prevalence of overweight and obesity according to educational level in adults, 2012. Source: www.volsgezondheidenzorg.info.

Among Dutch 4-20 year-olds, the prevalence of overweight and obesity increased slightly between 1981 (10.1%) and 2015 (12.1%) (18). The prevalence of obesity hardly changed during this period. These trends were more or less similar among boys and girls. In 2015, 9.3% of the 4-20 year-olds were overweight and an additional 2.8% were obese. Except for the youngest age group (4-12 years), boys are more often overweight or obese than girls (Figure 2.5) (18).

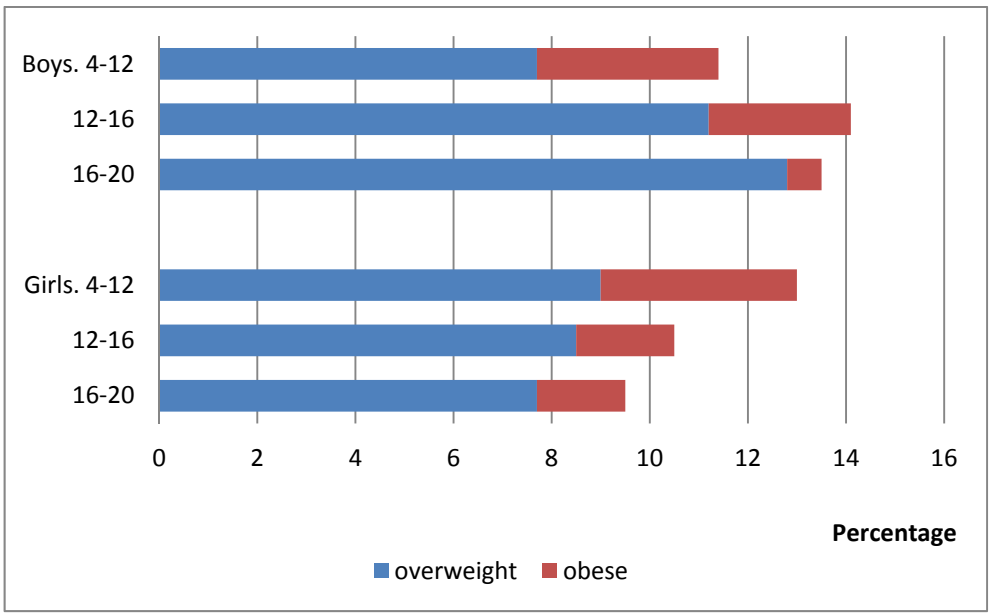

Figure 2.5. Prevalence of overweight and obesity according to age in children, 2015. Source: www.volksgezondheidenzorg.info.

Like in adults, among children the prevalence of overweight and obesity is higher in children with an immigration background. Of the 4-12 year old children of non-Western origin 22% is overweight or obese. The prevalence is 9% among their autochthonous counterparts. For obesity this is nine and two percent, respectively (20).

In most other European countries, overweight and obesity are more prevalent than they are in the Netherlands (Figure 2.6) (18). In several countries, such as England, Ireland, Spain, Greece and Germany, around 70 per cent of the men are overweight or obese. Among women, the prevalence of overweight and obesity is highest in Cyprus, England and Scotland. In some of the above-mentioned countries, one in four adults is obese (21). In almost all European countries, the prevalence of obesity increased over the last decennia, just as it did in the United States of America, Canada and Australia (22, 23). Although the prevalence of overweight and obesity is no longer increasing in the United States, 75% of the male and 67% of the female population is still overweight. One in three Americans is obese (24).

In comparison with other European countries, fewer Dutch children are overweight or obese (18). The prevalence of these conditions is highest in some Southern-European countries (Figure 2.7). In Greece, Italy, Cyprus, Malta and Spain, more than 30% of the children are overweight (25, 26). This is more than twice the prevalence found in the Netherlands. Among 6-9 year-old schoolchildren, the highest significant decrease in overweight prevalence was observed in Italy, Portugal and Slovenia and the highest significant increase in Latvia and Norway (26). Between 2002 and 2010, self-reported occurrence of overweight among 11, 13 and 15 year-olds stabilized in about half of the countries participating in the HBCS-study, including the Netherlands. However, increasing overweight prevalence was noted in many Eastern European countries over this same period (27).

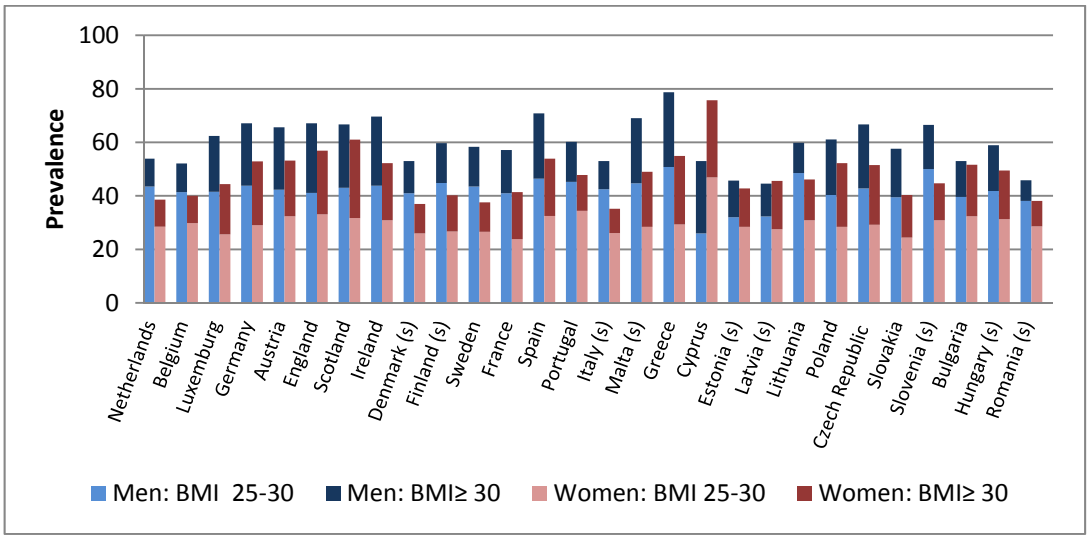

Figure 2.6. Prevalence of overweight and obesity in European countries. Data are not standardized. (s): self-reported data. Self-reported data can lead to an underestimation of the prevalence. Source: www.volksgezondheidenzorg.info.

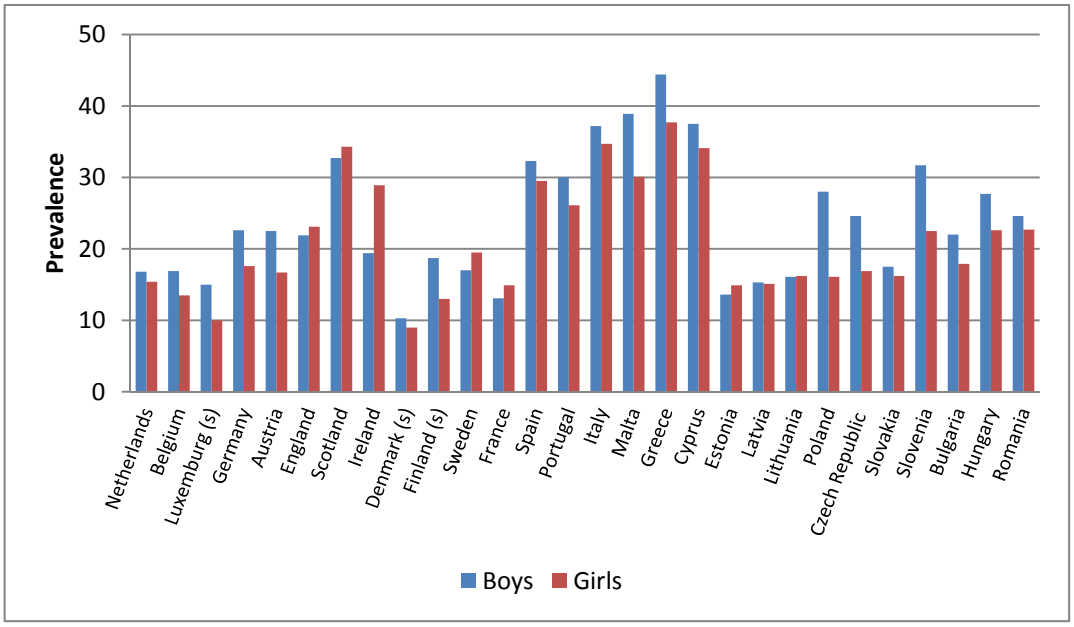

Figure 2.7. Prevalence of overweight and obesity combined in children across European countries. Data are not standardized. (s): self-reported data. Self-reported data can lead to underestimation of the prevalence. Source: www.volksgezondheidenzorg.info.

As described above, some of the recent epidemiological studies suggest there are breaks and decreases in obesity rates and sometimes conclude that the obesity epidemic is not increasing further. Although these findings are encouraging, it may be too early to be optimistic. Recently, the major potential biases and distortions that may have created the reported trends in such studies have been addressed (28). Studies reporting a break were mostly of short duration. Furthermore, focusing on trends in waist circumference rather than BMI leads to a less optimistic conclusion that the problem of obesity is still increasing.

2.4 Malnutrition and undernutrition

Malnutrition is caused primarily by poor food and nutrient intake. Disease and treatment can also contribute to the development of malnutrition due to anorexia, metabolic alterations and the side effects of treatment, which hamper food intake (29). A poor appetite is one of the central determinants preceding malnutrition in old age (30). Malnutrition may refer to a lack of certain micronutrients, but most studies in this field focus on protein energy malnutrition (undernutrition). Providing extra protein and energy to older undernourished individuals leads to a small but consistent weight gain and may reduce mortality. The effects on complications and functioning are less convincing (31).

There is no consensus on how to measure undernutrition (32). Because of this, it is unclear what the scope of the problem in the Netherlands is exactly. Textbox 2.2 describes the various working definitions used in this section to describe the prevalence of undernutrition in the Netherlands. Seven per cent of the community-dwelling individuals aged 55 or over that participated in the Longitudinal Aging Study Amsterdam (LASA) were undernourished (32). In the food consumption survey

among older (70+) community-dwelling Dutchmen, the prevalence of undernutrition was 12.5% (33).

Textbox 2.2. Working definitions of undernutrition.

LASA
BMI < 20.0 kg/m^2 and/or unintended weight loss of 5% or more in the past 6 months.

DNFCS-Older adults 2010-2012
Mid-upper arm circumference <25 cm and/or unintended weight loss of 4 kg in the last 6 months.

LPZ 2014
BMI < 18.5 (≤ 20.0 kg/m2 when 65 years or older) and/or unintended weight loss of more than 10% in the last 6 months or more than 5% in the last month.

LPZ 2008-2012
BMI < 18.5 (≤ 20.0 kg/m2 when 65 years or older) or BMI 18.5-20.0 (20.0-23.0 kg/m^2 when 65 years or older) in combination with no or minimal nutritional intake for three days or reduced intake for more than seven days or lower than normal nutritional intake and/or unintended weight loss of more than 6 kg in the last 6 months or more than 3 kg in the last month.

The prevalence is higher among patients receiving home care, patients admitted to hospitals and people living in institutions. The prevalence of undernutrition was 11.8% among hospital patients and 17% among people living in homes for long-term care, such as nursing homes (34). The prevalence among Dutch home-care patients may even be higher (35). The prevalence in nursing homes has declined from 26.9% in 2008 to 19.9% in 2012 (36). This is probably the result of increased attention to screening and treatment of undernutrition over recent years.

2.5 Relation between diet and non-communicable diseases

Research into diet and disease relationships is increasingly focused on dietary patterns and foods, instead of on nutrients. Indeed, individuals eat foods, not nutrients, and foods are eaten in a variety of combinations that can have interactive and potentially cumulative or confounding relationships with health. Current research provides evidence of moderate to strong links between healthy dietary patterns and reduced risks of obesity and non-communicable diseases, particularly cardiovascular disease, hypertension, type 2 diabetes and certain cancers (37). Several healthy dietary patterns have been studied, including a vegetarian diet, a Mediterranean-like diet, the Nordic diet, the DASH-diet (Dietary Approaches to Stop Hypertension) and diets with a higher level of compliance with nutritional guidelines measured by, for instance, the Healthy Eating Index.

Table 2.1 shows effect estimates for the relationships between healthy dietary patterns and disease or risk factors that, according to the Health Council of the Netherlands, have been convincingly proven (38).

In preparation of the new dietary guidelines to prevent non-communicable diseases that were released November 2015, the health Council evaluated all associations between diet and diet-related diseases that contribute most to death, life-years lost and disease burden in the Netherlands (39).

They concluded that a healthy diet decreases blood pressure by 2-6 mmHg and lowers the risk of mortality, cardiovascular diseases, type 2 diabetes and colorectal cancer by 15-25%. It was not yet possible to reach a conclusion on body weight. In contrast, the Nutrition Evidence Library (NEL) of the Unites States Department of Agriculture (USDA), in their systematic review of dietary patterns, concluded that moderate evidence indicates healthy dietary patterns are associated with lower BMI, waist circumference, the percentage of body fat or the risk of obesity (40). This discrepancy comes from the fact that the Health Council of the Netherlands based their conclusions on evidence from intervention studies only, while the NEL also considers evidence from observational studies. Recently, healthy dietary patterns have also been associated with a reduced risk of frailty in older individuals (41) and with a lower burden from several common diseases (42). These findings need to be confirmed in other studies.

Table 2.1. Relationship between dietary patterns and disease with convincing evidence, as concluded by the Health Council of the Netherlands (38).

	Vegetarian diet	Mediterranean-type diet	(New) Nordic diet	DASH-diet	Compliant with guidelines
Intervention studies*					
Systolic BP	-5 mmHg		-3 to -6 mmHg	-6 mmHg	
Diastolic BP	-2 mmHg		-3 to -4 mmHg	-3 mmHg	
Cohort studies**					
Mortality		20% lower risk			20% lower risk
CVD		20% lower risk			
CHD	25% lower risk	20% lower risk		20% lower risk	
Stroke		20% lower risk		20% lower risk	20% lower risk
Type 2 diabetes		15% lower risk		15% lower risk	15% lower risk
Colorectal cancer		15% lower risk		15% lower risk	15% lower risk

DASH: Dietary approaches to stop hypertension.

* Intervention studies with Western-type diets as control diets. ** For individuals with a high compared with a low index for this pattern, except for the vegetarian pattern, where the risk is compared with non-vegetarians.

Although the specific foods or nutrients that are part of the different healthy dietary patterns may vary, the dietary composition is generally similar. A healthy dietary pattern is high in vegetables, fruits, whole grains, low-fat or non-fat dairy, fish, legumes and nuts; moderate in

alcohol (among adults); low in red and processed meat and low in sugar-sweetened foods and drinks and refined grains. In general, healthy diets are low in salt (sodium) and saturated fatty acids (SFA) and rich in polyunsaturated fatty acids (PUFA) and fibre (37). For these various components of a healthy diet, associations with disease risk and intermediate risk factors are described in the following sections. As the NEL and the Health Council of the Netherlands have systematically evaluated many associations between diet and disease risk, the following sections are mainly based on their background documents. One has to keep in mind that the Health Council only considered intervention studies and prospective cohort studies, while the NEL also considered other observational studies. Effect estimates for those associations that the Health Council of the Netherlands classified as convincing are summarized in Appendix 2.

Fruit and vegetables
Several positive health effects of fruits and vegetables have been observed. According to the NEL, evidence for an association between increased fruit and vegetable intake and lower body weight is modest in middle adulthood (43). In contrast, based on intervention studies only, the Health Council concluded that, under ad-libitum circumstances, an effect of additional fruit and vegetable consumption on body weight is unlikely (44). A decrease in systolic blood pressure when participants increased their intake of fruit and vegetables has convincingly been demonstrated. In prospective cohort studies, high intakes of both vegetable and fruit have also convincingly been associated with a reduced risk of coronary heart disease, stroke and colorectal cancer. Convincing evidence also exists for inverse associations of green leafy vegetables and fruit with type 2 diabetes and lung cancer. In general, 250-300 grams of fruit - or vegetables - a day, i.e. 2-3 portions, lowers the risk of disease by approximately 10% compared with 50-100 grams (0.5-1 portion). For green leafy vegetables, such as lettuce, spinach and endive, a 10% risk reduction was found for 25-50 grams a day. The favourable effects of fruits and vegetables on health are ascribed to the many bioactive components that they contain and to their functional properties, such as low glycaemic load and energy density (45). The bioactive components may have antioxidant, anti-inflammatory and electrolyte properties and include a wide variety of micronutrients, such as vitamins (e.g. vitamins C, B6, D and E, folate) and minerals (e.g. selenium, potassium), phytochemicals and dietary fibre. Associations between fibre intake and disease risk are further described below.

Whole grains
Whole grains are those foods made from the entire grain seed, which consists of the bran, germ and endosperm. Examples of whole grains are whole wheat bread, brown rice, popcorn, oats and barley. Observational studies found a reduced BMI and waist circumference with higher whole grain intakes (46). However, short-term intervention studies observed no changes in weight with increased consumption of whole grains (47), so more research on the long-term effects is needed. The effect of whole grains on the plasma levels of LDL cholesterol may depend on the type of grain. While the consumption of oats lowers total and LDL cholesterol, results for wheat are inconsistent (47). According to the Health Council consumption of 60-90 grams of whole grain foods

per day reduces the risk of coronary heart disease, type 2 diabetes and colorectal cancer by 10-25%. This intake corresponds to 2-3 slices of whole wheat bread or 2 portions of oatmeal per day. Potential mechanisms for the health effects are diverse, since whole grains are rich in nutrients and phytochemicals such as antioxidants, vitamins and minerals. They are also rich in dietary fibre. Mechanisms may include immune protection and improvement in glucose metabolism (48).

Legumes
Several health effects are ascribed to legumes. In NHANES, a cross-sectional survey in the USA, bean consumption was associated with a lower body weight (49). Yet the Health Council concluded that there are too few intervention studies to draw any definite conclusions (50). The consumption of legumes instead of wheat or vegetables, however, has convincingly been shown to lower plasma LDL cholesterol levels. Consumption of 130 grams of legumes per day reduced LDL cholesterol by 0.2 mmol/l. There is also limited evidence for a favourable effect on systolic blood pressure and a reduced risk of coronary heart disease. Legumes have a low energy density, a low glycaemic index and are nutrient rich. They are generally low in fat but high in fibre and protein, B vitamins and minerals such as iron, calcium and potassium. These aspects likely contribute to the possible health effects of legumes (51).

Nuts and seeds
According to the Nutrition Evidence Library of the USDA, there is moderate evidence that the consumption of nuts has a favourable impact on cardiovascular disease risk factors, particularly serum lipid levels, when total calorie intake is held constant and diet is nutritionally sufficient (52). The NEL mentioned two prospective cohort studies which reported that an increased frequency of nut consumption is associated with a lower risk of weight gain or obesity (53, 54). The Health Council only found the evidence for favourable effects on plasma LDL cholesterol and coronary heart disease to be convincing (55). Very recently, a meta-analysis concluded that nuts also reduce total mortality risk (56). The underlying mechanisms for the health effects of nuts and seeds appear to include antioxidant and anti-inflammatory actions, particularly related to their monounsaturated and polyunsaturated fatty acids (MUFA and PUFA), as well as their vitamin (e.g. folic acid, niacin, vitamin E, and vitamin B6) and polyphenol content. Nuts are also a rich source of dietary fibre, minerals (e.g., copper, magnesium and potassium) and phytosterols (57).

Dietary fibre
A sufficient intake of dietary fibre reduces the risk of many diseases. Although some observational studies, such as the one conducted by Du et al.(58), suggest that a high fibre intake is associated with reduced weight gain, too few intervention studies have been carried out to draw definite conclusions (59). Convincing evidence, however, comes from intervention studies that have shown that dietary fibre reduces blood pressure, especially in hypertensive individuals. Additionally, several specific fibres, i.e. pectins and beta-glucans from barley and oats, have been shown to lower total cholesterol and LDL cholesterol levels. Furthermore, dietary fibre decreases the risk of coronary heart disease, stroke, type 2 diabetes, breast cancer and colorectal cancer. For each 10 grams a day of higher fibre consumption, the risk of these diseases decreases by 5 to

10%. Ten grams of dietary fibre can be obtained from four slices of 100% whole wheat bread or three dried prunes, or by replacing 200 grams of potatoes by brown beans. There are many potential mechanisms through which dietary fibre protects against CHD, stroke, diabetes and cancer. For example, dietary fibre is fermented in the small intestine to produce short-chain fatty acids, which have anti-carcinogenic properties and inhibit cholesterol synthesis. Additionally, fibres slow gastric emptying, reduce absorption from the small intestine and increase stool bulk. This may contribute to the maintenance of satiety, the attenuation of postprandial blood glucose, insulin and lipid levels and reduced contact time between potential carcinogens and mucosal cells. Also, fibres have been shown to increase the rate of bile excretion. This reduces serum total and LDL cholesterol and increases the binding between bile acids and carcinogens (60).

(Low-fat) dairy

Low-fat or non-fat dairy is part of some, but not all of the dietary patterns that are considered to be healthy. But convincing evidence is scarce. According to the systematic reviews of the Nutrition Evidence Library, moderate evidence suggests that dairy consumption may lower blood pressure and the risk for cardiovascular disease and type 2 diabetes (61). The Health Council of the Netherlands also concludes that dairy consumption may lower the risk of some diseases, such as type 2 diabetes, stroke, breast cancer and colorectal cancer (62). Only for colorectal cancer and type 2 diabetes does convincing evidence exist. The risk of colorectal cancer is reduced by 15 per cent per 400 g/day higher total dairy intake or 200 gr/day higher milk intake. The consumption of 60 grams of yoghurt a day reduces the risk of type 2 diabetes by 15%. Increased dairy consumption may also have some unfavourable effects. Intervention studies under ad-libitum circumstances have shown that increased dairy consumption results in modest weight gain when greater dairy intake is encouraged without other changes in diet (62). This is possibly the result of increased caloric intake. It is less likely that weight gain occurs when dairy food is taken under isocaloric circumstances. Indeed, the Nutrition Evidence Library states that strong evidence indicates that there is no unique role for dairy in weight control (61). Their conclusion is based not only on intervention studies, but also on cohort and case-control studies.

Fish and fish fatty acids

According to the NEL, moderate evidence shows that the consumption of two servings of seafood per week, which provide an average of 250 mg per day of long-chain n-3 fatty acids, is associated with reduced CHD mortality or sudden death in persons with cardiovascular disease (CVD). The Health Council also finds some of the cardioprotective effects of fish to be convincing. Compared with individuals who do not or rarely eat fish, those who consume fish at least once a week have a 15% lower risk of dying of coronary heart disease and a 10% lower risk of stroke (63). The risk of dying from CHD does not decrease further with higher intakes. A very high fish intake has also been associated with a reduced risk of non-fatal CHD. Fish is an important source of the long-chain omega-3 polyunsaturated fatty acids, eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) and essential nutrients, such as vitamin D, selenium and iodine (64). There is little doubt that EPA and DHA in fish

are key nutrients for the benefits and are important for CVD prevention. Intervention studies among individuals with (a high risk of) cardiovascular disease clearly demonstrated the protective effect of these fatty acids (65). Mechanisms underlying the beneficial effects of fish on cardiovascular disease include improved lipid profiles (66) and reduced blood pressure (67), presumably through reduced inflammation, oxidation and coagulation (68, 69).

Other fatty acids

The unfavourable effect of trans fatty acids on the risk of cardiovascular disease is well established. Trans fatty acids increase LDL cholesterol levels and the risk of coronary heart disease. They result from partial hydrogenation of liquid oils to more solid forms, which increases stability and thus shelf-life. Natural trans fatty acids are present in meat, milk and milk products from ruminants, due to hydrogenation in the rumen. Both industrial trans fatty acids and natural trans fatty acids seem to increase plasma LDL cholesterol levels to the same extent (70). Trans fatty acids also increase the risk of coronary heart disease. This is the case for industrial trans fatty acids, but some studies have found that ruminant trans fatty acids do not increase cardiovascular disease risk (71, 72). But the limited number of available studies prohibits any firm conclusions concerning whether the source of trans fatty acids is important (70). There is much more debate being conducted about the health effects of saturated fatty acids. The intake of saturated fatty acids increases LDL cholesterol levels when replacing carbohydrates, cis-MUFA or cis-PUFA (73). Despite this effect on LDL cholesterol levels, a recent meta-analysis conducted by de Souza et al. (71) concluded that saturated fatty acids are not associated with an increased CHD risk. However, the risk associated with the intake of saturated fatty acids is sensitive to the choice of replacement nutrient. There is convincing evidence that replacement of saturated with polyunsaturated fatty acids does reduce CHD risk both in prospective cohort studies and randomized controlled trials (73). The Health Council concluded that the effect of replacing saturated fat with carbohydrates is inconclusive. So polyunsaturated fatty acids may be more significant for cardiovascular disease risk than saturated fatty acids. Plant oils are the main source of polyunsaturated fatty acids.

Red and processed meat

Very little information from intervention studies is available on the association between meat consumption and the risk factors for non-communicable diseases (74). In cohort studies, however, the consumption of red meat and processed meat has convincingly been associated with an increased risk of stroke, type 2 diabetes, colorectal cancer and lung cancer. Per portion of red meat (about 100-120 grams) or 50 grams of processed meat a day, the risk of disease increases by 10-20%. Several potential mechanisms by which the consumption of red and processed meat may increase the risk of disease have been postulated, but conclusive evidence is lacking (75, 76). Red and processed meats are a source of saturated fatty acids, which have been associated with increased risk of various diseases, especially when replacing polyunsaturated fatty acids (see above). Moreover, red meat is a source of haem iron. High doses of iron may lead to oxidative stress, a state with an increased peroxidation of lipids, protein modification and

DNA damage. If continued for a long time, oxidative stress induced by iron may lead to the development of many diseases, such as cardiovascular disease, type 2 diabetes and atherosclerosis. Finally, processed meat contains sodium and nitrite preservatives, which can contribute to an increased risk of disease.

Alcohol and alcoholic beverages
The relation between alcohol consumption and the risk of non-communicable diseases is complex. Low to moderate alcohol consumption is associated with a reduced risk of coronary heart disease, heart failure, type 2 diabetes, dementia and lung cancer (77). However, for total mortality and stroke, the risk associated with alcohol consumption is J-shaped. This means that the risk is lowest in individuals who consume alcohol with moderation, but is increased in non-consumers and in individuals who drink more than ~15 grams of alcohol per day. Furthermore, binge drinking clearly increases CHD risk. Despite the positive effects of alcohol consumption on some diseases, even when consumed in low quantities, it increases the risk of breast and colorectal cancer. The increased risk of colorectal cancer is demonstrated for the consumption of wine as well as beer (78). Furthermore, alcohol increases the risk of many other diseases and conditions, such as injuries and mental and behavioural disorders. Alongside this comes the risk of social harm, ranging from social nuisances such as being kept awake at night to more serious consequences such as marital harm, child abuse, crime, violence and homicide. Generally, the higher the alcohol consumption, the greater is the risk (79).

Sugar sweetened beverages
According to the NEL, a moderate body of epidemiologic evidence suggests that greater consumption of sugar-sweetened beverages is associated with increased body weight in adults (80). The Health Council concluded that there is convincing evidence that ad-libitum consumption of sugar-sweetened beverages promotes weight gain in both adults and children (81). Furthermore, each 330 ml of higher intake per day, equalling one can of soda, increases the risk of type 2 diabetes by 20%. The association with type 2 diabetes can partly be explained by a higher body mass index in those people consuming sugar-sweetened beverages. According to the Nutrition Evidence Library, moderate evidence from prospective cohort studies indicates that a higher intake of added sugars, especially in the form of sugar-sweetened beverages, is also associated with an increased risk of stroke and coronary heart disease (CHD) in adults (82). The Health Council also concluded that these associations may exist, but graded the evidence as low (81).

Sodium
According to the Health Council, a reduction in sodium intake of 1.8 grams per day reduces systolic blood pressure by 2 mmHG in normotensive and by 5 mmHg in hypertensive individuals (83). Limited evidence also suggests that a higher sodium intake is associated with a higher CHD risk. The NEL endorses this conclusion. They say, "Although the reviewed evidence on associations between sodium intake and direct health outcomes has methodological flaws and limitations, when considered collectively, it indicates a positive relationship between higher levels of sodium intake and the risk of CVD. This evidence is

consistent with existing evidence on blood pressure as a surrogate indicator of CVD risk." (84)

2.6 Relationship between diet and risk factors for non-communicable diseases in children

Associations between diet and risk factors for non-communicable disease can already be seen in childhood. The Cardiovascular Risk in Young Finns study, for example, showed that a dietary pattern characterized by a high consumption of rye, potatoes, butter, sausages, milk and coffee, and beginning in childhood was significantly associated with higher total and LDL cholesterol levels, and C-reactive protein in both genders, and with systolic blood pressure and insulin levels among females (85). A "health-conscious" pattern that included a high consumption of vegetables, legumes and nuts, rye, cheese and other dairy products was inversely, but not significantly associated with the same risk factors. Furthermore, a randomized trial among 57 adolescents with prehypertension or hypertension found at a 3-month follow-up that the DASH diet resulted in a significantly greater decrease in systolic blood pressure than the usual-care group (86). Besides the DASH diet, a reduction in sodium intake significantly reduces systolic and diastolic blood pressure in children (87).

As described in Chapter 2.5, ad libitum consumption of sugar-sweetened beverages promotes weight gain in both adults and children. Results from Generation R showed that higher intake at 13 months was already significantly associated with higher BMI at ages 2, 3, 4 and 6 years, at least in girls (88) and with a higher cardiovascular risk factor score at 6 years in boys (89).

2.7 Consumers' perception of a healthy diet

Across different age groups, sexes and socio-economic groups and across different countries, there seems to be relative homogeneity in people's perceptions of healthy eating (90, 91). In a pan-European survey from 1998, low fat, more fruit and vegetables, balance and variety, and fresh natural foods were the most mentioned aspects of a healthy diet, both in the overall study population and among the Dutch participants (91). A lack of knowledge about nutrition was not a commonly cited barrier to healthy eating (91).
Consumers' interest in health and nutrition has grown substantially since (92). Healthy eating gets a lot of attention on regular media and social media. Besides scientists, doctors, dieticians and government organizations like the Health Council of the Netherlands and The Netherlands Nutrition Centre, food blogs and diet gurus provide lots of information about healthy eating. Because of this large amount of information coming from a variety of media, it becomes harder to distinguish scientifically proven food facts from misinformation about healthy food choices (93). This may lead to consumers becoming confused and, at least for some of them, to an indifference to healthy eating. A recent survey about food trends in the Netherlands showed that, indeed, 89% of the respondents considered food trends confusing. More than half of the respondents believed that the 'Wheel of Five' (Schijf van Vijf, see 3.4) is the healthiest way of eating (94). A large proportion (24%) of the participants reported that their own eating principle was the healthiest. Among other things, these principles were

'in moderation', 'tasty', 'varied', 'fresh', 'ecological' and 'ordinary'. A low-carbohydrate or low-sugar diet was considered the healthiest diet by 8% of the respondents. Furthermore, they thought vegetables, fruit, water and dairy were the healthiest products, and fast food, high-calorie snacks and soft drinks were the unhealthiest.

2.8 Key findings

- Diet is important for health, starting from conception and continuing through old age.
- Current research provides evidence of moderate to strong associations between healthy dietary patterns and lower risks of obesity and non-communicable diseases, particularly cardiovascular disease, hypertension, type 2 diabetes and certain cancers. Already in childhood, healthy dietary patterns are associated with more favourable risk factors for non-communicable diseases, such as blood pressure and plasma cholesterol levels.
- A healthy dietary pattern is: higher in vegetables, fruits, whole grains, low-fat or non-fat dairy, fish, legumes and nuts; moderate in alcohol (among adults); lower in red and processed meat; and low in sugar-sweetened foods and drinks and refined grains. In general, such diets are low in sodium and saturated fatty acids (SFA) and rich in polyunsaturated fatty acids (PUFA) and fibre.
- Across different age groups, sexes and socio-economic groups and across different countries, there seems to be relative homogeneity in the perceptions of healthy eating among consumers. They most often mention low fat, more fruit and vegetables, balance and variety, and fresh natural foods as aspects of a healthy diet. This is in line with the view of organizations such as the Health Council of the Netherlands concerning a healthy diet.
- Malnutrition is mainly prevalent in old age, while overweight and obesity are highly prevalent at all ages. The prevalence of overweight and obesity has increased since the 1980's.

3 How healthy is the Dutch diet?

A healthy diet helps to protect against malnutrition, obesity and nutrition-related non-communicable diseases. Furthermore a healthy diet means variation in food consumption, the intake of sufficient amounts of essential nutrients, and an energy intake that matches energy expenditure (see Chapter 2). This is why dietary guidelines are formulated. In order to evaluate the healthiness of the Dutch diet, consumption data might be compared to these dietary guidelines. This chapter describes the consumption survey system, the different dietary recommendations and how they were developed, and to what extent the Dutch population adheres to the dietary guidelines.

3.1 Food consumption surveys

In the Netherlands, food consumption survey data are used to evaluate the healthiness of the diet. Food consumption data provide insight into the consumption of foods, the intake of macronutrients and micronutrients, exposure to potential harmful chemical substances and food and nutrition trends. A schedule of the Dutch National Food Consumption Survey System and the related studies that have been carried out between 2003 and 2016 is shown in Figure 3.1, while Textbox 3.1 describes the system in more detail. The background report 'Food consumption in the Netherlands' extensively describes the food consumption in the Netherlands (95).

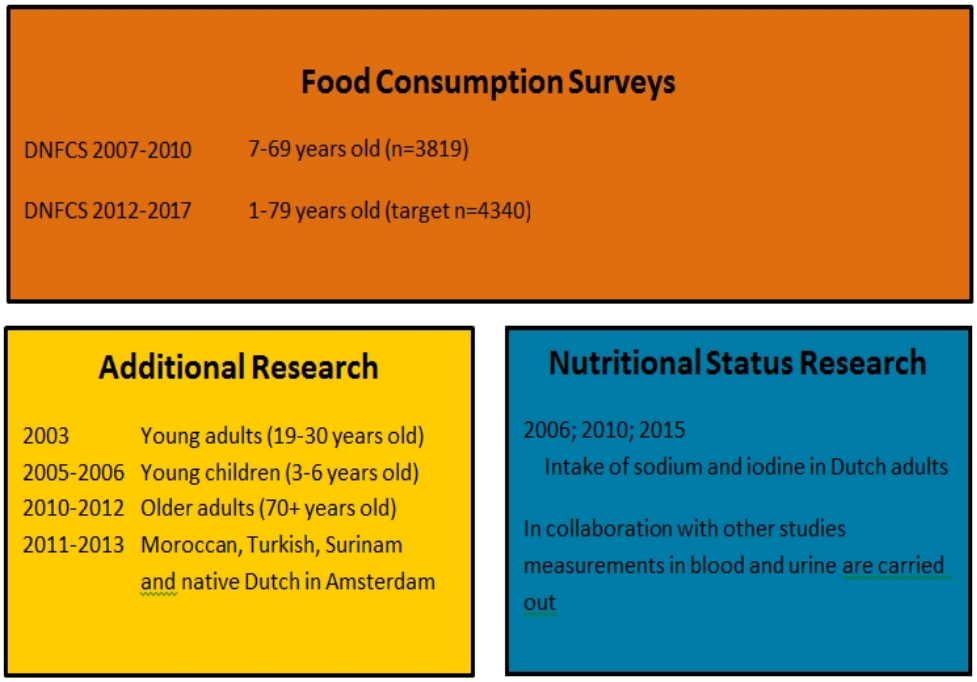

Figure 3.1. The Food Consumption Survey System and related studies that have been carried out between 2003 and 2016. References: DNFCS 2007-2010 (96), DNFCS 2012-2016(97); Additional research: 2003 (98), 2005-2006 (99), 2010-2012 (33), 2011-2013 (19); Nutritional status studies (100-103).

Textbox 3.1. The Dutch National Food Consumption Survey System.

The Food Consumption Survey System consists of three modules: nationwide food consumption surveys, additional research and nutritional status research.

The *nationwide food consumption surveys are* designed for the semi-continuous collection of basic data on the general Dutch population. The food consumption survey method comprises two 24-hour dietary recalls on two non-consecutive days, supplemented with questionnaire information on life style and the consumption frequency of specific foods and dietary supplements. For the youngest and oldest age groups, the dietary recalls are combined with food diaries. The nationwide food consumption surveys provide detailed information on what, when and where Dutch children and adults eat. The intake of energy and nutrients is calculated by linking consumed foods to the Dutch food composition database NEVO and linking consumed food supplements to the Dutch supplement database NES.

Additional research is needed for specific groups, such as young children, immigrants, pregnant and lactating women, and (institutionalized) elderly people. In a directed food consumption survey, the recruitment and/or method can be adapted to fit the specific needs of these subgroups.

When the food consumption survey indicates that there may be nutritional problems or issues (e.g. inadequate or excessive intake of certain vitamins or minerals), a follow-up study may be undertaken for example on nutritional status (if possible). *Nutritional status surveys* are also performed to gain insight into the intake of certain micronutrients for which food consumption surveys are not the best method to estimate intake (e.g. sodium and iodine). For the infrastructure of nutritional status surveys, there is cooperation with other studies. In 2006, 2010 and 2015, nutritional status studies on sodium and iodine were carried out in collaboration with the Doetinchem Cohort Study. Furthermore, in specific subgroups of the Dutch population, the intake of vitamins and minerals was determined through measurements in blood: for children of 4 and 8 years old (in collaboration with the PIAMA-cohort study) and for Surinamese and Dutch adults (in collaboration with the SUNSET-study). For nutritional status research, blood samples are also available for adults (in collaboration with the NL-de Maat study, www.rivm.nl/NLdemaat) and the elderly (in collaboration with the LASA study, www.lasa-vu.nl).

Textbox 3.1 (continued). The Dutch National Food Consumption Survey System.
The quality of national food consumption survey data depends on the representativeness of the study population for the general Dutch population and on the validity of the food consumption data. Subject characteristics of the nationwide food consumption surveys were representative for the region, urbanization level and educational level of the Dutch participants. However, selection bias towards persons that are interested in food and health cannot be excluded. The 24-h dietary recall using GloboDiet software has been validated and the results were comparable to other self-reported dietary assessment methods. It is, however, well-known that all self-reported dietary assessment methods include measurement errors and generally underestimate total energy intake, which is also the case for the Dutch surveys. Yet it has been acknowledged that these surveys are of major importance to developing food policies.

3.2 Dietary guidelines

On a regular basis, the Health Council of the Netherlands reviews and evaluates the scientific evidence on relationships between diet and dietary components and main dietary related diseases (see Chapter 2)., Dietary guidelines are derived from this evaluation, for which a considerable health gain can be expected, taking into account the scientific evidence and the current food consumption of the Dutch population. In November 2015, the Health Council published the *Dutch dietary guidelines 2015* (39). In earlier reports, the Health Council (and former Voedingsraad) published their guidelines in terms of nutrients. Over the course of time, they were extended with greater attention given to food groups, such as vegetables, fruit and fish, and dietary patterns like Mediterranean and vegetarian patterns. These guidelines reflect the current state of the art regarding nutrients, food and dietary patterns in relation to the risk of frequently occurring non-communicable diseases (see Chapter 2). The guidelines are formulated in terms of food groups, while scientific evidence on the relationship of nutrients to health is also included. The main recommendations given in the guidelines are summarized in Textbox 3.2. The guidelines are evidence-based integrated messages intended to reduce the risk of chronic diseases for the general population (104). Specific groups of patients can benefit from them, but might need additional advice. Also, pregnant women, infants and children up to two years of age are beyond the scope of the guidelines. No specific recommendations are given for the prevention of overweight or undesirable weight gain or for physical activity. The Health Council plans to update dietary reference intakes on specific nutrients (vitamins and minerals) during the coming years (see Chapter 3.4).

Textbox 3.2. Dutch dietary guidelines 2015 (39).

- Follow a dietary pattern that involves eating more plant-based and less animal-based food, as recommended in the guidelines.
- Eat at least 200 grams of vegetables and at least 200 grams of fruit daily.
- Eat at least 90 grams of brown bread, whole-meal bread or other whole grain products daily.
- Eat legumes weekly.
- Eat at least 15 grams of unsalted nuts daily.
- Take a few portions of dairy produce daily, including milk or yoghurt.
- Eat one serving of fish weekly, preferably oily fish.
- Drink three cups of tea daily.
- Replace refined cereal products by whole-grain products.
- Replace butter, hard margarines, and cooking fats by soft margarines, liquid cooking fats, and vegetable oils.
- Replace unfiltered coffee by filtered coffee.
- Limit the consumption of red meat, particularly processed meat.
- Minimize consumption of sugar-containing beverages.
- Don´t drink alcohol or no more than one glass daily.
- Limit salt intake to 6 grams daily.
- Nutrient supplements are not needed, except for specific groups to which supplementation applies.

The Dutch dietary guidelines of the Health Council are especially meant to serve nutrition policy purposes. They are not intended to advise consumers directly, since they do not cover the whole diet, are partly qualitative and do not primarily consider nutrient adequacy. An additional step is therefore needed for the derivation of Food-Based Dietary Guidelines (FBDGs), taking into account the guidelines for a healthy diet and the current diet of subgroups of the population.

Based on the Dutch dietary guidelines of 2015, the Netherlands Nutrition Centre was responsible for developing the Wheel of Five Guidelines and related public information materials. The Wheel of Five is structured in terms of food groups and is supposed to be feasible for the general public. The Wheel of Five Guidelines are visualized in a model, which aims to inform the public about a healthy diet (see Chapter 5.8). The elaboration of dietary guidelines is summarized in Figure 3.2.

