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Our food, our health

Healthy diet and safe food in the Netherlands

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A publication by the
National Institute for Public Health and the Environment
P.O. Box 1
3720 BA Bilthoven
The Netherlands

The report was originally published in Dutch under the title *Ons eten gemeten: Gezonde voeding en veilig voedsel in Nederland*
Translation: Taalcentrum-VU, Amsterdam

RIVM report number 270555009
ISBN 90-6960-135-4
ISBN 978-90-6960-135-9
NUR 882

FOREWORD

Food. We cannot survive without it. It is a primary life requirement for us all. But food is more than that. Food also plays an important role in terms of our health. An optimal diet helps to maintain good health.

In the Netherlands, an unhealthy dietary pattern is responsible for a large proportion of the ill-health and deaths due to cardiovascular diseases, diabetes and cancer. An increasing number of Dutch people are overweight. This is due to eating too much, particularly fat-rich foods, and to insufficient physical activity. The increase in the number of children with overweight is alarming. We must halt this trend by encouraging people to adopt a healthier diet and to be more physically active. The consumption of enough fruit, vegetables and fish is good for the heart and blood vessels. The quantity of food consumed is also important, and should be in line with the daily amount of physical activity. In short, eating healthily and in moderation is good for your health.

Needless to say, our food must also be *safe*. Much has been done in past centuries to ensure that this is the case. Production techniques have been greatly improved, the quality of our food is continually monitored, and control systems have been introduced. In the Netherlands, responsibility for food safety is shared by the Ministry of Health, Welfare and Sport, and the Ministry of Agriculture, Nature and Food Quality.

Although much has been achieved in terms of food safety, we must not rest on our laurels. New developments and emerging threats must be addressed. New products are being introduced all the time, such as food with health-promoting additions and genetically modified foods. Their safety must also be assured.

This report, which was commissioned by the Ministry of Health, Welfare and Sport, considers the various health-related aspects of diet and nutrition. It offers an overview of current knowledge concerning the effects of diet and foods upon health. It not only provides information about past trends and the current situation, but also considers future developments with regard to the nutritional value and safety of our food.

The report has been written in such a way as to make it useful to both scientists and policy-makers. It will undoubtedly make a substantial contribution to the production and consumption of healthy, safe food.

The Minister of Health, Welfare and Sport,

H. Hoogervorst

ACKNOWLEDGEMENTS

This report, originally published in Dutch under the title *Ons eten gemeten*, is a collaborative publication of the Nutrition, Medicines and Consumer Safety Division and the Public Health and Health Services Division of the National Institute for Public Health and the Environment (RIVM). The report is one of a series of reports on Public Health Forecasts in the Netherlands.
The report, moreover, contains contributions from other institutes and universities, which are gratefully acknowledged. The institutions in question are: Wageningen University, TNO Quality of Life, Vrije Universiteit Amsterdam, and Maastricht University.

Many individuals have made valuable contributions to this report. These include authors from RIVM and other institutes (mentioned above), reviewers and other experts consulted, as well as the members of the Policy Advisory Group. To acknowledge and underline the importance of their input, the names of all those involved have been included in Appendices 1-3.

The European Food Safety Authority (EFSA) considers this report to be a significant contribution to the international discussion on the risks and benefits of food, as well as an important reference guide for its Scientific Committee and Scientific Panels. For this reason, EFSA has provided financial support for the translation of this report into English. The RIVM would like to thank the European Food Safety Authority for this financial contribution.

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KEY MESSAGES

Dutch people are less healthy than they could be due to an unhealthy diet. In particular, they eat too much and consume the wrong types of foods.

- Over the past century, the Dutch diet has become healthier and safer. As a result, general health has improved and life expectancy has increased. However nowadays health is threatened by an unhealthy diet, and because the number of people who are overweight is increasing.
- The percentage of people classified as obese has doubled in the last 25 years to approximately 10% of the adult population. It is predicted that this figure will rise to 15% within the next 20 years. Most alarmingly, there is a comparable increase in the percentage of children who are overweight. Overweight and obesity are caused by an energy-dense diet in combination with a lack of physical activity, resulting in an energy imbalance.
- The unfavourable composition of the Dutch diet (based on the study of five important dietary factors) also leads to considerable health loss. The intake of saturated and *trans* fatty acids is too high, while the consumption of fish, fruit and vegetables is too low.
- Overweight and unfavourable dietary composition each account for approximately 40,000 cases of adult-onset diabetes, cardiovascular diseases and different types of cancer in total per year. Unfavourable dietary composition is twice as likely as overweight to result in death: 10% of all deaths in the Netherlands are attributable to the composition of the diet and 5% to overweight. In terms of the average life expectancy of all 40-year-olds, this means that unfavourable dietary composition reduces life expectancy by 1.2 years, while overweight will reduce life expectancy by 0.8 years. It is not known what proportion of the health problems caused by overweight can be attributed to diet.
- The overall health loss caused by an unhealthy diet is comparable to that caused by smoking. Measured in DALYs (Disability Adjusted Life Years: a summary measure which combines death and illness, using a disability weighing factor for the seriousness of the disease), the annual health loss due to an unhealthy diet is between 300,000 and 400,000 units. This figure includes 245,000 DALYs caused by unfavourable dietary composition and an unknown proportion of the 215,000 DALYs which are due to overweight. In the case of smoking, the annual health loss is estimated to be just over 350,000 DALYs.

Dietary interventions can reverse a substantial proportion of the health loss. However, if the current trends continue, life expectancy may fall.

- Approximately *one half* of all deaths and illnesses due to the unfavourable dietary composition can be avoided by means of dietary interventions which are considered feasible (based on small-scale experiments). In particular, reducing the content of saturated and *trans* fatty acids in foods and increasing the consumption of fish, fruit and vegetables appears to be effective. In the case of overweight and obesity, approximately *one quarter* of all deaths and illnesses can be prevented, assuming an average weight loss of three kilograms per person.

- These modelled dietary interventions are in line with current favourable trends in fish consumption and the decreasing content of saturated and *trans* fatty acids in the diet. However, the trends in overweight and the consumption of fruit and vegetables show a very unfavourable picture. This indicates that a far more forceful preventive approach is called for in this area.
- If these trends continue (and other factors remain unaltered), life expectancy in the Netherlands will start to fall for the first time in many decades.

Functional foods and dietary supplements do not offer a solution to the health problems caused by an unhealthy diet.

- Consumers who follow the dietary guidelines have no need for functional foods or supplements. Only certain specific risk groups (such as infants and elderly persons with a low micronutrient status) will benefit from such products. Even in that case, the health gains will be limited.
- In many cases, no evidence exists to support the health claims made for such foods and supplements. The consumer may well be misled by extravagant advertising.
- As they may be consumed in excessive quantities, some bio-active ingredients pose a real risk of health loss. This is particularly the case with vitamin supplements in which the unit dose exceeds (sometimes by a wide margin) the safe upper level of intake, as seen with vitamin B_6 for example. Such products are currently freely available. The safe upper level can also be exceeded when several ‘enriched’ products are used in combination.

In recent years Dutch food has become demonstrably safer in terms of chemical and microbiological contamination. Nevertheless, food safety is often the subject of negative media coverage.

- The food consumed in the Netherlands has become safer over the past 20 years. For example, the contamination of animal products with *Salmonella* has been reduced considerably, as has the concentration of dioxins in foods and human breast milk.
- Food safety generally reaches the news only when problems occur, usually due to unavoidable incidents (‘Good news is no news’). This creates a distorted picture of the actual situation.
- The government and private sector have long been engaged in efforts to increase food safety and to provide a high degree of consumer protection. Food in the Netherlands, therefore, is now safer than ever before.

Nevertheless, unsafe food leads to health loss and new threats are emerging.

- Although the overall number of incidents involving *Salmonella* contamination have decreased in the Netherlands, foodborne infections continue to present a persistent problem. Every year, there are between 300,000 and 700,000 reported cases of gastroenteritis and several hundred other cases of serious illness. Foodborne infections account for some 20 to 200 deaths each year. The overall annual health loss is estimated to be between 1,000 and 4,000 DALYs.

- In some cases, chemical contamination and the presence of naturally occurring chemical compounds in food lead to a limited degree of health loss in the population (either demonstrable or theoretically estimated). In terms of actual illness, allergens form the most important category of agents, but these must be considered separately, given the differences in individual susceptibility. In the Netherlands, the overall health loss attributable to chemical contamination and allergens is estimated to be between 1,500 and 2,000 DALYs per annum.
- Experts predict that food in the Netherlands will become even safer in future. This is largely due to the increased attention being devoted to food safety. At the same time, new threats to food safety may emerge. They include new types of foodborne infection, the globalization of food production chains, the increasing consumption of raw or unprocessed products, and the over-consumption of functional foods and dietary supplements.

Effective risk communication with the consumer is essential in any food safety incident or crisis.

- There are no indications that the consumer has a persistent or increasing loss of confidence in food safety. However, this confidence is subject to major fluctuations when incidents or crises occur.
- The major problems attached to food safety incidents are those of assessing the actual risk to health and the unpredictability of public perception. Effective methods for assessing the actual health effects involved are not always available. Alongside the objective, calculated risk, the consumer's perception of risk will often form a far more important factor. This perception will be determined by factors such as the perceived seriousness and controllability of the risk or its expected consequences, as well as the nature and extent of media coverage.
- Risk management (and hence crisis management) therefore requires an understanding of both the actual risk and the perceived risk. Adequate measures together with open and transparent communication with the consumer form the basis for success.

Much greater health gains are to be made through encouraging a healthy diet than through improving food safety. This has consequences in terms of the priorities to be set.

- The comparison of the health gains theoretically attainable from a healthier diet on the one hand and improved food safety on the other, shows a clear preference for the former. Just through ensuring a proper dietary composition, separate from avoiding overweight, the maximum health gains (in DALYs) are some 40 to 100 times greater than the current overall health loss due to unsafe food.
- Besides the potential health gains, other factors must be considered when establishing priorities. These include the current trends and the feasibility of the proposed interventions. Consequently, three priorities have been identified:

1. The promotion of a healthy diet, with the secondary aims of:
   - Reducing overweight and obesity (major health gains, unfavourable trends, and interventions which may not be fully feasible).
   - Promotion of a proper dietary composition (major health gains, variable trends and variable feasibility of interventions).
2. The maintenance and (where necessary) improvement of the current high level of food safety (limited health gains, important social mandate and good feasibility of interventions).
3. Improvement of risk assessment methodologies and of risk communication with the consumer, particularly in the event of a food safety incident or crisis.

The main opportunities for creating a healthier diet and for increasing food safety are to be found on the supply side, i.e. in the hands of the private sector.

- The private sector can make a major contribution to a healthier diet and safer food. This can be done by restricting the supply of 'unhealthy' foods, reducing portion sizes, reducing advertising for 'unhealthy' foods (particularly that targeting children), offering a more affordable range of 'healthy' foods, increasing the traceability of products or ingredients, and by introducing new (food safety) technologies.
- Experts expect great gains from product modification, in which the composition of foods will be made healthier and consumers will not be required to alter their eating habits dramatically.
- The private sector could do more to address its responsibilities with regard to the issues above, becoming even more active than it already is.

The consumer also has an important role to play.

- The human environment has a major influence on people's eating habits. However, each consumer has overall responsibility for choosing the food he or she eats, and for its safe storage and preparation. A significant cultural shift is required to render a healthy diet and concern for one's weight a social norm. Eventually, this shift must lead to permanent and sustainable behavioural changes.

The government must create the necessary conditions, and may be required to take enforcement action where appropriate.

- If consumers are to fulfil their responsibilities, they must be given adequate information about a healthy diet and safe food. But they must also put that knowledge into practice. This will require education, information campaigns and practical skills training, together with a more explicit representation of their interests by consumer organizations in order to ensure adequate product information.
- The Dutch government must maintain the current high level of food safety. It must also invest in an adequate response to new developments in the commercial food chains, in crisis management and in effective consultation with the consumer.
- A thorough understanding of the actual nutritional situation in the Netherlands is essential to proper food policy. This calls for an effective monitoring system which will not only 'keep a finger on the pulse' but will also be essential in evaluating and further developing policy with regard to healthy diets and food safety.

- An integrated strategy seems to offer the best potential for promoting healthier eating habits. Such a strategy must not only address the supply side, but also the consumer and his or her environment. There should therefore be a combination of pricing policy, legislation, guidelines for the catering industry, measures applying to public places, health education and a shift in social norms. These measures should eventually lead to the 'healthy choice' becoming the 'easy choice.' An active approach on the part of government and the various societal organizations is called for.

PART A

OUR FOOD, OUR HEALTH:

Summary of the main findings of the report

1 Introduction

The report entitled '*Our food, our health; Healthy diet and safe food in the Netherlands*' is an English translation of a report that was originally published in Dutch. The original report, written by the National Institute for Public Health and the Environment (RIVM) and entitled *'Ons eten gemeten; Gezonde voeding en veilig voedsel in Nederland'*, was presented to the Dutch Minister of Health, Welfare and Sport on September 1, 2004.

This English report, just like the original report in Dutch, consists of two parts, *A* and *B*. *Part A* contains a summary of the report's main findings and is based on the scientific data presented and discussed in *part B*. This report also includes corrections to the data on disease-free life expectancy in *part B, chapters 2* and *7* (*sections 2.4, 7.4* and *appendix 12*).

There are many aspects to food and diet. This summary, which is concerned with the past, present and future, provides answers to questions from the perspective of health. How healthy is the Dutch diet? How safe is Dutch food? What health gains are to be had through better diet and eating habits and by reducing overweight[1]? What is the appropriate balance between the desire for a healthy diet and that for ensuring food safety? How will this affect the various parties involved in food production, distribution and consumption?

In answering these questions, a pragmatic definition of the terms 'healthy diet' and 'safe food' is applied. A healthy diet relies on both the *composition* and the *quantity* of food consumed. Thus we should eat neither too much nor too little (energy intake in balance with energy expenditure), and the composition of the diet should be in line with the recommendations. With regard to food safety, the emphasis is not only on possible microbiological or chemical contamination, but also on potentially harmful naturally-occurring constituents. Where the amount of such substances (either in or on the supplied/consumed foods) is below the level which could be considered harmful to human health, the term 'safe food' is applied.

In the Netherlands, the findings presented in this report can assist the Ministries of Health, Welfare and Sport (VWS) and Agriculture, Nature and Food Quality (LNV) in their efforts to develop a view on healthy diet and safe food. The information is also of significance to other parties, including the local and national organizations which attempt to promote healthy diets and better health, organizations which control food safety, those which produce, process, distribute, sell or prepare food (including the agricultural sector, the food industry, supermarkets, restaurants, schools, staff canteens and healthcare institutes), organizations engaged in food and nutrition research and, of course, the people most closely involved: consumers and consumer organizations.

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1 Overweight is defined as a Body Mass Index (BMI) equal to or greater than 25; severe overweight (obesity) is defined as a BMI equal to or greater than 30.

2 Main findings

2.1 How healthy is the Dutch diet ?

a. A healthy diet and safe food have contributed to the improvement of general health and have increased the average life expectancy

Food is a primary life requirement. Today, people in the Netherlands live much longer than previous generations. That is partly due to the availability of a sufficient quantity of good quality food. The Dutch now live in an era and a part of the world with an abundant food supply, and stringent control of food safety aspects. Furthermore, they now have access to greater scientific knowledge concerning healthy eating habits and food safety.

b. Yet obesity is now one of the greatest threats to public health

- In the Netherlands, the percentage of people who may be described as obese has doubled over the past 25 years to approximately 10% of the adult population.
- The most worrying trend is the increase in the number of young children who are overweight or obese. In 1997, the percentage of overweight persons in the 2 to 20 age group varied between 7% and 16%, depending on age. In the case of girls aged 6, this represented a 100% increase compared to the 1980 figures, while for boys aged 6, there had been a 200% increase *(see figure 1)*. The trend is of particular concern because eating habits, like so many aspects of lifestyle, are acquired in these formative years.
- Among those with only primary or lower vocational education, obesity is roughly three times more prevalent than among those with higher vocational training or a university degree. However, the increase over time is seen in both groups.

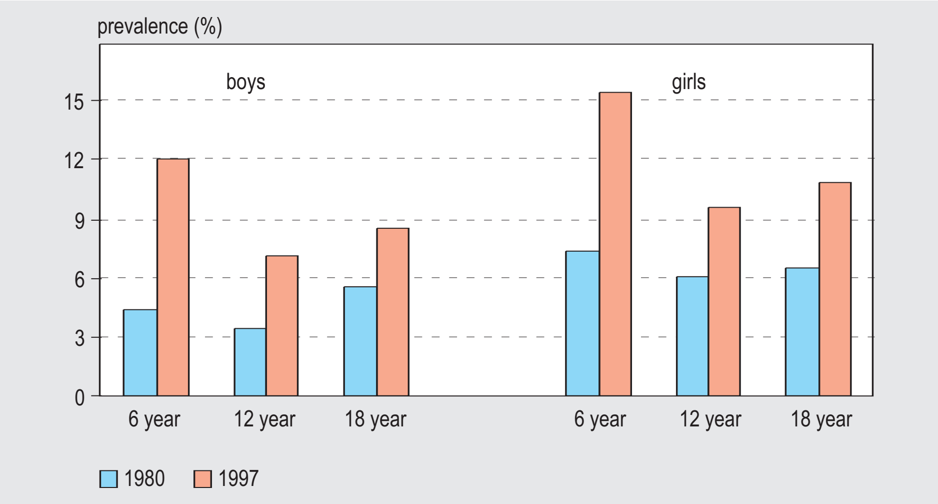

Figure 1: Prevalence of overweight among Dutch children by gender and age.

- Obesity is more prevalent among Turkish, Moroccan, Surinamese and Antillean men and women in the Netherlands than among the 'native Dutch' population. There are, however, no trend statistics available. There is less information relating to other ethnic groups.
- Food consumption of the average Dutch citizen has not increased in recent decades. In fact, between 1988 and 1998, energy intake fell by 5%. The cause of the increase of overweight is rather the over-consumption of food relative to the amount of physical activity undertaken. It is therefore clear that the degree of physical activity has decreased even further, although good statistics relating to trends in energy expenditure through physical activity are not available.
- It is expected that the incidence of overweight and especially that of obesity, will continue to rise sharply in the Netherlands. Given the current trend, the number of Dutch persons who are obese is likely to increase by 50% before the year 2020. Merely maintaining the current level will require significant efforts.

c. The composition of the Dutch diet is still far removed from the recommended healthy diet

In recent decades significant changes have occurred in the Dutch dietary pattern with regard to several important dietary factors. In the case of some factors, the diet has clearly become more healthy; for others, the reverse is true (see *table 1)*.

- The main improvements are the decrease in the content of saturated and *trans* fatty acids in foods, and the increase in the consumption of fish. Between 1988 and 1998, the consumption of *trans* fatty acids decreased by over 60% as a result of modifications to the composition of margarines and cooking fats. The consumption of saturated fatty acids decreased by 5%, largely due to the successful introduction of lower-fat dairy and meat products. Fish consumption appears to have increased: in 2001, the quantity of fish purchased for consumption at home had increased by 17% compared to the 1995 figure.
- However, fewer than 25% of people follow the recommendations with regard to the consumption of fruit, vegetables and dietary fibre. Over the course of 10 years (1988-1998), consumption of fruit and vegetables actually declined by between 15% and 20%. Despite improvements in terms of the fatty acid content of products, only 5% of the Dutch population follow a diet according to the recommended fatty acid pattern.

Table 1: Actual dietary consumption compared to the recommended intake in the Netherlands.

Dietary factor	Recommended intake	Average consumption 1998	Trend
Saturated fatty acids	< 10 energy per cent	14.5 energy per cent	Favourable
Trans fatty acids	< 1 energy per cent	1.8 energy per cent	Favourable
Fish	1 or two times per week	2 to 3 times per month	Favourable
Fruit	2 pieces per day (200 grams)	102 grams	Unfavourable
Vegetables	150-200 grams	120 grams	Unfavourable

In addition, many groups in the population have specific dietary problems which require certain additional recommendations.

- Mothers should be encouraged to breastfeed their infants.
- The eating habits of young people are showing a less favourable trend than those of the population as a whole. In particular, there has been a much sharper decline in the consumption of bread and vegetables.
- Undernutrition may be observed among some more elderly citizens, which may lead to vitamin and mineral deficiencies.
- The dietary composition of persons with a lower socio-economic status is, on average, less likely to be in accordance with the recommendations than that of people in the higher socio-economic groups.
- Few statistics are available with regard to the food consumption of ethnic minority groups. There is no uniform picture covering all groups. The fatty acid content of the diet of some groups is actually better than that of the native Dutch population, but the average content of vitamins and minerals is somewhat lower.

d. Overweight and unhealthy dietary composition cause considerable health loss

For the purposes of this document, 'health loss' is expressed in terms of the additional incidence of disease and mortality (e.g. through type 2 diabetes mellitus, cardiovascular diseases and various forms of cancer) which can be attributed to overweight or unfavourable dietary composition.

- Adults who are seriously overweight are five to twelve times more likely to develop diabetes, and two to three times more likely to develop cardiovascular diseases or certain forms of cancer.
- An excessive intake of the 'wrong' type of fats, such as saturated and *trans* fatty acids, increases the likelihood of developing cardiovascular diseases by 25%, while eating fish once or twice a week will *reduce* this risk by 25%.
- The consumption of an adequate quantity of fruit will reduce the risk of developing coronary heart diseases, stroke, lung cancer, breast cancer[2] and stomach cancer by between 20% and 30%, while an adequate intake of vegetables will reduce the risk of coronary heart diseases and lung cancer to approximately the same degree.
- Each year, 38,000 cases of cardiovascular diseases among adults aged 20 and above can be attributed to the unfavourable composition of the diet (calculated according to the five factors), as can 2,700 cases of cancer *(*see *figure 2)*.
- Overweight is responsible for 22,000 cases of diabetes, 16,000 cases of cardiovascular diseases and 2,200 cases of cancer each year (see *figure 2).* Other consequences of overweight, such as impaired mobility, have not been included.
- Approximately 10% of the total number of deaths in the Netherlands each year can be attributed to an unfavourable dietary composition, while overweight is directly responsible for 5% of deaths.

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[2] According to a recent report published by the Dutch Cancer Society, the relationship between diet and breast cancer is debatable.

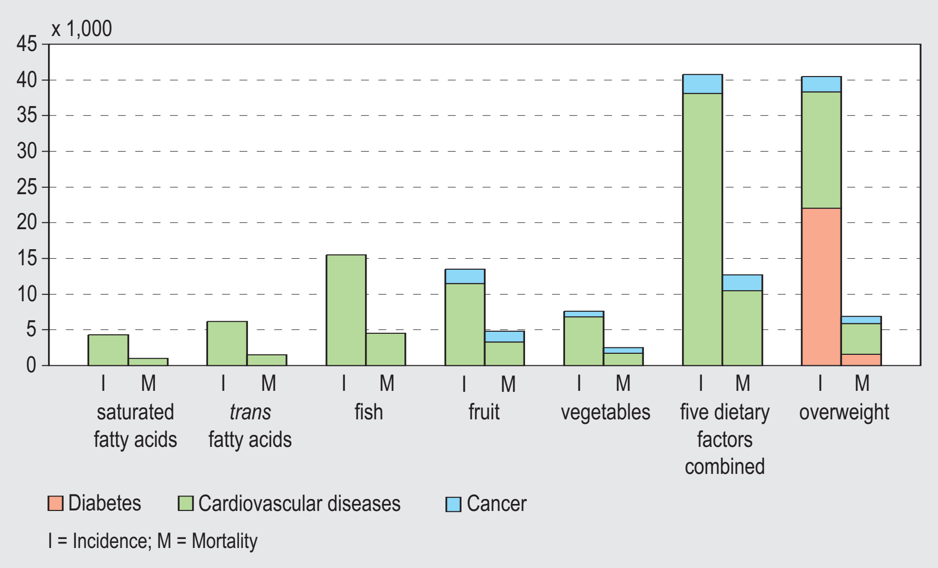

Figure 2: Calculated health loss due to the fact that the consumption of various fatty acids, fruit and vegetables (separate or in combination), as well as bodyweight (BMI), fails to meet the recommendations.

- When these statistics are combined and expressed in DALYs[3] per year (Disability Adjusted Life Years), approximately 215,000 DALYs lost as a result of the three diseases cited (cardiovascular diseases, cancer and diabetes mellitus) can be ascribed to overweight, and 245,000 DALYs to unfavourable dietary composition.
- The average decrease in life expectancy resulting from unfavourable dietary composition is 1.2 years (for the entire Dutch population aged 40 and above). In the case of overweight, the decrease in life expectancy is 0.8 years. The health loss will clearly be much greater for those who consistently eat too much or eat the wrong types of food.

In calculating the overall health loss due to an unhealthy diet, one cannot merely total the figures for overweight and unfavourable composition of the diet. Overweight is caused in part by the combination of insufficient physical activity and an energy-dense diet, which partially overlaps with the dietary composition consideration, although the exact degree of this overlap is unknown. Of the five dietary factors considered, fruit and vegetables can help to reduce weight due to their high fibre content and low energy density. However, over-consumption of energy-dense foods has not been included in the food consumption scenarios modelled.

[3] For several years now, the health gains or losses due to disease or risk factors have been expressed in terms of DALYs. Mortality and years lived with disease (weighed according to the seriousness of the disease) are combined in this figure.

e. Improved dietary patterns can lead to considerable health gains

The health loss presented above has been calculated by means of a comparison with the situation in which *all* Dutch people follow the dietary and weight recommendations. It should therefore be regarded as the *maximum* theoretical health gain.

However, because it would be overly optimistic to assume that everyone will adopt a healthy diet overnight, a calculation has also been made on the basis of dietary patterns which are *partially* improved in the direction of the recommendations. Experience with small-scale dietary interventions suggests that such an improvement is feasible. In these 'middle' scenarios we assume the following changes in the dietary patterns of persons who do not yet meet the recommendations in full:

- consumption of saturated fatty acids to be reduced by 2.5 energy per cent
- consumption of *trans* fatty acids to be reduced by 0.5 energy per cent
- consumption of fish to be increased by one or two portions per month
- consumption of vegetables to be increased by 50 grams per day
- consumption of fruit to be increased by 50 grams per day.

These dietary interventions will reduce the maximum annual incidence of disease and mortality attributable to the dietary composition (with regard to the five factors stated) by approximately fifty per cent (see *figure 3)*.

A significant assumption in these calculations is that the success of the small-scale interventions can be extrapolated to the level of the entire population. The improvements cited have varying relationships to the current trends. In the case of *trans* fatty acids, target consumption under the middle scenario is in line with the rapid decline seen in recent years. By contrast, the middle scenario target for fruit and vegetable

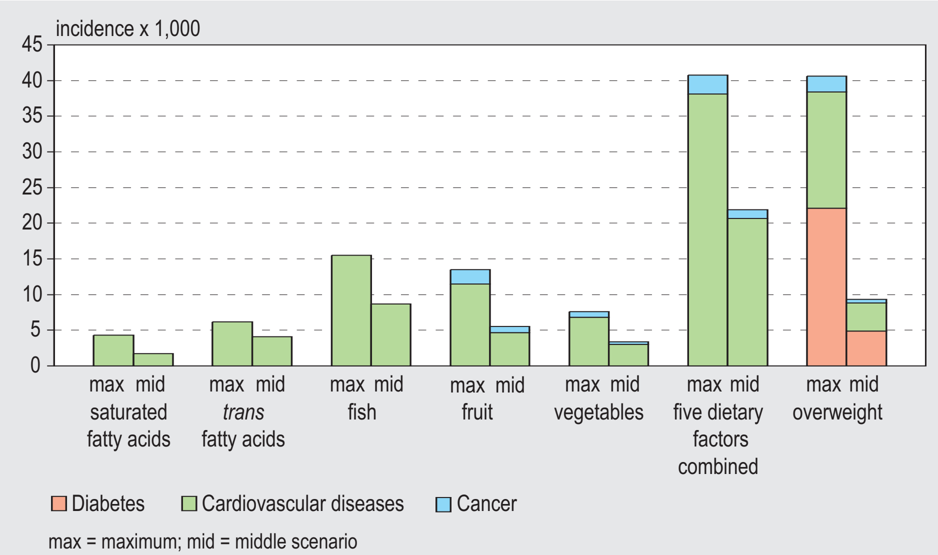

Figure 3: Reduction in annual incidence of disease in the Netherlands: maximum and middle scenarios.

consumption is at odds with the trend of recent years. The middle scenario targets for saturated fatty acids and fish consumption have, in this respect, an in-between position.

Concerning the fatty acid intake, the middle scenarios are somewhat less ambitious than the objectives stated in a Dutch government policy document entitled '*Langer Gezond Leven*' ('Living longer in good health'). The policy's target for saturated fatty acids is a reduction to 10 energy per cent by the year 2010, while that for *trans* fatty acids is a reduction to 1 energy per cent. These figures are in line with the dietary recommendations. The policy does not state any specific target for fish consumption, and while it does seek to increase consumption of fruit and vegetables, no firm figures are stated.

f. Only through firm action to tackle overweight can any substantial health gains be made

The results of small-scale experiments suggest that an average weight loss of three kilograms per person (1 BMI unit) is possible. The health gain that such a weight reduction would yield is in the order of *one quarter* of the maximum incidence of mortality and morbidity attributable to overweight (see *figure 3)*. However, the current trend runs in the opposite direction. Over the past 15 years, average bodyweight has actually *increased* by three kilograms and the number of persons with obesity, in particular, will continue to rise. The policy objective is to at least stabilize the current level of overweight, thus curbing the trend. The health loss that will be avoided in this manner is also in the order of *one quarter* of the current maximum incidence of mortality and morbidity attributable to overweight.
Compared to the health gains to be made under the middle scenarios for dietary composition, that achieved by reducing overweight will be less marked. Overweight is therefore a more difficult problem to counter than an unfavourable dietary composition.

g. Without interventions it is unlikely that the Dutch will eat more healthily in the future

Experts predict that the current trends in eating habits and in the types of food available on the market will continue for the coming 5 to 10 years *(*see *textbox 1).* Despite a growing number of new foods which are appropriate to a healthy diet, the overall range of products available will not become any healthier due to the even greater increase in unhealthy products. Consumers will buy more 'convenience foods' and the consumption of snacks, larger portions and products which are energy-dense will continue to rise.

Expectations are that the unfavourable effects will dominate. Children, teenagers and people with a lower socio-economic status will form a high-risk group. This relates to the over-consumption of energy-dense products which contain few other nutrients and are made particularly attractive by their strong sweet or salty flavour. Moreover, healthy food is generally more expensive. Without active social pressure to reverse these trends, an adverse effect on public health may be expected, especially in terms of the number of people suffering from overweight and various chronic diseases.

Textbox 1: Likely developments which will influence healthy and unhealthy dietary patterns in the Netherlands.

Greater availability of
- Products with improved nutritional quality, including healthy convenience foods (+)
- Energy-dense products (-)
- Unhealthy convenience foods (-)
- Larger portions (-)
- Functional foods and dietary supplements (?)

Eating habits
- Shift towards convenience foods (overall balance: (-))
- Shift towards larger portions and energy-dense products (-)
- More people who fail to eat breakfast (-)
- More snacks and other forms of 'grazing' (?)