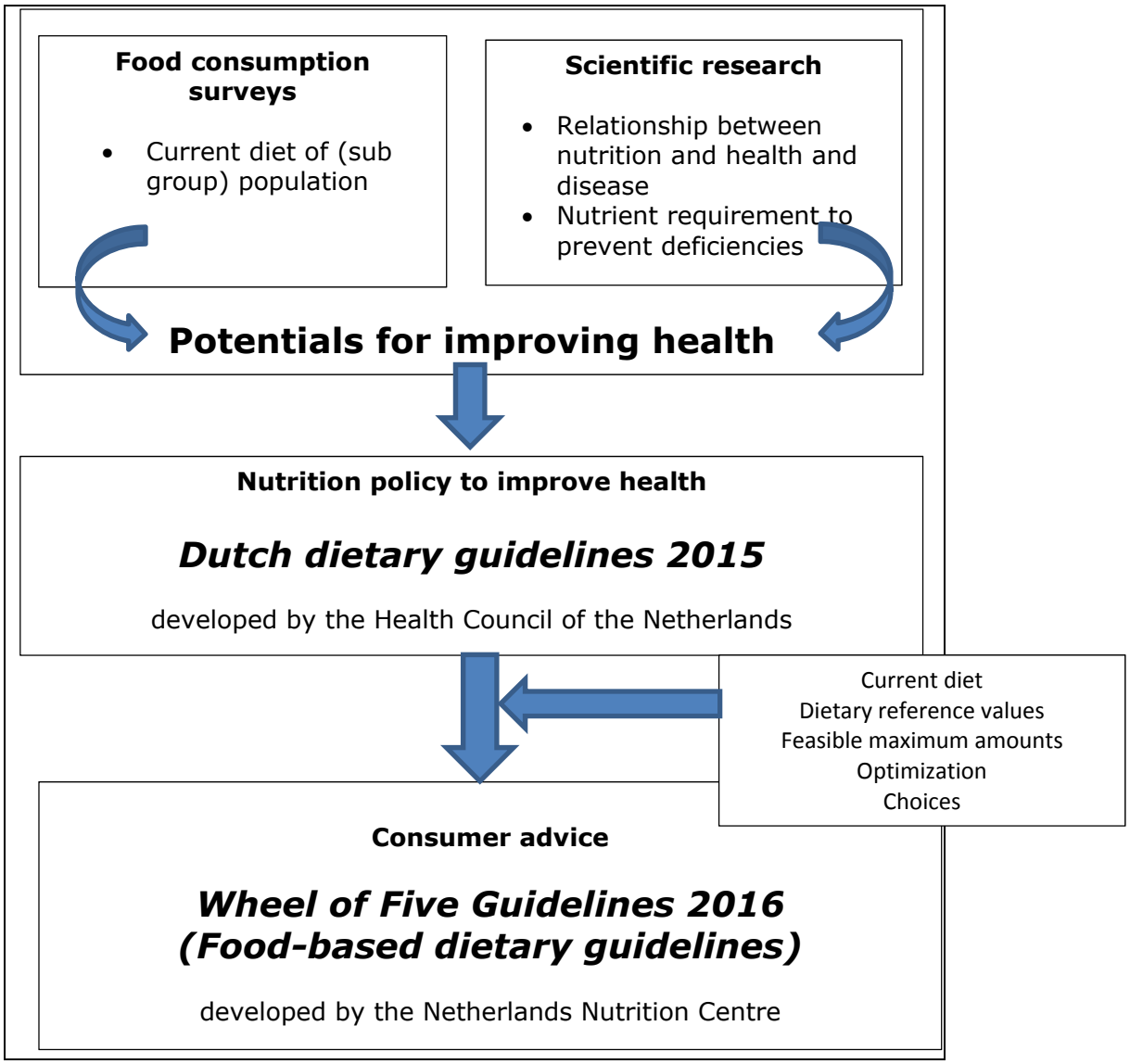

Figure 3.2. Elaboration of dietary guidelines in the Netherlands.

Apart from national dietary guidelines, there are also international guidelines for achieving a healthy diet. In Table 3.1 the Dutch dietary guidelines of 2015 are compared with those of the World Cancer Research Fund/American Institute for Cancer Research (WCRF/AIRC) (105) and the WHO (106). WCRF and WHO also refer to the promotion of physical activity and healthy weight. WHO member states agreed to reduce the global population's intake of salt by 30% and halt the rise in diabetes and obesity in adults and adolescents, as well as in childhood overweight by 2025. The Health Council plans to publish separate advice on norms for physical activity in 2017 (107).

Table 3.1. Dietary guidelines placed in an international perspective.

	WCRF/AIRC (105)	WHO (108)	Health Council of the Netherlands (39)
Energy intake		Balance between intake and expenditure	
Physical activity	Be active	Be active	
Weight	Within normal range	Avoid unhealthy weight gain	
Breastfeeding		Exclusively during the first 6 months of life; continuously until 2 years of age and beyond	
FOOD GROUPS			
Foods of plant origin	Preference		Preference
Vegetables **Fruit and berries**		At least 400 g (5 portions) of fruit and vegetables a day	200 g/day 200 g fruit/day
Whole grain		A healthy diet contains whole grains	90 g/day (bread or other whole grain products)
Pulses			Weekly
Nuts		A healthy diet contains nuts	15 g unsalted/day
Dairy			A few portions/day (including milk or yoghurt)
Fish			Once a week, preferably fatty fish
Red meat	Avoid use	Limit the consumption of fatty meat	Limit intake
Processed meat	Avoid use	Limit the consumption of processed meat	Limit intake
Vegetable oils		Use vegetable oil	Replace hard margarines, butter and fat with soft margarines, vegetable oils and fat
Energy dense foods	Limited		
Salt	Limited intake	Limit intake to <5 g/day	Limit intake to <6 g/day
Tea			3 cups/day
Coffee			Replace unfiltered with filtered coffee

	WCRF/AIRC (105)	WHO (108)	Health Council of the Netherlands (39)
Sugary drinks	Avoid use	Limited intake	As little as possible
Alcoholic drinks	Limited intake		None or max 1 glass/day
Dietary supplements			Not needed, except for some specific groups at risk
NUTRIENTS			
Total fat intake		Max 30% of total energy intake	
Saturated fatty acids		Shift from consumption of saturated to unsaturated fats	
Trans fatty acids		Industrial trans fats are not part of a healthy diet	
Free sugars		<10% of total energy; further reduction to <5% is suggested for additional health benefits	

The guidelines given above for a healthy diet are meant to be guidelines for people without specific health problems in order to prevent chronic diseases and malnutrition. Health organizations such as the Dutch Diabetes Association (www.diabetesfonds.nl), the Netherlands Heart Association (www.hartstichting.nl) and the Dutch Cancer Society (www.kwf.nl) refer to the Dietary guidelines of the Health Council of the Netherlands for prevention purposes. In addition, they further specify the guidelines for patients with diabetes mellitus (type I and II), cardiovascular diseases and cancer, respectively (see also Chapter 5.9). In the 'NDF Voedingsrichtlijn Diabetes 2015' (109) of the Dutch Diabetes Federation, special attention is given to a diet rich in whole grain products, fruit, vegetables, legumes and nuts; moderate alcohol consumption; a diet low in refined grain products, red and processed meat and low intake of sugar-containing drinks. The Netherlands Heart Association emphasizes a diet with as little saturated fatty acids as possible, low in salt, with lots of vegetables and fruit and with sufficient fibre. To reduce the risk of cancer, the Dutch Cancer Society advises eating at least 200 grams of vegetables and two pieces of fruit daily, limiting the consumption of red and processed meat to a maximum of 500 grams per week and ensuring an optimal intake of calcium (700-1,000 mg /day), e.g. by the consumption of 2 or 3 glasses of milk (products) and 1 or 2 slices of cheese.

3.3 Food consumption compared with the Dutch dietary guidelines

Most recent consumption data are available from DNFCS 2012-2014. They are compared with the Dutch dietary guidelines 2015 (39). In these guidelines, recommendations in terms of grams per day are given

only for a few specified product groups and they are not specified per age group. The guidelines for other food groups are less specific, expressed for example in terms of portions, frequencies or directions of preferred foods (see Textbox 3.2). Table 3.2 shows the consumption of the food groups mentioned in the Dutch dietary guidelines of 2015 in the Dutch adult population aged 19-79 years.

Table 3.2 Consumption of food groups indicated in the Dutch dietary guidelines of 2015 by the Dutch adult population aged 19-79 years (DNFCS 2012-2014), weighted for socio-demographic characters, season and day of the week.

	Recommended daily intake (39)	19-50 years		51-79 years	
		Men (n=273)	Women (n=259)	Men (n=281)	Women (n=234)
Vegetables					
Mean consumption in g/d	200	131	128	148	159
Fruit					
Mean consumption in g/d	200	79	107	122	148
Whole grain products					
Mean consumption in g/d	90	108	79	111	84
Legumes					
Mean # days/week	Weekly	0.3	0.3	0.3	0.5
Unsalted nuts					
Mean consumption in g/d	15	2	2	3	3
Fish*					
% with consumption at least once/week	Weekly (preferably fatty fish)	59	53	65	65
Tea (black and green)					
Mean consumption in g/d	450	146	293	223	362
Whole grain products	Replace refined products by whole grain products				
Mean % of whole grain products of total cereal products (incl. bread)		48	46	51	52
Soft margarines, liquid cooking fats, and vegetable oils	Replace butter, hard margarines and cooking fat by soft margarines, liquid cooking fats and vegetable oils				
Mean % of soft margarines, liquid cooking fats, and vegetable oils of total fats		50	40	46	44
Red meat and processed meat	Limit the consumption of red meat, particularly processed meat				
Mean consumption in g/d		82	59	83	51

	Recommended daily intake (39)	19-50 years		51-79 years	
		Men (n=273)	Women (n=259)	Men (n=281)	Women (n=234)
Sugar-containing beverages	Minimize consumption of sugar-containing beverages				
Mean consumption in g/d		315	194	112	69
Alcohol*	Don't drink alcohol or no more than one glass daily				
% Not drinking alcohol		17	35	18	33
% drinking ≤1 glass/d		54	81	43	55
Vitamin D containing supplements	Supplementation advice for specific groups				
				70-79 years, Men (n=144)	51-79 years, Women (n=241)
% using supplements with vitamin D in winter		Not applicable	Not applicable	20	48
% using supplements with vitamin D in rest of the year		Not applicable	Not applicable	15	38
Salt(110)		19-49 years		50-71 years	
		Men (n=73)	**Women (n=62)**	**Men (n=98)**	**Women (n=56)**
Median consumption in g/d	**Max 6 g/day**	**9.0**	**7.5**	**10.7**	**6.9**

*For fish and alcohol, the percentage of intake below the recommendations has been analysed from food frequency information in the general questionnaires of the respondents in DNFCS 2012-2014.

Very few adults in the Netherlands fully comply with all Dutch dietary guidelines of 2015 (97). Just over 10% of the adults eat the recommended 200 grams of fruits or more, and the percentage reaching the recommendation of at least 200 grams of vegetables is only marginally higher (see Figure 3.4). Almost half of the Dutch adults consume the recommended 90 grams of brown bread and wholegrain products or more, while nearly 60% eat fish at least once a week. 25% mentioned not to drink alcohol.

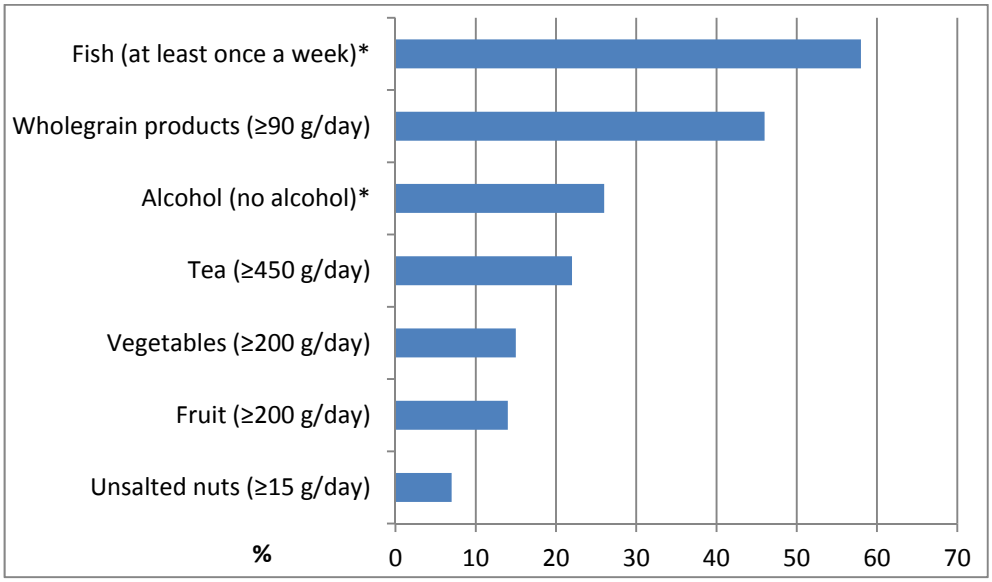

*Figure 3.4. Percentage of adults (19-79 years) complying with the quantitative recommendations of the Dutch dietary guidelines of 2015 (mid-term results DNFCS 2012-2014 (97)). *Information from food frequency questionnaires.*

Figure 3.5 illustrates the percentage of adults that meet the recommendations for vegetables, fruit, whole grain products, legumes, unsalted nuts, tea, and fish, according to age and sex. In DNFCS 2012-2014, about 10% of the men and women 19-50 years old consumed 200 grams of fruit and vegetables or more. For the 51-79 year-olds, compliance with the guidelines was just over 20%. It should be noted that data collection of DNFCS 2012-2014 took place before the new dietary guidelines for 2015 of the Health Council of the Netherlands were published. However, the recommendations for fruit and vegetables are unchanged. The new guideline to eat at least 90 g of whole grain products was met by about 60% of the men and almost 40% of the women, especially by eating brown and wholemeal bread. Unsalted nuts were hardly consumed. The consumption of tea was significantly higher for women than for men. Based on information in the food frequency questionnaire, more than 50% of the adult 19-50 year old respondents of DNFCS 2012-2014 consumed fish at least once per week. Also based on food frequency information about one third of the women did not drink alcohol, compared to less than 20% of the adult men. For the 51-79 year old adults, this percentage was over 60%. These data can be considered as a baseline measurement for the 2015 guidelines and it is important to monitor if consumption of these food groups increases during the coming years. Not meeting the recommendations should be interpreted as a risk of health loss.

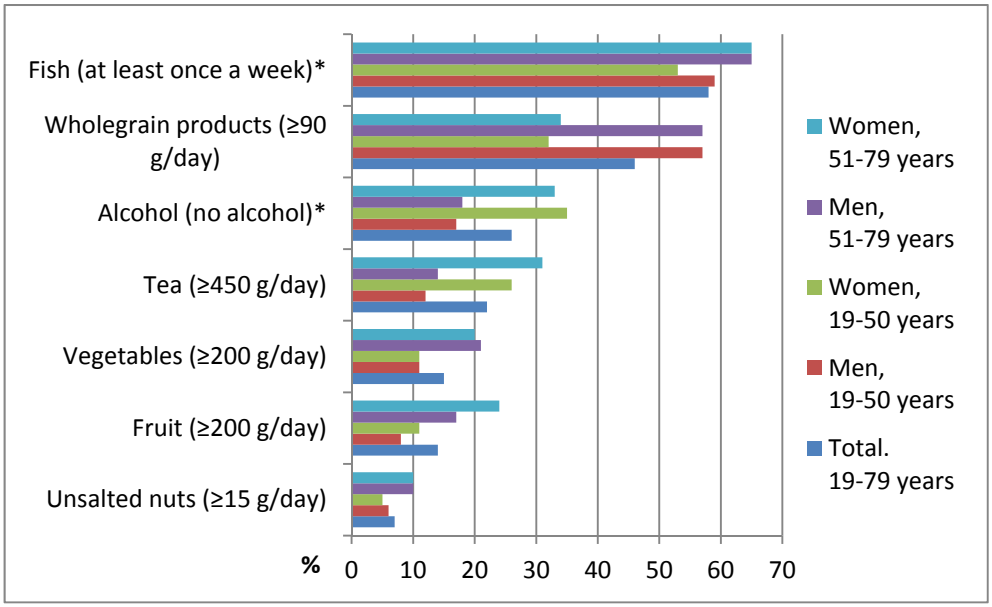

*Figure 3.5. Percentage of adults that meet the Dutch dietary guidelines of 2015 (DNFCS 2012-2014)(97). *Information from food frequency questionnaires.*

Dutch Healthy Diet (DHD) Index

Another way to assess the healthiness of the Dutch diet is to compute a healthy diet score from consumption data. The Dutch Healthy Diet Index has been developed by Wageningen University (111). It is a continuous score that represents adherence to the ten Dutch Guidelines for a Healthy Diet of 2006, including physical activity. For each guideline, a maximum score of ten points can be allotted (total maximum score is 100) when completely adhering to the guideline. In the referred study of Van Lee et al., the DHD-index has been applied to the data of young adults 19-30 y (DNFCS-2003). The mean ±SD of the DHD-index was 60.4±11.5 for women and 57.8±10.8 for men. The index showed to be a good measure of the nutrient density of diets. The DHD-index will be updated to the 2015 Dietary Guidelines and will be useful to evaluate DNFCS-2012-2016 data.

3.4 Evaluating nutrient adequacy

Contribution of food groups to intake of energy and nutrients

The foods we consume deliver energy and nutrients. Insight into the contribution of food groups to the intake of energy and nutrients is important for nutrition education. Tables 3.3 and 3.4 present food groups that contributed substantially (> 20%) to the macronutrient and micronutrient intake for adults and children (DNFCS 2007-2010)(96). None of the food groups contributed more than 20% to energy intake. The highest contribution to energy intake for children was by 'Snacks and sweets' (18.2%) and for adults by 'Bread and cereals' (17.5%). Some food groups like 'Bread and cereals' and food groups with animal products contributed substantially to many nutrients. For the animal products, this also includes saturated fatty acids. The higher contribution of non-alcoholic drinks to the intake of monosaccharides and disaccharides and vitamin C in children compared with adults resulted from the higher consumption of non-alcoholic drinks by children. Many drinks were enriched with vitamin C. Alcoholic drinks

constituted 7% of the total energy intake of adult men and 4% of the energy intake of adult women (112).

Table 3.3. Food groups that contributed ≥20% to macronutrient intake in children and adults (DNFCS 2007-2010).

Food group	Children (7-18 y)	Adults (19-69y)
Potatoes	Polysaccharides 24%	Polysaccharides 26%
Bread and cereals	Vegetable protein 49% Polysaccharides 44% Fibre 37%	Vegetable protein 48% Polysaccharides 46% Fibre 38%
Meat, fish, poultry, meat substitutes, processed meat, eggs	Animal protein 51% Total fat and saturated fatty acids 20%	Animal protein 56% Total fat and saturated fatty acids 21% EPA&DHA 23% (by fish)
Milk, milk products and cheese	Animal protein 40% Saturated and trans fatty acids 26%	Animal protein 38% Saturated and trans fatty acids 38%
Fats and oils	Total fat and mono unsaturated fatty acids 20%	Total fat and mono unsaturated fatty acids 20%
Non-alcoholic beverages	Mono and disaccharides 34%	Mono and disaccharides 24%
Sweet and savoury snacks	Total fat and saturated fatty acids 20% Polysaccharides 20%	

Table 3.4. Food groups that contributed ≥20% to micronutrient intake in children and adults (DNFCS 2007-2010).

Food group	Children (7-18 y)	Adults (19-69y)
Fruit		Vitamin C 20%
Bread and cereals	Folate eq 28% Copper 23% Iodine 60%* Iron 25% Magnesium 21% Sodium 27%*	Folate eq 23% Copper 24% Iodine 54%* Iron 23% Magnesium 20% Sodium 25%*
Meat, fish, poultry, meat substitutes, processed meat, eggs	Vitamin B_1 27% Vitamin B_6 24% Vitamin B_{12} 38% Vitamin D 32% (4% by fish) Iron 20% Phosphorus 20% Selenium 42% Sodium 22% Zinc 30%	Vitamin B_1 29% Vitamin B_6 29% Vitamin B_{12} 47% Vitamin D 37% (10% by fish) Iron 21% Phosphorus 23% Selenium 47% Sodium 22% Zinc 33%
Milk, milk products and cheese	RAE 25% Vitamin B_2 46% Vitamin B_{12} 44% Calcium 60% Phosphorus 34% Zinc 24%	RAE 25% Vitamin B_2 41% Vitamin B_{12} 40% Calcium 59% Phosphorus 32% Zinc 24%
Fats and oils	RAE 23% Vitamin D 40% Vitamin E 20%	RAE 24% Vitamin D 40% Vitamin E 24%
Non-alcoholic beverages	Vitamin C 37%	Vitamin C 26%

*without added salt during cooking or at table. RAE: Retinol activity equivalents.

Dietary reference intakes

Dietary reference intakes are quantitative reference values for nutrient intakes for healthy individuals and populations that are based on health criteria (113). Since 2014, recommendations of the Nordic Council and EFSA are the leading guides for the evaluation of the Dutch diet, if Dutch reference intakes are set before 2000 (114). The Health Council plans to update dietary reference values on specific nutrients (vitamins and minerals) during the coming years.

Nutrient intake compared to reference intakes

In DNFCS 2007-2010, overall 15% of energy intake by adults (19-69 years old) was supplied by proteins, half by carbohydrates and about one-third by fats. This distribution largely followed the 2006 recommendations for energy and macronutrients (115). In contrast, the intake of saturated fatty acids was too high for more than 90% of the population. The intake of trans fatty acids developed favourably over time, and is now less than 1% of energy intake for most of the population. Alcohol intake was too high for more than a quarter of the adult population and the intake of fibre per MJ was only two-thirds of the recommended level (Table 3.5). Overall, the contribution of macronutrients to energy intake for children (7-18 years old) was

comparable to that of adults, though the energy contribution of protein and alcohol was less.

Table 3.5. Resume of the interpretation of the intake of macronutrients by children and adults, based on DNFCS 2007-2010 (96) and Nutrient recommendations in use in 2016(114) (Unpublished data).

Adults	Children	Interpretation
Trans fatty acids, Linolenic acid, Carbohydrates Protein Total fat	**Trans fatty acids, Linolenic acid, Protein Total fat**	No public health problem 
ALA, N-3 fatty acids	**ALA, N-3 fatty acids**	Low intake, though unclear if deficiencies occur. More research needed: health effects, revision of the norm and/or nutritional status research 
Saturated fatty acids, Alcohol	**Saturated fatty acids, Alcohol**	Intake too high 
Fibre	**Fibre**	Low intake 

Table 3.6 presents an overview of the adequacy of micronutrient intake. For both adults and children, no health risks are to be expected related to the intake of vitamins B_2, B_6, B_{12}, E and K and the minerals iodine, copper and phosphorus. The median intake was similar to or higher than the adequate intake (AI). For some subgroups of the population, the intake of the vitamins A, B_1 and C, calcium, iron, potassium, magnesium, selenium and zinc was lower than recommended. However, it is not clear whether adverse health effects are to be expected, due to an intake of micronutrients that is too low or low nutritional status. A low nutritional status differs from a serious shortage in micronutrients, which has to be treated (116). Further research into this issue is needed.

Table 3.6. Resume of the interpretation of the intake of micronutrients by children and adults, based on DNFCS 2007-2010 (96) and Nutrient recommendations in use in 2016 (114).

Adults	Children	Interpretation	
Vitamin B_2, B_6, B_{12}, E, K Copper, Phosphorus, Selenium, Iodine, Zinc	**Vitamin B_2, B_6, B_{12}, C, E, K Copper, Phosphorus, Iodine**	No public health problem	
Vitamin A, B_1, C, Calcium, Magnesium, Potassium, Iron	**Vitamin A, B_1, Folate equivalents, Calcium, Magnesium, Potassium, Iron, Selenium, Zinc**	Low intake, though unclear if deficiencies occur. More research needed: health effects, revision of the norm and/or nutritional status research	
Sodium	**Sodium**	Intake too high	
	Vitamin D	Low intake, deficiencies	

Micronutrients of concern are vitamin D, folate equivalents and sodium. The intake of vitamin D is lower than recommended. This might be a health problem, especially for the senior population. Folate intake is too low for about 11% of the male and 30% of the fertile female adult population. The intake of sodium is above the guideline for most of the adults and children. The intake of sodium comes almost entirely from the intake of salt. Information on fortification and supplementation with specific micronutrients is described in Chapter 5.5.

3.5 Attention for subgroups in the population

Newborns and infants

Breastfeeding is the best nutrition when it comes to the health of a mother and child (see Chapter 2.2). The WHO recommends breastfeeding exclusively during the first six months after birth and to continue breastfeeding in combination with supplementary feeding until the age of two years (9). In 2015, 80% of mothers in the Netherlands started breastfeeding after delivery (Figure 3.6). The median duration of exclusive breastfeeding was eight weeks. The largest decrease in the number of breastfed infants occurs in the first two weeks after birth, when the prevalence of exclusive breastfeeding drops from 80% to 59%. At the age of three months, 47% of the infants are exclusively breastfed. At the age of six months this percentage is 39%. In 2015, the percentage of children exclusively breastfed at the age of six months was much higher than in 2005 (20%)(117).

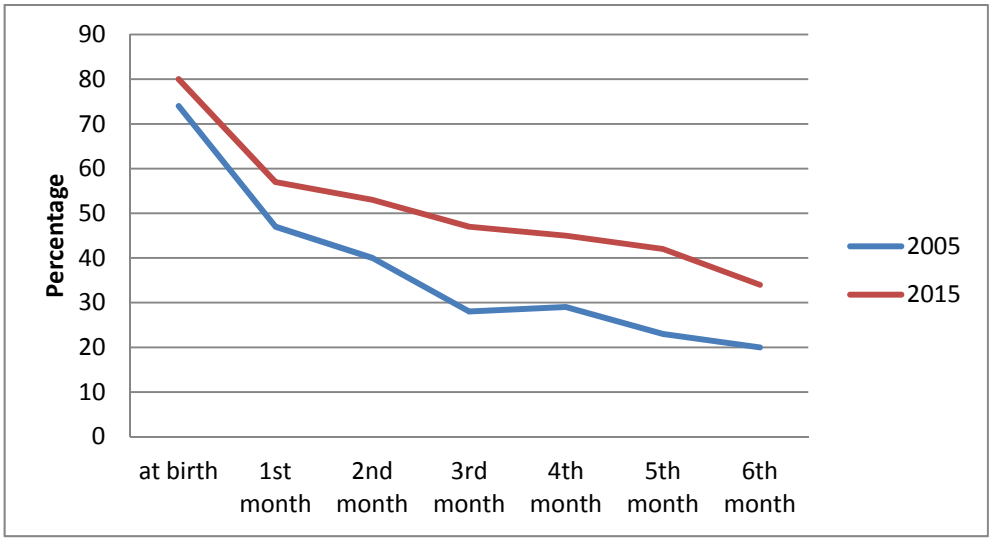

Figure 3.6. Prevalence of exclusive breastfeeding in 2005 and 2015.

Toddlers and young children

No recent information on the food consumption of toddlers and young children above 6 months is available. In a TNO survey published in 2002, it was shown that infants aged nine months had a low intake of fat, especially bread spreads, while the diet of infants aged 9, 12 and 18 months contained too much saturated fatty acids. In general, intake of minerals and vitamins was favourable compared with nutritional standards. Among toddlers aged 18 months, iron intake was low, as was the intake of vitamin D for those children not being given vitamin D supplements or follow-on milk (118).

Commissioned by Nutricia, the food consumption of young children that visited a day care centre was studied between 2011 and 2014. In this Eet Compleet Test 2015, 1,526 children aged 10-48 months were involved (119). The food consumption of each child on day care days was recorded in a two-day food diary, both by the day care personnel and by the parents/caretakers. None of the children ate in conformity with the Food-Based Dietary Guidelines 2011 (120). More than half of the youngsters ate less fruit than the recommended 150 g/day. Almost 40% did not consume the lower recommended amount of vegetables of 50-100 g/day (Figure 3.7). The children ate fish about once every 10 days. Overall, the consumption of the day care children on day care days was characterized by a low intake of fat and high intake of protein and energy. More than 50% of daily energy intake came from sugars.

A food consumption survey conducted among 2-6 year-old children was carried out in 2005/2006 (99). The diet of young Dutch children was sufficient with regard to proportions of total fat, carbohydrates and protein, but too rich in saturated fatty acids. The intake of fish, vegetables, fruit and fibre was generally low. The diet of the children was generally adequate for most vitamins and minerals. For vitamin D and folate, low intakes were observed (99).

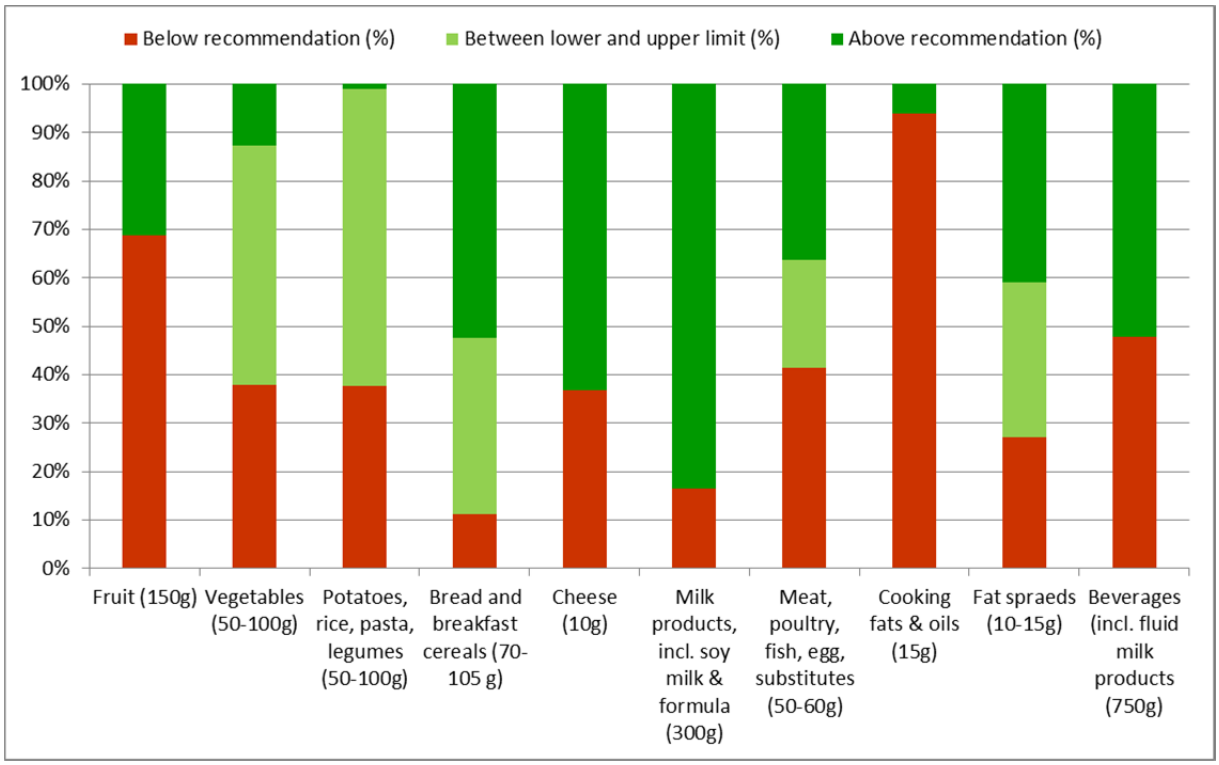

Figure 3.7. Adherence to dietary guidelines in children 1-4 years-old visiting day care centres (121).

Older adults

A food consumption survey conducted among community-dwelling Dutch adults over the age of 70 was carried out in 2010-2012 (33). They consumed more saturated fatty acids and more salt than recommended and less whole grain products, fruit and fish. To improve their diet, this group is advised to comply with the same recommendations as given for the general Dutch population. The mean intake of 5.2 µg of vitamin D was clearly inadequate. To reduce the risk of falling and fractures, women and men above 70 years of age are advised to supplement their vitamin D intake with 20 µg/day (122). Only one in four female adults over the age of 70 and one in five men complied with this recommendation (33). The prevalence of overweight, obesity and undernutrition among older adults is described in Chapter 2.

An inadequate protein status is frequently found among frail older adults and those in residential care. Tieland et al. (123) studied the habitual dietary intake, using 2 and 3-day food records collected from various studies involving 739 community-dwelling, 321 frail and 219 institutionalized elderly people. Protein in these older populations is mainly (>80%) provided by the three main meals, with most protein consumed during dinner. More than 60% of daily protein intake is of animal origin. Increasing protein intake at breakfast and lunch with high-quality protein sources, which may come from animal-based or plant-based protein sources, remains a promising strategy to postpone or treat sarcopenia (123). Maastricht University, the Free University Amsterdam (124) and Wageningen University and Research Centre

(www.caterwithcare.nl) cooperate with hospital settings to optimize nutritional care for frail and malnourished elderly.

Pregnant and lactating women
The Netherlands Nutrition Centre published a factsheet on Nutrition and pregnancy (125). The basic nutrition guidelines are in accordance with the Dutch dietary guidelines 2015 (39), supplemented with attention given to the intake of vitamin A and alcohol. Information about (adherence to) supplementation advice for pregnant women, i.e. for folic acid and vitamin D, is given in Chapter 5.5.

In the Netherlands, up-to-date representative information on the food consumption of pregnant and lactating women is lacking. The most recent information comes from the former 1997-1998 food consumption survey. The nutrient intake of pregnant women has been estimated by combining the 1997-1998 consumption data with recent (2014) food composition tables. The results suggest that the nutrient intake of pregnant women seems reasonably comparable to that of non-pregnant women of childbearing age. The intake of iron, vitamin B_1 and vitamin B_6 by these women, in particular, can be improved and attention to high vitamin A intake remains important. However, more research with more recent data is needed to see whether or not the dietary intake of pregnant women is indeed comparable to that of non-pregnant women of childbearing age.

Differences in dietary intake by socio-economic status
Educational qualifications are indicative for an individual's socio-economic status. Data from DNFCS 2007-2010 have been analysed for SES differences in the consumption of selected food groups included in the Dutch dietary guidelines of 2015 (39). Among both men and women, the low SES group consumed less fruit, vegetables and fish and more meat and fats than the high SES group (Figures 3.8 and 3.9). The use of dietary supplements was less common in the high SES group than in the low SES group (126).

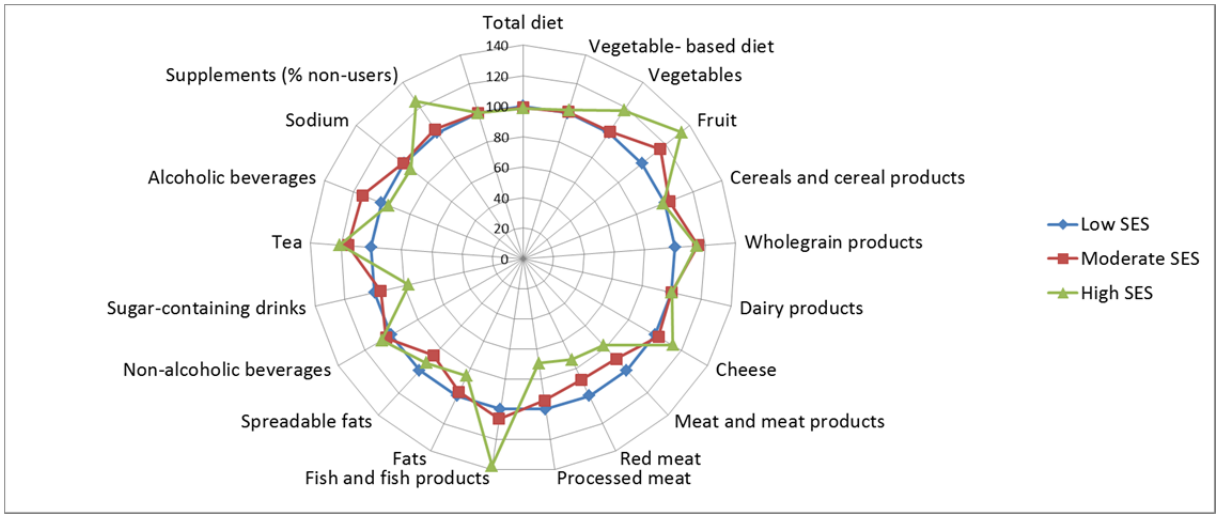

Figure 3.8. Relative intake (% compared to low SES) of selected food groups of interest according to the Dutch dietary guidelines of 2015, by socio-economic status in 1,055 adult Dutch men (DNFCS 2007-2010).

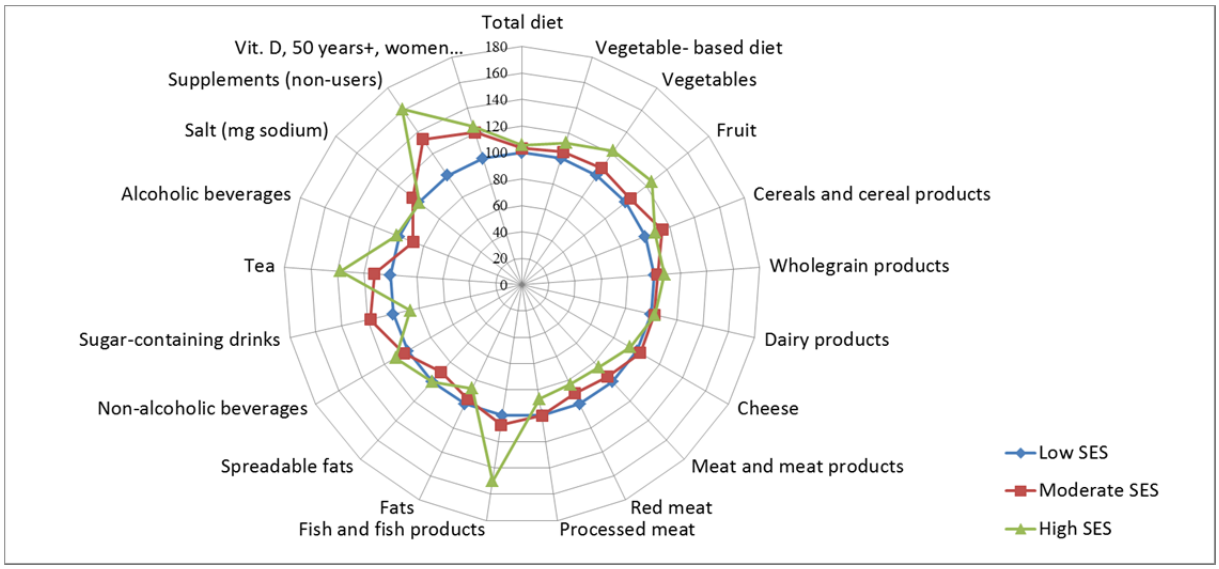

Figure 3.9. Relative intake (% compared to low SES) of selected food groups of interest according to the Dutch dietary guidelines of 2015, by socio-economic status in 1,047 adult Dutch women (DNFCS 2007-2010).

Differences by immigrant background

In 2011-2013, RIVM mapped the dietary habits of Moroccan, Turkish, Surinamese and native Dutch people in Amsterdam (19). This food consumption survey was conducted in cooperation with the HELIUS study (Healthy Life in an Urban Setting) of the Amsterdam Medical Centre. Dietary habits differ between the population groups (see Figures 3.10 and 3.11). People of Surinamese, Turkish and Moroccan origin take religious beliefs into account in their overall diet, such as a limited use of alcoholic drinks. Their diets also include traditional foods such as specific Surinamese vegetables like bitawiri and yardlong beans, ayran (Turkish yoghurt drink) and Turkish or Moroccan bread. In addition, the diet of the Asian Surinamese population is more often vegetarian without fish or vegan. Turkish people tend to eat more fruit than the ethnic Dutch. Surinamese and Moroccans consume relatively less saturated fatty acids. Due to the different food choices the mean intake of dietary fibre, calcium, and vitamin A was low in the immigrant population groups and the intake of vitamin B_1 was low especially among immigrant women. Furthermore, people of Surinamese origin had low mean intakes of iron and magnesium. Overall, a diet rich in whole-grain products, vegetables, fruit, dairy products, and spreads and cooking fats contributed to a higher intake of dietary fibre, calcium and vitamin A and B_1. Whether the low intakes are inadequate or harmful to health could not be determined in this study.

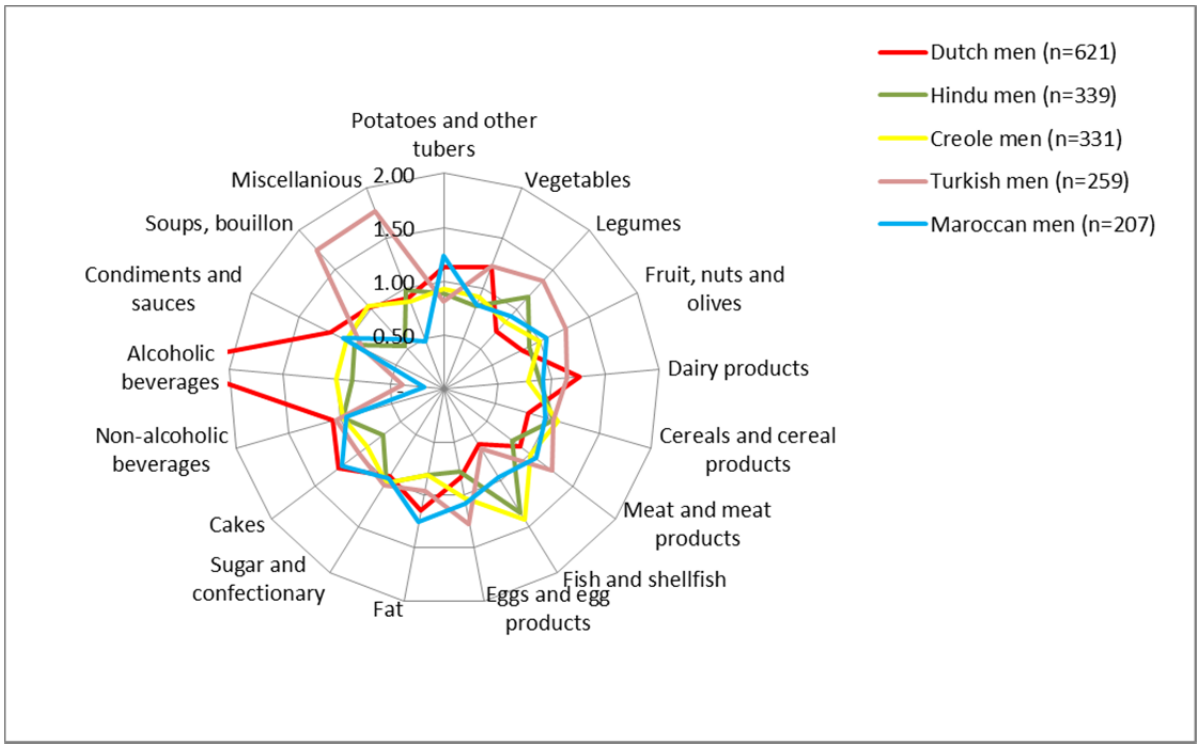

Figure 3.10. Relative intake of food groups (mean intake/overall study population mean) of Moroccan, Turkish, Surinamese and native Dutch males in Amsterdam.

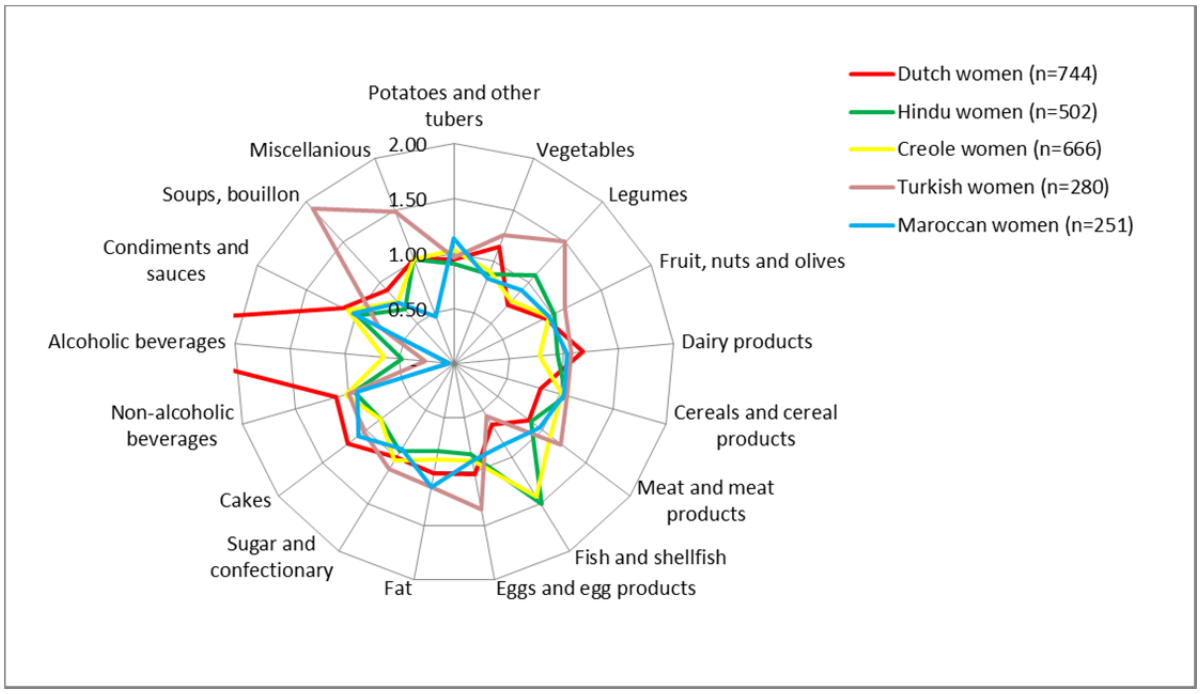

Figure 3.11. Relative intake of food groups (mean intake/overall study population mean) of Moroccan, Turkish, Surinamese and native Dutch females in Amsterdam.

Apart from dietary differences in the non-Western adult population in the Netherlands, cultural variations in breastfeeding and early feeding patterns have been studied. In the ABCD-study (Amsterdam-Born Children and their Development), the association between the father's and grandmother's attitudes regarding breastfeeding and the mother's breastfeeding behaviour in a multi-ethnic population was determined (n=5.131). Overall, 73.5% of the fathers and 59.1% of the grandmothers were positive towards breastfeeding. Both their attitudes were important determinants of maternal breastfeeding behaviour, independent of ethnicity(127).
In 2009/2010, Van Eijsden also examined variation among immigrants in maternal perceptions of growth and their influence on feeding practices among 143 Turkish and 143 Dutch infants, aged 0-6 months. More mothers of Turkish descent perceived a chubby infant as pretty (43%) compared with Dutch mothers (22%) and they were more often worried about their infant's growth. Turkish mothers were more likely to exclusively breastfeed until the age of at least 6 months (35.7% vs 14.7% of the Dutch mothers) and to start introducing complementary feeding, including rice flour porridge, at the age of 6 months. Infants of Turkish descent received, on average, one more milk feeding during the day and, if introduced to complementary foods before 6 months, were more often given uncommon types of foods (e.g. yoghurt and cookies) (128).

Vegetarians and vegans
Within the Dutch food consumption surveys there is hardly any information available on the diet of vegetarians and vegans, because of the low number of participants that are registered as vegetarians, vegans or as one-day-a-week meat consumers. Embedded within the Netherlands Cohort Study on diet and cancer (NLCS) (n=120,852; including 1,150 self-reported vegetarians), the NLCS-Meat Investigation Cohort (NLCS-MIC) was defined by combining all FFQ-confirmed-vegetarians, pescetarians, and one-day-a-week meat consumers from the total cohort. Vegetarians, pescetarians, and one-day-a-week meat consumers had more favourable dietary intakes (e.g. higher fibre/vegetables) and lifestyle characteristics (e.g. lower smoking rates) than regular meat consumers of both sexes. Vegetarians adhered to their diet longer than pescetarians and one-day-a-week meat consumers. Seventy-five per cent of vegetarians with a prevalent cancer at baseline had changed to this diet after diagnosis. It should be noted, however, that 50% of self-reported vegetarians reported meat or fish consumption on the FFQ and were classified either as pescetarians or as ≥ one-day-a-week meat consumers (129).

Information on the dietary intake of vegans comes from the EPIC Norfolk cohort (130). The mean intake of saturated fatty acids was approximately 5% of energy, less than half of the mean intake among meat-eaters (10–11%). Vegans had the highest intakes of fibre, vitamin B_1, folate, vitamin C, vitamin E, magnesium and iron, and the lowest intakes of retinol, vitamin B_{12}, vitamin D, calcium and zinc. The average nutrient intakes in non-meat-eaters are close to those currently recommended for good health.

3.6 Trends in food consumption

In 'Our food, our health, 2004', one of the main findings was that the composition of the Dutch diet is still far removed from the recommended healthy diet (1). It was concluded that few persons met the recommendations for the consumption of fruit, vegetables and dietary fibre. This was due to a decrease in the consumption of these food groups from the eighties onwards, that stabilized later on.

Slight differences in food consumption can be seen between DNFCS 2007-2010 (96) and the data of DNFCS 2012-2014 (97). In Table 3.7, the mean intake of the main food groups in both surveys is presented for the corresponding age groups differentiated by sex. The total mean consumption of foods and drinks per day was roughly equal for 9-50 year-old men and women. Older adults aged 51-69 years increased their daily intake by about 100 g between 2007-2010 and 2014-2014. A positive finding is that the consumption of fruit by young children has increased. For the older age groups, fruit consumption stabilized, as did the consumption of vegetables in all age groups. A decrease in the consumption of potatoes, dairy, meat, fat, cakes, alcohol and soups can be observed, though not in all age groups differentiated by sex. There are no recent nutrient intake data available yet, but because the consumption of fibre-containing food groups such as potatoes, bread and breakfast cereals, and fruit and vegetables has decreased, dietary fibre intake will still be low. The observed decreases in the consumption of alcoholic beverages, dairy, cakes and meat are favourable developments in terms of adherence to the current Dutch guidelines to eat more plant-based and less animal-based food and to limit the consumption of alcoholic drinks. These trends need to be confirmed after completing the data collection of DNFCS 2012-2016.

Hendriksen et al studied the daily intake of salt (sodium), iodine and potassium by adults in Doetinchem in 2006, 2010 and 2015. The intake of salt appeared to be stable over the years, but far above the recommended maximum of 6 g per day. In 2015, the median intake was 9.7 g for men and 7.4 g for women. The intake of iodine decreased over the years, but was sufficient (RDA = 150 microgram/day)(110).

In 'Our food, our health, 2004' it was also concluded that the fatty acid composition of the diet was unhealthy, though it had improved. In contrast to the Guidelines of a Healthy Diet 2006 (115), the current Dutch dietary guidelines of 2015 (39) no longer focus on reducing total and saturated fatty acid intake, but rather on the replacement of butter and hard margarines and cooking fat by soft margarines, liquid cooking fats and vegetable oils. When comparing 2007-2010 data with the 2012-2014 data, a decrease in the consumption of total fats and oils can be seen for all age groups differentiated by gender (see Table 3.7).

Table 3.7 Trend in mean food consumption (main food groups, mean g/day) of the Dutch population stratified by age and gender (DNFCS 2007-2010 and DNFCS 2012-2014), weighted for socio-demographic characteristics (97).

	Boys 9-18 years		Girls 9-18 years		Men 19-50 years		Women 19-50 years		Men 51-69 years		Women 51-69 years	
Food groups based on GloboDiet classification	**2010 (n= 703)**	**2014 (n= 259)**	**2010 (n= 706**	**2014 (n= 273**	**2010 (n= 704)**	**2014 (n= 273)**	**2010 (n= 698)**	**2014 (n= 259)**	**2010 (n= 351)**	**2014 (n= 137)**	**2010 (n= 353)**	**2014 (n= 114)**
Plant-based food groups												
Potatoes and other tubers	99	79	79	73	113	84	71	63	107	91	80	62
Vegetables	91	90	84	84	136	131	128	128	146	142	156	156
Legumes	3	3	2	2	5	3	4	4	7	4	3	7
Fruits, nuts and seeds, olives	81	94	93	115	101	97	115	115	126	129	153	148
Cereals and cereal products (incl. bread)	213	224	171	171	241	250	183	179	204	216	158	140
Total plant-based consumption*	**487**	**490**	**429**	**445**	**596**	**565**	**501**	**489**	**590**	**582**	**550**	**513**
Animal-based food groups												
Dairy products and substitutes	449	396	381	305	422	351	350	337	431	388	363	335
Meat, meat products and substitutes	111	111	88	80	138	131	92	88	136	123	93	86
Fish, shellfish and amphibians	8	7	6	7	17	14	14	14	20	19	20	25
Eggs and egg products	9	10	8	11	13	10	11	10	14	19	14	11
Total animal-based consumption*	**577**	**524**	**483**	**403**	**590**	**506**	**467**	**449**	**601**	**549**	**490**	**457**
Other food groups												
Fats and oils	26	22	20	17	33	28	22	18	33	29	24	20
Sugar and confectionery	58	60	48	46	43	43	33	31	31	31	25	27

	Boys 9-18 years		Girls 9-18 years		Men 19-50 years		Women 19-50 years		Men 51-69 years		Women 51-69 years	
Food groups based on GloboDiet classification	**2010 (n= 703)**	**2014 (n= 259)**	**2010 (n= 706**	**2014 (n= 273**	**2010 (n= 704)**	**2014 (n= 273)**	**2010 (n= 698)**	**2014 (n= 259)**	**2010 (n= 351)**	**2014 (n= 137)**	**2010 (n= 353)**	**2014 (n= 114)**
Cakes and sweet biscuits	50	47	47	43	41	40	42	33	45	47	42	39
Non-alcoholic beverages	1,216	1,307	1,173	1,202	1,800	1,909	1,932	2,035	1,530	1,714	1,798	2,084
Alcoholic beverages	65	51	25	8	334	312	80	61	320	271	140	99
Condiments, spices, sauces and yeast	34	34	27	27	44	54	30	36	30	39	25	31
Soups and stocks	17	12	16	13	28	18	25	24	41	35	33	39
Miscellaneous	0	2	2	2	2	3	4	5	1	3	4	12
Savoury snacks	33	32	25	23	25	33	21	16	16	16	9	13
Total other consumption**	**1,499**	**1,567**	**1,383**	**1,381**	**2,350**	**2,440**	**2,189**	**2,259**	**2,047**	**2,185**	**2,100**	**2,364**
Total mean consumption g/day	2,563	2,581	2,295	2,229	3,536	3,511	3,157	3,197	3,238	3,316	3,140	3,334

* Green cells refer to (slightly) higher consumption of plant-based foods and lower consumption of animal-based foods in 2012-2014 data compared with 2007-2010 data on 9-69 year-old men and women

** Other food groups contain both plant-based and animal-based foods

3.7 International comparisons

In the Netherlands, Scandinavian countries, Germany and the United Kingdom, the consumption of vegetables and fruit is low in comparison to southern and eastern European countries (131). In most European countries, the intake of fibre, for which vegetables, fruit and cereal products are important sources, is also low (132). Inhabitants of southern Europe consume more vegetable oils and less animal fats than in the Netherlands. Compared with other Europeans, the Dutch, together with inhabitants of Hungary and Austria, eat very little fish. In all European countries, the intake of vitamin D and folic acid is low, in comparison with the guidelines, and the intake of salt is too high (132). For the Netherlands, this situation seems unchanged in the most recent (preliminary) data of the food consumption survey in the Netherlands (97).

3.8 Consumers' perspective on the healthiness of their diet and popular diets

Although the Dutch diet is still far removed from the recommended healthy diet, in 1998 a majority of EU subjects believed they did not need to alter their diets, because they perceived them to be already healthy enough (91). A recent study (2015) in the Netherlands is consistent with this finding. Participants reported an average rate of 7.1 on a 10-point Likert scale when asked to qualify their own eating behaviour (94).

Popular diets

In order to obtain a better idea about popular diets, the foundation Collective Promotion for the Dutch Book provided a list of the most sold books on cooking and dieting published from 2011 to 2015. While Sonja Bakker dominated the top 10 cook-and-diet books in 2011/2012, books on low-carbohydrate diets were present in the top 10 diet books during the whole period of 2011-2015. Books on superfoods became more popular in 2014 and 2015.

It is interesting to follow the development of a hype, such as the superfoods hype. An analysis of the Internet forum Viva, which was one of the most active fora focused on this topic (RIVM, unpublished data), showed an increase in posts on superfoods from 2011 onwards. This increase peaked in 2014 and declined thereafter (see Figure 3.12). Until 2014, forum participants posted considerably more positive than negative posts. This switched thereafter. The development of the superfoods hype is consistent with phase 3 of the Gartner's Hype cycle (133, 134). In this third phase, after the hype has peaked in phase two when consumers' and media expectations are high and no one wants to be left behind, consumers look beyond the initial excitement and many consumers stop following the hype. As to be expected, Viva forum participants mainly use positive health effects as an argument to justify the use of superfoods. Economic arguments, such as the high costs, are most predominant among the counterarguments. It is difficult to give an overall judgement on the actual healthiness of popular diets. It depends on the level to which the diet really deviates from common dietary guidelines and on how strictly and for how long the diets are being followed by the consumer. In this respect, it is interesting to observe that most advice given on superfoods on Internet fora are to use them as a supplement to an otherwise healthy diet.

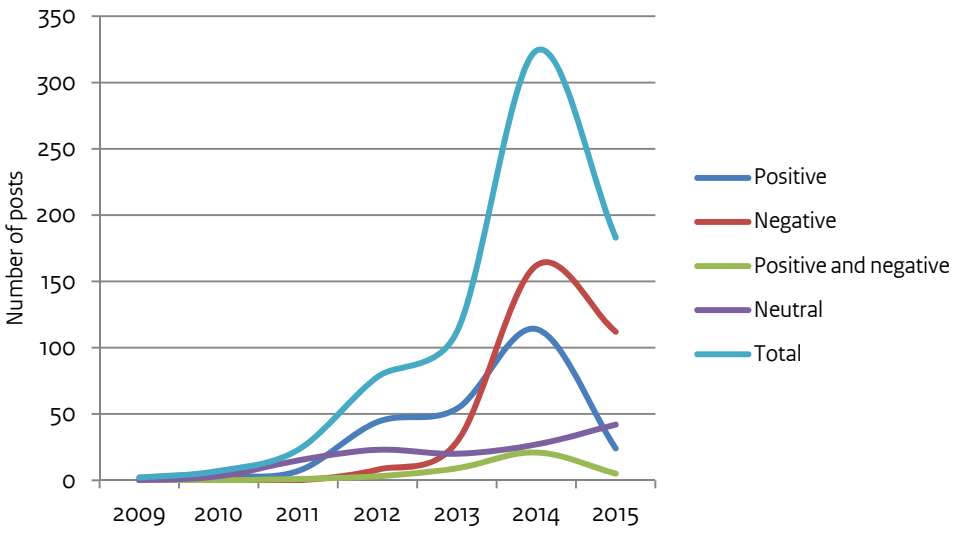

Figure 3.12. The development of the superfood hype in the period 2009-2016 based on posts from Viva.

3.9 Key findings

- To assess the healthiness of the Dutch diet and compare it with dietary guidelines, appropriate up-to-date food consumption data are needed. From to the Dutch Food Consumption Surveys, it can be concluded that the current Dutch diet generally does not meet the Dietary guidelines of 2015. For example, 76-91% of the adult population do not meet the guidelines for fruits and vegetables and 35-62% do not meet the guidelines for whole grain products.
- The consumption of fruits, vegetables and fibre declined during the eighties, but stabilized over the past decade for most age groups. The intake of salt remains too high. Interim results from the Dutch Food Consumption Survey 2012-2014 tentatively suggest there have been positive dietary changes. These include an increased consumption of fruit by children and an overall decrease in the consumption of animal products. This is in accordance with the Dutch dietary guidelines of 2015, to put greater emphasis on a plant-based diet.
- Persons with a low socio-economic status have a lower intake of fruit, vegetables and fish and a higher intake of meat and fats. The use of dietary supplements was less common in high SES groups than in low SES groups.
- Low intake of vitamin D is frequent in older adults, whereas protein intake is inadequate for many institutionalized elderly.

4 Health impact calculations on diets and body weight

After smoking, overweight and dietary intake are among the most important lifestyle factors that determine health loss and socioeconomic differences in health in the Netherlands. A healthy dietary pattern reduces blood pressure and the risk of a number of chronic diseases. Eating in accordance with the Dutch dietary guidelines or a Mediterranean diet lowers the risk of premature death with approximately 20% and the risk of stroke, coronary heart disease, diabetes and colorectal cancer with 15-20% (39).

In order to develop appropriate nutrition policies, it is important to know to what level present and future dietary measures and interventions have the potential to improve the health status of the target population. In this context, nutrition policies also include weight reduction or weight maintenance measures and interventions.

In 2006, for the Dutch population, RIVM published the potential health benefits of five nutritional scenarios based on the then prevailing recommendations for respectively: fruit, vegetables, fish, saturated fatty acids, and trans fatty acids (1). The report also included the potential health benefits of the weight reduction scenario to bring body weight back to normal levels (BMI < 25 kg/m^2). Since then, the RIVM Chronic Disease Model (CDM) to assess health impact has been updated, as has the required CDM input data (e.g. on relative risks for diseases). In Chapter 4.1, the CDM is explained in more detail.

Since 2006, more recent food consumption and food composition data have become available: the Dutch National Food Consumption Survey (DNFCS) 2007-2010 (96) and the Dutch Food Composition Database (NEVO) 2011 (135), respectively. In Chapter 4.2, we assess the potential health benefits for the Dutch population of the same five dietary factors that we used in the 2006 report (fruit, vegetables, fish, saturated fatty acids and trans fatty acids) and we compare these benefits with the potential health losses that would occur were the intake of these dietary factors most unfavourable. So a comparison is made between following the 2006 dietary guidelines fully versus entirely neglecting these dietary guidelines. In the 2006 recommendations, reducing the intake of saturated fatty acids and eliminating trans fatty acids as much as possible were still explicitly mentioned. The most recent recommendations (2015), recommend eating less, increasing fruit and vegetable consumption, eating more fish, reducing the intake of free sugars and reducing salt intake (39).

Recently we also assessed the health gain that can be obtained in the Dutch population by reducing salt intake down to the recommended maximal level of 6 g/d (136). Salt intake as such is not included in the RIVM CDM (as are the other dietary factors), but is modelled through the effects of salt reduction on blood pressure, which is included in the CDM. Because of this difference in the health impact calculation procedure, the health impact of salt reduction is discussed in a separate

subchapter (Chapter 4.3). Chapter 4.4 describes the health impact of overweight reduction.

4.1 RIVM Chronic Diseases Model (CDM)

The RIVM CDM is a computer model that simulates the health effects caused by changes in the prevalence of risk factors for chronic diseases in the Dutch population. Health effects can be defined in terms of classic epidemiological morbidity and mortality figures, but also in terms of life expectancy and health expectancy (137). In this chapter, we will focus on three health outcomes. Firstly, life expectancy (LE) defined as the average number of years that a newborn baby could expect to live if he or she were to follow the scenario. To obtain the outcome of LE, a birth cohort is simulated for a 100-year period (so, for a lifetime). Secondly, health expectancy is expressed in QALYs (quality adjusted life years). Since health is a function of length of life and quality of life, the QALY was developed as an attempt to combine the value of these attributes into a single index number. It assumes that a year of life lived in perfect health is worth 1 QALY (1 Year of Life × 1 Utility value = 1 QALY) and that a year of life lived in a state of less than this perfect health is worth less than 1, depending on the severity of the disease. Disease weights for the QALY calculation are derived from literature (138). To obtain the outcome in QALYs, a birth cohort was simulated for a lifetime. QALYs are also expressed in terms of "years lived in perfect health". Thirdly, the number of deaths over the coming 20 years is calculated from the number of people still alive after simulation for twenty years. To obtain this outcome, the current Dutch population was simulated for 20 years.

The CDM contains both dietary and non-dietary risk factors (examples of non-dietary factors are smoking, serum cholesterol, blood pressure, and body mass index). For each risk factor, the CDM contains a dose-response function derived from literature that describes the relationship between the risk factor and one or more chronic diseases. Twenty chronic diseases are incorporated in the CDM, such as cardiovascular diseases, different types of cancer, diabetes mellitus and arthrosis (137).

The CDM is permanently in development, with regular changes in its structure and with regular updates of parameter values. To ensure valid evaluations of newly projected policy measures and interventions, it is important that the CDM is up to date with the most recent input data on the exposure to all dietary and other risk factors, as well as on the risk estimates linking these factors to chronic diseases in the model. Calculations described in this chapter for nutritional factors (Chapters 4.2 and 4.3) have been made with version CDM-R 5.1 (launched in September 2012).

The CDM incorporates five dietary factors (fruit consumption, vegetable consumption, fish consumption, saturated fatty acids intake, and trans fatty acids intake) and one body weight indicator (BMI). In the model, an increase in fruit consumption relates to decreased risks of acute myocardial infarction, stroke, diabetes and lung cancer. An increased vegetable consumption relates to decreased risks of acute myocardial infarction and lung cancer. An increase in fish consumption relates to decreased risks of myocardial infarction and stroke. A reduction in

saturated fatty acids intake and a decrease in trans fatty acids intake are related to a decreased risk of myocardial infarction. A reduction in BMI is related to decreased risks of myocardial infarction, other coronary heart diseases, heart failure, stroke, Type 2diabetes mellitus, and cancer of the colon, breast, kidney and uterus. Age-specific relative risk estimates belonging to the above-mentioned associations were derived from literature as described in (137).

The individual intakes within the population are divided over four or five intake classes. Fruit and vegetable consumption are divided into five classes: < 50 grams per day (g/d); 50 to 100 g/d; 100 to 150 g/d; 150 to 200 g/d; and ≥ 200 g/d. Fish consumption is classified into four classes: never; <1 portion per week; 1 to 3 portions per week; and >3 portions per week. Saturated fatty acid intake is divided into five classes: 0 to 10 energy per cent (en%); 10 to 12.5 en%; 12.5 to 15 en%; 15 to 17.5 en%; and ≥ 17.5 en%, and trans fatty acid intake is divided into four classes: 0 to 1 energy per cent (en%); 1 to 1.5 en%; 1.5 to 2 en%; and ≥ 2 en%. The individual BMI-values within the population are divided in 3 classes: < 25, 25-30, and ≥ 30 kg/m^2. The actual distributions of intakes and BMI over the classes depend on age and gender. In the model, each individual may change each year from one intake or BMI category to another with a certain probability. These transition probabilities model the changes in intake and BMI distribution over time (137).

4.2 Health impact of dietary factors (excluding salt)

Intake scenarios

We used the DNFCS 2007-2010 data (96) to calculate the gender and age specific distributions over the intake categories used by the CDM. These distributions reflect the current habitual intakes and constitute the Current Intake scenario. We also constructed two extreme scenarios: a Best-case and a Worst-case scenario. In the Best-case scenario, 100% of the population adheres to the healthiest intake category (reflecting the dietary recommendations and guidelines, as given by the Dutch Health Council in 2006 (115): the highest category for fruit (>200g/d), vegetables (>200g/d) and fish consumption (>3 portions/week) and the lowest intake category for saturated (<10 en%) and trans fatty acids (<1 en%). In the Worst-case scenario, 100% of the population is assigned to the least healthy intake category: the lowest category for fruit (<50g/d), vegetables (<50g/d) and fish consumption (never) and the highest intake category for saturated (≥ 17.5 en%) and trans fatty acids (≥ 2 en%).

Health impact of dietary factors

We compared the health impact that the three scenarios have on three health outcomes: life expectancy (LE), QALYs, and number of deaths in the coming 20 years. Table 4.1 presents the health effects of the *Best-case* and *Worst-case* scenarios in comparison with the *Current Intake* scenario. The table shows that the total of the five studied dietary factors would result in an increase of about 0.7 years lived in full health, an increase in life expectancy of about 0.5 years, and a reduction in the number of deaths in the coming 20 years by about 75,000 (or, on average, 3,700 per year) when compared with the current intake

scenario. For comparison, the total mortality in the Netherlands amounts to 141,000 per year (including 39,000 for cardiovascular diseases and 43,000 for cancers) (139). Fruit and fish are the dietary factors with the highest contribution, which are followed by vegetables. Table 4.1 also shows that, if for dietary intakes we were to choose furthest away from dietary guidelines, we might lose about 1.2 healthy years, our life expectancy might be shortened by 0.8 years, and the number of deaths might increase by about 137,000 over a period of 20 years (or, on average, 6,800 per year). Low fruit and fish intakes would be the main contributors to the health loss in the *Worst-case* scenario. Note that the loss of health is also substantial if the previously achieved trans-fatty acids reductions are undone.

Table 4.1. Health Benefits and Health losses projected for Best-Case and Worst-Case scenarios versus Current Intake scenario.

	Best-Case versus current intake scenario	Worst-Case versus current intake scenario	Best-Case versus Worst-Case scenario
Fruit			
Δ Life expectancy at birth (y)	0.25	-0.27	0.52
Δ QALY at birth (y)	0.39	-0.42	0.81
Δ number of deaths in coming 20 yrs (n)	-36,508	42,631	79,139
Vegetables			
Δ Life expectancy at birth (y)	0.06	-0.085	0.145
Δ QALY at birth (y)	0.06	-0.086	0.146
Δ number of deaths in coming 20 yrs (n)	-10,615	15,000	25,615
Fish			
Δ Life expectancy at birth (y)	0.16	-0.21	0.37
Δ QALY at birth (y)	0.26	-0.33	0.59
Δ number of deaths in coming 20 yrs (n)	-26,463	34,504	60,967
Saturated fatty acids			
Δ Life expectancy at birth (y)	0.03	-0.04	0.07
Δ QALY at birth (y)	0.04	-0.06	0.10
Δ number of deaths in coming 20 yrs (n)	-4,368	6,384	10,752
Trans fatty acids			
Δ Life expectancy at birth (y)	0.003	-0.16	0.163
Δ QALY at birth (y)	0.004	-0.20	0.204
Δ number of deaths in coming 20 yrs (n)	-534	25,615	26,149
TOTAL DIETARY FACTORS			
Δ Life expectancy at birth (y)	0.49	-0.84	1.33
Δ QALY at birth (y)	0.72	-1.19	1.91
Δ number of deaths in coming 20 yrs (n)	-74,900	136,966	211,866

QALY: quality-adjusted life years (see text)

The last column of Table 4.1 is simply the difference between the first two columns and reflects the total health impact each dietary factor might have. In Figures 4.1 to 4.3, the effects of the various dietary factors in the two scenarios are visualized.

The results clearly demonstrate that, at the start of the second decade of this century (since the food consumption data used were collected from 2007-2010), the Dutch population can still gain health by adhering

to the dietary guidelines, which is reflected in the best-case scenario. Unhealthy eating patterns (as reflected by our worst-case scenario) might do more harm to our health (6,800 more deaths and 0.8 year shorter life expectancy) than we might gain by following the 2006 dietary guidelines.

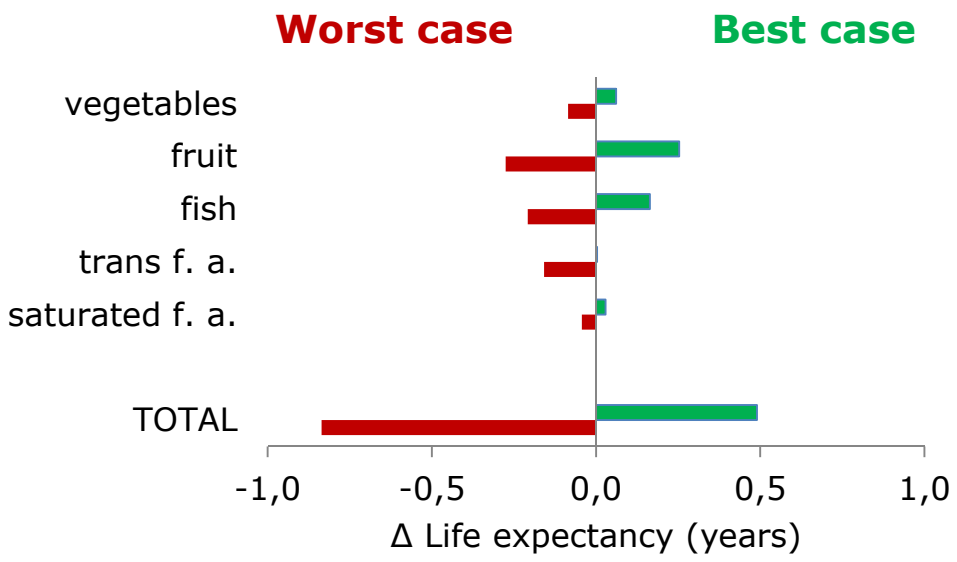

Figure 4.1. Number of life years lost (worst-case scenario) or gained (best-case scenario) compared with the current intake scenario for a birth cohort followed for a 100 years.

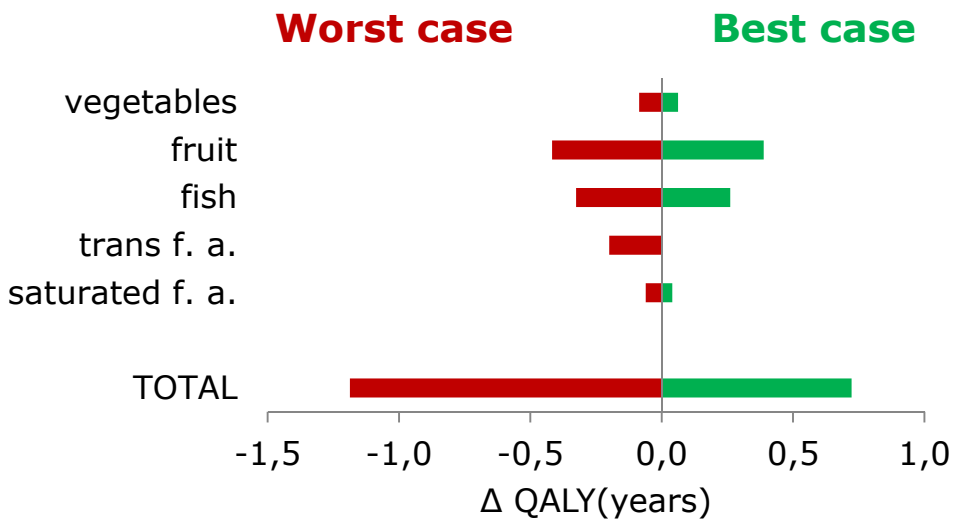

Figure 4.2. Number of QALYs (quality adjusted life years) lost (worst-case scenario) or gained (best-case scenario) compared with the current intake scenario for a birth cohort followed for a 100 years.

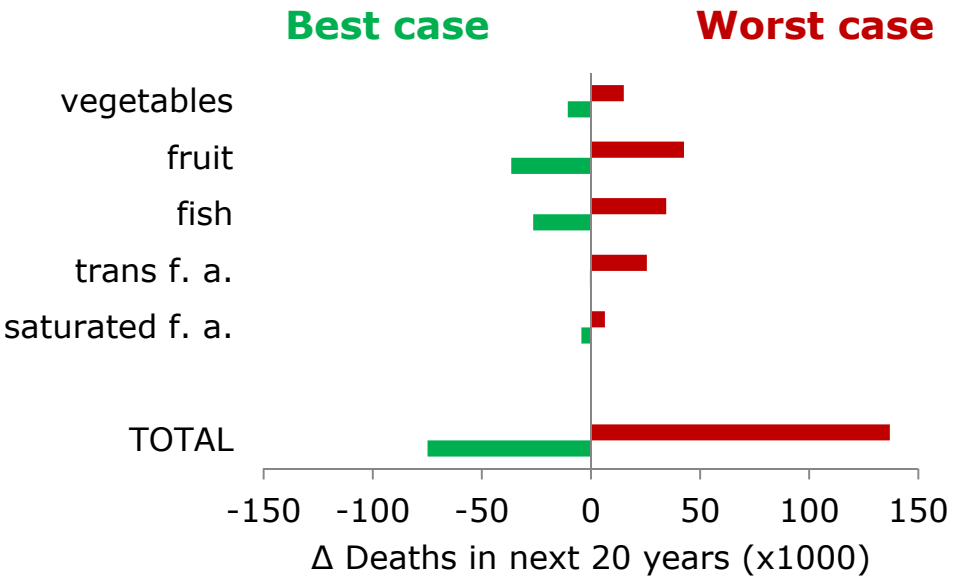

Figure 4.3. Increase (worst-case scenario) or decrease (best-case scenario) in number of deaths (x1000) in the coming 20 years compared with the current intake scenario.

In summary, the results indicate that the nutritional adequacy of our diets should permanently be maintained. The results also demonstrate that the greatest health can be gained by increasing fruit and fish consumption, followed by increasing vegetable consumption. In this respect, it should be mentioned that the Dutch Health Council recently modified the fish consumption recommendation from two times per week (115) to at least one time per week (39). It appears that the maximum health benefit is already achieved with one consumption day per week. So, we probably have already achieved more benefit from our present fish consumption than reflected in Figures 4.1 to 4.3.

With respect to trans fatty acids and saturated fatty acids, the Dutch population appears to have already achieved most of the potential health gains, but considerable health losses might occur if the intake of saturated and trans fatty acids were to increase again. Since a large part of the Dutch population is already in the most 'favourable' intake class for trans fatty acids, one might wonder whether this intake class, as used in the CDM, is too wide. Further subdivision might reveal that some health gain can still be achieved.

4.3 Health impact of salt reduction

Up to recently, no information had been published on the health impact of salt reduction in the Netherlands, at least none fully based on Dutch data. However, in 2014 RIVM published assessments of the health gain that can be achieved in the Dutch population with salt reductions down to the recommended maximal level of 6 g/d using the same DNFCS 2007-2010 data as has been used for the other food factors and the same RIVM CDM version (136). However, a main difference between the modelling process of salt and the other five dietary factors is that salt itself is not included in the CDM, but salt is modelled indirectly through

its effect on blood pressure. Methodologically, there were also some small differences in the projection conditions with the other dietary factors. In the salt calculations, the number of deaths was projected for a population of 20 years and older (for the other dietary factors, projection was from birth) and life expectancy was projected for a cohort of people 40-years old (for other dietary factors, it was projected for a birth cohort). The association between salt intake reduction and systolic blood pressure reduction was derived from a meta-analysis of He and MacGregor (140). On the basis of the dose-response relation of this meta-analysis and the current Dutch salt intake and systolic blood pressure distribution, we derived the dose-response relation between salt intake and systolic blood pressure (SBP) (136). The usual salt intake distributions of our scenarios were converted into usual SBP distributions. These distributions were subsequently divided into four classes (<120, 120–139, 140–159 and >160 mm Hg) and these classes were the main model input.

The main scenario studied was the health gain that can be achieved were the whole population to follow the dietary guideline of the recommended maximum level of 6 g/day (39). The median salt intake of the Dutch population aged ≥20 y was 8.4 g/d and the age-standardized mean systolic blood pressure was 128.2 mm Hg. The recommended maximum intake scenario (6 g/d) required a median salt intake reduction of 29% and would reduce systolic blood pressure by 1.3%.

We found that the health gain that could be obtained amounted to about 25,000 fewer deaths over a 20-year period (so, around 1,250 per year) and to an increased life expectancy of 0.15 year (136). Modelling exercises revealed that the differences in projection conditions between the exercise for salt and the exercise for the other dietary factors hardly affected the resulting figures. Therefore, the health gain that can be achieved by following the salt recommendation looks similar to the gain that can be achieved by following the fish consumption guideline (see Table 4.1, first column), looks smaller than the gain that can be achieved by following the fruits guideline, but looks larger than the gain can be achieved by following the vegetable guideline.

Unfortunately, the loss in QALYs by not following the salt guideline has not been calculated. Instead, the health loss was expressed in DALYs (see Textbox 4.1). The disability-adjusted life years (DALY) is a measure of the overall disease burden expressed as the number of years lost due to ill-health, disability or early death. It was projected that by following the salt guideline, the burden of disease for the Dutch population would be reduced by 56,400 DALYs (out of a total burden of disease of 10,611,000 DALY's, which is a reduction of 0.5%) (136). As an illustration, in the 2006 report 'Our food, our health' (1), following the fish, fruit and vegetable guidelines resulted in projected reductions of the burden of disease of 82,000, 95,000, and 47,000 DALYs. When compared with these 2006 data, the present salt guideline benefits would be a bit more than the vegetable benefits, but less than the benefits achieved by following the fish and fruit guidelines. This finding is comparable to the finding described above for life expectancy and total mortality.

Textbox 4.1. DALYs versus QALYs.

Several metrics can be used to quantify the health impact of changes in dietary intake and overweight prevalence. Metrics often used are Disability Adjusted Life Years (DALYs) and Quality Adjusted Life Years (QALYs). They are technically similar in that they both express health in time (life years) and give a weight to years lived with a disease. However, DALYs measure overall disease burden as health loss, expressed as the numbers of years lost due to ill health, disability or early death. QALYs measure health as 'years lived in perfect health'. They therefore express more or less an inverse value. More or less, since the measures originate from different disciplines, which causes the disease weights to be measured in a different way with a different interpretation, resulting in different values. Other differences relate to whether or not age weighting and discounting is applied.
In this report, the health impact of dietary factors is partly expressed in terms of QALYs and partly in terms of DALYs. This has to do with the choices made by the researchers in the various reported studies. This makes it more difficult to compare the effects directly. However, we generally look at differences in calculated DALYs or QALYs between scenarios or interventions. For example, when a new scenario in comparison with a reference scenario results in a health gain of 0.7 year (as calculated by the difference in QALYs), the outcome might also be interpreted as a 0.7 year reduction in health loss. Likewise, when a new scenario in comparison with a reference scenario results in a 0.7 year reduction of health loss (as calculated by the difference in DALYs), the outcome might also be interpreted as a similar gain in health.

It is also possible to study the health impact of potential salt-reduction interventions. We studied an intervention focused on food choice behaviour to adopt a healthier diet by choosing the foods with the lowest salt content within the same food group (commercially available products). We also studied a salt reduction intervention on processed foods, i.e. food product improvement. We virtually reduced the content of sodium in processed foods, taking into account that, in some foods, major sodium reductions are possible and in others hardly any are. On average, we virtually reduced the sodium content in processed foods by 50% (141). Both scenario interventions resulted in comparable benefits to the 'recommended maximum intake of 6 grams' scenario, and it was concluded that substantial health benefits might be achieved when added salt is removed from processed foods and when consumers choose more low-salt food alternatives (see also Chapter 5.5 on Food product improvement) (136).

Textbox 4.2. Manoeuvring between health benefits and health losses by following or neglecting dietary guidelines (142).

The *Best-case* scenario (fully following the dietary guidelines) and *Worst-case* scenario (doing the opposite of the dietary guidelines) are extremes. For example, it is very unlikely that the entire population will stop eating fruit and vegetables or will eat more than 200 grams of fruit and vegetables per day. On the other hand, the extreme scenarios illustrate the potential of nutritional interventions and rank the most important factors for the moment.

In practice, the actual health gains of following the dietary guidelines will depend on what dietary improvements have already been achieved in the previous years (as illustrated in Figures 4.1 – 4.3). This means that the nutritional health situation of a country can be characterized by a certain amount of room for manoeuvre, which might be different for the various dietary factors, depending on the progress made for the factor concerned. Yet, for national policy makers, it is important to know where the country's values lie with respect to such room for manoeuvre because it indicates what dietary factors still provide challenges for improvement. It also indicates what achievements should be treasured.

4.4 Health impact of body weight reduction

In 2000, 55% of Dutch men and 45% of Dutch women aged between 20 and 70 were overweight (BMI ≥ 25 kg/m^2) and 10% of the men and 12% of the women in this age category were obese (143). The best scenario would be to arrive at a BMI below 25 kg/m^2 for all individuals. The health impact of such a maximum scenario calculated using the year 2000 data amounted to a reduction of approximately 40,000 new cases of disease per year (diabetes, cardiovascular diseases, cancer) and to a reduction of approximately 7,000 deaths per year directly attributable to overweight (1).

However, modelling was also performed over a period of 20 years and the 20-year modelling differs from the directly–attributable calculation model in that it takes the substitute causes of death into account. Reducing the effect of one particular cause of death will result in a higher prevalence of other causes and vice versa. It appears that the cumulative health loss over a period of 20 years is indeed approximately 20 times the incidence rate of the one based on a one-year period, but the cumulative death rate is only 10-15 times the annual figure (1). If the cumulative death rate were divided by 20, the annual figure would amount to 4,000 deaths (instead of 7,000 deaths).

For the maximum scenario for weight reduction for adults 20 years old and older, the health impact would be a reduction of 246,000 DALYs per year. Life expectancy would increase by 0.8 year and the life expectancy free of disease by 2.3 years (1).

As indicated, the above calculations were based on the 2000 data. Since 2006, new data on overweight and obesity have also been collected. As described in Chapter 2.3, in 2015, still nearly half (50.3%) of the Dutch population of 19 years and older were overweight and nearly 13.7% still suffered from obesity (18). So, although we have not performed a maximum scenario based on the 2012 data with an updated CDM, it

may be assumed that the health impact of the maximum scenario for today's situation will not differ substantially from the above figures, provided that the relative risks have not really changed.

Obviously, the maximum scenario is an extreme scenario. To gain insight into realistic policy targets for overweight reduction at a population level, the impact of a large-scale implementation of a community intervention (applied to 90% of the general population) and an intensive lifestyle programme (applied to 10% of overweight adults) was estimated. Large-scale implementation of these two interventions over a period of 5 years may decrease the prevalence rates of overweight by 3 percentage points (e.g. to 45% instead of 48%) (144).

Another more realistic scenario for weight reduction might be the situation in which the distribution of BMI is moved in a way that everyone in the population shifts to a 1 unit (1.0 kg/m^2) lower BMI. As expected, the health impact for this more realistic scenario is substantially lower than it would be for the maximum scenario. For adults 20 years old and older, the health impact would be a reduction of 56,000 DALYs per year. Life expectancy would increase by 0.3 year and the life expectancy free of disease by 1.0 year (1).

We should keep in mind that, when calculating the overall health loss linked to an unhealthy diet, one cannot simply add the figures for unfavourable composition of the diet and for overweight. This is because overweight is caused by the combination of insufficient physical activity and the consumption of an energy-dense diet, and the last overlaps with the dietary composition recommendations mentioned above. For example, an increased intake of fruits and vegetables might help to reduce weight due to their high fibre content and low energy density.

4.5 Trends in diet related cardiometabolic diseases and cancer

As described in Chapter 2.5, a healthy diet rich in vegetables, fruits and dietary fibre and low in red and processed meat reduces the risk of CHD, stroke, diabetes and cancer. Chapter 4.2 described that a *predicted* ~137,000 deaths can be prevented over a 20-year period were everyone in the Netherlands to eat a healthy diet. This section describes the *observed* trends in these diet-related diseases over recent decades in the Netherlands.

The prevalence of CHD increased in men (by 25%) and women (by 15%) between 2001 and 2011. This increase can almost fully be explained by demographic changes, i.e. the increase and aging of the Dutch population. In the same period, a much stronger increase in stroke prevalence was observed. Stroke prevalence increased by 70% in men and by 55% in women. Besides demographic changes, the increase in the prevalence of overweight and obesity was partly responsible for this increase. In contrast, age and sex standardized mortality rates for CHD and stroke decreased between 1980 and 2012 (Figure 4.4 upper panels). The reduction in the consumption of trans fatty acids since the 1990s has contributed to this decline in mortality, as has the reduction in the percentage smokers since 1980 and improvements in the treatment for CHD and stroke (145, 146).