+: expected effect is favourable to public health;
- : expected effect is unfavourable to public health;
?: nature of effect is currently unknown

2.2 How safe is Dutch food ?

a. Dutch food has become safer in several respects, due to a high level of consumer protection

Over the past few decades, national and international governments have introduced an extensive system of legislation, standardization and control in the field of food safety. Producers have also introduced many more measures designed to enhance food safety. The food consumed in the Netherlands is therefore safer in many respects than it was in the past. This is clearly demonstrable in the case of a number of micro-biological and chemical contaminants. For example:

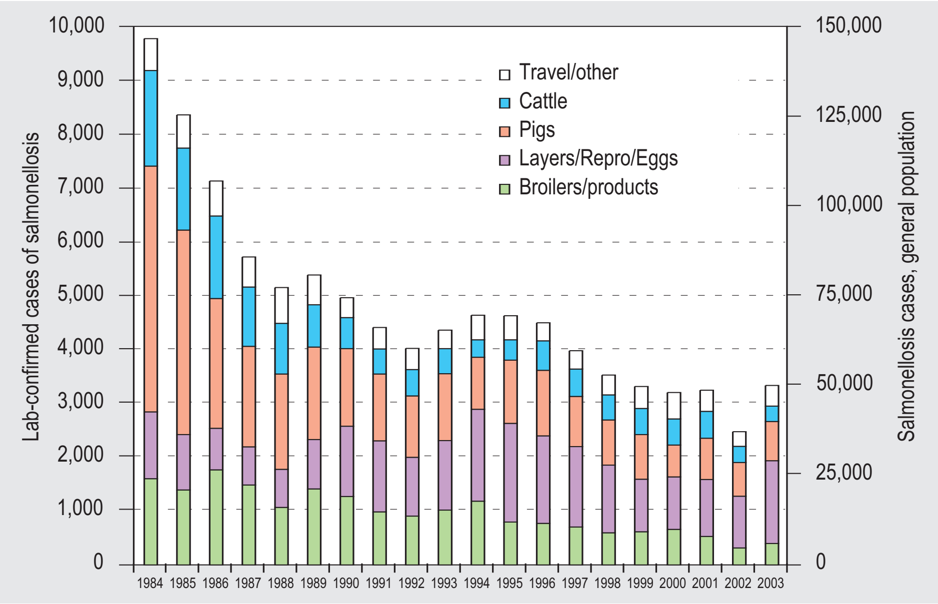

Figure 4: Trends in salmonellosis in the Netherlands.

- In the Netherlands, the incidence of food poisoning caused by *Salmonella* bacteria fell from approximately 150,000 cases in 1984 to approximately 50,000 in 2003 (see *figure 4*).
- The concentration of dioxins and PCBs in human milk in the Netherlands has halved over the past 10 to 15 years due to the reduction in exposure through foods.

The food-related incidents that have occurred in the Netherlands in recent years have had little or no effect on health. However, they do erode consumer confidence and serve to highlight shortcomings which still exist within the current food safety system.

b. And yet foodborne infections remain an obstinate and persistent problem

Based on population surveys, it is estimated that there are approximately 4.5 million cases of gastroenteritis (inflammation of the stomach and small and large intestines) each year. Of these, one third (i.e. 1.3 to 1.7 million) are thought to be due to a food-borne infection (see *textbox 2*). Between them, four types of bacteria and viruses are responsible for approximately half of all identifiable foodborne infections: *Campylobacter* spp., *Salmonella* spp., *Clostridium perfringens* and the noroviruses.

Textbox 2: Estimated annual incidence of gastroenteritis due to foodborne infections in the Netherlands.

Total number of gastroenteritis cases	4.5 million
Number with known causative agent	1.6 million
Number due to foodborne infection	0.3-0.7 million
Number not due to foodborne infection	0.8-1.3 million
Number with unknown causative agent	3 million
Number possibly due to foodborne infection	1 million [1]
Number not due to foodborne infection	2 million [1]

[1] While they have not been empirically tested, these figures are based on the ratio of 1:2 among the cases of gastroenteritis with a known pathogen.

Alongside the acute and usually mild health effects of gastroenteritis, there are also a few hundred cases of serious illness which can be attributed to foodborne infections involving a known pathogen. They include cases of toxoplasmosis, Guillain-Barré syndrome, Haemolytic uraemic syndrome and listeriosis. Between 20 and 200 persons die as a result of a food infection each year.

Expressed in DALYs, the estimated health loss due to foodborne infections with known causative agents is approximately 1,000 to 4,000 per annum. This is comparable to the health loss due to AIDS or bacterial meningitis. However, this figure is probably an underestimate given the unquantifiable contribution of food to the large number of gastroenteritis cases due to (as yet) unknown causative agents.

c. There are also chemical food constituents and contaminants responsible for some degree of demonstrable health loss

The health loss due to the presence of chemical food constituents or contaminants is more difficult to quantify than that due to microbiological contamination. A distinction is drawn between chemical contaminants and those chemical components which are naturally present in certain foods, such as nitrates, natural toxins and allergens.

In the case of chemical contamination, there are usually no acute effects but there can be chronic health effects, such as cancer, which become apparent only after a long period of time. Because of the delay involved, such effects can rarely be directly attributed to exposure to any one chemical substance. Estimates of safe (and unsafe) intake levels are usually based on experiments involving animals. The safe intake levels for many chemical food contaminants have been established in this way. In general, the intake of such substances in the Netherlands is well below the identified safe levels.

Table 2 provides an overview of the chemical substances found in food and posing some health risk, together with an estimate of the possible health gain (in DALYs) if exposure to these substances is avoided outright.

- In the case of allergens and certain natural toxins (phycotoxins and phytotoxins) there can indeed be an immediate and observable health effect. It is estimated that food allergies account for an annual health loss in the order of 1,000 DALYs. However, allergens form a separate category since the effects are partly due to genetic susceptibility and therefore vary from one person to another. They can also be avoided by a careful choice of food. The overall health loss due to the presence of natural toxins is smaller than that due to allergens.
- In the case of nitrates and nitrites, as well as a number of chemical substances which do not occur naturally in food (PAHs, acrylamide), estimates suggest that long-term health effects can arise in the form of cancer. Here, the estimated theoretical annual health loss is in the order of 500 to 1,000 DALYs.

Although information concerning developments over time is not available for some aspects, current information gives the general impression that Dutch food is now safer than it used to be. However, given the nature of the estimation methods used, it seems likely that the *microbiological* contamination levels have been *underestimated* (based as they are solely on information concerning proven food contamination by known agents). Conversely, the health risks posed by the *chemical* contamination of food are more likely to have been *overestimated,* since these often concern incidental measurements in excess of the identified safe levels, and because of the safety factors used and/or the conservative method of risk assessment applied (particularly with regard to genotoxic carcinogens).

Table 2: Chemical substances in food in the Netherlands, with the health risks and possible health gains if exposure is avoided.

Substance category	DALYs to be gained	Comments
Allergenic proteins etc.	1,000	Figure gives rough estimate for allergens in foods, such as shellfish, fish, milk, nuts, wheat, etc.
Mycotoxins (aflatoxins, etc.)	< 1	Figure relates specifically to aflatoxin B_1
Phycotoxins (DSP, ASP)	10-70	
Phytotoxins (anisatin)	< 1	
Nitrates/nitrites	100-500	Figure relates specifically to nitrosamines formed.
Growth promoting agents (non-natural analogues such as clenbuterol)	1	
Process contaminants (PAHs, acrylamide)	300-700	Figure relates mainly to acrylamide. The number of DALYs to be gained through avoidance of PAHs is between 5 and 10

To summarize, the main food safety problems are currently represented by microbial foodborne infections and allergens, and by the unavoidable occurrence of food-related incidents. It remains unclear whether the number of people suffering from some form of food allergy is increasing. The Dutch Health Council is currently collating the available scientific knowledge in this respect.

d. Food safety will continue to improve but new threats are likely to emerge

According to the experts, the measures taken by the government and food producers will ensure that our food becomes even more safe than it already is *(*see *textbox 3).* This will largely be due to better control systems and to the use of decontamination methods for dealing with micro-organisms on products of animal origin. However, no reduction in the incidence of microbiological contamination may be expected where this is due to incorrect storage and preparation on the part of the consumer. In fact, it is thought that the consumer's knowledge of food preparation and the necessary standards of hygiene is declining. In addition, new threats due to the globalization of food production and the food market will continue to demand attention. It may be expected that the favourable effects will outweigh the unfavourable effects, but only if the current level of protection is maintained and due attention is devoted to new threats.

Textbox 3: Likely developments in food supply and consumer behaviour which will determine whether food in the Netherlands becomes more or less safe.

Food supply

Better control systems due to extensive implementation of the Hazards Analysis Critical Control Points (HACCP) system (+)
More industrially prepared products in combination with better control systems (+)
More use of decontamination methods (+)
More products from other countries
- Longer turnaround time for products (-)
- Less adequate control systems and inspections in some countries (-)
- Import of new bacteria and viruses, or re-emergence of known bacteria and parasites which had previously been eradicated (-)

New products with new potential problems, such as the storage of pre-prepared products in shops (-)
More products with the same additives, e.g. many products having the same bio-active ingredients or natural flavourings (accumulation effect) (-)
More products with higher levels of contaminants due to the harmonization of international legislation favouring those countries in which less stringent rules are applied (-)
More contaminated products due to reduced government involvement and supervision (?)
Lower priority of food safety in times of economic recession (?)
Less effective mild preservation techniques (?)
Second generation of genetically modified crops (?)

Food preparation by consumer and catering establishments

More information provided to the consumer, but less knowledge on the part of the consumer with regard to hygiene in food preparation (-)

+: expected effect is favourable to public health;
- : expected effect is unfavourable to public health;
?: nature of effect is currently unknown

2.3 Healthy diet and safe food in balance

Many people and organizations make choices with regard to food, based on their own perspectives, in which health and safety play a role: consumers, food producers, the catering industry, organizations which produce the guidelines for a healthy diet, and the government which must make decisions on the collective efforts to be directed towards the promotion of a healthy diet and the improvement of food safety. Sometimes those decisions will relate to a single ingredient, food or product, while on other occasions they will relate to entire groups or batches of products. Interests other than those of health alone are also part of these decision making processes.

This report addresses the positive and negative effects on public health. For this purpose, it uses three questions to bring these aspects into balance:

1. What is the relationship between health loss due to an unhealthy diet on the one hand and unsafe food on the other?
2. What is the relationship between 'healthy' and 'safe' with regard to four common food items for which specific recommendations exist?
3. How does that relationship apply to new developments such as the use of functional foods and dietary supplements?

The DALY concept forms the basis for all comparisons.

a. The health loss due to unhealthy diet is many times greater than that attributable to unsafe food

When set against the health loss due solely to unfavourable dietary composition (245,000 DALYs), i.e. leaving the loss due to overweight aside, the estimated annual health loss due to microbiological foodborne infection involving known pathogens (1,000-4,000 DALYs) and chemical constituents (1,500-2,000 DALYs) is rather limited. The health loss due to unfavourable dietary composition is approximately 40 to 100 times greater than that due to unsafe food. Overweight also accounts for a far greater annual health loss (215,000 DALYs) than unsafe food.

b. The health gains to be made through the consumption of more fruit and vegetables, wholegrain products and fish, as well as through breastfeeding, are many times greater than the health risks involved

Any food or group of foods may have both favourable or unfavourable health effects. This can be confusing for the consumer, particularly when the official dietary guidelines recommend increased consumption of fish and vegetables, while it is recognized that these products can contain certain harmful contaminants. Accordingly, the balance between 'healthy' and 'safe' has been calculated for four groups of common foods for which specific recommendations exist:

- Fruit and vegetables: leafy vegetables can contain relatively high levels of nitrates, while pathogenic microorganisms may be found on all raw fruit and vegetables. They may also contain phytotoxins.
- Fish can contain dioxins or PCBs.
- Wholegrain cereal products (an important source of dietary fibre) can be contaminated with mycotoxins derived from fungi.
- Human milk can contain dioxins and PCBs, while it is possible for an HIV-positive mother to transfer the virus via the milk.

The annual gains to be made by following the consumption levels currently recommended (the maximum scenario) vary from approximately 1,000 to 2,400 DALYs (breastfeeding) to almost 100,000 DALYs (fish, fruit). Compared to these figures, the risks attributable to known contaminants, insofar as they are quantifiable, are usually some 100 times lower. In some cases the risks are even negligible.

This does not mean that no further consideration needs to be given to contaminants. Rather, it highlights the success of the system of standardization and control that has been developed in recent decades, as well as the necessity of ensuring that this system continues to adapt to new scientific insights and developments in both food supply and food consumption.

c. *The health claims of functional foods are often unproven and the over-consumption of bio-active ingredients can itself pose a risk*

The recommended diet will include all necessary nutrients. In recent years, however, a number of products have emerged for which the manufacturers make certain health claims. These are the so-called functional foods and dietary supplements. Research into any positive or negative health effects associated with these products is still in its early stages. Because legislation is, as yet, inadequate (although it is developing rapidly) consumers can easily be misled by extravagant advertising claims.

For the vast majority of functional foods and dietary supplements now on the market, there is not only insufficient evidence for the *presence* of beneficial health effects, but also for the *absence* of detrimental effects. It is therefore not possible (or not yet possible) to draw any useful conclusions regarding their contribution to public health. Only in the case of a few dietary supplements, such as folic acid and vitamin B_6 can firm statements be made:

- It has been shown that expectant mothers who take supplements containing folic acid at an early stage of their pregnancy can reduce the likelihood of birth defects (such as spina bifida). It has also been established that no health risks attach to the use of such supplements.
- In the case of vitamin B_6, the risk of overdosing exists, while there are no demonstrable positive effects attached to the use of the supplement. Approximately 16% of the products containing B_6 which are currently on the Dutch market contain a dose which exceeds (sometimes by a wide margin) the established safe upper level of intake. Moreover, the ordinary daily diet will contain sufficient vitamin B_6 and no groups with any deficiency are known.

The dosage of vitamins and minerals in many ‘enriched’ foodstuffs remains relatively low. Often, it is comparable to the quantity to be found in an ordinary daily diet (the ‘Recommended Daily Intake’). Furthermore, there are generally no indications of health risks attaching to most of the vitamins and minerals contained in dietary supplements. Nevertheless, the dietary supplements do pose a particular risk of overdosing, since the concentrations of vitamins and minerals in such products are very much higher than in the enriched foods. However, since the most recent National Food Consumption Survey (in 1998), no new information has become available concerning the consumer’s *usage* of high-dosage vitamin and mineral supplements, nor about trends in the use of supplements in general.

d. Consumers and scientists often have differing views about risks

Although the health loss due to an unhealthy diet is far greater than that due to unsafe food, consumers often view matters from a different perspective. They usually attach more weight to those risks which are beyond their sphere of influence, rather than to those which are due to their own choice of food and eating habits. Accordingly, food safety issues are often regarded as more serious (risk perception) and result in greater public disquiet than any unhealthy aspects of a diet that is not in line with the recommendations. The government and food producers must take this phenomenon seriously and must gain a better understanding of the underlying mechanisms. This is necessary not only to ensure adequate risk communication with the public, but also to maintain consumer confidence.

3 Significance of the findings

a. What are the priorities?

Priorities for policy are determined by several factors, such as the potential health gains, current trends and expectations, the feasibility of interventions, the balance between measures addressing a healthy diet and those directed at food safety, the costs of the measures, and so on. When these factors are taken into account, but leaving the question of costs aside, three important priorities in the field of healthy diet and safe food can be identified.

Priority 1: The promotion of a healthy diet, which involves a two-pronged approach

- *Reduction of overweight and obesity*

The calculations presented show that the maximum health gains achievable through the reduction of overweight are no greater than those to be made through the improvement of dietary composition. Nevertheless, there are various reasons for tackling the problem of overweight as a matter of the greatest urgency. Firstly, we see an unfavourable trend: the prevalence of overweight and obesity continues to increase, the rise being greatest among children and young people, which would suggest an even more acute problem in the future. Secondly, the seriousness of the obesity problem has long been underestimated, despite the scientific community having drawn attention to the upward trend in the 1980s. Only in the last few years attention has been devoted to overweight at the national and international political level. Thirdly, it would appear that the health loss which can be obviated by means of feasible weight-related interventions is relatively small (approximately 25% of the total). A major societal effort will therefore be required to ensure that the prevalence of overweight in the Netherlands does not rise further, and to avoid reaching the situation that can already be seen in the United States and the United Kingdom.

- *Promotion of a healthy composition of the diet*

It would not be appropriate to base policy solely on the reduction of overweight. A proper composition of fatty acids in the diet, regular fish consumption, and an adequate intake of fruit and vegetables can do just as much in reducing the incidence of cardiovascular diseases and cancer, quite aside from the considerations of achieving a proper bodyweight. When we look at the health gain thought achievable on the basis of previous small-scale experiments, we see that the effect of a proper dietary composition (based on the five dietary factors) is more than double that of the reduction in overweight. The trend is currently positive with regard to some factors (saturated fatty acids, *trans* fatty acids and fish consumption) but the decreasing consumption of fruit and vegetables is still worrisome. There are also a number of vulnerable groups, such as the very young and the very old, who face specific dietary problems which must be addressed separately. For example, very few babies under three months are now breastfed. And there is also some undernutrition among the elderly, with resulting vitamin and mineral deficiencies.

Priority 2: Maintenance and, where possible, improvement of the current high level of food safety

In the current situation, it is clear that the health loss attributable to unsafe food is many times smaller than that due to an unhealthy diet. This is largely due to the fact that an effective system of food safety measures and control has been developed in recent decades. Clearly, this system must be maintained. However, it is appropriate to ask what maintenance level will be required in the future, in the light of existing and newly emerging threats.

Priority 3: Better risk assessment methods and improved risk communication with the consumer

Food safety incidents, both large scale and small scale, will continue to occur. Human error, malfeasance and new 'surprises' can never be ruled out. The 'zero-risk' situation is therefore unattainable. In order to limit the impact of incidents, a more effective assessment of the actual health risks is required, together with a better risk communication with the consumer. As both uncertainty regarding the extent to which risks are known and social complexity (the number of stakeholders and conflicting interests) increase, so must a more open social debate be conducted.

b. Investing in a healthy diet is just as important as investing in other healthy lifestyle factors

In order to place the health loss attributable to an unhealthy diet and unsafe food in perspective, *table 3* presents a comparison of the health loss (in DALYs) due to these factors and that due to other lifestyle factors. The health loss for various other environmental factors is shown in order to put in perspective the part played by food safety. Lastly, a comparison is made with the health loss due to a number of significant diseases, irrespective of their causes. The calculations are particularly complex and the underlying data involve some uncertainties. As a result, the comparison is broad, and the health loss is presented in categories.

The comparison shows that the overall health loss due to an unhealthy diet is similar to that caused by smoking. The theoretical health gains which could be achieved merely by adopting a proper dietary composition (based on all five factors studied) is in second place and is of the same order as that of reducing obesity (shown here as ‘energy balance’), or of increasing physical activity. Moreover, it is shown that a proper dietary composition could provide health gains equivalent to the overall health loss due to the most common diseases in the Netherlands, including coronary heart diseases and depression.

c. Investing in food safety is just as important as investing in combating infectious diseases or in other environmental factors

Table 3 also shows that the demonstrable health loss due to microbiological contamination of food is comparable to that due to a number of significant infectious diseases such as AIDS. In the case of chemical contamination, the health loss is lower than that of a number of major environmental factors. However, the health loss due to allergens and acrylamide is greater than that caused by various substances found in the environment.

In the context of health protection, allergens must be considered separately, since most are normal constituents of certain foods that elicit greatly differing effects in different people. The most important form of protection is the avoidance by susceptible individuals of foods known to cause allergic reactions, and not the removal of allergens from the products concerned. Proper information concerning the presence of certain potential allergens in products is essential in order that the consumer can make well-informed choices.

Table 3: Annual health loss (in DALYs) due to dietary factors and energy balance, against other lifestyle factors, environmental factors and disease categories in the Netherlands.

DALYs lost	DIET			OTHER		DISEASE
	Dietary factors	Microbiological contamination	Chemical contamination	Other lifestyle factors	Environmental factors	Selection from Public Health Status Forecasts 2002
> 300,000	Unhealthy diet total [1]			Three lifestyle factors combined [2], Smoking		Cardiovascular diseases, all cancers
100,000-300,000	5 dietary factors together, energy-balance [3]			Lack of physical activity		Coronary heart diseases, depression, lung cancer, diabetes, alcohol-dependency
30,000-100,000	Excess of *trans* fatty acids, too little fruit, vegetables and fish			Alcohol consumption [4]		Road traffic accidents, breast cancer
10,000-30,000	Excess of saturated fatty acids				Particulate matter in atmosphere	Schizophrenia, prostate cancer, influenza
3,000-10,000		Gastroenteritis caused by micro-organisms in food			Passive smoking	Upper respiratory tract infections, HIV/AIDS [5], stomach and intestinal ulcers
1,000-3,000					Radon (interior)	Bacterial meningitis, bacterial STDs [5], tuberculosis
300-1,000		Campylobacter in food	Allergens, acrylamide			
<300		STEC 0157[5]	PAHs [5], other substances		Various substances	

1. Here, 'unhealthy diet total' relates to the overall health loss due to the dietary composition (the five modelled dietary factors together, in relation to cardiovascular diseases and the relevant types of cancer) plus the proportion of the health loss attributable to overweight (due to a positive energy balance).
2. This relates to the combined effects of smoking, lack of physical activity or excessive alcohol consumption on cardiovascular diseases, diabetes mellitus and the relevant types of cancer.
3. Energy balance is the dietary factor which accounts for the development of overweight. The health loss due to overweight has been modelled using BMI as indicator. Overweight can also be caused by lack of physical activity, which falls under 'other lifestyle factors' in this table.
4. It is assumed here that moderate alcohol consumption (one to three units per day for men and up to two for women) prevents cardiovascular diseases, as compared to total abstinence. The health loss due to alcohol dependency is shown in the seventh (right-hand) column.
5. HIV/AIDS: Human Immunodeficiency Virus / Acquired Immune Deficiency Syndrome; STD: Sexually Transmitted Disease; STEC: Shiga-toxin-producing Escherichia coli; PAHs: Polycyclic Aromatic Hydrocarbons.

4 Opportunities for prevention

What is required to address the three priorities successfully, and what part is to be played by the three parties most closely involved: the private sector, the consumer and the government? The answers to these questions will largely be determined by our knowledge of the factors which influence the dietary problems concerned, the points of policy action which can be derived from this knowledge, and the feasibility and returns of the proposed measures. It will be useful to review past successes and failures, as well as scientific insights into the psychology of behavioural change and risk perception.

The key elements in ensuring a healthy diet are the supply side (the food available), social norms and customs, and the consumer's behaviour (purchasing and eating habits). In the case of food safety, the entire food chain is important: from production to storage and preparation in the kitchen. The private sector, the consumer and the government each have a specific role in promoting a healthy diet and food safety.

a. The approach to, and opportunities for, the promotion of a healthy diet are not the same as those for smoking

According to modern views on health promotion, prevention is particularly effective if the interventions rely on an integrated approach. Such an approach not only addresses people directly about their personal behaviour, but also modifies the physical and social environment in such a way as to encourage desirable behaviour and discourage undesirable behaviour. This form of integrated approach is probably the key success factor in the United States' reduction of smoking. A similar approach is now being used in the Netherlands. The approach entails a combination of health-related information about stopping smoking, pricing measures, smoking bans in public places, other legislation and a shift in social norms. There is close cooperation between health institutes, the government, industry and the scientific field, and interventions are adapted to the 'settings' which are important to children and adults, such as school and the workplace.

Much can be learned from interventions to discourage smoking. However, it must be realized that there are marked differences with regard to diet and eating habits. In the case of smoking, there is a clear and unequivocal message: it is bad for you and for the people around you. While a person's overweight may cause some concern or inconvenience to others – as in prolonged or regular sick leave, greater nursing requirements or in the surgical situation – our eating habits are largely based on the necessity of eating, and are unlikely to cause any real harm to others. Accordingly, the relationship between the government and the production industry is different. In the case of smoking, the government's health promotion activities are diametrically opposed to the financial interests of the tobacco industry. In the case of food, the government actually needs the industry to produce healthy products which are appropriate to a healthy diet, while at the same time, that government must contend with an industry which currently produces and promotes many unhealthy products. A further consideration is that the healthy diet message is more complex than the non-smoking message, because the consumer must choose from a large and very diverse range of foods, some of which can have both favourable and unfavourable effects on health. However, the comparison with smoking demonstrates that intensive and creative efforts are required if changes are to be brought about successfully.

b. The private sector must devote greater attention to healthy and safe food

There are many ways in which food producers, wholesalers and the catering industry can help to combat overweight, to promote a healthy diet and to improve food safety.

Greater availability of healthy products, and less advertising for unhealthy products

Alongside a lack of physical activity, the cause of the rise in obesity is to be found in the overabundant supply of energy-dense foods in shops, workplace canteens and school dining halls. The advertising of unhealthy products is also a contributory factor. Convenience, flavour, price and acquired habits are the factors which determine the consumer's eating patterns. The private sector can use all these factors in promoting a healthier diet. The recently modified policy of the Dutch food producers federation (VAI/NFLI 2004), and its code of conduct for advertising and promotional activities, remains inadequate in this respect and can be improved.

Improved product composition and innovative product modification

There are many ways in which foods can be modified in order to render the 'healthy choice' the 'easy choice', without requiring consumers to alter their eating habits very much. In some cases, product modifications require no behavioural change at all on the part of the consumer. Examples from the past include the addition of iodine to table salt and the altered fatty acid composition of margarines. Moreover, such changes do not have to limit the consumer's choice. Rather, there are excellent opportunities for providing an extremely varied range of products, with something to appeal to every taste.

The maintenance and improvement of food safety in the light of new circumstances

Safe food is a precondition of healthy eating. The maintenance and further improvement of food safety begins with the awareness of its importance. There does indeed appear to be a high level of awareness in the Netherlands. Two aspects will be important in future. The first involves enhanced food safety in the animal (derivatives) food chain, by such means as ensuring good hygiene in the primary production phase and in the final phase of actually preparing the food. The second aspect is the introduction of more effective quality control for novel and existing ingredients, and for production chains.

Improved consumer information

Clear information, such as labelling to indicate the nutritional and safety aspects of a product, can help the consumer to make a sound choice with regard to both a healthy diet and safe food (avoidance of allergens). New and creative forms of information and labelling are required to enable the consumer to find the desired product information quickly and easily. The current labelling forms are not fully effective. The information must also take the consumer's perception of risk into account.

c. Consumers should be more aware of the advantages of a healthy diet, the disadvantages of overweight and an unhealthy diet, and the importance of hygiene during food preparation

A cultural turnabout is required

There will always be healthy and less healthy food products on the market. The most important requirement is a cultural shift on the part of the consumer and in the general social setting. There must be increased awareness that healthy food can also be enjoyable, while overweight and an unhealthy diet cause inconvenience, discomfort and disease. To date, the general public does not seem to be fully aware of the threat that an increase in the prevalence of overweight represents. However, it is important that this cultural shift is not based on any stigmatization of persons with overweight. The consumer is responsible for his or her own behaviour and, taking personal health interests into account, must take a personal decision to eat less or be more physically active.

Consumers must also realize that there is no such thing as 100% safe food, and that they are the last link in the food safety chain. They themselves are responsible for checking the expiration dates on packages, ensuring good hygiene in the kitchen to prevent cross-infections, and for the thorough cooking of products, particularly those of animal origin.

Awareness and information must be accompanied by practical skills

There are many people who wish to eat more healthily or to lose weight. However, a large proportion of the population does not know which foods are healthy and which are not, and may be confused by complex or contradictory messages. The consumer can only assume his responsibility if he has adequate knowledge about a healthy diet and about safe food, and if he possesses the skills required to put that knowledge into practice. However, the influence of the sheer size of the product range available, advertising and other (social) factors is so great that many people – particularly younger consumers – are not able to offer adequate resistance. This underscores the importance of the task awaiting consumer and educational organizations in providing good support.

d. The government must provide a strong impulse to the collective interests of a healthy diet, reduction of overweight and enhanced food safety

A healthy diet, the reduction of obesity rates and the promotion of food safety are all collective interests. Accordingly, the government has a part to play. In recent decades, the main emphasis of food policy has been on safety. The analysis offered by this report suggests that the reduction of overweight and the promotion of a healthy diet should be given higher priority than has hitherto been the case, without the current high level of food safety being adversely affected.

The emphasis should now be on effective implementation of the food policy

In the field of overweight (and a healthy diet) the government has opted to implement a preventive approach in partnership with a broad coalition of stakeholders. The approach, set out in a government policy document entitled 'Langer Gezond Leven' ('Living longer in good health'), addresses both lifestyle factors and environmental factors which encourage a healthy diet and sufficient physical activity. However, the emphasis should not be solely on overweight and energy balance, thereby masking the significant influence of a proper dietary composition on the prevalence of certain chronic diseases (both in association with and aside from overweight). In the parliamentary debate on Dutch government policy, the emphasis is placed on the personal responsibility of consumers and on the voluntary cooperation of the private sector. This is contradictory to the causal analysis made by experts, who call for the emphasis to be placed on the physical and social environment.

Legislative measures may be useful in promoting a healthy diet

With regard to a healthy diet and eating habits, the government seeks to exert far less control than in the case of food safety, preferring to leave many aspects to social forces. Food safety involves the use of legislation, sanctions, controls, inspections and supervision. It is felt that the interests of a healthy diet are better served by voluntary agreements and information. This difference in approach may be justified in terms of the principle of public health protection that applies to food safety. However, as this report makes clear, the promotion of a healthy diet requires a strong push by the government and by society itself. If incentives and voluntary agreements do not have the desired effect, legislation may prove appropriate. For example, measures could be introduced to curb advertising which targets children, or to stipulate which products may and may not be offered in schools or public places. The approach adopted to counter smoking can serve as an example.

New safety risks call for a new approach

In the field of food safety, the government's focus is shifting towards the safety of the entire food chain (whereby all parties - including the consumer - have a certain degree of responsibility) and to crisis management. In addition, consumer confidence in food safety (and the restoration of that confidence) has been high on the political agenda for some years. A strategy which is solely geared towards increasing food safety by means of ever more stringent standards will not be enough. The government must also involve the consumer in the decisions that have to be made, and must render its policy more transparent in order to achieve broader public support. Measures should be introduced requiring manufacturers to substantiate the health claims they make on behalf of functional foods and dietary supplements, thereby protecting the consumer against false claims. European legislation in this area is currently being drafted. The methodology for quantitative comparison of positive and negative health effects must also be developed further. Finally, in view of the ongoing globalization of food production chains, improved methods must be developed to trace the exact origins of products and their ingredients.

5 Monitoring and research

This report answers many questions. Its ability to do so derives from the large body of knowledge and information available in the Netherlands. However, there are also some questions which have yet to be answered in full, either because they fall outside the scope of the current report, because there are gaps in our knowledge, or because there are limitations in the continuity of the information flow. Moreover, new topics will emerge and will become important due to scientific and social developments. Four aspects in particular demand further consideration:

- The continuity of the National Food Consumption Surveys (VCP) and the supporting databases.
- Scientific research into the health and safety aspects of food and diet, and into better methodologies for the comparison of positive and negative health effects.
- Research into the determinants of consumer eating behaviour, and incentives whereby the private sector and other relevant parties can be encouraged to supply healthier and safer products.
- Research into the ways in which successful small-scale interventions can be implemented more widely. Here, the cost-effectiveness ratio must also be considered.

PART B

OUR FOOD, OUR HEALTH:

Healty diet and safe food in the Netherlands

1 INTRODUCTION

Why this report ?

For centuries, knowledge of what is good and safe to eat, and how it should be prepared, has been passed down from mother to daughter. In the early twentieth century, this empirical knowledge could be given a more scientific basis, partly due to advances in science and in epidemiology. Since then, our scientific knowledge concerning the relationship between nutrition, diet and health has greatly increased, and continues to develop today. That knowledge is mainly concerned with the biological effects of the individual constituents of food, such as nutrients, additives, micro-organisms and chemical contaminants. Preventive measures intended to promote healthy eating patterns and greater food safety are largely based on this type of knowledge. However, a more complete understanding of all potential health effects, both positive and negative, is required in order to weigh measures one against the other in terms of the likely health gains and the efforts to be made by policy makers.

Government policy and supervision must increasingly take into account issues which demand an 'integrated' product assessment, i.e. one which looks at both the positive and negative aspects of a certain food. Familiar examples include dioxins in human milk, PCBs in oily fish, and fungal toxins on cereals. While arriving at a scientific assessment of the positive and negative health effects is difficult in itself, it is also necessary to provide clear, unambiguous information to the public.

To date, sources which present coherent knowledge concerning the relationship between the many types of nutrients and other food constituents are scarce. Accordingly, there is an urgent need for integrated information about healthy diet and safe food to assist in formulating priorities for policy, both in the area of health protection and health promotion. This report attempts to fill the current void, at least in part, and also presents some of the likely developments in the field.

Diet and food in relation to health and health policy

Food and drink are, like the air we breathe, essential to human life and physical function. In all life phases, from conception to old age, an appropriate quantity and composition of the food is essential. In addition, a variety of other nutrients are required, as illustrated in *textbox 1.1*. This requirement can be met relatively simply, at least here in the Western world, by ensuring adequate variety in our diet. After all, most foods vary markedly in composition. In many cases, e.g. plant-based products, their composition can be extremely complex. This means that, in addition to the 'desired' nutrients, they are likely to contain numerous other substances and constituents. Some of those constituents may actually have an adverse effect on health, while others seem to promote good health.

Textbox 1.1: Diet and food constituents.

Diet contains more than just fuel for the body. Alongside substances which provide energy, we also consume those which build tissue and regulate bodily functions. These substances are necessary to create and replace tissue and cells, or to maintain their structure and function. This is not only important for children during their growth, but also for adults. Many of the tissues of our body, such as those of blood, bone and skin, are subject to a constant process of degeneration and replacement. The substances contained in our food which provide energy, regulate bodily functions and enable regeneration are generally referred to by the collective term 'nutrients'. Based on the quantity in which these nutrients are to be found in our diet, they are classified as either 'macronutrients' or 'micronutrients' (see *figure 1.1*).

1. **Naturally occurring constituents**
- **Nutrients**
  - Macronutrients: fats, carbohydrates, proteins, alcohol
  - Micronutrients: vitamins, minerals, trace elements

- **Other naturally occurring constituents** *(non-nutrients)*
  - Water
  - Fibre: non-digestible complex carbohydrates
  - Antinutritional factors: trypsin inhibitors (in soy), etc.
  - Secondary metabolites from plants and other organisms:
    - Bio-active compounds (polyphenols, lignans, etc)
    - Natural toxins (resistance factors)

2. **Non-naturally occurring constituents**
- **Additives**
  - Various categories (preservatives, colourings, flavouring agents etc.)

- **Contaminants** (from raw materials, process and/or environment)
  - Microbial contaminants (*Salmonella*, *Campylobacter*, etc.)
  - Chemical contaminants (PAHs, PCBs, Hg, Pb, etc.)

Figure 1.1: Naturally occurring and non-naturally occurring food constituents.

The main sources of energy are the carbohydrates and fats, and to a lesser extent the proteins. Although alcohol also provides energy, its contribution at the level of the population is small. The most important nutrients after the fats, carbohydrates and proteins are the vitamins, minerals and trace elements. Various such constituents, as well as metabolites derived from the essential fatty acids, have a regulatory function due to their involvement in metabolic processes such as fluid regulation and metabolism. Examples include B vitamins, zinc and selenium. More than 50 nutrients, most of which are essential to human life, have been identified. Here, 'essential' means that the body needs these substances in order to function, and is unable to produce them itself, or unable to do so in sufficient quantity (Den Hartog *et al.*, 1980; Binsbergen *et al.*, 2001).

Besides the nutrients, our diet also includes many other substances and constituents, both naturally occurring and non-naturally occurring (see *figure 1.1*). The naturally occurring constituents which are not regarded as nutrients are often termed 'non-nutrients'. However, there is no consensus regarding which substances fall into which group. (Some people regard water and fibre as nutrients).

The non-naturally occurring substances may or may not be introduced into food deliberately. Additives, for example, may be used to extend a product's shelf life, or to enhance its colour. However, there can also be undesired contaminants present. These may be chemical or microbial in nature, and can be introduced during cultivation, production, processing or storage.

It has long been realized that a relationship exists between diet and food on the one hand, and health and disease on the other. If our intake of the substances which provide energy is too low, the result will be undernutrition. Similarly, an inadequate intake of the vitamins and minerals required for regeneration and regulation is likely to lead to various deficiency diseases, some of which can be life-threatening.

Current scientific insights however, suggest a more complex relationship between diet and health, particularly in terms of the so-called 'lifestyle diseases'. A high energy intake with low energy expenditure is unhealthy, because this will result in overweight, which is a risk factor for a number of chronic diseases. Similarly, an excessive intake of certain macronutrients, such as the *trans* and saturated fatty acids, is known to have an adverse effect on health. Toxic effects have also been observed from a high intake of certain micronutrients, including vitamins.

Conversely, beneficial effects have been ascribed to certain non-nutrients, which are said to protect against some chronic illnesses. In particular, this is the case with fibre and certain plant metabolites (polyphenols and lignans) as found in fruit and vegetables. Other non-nutrients such as naturally occurring toxins and anti-nutritional factors, however, may lead to adverse health effects.

Given the undeniable importance of healthy diet and safe food in terms of public health, the Dutch government has for many decades devoted due attention to these factors, regarding this as one of its key tasks. The government is often in the front line of food safety issues, and is able to implement the measures required to ensure food safety. However, the promotion of healthy eating habits is a somewhat more difficult undertaking, given that this is largely a matter of individual choice and that it is more difficult to force changes in behaviour and lifestyle.

The possible harmful effects of non-naturally occurring food constituents form an important focus of government policy. This is particularly true for constituents which are introduced intentionally, such as preservatives and flavourings, and more recently the phytosterols and phytostanols added to margarines with a view to reducing cholesterol levels. It also applies to the constituents which are not intentionally added, such as chemical and microbiological contaminants. Besides the serious chronic illnesses associated with these contaminants, particular attention is devoted to acute health problems such as gastro-enteritis and food poisoning.

Given the more acute risk or greater severity of certain (potential) health effects, food contamination with microbial or chemical constituents often occupies a prominent place on the political agenda and in the public perception of food safety matters. The government therefore faces an important challenge. Although many experts now believe that our food is safer than ever before, this is not always the view held by the general public. The series of recent food-related incidents has demonstrated that not only must the government continue to strive to maintain the current high level of protection, it must also persuade the public that every due measure has been taken.

The government must also remain alert to ongoing developments (e.g. globalization of production and trade) which increase the vulnerability of food safety, and to new threats as and when they emerge.

The terms 'healthy diet' and 'food safety' and their determining factors

No unequivocal definition of the term 'diet' exists in the Netherlands. Some experts apply a rather narrow definition, while others are very much broader in their interpretation (see *textbox 1.2*). It is assumed that we must obtain the necessary nutrients from our everyday 'package' of the foods that we eat. The relative quantities of each nutrient will, however, vary greatly from one type of food to another. The same is true of the potentially deleterious food constituents. The determining factor of any definition of 'diet' is therefore the average package of foods consumed by the individual or population, whether or not expressed in terms of the nutrients and other constituents it contains.

In this report the authors have opted for a pragmatic approach whereby a more concrete definition is applied. This helps to delineate the term, rendering its essence clear (see *textbox 1.2*). The term 'diet' covers both the quantity and the composition of the food (and nutrients) consumed. We may speak of a 'healthy' diet if the total package,

Textbox 1.2: Definitions applying to (healthy) diet and (safe) food.

Some fifteen handbooks on diet and nutrition were consulted for this report. None contains a simple, usable definition of the terms 'diet' or 'nutrition'. Enquiries among various organizations (Ministry of Health, Wageningen University and Research Centre, the Netherlands Organization for Applied Scientific Research) reveal that both very broad and very narrow definitions exist. The broad definitions include all aspects of food and eating, including availability, eating habits, the consumption of nutrients and non-nutrients, absorption and digestion, nutritional status, etc.

A recent European Union document adopts a similarly broad definition of 'nutrition': "…the processes involved in obtaining and assimilating nutrients into the body so that the body functions properly and health is maintained" (EU, 2002). For pragmatic reasons, the authors of this report have opted for a more concrete definition of the terms 'diet' and 'food', making clear both the essence of each and the differentiation between the two. The definitions applied are also more in line with the objectives of government policy.

Diet: the total consumption of food and drink, expressed in terms of foods or nutrients and other food constituents, by an individual or a (sub-)population.
(i.e. what is actually consumed)

Food: the variety of foods made available by the agricultural sector and/or food processing industry.
(i.e. the products available to the general public)

Given these definitions, we may then apply the terms:

Healthy diet: when the consumption by the individual or (sub-)population, with regard to the quantity and composition of all nutrients and other constituents, is optimal for human health.

Safe food: when quantities of micro-organisms, chemical substances or other harmful constituents do not exceed levels likely to affect human health, on or in the foods offered or consumed.

calculated in terms of the quantity and composition of the nutrients and other health-promoting constituents, is 'optimal' (in terms of health) according to current scientific insights. Maintaining a healthy eating pattern is therefore a question of eating neither too much nor too little (the energy intake must be in balance with energy expenditure), and that the dietary composition (in terms of the main nutrients) is in line with the recommended levels. The term 'food' is defined as the complete range of foods and edible products made available by the agricultural sector and the food processing industry. We may speak of 'safe food' if the foodstuffs offered and eventually consumed contain no harmful concentrations of micro-organisms, chemical contaminants or other undesirable constituents, according to current scientific knowledge.

From the above, it will be clear that the relationships between diet, food and health are complex. Nevertheless, we wish to arrive at certain principles on which to base government policy. More specifically, we shall attempt to identify policy lines and related activities which make a real contribution in terms of maintaining or improving health. To assist in this process, a number of factors specifically related to diet have been added to the conceptual model of the Centre for Public Health Forecasting (cPHF), as shown in *figure 1.2* (see also Van Oers (Ed.), 2002; *Gezondheid op koers?* p. 56).

The main assumptions of the model presented in *figure 1.2* are (1) that the determinants do, by definition, determine health, (2) that within the 'determinants' block are the elements of prevention which affect the other determinants in various ways, (3) that health policy will control and direct preventive activities, and (4) that autonomous factors (beyond the influence of health policy) will also influence the overall process.

An examination of the figure from top to bottom, with specific attention for diet-related factors, reveals the following picture. The arrow between 'Health status' and 'Diet' is self-explanatory. While diet will have an influence on some personal characteristics (e.g. overweight) it should be noted that the interplay of diet and personal characteristics (e.g. individual differences in sensitivity to certain food constituents) will also affect overall health outcomes.

Diet in terms of actual consumption is determined by lifestyle factors (eating behaviour or eating habits) on the one hand, and the external factor (physical environment) of food supply on the other, both in terms of the range of foods available and their quality. Diet may therefore be regarded as the product of eating behaviour on the one hand and available foods on the other (Diet = Eating behaviour x Food supply).

Eating behaviour encompasses both the choice of food products and the manner in which they are stored and prepared. This in turn is determined by personal factors such as knowledge, attitude and preferences – from junk food to haute cuisine. In many cases (such as for babies, children, hospital patients and for others who rely on organized catering), the choice of food is actually determined by other people. Social

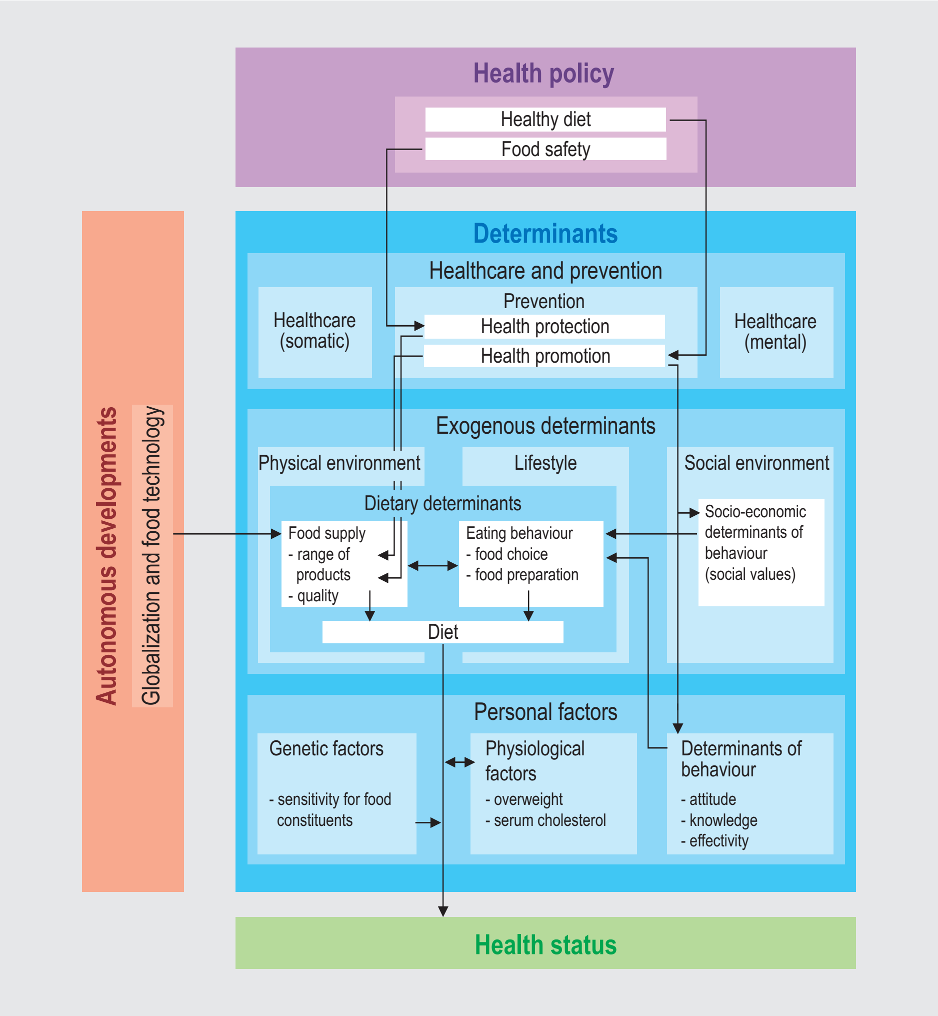

Figure 1.2: The cPHF conceptual model adapted for diet.

factors are also important in terms of income and the affordability of food products, and the role that eating and drinking play in the individual's life. The food supply is further influenced by 'autonomous' factors such as developments in food production technology and market globalization, as well as by food safety legislation and public information programmes designed to promote healthy eating behaviour.

From the perspective of prevention, food safety (in terms of legislation and enforcement) is a matter of health protection policy. Health promotion policy targets eating behaviour, both through personal characteristics (the behavioural determinants such as knowledge and attitude) and through social environmental factors (the socio-economic behavioural determinants). As a consequence, there is a certain logical differentiation (albeit not absolute) between policy addressing a healthy diet and that concerned with food safety.

Terms of reference, objective and structure of the report

The key question addressed by this report is how we can improve our diet, eating behaviour and food supply so as to maintain the health gains achieved in the past as well as making additional health gains in the future. The report also attempts to identify the extent to which the health gains of diet-related interventions relate to those which may be achieved through other types of intervention.

The objective of the report is to coherently present and analyse the scientific knowledge and government measures relating to both healthy diet and food safety. In doing so, we shall examine where the greatest potential health gains are to be made, or where past gains can be maintained, on the basis of previously identified principles for policy addressing eating behaviour and food supply. The report therefore seeks to provide important input for government policy.

Part A of the report presents a summary of the main findings, while Part B (starting with this introductory chapter) is structured to respect the existing distinction at the policy level between 'healthy' and 'safe'. *Chapters 2 and 4* form the main framework for each of these aspects, and each presents: a) a general summary of current knowledge and the status of health-promoting and health-threatening constituents in the diet, b) modifying factors; c) an identification of the most important dietary constituents which have a positive or adverse effect on health, and d) an analysis and quantification of the potential health gains or health losses. Further to this 'problem analysis', *chapters 3 and 5* describe the policy currently implemented by the government and the existing legislation and other measures addressing 'healthy diet' and 'safe food' respectively. These chapters therefore present a policy analysis.

These separate considerations of 'healthy diet' (*chapters 2 and 3*) and 'safe food' (*chapters 4 and 5*) are followed by three chapters in which the health aspects of diet and food supply are considered in greater cohesion. *Chapter 6* opens with a summary of the (alleged) positive and negative health aspects of the so-called 'functional foods' and dietary supplements. Current developments in legislation are also described. *Chapter 7* attempts to make a quantitative comparison between the health and safety aspects of certain recommended foods (such as fruit and vegetables, fish, cereals, etc.) and the 'functional foods' and supplements. Furthermore, the potential health gains of dietary interventions are compared with those addressing other lifestyle factors. *Chapter 8* considers in greater depth the coherence between 'healthy diet' and 'safe food' in the perception of the consumer. The contents of this chapter rely primarily on current knowledge and insights relating to eating behaviour and the risk perception of the general public, and on how these can influence each other. *Chapter 9* takes a look into the future, describing the likely trends and developments in food safety and eating behaviour for the coming five to ten years, together with their possible consequences for public health. *Chapter 10* presents a general discussion and the main conclusions of the report. This chapter also forms the basis for the 'Key Messages' of the report.

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2 HOW HEALTHY IS THE DUTCH DIET ?

2.1 Introduction

The state of public health in the Netherlands underwent a veritable revolution in the twentieth century. Over a one-hundred-year period, life expectancy (at birth) rose from 47.5 to 75.2 years for men, and from 50.4 to 80.5 years for women. The greatest gains were made during the first sixty years of the twentieth century, when life expectancy for both men and women increased by 24 years. In the case of men, the trend levelled out between 1960 and 1980, but life expectancy then increased by a further three years in the following two decades. The continual increase in women's life expectancy seems to have peaked in about 1990, with only 0.5 years having been added between 1990 and 2000 (CBS[1], 2004).

Underlying this increase in life expectancy is a shifting pattern of the causes of death, as shown in *figure 2.1*. Between 1900 and 1970, there were fewer pandemics of infectious diseases, but an increase in degenerative or chronic diseases such as cardiovascular disease and cancer. The period following 1970 has been termed the era of 'delayed degenerative diseases'. The mortality from cardiovascular disease fell, shifting to an older age group. After 1990, cancer mortality also levelled out (Mackenbach, 2001).

The reduction in deaths from infectious diseases must be seen as one of the great public health successes of the twentieth century. It is attributable to such factors as improved hygiene, vaccination programmes and safer food. That food became safer is largely due to the introduction of pasteurization, the emergence of the domestic refrigerator, and the publication of food safety guidelines. A second major success can be seen in improvements to diet and nutrition.

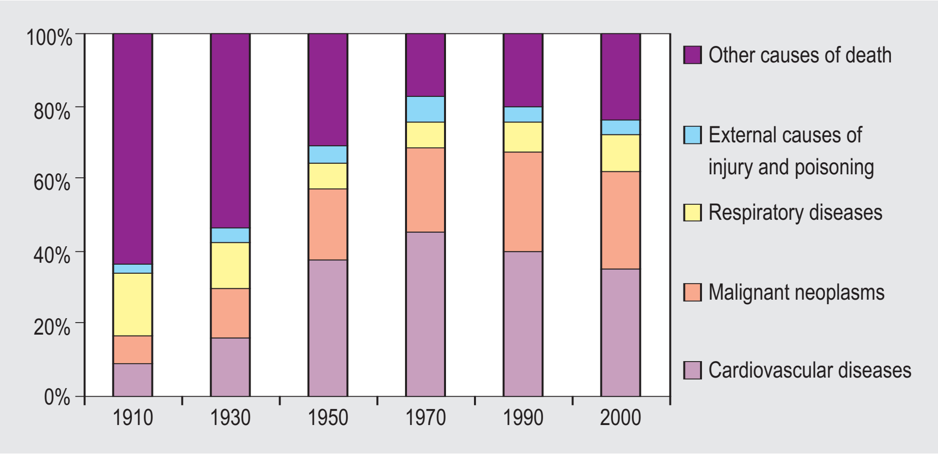

Figure 2.1: Mortality in the Netherlands in the twentieth century, by cause of death (Source: CBS, 2004).

[1] Statistics Netherlands, Voorburg/Heerlen

Not only have foods become microbiologically safer, their nutritional value has increased, serving to eliminate the major deficiency diseases such as pellagra and rachitis (US Centers for Disease Control, 1999). The chronic diseases which are now dominant do have an important relationship to diet and nutrition, but that relationship is of a very different order. This chapter therefore addresses the question, 'how healthy is our diet in these times of excess?' *Section 2.2* presents a summary of the relationships between diet and the major chronic diseases, while *section 2.3* describes the food consumption of the Dutch population. Based on this information, *section 2.4* goes on to assess the health loss in the Netherlands that can be attributed to an unhealthy diet and, conversely, the potential health gains to be made through dietary interventions. The way in which those interventions can be made is discussed in *section 2.5*, which is followed by a general discussion and conclusions in *section 2.6*.

2.2 Diet in relation to health and disease

M.C. Ocké, D. Kromhout #

There are many nutrients implicated in the development of diet-related chronic diseases. Some nutrients have an adverse effect on health, while others have a positive effect. Lifestyle factors, such as smoking, alcohol consumption and physical activity, also play a part, as do environmental factors and genetic susceptibility to certain diseases. This complex network of contributory causes has yet to be fully understood.

In 2003, the World Health Organization/Food and Agricultural Organization published a report which includes a summary of current scientific knowledge concerning the relationships between dietary factors and the most common diet-related diseases worldwide (WHO, 2003). The diseases in question are cardiovascular diseases, cancer, obesity (severe overweight), diabetes mellitus type 2, dental disorders and osteoporosis. These are also the main diet-related diseases in the Netherlands. As shown in *figure 2.1*, cardiovascular diseases and cancer are the main causes of death. Obesity is taking on epidemic proportions, its prevalence having doubled to approximately 10% over the past 25 years. Dental disorders, and caries in particular, affect almost the entire Dutch population. In 2000, there were over 400,000 people with osteoporosis and a similar number with diabetes mellitus type 2 (Van Oers, 2002). A number of these conditions are interrelated. For example, overweight and diabetes type 2 are important risk factors for cardiovascular diseases.

With contributions by R.A. Bausch-Goldbohm, W. Bosman, E.J.M. Feskens, C.P.G.M. de Groot, M.C.J.F. Jansen, J.C. Seidell, W.A. van Staveren and T.L.S. Visscher.

2.2.1 Dietary factors in relation to chronic diseases

Table 2.1 shows the relationships between nutrients and food products (or product groups) and the chronic diseases, where the WHO/FAO expert commission has identified 'convincing evidence' or 'probable evidence' of such relationships. The table has been adapted to reflect the situation in the Netherlands, insofar as information relating to fish salted in the Chinese manner, aflatoxins, excessive fluoride, hypocalcaemia and vitamin C deficiency has been omitted as irrelevant.

The extent to which dietary factors and certain diseases are interrelated is discussed below. However, this consideration is limited to those dietary factors for which 'convincing evidence' of a relationship exists, i.e. energy balance, fatty acid pattern, fruit and vegetables, fibre and sugar, certain vitamins and minerals, and alcohol consumption. Where possible, references to relevant reports of the Gezondheidsraad[2] are given, since these are directly applicable to the Dutch situation. Established relationships between dietary factors and less prevalent disorders, such as that between folic acid and neural tube defects, are not discussed in this chapter.

Energy balance
The food we eat is the source of energy for the human body. The main sources of energy in food are the carbohydrates and fats, with a small contribution being made by proteins and possibly by alcohol. In healthy people, the energy intake should be in balance with energy expenditure. Regular monitoring of body weight is a simple way of assessing whether this is the case. A slight *positive* energy balance over a longer period will lead to an increase in body weight. This may eventually lead to overweight, either moderate or severe. A *negative* energy balance can lead to underweight. The definitions of the terms 'overweight' and 'underweight' are given in *textbox 2.1*.

Overweight
During the period 1998 to 2001, 55% of Dutch men and 45% of Dutch women aged between 20 and 70 were overweight. Clinical obesity (severe overweight) could be seen in 10% of men in this age category, and in 12% of women (Blokstra & Schuit, 2003). This represents a twofold increase over the previous 25-year period (Visscher *et al*., 2002). It is predicted that the number of adults with obesity will rise by a further 50% over the coming 20 years (Bemelmans *et al., 2004*). The prevalence of overweight and obesity among children has also risen. Between 1980 and 1997, the number of young children with overweight more than doubled (see *figure 2.2*). Depending on age, the proportion of boys with overweight was between 7.1% and 15.5% in 1997, the figure for girls being between 8.2% and 16.1% (Fredriks *et al*., 2000).

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2 Health Council of the Netherlands, The Hague

Table 2.1: Summary of the evidence for relationships between dietary factors and obesity, diabetes mellitus type 2, cardiovascular diseases, cancer, dental disorders and osteoporosis, adapted to reflect the situation in the Netherlands (WHO, 2003).

	Obesity	Type 2 diabetes	Cardiovascular diseases	Cancer	Dental disorders	Osteo-porosis
Energy and fats						
High intake of energy-dense food	↑↑					
Saturated fatty acids		↑	↑↑			
Trans fatty acids			↑↑			
Dietary cholesterol			↑			
Myristic acid and palmitic acid			↑↑			
Linoleic acid			↓↓			
Fish and fish oil (EPA and DHA)			↓↓			
Phytosterols and phytostanols			↓			
α-Linolenic acid			↓			
Oleic acid			↓			
Stearic acid			-			
Nuts (unsalted)			↓			
Carbohydrates						
High intake of dietary fibre	↓↓	↓	↓			
Free sugars (frequency and quantity)					↑↑	
Sugar-free chewing gum					↓	
Starch					—	
Wholemeal cereal products			↓			
Vitamins						
Vitamin D					↓↓	↓↓
Vitamin E supplements			—			
Folic acid			↓			
Minerals						
High sodium intake			↑↑			
Products preserved in salt and salt				↑		
Potassium			↓↓			
Calcium						↓↓
Fluoride					↓↓	-
Meat						
Canned meat				↑		
Fruit and vegetables						
Fruit and vegetables	↓↓	↓	↓↓	↓		
Fresh fruit					-	
Non-alcoholic beverages						
Sugar-sweetened soft drink and fruit juice	↑				↑	
Very hot beverages (and food)				↑		
Unfiltered boiled coffee			↑			
Alcoholic beverages						
High alcohol intake			↑↑	↑↑		↑↑
Low to moderate alcohol intake			↓↓			
Other dietary factors						
Hard cheese					↓	
Exclusive breastfeeding (a)	↓					

Legend: ↑↑ = convincingly increases risk; ↑ = probably increases risk; ↓↓ = convincingly decreases risk; ↓ = probably decreases risk; — = convincingly unrelated; - = probably unrelated;
(a) this relates solely to the effect of receiving breastfeeding, not of giving it (see *textbox 2.4*).

Textbox 2.1: Classification of body weight.

The World Health Organization uses the 'body mass index' (BMI) as the indicator of a person's body fat in relation to his or her height. The body mass index is calculated by dividing weight by the square of the height (kg/m^2). The BMI categories shown in *table 2.2.* apply to Western adults. Different cut-off points apply in the case of children and ethnic groups.

Table 2.2: BMI classifications.

Classification of body weight	BMI
Underweight	< 18.5 kg/m^2
Normal weight	18.5-24.9 kg/m^2
Overweight	≥25 kg/m^2
Moderate overweight	25-29.9 kg/m^2
Severely overweight or obese	≥30 kg/m^2

In the Netherlands, among persons with a lower level of education (i.e. no formal education or primary level only), the prevalence of obesity is approximately three times greater than among those with a degree or higher vocational qualification (Van Lindert *et al.,* 2004). However, the increase in the number of persons with obesity may be across the board, regardless of education (Blokstra & Schuit, 2003). Among adults of Moroccan, Turkish, Surinamese and Antillean descent, obesity is more common than in the 'native' Dutch population. This is particularly true among women: the percentage of adult females with obesity varies from 20% in the Antillean ethnic group and 26% among the Turkish, compared to 12% in the mainstream Dutch population (Van Lindert *et al.*, 2004). Little information is available concerning the other ethnic groups. Obesity is also more common among Turkish and Moroccan children than among those of Dutch descent (Brussaard *et al.*, 1999).

Obesity is an important risk factor for a large number of chronic conditions (Gezondheidsraad, 2003a). Morbidity and co-morbidity rise in direct proportion to the body

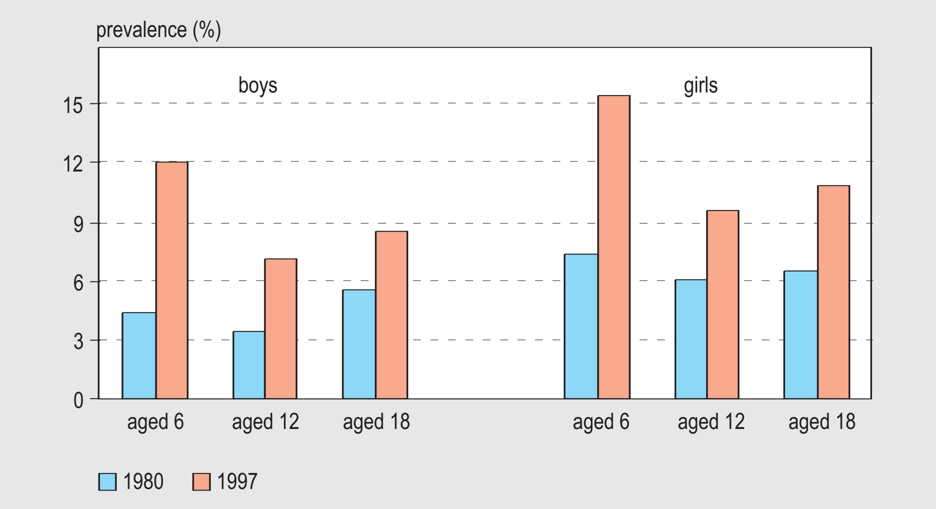

Figure 2.2: Prevalence of overweight in Dutch children, by gender and age (after Fredriks et al., 2000).

mass index (BMI). This is particularly true of diabetes mellitus type 2, but also holds for cardiovascular diseases, gallbladder diseases, conditions which impair mobility (such as arthritis), and various forms of cancer. An expert commission appointed by the International Agency for Research on Cancer (an official WHO agency) found 'convincing evidence' to suggest that obesity represents an increased likelihood of developing cancer of the colon, breast (post-menopause), uterus, kidney or oesophagus (IARC, 2002). Risk factors for cardiovascular diseases, glucose intolerance and (in the United States) diabetes mellitus type 2 are more prevalent among obese children than others of the same age. The reduced quality of life experienced by persons with obesity is not only due to the increased likelihood of (co-)morbidity, but also to psychological and social problems, including a higher rate of employment incapacity. The Health Council of the Netherlands states that treatment for obesity does not usually result in any permanent weight loss. It is therefore important to prevent obesity from developing in the first place (Gezondheidsraad, 2003a).