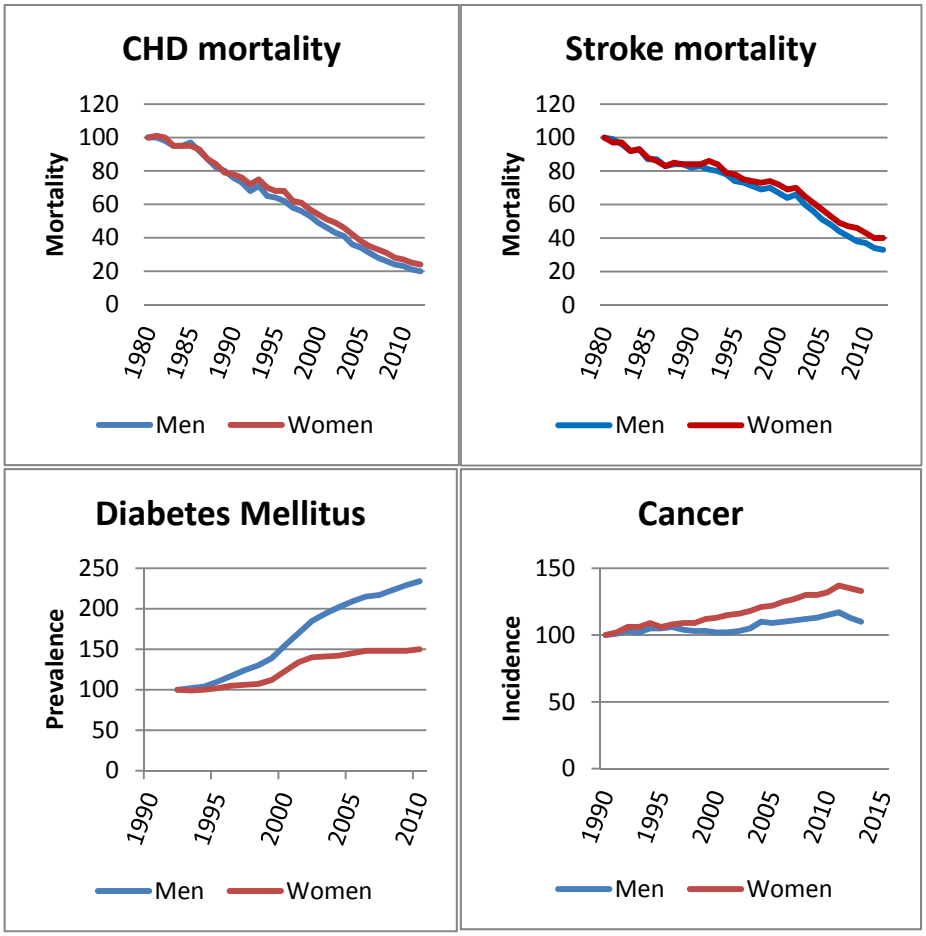

Figure 4.4. Trend in coronary heart disease mortality (CHD; upper left panel), stroke mortality (upper right panel), diabetes mellitus (lower left panel) and cancer (lower right panel), standardized to the age and sex distribution of the population in the first year (first year=100). Sources: CBS mortality statistics; CMR Nijmegen; IKNL / NKR, 2015.

Between 1992 and 2011, the prevalence of diabetes standardized by age and sex also increased. The increase was considerable; it doubled in men and increased by 50% in women (Figure 4.4 lower left panel) (147). Since the year 2000, the increase has been most prominent. Two-thirds of the increase in diabetes prevalence can be explained by the increase in overweight, intensified screening by general practitioners and the increased survival of diabetes patients.

The incidence of cancer also increased, in women from 1990 onwards and in men since 2001 (Figure 4.4 lower right panel). Since 2011, the number of new cancer cases has decreased (148). Cancer of the colon, rectum, breast and lung are among the most prevalent cancers in the Netherlands and are included in the protocol for the evaluation of diet-disease relationships of the Health Council in preparation for the updated Guidelines for a healthy diet. The number of new colorectal cancer cases and breast cancer cases increased by ~30% up to 2011 (149, 150). Approximately 15% of the increase in the incidence of colorectal cancer can be explained by changes in lifestyle. Since the 1980s, the incidence of lung cancer among men has decreased significantly, mainly as a result of

the lower prevalence of smoking (151). In women, however, the incidence has increased, which is ascribed to the increase in smoking women since 1960.

4.6 Key findings

- Following the current dietary guidelines for fruits, vegetables, fish, and saturated and trans fatty acids results in an increase of around 0.7 years lived in full health (QALY), an increase in life expectancy of about 0.5 year and an average reduction in mortality by 3,700 deaths per year (2.6%).
- Following the current dietary guideline for salt results in an increase in life expectancy of approximately 0.15 year and an average reduction in mortality by 1,250 deaths per year. A 40-year-old individual would decrease the number of DALYs lived by 0.5% if his salt intake was equal to the recommended maximum intake for the rest of his life.
- Following the dietary guidelines for fruit has the largest health impact, followed by, in decreasing order, fish, salt, vegetables, saturated fatty acids and trans fatty acids.
- A scenario in which all people fell within a normal weight range (BMI< 25 kg/m^2) would result in a decrease in the burden of disease by 246,000 DALYs, an increase of life expectancy by about 0.8 year, and an average reduction in mortality by 4,000 deaths per year. In practice, the health impact of realistic scenarios will be much less because the large-scale implementation of realistic interventions over 5 years may decrease the prevalence rates of overweight by 3 percentage points (e.g. 45% instead of 48%).
- The prevalence of diet-related, non-communicable diseases, such as diabetes, coronary heart disease, stroke and cancer has increased over the last 20-30 years. Part of the increase in prevalence can be explained by the aging of the Dutch population. The increase in diabetes and stroke can, however, also be partly ascribed to an increase in the prevalence of overweight and obesity. In contrast, CHD and stroke mortality have declined. The reduction in the consumption of trans fatty acids since the 1990s has contributed to this decline.

5 Policy actions to improve diet

The NOURISHING framework (2) comprises three broad domains of policy actions, which are essentially the three pillars of the response to unhealthy diets: the food environment, the food system, and behaviour change communication (see Figure 5.1). To develop a comprehensive and effective response to unhealthy eating, governments, civil society and the food industry should address all of the domains of actions together and implement policy actions from within all of the ten policy areas included in the framework.

The first domain includes six main areas in which actions can be taken to change food environments, including the information and market environments (see Chapters 5.1 to 5.6). The second domain in the food system aims to harness food policies and actions across sectors to ensure coherence with healthy eating behaviour (Chapter 5.7). The third domain includes three main areas in which actions can be taken to communicate behaviour change (chapters 5.8 to 5.9). The third domain on behaviour change communication includes policies and infrastructures to provide nutrition education and to develop skills. Although this domain is very relevant, few comprehensive sources on this topic are available and, as a result, we did not include this topic in this report.

In this chapter, we describe each of the ten policy areas in general terms, including the international context, where possible, followed by a reflection on the Dutch situation, sometimes described more thoroughly in separate subchapters.

Domain		Policy Area	Policy Options/Actions
Food environment	N	Nutrition label standards and regulations on the use of claims and implied claims on foods	e.g. Nutrient lists on food packages; clearly visible "interpretive" and calorie labels; menu, shelf labels; rules on nutrient and health claims
	O	Offer healthy foods and set standards in public institutions and other specific settings	e.g. Fruit and vegetable programmes; standards in education, work, health facilities; award schemes; choice architecture
	U	Use economic tools to address food affordability and purchase incentives	e.g. Targeted subsidies; price promotions at point of sale; unit pricing; health-related food taxes
	R	Restrict food advertising and other forms of commercial promotion	e.g. Restrict advertising to children that promotes unhealthy diets in all forms of media; sales promotions; packaging; sponsorship
	I	Improve the quality of the food supply	e.g. Reformulation; elimination of trans fats; reduce energy density of processed foods; portion size limits
	S	Set incentives and rules to create a healthy retail environment	e.g. Incentives for shops to locate in underserved areas; planning restrictions on food outlets; in-store promotions
Food system	H	Harness supply chain and actions across sectors to ensure coherence with health	e.g. Supply-chain incentives for production; public procurement through "short" chains; health-in-all policies; governance structures for multi-sectoral engagement
Behaviour change communication	I	Inform people about food and nutrition through public awareness	e.g. Education about food-based dietary guidelines, mass media, social marketing; community and public information campaigns
	N	Nutrition advice and counselling in health care settings	e.g. Nutrition advice for at-risk individuals; telephone advice and support; clinical guidelines for health professionals on effective interventions for nutrition
	G	Give nutrition education and skills	e.g. Nutrition, cooking/food production skills on education curricula; workplace health schemes; health literacy programmes

Figure 5.1. Food policies to promote healthy diets: the WCRF International NOURISHING framework (2).

5.1 Nutrition labelling and claims

Food labelling policies have been adopted relatively widely throughout the world. An increasing number of countries have developed – or are considering guidance on labels with 'interpretative' elements, including rules on nutrient and health claims, rather than just nutrient lists on food packages.

Food labels, either at the front or back of the pack, represent a way of communicating nutritional information. This communication on the food

label may come in three forms: the nutrition labelling, the nutrition logos that are interpretative elements regarding the healthiness of a food, and nutrition and health claims. Food labels are regarded as a possible tool to empower consumers and to facilitate healthier food choices. For this reason, food labelling policies have been adopted relatively widely throughout the world. Nutrition labelling is included in the WHO global strategy on diet, physical activity and health (152). Food labels and nutrition and health claims may also prompt the industry to produce healthier foods through product improvement, fortification and food innovation (see also Section 5.5).

Nutrition labelling

Legislation

As of 13 December 2014, The European Food Information Act (EC Regulation 1169/2011) has imposed requirements on what information on foods must be provided. In the Netherlands, the Law has led to the Warenwetbesluit Information Groceries. The purpose of this law is to improve the readability of the label and to give consumers information to make informed food choices with regard to health, safety and environmental origin. Sales over the Internet also fall under this law. The Dutch Food Safety Authority supervises its implementation.

The Food information act sets requirements for what must be put on food labels. What is and is not on the label depends on the way the product is packaged. Most foods in the store are pre-packaged by the manufacturer, not the retailer. For all these foods, the following information is mandatory:

- Name of the food.
- List of ingredients.
- Any allergens present.
- Amount of ingredients that are in the name or picture of the product.
- Net quantity of the product.
- Expiration date (best before or use by).
- Specific storage conditions or terms of use.
- Name and contact info of the manufacturer or distributor / importer.
- Any use or preparation, if the product is difficult to use without instructions.
- Country of origin or place of provenance.
- Percentage of alcohol if the product contains more than 1.2% alcohol.
- Nutrient declaration.

Regarding the nutrient declaration, it is mandatory to display information on energy and 6 nutrients (fat, saturated fatty acids, carbohydrates, sugars, protein and salt) on the label. This should be expressed per 100 grams or 100 millilitres, so that products can be compared. In addition to the six mandatory nutrients, the following nutrients may also be mentioned: monounsaturated fatty acids, polyunsaturated fatty acids, polyols, starch and fibre. Also, minerals and vitamins may be mentioned if they are present in significant amounts. To avoid confusion, only predefined terms may be used (e.g. salt rather than sodium). There are

also requirements regarding the font size of the provided information, for improved readability.
The obligation to provide nutritional information will apply starting 13 December 2016. For products with a nutrition or health claim (see section on health claims below), nutrition labelling is already required. Energy and nutrient declaration requirements apply only to pre-packaged foods. Restaurant meals have no obligation. Also, alcoholic drinks and some specific products such as fresh fruits and vegetables, spices and salt are not covered by the new rules. See http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32011R1169 for more information.

Prevalence of labelled nutritional information
In 2008/2009, an inventory of nutritional information on food labels in the 27 countries of the European Union was conducted for five food groups (sweet biscuits, breakfast cereals, pre-packaged chilled ready meals, carbonated soft drinks, and yoghurts). It was observed that more products include back-of-pack information than front-of-pack information. Ireland, the UK and the Netherlands were at the top end of the range for provision of back-of-pack information (>90% of the products). For front-of-pack information, this was also the case for Ireland and UK (75-82%), though not for the Netherlands (48%). In the Netherlands, about 70% of the foods in the inventory displayed information on 8 key nutrients, and 12% on 4 key nutrients (153). Because the requirements for energy and nutrient declaration will apply from December 2016 on, it is expected that more pre-packaged products already provide this information currently.

Public health effects
Nutrient labelling needs to be understood in order to be effective. To compare the healthiness of two foods (either from the same or different product category), nutrient tables seem as effective as traffic light labels (see Figure 5.1). But when no comparison product is available, nutrition tables seem less effective than traffic light labels or logos to communicate product healthiness. Thus, it seems that the energy and nutrient content information of nutrition tables lacks meaning on its own and has to be compared with other information to be interpreted meaningfully (154).

The majority of studies on food labelling and associated eating habits are based on relatively small study populations. In a meta-analysis of nine of these studies, it was concluded that when following food labelling it can be expected that 17% more people select a healthier option. The meta-analysis included three types of food labelling, guidelines for daily amounts, traffic light labelling and others (see Figure 5.1 for examples). Most of these types of labelling were displayed on the front-of-pack. All the three types of food labelling presented a positive, statistically significant effect. Traffic light labelling was the most effective labelling scheme and increased the number of people selecting a healthier option by almost 30%. Other food labels and Guidelines Daily Amounts followed with increases of 15% and 12%, respectively. The majority of the studies included in the meta-analyses were conducted in controlled settings or as online trials. Little insight exists on the extent food labels affect food purchases in real-world shopping settings (e.g. supermarkets), where most food purchases take place (155). Research does show that the more consumers know about nutrition, the more likely they are to consult and understand nutritional information on food labels. As a consequence,

consumers with prior knowledge are more likely to use label information effectively. They may focus better on relevant information, understand it, and make healthful decisions based on this information (156).

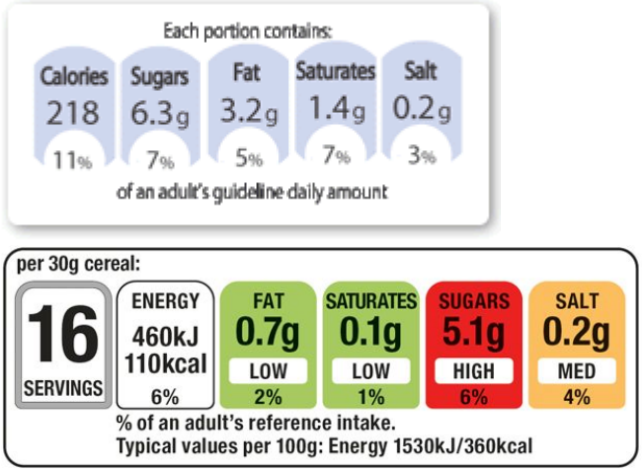

Figure 5.2. Examples of nutrient labelling schemes. At the left side the Guidelines Daily Amounts (GDA) system, at the right side the traffic light system.

Foods with a health logo

In addition to nutrition labelling, several front-of-pack signpost logos have been implemented in various countries (Figure 5.2). Examples of such health logos are the Swedish Keyhole logo, the Smart Choice (US), and Pick the Tick (Australia and New Zealand). These logos do not communicate precise nutrient content levels, but flag products that qualify against a priori, defined criteria across certain nutrients and energy (154).

Figure 5.3. Examples of front-of-pack health logos. The Choices Logo on the left, the Keyhole logo in the middle, and the Pick the Tick logo on the right.

In the Netherlands, the Choices logo ('het Vinkje') was in use, which has also been implemented in various other countries. The logo is a voluntary private initiative of the food industry. The logo was introduced in the Netherlands in 2006 as a response to the World Health Organization's call for the food industry to take an active role in helping to tackle the growing problem of obesity and diet-related diseases around the world. Products that complied with certain product-group-specific nutrient-based criteria were allowed to carry the logo. The Choices logo indicated that the product had a healthier nutrient composition than other products in the same food category. There were two versions of the logo. The logo with the green circle was for basic foods with a healthier composition, such as whole grain bread, skimmed and semi-skimmed dairy, and fresh fruit and vegetables. The logo with the blue circle was for discretionary

foods, such as powdered soup, chocolate sprinkles, bread toppings, jam, fruit juice, soda and pasta sauces. Besides that the logo was to help consumers select healthy food options easily, it also aimed to encourage the food industry to improve their products. The fact that not all producers participate in the programme is seen as one of the disadvantages of the Choices logo. Absence of a logo on a product can mean either that it does not qualify or that the producer does not participate.

In 2008/2009, an inventory of nutritional information on food labels in the 27 countries of the European Union was conducted for five food product groups (sweet biscuits, breakfast cereals, pre-packaged chilled ready meals, carbonated soft drinks, and yoghurts). The penetration of health logos, at 9%, was the highest in the Netherlands (153). At that time, it was due to the combination of the 'Choices logo' and the 'Healthy Choice Clover' by the Dutch retailer Albert Heijn. Both logos merged in 2012.

The Minister of Health, Welfare and Sport endorsed the Choices programme until October 2016. In preparation of future decision-making, a committee reviewed the scientific evidence for logo's that facilitate food choices. From this review the committee concluded that it has not been scientifically proven yet that logo's contribute to a healthier product offer of producers and a healthier product choice of consumers. Yet, a logo can fit in nutrition policies to inform consumers about a healthy diet (157). Part of the scientific evidence is described below.

Public Health effects
Logos have the potential to improve a population's nutrient intake. For the Choices logo, this potential was shown in a simulation study. In the most extreme scenario, all non-complying products consumed according to the national food consumption survey were replaced with products that comply with the label's criteria. Saturated fatty acids median intake reduced from 14.5 to 9.8 per cent of energy intake. The average predicted change in total-/HDL cholesterol ratio was modest (−0.03). The findings suggest that the consumption of foods that comply with the criteria for a front-of-pack label may contribute moderately to cardiovascular risk reduction by influencing blood lipids. These findings did not take into account other potential effects on related intermediaries and health outcomes, such as blood pressure, body mass index, stroke, diabetes and cancer (158). Whether the potential theoretical benefits of health logos such as the Choices logo are met in practice depends on the extent to which food manufacturers participate in the programme, whether consumers understand the logo and make healthier food choices because of the logo, and on whether food manufacturers improve the nutritional quality of their food products in order to qualify for the logo. The first issue is addressed above and the other issues are discussed below.

Based on two experiments conducted in Germany and the Netherlands with various types of labelling schemes, it was concluded that logos help consumers to distinguish healthier and unhealthy options within a product category. But logos based on overall product healthfulness within a product category can diminish consumers' ability to differentiate between categories, leading to a potential misinterpretation of product healthfulness. This misinterpretation is caused by an enounced

healthfulness perception of the relatively less healthful product category. Additionally, absence of such logos is not readily noticed when no comparison product is available and this may lead to an overestimation of a products' healthfulness. Labelling schemes such as The Multiple Traffic Light system did not have these disadvantages (154). This is in line with the outcome of a review on different front-of-pack labelling systems, including the Choices logo, on consumer preferences, understanding, use and the impact on purchasing patterns. The findings indicated that the Multiple Traffic Light system has most consistently helped consumers identify healthier products (159)

Logos might also improve public health through improving the nutritional quality of the food supply. In 2007-2009, this was studied for the Choices logo amongst 47 companies, 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). About half of the products were found to be existing products that complied with the Choices criteria; 168 products (20%) had been reformulated; 236 products (29%) were newly developed to comply with the Choices criteria. Most products carrying the logo as a result of food product improvement and the development of new products were soups and snacks, respectively. Sodium was the nutrient changed in most of the product groups, namely in processed meats, sandwiches, soups and sandwich fillings. Dietary fibre 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 (160).

Nutrition and health claims

Nutrition and health claims are used to highlight specific properties of foods that contain (added or natural) beneficial ingredients or are lower in nutrients we should be eating less of. In Europe, two categories of claims on foods are distinguished, i.e. nutrition claims and health claims. Nutrition claims refer to what a food contains and comprise content claims and comparative claims.

Table 5.1. Examples of nutrition and health claims.

Nutrition claims	Health claims
Content claims	General function claims
• High in fibre • No added sugar	ALA contributes to the maintenance of normal blood cholesterol levels
Comparative claims	Reduction of risk of disease claims
• Energy reduced • Light	Calcium and vitamin D help to reduce the loss of bone mineral in post-menopausal women. Low bone mineral density is a risk factor for osteoporotic bone fractures
	Growth and development claims
	Docosahexaenoic acid (DHA) intake contributes to the normal visual development of infants up to 12 months of age.

Health claims refer to what a food does and refer to general function claims, claims related to a reduction of risk of disease and claims related to the growth and development of children (see Table 5.1 for various

examples). A health claim can be made up from three components: an active ingredient, an effective function, and a health benefit, but one or two of these components is also allowed.
Legislation
The European Union regulates the use of health claims. In December 2006, Regulation 1924/2006 on nutrition and health claims made about foods was published. The Regulation aims to ensure that claims are truthful and do not mislead consumers. It also aims to stimulate innovation in the food industry to produce healthier food products.
The regulation states that claims should be understandable to an average consumer. The European Food Safety Authority (EFSA) evaluates whether the health claims submitted under the regulation are scientifically substantiated. Upon scientific evaluation by EFSA, it is up to the European Commission and the Member States to decide on authorization. As from 14 December 2012, all claims that are not authorized or are on hold/under consideration are prohibited. Health claims on botanicals remain allowed without any substantiation.
By 2015, EFSA evaluated around 3,000 health claim applications. The outcome of the scientific evaluation process was that approximately 250 health claims have been evaluated as being positive, a few with insufficient evidence, and the large majority of health claims proposals led to the conclusion that they are not scientifically substantiated. Most approved and authorized health claims fall within the area of general function claims for vitamins, minerals and other nutrients. EFSA hitherto has not found sufficient scientific support for any health claim on microorganisms, except for lactose digestion by yoghurt bacteria and only a few concerning "antioxidants".

In 2012, EU Regulation 432/2012 has established a list of general function claims under Article 13 of Regulation 1924/2006. At the same time, the European Commission installed an EU Register on nutrition and health claims which identifies all authorized and non-authorized health claims under Articles 13.1, 13.5 and 14 (http://ec.europa.eu/nuhclaims/). Since then, it is formally permitted to use slightly more than 200 established health claims on vitamins and minerals (and several other food ingredients) without further recurrence to the EC or the Member States.
Although the nutrition and health claim regulation indicates that by Jan 2009 nutrient profiles would be set with which food or certain categories of food must comply in order to bear nutrition or health claims, to date the EC has not yet set nutrient profiles due to political objections.

The enforcement of EU Regulations around nutrition and health claims on foods (Regulations 1924/2006, 432/2012, etc.) is the task of national food safety authorities. Regular intended or unintended breaches of the regulations on claims are reported, e.g. via EU Food Policy (www.eufoodpolicy.com). In the Netherlands, the Consumer Organization (Consumentenbond) hosts a 'wall of shame' identifying such examples: http://www.consumentenbond.nl/campagnes/kletsplaatjes/ .

Prevalence of health and nutrition claims in the food supply
An inventory of nutrition-related labelling on food and drink products from five product categories (sweet biscuits, breakfast cereals, pre-packed fresh ready meals, carbonated soft drinks, and yoghurts) showed that the

penetration of nutrition and health claims varies widely across the EU. Nutrition claims appeared front-of-pack on about 28% of all products audited in the Netherlands and back-of-pack on 23% of products. In contrast, health claims (including disease risk reduction claims) were used considerably less often and tended to appear back-of-pack (4%, range 1-8%) more than front-of-pack (2%, range 0–6%) (153).

Public health effects of a product with nutrition or health claims
Some view claims as a legitimate educational tool that will have a positive impact on consumer behaviour and nutrition awareness and, as such, say they contribute to public health. Whether this is true or not depends, in the first place on whether and how consumers understand the health claim. People do not always understand health and nutrition claims as they are intended. However, there is limited quantitative information available on the proportion of consumers who correctly understand claims already in use (161). In general, research shows that knowledge about nutrition supports understanding of claims on food labels (156). If people understand the claim, both personal factors and food-related factors affect purchasing behaviour. Adding health claims to products does increase their perceived healthiness. The claim structure was found to make a difference with respect to perceptions, but its influence depended on the level of relevance, familiarity and an individual's need for information. Furthermore, the type of health benefit proposed and the base product used also affected the perceptions of healthiness. Overall, the main factor influencing perceived healthiness and the intention to buy a product with a health claim is personal relevance (162). There is a tendency for health claims to be perceived more positively when linked to products with an overall positive health image, e.g. yoghurt or bread. Furthermore, consumers like simple wording, but they may also demand detailed explanations. At the point of sale, there are other factors that might have a much greater combined influence on purchasing behaviour than health claim-related determinants. These include buying out of habit and no tendency to read labels. Taste, brand and price, attractiveness of the product and packaging seem to be more important than health claims in influencing purchasing decisions (161).

There are many products on the market with vitamins and/or minerals added that carry *nutrition claims*. However, if the intake of micronutrients is already sufficient, a higher intake will not further contribute to public health (see Chapter 3.3). As such, the Health Council of the Netherlands has indicated 'that a diet that is in accordance with the Guidelines for a Healthy Diet supplies enough micronutrients for the general population' (163). The Health Council noted a few exceptions, i.e. for folic acid, vitamin D, vitamin K and vitamin B_{12} for specific population groups. Since there is little shortage of other vitamins and minerals in the Netherlands, foods with nutrition claims may cause consumers to think that (extra) health benefits are attained while there is no extra need for these ingredients because there is already a sufficient intake. At the same time, the proportion of the population with too high intake of micronutrients is also generally low. Similarly, there are many foods on the market with nutrition claims for reduced levels of saturated fatty acids or sodium. The intake of these nutrients is generally excessive. Substituting foods with normal levels of these compounds for foods with reduced levels potentially has a positive public health effect.

Applications for *health claims* in dossiers typically rely on studies involving volunteers in randomized clinical trials. The efficacy of the health effects under real life situations remains to be established. There are some exceptions to this, e.g. for products with plant sterols/stanols. For these products, a health claim is allowed for the maintenance of normal blood cholesterol concentrations (see http://ec.europa.eu/nuhclaims/). It was shown that the effect of lowering blood cholesterol that these plant sterols/stanols have is also apparent under free-living conditions. The blood cholesterol levels in people consuming plant sterols/stanols remained the same over years, while in controls there was in increase (164, 165). Yet whether or not such lowering of blood cholesterol levels has public health consequences in terms of lowering the incidence of coronary heart disease remains to be established. But it has been shown that it is not cost-effective to consume products with extra plant sterols/stanols next to statin therapy in the prevention of cardiovascular diseases (166).

5.2 Offer healthy foods in specific settings

Offering healthy foods and setting standards in public institutions and other specific settings is also considered as an important policy area. The school-based policies, programmes and interventions are typical, but there are also activities in sports canteens and in the workplace. Between 2010 and 2015, the Dutch Covenant on a Healthy Weight was implemented. This agreement was signed by several actors from national and local governments, industry and civil society organizations. The aim of the agreement was to reverse the trend towards a higher prevalence of overweight and obesity in children and adults. From 2015 onwards (until 2020), most of the activities of this covenant are being continued in a foundation (Youth on a Healthy Weight, 'Jongeren op Gezond Gewicht' in Dutch). Several (sub)programmes to improve the food supply at school, work and sports canteens are part of this covenant.

School environment

The 'whole school approach to health promotion' propagated by the WHO involves schools, families and communities (167). The principle is a comprehensive approach targeting multiple (un)healthy behaviours. Insight into the current behaviour of the pupils/students may be useful for adjusting the intervention to the specific needs of the school. In addition, health promotion should be tailored to other aspects of the school, such as the educational level and cultural background of teachers and pupils.

The whole school approach targets not only individual behaviours (e.g. through education), but also the physical environment by, for example, creating a healthy school canteen and/or removing vending machines, as well as the social environment by, for example, involving parents and implementing healthy school policies. The various initiatives are described below.

Healthy School Approach and Healthy School Logo

In the Healthy School collaboration ('Gezonde School' in Dutch), partners working together on promoting health in primary, secondary and vocational education. The partners include the Centre for Healthy Living of the RIVM, health-promoting institutes (e.g. the Netherlands Nutrition Centre), the association of Community Health Services and Regional

Medical Emergency Preparedness and Planning Offices in the Netherlands (GGD-GHOR Nederland) and educational organizations (PO, VO and MBO Raad) united in the "Education Agenda Sport, Physical Activity, and A Healthy Lifestyle". Financial support is obtained from the Ministry of Health, Welfare and Sport and the Ministry of Education, Culture and Science. The Healthy School approach is an approach to working on health and a healthy lifestyle in a structured and integrated manner. It consists of four pillars: early identification of risk factors among individual students, followed by indicated prevention, health education, offering an environment that promotes a healthy lifestyle and the development of health policies. In accordance with the whole school approach, Healthy School works with local partners to involve the community, e.g. through the Community Health Services (GGD), and JOGG (see below).

From 2012 to 2015, schools could apply for support of Healthy School activities. Schools could choose between customized advice from a Healthy School Advisor, (partial) reimbursement of the costs of Healthy School interventions, or the compensation of hours that their own staff spent on Healthy School activities. Between 2013 and 2015, a total of 3,250 schools received support, 1,714 of which received support for Healthy School interventions. Of these interventions 13% were related to nutrition; and this percentage was higher for vocational education (29.5%) than it was for primary education (8%) (168, 169).

Another line of action of the Healthy School collaboration is the "Healthy School Logo". Schools can earn a so-called "Health Logo" ('Vignet Gezonde School' in Dutch) with a certificate in various domains, including 'Nutrition' (see Table 5.2). In line with the four pillars mentioned above, the criteria for the certificate on Nutrition are: embedding of nutrition education in the curriculum, presence of a structure to identify and refer pupils with problems concerning nutrition and weight to care, presence of a written policy on healthy nutrition, and a healthy food environment. A healthy food environment encompasses the availability of drinking water, communication of the food policy to students and parents, and a food supply that complies with the Healthy School Canteen criteria of the Netherlands Nutrition Centre (see below). The aim formulated in the National Prevention Programme is that 850 (of approximately 8,000) schools have a Healthy School Logo in 2016. In January 2017, the 1000st school has received the Healthy School Logo.

Table 5.2. Number of schools with a Healthy School Logo and accompanying certificates in February 2016.*

	Primary education Started in 2011	Secondary education Started on 1-9-2014	Vocational education Started on 1-11-2013
Healthy School Logo (i.e. one or more certificates)	425	88	41
Certificates			
Sports and Physical activity	239	58	35
Nutrition	69	30	10
Smoking, alcohol and drugs prevention	9	6	0
Relationships and sexuality	30	2	0
Psychosocial well-being	177	9	2
Physical safety	8	NA	NA
Hygiene, skin, teeth and hearing	6	NA	NA
Environment and nature	8	NA	NA

*source: vignetgezondeschool.nl, access date: February 2016; NA=not applicable.

Healthy School Canteen Programme
In 2003, the Healthy School Canteen programme started. It is designed and performed by the Netherlands Nutrition Centre (170, 171). It aims to promote a healthy food environment and healthy food choice and is aimed at secondary schools and schools for vocational training in the Netherlands. Participating schools are encouraged to improve the food offered at school (in the canteen and/or vending machines), to embed education on healthy nutrition in the curriculum and to develop a policy on healthy nutrition. Since 2009, schools can be visited by a dietician, who takes an inventory of the current situation. Since 2013, the programme has been intensified and more dieticians have been recruited to visit schools, the so-called "Canteen Brigade". After taking the inventory, an action plan is drafted, in which goals and corresponding actions are set. Schools implement the action plan on their own and the results are evaluated after six months.

Manifest Healthier Food Supply in Schools
As part of the Covenant on a Healthy Weight, the Manifest Healthier Food Supply in Schools was valid from 2011 to 2015. The signing parties from the catering and vending sector, education and NGOs agreed to work towards a healthier food supply in schools. As a follow-up, the "Agreement for Healthy Nutrition at Schools" was signed in October 2015 (172). This agreement is valid from 2016 to 2020. The ambitions of this agreement are to achieve a healthy food supply and to improve the appearance of the canteen to make the healthy choice easier.

Guidelines for Healthy (School) Canteens
Both in the Healthy School Canteen Programme and the Manifest on Healthier Food Supply in Schools up to and including 2015, the aim for the food assortment was to achieve at least 75% of basic products according to the Dutch Food-Based Dietary guidelines of 2011 (120). These "basic" foods were part of the 2011 version of the "Wheel of Five"

and included fruit and vegetables, water, coffee, tea, dairy products, bread and rolls. "Non-basic" foods included all 'extras' such as crisps, salted snacks, fried snacks, candy bars, sweets and regular sodas. For school canteens a few exceptions were allowed, i.e. regular soda's, soups, sandwich fillings and sauces that are used for preparation of sandwiches or salads are regarded as "basic" products if they do not exceed certain caloric or portion size limits.

In 2014, the Nutrition Centre developed new guidelines for healthier school, company and sports canteens (173). The healthier option is defined using the Food-Based Dietary guidelines (120).
These guidelines describe five general rules for healthier canteens:

1. In every available product category, at least one healthier option is available.
2. Healthier options are placed in the most prominent places.
3. Encourage water consumption.
4. If fried options are available, these should be prepared using unsaturated fats.
5. The vision on the healthy food environment is recorded in the policies of the school, (sports) club or company.

In addition, these guidelines describe criteria for the total food assortment and appearance of the canteen at three levels.

In the Agreement for Healthy Nutrition at Schools of 2015 (172), the signing parties agreed to have a minimum of 60% healthier choice products in their visible assortment. This is the part of the assortment that is visible to the consumer at the counter in displays, showcases and vending machines. Also, the menu and other visuals such as posters should mainly portray healthy foods. In addition, school canteens should offer vegetables or fruit, encourage the consumption of water and make healthy food choices more seductive through the appearance of the canteen. The ambition for 2020 is to have a minimum of 80% healthier choice products in the visible assortment and to offer both vegetables *and* fruits in at least 25% of schools. From 2016 onwards in the Healthy School Canteen Programme, these criteria are also used for a healthy school canteen.

Compliance with the School canteen guidelines
In 2013, a monitoring study was performed among 198 schools that had no contact with the Nutrition Centre before (i.e. no visit of the Canteen Brigade or participation in the School canteen award) (174). In this study, 144 secondary schools, 40 vocational education schools and 14 schools offering both types of education were visited. During the visit, food supply was scanned by Nutrition and Dietetics students. Only 13 of the 198 schools had a supply of at least 75% basic products (7.6% of the secondary education schools and 2.5% of the vocational education schools). The average percentage of basic products that schools offered was 50.9%. The percentage of basic products in the assortment was significantly higher at vocational training colleges (in Dutch: Praktijkschool). These are mostly relatively small secondary schools (fewer than 500 students). At 22 vocational training colleges, the average percentage of basic products in the assortment was 64.9%, and 6 schools (27.2%) complied with the guideline of having at least 75% of the assortment consist of basic products. Schools that managed their own

canteen had significantly more basic products in the assortment than schools with an external caterer. None of the schools that had an external party to manage their canteen and/or vending machines met the guideline of having at least 75% of the assortment consist of basic foods.

Schools that comply with the criteria in the guideline for Healthy School Canteens, i.e. that at least 75% of their food assortment consists of basic foods, can be awarded the Healthy School Canteen Award. In 2013, 24 schools were awarded this Award. In 2014, 82 schools were awarded it, in 2015, 412 schools and in 2016, 187 schools were awarded the Award (175). At the end of 2016, 89% of secondary and vocational education schools had a Healthy School Canteen Award or were working towards this goal.

Sports canteens
In 2014, as part of the Covenant on a Healthy Weight, a programme aimed at healthier sports canteens was launched (see www.gezondesportkantine.nl). The goal of this 'Team:Fit' programme is to have 1,750 participating sports canteens by 2020. Participating sports clubs aim to have a healthier assortment of foods and drinks, and a responsible alcohol policy in their canteens. National sports organizations and the Netherlands Nutrition Centre support the implementation of the programme.

On the reference date of November 2016, 539 sports canteens were participating in 'Team:Fit' (Figure 5.3). Participating canteens were from clubs for 21 types of sports, such as soccer, tennis and hockey. Another 453 soccer clubs participate in 'Lekker Bezig' a programme aimed at promoting a healthier food supply in soccer canteens (176). This programme is a private initiative that collaborates with 'Team:Fit' since March 2016.

GfK monitored the implementation of the 'Team:Fit' programme (177, 178). Before the start of the programme, a survey was performed among visitors of sports canteens. This included adults and children that were club members themselves or parents that visited the canteen while their children were playing sports. Only 40-50% of the respondents indicated that it was always/often possible to make a healthy food choice in the sports canteen. The foods most frequently consumed were all relatively unhealthy products such as toasted ham and cheese sandwich (croque-monsieur), French fries, fried snacks, crisps and candy bars. The most frequently consumed drinks were also more unhealthy options, i.e. sport drinks and (regular) sodas. For adults, the most frequently consumed non-alcoholic drinks were tea/coffee, sport drinks and sodas.

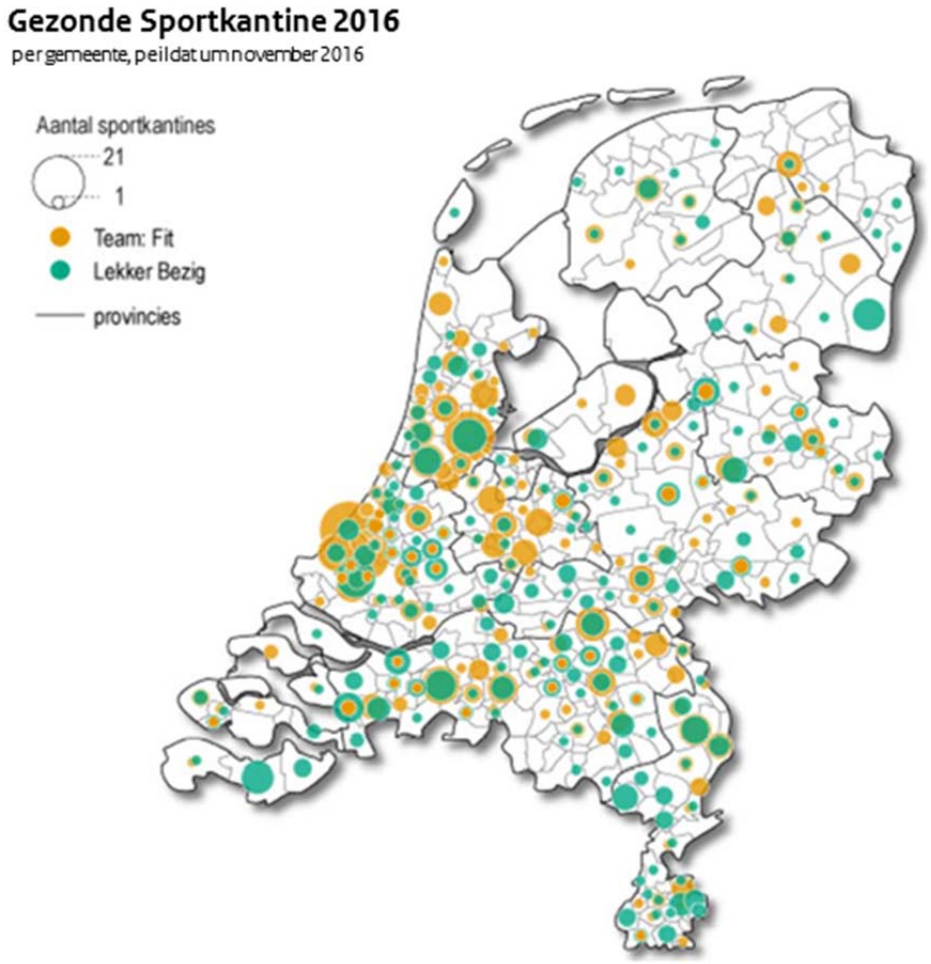

Figure 5.4. Number of healthy sports canteens per municipality, November 2016. Source: www.volksgezondheidenzorg.info

After the Healthy Sports Canteen programme was implemented for approximately a year, another survey was performed among visitors of participating canteens. The percentage of respondents that indicated that it was possible to make a healthy food choice in the canteen was somewhat higher than it was in 2013 (50-60%). Whether this is due to the implementation of the programme or whether the canteens that participated in the programme already offered healthier products before implementation is unknown. Yet despite the food on offer being healthier, the most frequently consumed items, according to the respondents, were the same as in the 2013 survey (toasted ham and cheese sandwich, fried snacks, sugared sport drinks and sodas). The only favourable trend was that spring water was consumed by more visitors than before the implementation of the programme (about 25% of visitors).

A survey taken among (committee) members of sports clubs that was performed in 2011 and 2014 (179, 180) yielded similar results. Canteens offered mainly unhealthy drinks and snacks. In this survey, alcoholic beverages were also included. After coffee and tea, low-alcohol beverages (e.g. beer, wine) were offered most often. Changes in the assortment offered by canteens between 2011 and 2014 appeared to be

minimal, except for a slight decrease in the percentage of canteens offering light soft drinks and energy drinks. In addition, in more canteens fruit (3 to 9%) and sausage rolls (4 to 14%) were offered. This survey also asked which products were the best-selling items in the canteen. The best-selling items were mostly unhealthy products, such as French fries and other fried snacks, and croque-monsieur. Changes made between 2011 and 2014 were small, but the demand for spring water seems to have risen.

Workplace
As part of the "National Prevention Programme-Everything is Health", the sector organization of caterers (Veneca), a health insurance company and researchers from the VU have developed a "healthy catering concept" for company catering (181). The aim is to implement this concept within the programme 'The Healthy Workplace' in many larger and smaller companies. Also, within the Dutch Covenant on a Healthy Weight (later Youth at a Healthy Weight; see below), "The Healthy Workplace" is one of the lines of action. It is aimed at healthy lifestyles, nutrition and physical activity, and sustainable employability. This programme has not yet been evaluated.

Other activities, the hospitality and catering sector
In January 2014, the Minister of Health and representatives of the food industry and the hospitality and catering sector signed an 'Agreement for Improvement of Food Composition', or in Dutch 'Akkoord Verbetering Productsamenstelling' (182). This agreement mainly focuses on changes in food composition (product improvement), which is addressed in Section 5.5. Although not implied by its name, the Agreement contains other actions besides food product improvement. It is aimed not only at a healthier food composition of individual (packaged) foods, but also at healthier meals and food assortments in stores, canteens and restaurants. To make it easier for consumers to consume less energy, signing parties agree to decrease portion sizes and/or promote the consumption of fruit and vegetables. The sector organizations of the retail and catering sector (Koninklijke Horeca Nederland and Veneca) encourage their members to make their food assortment healthier by choosing healthier options when purchasing and preparing food. Yet, at this time (end of 2015), no detailed working plans for the implementation of these actions have been published.

Healthy community
As mentioned before, from 2015 onwards most of the activities of the Covenant on a healthy weight are being continued in a foundation (www.jongerenopgezondgewicht.nl). The part of the programme that gives this foundation its name (Youth at a Healthy Weight: JOGG) is a community-based approach for overweight prevention in children (0-19 year). It is modelled after the French programme Ensemble Prévenons L'Obésité Des Enfants (EPODE). The EPODE model consists of 5 pillars (see figure 5.4): political support, public-private partnership, social marketing, integrated pathways prevention and care and monitoring and evaluation (183).
Within JOGG municipalities, public and private partners such as schools, sports clubs, family doctors and local supermarkets work together to increase physical activity among children and to improve their nutrition,

with the ultimate goal of increasing the percentage of children at a healthy weight.