The Health Council arrives at similar conclusions to those of the WHO with regard to the relationship between the risk of developing obesity and dietary factors, physical activity and environmental factors (see column 1 of *table 2.1*). It summarizes current knowledge of dietary factors as follows. The likelihood of over-consumption (i.e. energy intake in excess of energy expenditure) is greatest with a diet rich in fats, as opposed to a low-fat, high fibre diet. This is particularly so in combination with a lack of physical activity. The influence of various types of carbohydrates on the regulation of the energy balance is not yet fully understood. Various other dietary factors will also affect energy intake, including the energy density of the diet, the quantity consumed (portion size), and the frequency of meals (with particular regard to 'snacking'). The diet which is likely to do most to help maintain an appropriate energy balance is one with a low energy density, i.e. containing a large proportion of fruit, vegetables and cereal products (Gezondheidsraad, 2003a).

Underweight

A negative energy balance can lead to undernutrition and to underweight (BMI < 18.5 kg/m^2). Gradual, unintentional weight loss is an important indicator of insufficient energy intake. Persons who lose five or more kilograms over a period of five years have a higher risk of death than those who do not. Among older men, this level of weight loss is associated with an increase in the risk of death in the order of 2.2 (De Groot *et al.*, 2002). Unintentional weight loss of 4% per year has been shown to be an independent indicator of increased risk of death. Undernutrition is often accompanied by impaired physical functioning and a decrease in the quality of life (De Jong, 1999; Mathey, 2000).

With the exception of a number of specific groups, undernutrition is relatively uncommon in the Netherlands. The groups with a high prevalence of undernutrition are elderly persons in (residential) care, the chronically ill, and those addicted to alcohol or drugs. In one survey of 'apparently healthy' Dutch citizens aged between 70 and 75, 14% of men and 31% of women were found to have lost five or more kilograms in body weight over a period of ten years (De Groot *et al.*, 2002). Of elderly persons admitted to a long-term residential care facility, 30% are suffering from undernutrition (Anon., 2001), while among those admitted to hospital, the prevalence of undernutrition can rise to as much as 62% (Naber *et al.*, 1997; see also RIVM, 2004).

Fatty acids

Fatty acids in our diet play a particularly important part in the atherothrombotic process which underlies the development of coronary heart diseases. Various (classes of) fatty acids have various effects. The differences between the various classes of fatty acids is explained in *textbox 2.2*.

Textbox 2.2: Types of fatty acids in the diet.

Fat in our diet is mostly in the form of triglycerides, made up of glycerol and fatty acids. Fatty acids may be saturated (e.g. myristic acid and palmitic acid) or unsaturated, which means that they have one or more double bonds between the carbon atoms. The number of double bonds determines whether the fatty acid is monounsaturated (e.g. oleic acid) or polyunsaturated (e.g. linoleic acid). The site of the double bond is represented, for instance, as n-3 (α-linoleic acid, fish fatty acids) or n-6 (linoleic acid). The symbol omega (ω) is sometimes used instead of the 'n'. Double bonds can occur either in the *cis* or *trans* form.

Quantitative relationships have mostly been described between the intake of fatty acids on the one hand and intermediary risk factors, such as high concentrations of serum cholesterol fractions, on the other. In the case of saturated fatty acids, the relationship with serum LDL cholesterol ('bad' cholesterol) is the most important. The level of LDL cholesterol has a strong correlation with the total cholesterol level. Intervention studies have demonstrated that the replacement of one energy per cent saturated fatty acids by carbohydrates is accompanied by a reduction in the total serum cholesterol of 0.052 mmol/l; replacement with monounsaturated fatty acids results in a reduction of 0.048 mmol/l (Clarke *et al.*, 1997).

Trans fatty acids raise the LDL cholesterol level and lower that of HDL cholesterol ('good' cholesterol). Besides the adverse effects on serum cholesterol fractions, other adverse effects can be seen, having a link with the risk of coronary heart diseases such as thrombosis. On the basis of cohort studies, it is estimated that an increase in *trans* fatty acid intake equivalent to two energy per cent will produce a 25% increase in the risk of coronary heart diseases (Oomen, 2001).

Substitution of saturated fatty acids by polyunsaturated acids was shown to reduce the risk of coronary heart diseases in three of the four long-term intervention studies undertaken. The Health Council therefore concludes that the effect may be attributable to linoleic acid, although α-linolenic acid could also be responsible for the findings (Gezondheidsraad, 2001).

The n-3 or omega-3 unsaturated fatty acids listed in *textbox 2.2* are known to reduce the risk of fatal cardiovascular diseases. Fish is a rich source of these lipids. Epidemiological research and intervention studies have established that the consumption of fish reduces the risk of death from cardiovascular diseases. A daily intake of 400 mg fish fatty acids (the equivalent of eating fish once or twice per week) reduces the risk of coronary heart diseases by approximately 25%, compared to a situation in which no fish fatty acids are consumed (Bucher *et al*., 2002; Whelton *et al*., 2004, He *et al*., 2004).

Fruit and vegetables

Fruit and vegetables are important sources of dietary fibre and various vitamins, and help to prevent nutritional deficiencies. Moreover, a high consumption of fruit and vegetables reduces the risk of certain chronic diseases.

Based on cohort studies, it is estimated that the risk of coronary heart diseases can be reduced by 20% with a high consumption of fruit and vegetables, compared to a situation in which consumption is low (Liu *et al*., 2000; Hirvonen *et al*., 2001; Joshipura *et al*., 2001; Bazzano *et al.*, 2002; Steffen *et al.*, 2003). In the case of stroke, such a relative risk reduction can also be seen for the consumption of fruit and vegetables in combination (Joshipura *et al*., 1999; Hirvonen *et al.*, 2000; Johnsen *et al.*, 2003; Bazzano *et al.*, 2002; Steffen *et al.*, 2003). However, the results of cohort studies examining the consumption of fruit and vegetables separately are less consistent. In the largest cohort study, no relationship was established between the consumption of vegetables and the risk of stroke, but high consumption of fruit was estimated to reduce the risk by 30% (Joshipura *et al.*, 1999). The relative risks established by the largest cohort studies have been used as the basis for the modelling in *section 2.4* (see *table 2.3*).

In the early 1990s, it was estimated that high consumption of fruit and vegetables would reduce the risk of cancer, particularly its epithelial forms, by approximately 50% (Block *et al*., 1992). This risk reduction has since been subject to some downwards adjustment, and a discrepancy between patient-control and cohort studies has been noted. Both the IARC (2003) and the Signalling Committee Cancer of the Dutch Cancer Society (Signaleringscommissie Kanker KWF, 2004) have made an inventory of the evidence for a relationship between the consumption of fruit and/or vegetables and cancer. Both conclude that consumption is indeed likely to reduce the risk of cancer of the mouth and throat, oesophagus, stomach and lung. The IARC adds that there is some evidence, albeit limited, to suggest that the consumption of fruit and vegetables has a preventive effect with regard to cancers of the colon, ovary, bladder and kidney. If the evidence from cohort studies is considered in isolation, then the incidence of lung, stomach and breast cancer would appear to have an inverse relationship to the consumption of fruit, while cancer of the lung has a similar relationship to that of vegetables. As shown in *table 2.3*, the risk reductions are in the order of 20% (IARC, 2003). However, these estimates are based on some considerable uncertainties and with the exception of breast cancer, they are also conservative estimates. Moreover, exactly how high consumption of fruit and vegetables must be in order to achieve these risk reductions is not clear, since each study has compared different intake levels.

Besides nutrients, fruit and vegetables contain a wide range of non-nutrients, such as flavonoids and other polyphenols, which may also play a role in reducing the risks of

Table 2.3: Estimated health effects (relative risks) of high versus low consumption of fruit and vegetables.

Diseases	Reference	Fruit	Vegetables
Coronary heart diseases	Joshipura *et al.*, 2001	0.80	0.80
Stroke	Joshipura *et al.*, 1999	0.70	ns
Lung cancer	IARC, 2003	0.77	0.80
Stomach cancer	IARC, 2003	0.85	ns
Breast cancer	IARC, 2003	0.82	ns

ns = not significant

chronic diseases. Furthermore, the as yet unknown constituents of fruit and vegetables will probably have some significance in relation to health as well. To date, it has not been possible to demonstrate exactly how or why fruit and vegetables can offer protection against chronic disease.

Dietary fibre

Dietary fibre comprises indigestible carbohydrates. The main sources of fibre are brown, wholemeal and mixed-grain bread, potatoes, fruit and vegetables. Dietary fibre has a preventative effect with regard to obesity, coronary heart diseases and diabetes type 2. The possible effect with regard to bowel cancer remains disputed since the evidence, although based on well-conducted cohort studies (Park *et al.*, 2003; Bingham *et al.*, 2003) appears to be conflicting (KWF, 2004). A diet rich in fibre is more important in preventing overweight than one low in fat (Gezondheidsraad, 2003a). However, fibre supplements have not been consistently shown to have any positive effect in preventing obesity. Cohort studies reveal that an increase in daily fibre intake of more than 10 grams (for women) and 15 grams (for men) is associated with a 20-30% reduction in the risk of developing coronary heart diseases (Pietinen *et al.*, 1996; Rimm *et al.*, 1996; Wolk *et al.*, 1999; Mozaffarian *et al.*, 2003; Bazzano *et al.*, 2003). Various observation and intervention studies support the hypothesis that dietary fibre also reduces the risk of developing diabetes type 2 (Institute of Medicine, Food and Nutrition Board, 2002; Montonen *et al.*, 2003). The effects in terms of coronary heart diseases and diabetes type 2 are mostly attributed to dietary fibre derived from cereal products.

Sugar

The consumption of carbohydrates always entails some impact on the teeth. Whether that impact will lead to caries varies from individual to individual and, apart from the frequency of carbohydrate intake, will depend on the individual's oral hygiene regimen. With effective administration of fluoride, good oral hygiene and a relatively infrequent intake of carbohydrates, the risk of developing caries is small. Accordingly, the Health Council has not produced a dietary standard or guideline for sugar consumption (Gezondheidsraad, 2001).

Minerals and vitamins

The intake of the mineral sodium is positively related to blood pressure, while potassium has the opposite effect. Intervention studies demonstrate that a reduction of the daily sodium intake of one gram (almost 30% of the average estimated Dutch intake) by persons with no history of hypertension will result in a limited reduction of the systolic blood pressure of no more than 1 mm Hg. For those who do suffer from hypertension, the reduction is 2.5 mm Hg (Gezondheidsraad, 2000a). A meta-analysis of intervention studies of potassium intake suggests that potassium suppletion will reduce systolic blood pressure by 1.8 mm Hg in subjects who do not have elevated blood pressure, and by 4.4 mm Hg in those who do. Fruit and vegetables are good sources of potassium (Geleijnse & Grobbee, 2003). A diet which includes a high proportion of fruit, vegetables, fish, nuts, low-fat dairy products, and a low proportion of total fat and saturated fat has been shown to have a positive effect on blood pressure (Gezondheidsraad, 2000a).

Calcium and vitamin D are, alongside physical activity, two important factors in the development and maintenance of the skeleton. Among the elderly, a high intake of both calcium and vitamin D has been related to a lower risk of developing osteoporosis and bone fractures (Gezondheidsraad, 2000b; Ooms, 1994). A high consumption of milk and milk products, as well as a high intake of calcium (more than 1000 mg per day) demonstrate a slight but consistent reduction in the risk of bowel cancer (KWF, 2004).

This report does not examine the diet as a source of fluoride, since in the Netherlands, toothpaste containing fluoride is considered a far more important contributor to the prevention of oral health problems than the quantity of fluoride in the diet.

Alcohol

The consumption of alcohol, particularly in excess, can have many adverse effects (Klatsky & Friedman, 1995). According to the figures published by Statistics Netherlands (CBS), 831 people died in the Netherlands from an alcohol-related condition (e.g. alcoholic cirrhosis and alcoholic hepatitis) in the year 2000, where alcohol could be identified as an explicit contributory factor. This figure must be regarded as a minimum, since it does not include deaths which are indirectly related to alcohol consumption. For example, each year approximately 200-250 people die in road accidents in which at least one driver is under the influence of alcohol, with a further 3,000 to 3,500 individuals suffering serious injury.

Excessive alcohol consumption is also an important cause of osteoporosis and hypertension, the latter increasing the risk of stroke and coronary heart diseases (WHO, 2003). Alcohol consumption is also a risk factor in cancers of the mouth, throat, oesophagus, liver and breast. The most important public health effect of alcohol is the risk of breast cancer, since this is more prevalent than other alcohol-related forms of cancer. Women who consume one unit of alcoholic beverage per day are at approximately 8% higher risk of developing breast cancer than those who do not drink at all. There are also clear indications that alcohol consumption is implicated in the development of bowel cancer (KWF, 2004).

However, alongside the many negative effects of excessive alcohol consumption, there is evidence to suggest that moderate consumption (one to three units per day for men and one or two units a day for women) actually reduces the risk of coronary heart diseases, and possibly also stroke (although this is less clear), compared to total abstinence or high alcohol consumption (Holman *et al.*, 1996).

2.2.2 Dietary standards, Guidelines for Good Nutrition and Rules for a healthy diet

In the Netherlands, it falls to the Health Council (and formerly the Netherlands Nutrition Council) to formulate dietary reference values and guidelines for good nutrition and diet. The dietary standards offer 'average requirements', 'recommended quantities', 'adequate intakes' and 'acceptable upper limits' for the intake of various nutrients. The 'recommended quantity' and the 'adequate intake' reflect the level of intake at which no deficiency symptoms will appear, and at which the likelihood of chronic diseases is minimized. A recommended quantity is calculated on the basis of information regarding the average requirement and its variance; where insufficient information about the average requirement is available, the 'adequate intake' is proposed. The 'acceptable upper limit' is the quantity above which undesirable side-effects are likely to be seen (Gezondheidsraad, 2001). Since 2000, updates of the dietary standards have been published for a number of nutrients.

In 1986, the Nutrition Council published the *Guidelines for Good Nutrition*. This document described the average Dutch diet at that time, and set out the changes that were seen as desirable, based on the recommendations of the Nutrition Council and the Health Council with regard to the prevention of illness and disease.
The document offers the following guidelines:

- Maintain a varied diet.
- Limit your intake of fat – particularly saturated fat – but ensure that you eat a sufficient quantity of polyunsaturated fats.
- Moderate your cholesterol intake.
- Eat plenty of complex carbohydrates and dietary fibre, and avoid too frequent or excessive consumption of sugars.
- Moderate your alcohol consumption.
- Moderate your salt intake.

In addition to these guidelines, the document also stressed the importance of achieving and maintaining an appropriate body weight (Nutrition Council, 1986).

The guidelines have been subject to periodic re-evaluation based on current scientific knowledge (Nutrition Council, 1989, 1991). With regard to the guidelines for fat, this led to a shift in emphasis from the importance of limiting overall fat intake to that of limiting the intake of saturated fat. The importance of eating fish (n-3 fatty acids) was also given greater emphasis. In the case of the *trans* fatty acids, there was insufficient evidence at the time (the early 1990s) on which to base any recommendations. While the 1986 Guidelines for Good Nutrition may now appear somewhat dated, they are still adequate in their general outline. However, a revised version is currently being prepared by the Health Council and will incorporate the considerations described in *section 2.2.1*.

Textbox 2.3: Guidelines for Good Nutrition (most important changes in diet).

- The amount of protein in the diet may remain unaltered.
- A reduction in fat consumption, from an average of 40 energy per cent to an average of 30-35 energy per cent is considered necessary. This reduction should primarily be achieved through restricting the intake of saturated fats. Since 1991, the recommended consumption of saturated fats is no more than 10% of the daily energy intake.
- Individual consumption of cholesterol should be no higher than the average consumption level of 33 mg/MJ.
- The consumption of carbohydrates should increase from an average of approximately 45 energy per cent to 55 energy per cent. This increase should be accounted for by greater consumption of complex carbohydrates.
- The consumption of mono- and disaccharides should be limited, particularly in terms of frequency. An acceptable intake level would be between 15 and 25 energy per cent.
- Consumption of dietary fibre should increase from approximately 2.4 g/MJ to approximately 3 g/MJ.
- Excessive alcohol consumption should be discouraged.
- Individual consumption of table salt should not be higher than the former average consumption level of 9 g/day.

The most important dietary changes recommended by the Nutrition Council since its 1986 Guidelines for Good Nutrition are shown in *textbox 2.3*.

Based on these documents, the Netherlands Nutrition Centre published a set of ‘Rules for healthy diet’, representing a popularized account of recommended intake and dietary patterns for the purpose of general public information. The guidelines for the consumption of fruit and vegetables is included (see www.voedingscentrum.nl).

2.3 Food consumption and the intake of nutrients

M.C. Ocké, K.F.A.M. Hulshof #

Following a description of the relationships between dietary factors and the main diet-related chronic diseases, this section describes how healthy the Dutch diet actually is, and it also outlines current developments in food consumption patterns.

Developments in food consumption have been described by the Health Council of the Netherlands (Gezondheidsraad, 2002), based on an analysis of the results of the national Food Consumption Surveys for 1987/1988, 1992 and 1997/1998. (For the purposes of this account, we shall simply refer to ‘the period 1988 to 1998’). The most important findings of the Health Council are described below. Where possible, more recent information from other sources has also been incorporated, together with

With contributions by E. Anten-Kools, C.P.G.M. de Groot, S.A. Reijneveld, W.A. van Staveren and C. Thijs.

information relating to specific demographic groups. The consumption of functional foods, fortified products and dietary supplements is discussed in *chapter 6*.

In general, the developments seen are less marked than had been expected on the basis of market surveys. Nevertheless, they are in line with the moderate changes revealed by Social Planning Bureau's studies of the way in which Dutch people occupy their time. This might indicate that the average consumer is more conservative in his or her dietary choices than the trendwatchers assume. In this context, it should be noted that the trendwatchers' statements are usually based on short-term research among small and very specific groups of consumers. The difference may also be due to the fact that people with a heavy workload and little free time are not adequately represented on the panels used to assemble information about food consumption (Gezondheidsraad, 2002).

2.3.1 The general population

Mealtimes

In general, the traditional pattern of three meals a day was maintained during the period 1988 to 1998. Even in 2003, most people still appeared to be eating one hot meal per day (Albert Heijn, 2003). However, the trend during the period 1988-1998 was for slightly fewer people to eat breakfast (85% of respondents had eaten breakfast on both survey days in 1988, falling to 81% in 1998). This was particularly true of the lowest socio-economic group. The nutrient intake was slightly lower among those who frequently omitted breakfast (Gezondheidsraad, 2002).

For the hot meal of the day, which the Dutch usually take in the evening, there was a clear rise in the preference for products with relatively short preparation time and for pre-prepared convenience meals (Gezondheidsraad, 2002). In 1995, 19% of consumers stated that they purchased pre-prepared meals from time to time, while by 1999 this figure had risen to 25%. Sales figures also indicate a rising trend in the consumption of pre-prepared meals. Between the first half of 2001 and the first half of 2002, the total quantity (by weight) of pre-prepared meals sold rose from 32 million to 35 million kilograms, while the average number of purchases per consumer rose from 7.7 to 7.9 per year (Bijman *et al*., 2003).

During the period 1988 to 1998, the traditional Dutch hot meal, consisting of meat, potatoes and vegetables, lost ground to rice and pasta dishes, and composite dishes, i.e. those in which all ingredients are combined (Gezondheidsraad, 2002). However, in 2003, the potato remained the most commonly eaten basic ingredient (51%) of the hot meal (Albert Heijn, 2003). On average, a dinner prepared using potatoes as the staple ingredient contains more vegetables and more fat than one based around pasta or rice (Food Consumption Survey VCP-3 data 1998, supplementary analyses).

Between meals, the traditional beverages of tea and coffee were seen to give way to cold drinks (sugar-free and standard soft drinks, fruit juices), and bakery products replaced by nuts and packaged snacks. However, the information provides no indication that the habit of all-day 'grazing' has markedly increased (Gezondheidsraad, 2002).

The number of people eating out, i.e. eating breakfast, lunch and/or dinner at a location other than their own home, increased by between 3% and 5% between 1988 and 1998 (Gezondheidsraad, 2002). The proportion of consumers stating that they occasionally eat out was approximately 55% in 1999. The number of adults who often or exclusively do so rose from 6% in 1995 to 11% in 1999 (CBL, 2000).

Foods

During the period 1988-1998, the total consumption of staple foods such as potatoes, vegetables, fruit and meat can be seen to have fallen. This was accompanied by increased consumption of cereals, nuts, snacks, composite meals and non-alcoholic beverages (see *figure 2.3*). The most important changes were seen between 1988 and 1992.

In 1998, the average consumption of fish was low, at 10 grams per day (Gezondheidsraad, 2002). Fish was eaten two to three times a month on average. Only some 25% of the adult population met the recommended level of fish consumption, i.e. at least once a week (MORGEN project, 1993-1997). Based on the domestic consumption of fish and fish products, it would seem that consumption has since risen somewhat (the volume in 2001 being 17% higher than in 1995) (Bijman *et al.*, 2003).

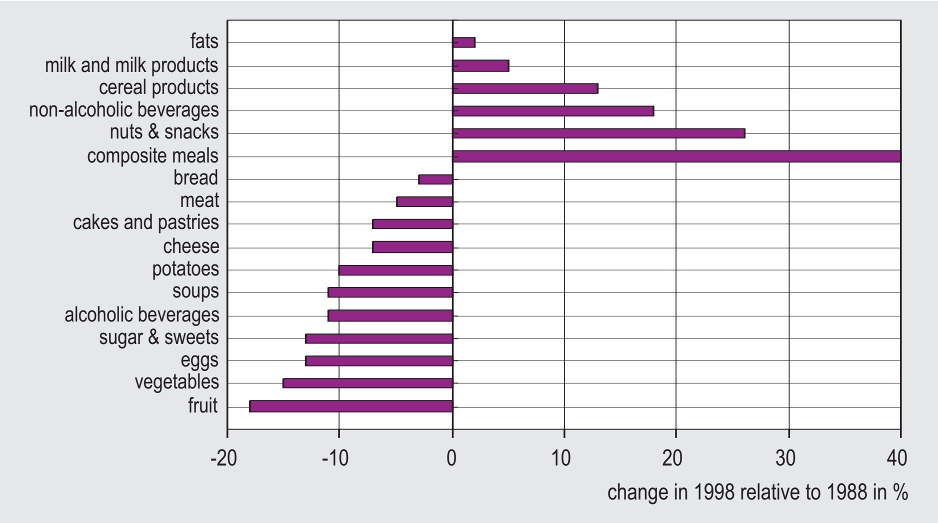

Figure 2.3: Change in the consumption of product groups between 1988 and 1998, expressed as a percentage of consumption in 1988 (VCP 1,3; after Gezondheidsraad, 2002).

During the period 1988-1998, the average daily consumption of fruit fell by 15% to 102 grams, while that of vegetables fell by 18% to 120 grams (Gezondheidsraad, 2002). The consumption level was therefore markedly lower than the recommended intake (150-200 grams vegetables, 2 pieces of fruit for persons aged 12 and above). Less than 25% of the population meets the recommendations with regard to fruit and vegetables. The consumption of fruit and vegetables, calculated on the basis of sales per household, fell yet further between 1999 and 2001 (Bijman *et al*., 2003).

Energy

The reported energy intake fell by 5% during the period 1988-1998. However, it is likely that part of this reduction is attributable to under-reporting. The number of people with overweight or obesity rose considerably during the period, as described in *section 2.2*. This would suggest that the reduction in energy intake was exceeded by a reduction in energy expenditure. In its report on obesity, the Health Council offers several indications of reduced energy expenditure, although quantitative information is not available (Gezondheidsraad, 2003a).

Fat and fatty acids

The average fat content of the diet and the composition of fatty acids has seen a positive trend over time. The reduction in the intake of *trans* fatty acids between 1988 and 1998 was in excess of 60%, which may clearly be described as substantial. This is attributable to the lower content of *trans* fatty acids in plant-based spreads and similar (semi-) hardened vegetable fat products. The reduction in total fat intake (approx. 5%), and hence that of the saturated fatty acids, is primarily due to changes in consumption patterns within the product groups ‘oils, fats and savoury sauces’ and ‘milk and milk products’, whereby products with a high fat content were replaced by ‘light’ versions having a lower fat content. To a limited extent, the reduced use of visible fats (spreads and cooking fats) was compensated by the consumption of products with industrially added ‘hidden’ fat. The reduction in the intake of saturated fatty acids in spreads and cooking fats, milk products, cheese, meat products, cakes and pastries was not accompanied by any increase in the intake of these fatty acids from sources such as potato products and pre-prepared meals (Gezondheidsraad, 2002).

Despite the favourable development over time, the quantity of saturated fatty acids and, to a lesser degree, *trans* fatty acids in the diet remains markedly higher than the recommended levels (see *table 2.4*). Only 5% of Dutch people have a diet in line with the recommended fatty acid pattern. The intake of unsaturated fatty acids is in line with the ‘adequate’ intake level, being an average of 20 energy per cent. The Netherlands Food Composition Table (the ‘NEVO’ table) does not yet present sufficient information with regard to the content of fish-derived fatty acids to allow the average intake of these nutrients to be calculated on the basis of the general food consumption surveys. Accordingly, the best substitution method appears to be an assessment of the frequency of fish consumption compared to the recommendations in this regard. (See the section on ‘Foods’ above).

Table 2.4: Average intake of fat and various fatty acids by Dutch men and women aged 20 and above, in energy per cent (en%).

	Recommended level	Men	Women
Total fat	20-30/35 (*)	36,6	37,0
Saturated fatty acids	< 10	14,4	14,6
Trans fatty acids	< 1	1,6	1,9
Unsaturated fatty acids	8-28/33 (*)	19,7	19,7
Linoleic acid	2	6,1	5,8
α-linolenic acid	1	1,7	1,2

Sources: intake of α-linolenic acid: Hulshof et al. 1999; intake of other nutrients: VCP 3 data 1998; recommendations: Gezondheidsraad 2001.
(*) The upper limit is for overweight individuals or for those exhibiting an undesirable weight increase; for others, the upper limit for total fat is 40 en% and for unsaturated fatty acids, 38 en% (Gezondheidsraad, 2001).

Dietary fibre, monosaccharides and disaccharides

The reduction in the consumption of bread, potatoes, fruit and vegetables renders it ever more difficult to achieve the recommended intake of dietary fibre. The average intake of dietary fibre is 2.3 grams per megajoule energy, which is somewhat below the recommended level of 3 grams per megajoule. In 1998, 17% of respondents met the guideline in this regard (Gezondheidsraad, 2002).

The World Health Organization uses the term ‘free sugars’ (as in *table 2.1*) to refer to all mono- and disaccharides (short-chain carbohydrates) which are added to products by the producer, cook or consumer, together with sugars derived from honey, syrups and fruit juices. No consumption statistics are available for these sugars. The overall quantity of mono- and disaccharides in the Dutch diet is approximately 23 energy per cent (Gezondheidsraad, 2002).

Vitamins and minerals

The intake of vitamins B_6 and C rose between 1988 and 1998. However, intake of most micronutrients (vitamins A, E, D and B_{12}, folic acid and the mineral iron) fell, while that of calcium remained unaltered. The reduction in the intake of vitamins A and D is partly due to the reduction in the use of spreads and cooking fats, the reduction in the consumption of liver (and liver products), and the shift from the consumption of full-fat milk (products) to that of semi-skimmed, skimmed and fat-reduced alternatives (Gezondheidsraad, 2002).

The intake of folic acid and ß-carotene fell during the period 1988-1998 due to the reduction in the consumption of vegetables (Gezondheidsraad, 2002). Studies of folic acid status reveal that, from the perspective of optimal homocysteine levels, at least 60% of adults had a suboptimal status during this period (Brussaard *et al.,* 1997a).
The average intake of iron, which was already lower than the recommended level in 1988, particularly among women of childbearing age, fell yet further during the ensuing ten years (Gezondheidsraad, 2002). However, studies of the iron *status* among adults during the period 1990-1993 do not indicate any widespread nutritional inadequacy (Brussaard *et al.*, 1997b).

The relevance of the low intake levels of the other micronutrients can only be determined by specific research into nutritional status. At present, too little information is available.
The average intake of sodium can only be effectively determined by measuring the sodium levels in 24-hour urine. In 2000, the Health Council estimated the sodium intake of Dutch adults to be an average of 3.7 grams per day, based on the results of the 'Intersalt' study and other, less extensive, recent studies (Gezondheidsraad, 2000a). Data on 190 adult subjects (male and female) derived from the Dutch part of the EPIC calibration study (1995-1997), indicate a slightly higher average intake of 3.9 grams per day. This corresponds to an average table salt consumption of 9-10 grams per day. The Guidelines for Good Nutrition recommend that individual consumption of table salt should not exceed 9 grams per day.

Alcohol

Based on sales figures for the year 2001, Dutch adults consume an average of 8.1 litres of alcohol per annum (PGD[3], 2002). This figure has remained reasonably stable over the past ten years. The proportion of men who drink alcoholic beverages either regularly or occasionally is 92%, while 80% of women do so. Among male adults, 43% drink less than one unit of alcohol per day, the figure for women being 57%; 38% of men and 17% of women are moderate drinkers (1 to 3 units per day for men and 1-2 units for women) (CBS, 2000).
Excessive alcohol consumption (3 or more units per day for men and 2 or more for women) is more prevalent among men (approximately 11%) than among women (approximately 6%). For men, excessive alcohol consumption is highest in early adulthood, while among women it first increases with age, and then declines. These age-related trends have been confirmed by survey-based studies (e.g. the MORGEN project, 1992-1997) although the extent to which questionnaires can provide reliable information regarding the proportion of moderate and excessive drinkers remains unclear.

2.3.2 Food consumption of specific age groups

Infants

In the Netherlands, a large proportion of mothers commence breastfeeding immediately after the birth of their baby. Since 1996, 70% or more of all mothers have done so, a percentage which was not matched in the preceding period (Burgmeijer & Reijneveld, 2001; Lanting *et al.*, 2002). In 2002, 75% of newborn infants were exclusively breastfed. By the age of three months, this figure has fallen considerably, with only 32% relying exclusively on mother-milk (whether directly from the breast or via a breast pump). At six months, the figure has fallen yet further to 17% (Lanting *et al.*, 2003). The percentage of infants relying on breast milk on the first day of life, at three months and at six months shows some increase since 1997, although the figures have levelled out in recent years (see *figure 2.4*).

[3] Marketing Board for Distilled Beverages

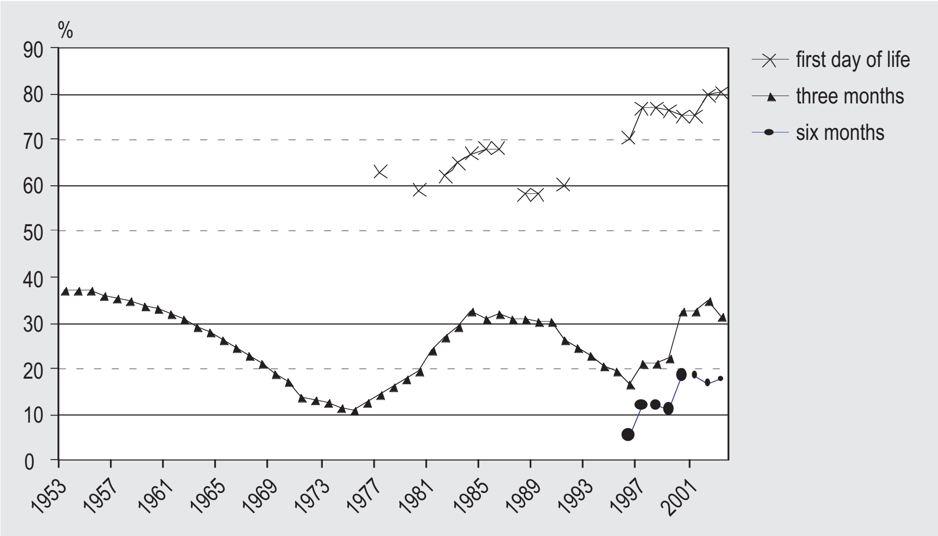

Figure 2.4: Percentage of Dutch babies exclusively breastfed on the first day of life, at three months and at six months (1953 – 2001).