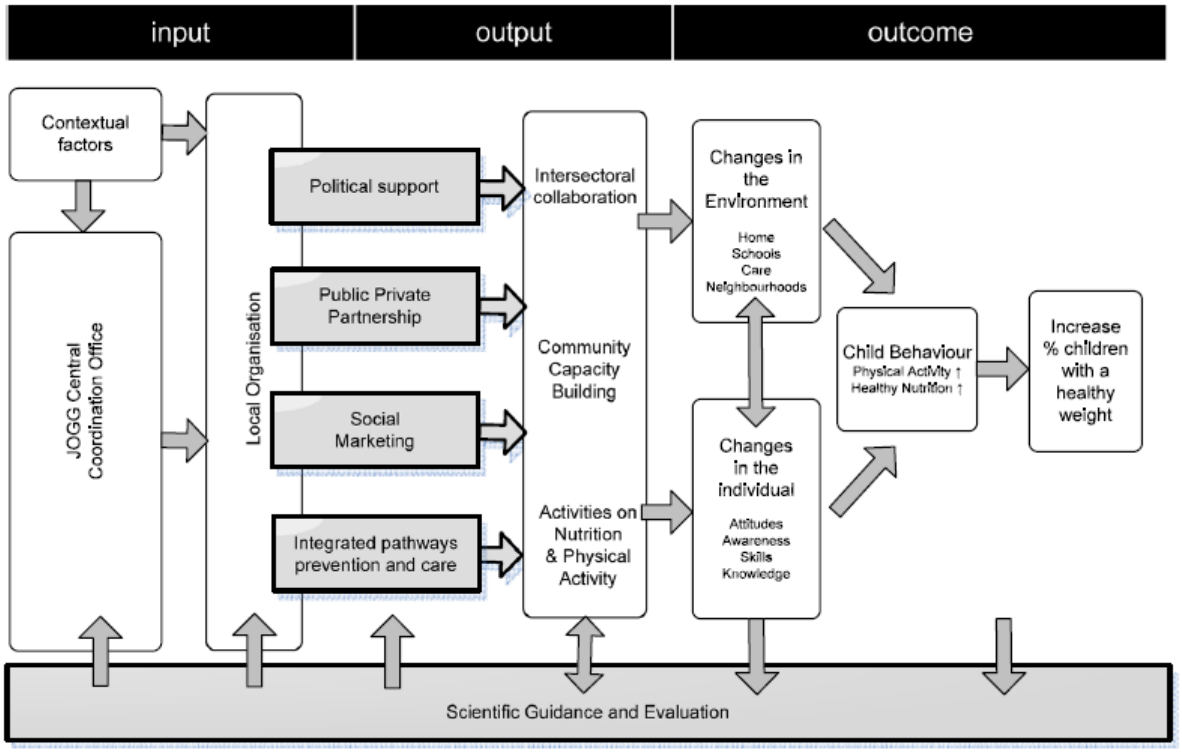

Figure 5.5. EPODE model (184).

In December 2016, there were 114 municipalities participating in JOGG (including the special Dutch municipalities Bonaire, Saba and St. Eustatius) (see Figure 5.5). Drenthe is a JOGG province. The second monitor of JOGG from February 2017 (185) shows that, at the end of 2016, about 799,000 children had been reached by JOGG. The programme is especially active in deprived neighbourhoods. Creating sustainable, effective public private collaborations remains a point of attention, yet it has improved since 2015. In 2016, 49 local monitoring and evaluation reports were published. Most of them were process evaluations and very few contained effect studies. However, local studies in JOGG communities suggest that there are positive trends in healthy body weight in some of them. From these studies, it is not possible to determine to what extent the JOGG approach contributed to these positive trends.

Figure 5.6. Municipalities participating in JOGG.
Source. www.volksgezondheidenzorg.info.

5.3 Use economic tools

Economic tools to address the affordability of food and behaviour change incentives for purchase have been widely discussed in recent years by governments, civil society and the media. A range of actions have been taken, including taxes and subsidies, and several governments are exploring the possibility of introducing fiscal measures to modify the intake of specific nutrients or groups of foods.

Food prices in relation to food choices

Price is one of the most important attributes for food choice (186-189). A study from Waterlander et al.(190) suggests that healthier diets, with more fruits and vegetables, are relatively more expensive than diets high in energy-dense foods. Fiscal measures, such as taxes or subsidies, are increasingly considered to be an important measure to limit consumption of unhealthy foods and increase the consumption of healthy foods (191). Such strategies are based on the economic theory that an increase in price will result in a decrease in quantity sold and vice versa, and thereby leads to healthier consumption patterns. A tax may be applied to foods or beverages with high levels of energy, saturated fatty acids, trans fatty acids, added sugar or salt. A tax would work by increasing the price for

consumers, thereby reducing demand and shifting population-level consumption. Subsidies work the other way around; a decrease in price would increase demand and may be effective for foods such as fruit and vegetables, and foods high in fibres.

Feasibility and effectiveness of pricing strategies
In 2015, the WHO reviewed the current evidence for the effectiveness of pricing strategies and concluded that taxes and subsidies have the potential to influence food purchases and may serve as an incentive to improve dietary habits at population level (191). It was noted however that this conclusion is supported by a diverse body of evidence in terms of research method, outcome of interest, type and level of taxes, setting and target food or nutrients. In addition, the effectiveness of pricing strategies is mostly studied in a theoretical setting and there is limited empirical evidence available (191, 192). Experimental choice studies, as performed in the Netherlands by Waterlander et al. (193), suggest that lowering the prices of healthy foods in general seems effective in increasing the purchased amount of these products. An observed side effect was that discounting healthy food items leads to a significant increase in total calories purchased. This is an important aspect of food pricing strategies; it will have an effect beyond the initial targeted foods or nutrients (191). A systematic review of modelling studies concluded that food taxes and subsidies can influence consumption in high-income countries and thereby influence health outcomes such as body weight (194). However, the quality of simulation studies depends on the assumptions made, such as the price change that is modelled in the scenario. Yet evidence suggests that little changes in price will also have a relevant effect on public health. Inclusion of healthier foods in nutrition assistance programmes can improve food consumption as well (191).

Given all the evidence considered by WHO, they concluded that taxes and subsidies are most influential at the point-of-purchase (191). The ultimate impact of a tax or subsidy will depend on how the tax or subsidy is designed and implemented. The potential for compensatory behaviour should be considered when a taxation policy is designed. Evidence suggests that taxation of sugar-sweetened beverages and subsidies on fruit and vegetables appear to be the most effective pricing strategies (195). Moreover, pricing strategies seem to be more effective for consumers with a low-income, since they spend a higher proportion of their income on foods and react faster to changes in price (196). The increase in price should be considerable in order for it to have an effect.

Pricing policy on foods in the Netherlands
In the Netherlands, higher taxes are only applied to alcohol. Subsidies on healthy foods are hardly available, although the Netherlands participates in the EU School Fruit Programme that is providing free fruit and vegetables at schools for 20 weeks to increase fruit and vegetable consumption (197). Around 4,500 schools have participated in the EU School Fruit Programme since 2010. A process evaluation showed that 98% of the participating schools were enthusiastic about the programme and children and their parents appreciated the programme as well. At the end of EU School Fruit, the percentage of children that brought fruit to school increased from 40% to 45% and the percentage of children that brought cookies decreased from 65% to 55%.

Subsidized milk is also provided at schools in the Netherlands. But little is known about the effectiveness of this programme.

Pricing policy on foods in Europe
Four European countries implemented taxation policies. Denmark introduced a fat tax, Finland a tax on sweets, ice cream and soft drinks, Hungary a public health product tax and France a tax on sugar-sweetened and artificially sweetened beverages. The fat tax introduced in Denmark in 2011 was intended to raise additional revenue to reduce the income tax burden and to reduce the consumption of saturated fats. The tax was raised on products that contained more than 2.3g of saturated fatty acids per 100g. The tax was abandoned as early as 2012 because of unintended consequences, such as cross-border shopping, job losses and negative profit impacts for producers (198). A preliminary analysis showed that for some products, the consumption dropped by 10 to 15%, but a formal evaluation has not been performed (191, 198).

In Finland the government has raised the tax on sweets and ice cream (per kg) and on soft drinks (per litre) since 2011. The tax has not been evaluated, but there was a decrease in the consumption of sweets and soft drinks between 2011 and 2014 (191). But the tax on sweets and ice cream ended at the beginning of 2017, after the European Commission decided the tax unfairly disadvantages producers in the countries that had implemented the taxes (199).

Hungary implemented a product tax intending to promote healthier consumption and encourage food product improvement in 2011. The revenues are to be used to fund the health care system. The taxes are applied to sugar-sweetened beverages, energy-drinks containing methylxanthines or taurine, confectionary, salted snacks and condiments, alcoholic beverages with a high sugar content, fruit jams, and ice creams. An evaluation showed that the consumption of the targeted products was reduced by 20 percentage points to 35% and that the composition of foods has changed (191).

In France, the tax on sugar-sweetened and artificially sweetened beverages has been effective since 2012. They impose a tax of € 7.16 per 1,000 litres on French manufacturers, importers and food outlets that serve their own prepared drinks. The impact of the tax has not yet been evaluated. However, the sales of sugar-sweetened beverages decreased by 3.3% between January and May 2012 (191).

Tax on sugar-sweetened beverages in Mexico
In January 2014, Mexico implemented an excise tax of 1 peso/L on sugar-sweetened beverages. A recent evaluation of the tax revealed that, during the first year of the tax, the average volume of taxed beverages purchased was 6% lower each month than was expected without the tax. Households with the lowest socio-economic status showed the greatest reduction in purchases (200). Future studies should demonstrate its impact in the long term, as well as its impact on health (201).

5.4 Restrict advertising

One of the most cited policies to change information environments is the restriction of unhealthy food marketing, particularly to children. It involves not just advertising, but also other forms of commercial promotion of unhealthy diets.

Regulating food marketing to children

People are exposed to the marketing of foods in different media (e.g. television or the Internet) and settings (e.g. schools or supermarkets) (202). Marketing covers 'any form of commercial communication or message that is designed to or has the effect of increasing the recognition, appeal and/or consumption of particular foods and services' (203). Studies have shown that the marketing of foods is often directed at foods high in fat, sugar and salt (203-205). Furthermore, food promotion directly influences food purchases (206). The evidence that food promotion increases snacking behaviour, energy intake or less healthy food choices and thus ultimately adversely affects weight gain is less conclusive (206). Despite the limited evidence of a direct effect of marketing on health status, food marketing is considered to be one of the factors that has contributed to the increase in obesity over the past decades (203, 207). Children especially are vulnerable to marketing strategies for foods. Children under 12 years old may be incapable of understanding the commercial intent of marketing and are susceptible to its commercial influence (208, 209).
In 2004, addressing food marketing aimed at children was highlighted as one of the actions in the Global Strategy on Diet, Physical Activity and Health of the World Health Organization (210). Since that time, the marketing of foods to children has been placed on the policy agenda.

Policy on food marketing to children in the Netherlands

As part of the Covenant on a healthy weight, the Federation of the Dutch Food Industry (FNLI) initiated an Advertising Code for Food Products in 2005 (In Dutch: 'Reclamecode voor Voedingsmiddelen') for the marketing of foods and beverages to children based on self-regulation (211). This Code aimed to prohibit active advertising with popular cartoon characters and campaigns to collect toys by foods. A general explanation of the Dutch Advertising Code Authority and the Dutch Advertising Code for Food Products is given in Textbox 5.1.

Textbox 5.1. Dutch Advertising Code for Food Products (212).

The *Dutch Advertising Code Authority* (in Dutch: 'Stichting Reclame Code (SRC)') is the body that deals with the self-regulating system of advertising. Self-regulation means that the advertising industry (advertisers, advertising agencies and the media) formulates the rules with which advertising must comply. The SRC encourages sensible and responsible advertising.
The *Dutch Advertising Code for Food Products* contains a body of rules with which all advertising should comply. It is divided into a General Section and a Special Section. The General Section stipulates, among other things, that advertisements may not be misleading or untrue. The Special Codes apply to advertising for specific products and services. The Code for advertising directed at children and young people is defined in a Special Code.

In 2006, the Netherlands Food and Consumer Product Safety Authority (NVWA) published a report about the marketing of unhealthy food and beverages to children in the year 2005. The NVWA monitored the market supply of food products for which manufacturers apply marketing strategies specifically aimed at children (213). They concluded that the marketing of foods and beverages was dominated by foods that are not part of a healthy diet, i.e. ones that have high levels of saturated fatty acids, trans fatty acids, salt, added sugar and low levels of fibre. In addition, the Internet was increasingly used as a medium for food marketing to children, but lacked good regulation. Finally, marketing strategies could be misleading (213).

In 2009, the policy document 'Overweight' (In Dutch: *Overgewicht*) was published (214). In this document, the Dutch government aimed to protect children under 12 from the marketing of foods that are not part of a healthy diet. The government considered a restriction in marketing could be achieved through self-regulation and urged the food industry to apply stricter regulations on the Dutch Advertising Code for Food Products. In 2010, the Dutch Advertising Code for Food Products was updated with stricter regulations (215). A restriction was introduced on the marketing of all foods and beverages to children under 7 for media that is targeted at children in this age group or where more than 25% of the target group was younger than 7 years. Furthermore, the FNLI called upon its members to be restrictive with marketing aimed at children aged 7-12 years. Exceptions were made for marketing on packages of food and beverages and point-of-sale marketing (215).

In February 2015, the Dutch Advertising Code for Food Products was again revised with stricter regulations. Marketing of food and beverages to children 7-12 years old is not allowed, unless the product meets specific nutritional criteria or the advertisement has been made in collaboration with a recognized authority (216). The criteria contain limits to calories, saturated fat, salt and sugar levels. Again, advertisement on packages and point-of-sale marketing are excluded from the restriction. In December 2016, the FNLI announced to make further restrictions in foods marketed to children. They will explore the possibilities of restricting the use of licensed media characters for children up and until 12 years on packages and point-of sale marketing. At the moment of writing, it is not clear when this new regulation will be implemented.

International regulation

In Europe, the Audio-visual Media Services Directive for the marketing of food and beverages to children has been active since 2010 (217). This Directive addresses the advertising of unhealthy food and beverages in children's programmes (Textbox 5.2). A new legislative proposal amending the directive has been adopted by the European Commission on 25 May 2016. The directive is currently open for review. A directive is a legislative act that sets out a goal that all EU countries must achieve. But it is up to the individual countries to decide how to do this. With respect to food marketing, the majority of the EU countries rely on general advertising regulations and on self-regulatory mechanisms (203).

Textbox 5.2. Audio-visual Media Services Directive Article 9 (217).
Member States and the Commission shall encourage media service providers to develop codes of conduct regarding inappropriate audio-visual commercial communications, accompanying or included in children's programmes, for foods and beverages containing nutrients and substances with a nutritional or physiological effect, particularly those such as fat, trans fatty acids, salt/sodium and sugars, excessive intake of which in the overall diet are not recommended.

The World Health Organization (WHO) is a strong advocate of limiting food marketing to children. In the Action Plan for the Global Strategy for the Prevention and Control of Non-Communicable Diseases from 2008-2013 and the one from 2013-2020, food marketing to children is addressed
(3, 218). The WHO developed recommendations to protect children against the marketing of unhealthy food and beverages. In the European Nutrition Action Plan 2015-2020 (152), strong measures that reduce the overall impact on children of all forms of marketing of unhealthy foods are recommended. They state that experience suggests that self-regulatory approaches have limitations and therefore recommend government leadership to establish the criteria for policy and independent monitoring to achieve optimal implementation. The WHO provided a Nutrient Profile Model in 2015 to categorize foods and beverages as fitting or not fitting within a healthy diet in order to help Member States develop policies to restrict food marketing to children (219).

At the European level, the EU Pledge to limit food and beverage advertising to children under 12 on TV, in print and on the Internet was launched in 2007 as a part of the European Union Platform for Action on Diet, Physical Activity and Health. This is an initiative launched by the leading food and beverage companies covering around 80% of the advertising spent in the EU. They committed to a) *no advertising products to children under 12 years, except for products which fulfil nutritional criteria* and b) *no communication related to products in primary schools* (220). The EU Pledge monitors marketing to children via annual monitoring reports. In the 2014 report, compliance with the commitments was monitored for television advertising and company-owned websites. Results showed an overall compliance rate of 98.5% for television and 97% for company websites.

Like the Netherlands, many European countries rely on general advertising regulations and self-regulatory mechanisms for the marketing of food and beverages to children (203). However, Sweden and Norway have stricter rules regarding marketing. These countries banned any advertising targeted at children under 12. In Sweden, the ban only covers broadcasts originating in Sweden. Therefore, the effectiveness of the measure might be undermined by advertising on cable and satellite television broadcasts originating in other countries (203).

Effects of regulation
The effects of the regulation are monitored by independent organizations, e.g. in the Netherlands by the Dutch Consumers Organization, by the implementers such as the Dutch Advertising Code Authority and by the EU Pledge. In 2011, the Ministry of Health, Welfare

and Sport commissioned the Dutch Consumers Organization to determine the extent to which the 2010 Dutch Advertising Code for Food Products protects children under 12 against food marketing that does not fulfil the criteria for a healthy nutrition (204). The Dutch Consumer Organization investigated 1) the exposure of children to food marketing and 2) the types of food advertisement to which children are exposed. The main conclusions drawn were that children under 12 are frequently exposed to food product marketing, especially on television, food packages and the websites of manufacturers. Ninety-four per cent of the advertised foods and beverages directed to children on television did not fulfil the criteria of healthy foods (i.e. low levels of saturated and trans fatty acids, salt, added sugar and high levels of fibre) of The Netherlands Nutrition Centre (2009). Hardly any advertised product online met the criteria for a healthy diet. Furthermore, 96% of the food products containing attractive marketing to children on the front of the package did not fit within a healthy diet.

The Dutch Advertising Code Authority monitors compliance of manufacturers with the Dutch Advertising Code for Food Products commissioned by the FNLI each year. In 2013, general compliance with the Dutch Advertising Code for Food Products was 96% (221). The EU Pledge monitored an increase of 37% in advertisement exposure to children in the Netherlands between 2005 and 2011, while the majority of other European countries showed decreases (222). In later evaluation reports, the Netherlands was not included (220).

At national and international levels, there is considerable debate about the implementation of the regulation for food marketing to children. The divergent conclusions drawn from the evaluation of the Dutch Advertising Code for Food Products by the FNLI and the Dutch Consumer Organization reflect the differences in opinions. The Dutch Consumer Organization advocates stricter nutrient profiles for the foods that should be exempted from food marketing strategies. In addition, exemptions for advertising on packages and point-of-sale marketing are a main concern for the Dutch Consumer Organization. At the international level, the WHO applies stricter nutrient profiles for food marketing than the EU Pledge. In addition, the WHO criteria restrict marketing for more product types and permit lower contents of unhealthy nutrients in foods and beverages than the EU Pledge criteria (223), leading to different conclusions about the effectiveness of food marketing restrictions to children. Furthermore, social media and internet generate new challenge with respect to the regulation and monitoring of marketing of foods to children.

Health impact of marketing restrictions to children

The effect of regulating marketing to children on purchases and consumption has not been investigated in the Netherlands. In other countries, limited information is available on the purchase and intake level. One of the few examples is a household expenditure survey of the Canadian province of Quebec, which has had an advertising ban since 1980. The study indicates that households with children were significantly less likely to purchase (-13% per week) and consume (-US$88 million per year) fast food if they lived in Quebec than if they lived in another Canadian province. The effect was bigger for French-speaking children than for English-speaking children, possibly due to

their access to media from the U.S. and other Canadian provinces (224). This study indicates that banning advertisements has beneficial effects on purchase. But the effects on body weight remain unknown. Information on the direct effect of food marketing regulation on obesity is not available, since obesity is influenced by numerous factors. Two modelling studies simulated the potential health gain when television advertisement would be totally banned. In 2009, the model of Veerman and colleagues predicted that, if exposure were reduced to zero, from one in seven up to one in three obese children might not have been obese in the USA (225). In 2010, Goris and colleagues also estimated the potential health gain of a ban on advertisements, but included more countries, including the Netherlands. The predicted effects suggested that 4%-18% (dependent on the scenario used) of Dutch obese children would not be obese when television advertisement would be totally banned (226). Therefore, although the evidence of a direct effect of food marketing to children on obesity is inconclusive, indirect evidence suggests that young children should be protected from food marketing to food products.

5.5 Improve the quality of the food supply

Improving the quality of the food supply is one of the ways to improve dietary intake. This section describes various approaches that can potentially contribute to achieving this aim. They include food product improvement (5.5.1), foods with added nutrients (5.5.2), food supplements (5.5.3) and novel foods (5.5.4).

5.5.1 Food product improvement

Food product improvement is defined as reformulating existing foods - or developing new products - to remove (e.g. trans fatty acids) or reduce (e.g. sugars, saturated fatty acids or salt) unhealthy food components while maintaining characteristics such as flavour, texture and shelf-life (227). Food product improvement is considered to be an important strategy to improve the nutrient intake that does not require the consumer to modify drastically his or her habitual dietary pattern.

Initiatives of food product improvement primarily focus on commonly eaten processed foods that contribute to high intakes of trans and saturated fatty acids, salt and added sugar. Fresh foods, such as fresh fruit and vegetables or fish, do not really qualify for food product improvement activities. Food product improvement also comes with certain limitations and challenges. The nutrients of fat, salt or added sugar all have technological properties that contribute to the structural characteristics of the products (227). Furthermore, consumer acceptance, (microbiological) safety aspects and food legislation are important factors that determine the level of reduction that can be achieved.

Food product improvement initiatives in the Netherlands

In the early 1990s, trans fatty acids were removed from margarines after cumulative evidence showed their adverse effects. Between 2003 and 2010, the Dutch Task Force for the Improvement of the Fatty Acid Composition (TFIFAC) (in Dutch: Task Force Verantwoorde vetzuursamenstelling) was a self-regulatory initiative (228). They aimed to encourage the food industry to reformulate foods to lower trans and

saturated fatty acid levels. Partners in this effort were Dutch suppliers and purchasers of vegetable oils and fats, collaborating specifically on trans and saturated fatty acids in industrial fats. Supplying sectors included in the task force were producers of potato products, bread, pastry, cakes and biscuits, snacks, margarines and vegetable fats and oils.

Sodium reduction in processed foods was initiated in 2006. After successful awareness campaigns run by the Dutch Consumers Association and the Heart Foundation, the Dutch Food and Grocery Industry established the Task Force Salt aiming to reduce sodium levels in processed foods on a voluntary basis by 12% in 2010 (229). Independent from the other food sectors, the bakery industry asked the government in 2008 to set mandatory maximum levels of sodium chloride in dry matter of flour. This agreement was established in the Dutch Commodities Act and in 2013 the levels were revised to lower maximum levels.

The activities of both Task Forces mentioned above were succeeded by the Agreement for the Improvement of Food Composition ("Akkoord Verbetering Productsamenstelling") in 2014 (182). All relevant sectors involved in food production and supply (the food industry, caterers, the restaurant sector and retail) and the Minister of Health, Welfare and Sport have signed the Agreement. In this Agreement, the parties agreed to gradually lower the amounts of salt, saturated fatty acids and added sugar in the form of monosaccharides and disaccharides in commonly eaten products by 2020. The reduction should be such that a person who eats according to the dietary guidelines should be able to comply with the recommended maximum intake of 6 grams of salt per day. In addition, the results of food product improvement should facilitate the consumer to reach a maximum of 10% of its energy intake from saturated fatty acids, as well as a lower energy intake (through reduction of fat and sugar). The agreement for the Improvement of Food Composition also contains agreements on increasing the offer of healthier options and smaller portion sizes in restaurants, catering and retail.

The working procedure is for representatives of the food sector to submit proposals for their planned food product improvement activities to a scientific advisory committee. This committee then evaluates the commitments based on the feasibility and ambition. The final approval of the commitments is granted by a steering committee consisting of the directors of all parties that signed the agreement.

Other initiatives that are linked with food product improvement, such as nutrition claims and the front-of-package logo 'Vinkje', are described in Chapter 5.1.

Monitoring the level of food product improvement in the Netherlands

Monitoring the level of food product improvement is essential to evaluating the progress of food product improvement. In the earlier initiatives such as the TFIFAC and the Task Force Salt, the progress was monitored by the initiators themselves. The associated parties of the TFIFAC collected their monitoring data over the period 2003 to 2009

(228). They reported reductions of trans fatty acids in several associated food groups. For example, the trans fatty acids content of raw bakery products decreased from 2.8% on a fat basis in 2003 to 1.7% in 2009. Also, the amount of saturated fatty acids was reduced. In processed oils and fats, for example, the proportion decreased from 31% to 28% on a fat basis. Another important achievement was that the share of liquid margarine and frying fats on the market increased from 22% to 44%. The achievement of the "Healthy Frying" campaign was that the volume share of liquid deep frying fats used in hotel, restaurant and catering businesses increased from 51% in 2004 to 78% in 2009. In addition to their own evaluation, the TFIFAC also asked RIVM to monitor the effect of the TFIFAC on food composition and fat intake. The results of this evaluation showed that the trans fatty acids content of the associated food groups was lower compared with the Dutch food composition data from 2001 (230). But based on the Dutch food composition database, the total concentration of fat and saturated fatty acids did not change significantly in any food group or subgroup that was part of the TFIFAC between 2001 and 2009. The impact of the TFIFAC on intake was calculated using the food consumption survey among young adults from 2003, using the food composition database from 2001 and the reformulated composition of the foods concerned. The median usual intake of TFA decreased from 1.0 to 0.8 En%. The median usual intake of saturated fatty acids did not change (12.9 En%). Yet, if the achievements of the "healthy frying" campaign were taken into account (by replacing all consumption of solid frying and cooking fats by liquid frying and cooking fats and all high SFA by low SFA margarines), the median usual intake of saturated fatty acids would have been significantly decreased to 12.1 En% (230).

The Task Force Salt reported their progress in 2010 (229). They reported an average reduction of 10%, ranging from an average of 6% in ready-to-eat meals to an average of 31% in salads. The effect of the Task Force Salt on daily salt intake was monitored in a 24-hour urine study between 2006 and 2010 in Doetinchem. This study showed that daily salt intake did not change significantly over the 4-year period (8.7 g/d to 8.5 g/d) (103).

The associated parties of the Agreement on Improvement in Product Composition of 2014 agreed to monitor the progress of the Agreement as follows:

- The food sectors control the compliance with the maximum levels by the individual food companies.
- Analyses of the levels of sodium and the fatty acids profile of foods by the Netherlands Foods and Consumer Product Safety Authority (NVWA).
- The Reformulation Monitor developed by RIVM is used to monitor the progress of the Agreement on the sodium, (saturated) fat or added sugar content of processed foods. The food industry provides data on the level of sodium, (saturated) fatty acids and/or added sugar to the 'Levensmiddelendatabase (LEDA)'. This information is combined with the monitoring data of the NVWA in order to obtain a representative database on the current food composition of processed foods in the Netherlands.
- The catering sector monitors their progress through market or trend research.

The monitoring system of the NVWA monitors the sodium and fatty acid profile in a representative selection of foods that have contributed most to sodium or fatty acid intake since 2009. The 2014 analysis showed that, on average, sodium or SFA levels did not decrease between 2009 and 2014. But comparable foods have a wide range in sodium and SFA levels. A comparison of exactly the same foods between 2011 and 2014 did show a significant reduction of sodium levels. The largest reductions were observed in canned vegetables and legumes (41.5%), ready-to-eat meals (20.1%), Gouda 48+ cheese (16.5%) and bread flour (11.9%) (231). Large differences in total fat and SFA content were found in snacks, such as potato chips, prawn crackers or savoury snacks (232). Also, large savoury snacks, such as croquettes, spring rolls and sausage rolls, had wide ranges in total fat and SFA content (233). This shows that there is still quite some potential for food product improvement activities within these food groups.

The 'Reformulation monitor' combines the information of the NVWA with information taken from the LEDA database to monitor the progress of the Agreement on the level in food groups. Food groups are selected based on similarities between the foods, but the foods are not necessarily identical. This provides information on the distribution of the recent levels of the foods concerned within food groups. The focus in the 'Reformulation monitor' is on the foods that contribute most to sodium or fatty acid intake. The information from this database is compared with the reference database, which is NEVO 2011. Early in 2015, RIVM reported the results on the changes in food composition from 2011 to July 2014 (234). In a few product groups, significant changes in sodium levels were observed. In bread, the sodium content was 21% lower in 2014 than it was in 2011. Salt added to vegetables and pulses in glass jars and tins also significantly decreased between 2011 and 2014. They had a 28% and 54% lower sodium level, respectively. The sodium level of cheese was reduced by approximately 11 per cent, but this difference was not statistically significant. In other food groups, such as crisps, the sodium content did not change. Saturated fatty acids and added sugar content was not reduced in all food groups. Whether with the current efforts the goals of the agreement will be met or not is thus questionable. Further monitoring of the sodium, saturated fatty acids, added sugar and energy content of foods will be needed.

In addition, there is a need to know the effects on total intake that the food product improvement activities have in order to assess whether these actions have resulted in lower intake levels among the Dutch population. The most recent monitoring study on salt intake was conducted in November 2015 and showed no difference in 24-hour sodium excretion, as compared with 2010 or 2006 (110).

Health impact of food product improvement

Food product improvement is expected to contribute to healthier nutrient intakes, which will contribute to the prevention of non-communicable diseases in the end. The health impact of salt reduction to their feasible technological minimal levels was simulated in a modelling study for the Dutch situation (136). In this study, a reduction of 2.3 g salt/d (obtained by sodium reduction in processed foods) may reduce the systolic blood pressure by 1.6 mmHg. This will subsequently result in 29,200 averted

cases of acute myocardial infarction (4%), 16,600 averted cases of congestive heart failure (1.8%) and 53,400 averted cases of stroke (6.0%) over a period of 20 years (see also Chapter 4.3).
For the health impact of changes in other dietary factors, see Chapter 4.2.

Possible adverse consequences of food product improvement
Food product improvement may have some adverse consequences. Salt is an important carrier of iodine in the Netherlands in order to prevent iodine deficiency disorders. Salt reduction may therefore reduce iodine intake. A Dutch simulation study showed that significant salt reduction of 50% is not likely to lead to inadequate iodine intakes in adults (235). However, salt reduction may result in iodine inadequacy in young children. In 2006, 2010 and 2015, the iodine status was monitored using 24-hour urine samples in Doetinchem (103, 110). A decline in iodine intake was observed between 2006 and 2010, but it stabilized thereafter. Continued monitoring of iodine intake is therefore essential to see whether iodine levels in salt need to be increased (see also Chapter 5.5.2 on foods with added nutrients).

Another adverse consequence of food product improvement may be the reduction of shelf-life. For example, in foods such as cheese or processed meats, salt functions as a preservative because it reduces the water activity and thereby prevents micro bacterial growth (236). The food safety aspects of food product improvement should therefore be considered before it can be implemented.

Food product improvement from an international perspective.
Food product improvement is considered an important strategy to improve nutrient intake worldwide. A salt reduction of 30% by 2025 is one of the targets that was set by the World Health Assembly of the WHO in May 2013. Several national and regional governmental groups, such as the UK Scientific Advisory Group on Nutrition, the US Institute of Medicine and the WHO have called on the food industry to reduce the salt level in processed foods (237-239). The EU established a framework to facilitate salt reduction initiatives in EU countries (240). In 2013, 83 countries had salt reduction strategies in place or planned (241). In Europe, most countries have set voluntary targets for several food products in cooperation with the food industry (240). In a few countries, such as South Africa and Argentina, mandatory targets have been set, but these targets mostly relate to a single food group (241, 242).

Food product improvement is part of the WHO Food and Nutrition Action Plan 2014, promoting the need for product reformulation and improvements to the nutritional quality of the food supply (152). Salt reduction in processed foods is mentioned as one of the main targets. Food product improvement activities focused on the other nutrients, such as SFA or added sugar, are briefly mentioned as well. Since 2014, attention has been shifting to the reduction of added sugar. The guideline of the WHO to limit the amount of free sugars to below 10% of energy intake may work as a facilitator. A network of scientists, united in the so-called Action on Sugar, was established in 2014 with the aim of setting targets to gradually reduce the sugar content in processed foods in order to reduce the level of overweight, obesity and diabetes. This network is built upon a similar framework as the World Action on Salt

and Health (WASH), which was successful in putting salt reduction on the political agenda and creating awareness about its importance.

A successful example of food product improvement is the salt reduction initiative in the UK. This initiative served as a role model for salt reduction initiatives worldwide. It consisted of three pillars: 1) voluntary sodium reduction targets for food categories and collaboration with the food industry; 2) improving and encouraging the use of nutrition labels and 3) undertaking consumer awareness campaigns and raising awareness. The UK Food Standards Agency (FSA) first published sodium reduction targets in 2006. The targets were established after consultation with all stakeholders. These targets covered 85 food groups and were initially aimed at 2010. They were revised in 2009 based on the success of the reductions. In 2012, the FSA evaluated the progress of the programme up to 2010. They showed that awareness among consumers had increased. Furthermore, the sodium content in foods had decreased; in certain foods by 20-40% (243). The average salt intake decreased from 9.6 g/d in 2000-2001 to 8.1 g/d in 2011 (244). Over the same period, a drop in blood pressure and mortality from stroke and ischemic heart disease in the population was observed (245). In 2010, the programme was transferred to the Public Health Responsibility Deals. In 2014, new targets were established to be achieved by 2017. Monitoring of the progress will now be done by the food industry. This has led to criticism from NGOs, who claim that this change will slow down the progress of the salt reduction initiative in the UK (246). Furthermore, NGOs stress the importance of an independent monitoring agency to evaluate the progress. New monitoring results will demonstrate how this programme will progress.

5.5.2 *Foods with added nutrients*

Manufacturers may add nutrients to foods for different reasons, such as to improve the nutritional value, to compensate for losses during processing, to achieve beneficial health effects and for commercial purposes. In this section, we use the term fortification as a synonym for the addition of micronutrients to foods irrespective the reason for doing so. This section mainly focuses on the addition of micronutrients to foods, because fortification with other nutrients is less common and information about it is scarce.

Micronutrients are added to some food categories whose intention is to replace (part of) a full diet, such as infant formula, follow-up formula, special diet foods (on prescription), and foods for energy-restricted diets. These additions are strictly regulated in order to prevent inadequate or excessive intake in subjects (totally) relying on such foods (e.g. (247, 248)). In this section, this type of fortification is not described, because the intention for adding these micronutrients is somewhat different from the reasons described above.

Legislation

Fortification can either be mandatory or voluntary. Some authorities legally oblige producers to fortify particular foods or food categories with specific micronutrients, often driven by a significant public health need. Such a mandatory practice delivers a high level of certainty for a constant supply of appropriately fortified foods. The chosen fortification

practice should be effective and efficacious for the target group. On the other hand, it should be safe for both target and non-target groups in the population, as both will be affected. Generally, basic commodities are selected for mandatory fortification, such as flour, salt and sugar. Yet generally consumed processed foods such as bread or margarine may also be suitable. Worldwide mandatory fortification with iodine, iron, vitamin A and, more recently, folic acid is largely applied. The most widely adopted measure is probably the iodization of salt (249). In the Netherlands, mandatory fortification has been legally unfeasible since an organic baker successfully contested the mandatory use of iodized salt in bread (250).

With a voluntary fortification practice, the food manufacturer freely chooses to fortify particular foods; this is also called market-driven fortification. This is sometimes encouraged by authorities. As an alternative to mandatory fortification, this is practised in the Netherlands. The formerly mandatory use of iodized bread salt and the mandatory addition of vitamins A and D to margarines ('Margarinebesluit') have been replaced by covenants concluded between the Dutch authorities and food manufacturers (163, 250-255).

Since 2006, there has been EU legislation on the voluntary addition of nutrients to foods (Regulation (EC) no 1925/2006) (256). These regulations aim to harmonize the policies of the different member states. Yet, in 2016, the proposed minimum and maximum fortification levels (article 6) were still not established. Consequently, a diversity of national legislation is still in force in the EU (257, 258). In addition, the harmonization of mandatory fortification practices pertinent at national or regional level in specific Member States is currently not justified across the Community (256).

In the Netherlands, the addition of micronutrients to foods is regulated in the 1996 'Warenwetbesluit toevoeging microvoedingsstoffen aan levensmiddelen' (255). This legislation allows the addition of micronutrients (other than substitution or restoration) with total amounts per reasonable daily consumption of at least 15% and at maximum 100% of the RDA provided in the legislation. There is specific legislation for iodine. The addition of vitamin A (retinoids), vitamin D, folic acid, selenium, copper and zinc is still prohibited in the Commodity Act. Originally, this prohibition was based on the lack of nutritional need and the small range between the requirements and the tolerable upper intake levels (163, 255). In 2004, the European Court decided that prohibiting the addition of micronutrients was only allowed if based on safety issues (259). Since 2007, therefore, a legal exemption has come into force for the addition of folic acid and vitamin D to foods up to a maximum level of 100 µg/100 kcal and 4.5 µg/100 kcal, respectively (260). Such maximum levels (Figure 5.6) are generally based on assumptions regarding the proposed intake and calculations that take into account the intake from 'regular' diet and supplements, the proportion of foods that can be fortified and the tolerable upper intake level of a specific micronutrient (261) (examples from other countries: (262-265)).

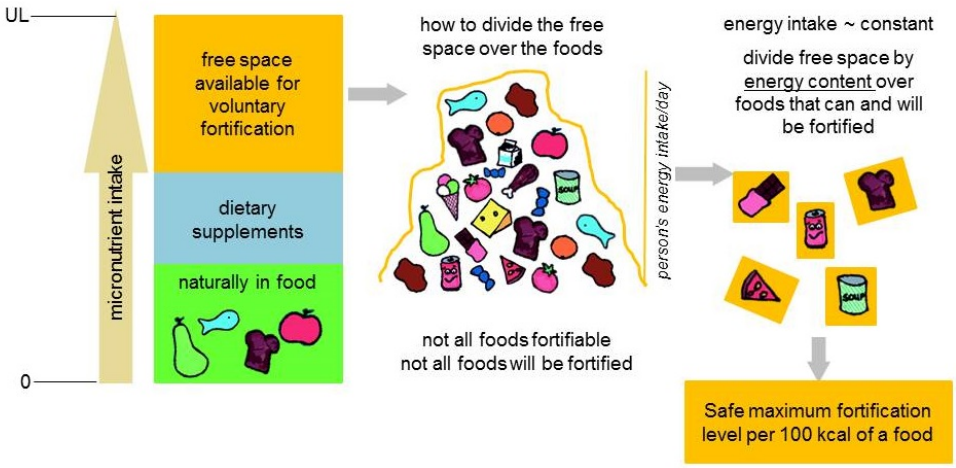

Figure 5.7. General overview of paradigm setting safe maximum fortification levels for voluntary fortification; based on (266, 267).

Contribution of added micronutrients to total intake

The market for foods with voluntarily added nutrients is generally lively. Changes in, for instance, legislation, accepted health claims, commercial results and consumers' acceptance have an effect on this market. There is no up-to-date database with information on fortified foods available on the Dutch market, including the nutritional value of the added nutrients. Altogether, this makes it difficult to monitor fortification practices, study trends and to compare results from different studies.

In the NEVO, the number of fortified foods increased from 82 products in 6 food groups in 2001 to 184 foods in 11 food groups in 2011 ((268, 269) and unpublished data). In the food consumption survey, a similar increase in the number of fortified foods reported was also observed. The number of reported foods increased from 15 in 1997-1998 to 174 in 2007-2010 (269, 270). In both cases, these foods do not represent brand-specific foods, but rather foods coded in the NEVO. One code may represent several brand-specific foods. In general, the contribution of fortified foods to the total intake of foods among young adults (19-30 yr.) in the Netherlands increased between 2003 and 2007-2010 (Figure 5.7). Food categories with a large contribution of fortified foods were fats, yoghurt, breakfast cereals, fruit and vegetable juice, and syrups. In 2007-2010, too, the categories of yeast and soy products made a large contribution of fortified foods to the total intake.

Due to the covenant agreeing to add vitamins A and D to fats (see above), virtually all these fats are fortified with these vitamins. Consequently, the contribution of fortified foods in the category of fats and especially in the subgroup margarines has been high over recent years ((268, 269) and unpublished data).

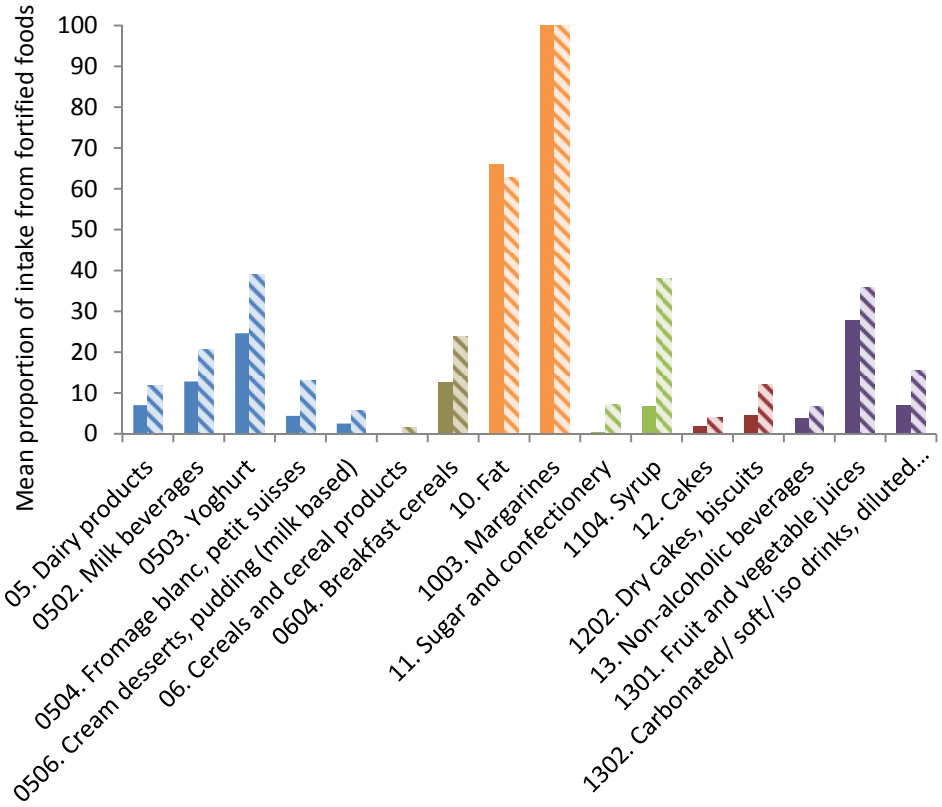

Figure 5.8. Contribution of fortified foods to the intake of different food (sub)groups (EPIC-soft classification) among 19-30-year-olds in the Netherlands in 2003 (solid fill) and 2007-2010 (dashed fill).

For most vitamins, the contribution of fortified foods to the specific vitamin intake is highest for younger children, compared with older children and adults (Figure 5.8). In the Netherlands, the proportional contribution of fortified foods to the mineral intake is generally less than it is to the vitamin intake. An exception is iodine (see below). On average, 38% of the vitamin D intake and 27% of the retinol intake originated from fortified foods in DNFCS 2007-2010. For retinol, this can be fully and, for vitamin D, largely traced back to the fortification of fats regulated in the covenant.

In DNFCS 2007-2010, on average 82% of the folate-equivalent intake originated from margarine fortified with folic acid. This proportion was lower for children than for adults. Other important sources for children were breakfast cereals and non-alcoholic beverages (unpublished data) (268, 269). As stated before, there are many aspects that may influence the market for voluntarily fortified foods. In 2015, the fortification of margarine with folic acid was discontinued by several brands. As a consequence, the results for folic acid may not represent the current situation. This discontinuation of folic acid fortification may be linked to the non-authorization of most health claims related to folic acid by the EC based on EFSA opinions (271).

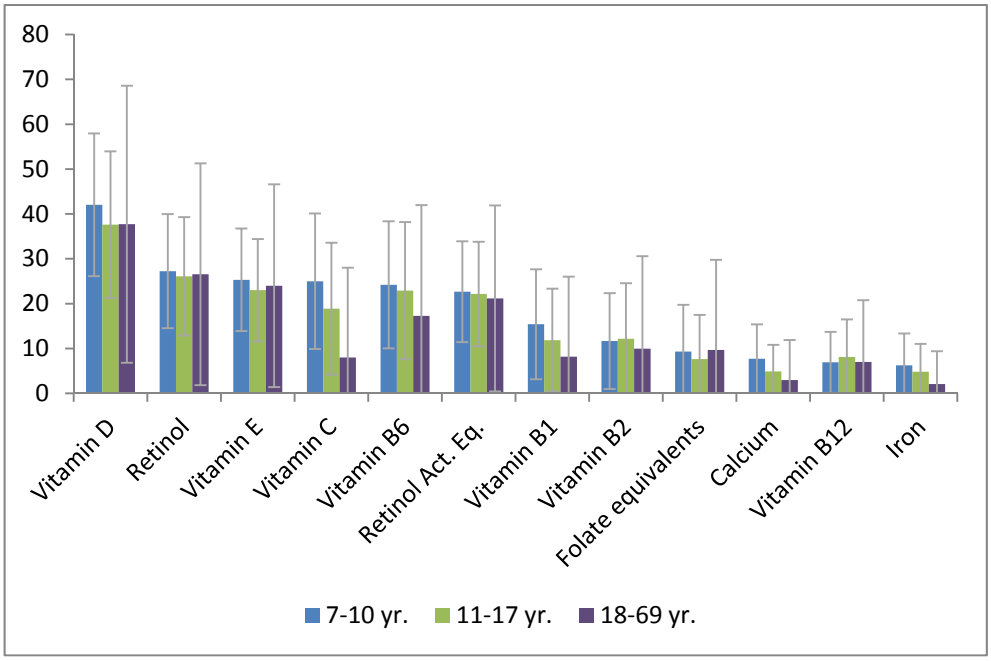

Figure 5.9. Contribution (%) of fortified foods to intake of specific vitamins and minerals – DNFCS 2007-2010. (96)

Without salt iodization, the iodine intake would be inadequate in a large part of the Dutch population (272, 273). In DNFCS 2007-2010, both iodine naturally present in foods and bread with iodized salt made a mean contribution to the total iodine intake of approximately 40% in the Dutch population (7-69 years). Iodized kitchen salt used in meal preparation had an average contribution of 13%. This shows the importance of iodized salt to the total iodine intake in the Dutch population. As indicated above, the use of iodized salt in bakery products is encouraged by a covenant concluded between the Dutch Ministry of Health and the bakery sector (252). But both iodized and non-iodized salt are used in the sectors of organic bread, bake-off bread, and bread-replacing foods. Preliminary results indicate that the use of iodized salt for organic bread production is somehow related to the market. Organic bread sold in supermarkets often contains iodized salt, whereas organic bread sold in organic food shops, food markets, catering or small bakeries seems to be produced without iodized salt (unpublished data). It is currently unknown whether subjects consuming bread or bread-replacement products without iodized salt have a food consumption pattern that compensates for this by the consumption of other iodine-rich foods. The ongoing reduction of salt intake and the consumers' focus on 'natural' food challenges the maintenance of adequate iodine intake. It is therefore important to monitor the iodine intake and the effect that fortification practices have regularly and, if necessary, to adapt the policy.

It is important to monitor food fortification practices and the consumption of fortified foods in order to evaluate the efficacy and safety of adding nutrients to foods. In the regular reports of the DNFCS, only the average contribution of fortified foods to the intake of specific nutrients is presented. The effect on the whole intake distribution and on the proportion of the population with inadequate or excessive intake is not regularly presented for fortification. It is therefore not possible to

conclude to what extent micronutrient intake from fortified foods contributes to the proportion meeting the dietary recommendations or exceeding the upper limits.

For European countries, the effect of micronutrient fortification on micronutrient adequacy seems modest and for none of the micronutrients included in the study was the tolerable upper intake level exceeded by the total intake from basic and fortified foods (258, 274). This may partly be due to the legislation. In the US there is continuous expansion of (uncontrolled) voluntarily fortified foods (275) and these foods contribute largely to the intake of micronutrients, especially among children (276, 277). Yet recently the potential risk of excessive micronutrient intake due to uncontrolled voluntary fortification was shown (277, 278). The proportion of children (1-3 yrs.) exceeding the tolerable upper intake level for a specific micronutrient increased, with an increased probability of consuming voluntarily fortified foods. This increase depended on the micronutrient; it was relatively high for retinol (15.7 % in the lowest quintile versus 30.2% in the highest quintile of probability) and selenium (lowest quintile 4.5%, highest quintile 9.3%). For other age groups, the usual intake was also positively correlated with the probability to consume voluntarily fortified foods (278).

5.5.3 *Food supplements*

Since 2002, there has been harmonized European legislation on food supplements; Directive 2002/46/EG (279). This EU legislation states which nutrients or other substances with a nutritional or physiological effect may be added to food supplements and in which form. In addition, it is being proposed that maximum levels per daily dosage should be set, taking into account the tolerable upper intake level and the intake of the substance from other sources. Currently, these maximum levels per daily dosage are still not set at the EU level. Therefore, Member States may have their own specific legislation.

In the Netherlands, the 'Warenwetbesluit voedingssupplementen' (280) contains general legislation regarding food supplements and refers to Directive 2002/46/EG. It also states that there is a specific national regulation for the addition of vitamin D and retinol to food supplements. There is specific legislation for herbal supplements at European level, as well as at national level in the Netherlands (Warenwetbesluit kruidenpreparaten (281))

Supplementation advice

In the advisory report *Towards an adequate intake of vitamins and minerals*, the Health Council of the Netherlands presented advice on what is needed for the general, healthy population in the Netherlands. This report does not cover the micronutrient intake of people with medical problems (163). The committee concluded that a good and varied diet is, in principle, sufficient to provide enough micronutrients to the general, healthy population and to exclude the risk of excessively high intake. Only certain groups at risk require an additional supply of some micronutrients to supplement a varied diet. These include, in particular, folic acid, vitamin D, vitamin K and vitamin B12 (see Table 5.3). For vitamin D, the supplementation advice was updated in 2012 (122).

Table 5.3. Overview of supplementation advice in the Netherlands (122, 163).

Nutrient		Life stage	Amount	
Folic acid	Women of childbearing age	Starting at least 4 wks before to 8 wks after conceptio n	400 µg/d	
Vitamin K	neonates	Directly after birth	1 mg (once)	
	neonates	Starting at day 8 to 12 wks after birth	150 µg/d	Unless ≥ 500 ml infant formula consumed per day[a]
Vitamin D	Young children	Until 4 yrs of age	10 µg/d	
	Women ≥50 years		10 µg/d	To be sure
	People ≥70 years		20 µg/d	
	Pregnant women		10 µg/d	To be sure
	People with dark skin colour		10 µg/d	
	People with in-adequate exposure to sunlight		10 µg/d	
Vitamin B12	Vegans		2.8 µg/d	through consumption of fortified products or a vitamin B12 dietary supplement.

[a] The Royal Dutch Organization of Midwives (KNOV) advises partly breastfed neonates 50 µg/d, until 12 weeks of age or ≥500 ml infant formula/d (282)

Folic acid

Taking additional folic acid around the time of conception lowers the risk of having a child with a neural tube defect (see Chapter 2.1). In 1993, the Dutch Health Council (Voedingsraad) advised women hoping to become pregnant to start folic acid supplementation (400 µg/d) in the periconceptional period, i.e. at least 4 weeks prior to conception to 8 weeks after conception (283). In 1995, a mass campaign was launched to increase awareness among women about the use of folic acid. Studies showed that the use of folic acid has increased since 1995 and the incidence of neural tube diseases has decreased (284, 285). In 2006, the Dutch Minister of Health, Welfare and Sport formulated the goal that, by 2010, 70% of women would sufficiently use folic acid in the

periconceptional period (286). But the adequate use of folic acid among pregnant women seems to have remained rather constant at around 50% since 2005 (Figure 5.9). Adequate use of folic acid in the periconceptional period is highest among well-educated women of Dutch origin (287-293), despite several initiatives to increase the use of folic acid among women with a non-Western ethnic background and with low socio-economic status (294). Nevertheless, these initiatives did increase the use of folic acid among women with a non-Western ethnic background (294). In countries with a mandatory folic acid fortification practice, the incidence of NTDs is lower than it is in countries without such a policy, such as the Netherlands (295).

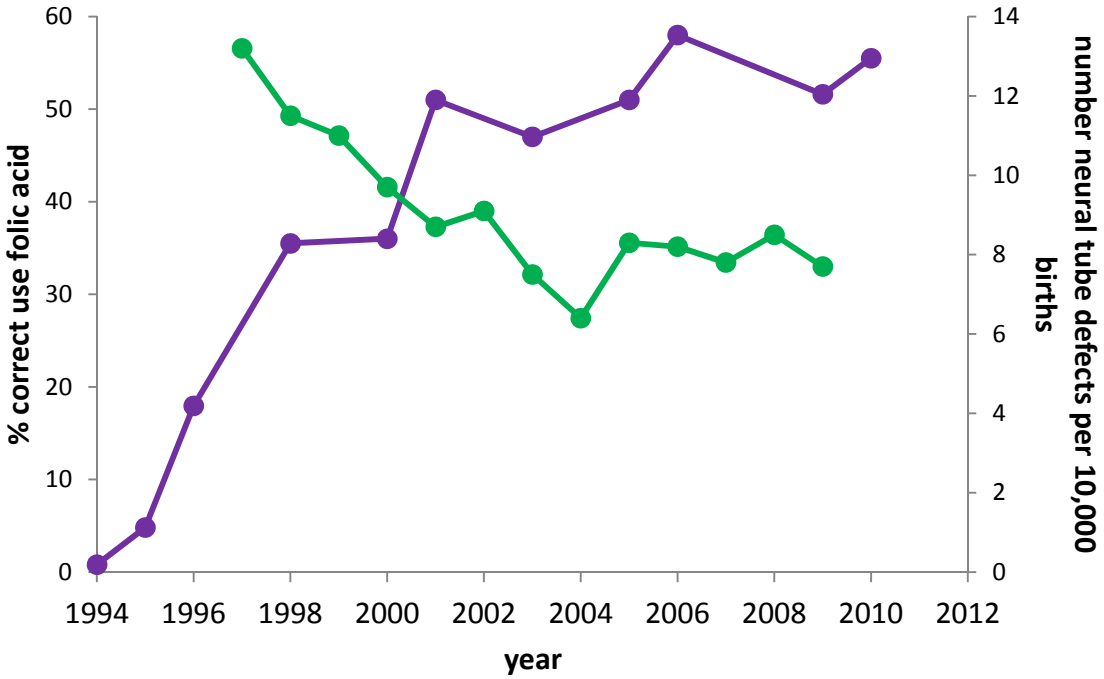

Figure 5.10. Percentage of women using folic acid adequately in the periconceptional period (purple) and the prevalence of neural tube diseases (green). (Based on: 284, 287, 296-307).

Vitamin D

Vitamin D is important for bone health and to reduce the risk of bone fractures in older adults. Fair-skinned children, adolescents and adults who are sufficiently exposed to sunlight and who consume a healthy and varied diet (including low-fat margarine, margarine and cooking fats and oils) do not require additional vitamin D. It is estimated that they obtain approximately two-thirds of their vitamin D requirement from exposure to sunlight and one-third from their diet. However, there are certain subgroups in the population who might well benefit from additional vitamin D (122, 163). See Table 5.3 for details on the vitamin D supplementation advice.

Information on the adherence to this advice is scarce. Among Dutch pregnant women, the use of a specific vitamin D supplement was around 3%, while the use of a multivitamin supplement was higher at 57% (292). The Royal Dutch Organization of Midwifes (KNOV) thinks more

research into the necessity and safety of routine vitamin D supplementation during pregnancy is needed, prior to giving general vitamin D supplementation advice for pregnant women (282, 308). This dissenting view may have resulted in low level of adherence to the advice of the Health Council. Studies conducted before 2012 showed a prevalence of vitamin D deficiency during pregnancy of 5-30% for women with a Western origin and 55-65% for women with non-European ancestry (254, 309). Among children attending day care at least 2 days a week, about 90% received vitamin D supplementation. But information on dosage and frequency was unavailable (121).

Also among the elderly, adherence to the supplementation advice is pretty low. In a study of van Ballegooijen et al. (310), almost 30% of the elderly reported that they used vitamin D supplementation, but most did not follow the advice of the Health Council exactly. Approximately 5% of the community-dwelling elderly reported that they used vitamin D supplements according to the advice of the Dutch Health Council. A healthy diet, adequate exposure to sunlight and the absence of health complaints were the reasons most mentioned for not using vitamin D supplements. Around 60% of the vitamin D supplement users did so on their doctor's advice. In the Dutch food consumption survey conducted among community-dwelling elderly, 18-26% used a vitamin D supplement all year round (assuming that all multivitamin/multimineral supplements contained vitamin D) (33). During the data collection of DNFCS-elderly, the supplementation advice was 10 micrograms/day for those with adequate sunlight exposure and light skin colour, for others this was 20 micrograms/day. But the vitamin D intake did not increase that much by using supplements. The average vitamin D intake from food only was 3.5 µg/d for women and 4.6 µg/d for men and for both sexes was 5.2 µg/d from food and supplements together. Also, at the higher percentiles of the intake distribution, the increase was only around 2 µg/d for men and around 6 µg/d for women.

Vitamin K
Since 1990, all full-term infants in the Netherlands have been receiving 1 milligram of vitamin K orally after birth in order to prevent early and classic vitamin K deficiency bleedings. To prevent late vitamin K deficiency bleedings, parents and carers are advised to give breastfed infants 25 micrograms of vitamin K daily from day 8 until they are three months old. Under this prophylaxis regime, approximately five infants develop late vitamin K deficiency bleedings every year. To improve this, the Health Council of the Netherlands advised the Dutch government to increase the vitamin K prophylaxis from 25 micrograms per day to 150 micrograms per day (311). There is no information available on the use of vitamin K in the first 3 months of life. March 2017, new recommendations on vitamin K supplementation will be published by the Health Council.

Vitamin B_{12}
Vitamin B_{12} (cobalamin) is necessary for the production of red blood cells and for the proper functioning of the nervous system. Vegans have a high risk of having a low vitamin B_{12} status due to excessively low vitamin B_{12} intake because their diet contains little or no animal products. Vegans are therefore advised to complete their vitamin B_{12}

intake up to the recommended daily allowance (for adults 2.8 µg/d) through the consumption of fortified products or a dietary vitamin B_{12} supplement (163). There is no information available on the use of vitamin B_{12} supplements or B_{12} fortified products by vegans.

Contribution of supplements to total intake

This section focuses on nutrients without supplementation advice. One out of three Dutch adult men and one out of two Dutch adult women use dietary supplements (96). In general, food supplements contribute more to the intake of vitamins than to the intake of minerals (Figure 5.10) (33, 96, 99, 312). But for most micronutrients, the contribution of food supplements is on average around 10% or less. One exception is for folic acid. Supplements contribute an average of 25-37% to the intake of folic acid. An explanation for this relatively large contribution from food supplements is that folic acid can only be consumed via fortified foods or food supplements. If natural folates are also taken into account, the contribution of supplements is also around 10%.

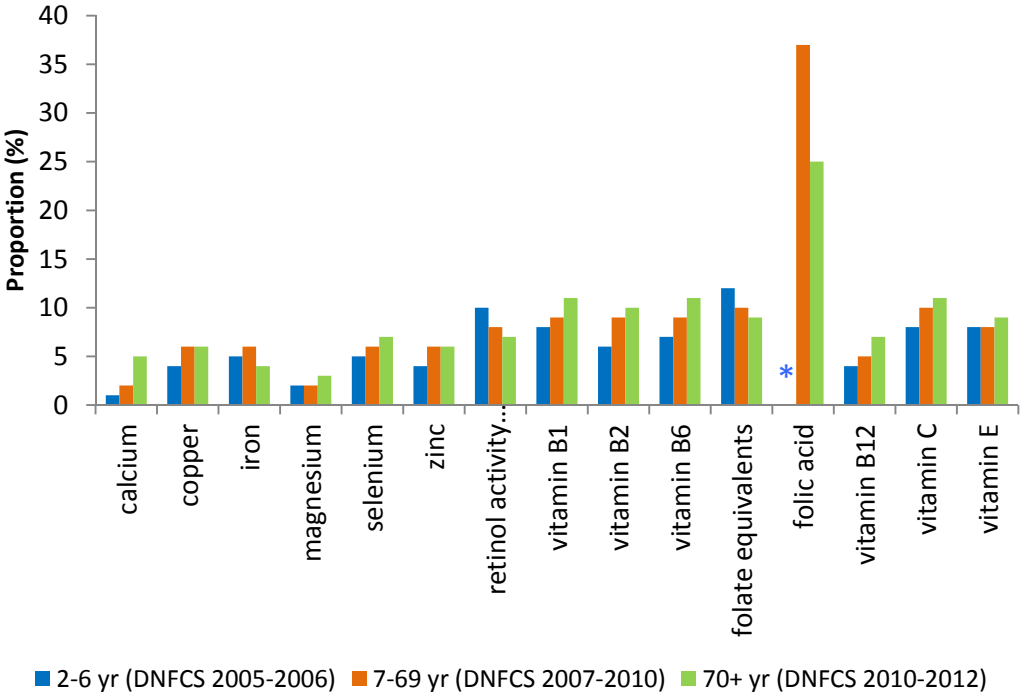

*Figure 5.11. Proportion of the total intake of several micronutrients from food supplements for three age groups (33, 96, 99, 312). * not available for DNFCS 2005-2006*

The average contribution of food supplements to the intake of micronutrients is generally small. For some micronutrients there seems to be an association with age. For calcium, selenium, vitamins B_1, B_2, B_6, B_{12} and C, the proportion taken in from food supplements increases with a person's age. On the other hand, for retinol activity equivalents and folate equivalents, the proportion decreases with age (Figure 5.10).
In general, the evaluation of the micronutrient intake in light of the dietary reference values did not show large changes if intake from food and supplements was considered instead of food sources only. For most

micronutrients, the proportion with intake below the EAR was less than 5 percentage points lower or the qualitative evaluation with the AI was equal if supplements were taken into account (Table 5.4). There were some exceptions. Adult women, especially, showed lower proportions, with intake below the EAR for vitamins A, B1, C, E, folate and selenium when supplements were taken into account.
The proportion with an intake above the UL did not increase more than 5 percentage points for most micronutrients. Exceptions were copper and zinc for children aged 2-3 years and zinc for boys 7-13 years old.

Some studies suggest that supplement users have higher vitamin intakes from foods than non-users and also report healthier diets (313, 314). Buurma et al. studied differences in the mean habitual intake from food between users and non-users of food supplements among Dutch adults in DNFCS 2007-2010 (E Buurma, article in preparation). Folate was the only micronutrient for which the mean habitual intake from food was higher for women who took food supplements than for non-users. This also resulted in a significantly lower proportion of female supplement users with folate intakes from food sources only that were below the EAR.

Table 5.4. Overview of the effect of food supplements on the evaluation of micronutrient intake with dietary reference values in comparison with intake from food sources only, based on DNFCS 2005-2006, DNFCS 2007-2010, DNFCS 2010-2012 (33, 96, 99, 312).

		vitamin A	vitamin B1	vitamin B2	vitamin B6	folate	vitamin B12	vitamin C	vitamin E	calcium	copper	iron	magnesium	phosphorus	potassium	selenium	zinc
boys	2-3 yr	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-
girls	2-3 yr	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-
boys	4-6 yr	-	-	-	-	-	-	-	-	-	-	↓ *	-	-		-	-
girls	4-6 yr	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-
boys	7-8 yr	↓	-	-	-	-	-	-	↓	-	-	↓ *[A]	-	-	-	↓	↓
girls	7-8 yr	↓	-	-	-	-	-	↓	↓	-	-	↓ *	-	-	-	↓ ↓	-
boys	9-13 yr	↓	-	-	-	↓ *[A]	-	↓	↓	-	-	-	-	-	-	↓	↓
girls	9-13 yr	↓ ↓	-	-	-	-	-	↓	↓	-	↓	↓ *[A]	-	↓	-	↓ ↓	↓ ↓
boys	14-18 yr	↓	-	-	-	-	-	↓	↓	-	-	-	-	-	-	↓	↓
girls	14-18 yr	↓ ↓	-	-	-	-	-	↓	↓	-	↓	-	-	↓	-	↓	↓ ↓
men	19-30 yr	↓	↓	↓	↓	↓	↓	↓	↓	-	-	↓ *[A]	-	-	-	↓	↓
women	19-30 yr	↓ ↓	↓ ↓	↓	↓	↓ ↓	↓	↓ ↓	↓ ↓	-	↓	-	-	-	-	↓ ↓	↓
men	31-50 yr	↓	↓	↓	↓	↓	↓	↓ ↓	↓	-	↓	-	-	-	-	↓	↓
women	31-50 yr	↓ ↓	↓ ↓	↓	↓	↓ ↓	↓	↓ ↓	↓ ↓	↓ *[A]	↓	-	-	-	-	↓ ↓	↓
men	51-69 yr	↓	-	↓	↓	↓	↓	↓ ↓	↓ ↓	↓ *[A]	-	-	-	-	-	↓	↓
women	51-69 yr	↓ ↓	↓ *	↓	↓	↓ ↓	↓	↓	↓ ↓	-	↓	-	-	-	-	↓ ↓	↓
men	70+ yr	↓	-	↓	↓	↓	-	↓	↓	-	↓	↓	-	-	-	↓ ↓	↓
women	70+ yr	↓ ↓	↓ *	↓	↓	↓	-	↓	↓	-	↓	↓	-	-	-	↓ ↓	-

- equal; ↓ less than 5%-points lower; ↓ ↓ ≥5%-points lower

* qualitative evaluation with AI from 'no statement' to 'low'

[A] qualitative evaluation with AI from 'no statement' to 'low' in part of the age group only

5.5.4 *Novel foods*

The food industry regularly introduces new foods and new food ingredients to the Dutch market. The motivations for such introductions can be varied, including an attempt to improve the quality of the diet, but this is certainly not necessary the case. The new products are often prepared from plants and animals that have been used in our food preparation for many years, sometimes even for centuries. But there is also an emerging group of new products on the market that are not a part of our habitual eating patterns, either because they are based on plants or animals not yet eaten by us or not yet in substantial amounts (e.g. insects, algae), or because they are prepared with slightly modified or even completely new technologies (e.g. in-vitro meat). For these categories of new foods and food ingredients, the European Commission (EC) has introduced the term 'novel food'. 'Novel food' means any food that was not used for human consumption to a significant degree within the European Union before 15 May 1997, irrespective of the dates of accession of Member States to the Union, and that falls into at least one of ten defined categories. Among other things, these categories concern the modified molecular structures of foods; origin of foods (mineral; microorganisms, fungi or algae; plants and their parts; animals or their parts); cell culture or tissue culture; novel production processes; and engineered nanomaterials (for more extensive clarification of the categories, see Regulation (EU) no 2015/2283) (315).

Regulation on Novel Food and Novel Food Ingredients

Since 1997, European Regulation (EC) no 258/97 on novel foods and novel food ingredients (316) has been in operation. The Regulation provides conditions to ensure that novel foods and ingredients do not present a danger to the consumer, do not mislead the consumer and do not differ from foods or food ingredients that they intend to replace to such an extent that their normal consumption would be nutritionally disadvantageous for the consumer. In September 2003, the Regulation was modified by stripping genetically modified organisms from the Regulation and by creating a new Regulation (EC) no 1829/2003 on genetically modified foods and animal feed. Certain additives to food preparations also fall outside the Regulation on Novel Foods and have their own Regulations, such as food additives, flavourings, food enzymes, and extraction solvents. In November 2015, the European Parliament and the Council approved a second modified Regulation based on a review, clarification and update of the previous Regulation. It also took into consideration scientific and technological developments (see Regulation (EU) no 2015/2283). But the general concept of the 'novel food' has not changed.

Union list of authorized novel foods

The Commission shall establish and update a Union list of novel foods authorized to be placed on the market within the Union. Only novel foods authorized and included on the Union list may be placed on the market as such, or used in or on foods in accordance with the conditions of use and the labelling requirements. By 1 January 2018, the Commission shall establish the Union list by including in it the novel foods authorized or notified under Regulation (EC) No 258/97, including any existing authorization conditions.

Not on only does the Commission authorize and include a novel food in the Union list if the food does not, on the basis of the scientific evidence available, pose a safety risk to human health, it also judges whether or not the food's intended use misleads the consumer, especially when the food is intended to replace another food and there is a significant change in the nutritional value. The Commission also assesses whether or not the food is intended to replace another food and whether or not it differs from that food in such a way that its normal consumption would be nutritionally disadvantageous for the consumer.

Application for a pre-market authorization
Currently, an application for a pre-market authorization is first assessed by a Member State food assessment body. In the Netherlands, the Medicines Evaluation Board (College Beoordeling Geneesmiddelen) supports the Ministry of Health, Welfare and Sport in the assessment of novel foods. The applicant needs to deliver a safety dossier that comprises: a specification of the novel food, the effect of the production process, the history of the organism used as the source of the novel food, anticipated intake/extent of use, previous human exposure to the novel food or its source, nutritional information, microbiological information and toxicological information. The Commission circulates the initial assessment report for comments and possible objections to all Member States. If no reasoned safety objections are presented, the novel food may be placed on the market. If reasoned safety objections are presented, the Commission requires an authorization decision. In most cases, this includes an additional assessment that is carried out by the European Food Safety Authority (EFSA). The authorization is granted to the applicant (individual authorization). In addition, another applicant may notify the Commission about the placement of a food on the market that is equivalent to the authorized food. This notification has to be substantiated by scientific evidence that shows the substantial equivalence of the notified food to the authorized food.

Sometimes companies have difficulty in assessing whether their product should be considered as a novel food or novel food ingredient. Decision trees have been developed to assist companies to determine whether this is the case or not (see www.english.cbg-meb.nl/human/novel-foods).

As soon as the new regulation (Regulation (EU) no. 2015/2283) (315) is put into effect (1 January 2018), the application procedure will be centralized. Applications/notifications will be directed to the Commission and EFSA will perform the evaluations. The new procedure is expected to be more efficient and easier for the applicants. The future role of the Member States in the procedure will probably be reduced.

Examples of authorizations and notifications
Up until the beginning of 2015, there were around 180 applications (7-10 applications/year). So far around 80 novel foods have been authorized for use in the EU. Lists of authorizations and notifications are available from the CBG-MEB website (www.english.cbg-meb.nl/human/novel-foods) and the European Commission website (www.ec.europa.eu/food/safety/novel_food/authorisations/index_en.htm). Examples of authorized novel foods include products traditionally eaten in non-EU countries, such as "noni juice" (made from a Tahitian plant), food

produced using the latest technological innovations, such as oils and dairy products enriched with phytosterols/phytostanols to reduce cholesterol, reduced-energy fat ("salatrim"), DHA-rich oil, a high-pressure fruit juice (which is an example of a food derived from new production processes), Baobab dried fruit pulp, Chia seeds, fish (Sardinops sagax) peptide product or synthetic vitamin K2. As far as we are aware, no inventory of un-authorized foods on the Dutch market has been made.

Discrepancy between approved and actual exposures to novel foods

The authorization Decision covers the conditions of use for novel foods or novel ingredients. So it describes the foods or food groups to which the applicant is allowed to add the novel food or novel ingredient and to what level. There is however no systematic monitoring of the level of introduction and the level of the consumption of novel foods as introduced on the market. Recently, we developed a simple approach to monitor the actual exposure of the population to a novel food and applied that approach to the post-launch monitoring of foods and supplements with Krill oil and oil from microalgae Schizochytrium sp. (317, 318). Through such post-launch monitoring, the possible impact of novel foods on the quality of the diet might be assessed, as well as whether the allowed daily exposures will be exceeded or not.

5.6 Setting incentives and rules to create healthy retail environments

The final action to change the food environment concerns the retail environment. Examples of potential policy actions include financial incentives for retailers to locate their business in underserved neighbourhoods (we are not familiar with examples for the Dutch situation), restrictions on point-of-sale promotion for unhealthy foods, and planning restrictions that ban or impose limits on the number of fast-food outlets in the vicinity of schools or in a given community. With respect to the last two examples, see Chapter 5.4 on policies governing marketing to children.

5.7 Harness supply chain and actions across sectors

Policies within this category aim to harness food policies and actions across sectors to ensure coherence with healthy eating. The rationale for taking policy action in the food system and supply chain has three aspects. First, agricultural and food system policies may have repercussions for policies to promote healthy eating. The EU Common Agricultural Policy (CAP) has influenced European agriculture for decades, with the objective of increasing productivity and the income of farmers. The CAP was criticized for having potential negative public health effects within the EU. By subsidizing milk and beef, foods with high saturated fat content became relatively cheap, whereas fruit and vegetables, which receive little support from CAP, are relatively expensive (319). Yet no consensus exists on the impact that CAP has had on EU food consumption (320). The most striking effect of CAP policies is likely to have been on health inequalities. Cheap fatty and sugary foods, and expensive fruit and vegetables, contribute to food poverty, i.e. "the inability to obtain food that makes up a healthy diet." (321). Recently, efforts have been made by the European Commission

to find synergies between agricultural policy and the stimulation of healthier food choices. Future CAP should be based on a sound impact assessment, including the impact on the healthiness of the diet.

Firstly, creating policy coherence (a 'health in all policies' approach) could increase the effectiveness and sustainability of the policy actions. Secondly, policies that address the food environment have inevitable repercussions upstream for the actors and activities in agriculture and food systems. The third aspect is that policy actions can be implemented in food systems with the explicit intention of changing food availability, affordability and acceptability to promote healthy diets. In general, governments have taken minimal actions in food systems. The main area of actual intervention has been leveraging 'short supply chains' for the provision of fruits and vegetables and other nutritious, often local foods to benefit farmers and consumers alike.

Some governments have taken cross-departmental and sectoral actions to promote 'health in all policies'. In our country, the WRR has prepared a policy document 'Naar een voedselbeleid' (To a food policy) (5) to which the Cabinet has responded by stating that the Cabinet identifies many of the developments and challenges mentioned by the WRR. The Cabinet agrees with WRR that modifications in the food system are necessary to guarantee, also for the future, that enough sustainable and healthy food is available. The Cabinet will approach these challenges with ambition and together with all relevant stakeholders. In February 2016, the Cabinet started this Food dialogue on the future of our food chain and our food supply.

5.8 Inform people through public awareness

There are various main domains in which actions can be taken to communicate behavioural change, ranging from population-wide actions all the way through to targeting specific individuals.

Healthy diet information to the general public

The first domain includes policies and infrastructures to inform people about food and nutrition through public awareness. Public awareness campaigns typically aim to communicate specific messages. They may be conducted around specific foods and nutrients, such as salt, sugary drinks, or fruits and vegetables, or they may be concerned with healthy eating more generally. The Dutch use different sources to obtain information on healthy eating (94). The Internet is the most consulted source of information, while 90-95% of the Dutch think that medical doctors, dieticians and education offices are reliable. Books are also considered to be a reliable source of information and books on cooking and dieting are popular (www.bestseller60.nl) (see Chapter 3.10).

The Netherlands Nutrition Centre has been the authority when it comes to informing the general public about healthy food for more than 70 years. Its website gets 9 million visits a year and 30,000 enquiries are processed by its information service each year. They developed the Wheel of Five Guidelines. These food-based dietary guidelines are set as recommended daily or weekly amounts of food groups, which differ by age and sex (322). They offer an optimal combination of products that

support health benefits, sufficient energy and essential nutrients (323). They are based on the Health Council of the Netherlands' Dutch dietary guidelines 2015 and were developed in close cooperation with RIVM. The Wheel of Five, a scientifically supported information model that shows the essence of healthy eating, visualizes the recommendations (see Figure 5.12). It visualises five segments, with different types of product groups in each segment:

1. Fruit and vegetables.
2. Wholemeal bread and grain products, potatoes.
3. Legumes, meat, fish, dairy and nuts.
4. Soft bread spreads and vegetable oils.
5. Drinks.

Soon, people choose a healthy diet by mainly eating foods mentioned in the Wheel of Five groups and limiting foods outside of the Wheel of Five product groups.

In a survey conducted among approximately 100 dieticians, 75% of them reported that they used the 'Wheel of Five' (324). In 2015, 93% of over a thousand respondents had heard of the name 'Schijf van Vijf'. Eighty-five per cent knew what it meant precisely or approximately. Yet fewer respondents (38%) reported that they currently eat according to the 'Schijf van Vijf' or have followed it sometime in the past (94).

Figure 5.12. The Dutch 'Wheel of Five' (Schijf van Vijf) 2016.

Earlier evaluation of consumption data (DNFCS 2007-2010) by Geurts et al showed that about 30% of the energy of the Dutch general population was derived from products within the Wheel of Five guidelines (325). Ideally, this should be 85%. A quarter of the diet in DNFCS 2007-2012 consists of products that are not included in the Wheel of Five, such as sweet and savoury snacks and beverages other than water, tea or

coffee. The Nutrition Centre recommends restricting the consumption of products that are not in the 'Wheel of Five' to an average of 15% of the energy requirement.

The Netherlands Nutrition Centre is also coordinating population-wide actions, but organizations and health professionals that would like to perform interventions on a subpopulation level might be interested in examples of interventions in the Intervention database 'Healthy and Active Living' (see Textbox 5.3).

Textbox 5.3. Intervention database 'healthy and active living'.
The Knowledge Centre for Sport Netherlands and RIVM Centre for Healthy Living (CGL), in collaboration with Trimbos Institute, present available lifestyle interventions in the intervention database 'Healthy and Active Living' (www.loketgezondleven.nl/leefstijlinterventies/interventiedatabase-gezond-en-actief-leven). In February 2017, the database contained 1,091 lifestyle interventions available in the Netherlands, 157 of which target nutrition in some way. Children are the main target group; 40% of these interventions focus on them. Consequently, 40% of the interventions are developed for the school setting. To improve the quality of interventions, a Recognition System for Interventions has been put in place. According to this system, 62 of the 157 (39.5%) interventions targeting nutrition have been recognized as being well-described (n=26), theoretically sound (n=28) or effective (n=8). Most effective interventions are in the field of overweight prevention.

Individualized nutritional advice
Already for more than a decade, 'personalized nutrition' has been advocated to overcome or supplement the limitations of the 'one-size fits all' dietary approach that originated from nutrition research in the 20th century (326-328). A European-wide study within the Food4Me project, an international endeavour funded by the EU (www.food4me.org), showed that personalized nutritional advice is more effective in improving dietary behaviour than conventional 'one-size-fits-all', population-based advice. The 'personalized nutrition' field is developing along similar lines as personalized medicine, which was boosted (again) by President Obama's recent 'Precision Medicine Initiative' (329, 330). Several approaches using a great variety of individual characteristics to tailor more individualized nutritional advice can be used. Some are widely used already, others are expected in the future.

- Classical personal nutritional advice by a dietician based on general/individual characteristics (for nutritional advice and counselling in health care settings, see Chapter 5.9).
- Individual advice based on a variety of questionnaires such as the 'Eetmeter' of the Netherlands Nutrition Centre. The Eetmeter provides personal advice based on information collected in a food dairy (http://mijn.voedingscentrum.nl/nl/eetmeter/). Other examples of numerous 'food-based tools', such as apps, are illustrated on the Quantified Self website (http://quantifiedself.com/guide/tag/food). It is expected that this form of advice will be increasingly based on the actual and/or real time measurements of existing biomarkers.

- Advice or prescription from a clinical perspective when specific patients are involved, so-called food for special medical purposes. These foods are intended for the exclusive or partial feeding of people whose nutritional requirements cannot be met by normal foods. The Directive 1999/21/EC lays down requirements on their composition labelling and manufacturing, and gives guidance for the minimum and maximum levels of vitamins and minerals (331).
- Advice based on personal meal response data (i.e. glucose), including so-called challenge tests (OGTT, MMT, e.a). An increasingly popular/applied approach to indicate homeostasis as a state of health that embraces the concept of the 'ability to adapt' as one of the major proposed aspects of Health (7) is to follow/measure, repeatedly over time (usually 120-240 min.), appropriate biomarkers in blood. Based on this type of analysis, an accurate personalized predictor of glycaemic response has been recently published (332).
- Advice based on full 'omics' technologies, collectively often addressed as nutrigenomics, analysing everything possible within transcriptomics, metabolomics, proteomics and (meta)genomics (see Textbox 5.4). A proof of principle study was published in 2012 (333) that described an integrated personal omics profile (iPOP) that indicated two different viral infections and a pre-diabetic state of the principle investigator.

The translation of the outcomes of nutrigenomics research, with its increasing biological complexity, into an actionable gene-nutrient framework is of utmost importance if we want to accomplish any level of individualized nutrition. Various scientific and ethical aspects for (genetics-based) individualized nutrition related to the Food4Me project were discussed in greater detail by Görman and colleagues (334). One of the expected outcomes is the production of best practice guidelines for communicating about personal nutrition. Another paper will be added in which criteria for how to evaluate scientific validity and evidence for personal benefit guidelines will be presented (Grimaldi et al. in preparation).

Textbox 5.4. Nutrigenomics (327, 328, 335-344).

Nutrigenomics combines the study of nutrition and genetics to discover the different ways people respond to food based on their genetic make-up. While humans are very similar genetically, we all have some 4 million differences in our genetic blueprints that set us apart from each other. These differences - tiny with respect to our 6 billion base pairs containing genome - determine both the effect nutrients have on our bodies and how we metabolize the food we eat. Individualized advice based on 'omic' technologies hinges on this two-way relationship between nutrients and genes. On the one hand, the nutrients and bioactive food compounds we consume can affect the way our genes are expressed. On the other hand, our genes are able to influence how our bodies respond to nutrients and bioactive compounds. The goal for nutrigenomic scientists is to unravel these complex interactions so that tailored diets can be developed, which complement a person's unique genetic profile. Not only will this optimize the health of the individual, but it may also work on a larger scale to help prevent malnutrition and non-communicable diseases such as obesity, type 2 diabetes, cardiovascular disease and cancer.

One of the first 'nutrigenetics' examples (in retrospect) with public health significance was the discovery in the 1960's that a diet low in phenylalanine could prevent the severe developmental consequences from a single gene defect in the phenylalanine hydroxylase gene causing phenylketonuria (PKU). At present for < 20 single gene defects that cause PKU, dietary measures can be effectively taken at a young age. These are therefore implemented in various newborn screening programmes across the world. Most non-communicable diseases, however, are multigenic and multifactorial. So a shift from nutrigenetics towards nutrigenomics has taken place. At present, these two fields coexist and are defined as the science of the effect of genetic variation on dietary response and the role of nutrients and bioactive food compounds in gene expression, respectively. Exploitation of this genomic information, along with high-throughput 'omic' technologies, allows the acquisition of new knowledge aimed at obtaining a better understanding of nutrient-gene interactions, depending on the genotype, with the ultimate goal of developing individualized nutrition strategies for optimal health and disease prevention.

Textbox 5.4 (continued). Nutrigenomics (327, 328, 335-344).

There are three central factors that underpin nutrigenetics and nutrigenomics as an important science. Firstly, there is considerable diversity in the inherited genome between ethnic groups and individuals, which affects nutrient bioavailability and metabolism. Secondly, people differ greatly in their food/nutrient availability and choices depending on cultural, economic, geographical and taste perception differences. Thirdly, malnutrition (deficiency or excess) itself can affect gene expression and genome stability; the latter leading to mutations at the gene sequence or chromosomal level which may cause abnormal gene dosage and gene expression, leading to adverse phenotypes during the various life stages. The importance of these central factors has been repeatedly demonstrated in various publications and can, for example, be nicely illustrated by the results of two recent studies on omega-3 fatty acids (n-3 PUFAs). The results of a study among Inuit from Greenland suggest that the (cardiovascular) benefits of fish oil depend on the genome because, at several loci involved in processing PUFAs, the Inuit genomes differ from European and Han Chinese genomes. Another study showed that the effect of n-3 PUFAs on Alzheimer disease is most prominent for carriers of certain APOE4 variants.

There are several important emerging aspects of nutrient-gene interactions evolving rapidly. Amongst others, these are epigenetics-epigenomics and the human microbiome. Epigenetics has the potential to help explain both intragenerational and transgenerational effects. Epigenetics refers to modifications in gene expression caused by heritable, but potentially reversible changes in DNA methylation and chromatin structure, including histone modifications and non-coding RNA expression (including micro-RNA's). Epigenomics pertains to the analysis of epigenetic changes in a cell or entire organism. Epigenetic processes have a strong influence on normal growth and development, and these processes are deregulated in diseases such as cancer. Diet, on its own or by interaction with other environmental factors, can cause epigenetic changes that may turn certain genes on or off. Epigenetic silencing of genes that would normally protect against a disease, as a result, could make people more susceptible to developing that disease later in life. The epigenome, which is heritable and modifiable by diet, is the global epigenetic pattern.

Also, due to technical advances, the detailed genome analysis of the human microbiome is rapidly increasing our understanding of the microbiota's role in health and disease. Together with the human genome, the study of the complete collection of all genomes is known as metagenomics.

As part of the project, a six-month intervention study, involving ~1,600 participants in Europe, investigated the effect of including individual diet and lifestyle information, with or without phenotypic and genotypic information, in individualized nutritional advice. Only five genes (MTHFR, FTO, TCF7L2, APOE4, FADS1) with solid evidence for gene-nutrient interactions were selected for genotyping in all participants. Participants that received personalized nutritional advice ate significantly healthier diets, increased their B vitamin folate intake and consumed significantly less energy, red meat, salt and saturated fat

than those randomized to the control group; regardless of whether personalization was based on their diet alone, their phenotype or their genotype. To reassure public concerns, a service provider would need to provide credible expertise and use a secure system for storing personal data to maintain user anonymity and privacy. Another outcome suggested was to make Nutritional Genecards for robust reproducible gene-diet interactions in line with other initiatives such as PharmGKB, Genecards, Clinical Gene Reviews, etc.

Despite the estimation that it will probably take some time before we can really tailor dietary advice, as early as 2000 the first company, called Sciona, was formed in the United Kingdom with the goal of bringing the benefits of the Human Genome Project directly to the consumer. Unfortunately, it could not live up to these expectations with regard to nutritional advice in the years after and disappeared. In retrospect, this is fully understandable in the light of the still increasing complexity between nutrition and human biology. At present, a few companies (for example Nutrigenomix, DNAfit, Nutrilite) are still offering genotyping services to support their dietary advice. It concerns mainly weight loss and is restricted to a very limited set of variants in genes like the PPARs, FABP2, ADRBs, ACE and APOA2. In general, the personal utility of these services is still seriously questioned and debated (345).

5.9 Nutrition advice and counselling in health care settings

The second domain on behaviour change communication includes policies and infrastructures for advice and counselling in health care settings. Health care settings are often mentioned in relation to nutrition, obesity and NCD prevention.

The Ministry of Health, Welfare and Sport is focused on a programmatic, integrated approach of prevention and care for NCDs (181, 346). 'Disease management programmes' focus on increased multidisciplinary collaboration, efficiency, and transparency of health care quality. Prevention and care are provided according to health care standards that have been developed for several diseases, e.g. diabetes, asthma, COPD, CVA/TIA, obesity and Vascular Risk Management (347). Besides disease-specific care, these standards also contain 'generic modules', e.g. for quitting smoking and nutrition. The generic module nutrition describes care aimed at acquiring healthy dietary behaviour (348). In addition, disease-specific information may be added in the corresponding care standard.