Despite this trend, breastfeeding remains less prevalent in the Netherlands than in some other European countries (Breastfeeding Promotion Foundation/SZB, 2002). In Scandinavia in particular, breastfeeding is more common and continues for longer. In 1999, 92% of Norwegian babies were exclusively breastfed for the first three months of life (SZB, 1999). A summary of the health effects of breastfeeding compared to those of bottle-feeding is given in *textbox 2.4*. (See also RIVM, 2004).

Textbox 2.4: The health effects of breastfeeding.

There is convincing evidence that breastfeeding protects infants against a number of conditions, including infections of the middle ear (Oddy, 2001), asthma and conditions of the lower respiratory passages (Bachrach *et al.*, 2003). Given that all three of these conditions are common, and that the risk reduction in question is in double-digit percentages (up to 50% in recurrent middle ear infections), this is an issue of importance to public health. In addition, breastfeeding has been shown to have a slight positive effect on cognitive development (Anderson *et al.*, 1999). Moreover, there are grounds to suppose that the risk of obesity is lower among those who were breastfed as infants (WHO, 2003). Breastfeeding also has a favourable health effect for the mother, the risk of pre-menopausal breast cancer being substantially lower (Beral *et al.*, 2002).
Despite the decreasing levels of dioxins and PCBs in mother-milk (see *chapter 4.3*) the presence of these substances remains a matter of concern, albeit minor. Another reason that breastfeeding may not be considered the optimal source of nutrition for babies is the risk of HIV transmission. *Chapter 7* examines the balance between the positive and the negative effects of breastfeeding in greater detail. The World Health Organization advises that babies should be exclusively breastfed up to the age of six months in order to achieve the greatest possible health gain (WHO, 1998, 2001). It also recommends monitoring the growth of breastfed children against a growth curve published for this specific purpose.

Children

Information relating to the nutrition of young children aged 9, 12 and 18 months has recently been published (Breedveld & Hulshof, 2002). When this information was compared to the published nutritional standards for these age groups, the following issues were identified. Infants aged nine months have a low intake of fat, and the diet of all three age groups has an unfavourable composition of fatty acids (the saturated fatty acids content being too high). Among the toddlers aged 18 months, iron intake was too low, as was that of vitamin D for those children not being given vitamin D supplements or follow-on milk. Because no data relating to vitamin D or iron status are available, it is not possible to state whether the children concerned suffer from any actual deficiency of these micronutrients.

Teenagers

Overall, the food consumption of young people developed along the same lines as those of the general population during the period 1988-1998, but the adverse trends were more marked. In particular, there was an above-average reduction in the consumption of bread and vegetables. Although the overall consumption of alcoholic beverages declined during the period in question, consumption by 13 to 18-year-olds rose. The increase was particularly marked among young males, being 86%.

Teenagers and adolescents' intake of vitamin A was lower than the recommended level. However, in the absence of data relating to the vitamin A status, the significance of this finding is unclear (Gezondheidsraad, 2002).

The elderly

In general, elderly persons living independently have an adequate intake of fruit and vegetables, but their intake of fats is not in line with the recommendations, particularly with regard to the fatty acid composition. The average intake of micronutrients is adequate, except for that of vitamin D (Anon., 1998).

Based on food consumption surveys, it can be concluded that the average energy intake of elderly persons living independently is adequate, except in the case of a few specific sub-groups. Among those aged 75 and above, 32% of women and 10% of men were found to have an energy intake of less than 6.3 MJ per day (De Groot *et al.*, 1999). This corresponds to a low energy requirement due to limited physical activity, and a low resting metabolism. Given a daily diet in line with this low energy requirement, it becomes difficult to obtain sufficient nutrients (Voedingsraad, 1995). As the elderly become more dependent on care, so they expend less energy. Among institutionalized elderly women, the average intake of the vitamins A, B_1, B_6, C, D, and E is below the recommended daily level, as is that of calcium (Mathey, 2000; Wouters-Wesseling *et al.*, 2002). Data relating to men in the same situation is limited, but points in the same direction. This is a serious situation, especially if it continues for a long period of time.

An inadequate micronutrient status is frequently found among frail elderly persons and those in residential care. The proportion of women over 80 who have an inadequate vitamin D status is estimated to be 65% (Ooms, 1994). Low values of the vitamins B_6, B_{12} and folic acid are also often found among seniors. It is simply impossible for many people over 75 to acquire sufficient vitamin D and vitamin B_{12} through their regular diet. Suppletion of vitamin D is therefore recommended for women aged 50 and above, and for men aged 60 and above (Voedingscentrum, 2003), while that of vitamin B_{12} is recommended for all seniors with a low vitamin B_{12} status (Gezondheidsraad, 2003b; see also RIVM, 2004).

2.3.3 Food consumption among the lower socio-economic and ethnic groups

Lower socio-economic status groups

In dietary surveys, persons with a lower socio-economic status reported having a higher consumption of potatoes, meat and meat products, visible fats, coffee and (for men) soft drinks than those in the higher socio-economic groups. On the other hand, consumption of vegetables, cheese and alcohol was greater in the higher socio-economic groups (Hulshof *et al.*, 2003).

The intake of dietary fibre and most micronutrients was found to be slightly less favourable among the lower socio-economic groups (see *table 2.5*). However, one notable exception is the fat-soluble vitamins. The fat intake of the lower socio-economic groups was slightly higher than that of the higher groups, except in the case of saturated fatty acids. In general, the diet of the lower socio-economic groups fell short of the recommended nutritional standards more often than that of higher socio-economic groups (Hulshof *et al*., 2003).

Ethnic groups

Although information relating to the diet and nutrition of ethnic groups is scant, that which does exist suggests that the intake of macronutrients, particularly in terms of fatty acids, is more favourable among the Turkish, Moroccan and Surinamese communities in the Netherlands than among the ‘native’ Dutch population (Van Leest *et al.*, 2002; Brussaard *et al*., 1999). However, the Turkish and Moroccan communities have a lower average intake of many vitamins and minerals (Brussaard *et al.*, 1999). No uni-

Table 2.5: Average daily intake of energy and nutrients, in men aged twenty and over, by socio-economic status (SES) (VCP-3, 1998).

	High SES	Average SES	Low SES	Very low SES
Energy (MJ)	10,8	10,9	11,0	10,9
Protein (en%)	15,2	14,7	14,7	14,8
Vegetable protein (en%)	5,3	5,3	5,0	4,8
Total fat (en%)	36,6	36,1	36,8	38,9
Saturated fatty acids (en%)	14,4	14,2	14,3	15,4
Total carbohydrates (en%)	42,4	44,6	44,1	41,8
Dietary fibre (g/MJ)	2,4	2,3	2,2	2,3
Calcium (mg)	1.086	1.027	986	956
Iron (mg)	13,2	12,9	12,4	12,6
Vitamin A (RE)	833	759	769	818

Source: Hulshof *et al*., 2003.

form trends are to be observed across the board of the various ethnic groups in the Netherlands. Further research into their food consumption and nutritional status is required to confirm and elaborate these findings.

2.4 Potential health gain through improvements to the diet

W.M.M. Verschuren, R.T. Hoogenveen, P.G.N. Kramers, D. Kromhout, M.C. Ocké

Earlier in this chapter, we considered the relationship between certain dietary components and six common diseases. Information about the food consumption of the Dutch population was then given. By combining these two aspects, it becomes possible to estimate the health loss currently suffered by the Dutch due to a sub-optimal diet. At the same time this gives an indication of the maximum potential health gain which can be achieved through improvements to the diet.

The effects on public health have been calculated for five dietary factors, both individually and in combination. They are: saturated fatty acids, *trans* fatty acids, fish (as a source of n-3 fatty acids), fruit and vegetables. A large proportion of the Dutch population fails to meet the recommended consumption levels for each of these dietary factors (see *section 2.3*). There is firm evidence to indicate that these factors are associated with certain forms of cardiovascular diseases and/or cancer (see *section 2.2*). The current health loss due to overweight has been calculated separately. The effects of alcohol consumption on public health are calculated in *chapter 7,* in which the potential health gain through dietary inventions is compared with that which may be achieved through interventions targeting other lifestyle factors.

The effects of the five dietary factors and of overweight have been calculated for various forms of cardiovascular diseases, cancer and diabetes, as shown in the second column of *table 2.6*. Each of these diseases has been shown to have a clear relationship with one of the five dietary factors or with overweight. For each of these relationships, the relative risk (RR, as derived from the literature) has been used as the basis of the calculations. A full list of the RRs by risk factor category, age range and gender is given in *appendix 12*, with sources stated.

Health loss and health gain in three scenarios
First of all, we have calculated the health loss that can, in theory, be attributed to the current sub-optimal dietary pattern and body weight of the Dutch population. This is the same as the health gain that could be theoretically achieved were everyone immediately to achieve the recommended weight and adopt the various other recommendations with regard to diet. Clearly, this cannot be realized in practice. Accordingly, we have also calculated the health gain that can be achieved through those interventions which are indeed considered feasible, based on the results of several small-scale experiments.

All calculations rely on comparisons. The current health loss is calculated by comparing the actual situation today with the hypothetical situation in which everyone complies with the recommendations for a healthy diet. The more realistic health gain is calculated by comparing the current situation with one in which the effects of the interventions considered feasible are simulated. The three situations are termed 'scenarios'. The 'reference' scenario represents the current situation. The 'maximum' (or 'Utopian') scenario represents the situation in which everyone meets the dietary recommendations, and the 'middle' scenario which falls between the two, is considered to be an attainable scenario in practice.

Definition of the scenarios

In technical terms, the scenarios have been defined for each risk factor as the division of the total population into between three and five categories according to intake of the five dietary factors or BMI value. In the maximum scenario, everyone therefore falls into the 'most favourable' category, while in the middle scenario, those who have not yet achieved the most favourable category move up one category (towards most favourable) in comparison to the reference scenario (a more detailed explanation is provided in *appendix 12*). *Table 2.6* presents a summary of this, using average values. The third and fourth column show the reference and maximum scenarios respectively. The middle scenario in column 5 presents a distribution which lies between the two, as deemed feasible on the basis of documented (usually small-scale) interventions.

For saturated fat, fruit and vegetables, this feasible situation is reasonably in line with the actual changes achieved in intervention studies (Ammerman *et al.*, 2002). These interventions were small-scale and involved various strategies and populations. In the case of saturated fatty acids, the greatest reductions were seen among the risk populations. Successful approaches included working in small groups and working towards firm, quantifiable objectives. In the case of fruit-and-vegetable interventions, the number of studies which quantify the changes achieved (n=12) is not enough to identify the successful interventions. In the case of *trans* fatty acids, the reduction in consumption seems feasible, given the ongoing efforts to reduce or eliminate the *trans* fat content of industrially produced pastries and fried products (Gezondheidsraad, 2002). No relevant intervention studies have been conducted with regard to the consumption of fish, but it is assumed that an increase in the frequency of consumption on the part of those who do not currently eat fish weekly is possible (whereby they will in future do so once or even twice a week). Finally, in the case of BMI, the middle scenario assumes that everyone will be able to shed 1 kg/m^2, being an average of approximately 3 kg per person. Although this weight loss is considered feasible on the basis of successful intervention studies (Lean, 2000), it nevertheless seems somewhat 'Utopian' given the current weight trends within the Dutch population. In every case, the scenarios are based on the premise that the small-scale successes achieved can be extrapolated to the population as a whole.

Table 2.6: Summary of the assumptions in the three scenarios and the diseases for which a relationship has been calculated, for five dietary factors and overweight (in terms of BMI), with the policy objectives for the purpose of comparison.

Dietary factors, BMI	Associated diseases	Current situation, on average (reference scenario)	Recommendation (maximum scenario)	'Feasible' (middle scenario)[1]	Policy objective
Saturated fat	Coronary heart diseases	Consumption approx. 14.5 en%	< 10 en%	Reduction of 2.5 en%	10 en% in 2010
Trans fatty acids	Coronary heart diseases	Consumption approx. 1.8 en%	< 1 en%	Reduction of 0.5 en%	1 en% in 2010
Fish	Coronary heart diseases, stroke	Consumption approx. 2-3x per month	1-2x per week	Increase of 1-2x per month	Not a policy objective
Fruit	Coronary heart diseases, stroke, cancer of the lung, stomach, breast	Consumption approx. 100 g/day	200 g/day	Increase of 50 g/day	Increased consumption
Vegetables	Coronary heart diseases, lung cancer	Consumption approx. 120 g/day	200 g/day	Increase of 50 g/day	Increased consumption
BMI	Coronary heart diseases, heart failure, stroke, cancer of the colon, breast, uterus, kidney, type 2 diabetes	>25 kg/m^2 approx. 50% >30 kg/m^2 approx. 10%	< 25 kg/m^2	Reduction of 1 kg/m^2	No further increase

[1] Amendment only for those groups that are not yet in the most favourable category.

If we compare the choices for the middle scenario, as based on the literature, with the policy objectives stated in the Ministry of Health's policy document *Langer gezond leven* ('A longer life in good health', VWS, 2003), we see that the objectives with regard to the consumption of saturated and *trans* fatty acids in 2010 are in line with the current recommended levels and hence more ambitious than the levels on which the middle scenario is based. The reverse holds true of the BMI targets, for which policy 'merely' aims to halt the trend towards overweight (see *chapter 3*).

Three calculation methods

Three types of calculation have been made, giving rise to the following results:

- The directly attributable health loss, per annum, in terms of disease, death and DALYs.
- The cumulative health loss over 20 years. This simulation of the development in disease and death over a longer period provides a more realistic picture than the 'directly attributable' method, and can therefore serve to confirm or elaborate the outcome thus achieved.
- The effect in terms of life expectancy and disease-free life expectancy. This simulates the overall effect throughout the entire lifetime, taking the substitute causes of death into account.

Textbox 2.5: Summary of the three methods used to calculate health loss.
(See also *appendix 12*)

Directly attributable annual health loss. This can be illustrated using an example in which it is known that the consumption of fish once a week will reduce the risk of cardiovascular diseases by 25%, compared to the situation in which fish is eaten less than once a week (the relative risk, RR, is thus 0.75). If the number of people who eat too little fish (or none at all) is also known, it becomes possible to calculate which fraction of the current incidence of cardiovascular diseases is attributable to low fish consumption (the population-attributable risk, or PAR), and hence the incidence which can theoretically be avoided by greater consumption of fish. In the tables and figures, the calculated health loss for adults aged 20 and above is expressed as the number of new cases of disease, the number of deaths, and the number of DALYs (Disability Adjusted Life Years), whereby death and disease, the latter weighed in terms of severity and duration, are combined.

The cumulative health loss over a period of 20 years. This calculation relies on the RIVM's 'Chronic Diseases Model', which calculates in yearly stages the number of people, for example, who eat fish, develop cardiovascular diseases and eventually die. The outcomes in terms of disease and death are determined by the input distribution of fish-eaters, by the likelihood of developing cardiovascular diseases in the next annual 'step' in relation to the consumption of fish, etc. The calculated risk of disease is based on the same RRs as in the previous method. This model-based approach is more realistic than the directly attributable approach in that it takes delay and substitution effects into account, where delay refers to the fact that people may be spared cardiovascular diseases due to higher fish consumption in the earlier phases, but will go on to develop it at a later stage. Substitution refers to the fact that these 'spared' people will live longer but may develop some other form of disease and will eventually die of another cause. The original model calculation was based on a cohort of subjects representing the demographic composition of the Dutch population aged 20 and above, with life career over 20 years being simulated.

The effects on life expectancy. Effects in terms of life expectancy were also calculated using the RIVM's Chronic Diseases Model. The results of all effects and interactions on the overall life career of a cohort of 40-year-old subjects are projected, whereby the effect of the substitution disease is assumed to be far greater than in the 20-year approach. In addition to the life expectancy, the disease-free life expectancy is calculated by subtracting the number of years during which a person suffers from one of the modelled diseases from the total life expectancy.

For each of the three scenarios, these outcomes are calculated in relation to the various premises with regard to consumption and BMI, as described above. In the case of the 20-year cumulative health loss and life expectancy methods, a dynamic calculation model has been used: the RIVM's 'Chronic Diseases Model'. For the dietary factors, it is assumed that the proportion of the population falling into each of the risk factor categories will remain constant during the period considered by the model. For BMI, age-related changes are accounted for in the model.

A brief explanation of the three calculation methods is given in *textbox 2.5*, with a more comprehensive account of the methodologies, model calculations and scenario assumptions included in *appendix 12*, along with detailed outcomes. *Sections 2.4.1* and *2.4.2* present the main findings.

2.4.1 Current health loss in the Dutch population: the maximum scenario

Directly attributable health loss

Figure 2.5 presents the health loss accounted for by each of the five dietary factors (individually and in combination) and by overweight (BMI) in the maximum scenario, as compared to the reference scenario. The effect of overweight has not been included in the combined calculation since there is a relation between diet and BMI. *Figure 2.5* presents the death rate and incidence (absolute number of cases) of disease, categorized for diabetes, cardiovascular diseases and cancer.

Of the dietary factors, the greatest number of deaths and cases of disease are attributable to inadequate consumption of fish and fruit. The effect of overweight is comparable to the combined effect of the dietary factors in terms of disease (both approximately 40,000), but approximately half in terms of deaths (approximately 7,000 compared to 13,000). The DALY values (*table 2.7*) combine the incidence of disease with the death rate. Here too, the combined effect of the five dietary factors exceeds that of overweight. These figures are used in *section 7.5* to arrive at comparisons with other causes of death and disease.

When we compare the three categories of disease (*figure 2.5*), we see that the health loss due to cardiovascular diseases is many times greater than that caused by cancer. This is true of the five dietary factors in combination (incidence 14 times greater and deaths 5 times greater), as well as for BMI (7 and 4 times greater respectively). Diabetes is influenced only by BMI. With regard to incidence, the health loss is higher than for cardiovascular diseases but the death rate is lower due to the limited fatality of diabetes. Cardiovascular diseases has been approximated to account for 38,000 cases of disease and 10,500 deaths, being 25% of the total in each case. BMI has an effect on all three categories of disease. In the case of diabetes, approximately 50% of the total incidence and of all deaths may be attributable to overweight. Finally, it is noticeable that the difference between the incidence and the death rate from cancer is much smaller than in the other two categories. This reflects the higher fatality of most forms of cancer.

It should be noted that the evidence of the effects attributable to the dietary factors is of varying weight, whereby the results are subject to a varying degree of uncertainty. This uncertainty is greater with regard to the relative risks for fruit and vegetables than for the fatty acids. The uncertainty in the relative risks for overweight lies somewhere in the middle. The differences are due to the varying research methods employed by the relevant studies: prospective observational studies with questionnaire-derived data for fruit and vegetables, the same type of study supplemented by height and weight measurements for BMI, and intervention studies (with risk factors and disease incidence as outcome indicators) for fatty acids. The relationship between fruit consumption and breast cancer is not endorsed by all expert groups (see *section 2.2*). If the supposed relationship is discounted, the health loss attributable to addi-

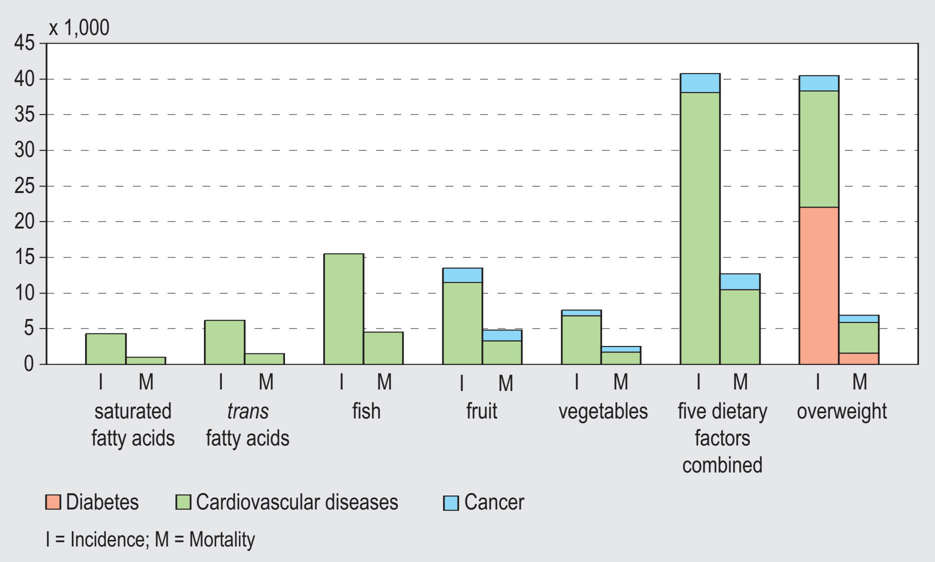

Figure 2.5: Calculated health loss due to the consumption of various fatty acids, fruit and vegetables (individually and in combination) and body weight not being in line with recommendations: number of cases of disease (incidence) or death directly attributable on one-year basis.

tional cancer cases falls by approximately one third and the death rate from cancer by approximately one fifth. However, the reduction in the total death rate due to inadequate consumption of fruit is less than 10%.

The statistics presented here may differ from those of previous publications due to the use of more recent research findings. For example, the Public Health Status and Forecast report of 2002 concluded that almost 5% of all deaths may be attributable to excess intake of saturated fatty acids (Van Oers, 2002). The much lower figure of 1% used in this report is due to the use of more accurate age-specific relative risks. Moreover, the results shown in *table 2.7* are not directly comparable to the data previously published in the report “Enkele belangrijke ontwikkelingen in de voedselconsumptie” (Some important developments in food consumption, Gezondheidsraad, 2002) since this report focused on a specific population group: young adults of lower socio-economic status. The 2002 Public Health Status and Forecast report put the contribution of inadequate fruit and vegetable consumption to the overall death rate at almost 5%. This is comparable to the current estimate, which is based on more recent data (IARC, 2003). In the 2004 report published by the Dutch Cancer Society (KWF) it is estimated that 2,000 new cases of cancer each year are attributable to overweight. This figure corresponds well with the estimate presented here. Rougoor *et al.* (2003) arrive at an estimate of 23,000 deaths per year due to the effect of diet. This figure differs somewhat from those offered in the current report (13,000 deaths due to dietary composition and 7,000 to overweight, which cannot be totalled due to partial overlap) because Rougoor used the higher Public Health Status and Forecasts figures for saturated fats, did not allow for the effect of *trans* fatty acids and fish consumption, and included a proportion of the deaths due to high blood pressure and cholesterol. Because these are intermediary factors, the total of 23,000 could well be an overestimate.

The cumulative health loss over a period of 20 years

As previously stated, 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*. If we compare the cumulative 20-years effects with the directly attributable effects (see *appendix 12*) we find that the figures for the incidence of diseases are some 20 times greater, but those for deaths are in the order of 10 to 15 times greater (see *figure 2.6*). This provides an understanding of how the model works. Firstly, time delay plays a part. In the directly-attributable calculation on a one-year basis, the mortality is calculated as immediately occurring; in the 20-years projection, death occurs only after a variable number of years of illness. That the 20-years incidence is more than 20 times the annual figure reflects the increasing age of the modelled cohort.

A further aspect is the occurrence of, for instance, cardiovascular diseases as a complication of diabetes. The one-year calculation includes only the direct associations, and not this type of secondary complication. In the 20-year calculation, the shift in the incidence of diabetes over a longer period also influences the incidence of cardiovascular diseases and related deaths.

Calculated over a 20-year period, the effect on the death rate is therefore proportionally smaller than in the directly-attributable calculation model. Accordingly, the con-

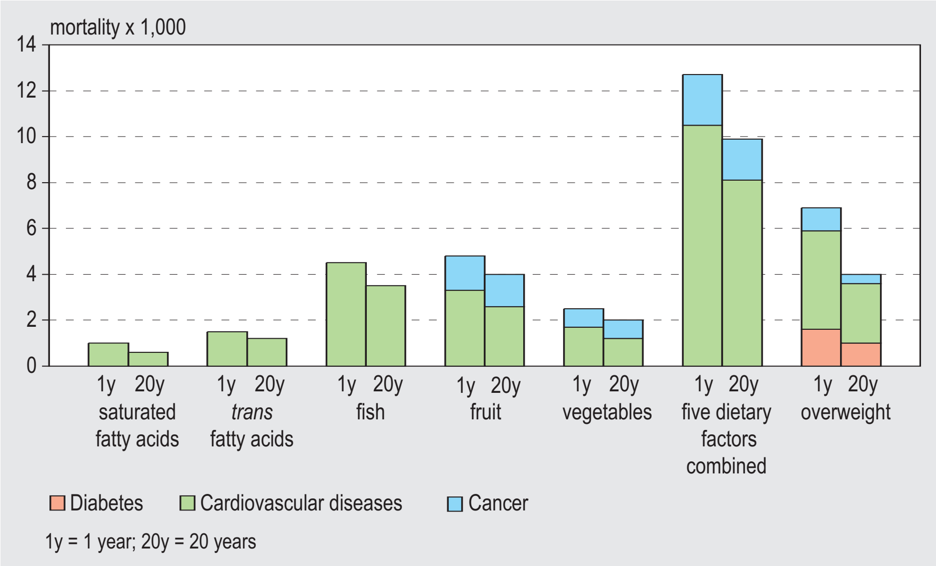

Figure 2.6: Calculated health loss through death, due to the consumption of five dietary factors and body weight not being in line with the recommendations; comparison of directly-attributable deaths with the cumulative death rate over twenty years (divided by 20; '20 y').

tribution of the dietary composition (five dietary factors) and that of the BMI to the total death rate falls in the 20-years model, to approximately 5% and 2,5% respectively (see *figure 2.6*). Although the results for the 20-years cumulative effect are more difficult to interpret, they do provide a better approximation of the actual situation than the directly-attributable method. The 20-years calculations introduce 'light and shade' into the directly-attributable method, but also support the results thus derived with regard to the extent of the effects.

The effect on life expectancy

When we consider health loss over an even longer period, i.e. that of total life expectancy, the aspects of substitute causes of death and the cumulative ('stacked') effects play an even greater role (see *table 2.7*). The largest reductions in life expectancy are attributable to dietary factors in combination (1.2 years) and overweight (0.8 years). Of the individual dietary factors, inadequate consumption of fruit (0.5 years) and fish (0.3 years) can once again be seen to have the greatest effect. The loss of 1.2 years' life expectancy due to dietary factors may not seem spectacular compared to the 13,000 deaths thus caused. However, the death rate quoted is less than 10% of the number of deaths each year. Life expectancy is calculated on the basis of the total number of deaths, whereby substantial variations would be required to bring about even a minor difference in life expectancy. The loss of disease-free years is in all cases larger than the reduction in life expectancy (see *table 2.7*). This can best be understood by realizing that the health loss is also the health gain that can, in theory, be achieved by effective dietary interventions. If life expectancy (calculated from the age of 40) increases by 1.2 years, the disease-free life expectancy increases by 2 years (see *table 2.7*). In other words, healthier eating habits postpone disease longer than they postpone death. However, this apparent 'compression of morbidity' is, at least in part, a consequence of the modelling technique: the postponed deaths includes all causes of death (some of which are not influenced by nutrition), whereas the postponed morbidity only refers to the diseases included in the model.

Table 2.7: Calculated effect in DALYs per year for adults aged 20 and above, and effect on life expectancy and disease-free life expectancy for 40-year-olds, under the maximum and middle scenario.

Factor	DALYs		Life expectancy Total		Life expectancy free of disease	
Scenario	Maximum	Middle	Maximum	Middle	Maximum	Middle
Saturated fat	25.000	10.000	0.1	<0.1	0.2	0.1
Trans fatty acids	32.000	22.000	0.1	0.1	0.3	0.2
Fish	82.000	46.000	0.3	0.2	0.5	0.3
Fruit	95.000	38.000	0.5	0.2	0.7	0.3
Vegetables	47.000	21.000	0.3	0.1	0.4	0.2
Five dietary factors combined	246.000	128.000	1.2	0.6	2.0	1.0
BMI	215.600	56.000	0.8	0.3	2.3	1.0

2.4.2 The realistic health gain: middle scenario

From the foregoing, we may conclude that much of the current health loss in the Netherlands is due to unfavourable dietary composition and overweight. In theory, this loss is also the gain that can be achieved through interventions addressing the five dietary factors and overweight (the 'maximum' scenario). However, experience shows that it would be unrealistic to expect that everyone would comply with the recommendations within the foreseeable future, even if substantial investments are made. Accordingly, a realistic 'middle' scenario has been produced, representing the health gain to be made by the interventions which are thought feasible, and which have proven themselves to be so during small-scale trials.

Table 2.7 presents selected key figures and *figure 2.7* shows the results in terms of new cases of disease under the middle scenario, in a direct comparison with the maximum scenario. As may be seen from *figure 2.7*, the outcomes for the dietary factors in the middle scenario are some 1.5 to 2.5 times smaller than in the maximum scenario. In the case of overweight, the reduction is more than four times. In terms of deaths, the reductions are comparable (see tables in *appendix 12*). The reduction in cardiovascular diseases which could be achieved by addressing all dietary factors in combination is 13-14% in the middle scenario (compared to approximately 25% in the maximum scenario), with 5% to 6% only by increasing the consumption of fish. Interventions targeting BMI would yield a 50% reduction in diabetes under the maximum scenario; in the middle scenario this figure falls to approximately 11%. Accordingly, the reduction in the total death rate which could be achieved through dietary interventions falls from

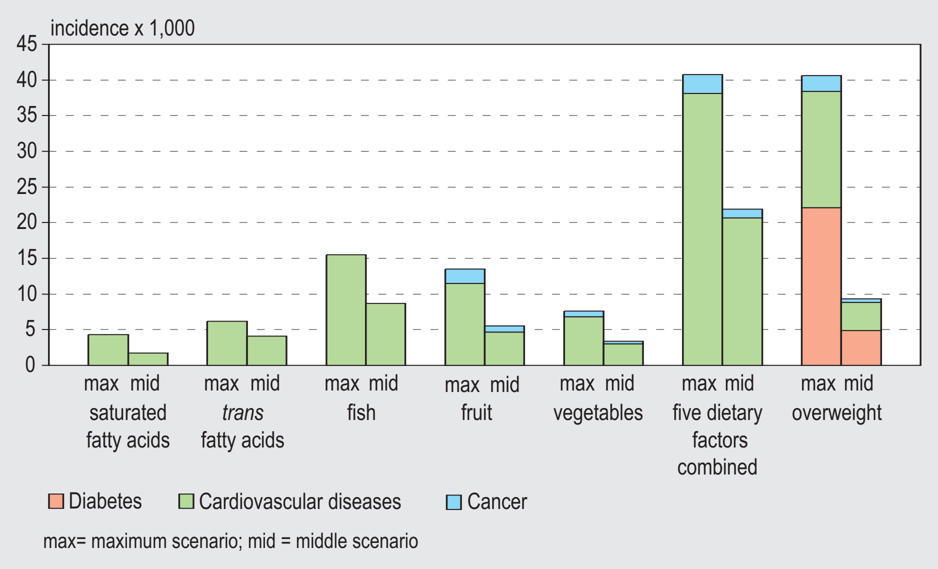

Figure 2.7: Calculated health gain for five dietary factors and overweight, by new cases of disease (incidence), directly attributable on a one-year basis: the maximum scenario (in which everyone complies with the recommendations) compared to the middle scenario (interventions considered feasible).