The healthcare standard for the treatment of obesity was developed by the "Partnership Overweight Netherlands" (349). It describes a 'stepped care approach' for the treatment of overweight and obesity, with the intensity of the treatment dependent on the level of weight-related health risk and the preferences of the patient. For patients with a moderately increased risk to (extremely) high risk, the first line of treatment consist of a 'combined lifestyle intervention', i.e. a programme that consists of physical activity, dietary advice and behavioural counselling. Health care standards do not prescribe which health care provider delivers care, but rather the required competences. Usually the primary care physician coordinates care, guided by the treatment plan that is made in

cooperation with the patient. For nutritional advice, the stepped care approach consists of four levels. The lowest level of care consists of self-management without the support of a health care professional. The second level consists of general nutritional advice provided by the primary care physician and/or nurse practitioner. The third level is individual dietary treatment by a general dietician, and the fourth level of care is specialized dietary treatment by a specialized dietician (348).

Integration of care in the community is supported by the Ministry of Health, Welfare and Sport through programmes such as Youth at a Healthy Weight (JOGG; www.jongerenopgezondgewicht.nl), Sports and physical activity in the Environment (SBB; www.sportindebuurt.nl), and 'Proeftuinen' (350). Primary care professionals play a central role in these programmes by referring patients to community programmes and coordinating care. Knowledge of the relevant partners in the neighbourhood is essential. One of the tasks of nurse practitioners is to develop and maintain a 'social map', including people and organizations active in the field of healthy lifestyle both within and outside the health care sector, e.g. dieticians, physical therapists, welfare organizations, sports clubs and social district teams. Often community programmes are organized at the level of the Municipal Health Service (GGD- region) and/or the municipality. The Centre for Healthy Living of the RIVM supports municipalities with information and examples of health promotion in municipalities and/or neighbourhoods (www.loketgezondleven.nl/gezonde-gemeente).

Some selective screening programmes for people at high risk for non-communicable diseases have been developed and pilot schemes have been performed in primary care settings. Examples are 'BeweegKuur' (www.beweegkuur.nl), 'Preventieconsult' (351) and 'Personal Health Check' (www.persoonlijkegezondheidscheck.nl). These programmes consist of identifying people that are at high risk of developing non-communicable diseases, followed by general or no advice for people with no or intermediate risk, and higher intensity treatment programmes for people at high risk. In addition, people with intermediate risk may be referred to community programmes immediately. People with higher risk may be referred to these community programmes after they complete the treatment programme.

In theory, the programmes for screening, disease management and community care encompass the entire chain of prevention activities. In practice, however, coherence between these programmes is limited (350, 352). Although improvements in multidisciplinary cooperation and the health care transparency of disease management programmes have been reported, the negative aspects of disease management programmes such as increased administrative tasks and the lack of payment for patients with comorbidity or multimorbidity have also been reported (350, 353). Other factors hampering an integrated approach to prevention and care are the lack of structural funding for primary prevention (after selective screening) and the lack of evidence for the (cost)effectiveness of programmes (352, 354). The bottlenecks for effective nutrition counselling include the limited nutrition education of healthcare staff and/or limited cooperation with dietetic practices (353).

5.10 Key findings

Nourishing Framework domain: Food environment

- Information on the packaging may help the conscious consumer to make the healthy choice. But because the percentage of conscious consumers is low, the overall effect will be small.
- In recent years, several programmes have been implemented to improve the food environment in schools and other settings. Programmes and guidelines for healthier school, company and sports canteens have led to positive changes in the food assortment, but many canteens do not comply to even the most lenient level of these guidelines, i.e. that a healthier option is available in each product category.
- The JOGG (Youth at a Healthy weight) approach is an integrated approach in a community setting, where public and private partners work together to decrease the percentage of children with an unhealthy body weight. Local studies in several JOGG communities suggest there are positive trends in healthy body weight. It is not yet possible to determine to what extent the JOGG approach contributed to these trends.
- Taxation of sugar-sweetened beverages and subsidies on fruit and vegetables are suggested as effective pricing strategies. Since low-income consumers place greater emphasis on price than others do, taxation might especially be an effective measure to influence their food choices. In the Netherlands, no taxation strategies exist, except for alcohol. Subsidies are allocated to school fruits and school milk in the Netherlands. The effectiveness of subsidies, however, seems limited.
- Food marketing regulations can be used to limit the exposure of food marketing to children. In the Netherlands, food marketing to children is based on self-regulation. Advertising targeting children under 12 is prohibited, but many exceptions are in place for foods that meet specific nutrient profiles and for point-of-sale marketing and advertising on packages. The actual impact of marketing restrictions on health outcomes is difficult to determine.
- In the Netherlands, the food industry has taken several actions to improve food composition. Most recently in 2014, the Dutch Ministry of Health, Welfare and Sport initiated the 'Agreement for the Improvement of Food Composition' to reduce the levels of sodium, added sugar, saturated fatty acids and the energy-density of food products. The level of trans and saturated fatty acids in foods has been successfully reduced since the 1990s. Up until 2015, sodium levels were reduced in certain food categories, such as bread, but in other food categories no or few changes have been reported. No or few changes have been reported for nutrients other than sodium. Health impact calculations have shown that food product improvement can lead to substantial health gains if implemented successfully.
- Mandatory or encouraged fortification practices, often driven by a significant public health need, are generally most successful in improving nutrient intake. In the Netherlands, encouraged fortification that is regulated via covenants is having a substantial impact on the micronutrient intake of iodine, vitamin D and

vitamin A. Voluntary fortification practices seem to be having a modest impact on nutrient intake.
- To enable supplementation advice to be successful, it is important to have regular and consistent nutrition education. For infants this resulted in high frequency of users of vitamin D supplements. The current intake of food supplements among the Dutch population does not contribute greatly to decreasing the proportion of the population with an inadequate intake.
- Although, in theory, novel foods can increase the supply of healthier products, it is unclear whether they actually play a role in improving the quality of the food supply. The number of foods that have been approved as novel foods is still quite limited. In addition, there is no systematic monitoring of the level of the introduction and the level of the consumption of novel foods as introduced to the market.

Nourishing framework domain: Food system
- Creating policy coherence (a 'health in all policies' approach) could increase the effectiveness and sustainability of the policy actions. In response to a policy document 'Naar een voedselbeleid' (To a food policy), the Cabinet agreed with WRR that modifications in the food system are necessary to guarantee enough sustainable and healthy food, also for the future. In February 2016, the Cabinet started a Food Dialogue with all relevant stakeholders on the future of our food chain and our food supply.

Nourishing framework domain: Behaviour change communication
- In the Netherlands, the Nutrition Centre (Voedingscentrum) is the authority for providing consumers with scientifically sound and independent information on a healthy, safe and sustainable food choice. They developed the food-based dietary guidelines ('Wheel of Five' Guidelines), which is known by a large part of the Dutch population. Increasingly, their information is personalized. Personalized nutritional advice is more effective in improving dietary behaviour than conventional 'one-size-fits-all', population-based advice, regardless of whether personalization is based on their diet alone, their phenotype or their genotype.
- Nutritional advice is a part of several health care standards. Nutritional advice is provided following a stepped care approach according to the needs and wishes of the patient. Primary care providers play a central role in the integration of care into the community by referring patients to community programmes and by coordinating care.

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References

1. van Kreijl CF, Knaap AGAC, van Raaij JMA, (eds). Our food, our health. Healthy diet and safe food in the Netherlands. Bilthoven; 2006. RIVM report 270555009.
2. Hawkes C, Jewell J, Allen K. A food policy package for healthy diets and the prevention of obesity and diet-related non-communicable diseases: the NOURISHING framework. Obesity Reviews. 2013;14 Suppl 2:159-68.
3. WHO. Global Action Plan for the prevention and control of noncommunicable diseases 2013-2020. Geneva: World Health Organization; 2013.
4. van Kreijl CF, Knaap AGAC, (eds). Ons eten gemeten. Gezonde voeding en veilig voedsel in Nederland. Bilthoven; 2004. RIVM report 270555007.
5. Wetenschappelijke Raad voor het Regeringsbeleid. Naar een voedselbeleid. Den Haag/Amsterdam: WRR/Amsterdam University Press; 2014.
6. Dijksma SAM, Schippers EI. Kabinetsreactie op het WRR-rapport "Naar een voedselbeleid". Den Haag2015.
7. Huber M, Knottnerus JA, Green L, van der Horst H, Jadad AR, Kromhout D, et al. How should we define health? BMJ. 2011;343:d4163.
8. Huber M, van Vliet M, Giezenberg M, Winkens B, Heerkens Y, Dagnelie PC, et al. Towards a 'patient-centred' operationalisation of the new dynamic concept of health: a mixed methods study. BMJ Open. 2016;6(1):e010091.
9. WHO. Healthy Diet. 2015 [Available from: http://www.who.int/mediacentre/factsheets/fs394/en/.
10. Cohain JS. The latest research on preconception and prenatal nutrition. Midwifery Today Int Midwife. 2013(106):52-4.
11. De-Regil LM, Palacios C, Lombardo LK, Pena-Rosas JP. Vitamin D supplementation for women during pregnancy. Cochrane Database of Systematic Reviews. 2016;1:CD008873.
12. De-Regil LM, Pena-Rosas JP, Fernandez-Gaxiola AC, Rayco-Solon P. Effects and safety of periconceptional oral folate supplementation for preventing birth defects. Cochrane Database of Systematic Reviews. 2015;12:CD007950.
13. EFSA. Scientific Opinion on health benefits of seafood (fish and shellfish) consumption in relation to health risks associated with exposure to methylmercury. EFSA Journal. 2014;12(7):3761.
14. Buijssen M, Jajou R, van Kessel FGB, Vonk Noordegraaf-Schouten MJM, Zeilmaker MJ, Wijga AH, et al. Health effects of breastfeeding: an update. Systematic literature review. Bilthoven: RIVM; 2015. RIVM report 2015-0043.
15. Lim SS, Vos T, Flaxman AD, Danaei G, Shibuya K, Adair-Rohani H, et al. A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990-2010: a systematic analysis for the Global Burden of Disease Study 2010. Lancet. 2012;380(9859):2224-60.
16. WHO. Factsheet Overweight and Obesity. 2015 (no 311).

17. Franssen SJ, van der Wal MF, Jansen P, van Eijsden M. Onder- en overgewicht bij Amsterdamse kinderen. Een trendanalyse en prognose. Nederlands Tijdschrift Geneeskunde. 2015;159:A8967.
18. Volksgezondheidenzorg.info. Overgewicht Bilthoven: RIVM; 2016 [Available from: https://www.volksgezondheidenzorg.info/onderwerp/overgewicht.
19. de Boer EJ, Brants HAM, Beukers M, Ocké MC, Dekker L, Nicolaou M, et al. Voeding van Marokkaanse, Turkse, Surinaamse en autochtone Nederlanders in Amsterdam. Bilthoven; 2015. RIVM report 2015-099.
20. CBS. Overgewicht ouders en kinderen gaat vaak samen: CBS; 2016 [Available from: https://www.cbs.nl/nl-nl/nieuws/2016/32/overgewicht-ouders-en-kinderen-gaat-vaak-samen.
21. World Obesity Federation. Adult overweight and obesity in the European Union (EU28) based on Measured Height and Weight. 2015.
22. Seidell JC. Prevalence and time trends of obesity in Europe. Journal of Endocrinological Investigation. 2002;25(10):816-22.
23. World Obesity Federation. Changes in % adult obesity prevalence over time in selected countries around the Globe. 2014.
24. Flegal KM, Carroll MD, Kit BK, Ogden CL. Prevalence of obesity and trends in the distribution of body mass index among US adults, 1999-2010. JAMA. 2012;307(5):491-7.
25. World Obesity Federation. % Childhood overweight in the European Union (EU27). 2014.
26. Wijnhoven TM, van Raaij JM, Spinelli A, Starc G, Hassapidou M, Spiroski I, et al. WHO European Childhood Obesity Surveillance Initiative: body mass index and level of overweight among 6-9-year-old children from school year 2007/2008 to school year 2009/2010. BMC Public Health. 2014;14:806.
27. Ahluwalia N, Dalmasso P, Rasmussen M, Lipsky L, Currie C, Haug E, et al. Trends in overweight prevalence among 11-, 13- and 15-year-olds in 25 countries in Europe, Canada and USA from 2002 to 2010. European Journal of Public Health. 2015;25 Suppl 2:28-32.
28. Visscher TL, Heitmann BL, Rissanen A, Lahti-Koski M, Lissner L. A break in the obesity epidemic? Explained by biases or misinterpretation of the data? International Journal of Obesity (London). 2015;39(2):189-98.
29. Dutch-Malnutrition-Steering-Group. http://www.fightmalnutrition.eu/ 2015 [
30. van der Pols-Vijlbrief R, Wijnhoven HA, Schaap LA, Terwee CB, Visser M. Determinants of protein-energy malnutrition in community-dwelling older adults: a systematic review of observational studies. Ageing Research Reviews. 2014;18:112-31.
31. Milne AC, Potter J, Vivanti A, Avenell A. Protein and energy supplementation in elderly people at risk from malnutrition. Cochrane Database of Systematic Reviews. 2009(2):CD003288.
32. Gezondheidsraad. Ondervoeding bij ouderen. Den Haag; 2011. Report No.: 2011/32.

33. Ocké MC, Buurma-Rethans EJM, de Boer EJ, Wilson-van den Hooven C, Etemad-Ghameshlou Z, Drijvers JJMM, et al. Diet of community-dwelling older adults. Dutch National Food Consumption Survey Older Adults 2010-2012. Bilthoven: RIVM; 2013. RIVM report 050413001.
34. Halfens RJG, Meijers JMM, Meesterberends E, Neyens JCL, Rondas AALM, S. R, et al. Landelijke Prevalentiemeting Zorgproblemen. Rapportage resultaten 2014. Maastricht: Maastricht University, CAPHRI School for Public Health and Primary Care; 2014.
35. Schilp J, Kruizenga HM, Wijnhoven HA, Leistra E, Evers AM, van Binsbergen JJ, et al. High prevalence of undernutrition in Dutch community-dwelling older individuals. Nutrition. 2012;28(11-12):1151-6.
36. Halfens RJ, Meesterberends E, Meijers JM, van Nie NC, Schols JM. Basiszorg in het verpleeghuis: longitudinale weergave van zorgproblemen gemeten door de Landelijke Prevalentiemeting Zorgproblemen. Tijdschrift voor Gerontologie en Geriatrie. 2013;44(6):242-52.
37. Committee DGA. Scientific Report of the 2015 Dietary Guidelines Advisory Committee. 2015.
38. Gezondheidsraad. Voedingspatronen - Achtergronddocument bij Richtlijnen goede voeding 2015. Den Haag; 2015. Report No.: A15/29.
39. Health Council of the Netherlands. Dutch Dietary Guidelines 2015. The Hague: Health Council of the Netherlands; 2015. Report No.: 2015/24E.
40. Library NE. A series of systematic reviews on the relationship between dietary patterns and health outcomes. Alexandia, VA; 2014.
41. Leon-Munoz LM, Garcia-Esquinas E, Lopez-Garcia E, Banegas JR, Rodriguez-Artalejo F. Major dietary patterns and risk of frailty in older adults: a prospective cohort study. BMC Medicine. 2015;13:11.
42. Struijk EA, Beulens JW, May AM, Fransen HP, Boer JM, de Wit GA, et al. Dietary patterns in relation to disease burden expressed in Disability-Adjusted Life Years. American Journal of Clinical Nutrition. 2014;100(4):1158-65.
43. USDA. Nutrition Evidence Library: Vegetables/Fuits 2010 [Available from: http://www.nel.gov/topic.cfm?cat=3290.
44. Gezondheidsraad. Groente en fruit - Achtergronddocument bij Richtlijnen goede voeding 2015. Den Haag; 2015. Report No.: A5/12.
45. Liu RH. Health-promoting components of fruits and vegetables in the diet. Advances in Nutrition. 2013;4(3):384S-92S.
46. Harland JI, Garton LE. Whole-grain intake as a marker of healthy body weight and adiposity. Public Health Nutrition. 2008;11(6):554-63.
47. Gezondheidsraad. Granen en graanproducten - Achtergronddocument bij Richtlijnen goede voeding 2015. Den Haag; 2015. Report No.: A15/11.
48. Slavin J. Why whole grains are protective: biological mechanisms. The Proceedings of the Nutrition Society. 2003;62(1):129-34.

49. Papanikolaou Y, Fulgoni VL, 3rd. Bean consumption is associated with greater nutrient intake, reduced systolic blood pressure, lower body weight, and a smaller waist circumference in adults: results from the National Health and Nutrition Examination Survey 1999-2002. Journal of the American College of Nutrition. 2008;27(5):569-76.
50. Gezondheidsraad. Peulvruchten - Achtergronddocument bij Richtlijnen goede voeding 2015. Den Haag; 2015. Report No.: A15/18.
51. Rebello CJ, Greenway FL, Finley JW. A review of the nutritional value of legumes and their effects on obesity and its related co-morbidities. Obesity Reviews. 2014;15(5):392-407.
52. USDA. What are the health effects related to consumption of nuts? 2010 [Available from: http://www.nel.gov/evidence.cfm?evidence_summary_id=250217.
53. Bes-Rastrollo M, Sabate J, Gomez-Gracia E, Alonso A, Martinez JA, Martinez-Gonzalez MA. Nut consumption and weight gain in a Mediterranean cohort: The SUN study. Obesity (Silver Spring). 2007;15(1):107-16.
54. Bes-Rastrollo M, Wedick NM, Martinez-Gonzalez MA, Li TY, Sampson L, Hu FB. Prospective study of nut consumption, long-term weight change, and obesity risk in women. American Journal of Clinical Nutrition. 2009;89(6):1913-9.
55. Gezondheidsraad. Noten en zaden - Achtergronddocument bij Richtlijnen goede voeding. Den Haag; 2015. Report No.: A15/16.
56. Grosso G, Yang J, Marventano S, Micek A, Galvano F, Kales SN. Nut consumption on all-cause, cardiovascular, and cancer mortality risk: a systematic review and meta-analysis of epidemiologic studies. American Journal of Clinical Nutrition. 2015;101(4):783-93.
57. Sabate J, Oda K, Ros E. Nut consumption and blood lipid levels: a pooled analysis of 25 intervention trials. Archives of Internal Medicine. 2010;170(9):821-7.
58. Du H, van der AD, Boshuizen HC, Forouhi NG, Wareham NJ, Halkjaer J, et al. Dietary fiber and subsequent changes in body weight and waist circumference in European men and women. American Journal of Clinical Nutrition. 2010;91(2):329-36.
59. Gezondheidsraad. Voedingsvezel - Achtergronddocument bij Richtlijnen goede voeding. Den Haag; 2015. Report No.: A15/30.
60. Lattimer JM, Haub MD. Effects of dietary fiber and its components on metabolic health. Nutrients. 2010;2(12):1266-89.
61. USDA. Nutrition Evidence Library: Dairy 2010 [Available from: http://www.nel.gov/topic.cfm?cat=3286.
62. Gezondheidsraad. Zuivel - Achtergronddocument bij Richtlijnen goede voeding 2015. Den Haag; 2015. Report No.: A15/32.
63. Gezondheidsraad. Vis - Achtergronddocument bij Richtlijnen goede voeding 2015. Den Haag; 2015. Report No.: A15/25.
64. He K. Fish, long-chain omega-3 polyunsaturated fatty acids and prevention of cardiovascular disease--eat fish or take fish oil supplement? Progress in Cardiovascular Diseases. 2009;52(2):95-114.
65. Gezondheidsraad. Eicosapentaeenzuur en docosahexaeenzuur – Achtergronddocument bij Richtlijnen goede voeding 2015. Den Haag; 2015. Report No.: A15/17.

66. Balk EM, Lichtenstein AH, Chung M, Kupelnick B, Chew P, Lau J. Effects of omega-3 fatty acids on serum markers of cardiovascular disease risk: a systematic review. Atherosclerosis. 2006;189(1):19-30.
67. Miller PE, Van Elswyk M, Alexander DD. Long-chain omega-3 fatty acids eicosapentaenoic acid and docosahexaenoic acid and blood pressure: a meta-analysis of randomized controlled trials. American Journal of Hypertension. 2014;27(7):885-96.
68. Calder PC. n-3 Fatty acids and cardiovascular disease: evidence explained and mechanisms explored. Clinical Science. 2004;107(1):1-11.
69. Harris WS, Miller M, Tighe AP, Davidson MH, Schaefer EJ. Omega-3 fatty acids and coronary heart disease risk: clinical and mechanistic perspectives. Atherosclerosis. 2008;197(1):12-24.
70. Gezondheidsraad. Transvetzuren - Achtergronddocument bij Richtlijnen goede voeding 2015. Den Haag; 2015. Report No.: A15/20.
71. de Souza RJ, Mente A, Maroleanu A, Cozma AI, Ha V, Kishibe T, et al. Intake of saturated and trans unsaturated fatty acids and risk of all cause mortality, cardiovascular disease, and type 2 diabetes: systematic review and meta-analysis of observational studies. BMJ. 2015;351:h3978.
72. Bendsen NT, Christensen R, Bartels EM, Astrup A. Consumption of industrial and ruminant trans fatty acids and risk of coronary heart disease: a systematic review and meta-analysis of cohort studies. European Journal of Clinical Nutrition. 2011;65(7):773-83.
73. Gezondheidsraad. Verzadigde, enkelvoudig en meervoudig onverzadigde (n-6) vetzuren - Achtergronddocument bij Richtlijnen goede voeding 2015. Den Haag; 2015. Report No.: A15/22.
74. Gezondheidsraad. Vlees - Achtergronddocument bij Richtlijnen goede voeding 2015. Den Haag; 2015. Report No.: A15/27.
75. Kaluza J, Wolk A, Larsson SC. Red meat consumption and risk of stroke: a meta-analysis of prospective studies. Stroke. 2012;43(10):2556-60.
76. Santarelli RL, Pierre F, Corpet DE. Processed meat and colorectal cancer: a review of epidemiologic and experimental evidence. Nutrition and Cancer. 2008;60(2):131-44.
77. Gezondheidsraad. Alcohol - Achtergronddocument bij Richtlijnen goede voeding 2015. Den Haag; 2015. Report No.: A15/05.
78. Gezondheidsraad. Alcoholhoudende dranken - Achtergronddocument bij Richtlijnen goede voeding 2015. Den Haag; 2015. Report No.: A15/06.
79. Anderson P, B. B. Alcohol in Europe: a public health perspective. London: Institute of Alcohol Studies; 2006.
80. USDA. Nutrition Evidence Library: Sugars/Sweeteners 2015 [Available from: http://www.nel.gov/topic.cfm?cat=3292.
81. Gezondheidsraad. Dranken met toegevoegd suilker - Achtergronddocument bij Richtlijnen goede voeding 2015. Den Haag; 2015. Report No.: A15/08.
82. USDA. What Is the Relationship Between Added Sugars and Risk of Cardiovascular Disease? 2015 [Available from: http://www.nel.gov/conclusion.cfm?conclusion_statement_id=250454.

83. Gezondheidsraad. Natrium - Achtergronddocument bij Richtlijnen goede voeding 2015. Den Haag; 2015. Report No.: A15/15.
84. USDA. Nutrition Evidence Library: minerals 2015 [Available from: http://www.nel.gov/topic.cfm?cat=3300.
85. Mikkila V, Rasanen L, Raitakari OT, Marniemi J, Pietinen P, Ronnemaa T, et al. Major dietary patterns and cardiovascular risk factors from childhood to adulthood. The Cardiovascular Risk in Young Finns Study. British Journal of Nutrition. 2007;98(1):218-25.
86. Couch SC, Saelens BE, Levin L, Dart K, Falciglia G, Daniels SR. The efficacy of a clinic-based behavioral nutrition intervention emphasizing a DASH-type diet for adolescents with elevated blood pressure. Journal of Pediatrics. 2008;152(4):494-501.
87. Aburto NJ, Ziolkovska A, Hooper L, Elliott P, Cappuccio FP, Meerpohl JJ. Effect of lower sodium intake on health: systematic review and meta-analyses. BMJ. 2013;346:f1326.
88. Leermakers ET, Felix JF, Erler NS, Cerimagic A, Wijtzes AI, Hofman A, et al. Sugar-containing beverage intake in toddlers and body composition up to age 6 years: The Generation R Study. European Journal of Clinical Nutrition. 2015;69(3):314-21.
89. Leermakers ET, Felix JF, Jaddoe VW, Raat H, Franco OH, Kiefte-de Jong JC. Sugar-containing beverage intake at the age of 1 year and cardiometabolic health at the age of 6 years: the Generation R Study. International Journal of Behavioral Nutrition and Physical Activity. 2015;12:114.
90. Paquette MC. Perceptions of healthy eating: state of knowledge and research gaps. Canadian Journal of Public Health = Revue Canadienne de Santé Publique. 2005;96 Suppl 3:S15-9, S6-21.
91. Lappalainen R, Kearny J, Gibney M. A pan EU survey of consumer attitudes to food, nutrition and health: An overview. Food Quality and Preference. 1998;9(6):467-78.
92. European Commission. Functional Foods. Brussels; 2010.
93. Evers W, Carol B. Picking the nutrition facts from the fads: an Internet-based tutorial. Journal of Nutrition Education and Behavior. 2007;39(2):103-4.
94. Network For Food Experts. Voedseltrends 2015 [Available from: http://www.nvvl.nl/wp-content/uploads/2015/05/Rapportage-NVVL-voedseltrends1.pdf.
95. Geurts M, Bakel van M, van Rossum C, De Boer E, Ocké M. Food consumption in the Netherlands. Background report 'What's on our plate? Safe, healthy and sustainable food in the Netherlands'. Bilthoven: RIVM; 2017. RIVM report: 2016-0195.
96. Van Rossum CTM, Fransen HP, Verkaik-Kloosterman J, Buurma-Rethans EJM, Ocké MC. Dutch National Food Consumption Survey 2007-2010. Diet of children and adults aged 7 to 69 years. Bilthoven: RIVM; 2011. RIVM report: 350050006.
97. van Rossum CTM, Beukers M, de Boer EJ, Brants HAM, Buurma-Rethans EJM, Ocké MC, et al. The diet of the Dutch; Results of the first 2 years of the Dutch National Food Consumption Survey 2012-2016 (in preparation). Bilthoven: RIVM; 2016. RIVM report: 2016-0082.

98. Hulshof KFAM, Ocke MC, van Rossum CTM, Buurma-Rethans EJM, Brants HAM, Drijvers JJMM, et al. Results of the national food consumption survey 2003. Bilthoven: RIVM; 2004. RIVM report: 350030002.
99. Ocké MC, Van Rossum CTM, Fransen HP, Buurma EJM, De Boer EJ, Brants HAM, et al. Dutch National Food Consumption Survey - Young Children 2005/2006. Bilthoven: RIVM; 2008. RIVM report: 350070001.
100. Wilson-van den Hooven C, Fransen HJ, Ris-Stalpers C, Ocké MC. 24-uurs urine-excretie van jodium. Voedingsstatusonderzoek bij volwassen Nederlanders. Bilthoven: RIVM; 2007. RIVM report: 350050005.
101. van den Hooven C, Fransen H, Jansen E, Ocke M. 24-uurs urine-excretie van natrium. Voedingsstatusonderzoek bij volwassen Nederlanders. Bilthoven: RIVM; 2007. RIVM briefrapport 350050004.
102. Hendriksen MAH, Wilson-van den Hooven EC, van der A DL. Salt and iodine intake among adults in Doetinchem in 2010. Bilthoven: RIVM; 2011. RIVM Report 350070004.
103. Hendriksen MA, van Raaij JM, Geleijnse JM, Wilson-van den Hooven C, Ocke MC, van der AD. Monitoring salt and iodine intakes in Dutch adults between 2006 and 2010 using 24 h urinary sodium and iodine excretions. Public Health Nutrition. 2014;17(7):1431-8.
104. Kromhout D, C.J.K. S, J. dG, R.D. W. The 2015 Dutch food-based dietary guidelines. European Journal of Clinical Nutrition. 2016;70:869-76.
105. WCRF, AICR. Policy and action for cancer prevention. Food, nutrition, and physical activity: a global perspective. Washington DC: AICR; 2009.
106. WHO. WHO European action plan for food and nutrition policy 2007-2012. Copenhagen; 2008. Report No.: E91153.
107. Gezondheidsraad. Werkprogramma 2017. 2016 [Available from: https://www.gezondheidsraad.nl/sites/default/files/a1602_werkprogramman_2017_gezondheidsraad_1.pdf.
108. WHO. Healthy Diet: WHO; 2015 [updated May 2015. Available from: http://www.who.int/nutrition/publications/nutrientrequirements/healthydiet_factsheet394.pdf.
109. Nederlandse Diabetes Federatie. NDF Voedingsrichtlijn diabetes 2015. Amersfoort: Nederlandse Diabetes Federatie; 2015.
110. Hendriksen MAH, Etemad E, van den Bogaard CHM, van der A DL. Zout-, jodium- en kaliuminname 2015. Voedingsstatusonderzoek bij volwassenen uit Doetinchem. Bilthoven: Rijksinstituut voor Volksgezondheid en Milieu; 2016. RIVM Briefrapport 2016-0081.
111. van Lee L, Geelen A, van Huysduynen EJ, de Vries JH, van't Veer P, Feskens EJM. The Dutch Healthy Diet index (DHD-index): an instrument to measure adherence to the Dutch Guidelines for a Healthy Diet. Nutrition Journal. 2012;11:49.
112. Beukers M, van Rossum CTM. MEMO Bijdrage van voedingsmiddelengroepen aan de inneming van mono- en disachariden en energie Bilthoven: RIVM; 2013 [Available from: http://www.rivm.nl/dsresource?objectid=rivmp:210583&type=org&disposition=inline.

113. EFSA. Scientific opinion on principles for deriving and applying Dietare Reference Values. EFSA Journal. 2010;8(3).
114. Gezondheidsraad. Tijdelijke voedingsnormen 2014 [Available from: http://www.gezondheidsraad.nl/nl/nieuws/tijdelijke-voedingsnormen.
115. Gezondheidsraad. Richtlijnen Goede Voeding 2006. Den Haag; 2006. Report No. 2006/21E.
116. Gezondheidsraad. Naar een voldoende inname van viamines en mineralen. Den Haag: Gezondheidsraad; 2009. Report No.: 2009/06.
117. Peeters D, Lanting CI, van Wouwe JP. Peiling melkvoeding van zuigelingen 2015. Leiden: TNO; 2015. Report No.: TNO/CH 2015 R10385.
118. Breedveld BC, Hulshof KFAM. Zo eten jonge peuters in Nederland 2002. Resultaten van het Voedsingsstoffen Inname Onderzoek (VIO) 2002. Den Haag: Voedingscentgrum; 2002. Report No.: 762.
119. Goldbohm RA, Rubingh CM, Lanting CI, Joosten KFM. Food consumption and nutrient intake by children aged 10 to 48 months attending day care in the Netherlands. Nutrients. 2016;8.
120. Voedingscentrum. Richtlijnen voedselkeuze. 2011.
121. De Jong-Rubingh C, Bausch-Goldbohm RA. De Eet Compleet Test: 2-daags voedselconsumptie onderzoek onder kinderen van 1-4 jaar die een kinderdagverblijf bezoeken. Zeist: TNO; 2015. Report No.: TNO 2014 R11714.
122. Gezondheidsraad. Evaluatie van de voedingsnormen voor vitamine D. Den Haag: Gezondheidsraad; 2012. Report No.: 2012/15.
123. Tieland M, Borgonjen-Van den Berg KJ, Van Loon LJ, de Groot LC. Dietary Protein Intake in Dutch Elderly People: A Focus on Protein Sources. Nutrients. 2015;7(12):9697-706.
124. Neelemaat F. Post-discharge nutritional support in malnourished ill elderly patient. Effectiveness and cost-effectiveness. Amsterdam: Vrije Universiteit; 2012.
125. Voedingscentrum. Factsheet Voeding en zwangerschap 2015 [Available from: http://www.voedingscentrum.nl/Assets/Uploads/voedingscentrum/Documents/Professionals/Pers/Factsheets/Factsheet%20Voeding%20en%20zwangerschap.pdf.
126. van Bussel LM, van Rossum CTM, Ocké MC, Temme EHM, Boon P.E.. Socioeconomic differences in aspects of healthy, sustainable and safe food consumption among adults in the Netherlands (in preparation). 2016.
127. Van Eijsden M, Berkenpas M, van der Wal M. Borstvoeding in een multi-etnische populatie: de rol van de (aanstaande) vader en grootmoeder. Tijdschrift voor Gezondheidswetenschappen 2009;87(3):100-8.
128. Van Eijsden M, Meijers C, Jansen J, De Kroon M, Vrijkotte T. Cultural variation in early feeding pattern and maternal perceptions of infant growth. British Journal of Nutrition. 2015;114:481-8.

129. Gilsing AM, Weijenberg MP, Goldbohm RA, Dagnelie PC, van den Brandt PA, Schouten LJ. The Netherlands Cohort Study−Meat Investigation Cohort; a population-based cohort over-represented with vegetarians, pescetarians and low meat consumers. Nutrition Journal. 2013;12.
130. Welch AA, Shakya-Shrestha S, Lentjes MA, Wareham NJ, Khaw KT. Dietary intake and status of n-3 polyunsaturated fatty acids in a population of fish-eating and non-fish-eating meat-eaters, vegetarians, and vegans and the product-precursor ratio [corrected] of α-linolenic acid to long-chain n-3 polyunsaturated fatty acids: results from the EPIC-Norfolk cohort. American Journal of Clinical Nutrition. 2010;95(5):1040-51.
131. Volksgezondheidenzorg.info. Internationale verschillen in voeding bij volwassenen Bilthoven: RIVM; 2014 [Available from: https://www.volksgezondheidenzorg.info/onderwerp/voeding/regionaal-internationaal/internationale-verschillen#node-internationale-verschillen-voeding-bij-volwassenen.
132. Elmadfa I. European Nutrition and Health Report 2009. Vienna; 2009.
133. Lajoie EW, Bridges L. Innovation Decisions: Using the Gartner hype cycle. Library Leadership and Management. 2014;28(4):1-7.
134. Teiwik A, Ydergärd J. Applying Gartner's hype cycle on the health food industry (Master's thesis, Chalmers University of Technology) 2015.
135. RIVM. NEVO-tabel. Nederlands Voedingsstoffenbestand 2011. Den Haag: Voedingscentrum; 2011.
136. Hendriksen MA, Hoogenveen RT, Hoekstra J, Geleijnse JM, Boshuizen HC, van Raaij JM. Potential effect of salt reduction in processed foods on health. American Journal of Clinical Nutrition. 2014;99(3):446-53.
137. Hoogenveen RT, van Baal PH, Boshuizen HC. Chronic disease projections in heterogeneous ageing populations: approximating multi-state models of joint distributions by modelling marginal distributions. Mathematical Medicine and Biology 2010;27(1):1-19.
138. Stouthard MEA, Essink-Bot ML, Bonsel BJ. Disability weights for diseases. A modified protocol and results for a Western European region. European Journal of Public Health. 2000;10(1):24-30.
139. Hartstichting. Hart- en vaatziekten in Nederland 2013. Den Haag: Hartstichting; 2013.
140. He FJ, MacGregor GA. Effect of longer-term modest salt reduction on blood pressure. Cochrane Database of Systematic Reviews. 2004(3):CD004937.
141. Hendriksen MA, Verkaik-Kloosterman J, Noort MW, van Raaij JM. Nutritional impact of sodium reduction strategies on sodium intake from processed foods. European Journal of Clinical Nutrition. 2015.
142. van Raaij JMA, Büchner FL, Hendriksen MA, van Duijnhoven FJ, Hoogenveen RT, Toxopeus I, Hoekstra J. Manoeuvring between health benefits and health losses by following or neglecting dietary guidelines: where do we stand? (submitted).
143. Blokstra A, Schuit AJ. Factsheet overgewicht. Prevalentie overgewicht. Bilthoven; 2003. Report No.: 260301/f1/2003.

144. Bemelmans W, van Baal P, Wendel-Vos W, Schuit J, Feskens E, Ament A, et al. The costs, effects and cost-effectiveness of counteracting overweight on a population level. A scientific base for policy targets for the Dutch National Plan for Action. Preventive Medicine. 2008;46(2):127-32.
145. Volksgezondheidenzorg.info. Beroerte Bilthoven: RIVM; 2015 [Available from: https://www.volksgezondheidenzorg.info/onderwerp/beroerte.
146. Volksgezondheidenzorg.info. Coronaire Hartziekten Bilthoven: RIVM; 2015 [Available from: https://www.volksgezondheidenzorg.info/onderwerp/coronaire-hartziekten.
147. Volksgezondheidenzorg.info. Diabetes Mellitus Bilthoven: RIVM; 2015 [Available from: https://www.volksgezondheidenzorg.info/onderwerp/diabetes-mellitus.
148. Volksgezondheidenzorg.info. Kanker Bilthoven: RIVM; 2015 [Available from: https://www.volksgezondheidenzorg.info/onderwerp/kanker.
149. Volksgezondheidenzorg.info. Dikkedarmkanker Bilthoven: RIVM; 2015 [Available from: https://www.volksgezondheidenzorg.info/onderwerp/dikkedarmkanker.
150. Volksgezondheidenzorg.info. Borstkanker Bilthoven: RIVM; 2015 [Available from: https://www.volksgezondheidenzorg.info/onderwerp/borstkanker.
151. Volksgezondheidenzorg.info. Longkanker Bilthoven: RIVM; 2015 [Available from: https://www.volksgezondheidenzorg.info/onderwerp/longkanker.
152. WHO. European Food and Nutrition Action Plan 2015-2020. World Health Organization Regional Office for Europe; 2014.
153. Storcksdieck genannt Bonsmann S, Celemin LF, Larranaga A, Egger S, Wills JM, Hodgkins C, et al. Penetration of nutrition information on food labels across the EU-27 plus Turkey. European Journal of Clinical Nutrition. 2010;64(12):1379-85.
154. van Herpen E, Hieke S, van Trijp HC. Inferring product healthfulness from nutrition labelling. The influence of reference points. Appetite. 2014;72:138-49.
155. Cecchini M, Warin L. Impact of food labelling systems on food choices and eating behaviours: a systematic review and meta-analysis of randomized studies. Obesity Reviews. 2016;17(3):201-10.
156. Miller LM, Cassady DL. The effects of nutrition knowledge on food label use. A review of the literature. Appetite. 2015;92:207-16.
157. Hoogendoorn MP, Van den Berg M. De waarde van een voedselkeuzelogo voor het voedingsbeleid. Bilthoven: Rijksinstituut voor Volksgezondheid en Milieu (RIVM); 2016. RIVM report: 2016-0144.
158. Vyth EL, Hendriksen MA, Roodenburg AJ, Steenhuis IH, van Raaij JM, Verhagen H, et al. Consuming a diet complying with front-of-pack label criteria may reduce cholesterol levels: a modeling study. European Journal of Clinical Nutrition. 2012;66(4):510-6.

159. Hawley KL, Roberto CA, Bragg MA, Liu PJ, Schwartz MB, Brownell KD. The science on front-of-package food labels. Public Health Nutrition. 2013;16(3):430-9.
160. Vyth EL, Steenhuis IH, Roodenburg AJ, Brug J, Seidell JC. Front-of-pack nutrition label stimulates healthier product development: a quantitative analysis. International Journal of Behavior Nutrition and Physical Activity. 2010;7:65.
161. Wills JM, Storcksdieck genannt Bonsmann S, Kolka M, Grunert KG. European consumers and health claims: attitudes, understanding and purchasing behaviour. The Proceedings of the Nutrition Society. 2012;71(2):229-36.
162. Dean M, Lahteenmaki L, Shepherd R. Nutrition communication: consumer perceptions and predicting intentions. The Proceedings of the Nutrition Society. 2011;70(1):19-25.
163. Health Council of the Netherlands. Towards an adequate intake of vitamins and minerals. Health Council of the Netherlands; 2009 2009. Report No.: 2009/06.
164. Fransen HP, de Jong N, Wolfs M, Verhagen H, Verschuren WM, Lutjohann D, et al. Customary use of plant sterol and plant stanol enriched margarine is associated with changes in serum plant sterol and stanol concentrations in humans. Journal of Nutrition. 2007;137(5):1301-6.
165. Wolfs M, de Jong N, Ocke MC, Verhagen H, Verschuren WMM. Effectiveness of customary use of phytosterol/-stanol enriched margarines on blood cholesterol lowering. Food and chemical toxicology : an international journal published for the British Industrial Biological Research Association. 2006;44(10):1682-8.
166. Eussen SR, Feenstra TL, Toxopeus IB, Hoekstra J, Klungel OH, Verhagen H, et al. Costs and health effects of adding functional foods containing phytosterols/-stanols to statin therapy in the prevention of cardiovascular disease. European Journal of Pharmacology. 2011;668 Suppl 1:S91-100.
167. WHO. WHO Technical Report series. Promoting Health Through Schools. 1997.
168. Gezondeschool.nl. https://www.gezondeschool.nl/advies-en-ondersteuning/ondersteuningsaanbod/ondersteuningsronde-voorjaar-2015 2016 [
169. Gezondeschool.nl. https://www.gezondeschool.nl/advies-en-ondersteuning/ondersteuningsaanbod/resultaten-eerdere-rondes 2016 [
170. Mensink F, Schwinghammer SA, Smeets A. The Healthy School Canteen programme: a promising intervention to make the school food environment healthier. Journal of Environmental and Public Health. 2012;2012:415746.
171. Website Healthy School Canteen [Internet]. Available from: http://gezondeschoolkantine.voedingscentrum.nl/nl.aspx.
172. Anonymous. Akkoord Gezonde Voeding op Scholen 2016-2020 2015 [Available from: https://jongerenopgezondgewicht.nl/userfiles/Wat%20we%20doen/Akkoord%20Gezonde%20Voeding%20op%20Scholen%2020162020.pdf.
173. Wolvers D, Mensink F, Peters S. Factsheet Richtlijnen Gezondere Kantines. Den Haag: Voedingscentrum; 2014.

174. Zeinstra G, Timmers M, van der Velden N. Monitoronderzoek De Gezonde Schoolkantine. Berg en Dal: IResearch; 2013.
175. Voedingscentrum. Koplopers in beeld Den Haag2016 [Available from: http://gezondeschoolkantine.voedingscentrum.nl/nl/wat-waarom/koplopersinbeeld.aspx.
176. Volksgezondheidenzorg.info. Gezonde Sportkantine per gemeente Bilthoven: RIVM; 2016 [Available from: https://www.volksgezondheidenzorg.info/sport/sportopdekaart/beleid-sportvereniging#!node-gezonde-sportkantine-gemeente.
177. Temminghof M, Hoogwerf I. De Gezonde Sportkantine. Onderzoek onder koplopers sportkantines. GfK; 2015.
178. Temminghof M, van Vlerken A. De Gezonde Sportkantine. 2014.
179. van Kalmhout J. Gezonde sportkantine. Meting 2014. Mulier Instituut; 2015.
180. van Kalmhout J, van den Dool R. Gezonde kantine? Uitkomsten Nationaal Sport Onderzoek najaar 2013. Mulier Instituut; 2014.
181. Anonymous. Alles is Gezondheid...Het Nationaal Programma Preventie 2014-2016. Rijksoverheid 2013.
182. Akkoord Verbetering Productsamenstelling zout, verzadigd vet, suiker (calorieën). Den Haag 2014.
183. Van Koperen TM, Jebb SA, Summerbell CD, Visscher TL, Romon M, Borys JM, et al. Characterizing the EPODE logic model: unravelling the past and informing the future. Obesity Reviews. 2013;14(2):162-70.
184. van Koperen MT, van der Kleij RM, Renders CC, Crone MM, Hendriks AM, Jansen MM, et al. Design of CIAO, a research program to support the development of an integrated approach to prevent overweight and obesity in the Netherlands. BMC Obesity. 2014;1:5.
185. Collard D, Scholten V, Reijgersberg N, Breedveld K. Monitor Jongeren Op Gezond Gewicht 2016. Utrecht: Mulier Instituut; 2017.
186. European Commission. Special Eurobarometer 238 - Risk Issues. 2006.
187. FAO. Prospects for the Future: Nutritional, Environmental and Sustainable Food Production Considerations - Changes in Cultural and Consumer Habits 1999 [Available from: http://www.fao.org/docrep/meeting/X2697e.htm.
188. Jacquier C, Bonthoux F, Baciu M, Ruffieux B. Improving the effectiveness of nutritional information policies: Assessment of unconscious pleasure mechanisms involved in food-choice decisions. Nutrition Reviews. 2012;70(2):118-31.
189. Sobal J, Bisogni CA. Constructing food choice decisions. Annals of Behavioral Medicine. 2009;38(SUPPL.):S37-S46.
190. Waterlander WE, De Haas WE, Van Amstel I, Schuit AJ, Twisk JW, Visser M, et al. Energy density, energy costs and income - How are they related? Public Health Nutrition. 2010;13(10):1599-608.
191. WHO. Using price policies to promote healthier diets. Denmark: World Health Organization Regional Office for Europe; 2015.
192. Hawkes C. Food taxes: What type of evidence is available to inform policy development? Nutrition Bulletin. 2012;37(1):51-6.
193. Waterlander WE. Put the money where the mouth is: the feasibility and effectiveness of food pricing strategies to stimulate healthy eating. Amsterdam: Free University; 2012.