10% in the maximum scenario to approximately 5% in the middle scenario, while that of interventions addressing overweight falls from 5% to 1%. It would seem that the health loss due to the current prevalence of overweight will be more difficult to 'reclaim' than that caused by dietary factors.

Overweight must be regarded as a special case, since in practice its prevalence is expected to increase while policy strives for a stabilization. However, it is reasonable to expect that the health gain to be achieved through the realistic scenario presented here (weight reduction of one BMI unit, being approximately three kilograms, rather than a stabilization), will be broadly equivalent to the health gain achieved by stabilizing weight rather than allowing a further increase of one BMI unit.

In general, the same reductions in the effects (compared to the maximum scenario) are to be seen in the cumulative calculations over a 20-year period. While in the maximum scenario deaths attributable to the five dietary factors in combination fall by 5% and those attributable to BMI by 3%, the figures fall to approximately 2% and less than 1% in the middle scenario. Nevertheless, the 20-years model shows a 14% reduction in the incidence of diabetes and a 3% reduction in that of cardiovascular diseases (almost 140,000 cases each). For these and other figures, please refer to the tables in *appendix 12*.

The effect in terms of life expectancy is also halved in the middle scenario, to 0.6 years in the case of dietary composition (all five factors in combination) and 0.3 years for BMI. Half of the additional life term will be spent in good health.

The current trends have not been taken into account in these middle scenarios. As previously stated, improvements can now be seen in the consumption of saturated and *trans* fatty acids and fish consumption, while the situation is worsening in terms of the consumption of fruit and vegetables and with respect to overweight. If these trends continue, it is reasonable to assume that the health gain calculated for the positive trends (0.3 years additional life expectancy; see *table 2.7*) will indeed be achieved, but will be offset by negative developments (loss of 0.3 years due to inadequate consumption of fruit and vegetables and 0.3 years due to overweight, with some overlap rendering it inappropriate to add these figures together). If all other factors remain constant, life expectancy would then fall.

A recent study examining policy objectives with regard to overweight chose to adopt different scenarios to those used in this report (Bemelmans *et al*., 2004). However, insofar as the results are directly comparable, they present a consistent picture.

Conclusion: realistic health gain through dietary and body weight interventions
Taking all factors into account, we conclude that substantial health gains can be made through dietary interventions which are considered feasible. For example, there would be over 20,000 fewer cases of cardiovascular diseases each year. Similarly, interventions addressing body weight would result in almost 5,000 fewer new cases of diabetes each year and 4,000 fewer cases of cardiovascular disease. Seen over a longer

period, this would result in a limited gain in terms of mortality and life expectancy, due to the substitution effect of other causes of death. Of the possible dietary interventions, those targeting consumption of fish and fruit will have the greatest effect. By means of the feasible interventions in these areas, approximately half of the health loss due to unfavourable dietary composition can be reversed (See *section 4.2.1*). The formulated BMI intervention will offset only a quarter of the health loss that would otherwise be experienced. Given the principles adopted, overweight is therefore likely to prove a more stubborn problem than a sub-optimal choice of food.

2.5 Options for dietary interventions

H. Verkleij, C.F. van Kreijl [#]

As previously stated in *section 2.4*, substantial health gains can be achieved through attention to diet and good nutrition. Moreover, various unfavourable trends in food consumption and the increasing average body weight also compel to interventions in order to prevent further health loss. *Chapter 1* (*figure 1.2*) demonstrates that our diet is the result of the food supply (physical environment) and eating behaviour (lifestyle). Interventions must therefore be in line with the current available knowledge about these determinants of food intake. The underlying theory and mechanisms of eating behaviour are explained in greater detail in *chapter 8*, which also examines the elements of risk perception in relation to food safety. This section focuses on the application of this knowledge in terms of dietary practice, with particular reference to interventions targeting the environmental and personal factors.

2.5.1 Food supply and other environmental factors

Recent decades have seen an enormous growth in the food supply, both in terms of the variety of foods available and in the number of sales outlets. At the same time, the consumer's purchasing power has increased. The assortment of foods offered by the local supermarket, staff restaurant or school canteen will have a clear influence on the consumer's choice. The availability and accessibility of foods is an important determinant of eating behaviour.

The obesogenic environment as an important cause of the increase in overweight
The increase in the prevalence of overweight and obesity provides a good example by which the role of environmental factors can be explained. The main cause of this increase is that Dutch people now engage in less physical activity and, at the same time, eat too much and the 'wrong' type of foods. The World Health Organization (2003) cites four factors with convincing, or extremely plausible, evidence that they help to foster overweight and obesity. Alongside a sedentary lifestyle and high con-

[#] With contributions by C.P.G.M. de Groot, S.A. Reijneveld, W.A. van Staveren, C. Thijs sumption of energy-dense food products, the WHO points to the extensive advertising campaigns for energy-dense foods and the high number of sales outlets offering convenience food.

In its report on obesity, the Health Council of the Netherlands also states that, alongside the individual factors, environmental factors are likely to be of great importance in the development and maintenance of overweight in both adults and children (Gezondheidsraad, 2003a). Obvious examples of such environmental factors include the habit of watching television or playing computer games (which not only represent a particularly inactive lifestyle but also encourage the consumption of snacks). Other examples are vending machines and school canteens, which supply high-energy soft drinks and snacks, and fast-food restaurants offering 'super-sized' portions. Intrusive television commercials promote drinks and snacks with a high sugar and/or fat content.

Each year in the Netherlands, some 40 million euros are spent on television advertisements which specifically target children (including those for non-food products). Approximately 70% of the advertising between children's programmes is for candy, snacks and soft drinks (Gezondheidsraad, 2003a). But do such commercials actually influence the eating behaviour? The Health Council cites controlled and randomized American research which suggests that television advertising strongly influences the preferences of young children, prompting them to favour the energy-dense snacks and soft drinks thus promoted. It has long been known that this type of advertising has a clear effect on parents' purchasing habits and on children's energy intake (Gezondheidsraad, 2003a). *Textbox 2.6* provides an account of the extent and influence of food products advertising aimed at children in Australia.

Textbox 2.6: Food advertising.

The Australian 'Coalition on Food Advertising to Children' has examined a number of studies carried out in both Australia and New Zealand over the past ten years. Among the conclusions which emerge are:

- In Australia, television is the main medium by which the food industry and fast-food chains attempt to reach children. Australian children aged 5 to 12 watch an average of two-and-a-half hours of television per day, of which over fifty minutes could be advertising. Commercials for candy (confectionery) and fast-food restaurants are broadcast three times more frequently during children's programming than at other times of the day. During children's programming, an average of 26 commercials per hour are broadcast, one third of which are for food products. Of the food advertisements, an average of 72% are for products with high energy density and low nutritional value. Chocolate, other confectionery, sweetened breakfast cereals and fast-food restaurants are dominant on the list of food commercials.
- Other studies reveal that children in families who regularly watch television during mealtimes are likely to consume more of the advertised 'unhealthy' products (pizza, savoury snacks, soft drinks) and less fruit and vegetables. Children who spend more time watching television are also likely to weigh more than their counterparts who spend less time doing so.

The coalition therefore concludes that the content of televised food advertising in Australia is almost diametrically opposed to the government's message on healthy diet and good nutrition.

Source: Mehta, 2002.

Based on the findings of the WHO, the Health Council and the Netherlands Council for Public Health and Health Care (RVZ, 2002), it is reasonable to conclude that attempts to prevent overweight and obesity by means of behavioural change will be doomed to failure without corresponding modification of this obesogenic environment. Accordingly, strategies must be sought whereby people are not required to make a conscious decision to take more exercise or to eat less. The Health Council has not been afraid to propose some far-reaching measures, such as banning motorized traffic from city centres in order to encourage walking and cycling, or implementing a gradual reduction in the energy value of processed foods (Gezondheidsraad, 2003a).

Positive trend in fatty acid consumption due to improved product composition

A second example of the influence of environmental factors is the reduction in the consumption of saturated fatty acids and *trans* fatty acids. The reduction in intake of saturated fatty acids, albeit limited, is attributed to the modifications made to the fat content and fatty acid composition of food products, with greater availability of fat-reduced ('light') versions, skimmed and semi-skimmed dairy products and products with improved fatty acid composition. Large groups of consumers have subsequently been prompted to purchase such products by advertising, low prices and health education messages. The substantial reduction in the consumption of *trans* fatty acids is largely due to the reduced content of these fatty acids in foods, and particularly in spreads and cooking fats (see also *section 2.3*). A further reduction of the *trans* fatty acid content of biscuits, bakery products and pre-prepared fried foods in particular would achieve yet further health gains (Kraak, 2004). The food-processing industry has undertaken to modify the fatty acid composition of many products, partly on its own initiative and partly as a response to the recommendations made or endorsed by the government.

Trend towards convenience foods displaces fruit and vegetables

A third example of environmental factors may be seen in the reduced consumption of fruit and vegetables. In recent decades, a far greater range of fruit and vegetables has become available in our shops. While many varieties were once seasonal, modern transport and storage technology enables them to be imported from abroad and made available all year round. Nevertheless, the consumption of fruit and vegetables in the Netherlands is falling. This may be due in part to the increasing demand for convenience foods: products which are easy to carry, to store, to prepare and to eat. Convenience foods, such as ready-to-eat meals generally have a low vegetable content. The increase in the consumption of rice and pasta products as the main meal of the day also plays a role, since these meals generally contain less vegetables than the traditional evening meal with potatoes .

Modifications to product composition could help to obtain greater consumption of fruit and vegetables. For example, it would be possible to include a higher (high-fibre) vegetable content in certain convenience foods, such as pizzas. It is possible that lower prices would also prove an effective method of encouraging consumers to eat more fruit and vegetables. In 2003, Dutch households with a lower income were twice as likely to economize on food, beverages and tobacco than those with a higher income (CBS, 2003). It is known that the consumption of fruit and vegetables is higher in those countries in which these items are cheaper, such as the Mediterranean countries. Bol *et al.* (2004) state that the reform of European Union agricultural subsidies must be conducted in such a way as to ensure that fruit and vegetables do not become disproportionately expensive.

Making the healthy choice the easy choice
To summarize: environmental interventions can encourage a healthy choice of food and diet. Such interventions could include ensuring the wide availability of affordable healthy food products, and raising the profile of those products to promote recognizability. The further encouragement of product modification provides a promising principle for policy and indeed has already accounted for important health gains. Other principles may include pricing policy and control of advertising.

The settings in which successful environmental interventions can be implemented include the school, workplace, family, neighbourhood, youth health and welfare services, and first-line health services. The interventions will require cooperation on the part of the food processing and advertising industries, supermarkets, staff restaurants and school canteens. Given that lack of physical exercise is another important cause of overweight, principles for policy also exist in the cooperation with other sectors, such as the transport, computer games and infrastructure sectors.

2.5.2 Interventions targeting personal factors

Making healthy food more readily available and accessible is one side of the equation. The consumer's cooperation is also required. After all, in most cases it is the consumer who must actually adopt the healthy options. Alongside the environmental factors discussed in the preceding section, our eating behaviour is determined by numerous personal factors: intentions, thoughts, ideas, feelings and perceptions. The behavioural intention is the most direct determinant and is in turn determined by attitude, norms, awareness and knowledge with regard to diet and nutrition. A realization of one's own abilities and the opportunities to adopt or change a certain behaviour also play a part. Health considerations actually play a relatively minor role, except in the case of foods which are perceived to be particularly unsafe, or when the individual is prompted to think more about his or her own health. This is why young mothers and the elderly are inclined to be more interested in a healthy diet.

Intervention strategies designed to bring about permanent change in eating behaviour must take these and other personal factors into account (see *table 8.1* in *chapter 8*). Attempts to alter attitude will be primarily concerned with the expected advantages and disadvantages of certain food products (flavour, ease of preparation, cost, current habits), which can vary from one demographic group to another. Making 'the healthy choice the easy choice', for instance by clearly labelling the healthy products, can help to enhance opportunities for behavioural control. Similarly, raising consumer awareness is important: many people have a tendency to underestimate their actual food consumption. The target group's own social network and social environment will provide the best avenue of approach for interventions targeting personal factors, perhaps through everyday role models and peer instruction.

Discouraging fat consumption requires a different approach to promoting fruit and vegetables

There is a relatively large body of research into the personal determinants of fat consumption and fat reduction (Baranowski *et al*., 1999; Brug, 2000). One important barrier to the adoption of a diet with less fat is the lack of awareness regarding the fat content of one's current diet (Brug & Van Assema, 2001). Expectations with regard to taste, cost and ease of preparation also account for negative attitudes towards fat reduction. A tailor-made dietary advice with regard to fat may raise people's awareness of their own consumption and, allowing for attitudes and perceived behavioural control, may encourage a reduction (Brug *et al*., 2003).

Interventions to encourage the consumption of fruit and vegetables must take into account the fact that many people do not find the taste of many vegetables particularly appealing, being an acquired taste which some find difficult to change (Glanz *et al*., 1998). Moreover, people who eat relatively little fruit and vegetables tend not to appreciate their positive qualities (vitamin content, digestibility), and are less aware of why fruit and vegetables are considered healthy. There are also many people who seriously overestimate their own consumption of fruit and vegetables.

Information about healthy diet can sometimes bring about radical change

That eating behaviour can indeed be influenced by education and information is amply illustrated by the increase in the consumption of brown bread in the Netherlands seen since 1960. The shift from white bread to brown was due to a number of factors, including lower price and (for some) better flavour. Even more importantly, however, it was the result of nutritional information which placed the emphasis on the health benefits of brown bread: it is a rich source of dietary fibre and therefore improves or maintains good bowel function. The agricultural sector and food industry then fostered the development by producing proportionately more brown bread. The trend began among the higher income groups and was then, to a lesser degree, adopted by other income groups (De Bekker, 1978). It is possible that part of this success can be attributed to the fact that the transition from white bread to brown is not such a great leap, and that little change to one's usual eating habits is required.

2.5.3 Interventions will vary according to target group

Eating behaviour varies by age, gender and other socio-demographic factors such as socio-economic status and ethnic origin. It is therefore important to differentiate dietary interventions accordingly. The World Health Organization, for example, distinguishes five age categories: the unborn child, babies and toddlers, children and adolescents, adults, and the elderly. The WHO calls for particular attention to be paid to the risk factors for children (especially the environmental factors) and for adults, as it is in this group that the greatest health gains are to be made in the short term. At the same time, the WHO states that successful dietary interventions targeting the elderly are indeed possible, and could well lead to a considerable reduction in the likelihood of disease (WHO, 2003). The following paragraphs present some of the specific characteristics which must be borne in mind when designing dietary interventions addressing infants, young people, elderly people in need of care, lower socio-economic groups and ethnic minorities.

Infants

Various factors influence a mother's choice between breastfeeding and bottle-feeding. In most cases, the choice will be made even before the baby is born, perhaps even before becoming pregnant. The determinants of that choice are the norms instilled by the mother's social setting and her own attitude to breastfeeding. Her main motive for opting in favour of breastfeeding is usually the health of the child. Complications during pregnancy or childbirth, anticipated practical problems, or bad experiences in the past may serve to swing the decision in favour of bottle-feeding immediately after the child is born.

The duration of breastfeeding is primarily determined by the degree to which mothers believe they can cope with any problems that occur. The most common reason for discontinuing breastfeeding soon after birth is the mother's inability to produce enough milk. After three months, the main reason is the difficulty of combining breastfeeding and work. Obviously, breastfeeding is also more difficult when the child is being cared for elsewhere for part of the day. Mothers with lower educational qualifications and those who smoke tend to discontinue exclusive breastfeeding sooner than others (Burgmeijer & Reijneveld, 2001).

Because the majority of Dutch mothers do begin with breastfeeding, measures designed to prolong the duration of breastfeeding offer the greatest opportunity of enhancing the level of breastfeeding in the Netherlands. This will entail helping mothers overcome the practical problems involved, the provision of successful examples, and practical measures to facilitate the combination of breastfeeding and work (see also RIVM, 2004).

Young people

Obesity and unhealthy eating behaviour are now particularly prevalent among children (see *section 2.3*). When the child is very young, the parents are the main determinants of behaviour. Later, this role is taken by the child's peer group: other children of the same age. Research into the success and failure factors for health interventions in other areas than nutrition suggests that a combination of interventions (such as education together with an advertising ban) is required in order to be effective. The research further reveals the importance of the school setting (but also that it is difficult to implement interventions within the educational sector). Feedback relating to the interventions is likely to enhance their success. Active involvement of the young people themselves will also be more effective, although more labour-intensive and hence more expensive (Jansen *et al*., 2002). The influence of advertising, both in its traditional and newer forms, on the eating behaviour of young people is also seen as an increasingly important factor (see *textbox 2.6*).

The (vulnerable) elderly
The elderly, particularly those requiring full-time care, are at increased risk of a qualitatively and quantitatively inadequate diet (see *section 2.3*). The prevention of undernutrition in the elderly is important because they have greater difficulty in regulating their energy balance than their younger counterparts. Once the energy balance is negative, it can be difficult to rectify (Roberts *et al*., 1994). In order to reduce the effects of undernutrition among elderly persons in care, it is important to recognize the risks and the causes as soon as possible, whereupon timely preventive interventions can be advised.

It is here that the principles and opportunities for policy lie. It is important to maintain appropriate physical activity (Chin A Paw, 1999) and to monitor the body weight of these risk groups among the elderly on a regular basis. A first requirement is therefore that personnel in the health care sector are trained to recognize the risk factors and remain alert to the warning signs, perhaps relying in part on the simple screening methods already available. The implementation of the multidisciplinary guideline 'Sensible supply of fluids and nutrition' (Anon., 2001) deserves consideration by those in the health care sector. Adequate supplements and/or fortified products developed especially for the elderly can also greatly assist in the prevention of undernutrition (De Jong, 1999), while flavour-enhancers and a positive social environment during mealtimes will also have a positive influence (Mathey, 2000; see also RIVM, 2004).

Ethnic groups and the lower socio-economic groups
Various ethnic groups have a high prevalence of overweight, while the lower socio-economic groups display an above-average prevalence of both overweight and other nutritional problems (see *section 2.3*). Both groups are difficult to reach with health promoting programmes intended for the Dutch general public. Moreover, the residential setting of these groups is often not conducive to good health. Interventions must therefore include additional, specific attention for these groups. Such interventions might include ensuring an adequate range of affordable healthy foods is available in the deprived urban areas, and introducing facilities to encourage physical activity. The interventions targeting ethnic groups must also take into account their cultural norms and customs. In many cases, information in the group's own language and offered by representatives of their own culture will prove most effective (Jansen *et al*., 2002).

2.5.4 The integrated approach and comparison with interventions targeting smoking

According to modern views on health promotion, prevention will be more effective if the interventions are combined within an integrated approach (Gezondheidsraad, 2003a; Jansen *et al*., 2002; Van Oers, 2002; see also *chapter 8*). An integrated approach not only addresses individuals about their behaviour, but modifies the physical and social environment in such a way as to support the desired behaviour to the greatest degree possible. This type of integrated strategy may well account for the success of anti-smoking efforts in the United States, where it was decided to implement a combination of health education focused on giving up smoking, pricing policy, legislation and the modification of social norms. The overall programme has involved health care organizations, the government, the private sector and the scientific community working together.

Much can be learned from the anti-smoking interventions, but it must be remembered that there are important differences between smoking on the one hand, and diet on the other. In the case of smoking, there is a clear and unequivocal message: it is bad for the person who smokes *and* for others in the vicinity. In the case of diet, eating is a necessary activity and, no matter how unhealthy one's diet, will not cause any direct harm to the health of others. Accordingly, the relationship between the government and the private sector is somewhat different. With smoking, the government and its health interests is in direct opposition to the tobacco industry and its economic interests. In diet and nutrition, however, the government needs the industry to produce healthy products, while that same government must oppose the industry's production and sale of too many unhealthy products. In addition, the healthy diet message is more complex than the non-smoking message, since the consumer is required to choose from a large and varied range of foods and food products, which have both positive and adverse effects on health in varying degrees. The important factor is the person's overall dietary pattern: what is healthy and what is less healthy in one product will depend in part on the other components of the diet and on personal health characteristics. The comparison with smoking does however show us how intensive and creative our investments in a healthy diet must be in order to achieve the desired changes.

2.6 Summary and conclusions

Overweight, in both adults and children, is a major public health problem which shows no sign of abating. Approximately 50% of Dutch adults are now overweight, and some 10% are defined as obese. This situation is accompanied by considerable effects on disease burden: 22,000 extra new cases of diabetes each year, 16.000 of cardiovascular diseases and 2,000 of various forms of cancer. Approximately 5% of annual mortality is thought to be directly attributable to overweight. Taking into account the postponement of death and other factors, this figure is slightly lower over a period of

20 years: if the prevalence of overweight remains stable, 3% of mortality among today's adult population will be due to overweight. In terms of the average life expectancy of Dutch men and women aged 40, this entails a loss of 0.8 years due to overweight alone. If everyone in the country were to lose approximately three kilograms (1 BMI unit), some 20% of this health loss could be undone. An integrated strategy, combining changes in the physical and social environment with measures to support changes in individual diet and physical activity, is recommended in order to halt and reverse the current epidemic of overweight. Specific attention should be devoted to the lower socio-economic and ethnic groups. In terms of dietary interventions, diets with a low energy-density, and with much fruit, vegetables and cereal products, hold out the best opportunities for success.

In addition to poor energy balance, the average Dutch diet displays shortcomings in other aspects. The main problems are inadequate consumption of fruit, vegetables and fish, and excessive consumption of products with a high concentration of saturated and *trans* fatty acids. The combination of these unfavourable dietary factors accounts for 38,000 extra new cases of cardiovascular diseases each year, and almost 3,000 cases of cancer. Some 10% of all mortality can be attributed to the combination of five dietary factors. When factors such as postponement of death are taken into account, the estimate is halved: if consumption patterns remain unaltered, approximately 5% of mortality occurring during the coming 20 years will be attributable to unfavourable dietary composition. This is expected to result in the loss of 1.2 years in the life expectancy of all Dutch citizens currently aged 40 and above. It is the inadequate consumption of fish and fruit which has the greatest effect in this respect. Interventions addressing the five dietary factors and considered feasible will offset approximately half of the total health loss. The projected increase in the number of disease-free years resulting from dietary interventions shows that intervention postpones disease longer than it postpones death and that intervention therefore results in a longer period in good health.

It is recommended that the current dietary problems are addressed by rendering 'the healthy choice the easy choice' and by influencing eating behaviour in a positive direction. Making it easier to adopt a healthy diet will demand a combination of improved product composition (particularly that of convenience foods) and supporting changes to the physical and social environment.

Those in the lower socio-economic groups have, on average, a slightly more unfavourable dietary pattern than those in the higher socio-economic groups. Little is known about the diet of ethnic groups. In some respects, their diets would seem to be healthier than average (fatty acid pattern), while in others they appear to be somewhat less healthy than average (particularly with regard to vitamins and minerals).

Attention must also be devoted to the diet of the very young and the very old. The average duration of breastfeeding is currently not long enough. Working mothers experience a number of practical obstacles to breastfeeding. Principles for policy include removal of these obstacles and changes to the social norms (even limited breastfeeding still has advantages).

As they lose independence, the elderly have an increased chance of undernutrition and particularly of deficiencies of vitamins D and B_{12}. The use of existing screening methods in the health care sector is important in identifying the warning signs of undernutrition in time. Undernutrition among institutionalized elderly can be prevented by such means as encouraging physical activity, the use of supplements, fortified products and flavour-enhancers, and ensuring a stimulating social environment during meals.

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3 WHAT IS THE GOVERNMENT DOING TO PROMOTE A HEALTHY DIET ?

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3.1 Introduction

Chapter 2 described the extent to which the Dutch diet may be considered 'healthy' or 'unhealthy'. What are the contributory factors and what health gain can be achieved through change? This chapter provides an account of the action taken by the Dutch government in recent years to promote a healthy diet, and what the actual results of its efforts have been in practice. This mainly involves the diet-oriented efforts made of the Ministry of Health [in full: Ministry of Health, Welfare and Sport] as part of its broad prevention policy designed to promote a healthy lifestyle. The policy therefore addresses aspects other than healthy diet and nutrition, such as not smoking, moderate alcohol consumption, more exercise and safe sex. This chapter does not consider other areas of departmental policy which are relevant to a healthy diet, such as agriculture, education and international trade. Neither does it examine in detail the activities of other organizations targeting a healthy diet and nutrition, such as regional health authorities, residential care facilities, the Consumer Association and research institutes.

This account of government efforts is based on the official policy documents of the past twenty years, where these relate to prevention policy in general and to diet and nutrition in particular (see *table 3.1*). The first Policy Document on Nutrition, published in 1983, has been taken as the starting point. However, the emphasis falls on the period following the publication of the document *Nederland: Goed Gevoed?* ('The Netherlands: Well Fed?') in 1998. Further information has been acquired by means of interviews with policy staff from the Ministry of Health.

Section 3.2 focuses on policy intended to promote a healthy diet. It describes the objectives which the ministry wishes to achieve, the target groups addressed, and the division of roles and responsibilities adopted. *Section 3.3* then offers an account of the instruments applied by the ministry, together with the specific measures designed to promote a healthy diet. The effects of these instruments and measures in practice are then presented in *section 3.4*. The efforts addressing the main dietary problems outlined in *chapter 2* are described in greater detail in *section 3.5*. The final section of this chapter, *section 3.6*, presents the summary and conclusions.

3.2 Policy: objectives, target groups, roles and responsibilities

Table 3.1 presents a list of the official Dutch policy documents which have addressed issues of healthy diet and nutrition.[1]

Table 3.1: Policy documents focusing on healthy diet and nutrition as published by the Ministry of Health, Welfare and Sport (VWS) [formerly Ministry of Welfare, Health and Cultural Affairs, WVC].

Document	Ministry	Year of publication
Nota Voedingsbeleid[a] [2]	WVC, also on behalf of LNV[g] and EZ[h]	1983
Nota Voedingsbeleid, 1e voortgangsrapportage[b]	WVC, also on behalf of LNV and EZ	1987
Nota Voedingsbeleid, 2e voortgangsrapportage[c]	WVC, also on behalf of LNV and EZ	1993
Gezond en Wel[d]	VWS	1995
Nederland: Goed Gevoed?[e]	VWS	1998
Langer gezond leven[f]	VWS	2003

[a] 'Policy Document on Nutrition'
[b] 'Policy Document on Nutrition, First Progress Report'
[c] 'Policy Document on Nutrition, Second Progress Report'
[d] 'Health and Well-being'
[e] 'The Netherlands: Well Fed?'
[f] 'Living longer in good health'
[g] LNV: Ministry of Agriculture, Nature and Food Quality
[h] EZ: Ministry of Economic Affairs

Objectives: from general objectives to a more comprehensive set of specific targets

The first official policy document on diet and nutrition, published in 1983, included two distinct main objectives: to ensure good food supply with safe foods, and to promote good eating habits. Anno 2003, these remain the main objectives of the government's nutrition policy. The 1983 document did not include any explicit objectives with regard to food consumption, since at the time there was inadequate insight into the relationships between health problems, nutrition and food consumption figures. The measures proposed by the document were mostly concerned with investments in research and infrastructure.

It was in the 'First Progress Report', published in 1987, that 'lowering fat consumption' became a priority. This objective was based on the 1986 advisory report by the (then) Nutrition Council, the 'Guidelines for Good Nutrition' (see *chapter 2*), which stated that 'high fat consumption is still the greatest problem of the Dutch diet'. The 'Second Progress Report' (1993) placed the emphasis on the consumption of *saturated* fats.

1 In addition to the published policy documents, the Ministry of Health's annual budget and work plan devotes attention to nutrition policy (in the policy sections on prevention and health protection). However, because the descriptions in the annual reports are somewhat general and are themselves based on the policy documents (to which they refer), it has been decided not to include the reports as a separate source.

2 This was the first policy document to include written statements of the government's standpoints and intentions with regard to a healthy diet and safe food. Alongside the plans for the future, the document also presented a comprehensive account of the achievements thus far and of work in progress.

The policy document *Gezond en Wel* (Health and Well-being, 1995) presented the first quantification of objectives. It attempted to encourage a further reduction in fat consumption to below 35 energy per cent. Another objective was to increase consumption of fruit and vegetables by at least ten per cent.

The 1998 policy document *Nederland: Goed gevoed?* (The Netherlands: Well Fed?) stated that the overall objective, to 'promote good eating habits', in effect included two types of objective: those to promote good eating habits in general, and those targeting specific nutrition issues (see *textbox 3.1*). With this document, the Ministry of Health wished to make clear that government policy was concerned with more than a healthy dietary pattern alone. Nevertheless, the general objectives which had already been stated in the 1995 document *Gezond en Wel* continued to enjoy priority, the objective for fat consumption being subdivided into total fat (less than 35 energy per cent) and saturated fats (less than 10 energy per cent). For the consumption of vegetables, the target value of 200 grams per day was added. The target for fruit consumption became two pieces per day. The increased consumption of fruit and vegetables would also achieve the aim of increasing the intake of dietary fibre.

Textbox 3.1: Two types of objective within the main objective of promoting good eating habits.
(source: Nederland: Goed Gevoed?, 1998).

Objectives intended to promote good eating habits in general:
- reduced fat intake (particularly that of saturated fats)
- increased consumption of digestible complex carbohydrates
- increased consumption of dietary fibre
- achievement and maintenance of normal body-weight
- increased consumption of fruit and vegetables

Objectives addressing specific nutrition issues:
- prevention of deficits of essential nutrients (such as iodine)
- encouragement of breastfeeding as a means of preventing disease
- prevention of some specific diet-related diseases (such as osteoporosis)
- prevention of the onset of risk factors (such as hypertension)
- promotion of the quality of life among patients with chronic diet-related diseases
- prevention of the adverse effects of over-sensitivity or allergy to food constituents

The document *Langer gezond leven* (Living longer in good health) set out the following objectives, to be met by the year 2010:
- reduction of the intake of *trans* fatty acids to 1 energy per cent
- reduction of the intake of saturated fats to 10 energy per cent
- increase in the proportion of babies being exclusively breastfed for the first six months of life to 25%

It was further stated that the government would continue to encourage the consumption of more fruit and vegetables, and wished to ensure that consumers would acquire an appropriate quantity of vitamins and minerals in the diet. The document also stated the intention of achieving a twofold increase (from 35% to 70%) in the number of pregnant women taking folic acid supplements throughout the recommended period in order to prevent spina bifida in the newborn baby. Overweight was cited as one of the three 'spearhead' areas in which the government wished to achieve firm results within the coming years, the target being to stabilize the overall number of people with overweight or obesity, and to bring about a reduction in the number of children so affected. The government stated that the attainment of these objectives would depend on policy addressing both diet and the promotion of physical activity. After all, the main cause of overweight is an imbalance between energy intake through the diet on the one hand and energy expenditure through physical activity on the other.

Target groups: alternating focus between consumers, vulnerable groups and producers

The first policy document on nutrition acknowledged that there are certain 'vulnerable' groups which would benefit from a specific preventive approach. The groups identified were: babies (and their parents), children, the elderly, ethnic groups and those with an 'alternative' diet. Although the lower socio-economic groups were not specifically included in this list, the document did acknowledge that dietary advice and nutrition education was likely to have less impact on these groups.

In the 1998 policy document *Nederland: Goed Gevoed?* the statement 'information targeting specific groups may be useful' gave way to a deliberate choice for this approach. It was noted that policy whereby certain groups would be targeted in a certain way should be developed, and that intervention strategies should be similarly specific. The 1998 document presented general action programmes for the Dutch population as a whole, and for young people, the elderly, the lower socio-economic groups and ethnic minorities.

Finally, the most recent policy document, *Langer gezond leven* (2003) identifies only three target groups: young people, the elderly and those with a lower standard of education. Ethnic minorities are thus no longer seen as a separate target group for prevention measures, although their more vulnerable members will generally fall under one or more of the target groups that are cited. The government has opted to distinguish several specific policy areas (nutrition, smoking, alcohol) within prevention policy as a whole, and increasingly avoids singling out specific target groups. This approach is further to the broadening of the government's nutritional policy (aimed at promoting health and preventing disease) to become a more general policy by which the government wishes to promote a healthy diet and a healthy lifestyle.

The government's policy on diet and nutrition also targets food producers and processors. Besides encouraging a healthy choice of food and healthy eating habits on the part of the consumer, the Ministry of Health's efforts have increasingly focused on the food supply chain. Producers are encouraged to make their products 'healthier', and to assist in making 'the healthy choice the easy choice' for consumers. For example, as part of the *Let op vet* ('Watch the fat') campaign (see *textbox 3.2*), producers were encouraged to modify the fat composition of their products. The 2003 document also announced the intention of arriving at agreements regarding overweight within the context of the 'Regular Consultation Platform on the Sale of Food and Drugs Act'

(ROW)[3]. These agreements would cover aspects such as modifications in product composition, portion size, the contents of confectionery and soft drinks vending machines, product information and advertising. The agreements are now subject to discussion by an 'offshoot' of the ROW, the 'Regular Consultation Platform on Overweight' (ROO), the meetings of which are separate to those of the ROW, although the membership is the same.

Division of roles and responsibilities: ensuring consumer choice, stressing personal responsibility

The first policy document on nutrition (1983) devoted considerable attention to the role of the government. It was noted that the government's influence in terms of promoting good eating habits was of a different order to that with regard to food safety. "In a society with the character and traditions of ours, it is appropriate to apply some caution with regard to interventions in the personal life of the individual". The effectiveness of government policy addressing healthy diet is therefore not so much reliant on legislation, but more on the promotion of a cohesive set of activities which enhance the consumer's ability to make appropriate dietary choices. It is acknowledged that the government's activities and strategies in this regard should focus on fostering knowledge about aspects of nutrition, making regular and targeted use of the mass media for the purposes of information and education with regard to diet and nutrition. Such information should reflect and make use of current trends (such as the preference for slenderness and more natural behaviour), while negative attitudes and misconceptions ("healthy food is less flavoursome and more difficult to prepare") should be countered.

The 1998 policy document states that further health gain can be achieved by focusing policy on the improvement of both eating habits and food supply. It emphasizes the citizen's personal responsibility with regard to improving eating habits, this being in line with the more integrated approach seen in the prevention strategy of recent years. This entails a shift in emphasis onto creating awareness of the opportunities for improving and maintaining one's own health. The government sees its own role as one of 'initiator', where necessary as the 'director', and the 'monitor' of the process of a nutrition policy focused on promoting health and preventing disease.

The 2003 policy document adds that the individual has primary responsibility for ensuring a healthy lifestyle and healthy diet, and that more will be done to draw the individual's attention to the adverse effects of an unhealthy lifestyle. The government does not wish to interfere in personal choices, but it does consider itself responsible for the identification and provision of clear information about the consequences of those choices, and for promoting the availability of 'healthy' products. One of the

3 The Regulier Overleg Warenwet (Regular Consultation Platform on the Food and Drugs Act; ROW) is a discussion platform comprising representatives of industry, trade and consumers. The government, the regulatory authorities and the Nutrition Centre also take part in its deliberations. The government traditionally submits draft legislation further to national and European consumer protection laws to the ROW for consideration and advice.

explicit principles on which the government bases its approach is that 'the healthy choice must be the easy choice'. Accordingly, it will remind local authorities, the private sector, producers, schools, health care providers and health insurers of their responsibilities with regard to the health of the individual. For example, the private sector is to be reminded of its social responsibility in the field of public health. The government is to encourage a system of self-regulation in this regard, and will introduce legislation only if such a system proves ineffective.

To summarize, we may state that the government's aim has always been to enable and promote a healthy (or healthier) choice on the part of the consumer. Over the years, this general objective has been further elaborated and quantified. The government has adopted a two-pronged approach, targeting both the consumer (the general population and some vulnerable groups) and the producer. It has always maintained a more tentative 'hands-off' approach with regard to the promotion of healthy eating habits, based on the realization that the consumer is entitled to a free choice. The government sees its own role in terms of creating appropriate conditions, providing information and encouraging healthier choices, rather than enforcing them. It wishes to entice the consumer towards the healthier choice, and is now increasingly firm in opting to do so in association with the other actors involved. However, the fact that the final choice must always fall to the consumer himself or herself is subject to increasing emphasis.

3.3 Instruments and measures

As stated above, the government's role in the field of healthy diet is that of providing information and facilitating the healthy choice. This section explains what this actually means in terms of policy instruments and measures. The measures are classified according to the system developed by Van der Doelen (1993), who distinguishes six policy instruments, some of which promote desirable aspects while others repress the undesirable aspects (see *table 3.2*).

Table 3.2: The classification of policy instruments according to Van der Doelen (1993).

	Incentive	Repressive
Communicative	Information	Propaganda
Economic	Subsidy	Levy
Legislative	Covenant	Order / ban

Information: from labelling to public campaigns

The Dutch government has made extensive use of public information to promote a healthy diet. After all, the consumer must have adequate and reliable information on which to base the 'healthy' choice. The packaging of a product and its labelling, for example, informs the consumer about the composition and nutritional value of that product.

The government designated the Netherlands Nutrition Centre as the health promotion institute (GBI) for nutrition, one of its main tasks being to inform consumers about healthy diet and nutrition. The Nutrition Centre's activities in this area include providing information via a website and digital newsletter, operating a telephone helpdesk to answer consumer questions, producing and distributing printed information, providing information about special diets suitable for certain types of patient, information about branded items suitable for those with increased sensitivity or allergies, and conducting projects and campaigns [4]. Public campaigns, some several years in duration, inform the consumer about the importance of a healthy diet (see *textbox 3.2*).

Subsidies for interventions, research, school milk and fruit and vegetables in schools

The economic instrument of the subsidy is also extensively used. Subsidies are primarily intended to fund prevention activities (interventions) and third-party research. They are awarded directly or through intermediary organizations such as the Netherlands Organization for Health Research and Development (ZonMw) and the Fonds Openbare Gezondheidszorg (Fund for Public Health Care). The Nutrition Centre itself is in receipt of ongoing subsidy. To date, the Dutch government has chosen to subsidize specific 'healthy' foods to a limited extent only. For example, subsidized school milk [5] is provided and, since January 2003, subsidized fruit and vegetables have been distributed in several hundred Dutch primary schools as part of a temporary nutritional awareness campaign [6].

Voluntary agreements: the emphasis on cooperation with the private sector, with legislation only where necessary

The government applies extreme caution with regard to the use of legislative instruments. It prefers to encourage self-regulation by the private sector, with the bare minimum of legislation intended to enforce 'responsible behaviour'. The 2003 policy document *Langer gezond leven* states that the government intends to increase the emphasis on agreements ('covenants') yet further. As part of the action plan on overweight, for example, there will be a covenant with the private sector establishing agreements on advertising, portion size, product composition and the like.

However, binding legislation also exists. It includes the various safety directives for baby foods and special diet foods, the requirements for food labelling ('declaration of nutritional values'), and a directive covering the addition of essential nutrients to

[4] In 2003, the ongoing campaigns were those promoting breastfeeding, addressing the school canteen, encouraging the maintenance of a healthy (weight-reduction) diet, and promoting good nutrition among the lower socio-economic groups

[5] The subsidy is no longer provided by the Dutch government but now comes from the European Union. The provision of school milk has been subject to reduction over the years. Fewer primary schools now supply milk, and there is only one dairy company which supplies schools directly.

[6] Under this scheme, a total of 70,000 primary school pupils will receive a free portion of fruit or vegetables twice a week for two years. The intention is that the children will come to regard fruit and vegetables as tasty, healthy and 'cool', representing a healthy snack which becomes part of their daily school routine (www.voedingscentrum.nl).

Textbox 3.2: The Nutrition Centre's public campaigns.

In 2002, the Nutrition Centre launched a five-year campaign intended to prevent overweight. This campaign follows two earlier national campaigns (*Let op Vet*, 1991 to 1995 and *Goede voeding, wat let je?*, 1997 to 2001) each of which was notable for a combination of activities addressing both the consumer and the environment. The mass media were used to provide information, and there were activities providing information directly to individuals, such as nutrition tests and recipe books. The campaigns also encouraged product modification. Each of the Nutrition Centre's campaigns is implemented in several phases, the first designed to increase awareness on the part of the target groups, whereupon the emphasis shifts to behavioural change in the later phases. The campaigns target both the general population and specific target groups. Their objectives and target groups are based in part on the results of the Food Consumption Surveys.

The Good Nutrition Steering Group is responsible for devising, preparing and running each campaign. The Steering Group was founded by the government in 1987, with the task of implementing the Nutrition Centre's 'Guidelines for Good Nutrition'. The reduction of fat consumption was given particular emphasis at this time. The Steering Group comprises representatives of organizations involved in all aspects of nutrition, food production, information, as well as the government and consumer groups. Since its inception, the Good Nutrition Steering Group combined its activities in connection with the coordination of public campaigns with efforts to promote product modification. Having now become a project within the Nutrition Centre itself, the Steering Group's activities addressing the food supply have been discontinued.

some products (e.g. iodine in bread and salt). The Council of Europe and the European Parliament are currently considering proposals for legislation to control the claims made of certain food products (e.g. 'functional foods') by their manufacturers, and to set standards with regard to the 'enrichment' or 'fortification' of food products (see also *chapter 6*).

Research as a precondition of effective policy

Alongside the instruments described above, the government has also commissioned various research studies, recognizing the importance of research as a precondition of effective policy. Investments have been made in research into the dietary patterns of the general public, into the relationship between nutrition and certain health problems, and an infrastructure for nutrition research has been put in place. For example, a survey system providing ongoing information about food consumption in the Netherlands has been developed. The results form the main input when formulating new policy objectives and priorities.

To summarize, the government has chosen to implement its policy of targeting a healthy diet largely through the use of stimulatory instruments. Consumers are encouraged to eat healthily (mainly through public information), while consultation is used to encourage manufacturers to produce a healthier range of products. This is appropriate to the division of roles and responsibilities in diet and nutrition interventions. Unlike policy addressing food safety (see *chapter 5*), policy on nutrition is notable for its relatively limited reliance on binding legislation.

3.4 The effects of policy in practice

The foregoing section describes the instruments which the government has opted to apply in pursuing its objectives. This section examines the effects of those instruments to date.

Increasing attention for evaluation

Information about the effects of dietary interventions is relatively sparse. In *Effecten van preventie* ('Effects of prevention', Gunning-Schepers & Jansen, 1997) the authors note that the information required on efficacy, to be derived from controlled intervention studies, is not widely available in the Netherlands, going on to note that certain types of intervention (e.g. legislation) do not lend themselves to experimental evaluation. The availability of information concerning effectiveness also leaves something to be desired. In 1996, however, the founding of the Netherlands Organization for Health Research and Development (ZON, now ZonMw), the intermediary organization for the programming and funding of research projects in the field of prevention, represented a step forwards. The ZonMw Prevention Programme forms the framework within which research, development, evaluation and implementation of preventative interventions – including those involving healthy nutrition – is managed. The programme also includes research into the effectiveness of public information about healthy nutrition, with evaluations of the public campaigns being conducted. However, the ZonMw budget is currently under extreme pressure.

The effects of mass media health education: mainly a question of awareness

Although mass media health education campaigns do not readily lend themselves to evaluation (Gunning-Schepers & Jansen, 1997), it is generally accepted that they do serve to raise public awareness of the consequences of eating behaviour, and that they can enhance knowledge of the ways in which risks can be reduced. A report on the Nutrition Centre's public campaigns (Maessen, 2001) states that the studies (and review studies) cited in the literature indicate that the main effect of mass media information is to be seen in terms of knowledge and awareness, with effects on attitude and behaviour seen to a lesser extent. Gunning-Schepers & Jansen (1997) state that information programmes which are solely intended to provide information to the target group (such as televised public information messages) are unlikely to have any direct effects on health. Their main benefit is in the area of 'agenda-setting' (i.e. bringing a topic to the attention of a wide audience). Actual health effects are more likely to be derived from programmes which not only provide information, but which also influence behaviour and enhance the skills required to develop a healthier lifestyle.

Integrated national campaigns have more effect

The public campaigns run by the Nutrition Centre go further than merely providing mass media information. They include numerous subsidiary activities targeting the consumer and the industry (see *textbox 3.2*). These campaigns are subject to extensive evaluation, both during their implementation and upon completion. A 'zero measurement' (reference situation) is first taken. In each year of the campaign, the effects are evaluated by examining such aspects as the target group's awareness of the campaign, and the knowledge, awareness, attitudes and intentions with regard to (changes to) eating behaviour (see *chapter 8* for terms and definitions). Process evaluations are also conducted. The results of the evaluations sometimes lead to the form and structure of the campaign being adjusted.

Textboxes 3.3 and *3.4* describe the campaign evaluations. During the *Let op Vet* ('Watch the Fat') campaign, national fat consumption did indeed fall slightly, but the effects of the campaign *Goede voeding, wat let je* ('Good nutrition – what's stopping you?') were disappointing. This may have been due to the complexity of the message. The Nutrition Centre has therefore decided to limit the current campaign addressing overweight to just one message.

A few national interventions promoted or enforced by the government to provide public information have not been subject to any evaluation of effects. They include product labelling, the special logo and label for fruit and vegetables, and dietetic recommendations.

Textbox 3.3: 'Watch the Fat' (1991 to 1995), intended to reduce the consumption of (saturated) fats.

The evaluations revealed a reasonably high awareness level for the campaign itself, and some effect in terms of awareness of the problem of fat consumption. In almost all aspects, the first year was more successful than the subsequent years. Maessen (2001) suggests that this might have been due to the larger budget available and the higher number of activities undertaken during the first year. The objective of the second and third years – to improve attitudes – was not achieved. Furthermore, few changes in the target group's actual behaviour or in the determinants of behaviour were seen. According to the evaluations, the overall objective of the campaign, behavioural change, was therefore not attained.

However, the National Food Consumption Survey reveals that fat consumption has been reduced since, with fat intake falling from 40.0 energy per cent in 1987/1988 to 36.9 energy per cent in 1992, and that of saturated fats from 16.5 to 14.1 energy per cent. The RIVM report *Effecten van preventie* ('Effects of Prevention'; Gunning-Schepers & Jansen, 1997) points out that it remains unclear whether the reduction in fat consumption was due to changes in consumer demand or to product modification on the supply side. The campaign encouraged a number of activities on the part of manufacturers, which in the first year in particular led to additional advertising, the introduction of new or modified products with a lower fat content, and temporary price reductions. The umbrella organization representing Dutch supermarkets (CBL) played an active role in this. The RIVM report goes on to comment on the integrated approach: "… the added value of the combination of interventions targeting both demand and supply is difficult to quantify, but may be argued. Interdepartmental cooperation on a national scale resulted in greater coordination and more consistency in the message presented and the related activities. Moreover, an information message and assorted themes which are announced well in advance of the campaign, offer various points of departure for (commercial) initiatives designed to adjust the supply side, and hence demand, on a permanent basis."

Textbox 3.4: 'Good nutrition: what's stopping you? (1997 to 2001), intended to increase the consumption of complex carbohydrates, dietary fibre and antioxidants.

The interim measurements reveal that, after two years, there was a slight improvement in terms of the determinants of behaviour (with the exception of fruit consumption) which could lead to a positive change in consumption patterns. However, the main barrier to actual behavioural change – misconceptions – remained in place (Maessen, 2001). The target group agrees that their diet is not sufficiently healthy, but blames this on environmental factors and does not accept personal responsibility. Accordingly, the campaign did not bring about any positive behavioural change. In fact, the consumption of fruit and vegetables actually fell. Awareness among the target groups was at a reasonably high level, and knowledge with regard to good nutrition was slightly improved.

Subsidized fruit and vegetables in schools: results not yet known

No research has ever been undertaken into the effects of providing subsidized school milk. It is too early to make any statement with regard to the effects of the current programme providing subsidized fruit and vegetables to schoolchildren. A zero (reference) measurement was taken in early 2003, to be followed by further measurements in 2004 and 2005. At the end of the programme, it will then be possible to state whether the project has been a success.

The positive effects of agreements with the private sector

The RIVM report *Effecten van preventie* (Gunning-Schepers & Jansen, 1997) states that modification of the available supply of food products can support government interventions, or could even render such interventions superfluous. With regard to the reduction of (saturated) fat consumption, this would apply to the composition of margarines, products with reduced fat content, and fat substitutes. The introduction of 'functional foods' has also been cited as a development which can enhance the availability of healthy food. It is difficult to assess the effectiveness of legislation. However, it seems reasonable to assume that the addition of iodine to bread and salt (under the Commodities Act Decree) has helped to reduce the incidence of iodine deficiency (struma) in the Netherlands.

To summarize, there are several examples of dietary interventions which have been successful to a greater or lesser degree. Success is most marked where an integrated approach is adopted, addressing both the consumer and the food industry.

3.5 Efforts targeting the main nutritional problems

Chapter 2 listed a number of major diet-related health problems, the resolution of which could result in substantial health gain. This section describes the Dutch government's efforts with regard to these specific nutritional problems.

Overweight

Until a few years ago, overweight was not treated as a priority. It was in the 1998 policy document *Nederland: Goed Gevoed?* ('The Netherlands: well fed?') that it became one of the objectives of nutrition policy (see *textbox 3.1*). In late 2002, a response to the Health Council's advisory report on the National Food Consumption Surveys set out the measures that had since been taken to counter overweight. The Health Council was asked to produce recommendations with regard to obesity, a knowledge centre was founded to provide information and to help prevent overweight, and the Nutrition Centre was asked to devise and implement a public campaign. The subsequent policy document *Langer gezond leven* ('Living longer in good health') (2003) raised overweight to the status of 'spearhead'. The approach is still under development, with the government attempting to form a broad coalition of interested parties. In May 2003, a start-up conference was held, to which 25 relevant social organizations were invited. Themes and action points were established during the conference. One of the main intentions is for the government to make agreements with both the suppliers of food products and organizers of physical activities, whereby 'the healthy choice can be made the easy choice'.

Fat intake

Reduction of fat intake was cited as an objective in the First Progress Report further to the 1983 policy document. The *Let op Vet* ('Watch the Fat') campaign was instigated with this aim in mind. Subsequent Nutrition Centre campaigns (*Goed gevoed, wat let je and Maak je niet dik*) also adopted reduction of fat intake and the improvement of the fatty acid composition of the diet as important aims. The government has opted to follow a two-pronged approach. On the one hand, the consumer is encouraged to eat less fat and to increase the proportion of the 'better' fats within the total amount consumed. On the other, manufacturers are encouraged to modify their products. In the 2003 policy document ('Living longer in good health') the government encourages the food industry to develop products with a reduced fat content and improved fatty acid composition. Further to this, the Nutrition Centre compiled a project plan in 2003, entitled 'Hidden fats'. Its intention is to increase knowledge of the hidden fat content of foods, in collaboration with manufacturers themselves.

Fruit and vegetable consumption

For several years, one of the government's main dietary objectives has been to increase the consumption of fruit and vegetables. The Nutrition Centre's second public campaign was intended to achieve this aim, but appears to have been unsuccessful. The consumption of fruit and vegetables has been falling for several years. A number of other national initiatives have been launched to encourage consumers to eat more fruit and vegetables. They include:

- a specially designed logo and label for fruit and vegetables, which producers can apply to their products to provide additional consumer information
- the project in which schoolchildren are given a free portion of fruit or vegetables twice weekly (see *section 3.3*)
- the campaign *Lekker in je vel met groente en fruit* ('Feel good with fruit and vegetables'), launched in 2003 to tie in with the trend for 'wellness' diets. The campaign seeks to encourage the consumption of fruit and vegetables among young adults by emphasizing the short-term positive effects (helping to maintain both a healthy

weight and adequate resistance). The campaign is run by AGF Promotie Nederland (Central marketing and communication bureau for the Dutch produce sector)

The following may be added with regard to the two nutritional problems linked to a certain life phase.

The elderly

It was the 1998 policy document which designated the elderly as a separate target group, acknowledging the risk of undernutrition. An action programme was announced, primarily intended to enhance the expertise of care-givers in the health sector. The intention was to conduct a study of the nutritional status of elderly persons and of means by which this could be improved. The market introduction of foods with high nutritional value would also be encouraged. The subsequent 2003 policy document does not devote any attention to the nutritional status of the elderly. Apparently, their situation is no longer regarded as problematic.

Breastfeeding

It has long been acknowledged that the proportion of Dutch newborn babies being breastfed is too low. The government has stated the objective of increasing the percentage, and has taken certain measures in this respect. For example, the *Warenwetregeling Zuigelingenvoeding* (Commodities Decree on Baby Food Preparations) includes a ban on the advertising of mother-milk substitutes by the industry. The World Health Organization's International Code of Conduct also restricts the marketing of such preparations. The Dutch Food and Consumer Product Safety Authority operates an active and repressive enforcement strategy. In the late 1990s, the Nutrition Centre produced guidelines for baby foods, included in a Health Care Inspectorate bulletin on nutrition for children under four, intended for the use of health sector staff. *Stichting Zorg voor Borstvoeding* (the Breastfeeding Promotion Foundation), which is funded by ZonMw, participates in the worldwide Baby Friendly Hospital Initiative, under the auspices of the WHO and Unicef. Part of the initiative entails certification of hospitals with an active breastfeeding policy.

The 2003 policy document points to a rising trend, but states that the percentage of breastfed babies remains too low. The objective of having at least 25% of children breastfed for the first six months of life was set. Accordingly, the Nutrition Centre was asked by the Ministry of Health to devise an action plan to encourage breastfeeding. The plan includes a five-year campaign *Borstvoeding verdient tijd* ('Breastfeeding deserves time') which was commenced in 2003. It draws attention to the benefits of breastfeeding from various perspectives: the mother, the child, the environment, health care and policy.

In summary, we may state that the Ministry of Health has devoted both ongoing and incidental attention to the dietary problems listed, and established policy objectives accordingly. Priority has been given to fat intake and to the consumption of fruit and vegetables, while breastfeeding has also enjoyed ongoing attention. However, the efforts to date have not (yet) had the desired effect. The 2003 policy document ('Living longer in good health') announced activities relating to four of the five issues: undernutrition among the elderly was no longer included. Given the extent of this problem, it does seem advisable to devote attention to undernutrition among the elderly once again. It is too early to make any statement regarding the extent to which the new initiatives will be able to alleviate the problems they address.

3.6 Summary and conclusions

As long ago as the 1980s, the Dutch government acknowledged that the dietary pattern has a strong influence on public health, and set itself the task of promoting healthy (or healthier) choices on the part of consumers. At the time, the priority was the role of fatty acids in the development of coronary heart diseases. It was decided to invest in periodic research into food consumption, but no structural budget was set. 'Guidelines for Good Nutrition' were also established. The general objective (the encouragement of the healthy choice) has since been elaborated to form quantitative targets for the general population and, since the mid-1990s, there has been a conscious effort to inform specific target groups.

The measures implemented by the government over the past twenty years have targeted both consumers and food producers. Agreements with the industry have had a positive effect. A greater range of products with lower saturated fat content has served to reduce consumption of these fats, although not to the degree considered desirable under the 'Guidelines for Good Nutrition'. The government realizes that the consumer must be allowed a reasonable freedom of choice with regard to the range of foods, whereby its own role is to create the preconditions, provide information and encourage the healthy choice. It wishes to 'seduce' the consumer into making the healthy choice, and is increasingly doing so in collaboration with other parties. The fact that it is the consumer who bears final responsibility for making the healthy choice is subject to ever greater emphasis.

Government policy continues to address the diet-related areas in which substantial health gains are possible, as listed in *chapter 2*, to a greater or lesser extent. However, it is only since the publication of the 2003 policy document 'Living longer in good health' that a specific policy on overweight has been in place. Investments are now being made in research and knowledge development (albeit on a limited scale) and a national campaign has been launched. Since the late 1990s, several measures have been implemented and initiatives begun to encourage the consumption of fruit and vegetables, and that of products containing high levels of dietary fibre. Nevertheless, there has been a reduction in the consumption of such products. An initiative which can reverse this trend must now be sought. The promotion of breastfeeding has formed part of nutrition policy for many years, but it was not until 2003 that a quantitative target was set and a public campaign begun. Finally, undernutrition among the extremely elderly and those in residential care was subject to specific attention in the

1998 policy document but is not acknowledged as a problem in the later (2003) document.

It is not possible to state whether the government's interventions to promote a healthy diet have been successful based on an analysis of the policy documents alone. However, some conclusions may be drawn, and indicators for future policy may be identified based on epidemiological trends and the experience gained in preventive interventions to date.

The problem of overweight has only recently been placed on the agenda. It is a significant problem which deserves to be given high priority in public health policy. Success will depend on the concerted efforts of many actors, comparable to the efforts intended to reduce smoking and excessive alcohol consumption. However, the government's role with regard to overweight is somewhat more difficult than that in these other areas of public health, since overweight is an individual problem and does not directly affect the health of others. As stated in *section 3.4*, an integrated approach targeting both producers (supply) and consumers (behaviour) seems to be the most promising. The food industry can do much to help by improving the composition of products, by developing and promoting products with a low energy-density but high nutritional value, by modifying portion sizes, and by reducing the amount of advertising for 'between meals' snacks and drinks. At the same time, consumer awareness of the problem should be increased, with clear and unequivocal messages enabling and 'seducing' the public to make the healthy choices. It is important that this message is directed at specific target groups in their relevant settings.

A similar approach is appropriate with regard to promoting the consumption of fruit and vegetables. The campaign *Goede voeding, wat let je?* ('Good nutrition: what's stopping you?') did not have the desired effect. Apart from information and education, various initiatives are required to make fruit and vegetables the easier, more attractive choice. It remains unclear whether initiatives such as that in which free fruit and vegetables are provided to schoolchildren will serve to increase consumption on a permanent basis.

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4 HOW SAFE IS DUTCH FOOD ?

4.1 Introduction and scope

Foods are often of complex composition. In addition to various useful nutrients and other constituents which are beneficial to health, they can also contain components which are less desirable, or even harmful to health. It is the presence of these 'harmful' constituents which forms the main determinant of food safety and, together with the nutritional aspects, determines the quality of our food.

Determinants of food safety

The two main determinants of food safety are the food supply, and the manner in which food is stored and prepared (see *chapter 1, figure 1.2*).

On the supply side, the most important factor is the quality of the end product, and hence the quality of the food purchased by the consumer. Various potential safety problems exist here, relating to foods with undesirable microbiological contamination, foods which contain harmful chemicals, and foods with bio-active ingredients which are in themselves beneficial to health, but which can be harmful when consumed in excess. ("Too much of a good thing"). The so-called 'genetically modified' foods form a special category which often draw public and political attention due to their alleged health risks.

Storage and preparation practice falls under the personal responsibility of the consumer (as part of eating behaviour). This is particularly important in the domestic situation in order to preclude microbiological contamination. However, professional caterers, such as restaurants and institutional kitchens, also bear a personal responsibility in this regard.

Scope

This chapter will focus mainly on the first two food safety threats: microbiological contamination (*section 4.2*) and chemical contamination, i.e. the presence of harmful chemicals (*section 4.3*). Food safety as a whole, i.e. both microbiological and chemical, will be considered in a broader context in *section 4.4*, which also addresses controversial aspects such as 'organic farming' and the 'hygiene hypothesis'.

Chapter 6 examines the situation with regard to specific health promoting foods (also called 'functional foods'), dietary supplements and herbal preparations which (are claimed to) have a beneficial health effect but which can also be harmful when taken in excess. *Chapter 7* (*section 7.3*) presents a more detailed consideration of the health-related and safety aspects of these type of products.

This chapter does not consider the topic of genetically modified foods in great detail. A summary of key information on the subject is presented in *textbox 4.1*. In fact, in

Textbox 4.1: Genetically modified foods.

The term 'genetically modified foods' includes all products which consist of, are derived from, or are obtained using genetically modified organisms (GMOs). Examples include genetically modified crops such as soy, corn and rape. Foods for which the production process relies on the use of genetically modified micro-organisms (GMMs), or enzymes derived from those micro-organisms, also fall under the heading of 'genetically modified foods'. They include certain dairy products, such as cheese, and some bakery products.
Genetically modified crops are grown on a large scale in a number of countries, notably the United States, Canada and China. In Europe, we have been rather reluctant to follow suit. In 1998, a number of EU member states (Austria , France, Germany, Greece, Italy and Luxembourg) actually imposed a moratorium on the cultivation of such crops, invoking the precautionary measures included in their environmental legislation. Although no formal moratorium has been imposed in the Netherlands, the Ministry of Housing, Spatial Planning and the Environment has prevented cultivation (whether for research or production) in a number of cases, citing the same precautionary reasons. Accordingly, the commercial cultivation of genetically modified crops remains limited throughout Europe, and even the admission into the EU of imported GM end products forms a seemingly insurmountable problem for some member states. By 2004, however, some change in this situation could be seen, with the European Commission taking steps to have the moratoria lifted.
For the time being, the (supposed) risks presented by GM crops seem to be in areas other than food itself, such as the environmental impact of cultivation activities (ecology, out-crossing, etc.), veterinary health (use in animal feeds) and consumer perception. A further important point for attention is the use of certain marker genes (antibiotic resistance genes) which, upon dissemination in the environment or among humans and animals, could have a negative effect on medical and veterinary practice. Although this risk has been assessed as extremely small (Bennet *et al.*, 2004), the general trend today throughout Europe is not to use marker genes of this type. They are permitted only in older products, with the potential health risks being assessed on a case-by-case basis.
In terms of the risks associated with consumption, it is important to realize that the current first-generation GM crops were created with a view to achieving agronomic advantages. These crops have one or more new proteins (intended to promote herbicide or disease resistance) which are mostly present in extremely low levels. In these cases, the food safety evaluation is concerned with the possible toxic or allergenic properties of the new protein, and with possible pleiotropic effects of the genetic modification, i.e. unintended structural alterations to the genome or possible secondary effects on the organism's metabolism resulting from the expression of the new protein. This may result in changes to the levels of naturally occurring toxins, or other secondary plant metabolites.
In the European Union, legislation (Directives 90/219/EC and 90/220/EC) was implemented several years ago to address the environmental risks of GMOs, which has since been regularly amended (98/81/EC, 2001/18/EC). Genetically modified foods fall under the so-called 'Novel Food' directive (97/258/EC) while until recently, animal feeds were not covered by any specific GMO regulations. The implementation of Directive EC1829/2003, which came into effect in April 2004, means that there is now a single regulation covering both GM foods and GM animal feeds. Two supplementary directives (EC1830/2003 and EC65/2004) have been implemented as well, regulating the traceability and labelling respectively of GM organisms and foods, and implementing a system of uniform identification numbers. All these directives are to be incorporated into the national legislation of the various member states. In the Netherlands, the safety assessment of GM products within the scope of the 'Novel Food' directive is the task of the Health Council's "Commissie Nieuwe Voedingsmiddelen" (Commission on Novel Foods). The evaluation of the toxic effects of, say, new proteins is in principle comparable to that of other deliberately added substances such as additives. Assessment of the possible pleiotropic effects relies on a measurement of the levels of the main naturally-occurring toxins and other secondary metabolites. Alternatively, toxicological and clinical studies of the food as a whole are conducted.

terms of the safety assessment with regard to consumption, these foods are not so very different from conventional foods. Only the technology by which such products are derived differs. In the Netherlands, we assume at present that the current procedures for the assessment of GM food products (with particular regard to the genetic modification itself) are adequate to establish their safety (RVZ/RIKILT, 2001). Accordingly, GM foods may be regarded as being just as safe as their conventionally produced counterparts. However, this does not detract from the fact that there are some problems in terms of regulation and enforcement. In particular, better 'tracking and tracing' detection methods for GM products are required. Also, the second generation of GM crops, in which nutritional changes have been made (e.g. to the levels of micronutrients or other bio-active constituents), may present new risks in future (RVZ/RIKILT, 2001).