194. Thow AM, Jan S, Leeder S, Swinburn B. The effect of fiscal policy on diet, obesity and chronic disease: A systematic review. Bulletin of the World Health Organization. 2010;88(8):609-14.
195. Thow AM, Downs S, Jan S. A systematic review of the effectiveness of food taxes and subsidies to improve diets: Understanding the recent evidence. Nutrition Reviews. 2014;72(9):551-65.
196. Steenhuis IHM, Waterlander WE, De Mul A. Consumer food choices: The role of price and pricing strategies. Public Health Nutrition. 2011;14(12):2220-6.
197. Mittermayer F, Pederson R. Integrating public health into mainstream policy. Eurohealth 15(4).
198. Vallgarda S, Holm L, Jensen JD. The Danish tax on saturated fat: why it did not survive. European Journal of Clinical Nutrition. 2015;69(2):223-6.
199. Yle. Tax on sweets and ice cream to be dropped Helsinki 2015 [updated 29.9.2015. Available from: http://yle.fi/uutiset/tax_on_sweets_and_ice_cream_to_be_dropped/8340402.
200. Colchero MA, Popkin BM, Rivera JA, Ng SW. Beverage purchases from stores in Mexico under the excise tax on sugar sweetened beverages: observational study. BMJ. 2016;352:h6704.
201. Sassi F. Taxing sugar. BMJ. 2016;352:h6904.
202. Chambers SA, Freeman R, Anderson AS, MacGillivray S. Reducing the volume, exposure and negative impacts of advertising for foods high in fat, sugar and salt to children: A systematic review of the evidence from statutory and self-regulatory actions and educational measures. Preventive Medicine. 2015;75(0):32-43.
203. WHO. Marketing of foods high in fat, salt and sugar to children: update 2012-2013. World Health Organization Regional Office for Europe; 2013.
204. Consumentenbond. Monitoring voedingsreclame kinderen Consumentenbond 2011.
205. Kelly B, King ML, Chapman Mnd K, Boyland E, Bauman AE, Baur LA. A hierarchy of unhealthy food promotion effects: identifying methodological approaches and knowledge gaps. American Journal of Public Health. 2015;105(4):e86-95.
206. Cairns G, Angus K, Hastings G, Caraher M. Systematic reviews of the evidence on the nature, extent and effects of food marketing to children. A retrospective summary. Appetite. 2013;62(0):209-15.
207. Lobstein T, Dibb S. Evidence of a possible link between obesogenic food advertising and child overweight. Obesity Reviews. 2005;6(3):203-8.
208. McGinnis J, Gootman J, Kraak V. Food marketing to children and youth: threat or opportunity? Washington DC: Institute of Medicine; 2006.
209. Wilcox B, Kunkel D, Cantor J, Dowrick P, Linn S, Palmer E. Report of the APA Task Force on Advertising and Children. Washington DC; 2004.
210. WHO. Global Strategy on Diet, Physical Activity and Health. Geneva, Switzerland: World Health Organization; 2004.
211. FNLI. Visie levensmiddelenindustrie op reclame gericht op kinderen. Federatie Nederlandse Levensmiddelen Industrie; 2015.

212. Stichting Reclame Code. The Dutch Advertising Code Information about the working procedures of the advertising code committee and the board of appeal. Stichting Reclame Code; 2012.
213. NVWA. Kidsmarketing. Nederlandse Voedsel en Waren Autoriteit, Ontwikkeling ASe; 2006. Report No.: ZD05K303.
214. Klink A. Nota Overgewicht. Uit balans: de last van overgewicht. Den Haag. 2009.
215. Stichting Reclame Code. De Nederlandse Reclame Code. Stichting Reclame Code; 2011.
216. Stichting Reclame Code. Voedingskundige criteria reclame gericht op kinderen. Stichting Reclame Code; 2015.
217. Audiovisual Media Services Directive; 2010.
218. WHO. 2008-2013 Action Plan for the Global Strategy for the Prevention and Control of Noncommunicable Diseases. Geneva: World Health Organization; 2008.
219. WHO. WHO Regional Office for Europe nutrient profile model. World Health Organisation Regional Office for Europe; 2015.
220. EU Pledge. 2013 Monitoring report. EU Pledge; 2014.
221. Stichting Reclame Code. Jaarverslag Stichting Reclame Code 2013. Stichting Reclame Code; 2013.
222. EU Pledge. 2012 Monitoring report. EU Pledge; 2013.
223. Brinsden H, Lobstein T. Comparison of nutrient profiling schemes for restricting the marketing of food and drink to children. Pediatric Obesity. 2013;8(4):325-37.
224. Dhar T, Baylis K. Fast-food consumption and the ban on advertising targeting children: The Quebec experience. Journal of Marketing Research. 2011;48(5):799-813.
225. Veerman JL, Van Beeck EF, Barendregt JJ, MacKenbach JP. By how much would limiting TV food advertising reduce childhood obesity. European Journal of Public Health. 2009;19(4):365-9.
226. Goris JM, Petersen S, Stamatakis E, Veerman JL. Television food advertising and the prevalence of childhood overweight and obesity: a multicountry comparison. Public Health Nutrition. 2010;13(7):1003-12.
227. van Raaij J, Hendriksen M, Verhagen H. Potential for improvement of population diet through reformulation of commonly eaten foods. Public Health Nutrition. 2009;12(3):325-30.
228. Task Force for the Improvement of the Fatty Acid Composition. Better fatty acid composition in products containing vegetable oils and fats. Dutch Task Force for the Improvement of the Fatt Acid Composition 2003-2010. Rijswijk: Product Board for Margarine, Fats and Oils (MVO); 2011.
229. FNLI. Rapportage Actieplan Zout in Levensmiddelen Fase 1. Rijswijk: Federatie Nederlandse Levensmiddelen Industrie (FNLI); 2010.
230. Temme EH, Millenaar IL, Van Donkersgoed G, Westenbrink S. Impact of fatty acid food reformulations on intake of Dutch young adults. Acta Cardiologica. 2011;66(6):721-8.
231. NVWA. Monitoring van het gehalte aan keukenzout in diverse levensmiddelen 2014. Utrecht: Nederlandse Voedsel en Warenautoriteit; 2015.
232. NVWA. De vetzuursamenstelling van producten - hartige snacks, klein. NVWA; 2014.

233. NVWA. De vetzuursamenstelling van producten - Hartige snacks, groot. NVWA; 2014.
234. Temme EHM, Milder IEJ, Westenbrink S, Toxopeus IB, Van den Bogaard CHM, Van Raaij J. Monitor Productsamenstelling voor zout, verzadigd vet en suiker. RIVM Herformuleringsmonitor 2014. Bilthoven: RIVM; 2015. RIVM briefrapport 2015-0034.
235. Verkaik-Kloosterman J, van 't Veer P, Ocke MC. Reduction of salt: will iodine intake remain adequate in The Netherlands? British Journal of Nutrition. 2010;104(11):1712-8.
236. Henney JE, Taylor CL, Boon CS. Taste and flavor roles of sodium In foods: a unique challenge to reducing sodium intake. 2010.
237. Scientific Advisory Committee on Nutrition. Salt and Health. 2003.
238. Strom BL, Yatkine AL, Oria M. Sodium intake in populations: assessment of evidence. Washington: Institute of Medicine, 2013. Report No.: 978-0-309-28295-6.
239. WHO. Guideline: Sodium intake for adults and children. Geneva, Switzerland: World Health Organization (WHO); 2012.
240. EU High Level Group on Diet and Physical Activity. Survey on Members States' Implementation of the EU Salt Reduction Framework. Brussels, Belgium: European Union; 2008.
241. Webster J, Trieu K, Dunford E, Hawkes C. Target Salt 2025: A Global Overview of National Programs to Encourage the Food Industry to Reduce Salt in Foods. Nutrients. 2014;6(8):3274-87.
242. Charlton K, Webster J, Kowal P. To Legislate or Not to Legislate? A Comparison of the UK and South African Approaches to the Development and Implementation of Salt Reduction Programs. Nutrients. 2014;6(9):3672-95.
243. Wyness LA, Butriss JL, Stanner SA. Reducing the population's sodium intake: the UK Food Standards Agency's salt reduction programme. Public Health Nutrition. 2012;15(2):254-61.
244. Sadler K, Nicholson S, Steer T, Gill V, Bates B, Tipping S, et al. National Diet and Nutrition Survey - Assessment of dietary sodium in adults (aged 19 to 64 years) in England, 2011. Department of Health; 2012.
245. He FJ, Pombo-Rodrigues S, Macgregor GA. Salt reduction in England from 2003 to 2011: its relationship to blood pressure, stroke and ischaemic heart disease mortality. BMJ Open. 2014;4(4):e004549.
246. MacGregor GA, He FJ, Pombo-Rodrigues S. Food and the responsibility deal: how the salt reduction strategy was derailed. BMJ. 2015;350:h1936.
247. Anonymous. Warenwetregeling babyvoeding. Staatscourant. 1997;19:10.
248. European Commission. Commission Directive 2006/141/EC of 22 December 2006 on infant formulae and follow-on formulae and amending Directive 1999/21/EC. Official Journal of the European Union. 2006:L 401/1 - L /33.
249. Allen L, De Benoist B, Dary O, Hurrell R. Guidelines on food fortification with micronutrients. Geneva; 2006.
250. Health Council of the Netherlands. Towards maintaining an optimum iodine intake. The Hague: Health Council of the Netherlands; 2008.

251. Anonymous. Convenant Vitaminering van Smeerbare vetproducten (GZB/VVB/997542) 1999 [updated 2006/07/25. Available from: www.mvo.nl.
252. Anonymous. Convenant gebruik bakkerszout. Staatscourant. 2008;325.
253. Kraak H. Convenant verlengd. Fabrikanten blijven vrijwillig vitamine A en D toevoegen aan smeervetten. Voeding Nu. 2004;6(2):14-5.
254. Health Council of the Netherlands. Towards an adequate intake of vitamin D. The Hague: Health Council of the Netherlands; 2008.
255. Anonymous. Warenwetbesluit Toevoeging micro-voedingsstoffen aan levensmiddelen. Staatsblad. 1996;311:1-18.
256. Anonymous. Regulation (EC) No 1925/2006 of the European Parliament and of the Council of 20 December 2006 on the addition of vitamins and minerals and of certain other substances to foods. Official Journal of the European Union. 2006;L 404:26-38.
257. Hoey L, McNulty H, Askin N, Dunne A, Ward M, Pentieva K, et al. Effect of a voluntary food fortification policy on folate, related B vitamin status, and homocysteine in healthy adults. American Journal of Clinical Nutrition. 2007;86(5):1405-13.
258. Hennessy A, Walton J, Flynn A. The impact of voluntary food fortification on micronutrient intakes and status in European countries: a review. The Proceedings of the Nutrition Society. 2013;72(4):433-40.
259. Europese Hof van J. Arrest van het Hof (Derde kamer) van 2 december 2004 in zaak C-41/02: Commissie van de Europese Gemeenschappen tegen Koninkrijk der Nederlanden. Publicatieblad van de Europese Unie. 2005;C19/02.
260. Anonymous. Warenwetregeling vrijstelling toevoeging foliumzuur en vitamine D aan levensmiddelen. Staatscourant. 2007;12:11-2.
261. Kloosterman J, Fransen HP, de Stoppelaar J, Verhagen H, Rompelberg C. Safe addition of vitamins and minerals to foods: setting maximum levels for fortification in the Netherlands. European Journal of Nutrition. 2007;46(4):220-9.
262. Flynn A, Moreiras O, Stehle P, Fletcher RJ, Muller DJ, Rolland V. Vitamins and minerals: a model for safe addition to foods. European Journal of Nutrition. 2003;42(2):118-30.
263. Domke A, Grossklaus R, Niemann B, Przyrembel H, Richter K, Schmidt E, et al. Verwendung von Vitaminen in Lebensmitteln - Toxicologische und ernährungsphysiologische Aspekte. Berlin; 2004.
264. Domke A, Grossklaus R, Niemann B, Przyrembel H, Richter K, Schmidt E, et al. Verwendung von Mineralstoffen in Lebensmitteln - Toxicologische und ernährungsphysiologische Aspekte. Berlin; 2004.
265. Bruins MJ, Mugambi G, Verkaik-Kloosterman J, Hoekstra J, Kraemer K, Osendarp S, et al. Addressing the risk of inadequate and excessive micronutrient intakes: traditional versus new approaches to setting adequate and safe micronutrient levels in foods. Food & Nutrition Research. 2015;59:26020.

266. Verkaik-Kloosterman J. Estimation of micronutrient intake distributions. Development of methods to support food and nutrition policy making. Wageningen: Wageningen University; 2011.
267. Verkaik-Kloosterman J, Dekkers ALM, Dodd KW, Kirkpatrick SI, Ocké MC. A new approach to estimate safe maximum fortification levels for micronutrients. 2012.
268. Van Rossum C, Verkaik-Kloosterman J, Beukers M, Westenbrink S. Impact of fortified foods during last decade in the Netherlands. Annals of Nutrition and Metabolism. 2013;63(suppl 1):183.
269. Geurts M, Van Rossum C, Brants H, Verkaik-Kloosterman J, Westenbrink S. Veranderingen in het aanbod van voedingsmiddelen en de voedselconsumptie. Bilthoven: RIVM; 2013. RIVM briefrapport 090429001.
270. Geurts M, Westenbrink S, Verkaik-Kloosterman J, Van Rossum CT. Trends in food consumpiton over 25 years in a Dutch adult population. Annals of Nutrition and Metabolism. 2013;63(suppl 1):248.
271. European Commission. Nutrition and Health Claims Brussels: European Commission; last updated: 09-10-2015 [Available from: http://ec.europa.eu/geninfo/legal_notices_en.htm#copyright.
272. Verkaik-Kloosterman J, Buurma-Rethans EJM, Dekkers ALM. Inzicht in de jodiuminname van kinderen en volwassenen in Nederland. Resultaten uit de Voedselconsumptiepeiling 2007-2010. Bilthoven: RIVM; 2012. RIVM report 350090012.
273. Geurts M, Verkaik-Kloosterman J. De jodiuminname van de Nederlandse bevolking na verdere zoutverlaging in brood. Bilthoven: RIVM; 2014. RIVM briefrapport 2014-0054.
274. Hennessy A, Hannon EM, Walton J, Flynn A. Impact of voluntary food fortification practices in Ireland: trends in nutrient intakes in Irish adults between 1997-9 and 2008-10. British Journal of Nutrition. 2014:1-11.
275. American Dietetic Association. Position of the American Dietetic Association: fortification and nutritional supplements. Journal of the American Dietetic Association. 2005;105(8):1300-11.
276. Berner LA, Clydesdale FM, Douglass JS. Fortification contributed greatly to vitamin and mineral intakes in the United States, 1989-1991. Journal of Nutrition. 2001;131(8):2177-83.
277. Berner LA, Keast DR, Bailey RL, Dwyer JT. Fortified foods are major contributors to nutrient intakes in diets of US children and adolescents. Journal of the Academy of Nutrition and Dietetics. 2014;114(7):1009-22 e8.
278. Sacco JE, Dodd KW, Kirkpatrick SI, Tarasuk V. Voluntary food fortification in the United States: potential for excessive intakes. European Journal of Clinical Nutrition. 2013;67(6):592-7.
279. Anonymous. Regeling van de Minister van Volksgezondheid, Welzijn en Sport van 6 februari 2012, nr. VGP/3102292, houdende wijziging van de Warenwetregeling voedingssupplementen in verband met wijzigingen van Richtlijn 2002/46/EG. Staatscourant. 2012;2810:1-2.
280. Anonymous. Warenwetregeling voedingssupplementen. Staatscourant. 2003;66:10.
281. Anonymous. Warenwetbesluit Kruidenpreparaten. Staatsblad. 2001;56.

282. KNOV. Vitamine D en K Utrecht: KNOV; 24 october 2013 (update 26 May 2014) [Available from: http://www.knov.nl/vakkennis-en-wetenschap/tekstpagina/536/vitamine-d-en-k/.
283. Voedingsraad. Advies beoordeling effectiviteit van de strumaprofylaxe in Nederland. The Hague: Netherlands Bureau for Nutrition Education; 1993.
284. Woude PA, Walle HE, Berg LT. Periconceptional folic acid use: still room to improve. Birth Defects Research Part A, Clinical and Molecular Teratology. 2012;94(2):96-101.
285. de Smid DJ, de Jong-van den Berg LT, Cornel MC. Foliumzuursuppletiebeleid bij zwangerschap werkt, maar moet beter. Nederlands Tijdschrift voor Geneeskunde. 2012;156(41):A4512.
286. VWS. Prenatale screening. Brief van de Minister van Volksgezondheid, Welzijn en Sport. Den Haag; KST94077; 2006.
287. Mannien J, de Jonge A, Cornel MC, Spelten E, Hutton EK. Factors associated with not using folic acid supplements preconceptionally. Public Health Nutrition. 2014;17(10):2344-50.
288. Timmermans S, Jaddoe VW, Mackenbach JP, Hofman A, Steegers-Theunissen RP, Steegers EA. Determinants of folic acid use in early pregnancy in a multi-ethnic urban population in the Netherlands: the Generation R Study. Preventive Medicine. 2008;47(4):427-32.
289. Barbour RS, Macleod M, Mires G, Anderson AS. Uptake of folic acid supplements before and during pregnancy: focus group analysis of women's views and experiences. Journal of Human Nutrition and Dietetics. 2012;25(2):140-7.
290. McGuire M, Cleary B, Sahm L, Murphy DJ. Prevalence and predictors of periconceptional folic acid uptake--prospective cohort study in an Irish urban obstetric population. Human Reproduction. 2010;25(2):535-43.
291. Stockley L, Lund V. Use of folic acid supplements, particularly by low-income and young women: a series of systematic reviews to inform public health policy in the UK. Public Health Nutrition. 2008;11(8):807-21.
292. Oliver EM, Grimshaw KE, Schoemaker AA, Keil T, McBride D, Sprikkelman AB, et al. Dietary habits and supplement use in relation to national pregnancy recommendations: data from the EuroPrevall birth cohort. Maternal and Child Health Journal. 2014;18(10):2408-25.
293. de Jong-Van den Berg LT, Hernandez-Diaz S, Werler MM, Louik C, Mitchell AA. Trends and predictors of folic acid awareness and periconceptional use in pregnant women. American Journal of Obstetrics & Gynecology. 2005;192(1):121-8.
294. De Jonge A, Mohangoo AD, Korfker DG, Schönbeck Y, Van der Pal SM, Detmar SB. Effect van stimuleringsbeleid preconceptioneel foliumzuurgebruik op kennis en gebruik van foliumzuur door allochtone vrouwen. Leiden: TNO; 2008. Report No.: KvL/P&Z 2008.134.
295. Obeid R, Pietrzik K, Oakley GP, Jr., Kancherla V, Holzgreve W, Wieser S. Preventable spina bifida and anencephaly in Europe. Birth Defects Research Part A, Clinical and Molecular Teratology. 2015;103(9):763-71.
296. Health Council of the Netherlands. Towards an optimal use of folic acid. The Hague: Health Council of the Netherlands; 2008.

297. de Jong-van den Berg LT, de Walle HE, van der Pal-de Bruin KM, Buitendijk SE, Cornel MC. Increasing awareness of and behaviour towards periconceptional folic acid consumption in the Netherlands from 1994 to 1995. European Journal of Clinical Pharmacology. 1998;54(4):329-31.
298. de Walle HE, van der Pal KM, de Jong-van den Berg LT, Schouten J, de Rover CM, Buitendijk SE, et al. Periconceptional folic acid in the Netherlands in 1995. Socioeconomic differences. Journal of Epidemiology and Community Health. 1998;52(12):826-7.
299. de Walle HE, Cornel MC, de Smit DJ, de Jong-Van Den Berg LT. Preconceptional use of folic acid amongst women of advanced maternal age. Prenatal Diagnosis. 1999;19(10):996-7.
300. de Walle HE, van der Pal KM, de Jong-van den Berg LT, Jeeninga W, Schouten JS, de Rover CM, et al. Effect of mass media campaign to reduce socioeconomic differences in women's awareness and behaviour concerning use of folic acid: cross sectional study. BMJ. 1999;319(7205):291-2.
301. de Walle HE, Cornel MC, de Jong-van den Berg LT. Three years after the Dutch folic acid campaign: growing socioeconomic differences. Preventive Medicine. 2002;35(1):65-9.
302. de Walle HE, de Jong-van den Berg LT. Insufficient folic acid intake in the Netherlands: what about the future? Teratology. 2002;66(1):40-3.
303. de Walle HE, de Jong-van den Berg LT. Growing gap in folic acid intake with respect to level of education in the Netherlands. Community Genetics. 2007;10(2):93-6.
304. de Walle HE, de Jong-van den Berg LT. Ten years after the Dutch public health campaign on folic acid: the continuing challenge. European Journal of Clinical Pharmacology. 2008;64(5):539-43.
305. Steenweg RJ, Hennin HL, Bety J, Gilchrist HG, Williams TD, Crossin GT, et al. Sources of diel variation in energetic physiology in an Arctic-breeding, diving seaduck. General and Comparative Endocrinology. 2015;216:39-45.
306. Baron R, Mannien J, te Velde SJ, Klomp T, Hutton EK, Brug J. Socio-demographic inequalities across a range of health status indicators and health behaviours among pregnant women in prenatal primary care: a cross-sectional study. BMC Pregnancy Childbirth. 2015;15:261.
307. Mohangoo AD, Van Gameren HBM, Schönbeck Y, Buitendijk SE, Van der Pal-de Bruin KM. Aangeboren afwijkingen in Nederland 1997-2009: Gebaseerd op de landelijke verloskunde en neonatolotie registraties. Leiden: TNO; 2011. Report No.: TNO/CH 2001.042.
308. De-Regil LM, Palacios C, Ansary A, Kulier R, Pena-Rosas JP. Vitamin D supplementation for women during pregnancy. Cochrane Database of Systematic Reviews. 2012;2:CD008873.
309. Vinkhuyzen AA, Eyles DW, Burne TH, Blanken LM, Kruithof CJ, Verhulst F, et al. Prevalence and predictors of vitamin D deficiency based on maternal mid-gestation and neonatal cord bloods: The Generation R Study. Journal of Steroid Biochemistry and Molecular Biology. 2015.
310. van Ballegooijen AJ, Visser M, Brouwer IA. Determinanten van vitamine D- gebruik door thuiswonende ouderen. Tijdschrift voor Gerontologie en Geriatrie. 2015;46(5):282-9.

311. Gezondheidsraad. Graadmeter #3 (extra inname vitamine K gewenst voor borstgevoede zuigelingen). Den Haag: Gezondheidsraad; 2010.
312. Büchner FL, Jansen-van der Vliet M, Van Rossum CTM. Copper intake in young Children. Bilthoven: RIVM; 2010. RIVM report 350023001.
313. Rock CL. Multivitamin-multimineral supplements: who uses them? American Journal of Clinical Nutrition. 2007;85(1):277S-9S.
314. Murphy SP, White KK, Park SY, Sharma S. Multivitamin-multimineral supplements' effect on total nutrient intake. American Journal of Clinical Nutrition. 2007;85(1):280S-4S.
315. European Parliament, Council of the European Union. Regulation (EU) No 2015/2283 of the European Parliament and of the Council of 25 November 2015 concerning novel foods. Official Journal of the European Union. 2015;58(25 November 2015):L327/1-L/22.
316. European Parliament, Council of the European Union. Regulation (EC) No 258/97 of the European Parliament and of the Council of 27 January 1997 concerning novel foods and novel food ingredients. Official Journal of the European Union. 1997;40(14 February 1997):L43.
317. Brosens M, Hendriksen M, Niekerk M, Temme L, van Raaij J. Post-launch monitoring of novel foods/ingredients: Methodology applied to additive stevia. Bilthoven: RIVM; 2014. RIVM briefrapport 090432001.
318. Brosens M, Niekerk M, Temme L, van Raaij J. Post-launch monitoring of foods and supplements with Krill oil and oil from microalgae Schizochytrium sp. Bilthoven: RIVM; 2014. RIVM Briefrapport 2014-0114.
319. Schafer Elinder L. Public Health Aspects of the EU Common Agricultural Policy: developments and recommendations for change in four sectors: fruit and vegetables, dairy, wine, tobacco. Stockholm, Sweden: National Institute for Public Health 2003.
320. Schmidhuber J. The EU Diet - Evolution, Evaluation and Impacts of the CAP. Rome, Italy: FAO; 2014.
321. Birt C, Maryon-Davis A, Stewart L, Parkin C, SCapewell S, Mwatsama M. A CAP on Health? The Impact of the EU Common Agricultural Policy on Public Health. London, UK: Faculty of Public Health; 2007.
322. Voedingscentrum. Richtlijnen Schijf van Vijf 2016 2016 [Available from: http://www.voedingscentrum.nl/Assets/Uploads/voedingscentrum/Documents/Consumenten/Schijf%20van%20Vijf%202016/VC_Richtlijnen_Schijf_van_Vijf_2016.pdf.
323. Voedingscentrum. Gezond eten met de Schijf van Vijf 2016 [Available from: http://www.voedingscentrum.nl/nl/gezond-eten-met-de-schijf-van-vijf.aspx.
324. Voedingscentrum. Waarom ziet de Schijf van Vijf er zo uit? Den Haag: Voedingscentrum; 2016 [Available from: http://www.voedingscentrum.nl/professionals/schijf-van-vijf/waarom-ziet-de-schijf-van-vijf-er-zo-uit.aspx.

325. Geurts M, Toxopeus I, van Rossum CTM, Vennemann F, Buurma-Rethans E, Ocké M. MEMO: Achtergrondgegevens van referentievoedingen voor de Richtlijnen Schijf van Vijf 2016 - version 22016. Available from: http://www.rivm.nl/dsresource?objectid=84accf39-3688-4d19-8709-d8992e6e9c2a&type=pdf&disposition=inline.
326. Kaput J, Ordovas JM, Ferguson L, van Ommen B, Rodriguez RL, Allen L, et al. The case for strategic international alliances to harness nutritional genomics for public and personal health. British Journal of Nutrition. 2005;94(5):623-32.
327. Fenech M, El-Sohemy A, Cahill L, Ferguson LR, French TA, Tai ES, et al. Nutrigenetics and nutrigenomics: viewpoints on the current status and applications in nutrition research and practice. Journal of Nutrigenetics and Nutrigenomics. 2011;4(2):69-89.
328. Simopoulos AP. Nutrigenetics/Nutrigenomics. Annual Review of Public Health. 2010;31:53-68.
329. Collins FS, Varmus H. A new initiative on precision medicine. The New England Journal of Medicine. 2015;372(9):793-5.
330. Personalized Medicine Coalition. The case for personalized medicine. 2014.
331. European Commission. Commission Directive 1999/21/EC of 25 March 1999 on dietary foods for special medical purposes. Official Journal of the European Communities. 1999:L91/29-L91/36.
332. Zeevi D, Korem T, Zmora N, Israeli D, Rothschild D, Weinberger A, et al. Personalized Nutrition by Prediction of Glycemic Responses. Cell. 2015;163(5):1079-94.
333. Chen R, Mias George I, Li-Pook-Than J, Jiang L, Lam Hugo YK, Chen R, et al. Personal Omics Profiling Reveals Dynamic Molecular and Medical Phenotypes. Cell. 2012;148(6):1293-307.
334. Gorman U, Mathers JC, Grimaldi KA, Ahlgren J, Nordstrom K. Do we know enough? A scientific and ethical analysis of the basis for genetic-based personalized nutrition. Genes & Nutrition. 2013;8(4):373-81.
335. Therrell BL, Padilla CD, Loeber JG, Kneisser I, Saadallah A, Borrajo GJ, et al. Current status of newborn screening worldwide: 2015. Seminars in Perinatology. 2015;39(3):171-87.
336. Kaput J. Nutrigenomics research for personalized nutrition and medicine. Current Opinion in Biotechnology. 2008;19(2):110-20.
337. Fumagalli M, Moltke I, Grarup N, Racimo F, Bjerregaard P, Jorgensen ME, et al. Greenlandic Inuit show genetic signatures of diet and climate adaptation. Science. 2015;349(6254):1343-7.
338. Kroger E, Laforce R, Jr. Fish Consumption, Brain Mercury, and Neuropathology in Patients With Alzheimer Disease and Dementia. JAMA. 2016;315(5):465-6.
339. Jirtle RL, Skinner MK. Environmental epigenomics and disease susceptibility. Nature Reviews Genetics. 2007;8(4):253-62.
340. Mathers JC, McKay JA. Epigenetics - potential contribution to fetal programming. Advances in Experimental Medicine and Biology. 2009;646:119-23.
341. Monteiro JP, Kussmann M, Kaput J. The genomics of micronutrient requirements. Genes & Nutrition. 2015;10(4):466.
342. Gerhauser C. Cancer chemoprevention and nutriepigenetics: state of the art and future challenges. Topics in Current Chemistry. 2013;329:73-132.

343. Cho I, Blaser MJ. The human microbiome: at the interface of health and disease. Nature Reviews Genetics. 2012;13(4):260-70.
344. Zmora N, Zeevi D, Korem T, Segal E, Elinav E. Taking it Personally: Personalized Utilization of the Human Microbiome in Health and Disease. Cell Host & Microbe. 2016;19(1):12-20.
345. Roberts JS, Ostergren J. Direct-to-Consumer Genetic Testing and Personal Genomics Services: A Review of Recent Empirical Studies. Current Genetic Medicine Reports. 2013;1(3):182-200.
346. Schippers EI, van Rijn MJ. Kamerbrief over Landelijke nota gezondheidsbeleid 2016-2019. 2015.
347. Zorginstituut Nederland. Zorgstandaarden: Zorginstituut Nederland; [Available from: https://www.zorginstituutnederland.nl/kwaliteit/zorginzicht/zorgstandaarden.
348. Zorgmodule voeding. Amsterdam: Ontwikkel- en onderhoudsgroep zorgmodule voeding,; 2012.
349. Partnerschap Overgewicht Nederland. Zorgstandaard obesitas. Amsterdam; 2010.
350. Drewes HW, Heijink R, Struijs JN, Baan CA. Samen werken aan duurzame zorg. Landelijke monitor proeftuinen. Bilthoven: RIVM; 2015. RIVM Report 2015-0076.
351. Dekker JM, Alssema M, Janssen PGH, Van der Paardt M, Festen CCS, M.J.W. VO, et al. NHG Standaard het PreventieConsult module Cardiometabool Risico. Huisarts en Wetenschap. 2011;54(3):138-55.
352. Hollander M, Schellevis F, de Wit N. Preventie hart- en vaatziekten is los zand. Medisch Contact. 2016(06):34-6.
353. Tol J. Dietetics and weight management in primary health care: Tilburg University; 2015.
354. van den Berg M, Post NAM, H.H. H-vR, Baan CA, Schoemaker CG. Preventie in de Zorg. Bilthoven: RIVM; 2013. RIVM Report 010003002/2013.
355. Gezondheidsraad. Kalium - Achtergronddocument bij Richtlijnen goede voeding 2015 Den Haag; 2015. Report No.: A15/13.
356. Gezondheidsraad. Voedingscholesterol - Achtergronddocument bij Richtlijnen goede voeding 2015. Den Haag; 2015. Report No.: A15/28.
357. Gezondheidsraad. Eieren - Achtergronddocument bij Richtlijnen goede voeding 2015. . Den Haag; 2015. Report No.: A15/09.
358. Gezondheidsraad. Vetten en oliën - Achtergronddocument bij Richtlijnen goede voeding 2015. . Den Haag; 2015. Report No.: A15/24.
359. Gezondheidsraad. Thee - Achtergronddocument bij Richtlijnen goede voeding 2015. Den Haag; 2015. Report No.: A15/19.
360. Gezondheidsraad. Koffie - Achtergronddocument bij Richtlijnen goede voeding 2015. Den Haag; 2015. Report No.: A15/14.
361. Gezondheidsraad. Verteerbare koolhydraten - Achtergronddocument bij Richtlijnen goede voeding 2015. Den Haag; 2015. Report No.: A15/23.

Appendix 1: List of abbreviations

AI	Adequate intake
ALA	Alpha-linoleic acid
BMI	Body Mass Index
CDM	Chronic Disease Model
CHD	Coronary heart disease
COPD	Chronic obstructive pulmonary disease
CVD	Cardiovascular diseases
DASH	Dietary Approaches to Stop Hypertension
DHA	Docosahexaenoic acid
DHD	Dutch Healthy Diet
DNFCS	Dutch National Food Consumption Survey
EAR	Estimated Average Requirements
EC	European Commission
EFSA	European Food Safety Authority
EPA	Eicosapentaenoic acid
EPIC	European prospective investigation into cancer and nutrition
EPODE	Ensemble Prévenons L'Obésité Des Enfants
ESPEN	European Society for Clinical Nutrition and Metabolism
EU	European Union
FBDG	Food-Based Dietary Guidelines
FNLI	Federation of the Dutch Food Industry
FSA	Food Standards Agency
IOM	Institute of Medicine
JOGG	Youth at a Healthy Weight
LASA	Longitudinal Aging Study Amsterdam
LDL	Low Density Lipoprotein
LE	Life expectancy
LEDA	Levensmiddelendatabase
MUFA	Monounsaturated fatty acids
NCD	Non-communicable disease
NEL	Nutrition Evidence Library
NES	Dutch supplement database
NEVO	Dutch food composition database
NGO	Nongovernmental organization
NPP	National Prevention Programme (Everything is Health)
NPS	Nutrient profiling systems
NVVL	Network for Food Experts
NVWA	Netherlands Foods and Consumer Product Safety Authority
PKU	Phenylketonuria
PUFA	Polyunsaturated fatty acids
QALY	Quality adjusted life years
RAE	Retinol activity equivalents
RDA	Recommended daily allowance
SFA	Saturated fatty acids
SME	Small and medium scale enterprises
TFA	Trans fatty acids
TFIFAC	Dutch Task Force for the Improvement of the Fatty Acid Composition

UL	Upper limit
USDA	Unites Stated Department of Agriculture
WASH	World Action of Salt and Health
WCRF	World Cancer Research Fund
WHO	World Health Organization
WRR	Dutch Scientific Council for Government Policy

Appendix 2. Effect estimates for relations between diet and disease, which the Health Council of the Netherlands classified as convincing

	Change in level of			Change in risk of						
	Systolic blood pressure (mmHg)	**LDL-cholesterol (mmol/l)**	**Body weight (kg)**	**Total mortality**	**Coronary heart disease**	**Stroke**	**Type 2 diabetes**	**Colo-rectal cancer**	**Breast cancer**	**Lung cancer**
FRUIT AND VEGETABLES (44)										
Total	-3 per 400 gram									
Vegetables					-10% for 250 vs 125 gr/d	-10% per 200 gr/d		-10% for 250 vs 100 gr/d		
Green leafy vegetables							-10% for ≥60 vs 10 gr/d			-10% per 25 gr/d
Fruit					-10% for 250 vs 50 gr/d	-30% per 200 gr/d	-10% for 300 vs 50 gr/d	-10% for 300 vs 100 gr/d		-10% for 200 vs 50 gr/d
WHOLE GRAINS (47)										
Total					-25% for 90 gr/d		-25% for 60 gr/d	-10% for 90 gr/d		
Oats		-0.2 per 30-60 gr/d								
LEGUMES (50)										
Total		-0.2 per 130 gr/d								
NUTS AND SEEDS (55)										
Nuts		-0.15 per 35 gr/d			-20% for 15 gr/d					
Flaxseed		-0.15 per 35 gr/d								

	Change in level of			Change in risk of						
	Systolic blood pressure (mmHg)	LDL-cholesterol (mmol/l)	Body weight (kg)	Total mortality	Coronary heart disease	Stroke	Type 2 diabetes	Colo-rectal cancer	Breast cancer	Lung cancer
DIETARY FIBRE (59)										
Total	-4 to -6 per 10 gr/d[1]	-0.05 per 1 gr/d[2]			-10% per 7 gr/d	-15% for high vs low intake	-5% per 10 gr/d	-10% per 10 gr/d	-5% per 10 gr/d	
Grain fibre					-15% per 7 gr/d		-5% per 2 gr/d	-10% per 10 gr/d		
DAIRY (62)										
Total			+0.5 with 3 portions / d for 6 months					-15% per 400 gr/d		
Milk								-10% per 200 gr/d		
Yoghurt							-15% for ≥60 vs <10 gr/d			
FISH (63)										
Fish					-15% for ≥1x/wk vs <1x/month[4] -20% for ≥5x/wk vs <1x/month[5]	-10% for ≥1x/wk vs <1x/month				
FATTY ACIDS (65, 70, 73)										
EPA+DHA	-4.5 per 4 gr/d[1]	+0.2 for 1,5 gr/d			-10% for 1 gr/d[4,6]					
MUFA		-0.009 per 1 en%[7]								

	Change in level of			Change in risk of						
	Systolic blood pressure (mmHg)	LDL-cholesterol (mmol/l)	Body weight (kg)	Total mortality	Coronary heart disease	Stroke	Type 2 diabetes	Colo-rectal cancer	Breast cancer	Lung cancer
		-0.041 per 1 en%[8]								
PUFA		-0.019 per 1 en%[7] -0.051 per 1 en%[8]			-15% for 10 en%[8,11] -10% per 5 en%[8,12]					
Saturated		+0.032 per 1 en%[7]								
Trans		+0.040 per 1 en%[7] +0.038 per 1 en%[9] +0.051 per 1 en%[10]			+20% per 2 en%					
RED MEAT (74)										
Total						+10% for 100-120 gr/d	+15% for 100 gr/d	+10% for 100 gr/d		+20% for 100-120 gr/d
Processed						+10% for 50 gr/d	+20% for 50 gr/d	+15% for 50 gr/d		
Unprocessed						+10% for 100-120 gr/d	+15% for 100-120 gr/d			
ALCOHOL (77, 78)										
Total[13]	-1.0 for			-15% for 6	-25% for ≥2,5 vs	-20% for	-20% for 6-	+20% for 30-	+5% for	

	Change in level of			Change in risk of						
	Systolic blood pressure (mmHg)	LDL-cholesterol (mmol/l)	Body weight (kg)	Total mortality	Coronary heart disease	Stroke	Type 2 diabetes	Colo-rectal cancer	Breast cancer	Lung cancer
	10% reduction			vs 0 gr/d	0 gr/d +45% for binge vs regular	>0-15 vs 0 gr/d +35% for ≥30 vs 0-15 gr/d	48 (men) and >0-24 (women) gr/d	60 vs 0 gr/d	5-15 vs 0.1-5 gr/d +10% for 15-30 vs 0.1-5 gr/d	
From wine				-30% (men) and -20% (women) for >0-10 vs 0 gr/d +20% for >40 vs >0-3 gr/d (men) +15% for >20 vs >0-3 gr/d (women)				+20% for 20-40 vs >0-3 gr/d		-25% for >0-12 vs 0 gr/d
From beer				+10% (men) and +15% (women) for 10-20			+15% for >0 vs no beer (men)	+35% for 20-40 vs >0-3 gr/d		-20% for 5-15 (men) and >0-5 (women) vs 0 gr/d

	Change in level of			Change in risk of						
	Systolic blood pressure (mmHg)	LDL-cholesterol (mmol/l)	Body weight (kg)	Total mortality	Coronary heart disease	Stroke	Type 2 diabetes	Colo-rectal cancer	Breast cancer	Lung cancer
				vs >0-3 gr/d						+90% for ≥15 vs 0 gr/d (women)
From spirits							+10% for 0.1-12 vs 0 gr/d (women)			+35% for ≥ 15 vs 0 gr/d (men)
SUGAR-SWEETENED BEVERAGES (81)										
Total			+1 for 1 liter/d[14] -0.3 kg/m^2 when replaced with zero calorie drinks[15]				+20% per 330 ml/d			
OTHER										
Sodium (83)	-2 with 1.8 gr/d reduction[1] [6] -5 with 1.8 gr/d reduction[1]									
Potassium	-4 with 2					-10% per				

	Change in level of			Change in risk of						
	Systolic blood pressure (mmHg)	LDL-cholesterol (mmol/l)	Body weight (kg)	Total mortality	Coronary heart disease	Stroke	Type 2 diabetes	Colo-rectal cancer	Breast cancer	Lung cancer
(355)	gr/d increase[1]					1 gr/d				
Cholesterol (356)		+0.05 per 100 mg/d[17]					+25% for 400 mg/d			
Eggs (357)							+40% for ≥ 1 p/d vs <1 p/wk			
Soft margarines (358)		-0,20 for 10en%[18]								
Black tea (359)	-2 for 5 cups/d					-10% for 3 cups/d	-15% for 4 cups/d			
Green tea (359)	-2 for 3 cups/d	-0,05 for 3 cups/d				-10% for 3 cups/d				
Coffee (360)		+0.30 for 5-6 cups/d[19]			-10% for 2-4 cups/d	-10% for 2-4 cups/d	-30% for 5 cups/d			
Mono-sac-charides and disaccharides (361)		+0.25 for 15 en%[20]								
Glycaemic index (361)					+10% for 85 vs 70 units		+10% per 5 units[21]			
Glycaemic load (361)					+30% for 225 vs 135 units		+5% per 20 units			

1. In hypertensives, 2. Trials with beta-glucans or pectin, 3. DHA only, 4. CHD mortality, 5. Non-fatal CHD, 6. In persons with (high risk of) CVD, 7. When replacing carbohydrates, 8. When replacing Saturated fatty acids, 9. When replacing cis-Monounsaturated fatty acids, 10. When replacing cis-Polyunsaturated fatty acids, 11. In intervention studies, 12. In cohort studies, 13. Additional associations: 20% lower heart failure risk for 2-28 vs 0

gr/d; 25% lower risk of dementia/cognitive decline for >0-30 vs 0 gr/d, 14. Body weight in adults, 15. Weight change in children and adolescents, 16. In normotensives, 17. Cholesterol from eggs, 18. When replacing butter, 19. Unfiltered Coffee, 20. When replacing starch, 21 Seems largely restricted to North-American countries.

J.M.A. Boer | E.J.M. Buurma-Rethans | M. Hendriksen | H.J. van Kranen |
I.E.J. Milder | M.C. Ocké | J. Verkaik-Kloosterman | J. van Raaij

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