The consumer's risk perception

An important aspect of food safety, and one that must certainly not be underestimated, is the consumer's perception. The health risk of eating microbiologically or chemically contaminated food is not only an objectively measurable or calculable risk. It is also a 'perceived risk', the extent of which is largely determined by the context and by subjective aspects during observation. The genetically modified food products mentioned above provide a good example. In terms of microbiological or chemical contamination, they present no specific problem. However, the consumer's perception is quite different, as demonstrated by the ongoing controversy surrounding these products. Here, the extent of the perceived risk relies also on other factors, such as the idea that man has been 'meddling' with nature, trust, confidence, etc. It therefore falls to the government and the food industry to gain a more complete understanding of the consumer's risk perception with regard to food safety. This is also essential if there is to be effective risk communication between the government and the general public, which calls for an active two-way interchange of information. Although there are currently no indications of any persistent or growing lack of consumer confidence in food safety (Timmers & De Jonge, 2004), good risk communication can help to maintain consumer confidence. Therefore, *chapter 8* (*section 8.3*) examines the mechanisms of risk perception in greater detail, including the relationship between risk perception and eating behaviour (*section 8.2*).

4.2 Pathogenic micro-organisms in our food

A.H. Havelaar, Y.T.H.P. van Duijnhoven #

4.2.1 Introduction

The microbiological contamination of foods and products is and will remain a topical issue, attracting considerable attention from the media and public alike. In January 2001, for example, a New Year's reception in The Hague was identified as the source of foodborne infection involving norovirus contamination. In October 2001, an outbreak of Salmonella in a clinic in Zwolle was subject to much media coverage and discussion. In 2002, a group of schoolchildren were taken ill having drunk untreated milk during a visit to a dairy farm. The milk was found to be the source of a Campylobacter infection. In 2003, no fewer than 85 of over one hundred people attending a barbecue in Hoofddorp were taken ill, 35 requiring admission to hospital. In that same year, two Dutch sporting heroes, Pieter van den Hoogeband and Martin Verkerk, succumbed to foodborne infection which seriously affected their match performance.

The Dutch government has long recognized the problem of foodborne infections (see *chapter 5*). Nevertheless, a joint study conducted by the Dutch Consumers' Association and the Food and Consumer Product Safety Authority (VWA) in 2003 once again revealed that the problem of Salmonella and Campylobacter contamination of chicken meat remains stubborn (Van der Zee & Wit, 2003; Kramer *et al*., 2003). The outcome prompted the VWA to submit a letter (dated 17 July 2003) to the Minister of Health, Welfare and Sport and the Minister of Agriculture, Nature and Food Quality advising them to "renew agreements with the poultry sector, so that interventions leading to a permanent and substantial reduction of these contaminants can be made as quickly as possible."

This part of *chapter 4* presents a summary of current knowledge concerning foodborne infections caused by pathogenic micro-organisms. Following a general overview of the types of pathogenic micro-organisms that can occur in food, we consider the nature and severity of the associated illnesses (*section 4.2.2*). An estimate of the number of foodborne infections in the Netherlands is then given (*section 4.2.3*), followed by an account of the foods in which pathogenic micro-organisms are most commonly found and the factors which influence the likelihood of contamination (*section 4.2.4*). *Section 4.2.5.* goes on to identify the main microbial hazards in terms of potential health gain. *Section 4.2.6* presents the summary and conclusions.

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4.2.2 Overview of pathogenic micro-organisms and other infectious agents in food

The types of pathogenic micro-organisms and other infectious agents in food

Many different types of micro-organisms and other infectious agents can occur in our food, the majority of which are not pathogenic, i.e. they will not cause illness. However, when food is kept for too long or is stored at too high a temperature, micro-organisms (such as bacteria, fungi and yeasts) can multiply, usually causing food spoilage. In general, the flora responsible for this process does not pose a risk to consumer health. Indeed, there is a certain degree of 'built-in protection', since the consumer will be warned by the smell, appearance and/or off-flavour of a product that has spoiled.

The pathogenic micro-organisms and other infectious agents are therefore in a relative minority, but can nevertheless give rise to many symptoms of illness. New pathogens are still being discovered today; new associations are being made between known conditions and known pathogens, new links are being identified between known types of pathogens and the manner in which they are distributed via food. And problems that were thought to be under control have reappeared or are increasing in extent. These are referred to as emerging and re-emerging infections. *Table 4.1* presents a general overview of the main groups of pathogens to be found in food. In addition to a biological classification, they have been arranged according to their mechanism of action (see *textbox 4.2*), and the most prevalent conditions or symptoms they cause. The table is not exhaustive. A more comprehensive list of the known foodborne pathogenic micro-organisms and other infectious agents and their associated symptoms can be found in *appendix 5*.

It is not always possible to draw a clear distinction between flora responsible for spoilage and pathogens. Among the micro-organisms which can multiply under normal storage conditions and which can cause spoilage, we also see a number of pathogens (e.g. *Bacillus cereus*, *Listeria monocytogenes*). Moreover, in larger quantities, the metabolic by-products of the micro-organisms responsible for spoilage can also cause symptoms of illness. The food industry must therefore do everything possible to stop the multiplication of micro-organisms, not only to prevent spoilage, but also to protect public health.

The severity of foodborne infection/foodborne intoxication symptoms

The intestinal tract is the main route by which all the pathogens listed in *appendix 5* enter the body. Many foodborne pathogens have therefore specialized in multiplying in the intestines, and their pathogenic properties involve a disruption of the normal bowel functions (enteric symptoms). In most cases, the result is an episode of gastroenteritis. The prevailing symptoms will vary according to the nature of the organism itself. Bacteria, viruses and protozoa usually cause vomiting, watery diarrhoea, or symptoms similar to those of dysentery, with blood and mucus in the faeces and violent stomach cramps. The presence of a tapeworm in the gastrointestinal tract will usually not lead to specific symptoms, but rather to a general feeling of discomfort.

Table 4.1: Taxonomy of pathogenic micro-organisms and other infectious agents found in food and their main associated symptoms of disease.

Organism	Mechanism of action[1]	Clinical picture when active	
		In intestinal tract	Elsewhere (non-enteric)
Bacteria	Infection	Gastroenteritis incl. dysenteria, cholera	Typhoid, abortion, meningitis, Guillain-Barré syndrome, haemolytic uremic syndrome, reactive arthritis, inflammatory bowel diseases
	Intoxication	Gastroenteritis, especially accompanied by vomiting	Botulism
Viruses	Infection	Gastroenteritis	Hepatitis, meningitis
Prions	Infection	-	Variant Creutzfeld-Jacob disease
Fungi	Intoxication	-	Carcinogenic, immuno-suppressive, neurotoxic (*see also chapter 4.3*)
Protozoa	Infection	Gastroenteritis incl. dysenteria	Congenital toxoplasmosis, abscesses
Helminths	Infection	Discomfort, diarrhoea	Liver/lung disease, encephalitis/ meningitis, larva migrans syndrome, trichinellosis, space-occupying processes

[1] See *Textbox 4.2*

There are also pathogens which remain present in the intestines only briefly, and then migrate to other parts of the body. They may develop a generalized infection (for example, septic conditions such as typhoid) or they may affect specific organs such as the nervous system (including the brain), the liver, etc. Moreover, larval stages of migrating parasites can often cause serious problems elsewhere in the body. Usually, non-enteric symptoms are directly related to the presence of the pathogen in the affected organ, as in the case of liver damage caused by hepatitis viruses. However, Haemolytic Uraemic Syndrome (HUS) is caused because toxins of a certain type of *Escherichia coli* which are produced in the intestines, end up in the kidneys via the bloodstream, where they cause serious damage to the capillary blood vessels and coagulation of platelets, which can lead to acute, and sometimes even chronic, kidney failure.
Finally, there are also illnesses which are caused by the immune system attacking the body's own cells. This can occur if the same immunologically-active structures (epitopes) are found on the surface of the micro-organism as on human cells. This phenomenon is known as 'molecular mimicry' and is at the root of conditions such as Guillain-Barré syndrome and reactive arthritis.

4.2.3 The scale of foodborne infections in the Netherlands and their effect on public health

It is extremely difficult to state the exact scale of foodborne infections and intoxications in the Netherlands, or the resultant impact on public health. This is because many of the people affected do not seek medical assistance, or because even if they

Textbox 4.2: The mechanisms of pathogenic organisms and micro-organisms in food.

Infections
Infections result from the entry and survival of pathogenic organisms in the intestinal tract. These organisms will then multiply in the intestinal tract or elsewhere in the body. In general, infections occur following a single exposure. The 'incubation time', being the period between exposure and the onset of symptoms, can vary from a few hours to several months, or even several years in the case of prions, some bacteria (the mycobacteria) and parasites (e.g. echinococci). Infectious organisms can disrupt the normal function of the host in various ways, including the invasion and destruction of cells, and the production of toxins. It is generally assumed that, in theory, it takes only one organism to initiate the process of infection, although the likelihood of this happening is small.
The nature of the symptoms of illness depends primarily on the extent to which the host's immune system is able to control the multiplication of the infectious organisms. An extremely effective immune system may prevent any symptoms appearing at all (i.e. the infection is 'asymptomatic'). In many cases, the immune system will be able to eliminate the pathogenic organism or micro-organism from the body after a period during which symptoms are apparent. In some cases, however, the infection will be chronic, resulting in permanent symptoms or even death. This also applies to parasites such as roundworms and tapeworms. The tapeworm *Taenia saginata* forms an exception to the multiplication rule, in that each larva ingested will result in one new worm, which does not reproduce further. The nature of the symptoms produced will depend on the number of worms present in the body, and hence on the number of larvae ingested.

Intoxications
The term 'intoxication' refers to the multiplication of, and toxin production by, pathogenic organisms in the food prior to consumption. Intoxications can be acute, as the result of a single exposure (this is usually the case for bacterial toxins), or may appear after prolonged exposure, as usual in the case of the toxins produced by fungi.
Because these mycotoxins lend themselves to the same analysis as toxic substances, we shall consider them in more detail in *section 4.3.* The likelihood of becoming ill and the severity of the symptoms are directly proportional to the quantity of toxin ingested and the harm caused to the host.

NB: Although the distinction between 'infections' and 'intoxications' is a useful one, the borderline between the two is not absolute. The pathogenicity of many infectious bacteria and some viruses results from the production of toxins *in vivo* (inside the body), and are therefore also termed toxicoinfections. In the case of intoxications involving the *Clostridium perfringens* bacterium, toxins are produced during the process of spore production by the vegetative cells present in the food. The *Bacillus cereus* bacterium has strains which can cause foodborne infection as well as some which cause foodborne intoxication. *Clostridium botulinum* usually causes a foodborne intoxication, but can (for example when ingested in honey) reproduce in the intestinal tract of very young children and cause a toxicoinfection.

do, no further laboratory examinations are requested. Also, many of the pathogenic micro-organisms and other infectious agents listed here are not found exclusively in food, but can infect humans by other routes, including direct contact with other people or animals, via water (either through consumption or contact, as in swimming) or via the environment in the broadest sense of the term. It is therefore not possible to establish an adequate surveillance system which can directly quantify the scale and exact health effect of foodborne infections.

Indirectly, information relating to the probable incidence of foodborne infections can be inferred from the total number of recorded 'relevant illness reports', together with estimates of the percentage of these reports which are indeed attributable to food. In principle, two approaches are available: (i) based on the causal pathogenic agents (known as *strain or laboratory surveillance*, see *textbox 4.3*), or (ii) based on the resulting condition or symptoms (known as *syndrome surveillance;* see *textbox 4.4*).

Finally, we may note that much research is conducted into explosive outbreaks of foodborne infections. Of course, this research is primarily intended to resolve the problem as quickly as possible, but it is also conducted with the associated publicity in mind, and because it can help to reveal where the weak points of our food safety system lie.

Tekstblok 4.3: Strain or laboratory surveillance.

In strain or laboratory surveillance, data from medical laboratories is used to determine how often a given pathogenic organism or micro-organism is identified. Gastroenteritis is a relatively mild condition and only a small proportion of patients will consult a doctor. In most cases, the doctor will then advise them to wait until the symptoms disappear spontaneously. In some cases, generally the most serious ones, or those involving particularly vulnerable patients, the doctor will submit a sample of the patient's faeces to a medical microbiology laboratory in order to identify the organism responsible for the symptoms. Only a limited number of micro-organism types will be tested for, and so the results are biased in favour of the known and expected. Most national surveillance systems are based on these kind of laboratory statistics. However, the data represents only the tip of the iceberg: see *figure 4.1*. The relative size of this 'tip' varies according to the organism involved and by demographic group. Information about the symptoms prompting the laboratory tests is not available, while details of the denominator population and the adherence areas to which the data refers are not routinely available. Laboratory data is, however, relatively simple to obtain, and can be gathered on an ongoing basis. It therefore forms a good basis for a study of trends, assuming that the proportion of patients attending for a consultation and the response of doctors will remain unaltered over time.

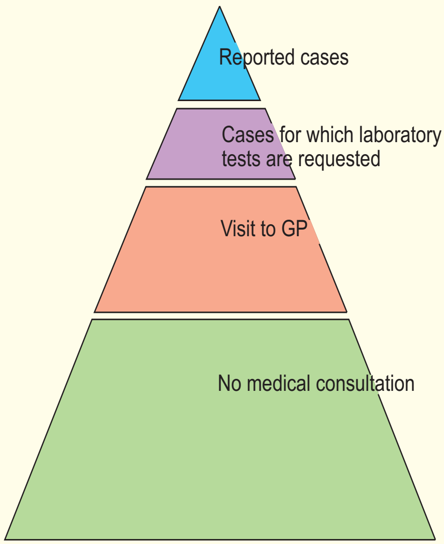


Figure 4.1: Surveillance pyramid for gastroenteritis (De Wit, 2002).

Textbox 4.4: Syndrome surveillance.

To gain a greater understanding of the degree of selection which takes place in laboratory surveillance, specific studies must be conducted targeting either those patients who consult their doctor or all patients in the population. This type of research is therefore not based on any particular organism, but on a certain type of illness or set of symptoms. Hence the name 'syndrome surveillance.' In order to make any statements about the contribution of various pathogenic agents, samples (e.g. faeces) are collected from registered patients and investigated. In the ideal situation samples from healthy control subjects will also be tested. In the Netherlands, this type of research was conducted on a large scale during the period 1996-1999. Internationally, only England and Wales can provide comparable data. In some cases, syndrome surveillance is based on longer-term activities, such as the inclusion of gastroenteritis cases (since 1996) in the Continuous Morbidity Registry maintained by the Netherlands Institute for Health Services Research (NIVEL), the mandatory reporting of foodborne infections to the Health Care Inspectorate (IGZ) and the registration of consumer complaints by the Food and Consumer Product Safety Authority (VWA).

Estimated incidence of foodborne infections and the impact on public health
An estimate of the overall incidence of foodborne infections in the Netherlands, based on laboratory and syndrome surveillance, must rely on information derived from several sources. It is therefore subject to a considerable margin of uncertainty. In the Netherlands, relatively good information is available with regard to the incidence of gastroenteritis and the causal micro-organisms. However, our understanding of other conditions which may be connected to foodborne infections or intoxications is fragmentary, deriving in part from laboratory surveillance (e.g. for STEC O157), and in part on syndrome surveillance (e.g. for Guillain-Barré syndrome). Often, the relevant research projects are short-term in nature rather than ongoing. That still leaves a difficult question to be answered: how many of these cases were attributable, directly or indirectly, to infected or contaminated food. Case-control studies have been widely used, but are subject to a number of limitations. In some cases (such as that of Salmonella) a comparison of types of bacteria in certain reservoirs (e.g. farm animals) and in humans will reveal information concerning the relative contributions of these various reservoirs. Unofficial estimates of the number of cases of illness resulting from foodborne infections and/or intoxications (hereafter 'foodborne infections') in the Netherlands vary from 2 to 4 million per year (Rougoor *et al*., 2003). *Appendix E* of the Health Council of the Netherlands' report on foodborne infections (Gezondheidsraad, 2000) places the estimate of illnesses caused by known pathogens at 250,000 to one million cases per annum. Some of the data on which the Health Council based its figures (a number of incidence statistics, proportion of food-related illnesses) has since been superseded by more accurate information (Van Duynhoven *et al*., 2001, 2002; Van Pelt *et al*., 2003; De Wit *et al*., 2001a, b). This section presents the latest estimates and the trends they reveal.

In *figure 4.2* the estimates of the incidence of foodborne infections and intoxications in the Netherlands have been summarized as accurately as possible. For a large number of pathogens which can be transmitted in food (whether exclusively or not) the incidence of illness in the total population is given, alongside an indication of the proportion of all illnesses attributable to food. As stated above, this fraction is largely unclear for the majority of pathogens, whereupon the figures presented are qualitative in nature. A substantiation of the data presented for cases of gastroenteritis is to be found in *appendix 6*.

Gastroenteritis: In 1999, a population study was conducted into the incidence of gastroenteritis in the Netherlands. It determined the standardized incidence to be 283 cases per 1000 person years. Based on the total population, this is the equivalent of 4.5 million cases of gastroenteritis per year. The highest incidence is seen among children, particularly those aged four years or below. Extensive microbiological tests identified the pathogenic micro-organism responsible in 36% of cases (5% bacteria, 21% viruses, 6% protozoa and 4% bacterial toxins). In other words, the cause of 1.6 million cases of gastroenteritis per annum is known. A proportion of these cases is attributed to foodborne infections. The exact extent to which this happens varies according to the micro-organism concerned (see appendix 6). Based on these statistics, the number

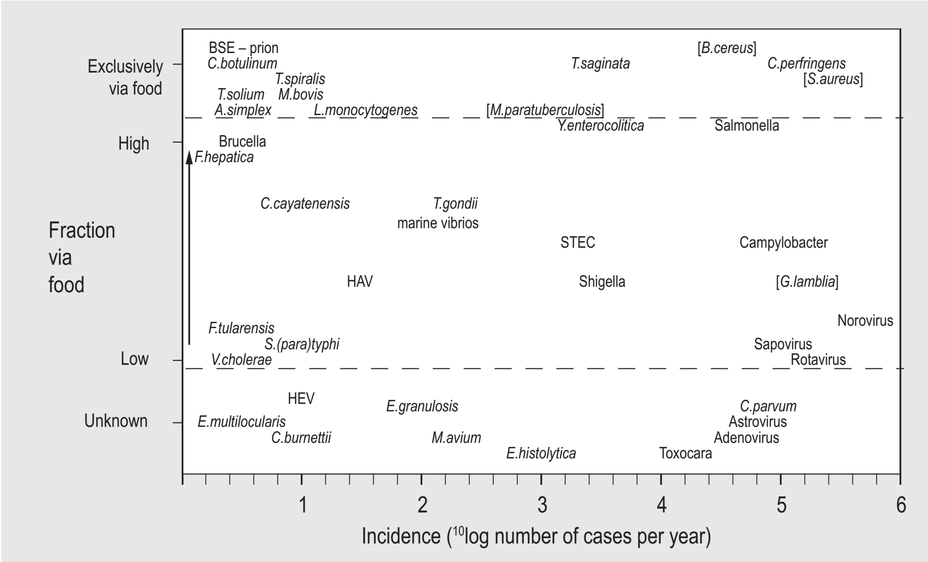


Figure 4.2: Estimated incidence of foodborne infections in the Netherlands.
The severity of illnesses will vary greatly and is not taken into account in this figure (see Appendix 5). Where the name of an organism appears between square brackets, this indicates that the incidence cannot be accurately established, because the organism is found in approximately the same frequency in patients as in controls, (B. cereus. S. aureus. G. lamblia) or because a causal relationship between the organism and a specific illness has not yet been established (M. paratuberculosis and Crohn's disease).

of cases of gastroenteritis caused by known pathogens in food is currently more than 300,000 to 750,000 per annum (see *table 4.2*). This is between 20% and 50% of the 1.6 million cases of gastroenteritis attributable to known pathogens. Estimates of the total number of deaths from food-related gastroenteritis are subject to an even lesser degree of accuracy, but are currently placed at between 20 and 200 per year, mostly among elderly people. Because the exact cause of the gastroenteritis could be established in only one third of cases, the figures presented here are likely to be an underestimate of the actual incidence. It is possible that new pathogens which can, to some extent, be transmitted in food will be identified in the future. If food were to contribute equally to the incidence of gastroenteritis caused by unknown pathogens (3 million cases per year), the number of such cases can be placed between 600,000 and 1.3 million per year, being equivalent to a total incidence of between 900,000 and 2 million cases of foodborne gastroenteritis per year.

Non-enteric complications: In a number of cases, gastroenteritis can lead to further, serious complications, such as Guillain-Barré syndrome following a Campylobacter infection (approximately 60 cases per year), reactive arthritis following various bacterial infections (with 1400 cases per annum due to Campylobacter alone; Mangen *et al.*, 2004), and Haemolytic Uraemic Syndrome (HUS) as a complication of infection with Shiga toxin producing E. coli (STEC; 20-30 cases per year; Havelaar *et al.*, 2003). These complications are also responsible for a number of deaths each year, sometimes

*Table 4.2: Incidence of food-related gastroenteritis caused by known pathogens in the Netherlands.**

Organism	Incidence gastroenteritis (per year, all causes)	Food attributable fraction	Incidence food-related gastroenteritis (per year)
Campylobacter spp.	107,000	0.3 – 0.8	32,100 – 85,600
Salmonella spp.	53,500	> 0.9	48,200 – 53,500
Shigella spp.	1,000 – 10,000	0.1 – 0.5	100 – 5,000
Escherichia coli O157	1,250	0.5 – 0.9	625 – 1,125
Yersinia enterocolotica	1,000 – 10,000	> 0.9	900 – 1,000
Total infectious bacteria			82,000 – 146,000
Clostridium perfringens toxins	147,000	1	147,000
Staphylococcus aureus toxins	0 – 236,000	1	0 – 236,000
Bacillus cereus toxines	0 – 35,700	1	0 – 35,700
Total toxinogenic bacteria			147,000 – 419,000
Norovirus	499,500	0.1 – 0.2	50,000 – 100,000
Sapovirus	107,000	0 – 0.1	0 – 10,700
Rotavirus groep A	191,800	0 – 0.1	0 – 19,200
Total viruses			50,000 – 130,000
Giardia lamblia	0 – 165,000	< 0.3	0 – 50,000
Total protozoa			0 – 50,000
Total known microorganisms			279,000 – 745,000

* Based on studies in 1996-1999, see *Appendix 6* for a more detailed substantiation.

involving young children. As in the case of gastroenteritis, only a proportion of the cases can be attributed to foodborne transmission, depending on the actual micro-organism in question.

Other, usually enteric, pathogens cause diseases which, after primary infection, are always severe in nature. They include cholera, typhoid, paratyphoid, botulism, listeriosis, trichinellosis, toxoplasmosis, brucellosis, Q-fever and hepatitis A. However, for most of these infectious diseases, the number of cases notified by Dutch doctors to the Health Care Inspectorate is small: no more than ten per year. Moreover, the majority of cases are contracted overseas. The number of cases of hepatitis A (HAV) and toxoplasmosis (*T. gondii*) (several hundreds to thousands per year) is markedly higher, as shown in *figure 4.2*. However, the proportion of these cases which can be attributed to the consumption of infected food remains unknown, as does the number of deaths resulting from such infections. It is clear that the number of cases reported to the Health Care Inspectorate represents only a fraction of the actual incidence. The degree of selection depends on such factors as the seriousness of the disease and the need for measures such as source and contact-tracing. Based on serological research (the PIENTER project, De Melker & Conijn-van Spaendonck, 1998), the number of cases of Toxoplasma infection has been estimated at 12,000 per year. The majority are asymptomatic or present only mild symptoms (Kortbeek, personal communication).

Comparison of the Dutch situation with that in other countries

In many other industrialized countries as well, only general statistics relating to foodborne infections are available. Most have only the data derived from laboratory surveillance. Nothing is known concerning differences in the extent of under-reporting, which makes a direct comparison of the statistics from the various countries quite difficult. A few countries have produced estimates similar to those of the Health Council of the Netherlands (2000) and those presented in this chapter. The estimates for the United States were published in 1999 (Mead *et al.*, 1999), and reveal a total of 76 million cases of illness, 14 million of which were caused by known pathogens. When adjusted according for the Dutch population figures, this is the equivalent of more than 800,000 cases due to known pathogens, being comparable to the upper limit of the Dutch estimates. Unlike the Netherlands, the United States has no reliable data concerning the incidence of gastroenteritis in the general population, and the pathogens responsible. Apart from the Netherlands, only England and Wales have collected such data (for the period 1993-1995) by means of a longitudinal population study (Wheeler *et al.*, 1999). A comparison of the Dutch situation with that in England and Wales suggests that the incidence of gastroenteritis is markedly higher in the Netherlands (283 per 1,000 person years against 190 per 1,000; Wheeler *et al.*, 1999; De Wit *et al.*, 2001b). However, given a clear difference in the proportion of gastroenteritis patients consulting a general practitioner in the Netherlands (approximately one in twenty will do so compared to almost one in six in England and Wales), the incidence of gastroenteritis as presented to a physician is lower in the Netherlands than in England and Wales (Wheeler *et al.*, 1999, De Wit *et al.*, 2001c). Based on these statistics, Adak *et al.* (2002) estimate that there were approximately 2.4 million cases of foodborne infections and intoxications in England and Wales in 1995 (population approximately 60 million), with 21,000 hospital admissions and more than 720 deaths. By 2000, these figures had fallen to 1.3 million cases, 21,000 hospital admissions and 480 deaths.

Trends in foodborne infections in the Netherlands

To follow the trends in gastroenteritis and some of the micro-organisms responsible, we can use the data relating to patient consultations for gastroenteritis taken from the Continuous Morbidity Registration Centres (CMR sentinel stations) maintained by the NIVEL, and from laboratory surveillance systems such as the Infectious Diseases Surveillance Information System (ISIS), the Laboratory Surveillance of Infectious Diseases (LSI), and weekly virological reports (produced by the Clinical Virology Workgroup).

The CMR includes information relating to consultations for gastroenteritis during the periods 1992/1993 and from 1996 onwards. Between 1992 and 1999, the number of consultations fluctuated from 53 to 71 per 10,000 person years. In 2000, the figure rose to 91 per 10,000, the greatest increase being seen in male children under the age of one year and, to a lesser extent, in children of both sexes aged between 1 and 9 (Bartelds, 2001). In 2001, the figure rose yet further to 101 consultations per 10,000 head of population. The cause of this increase remains unclear, and it is not known whether food played any part.

Statistics produced by the LSI show a gradually decreasing trend in the incidence of salmonellosis, beginning in the 1980s (see *figure 4.3*). Temporary deviations from this trend may be seen, as in the mid-1990s (primarily due to the presence of *S.* Enteritidis in eggs). In 2001, there was a rise in the number of isolated (multiresistant) *S.* Typhimurium DT 104 identified (Van Pelt *et al.*, 2003, 2001). In 2003, the import of infected eggs further to the avian influenza crisis resulted in another rise in the incidence of *S. enteritidis* (Mevius & Van Pelt, 2004). Statistics relating to the incidence of Campylobacter have been kept since 1996 and show no clear trend, whether upwards or downwards. As shown by *figure 4.3*, the vast majority of Salmonella infections are due to infected food (cross-contamination included). In the case of Campylobacter, the relative role of food in relation to other risk factors (e.g. contact with pets, contaminated water, foreign travel) is less clear (Havelaar 2002, Evers *et al.*, 2004).

Outbreaks of foodborne infections

Outbreaks of foodborne infections provide another, albeit limited, source of information about the incidence and trends in such infections (see *textbox 4.5*). In the period from 1999 to 2002, between 300 and 350 explosive outbreaks were reported to the Food and Consumer Product Safety Authority (the former Inspectorate for Health Protection and Veterinary Public Health, KvW) each year, involving a total of between 1,500 and 1,800 cases of illness per year (Van Duynhoven *et al.*, 2001; 2003). In almost three quarters of these explosive outbreaks, the implicated food products had been

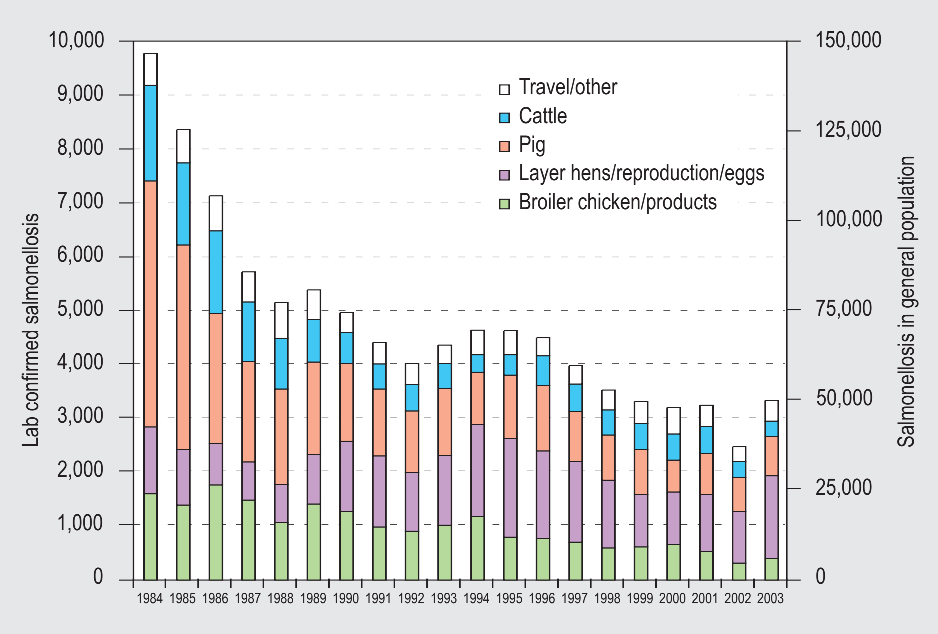


Figure 4.3: Trends in salmonellosis in the Netherlands.
The figure shows the trend in the number of registered cases of salmonellosis as identified by laboratory surveillance (left y axis) and an extrapolation to the total number of cases in the Dutch population (right y axis). The extrapolation factor is derived from recent epidemiological studies (Van Pelt et al., 2003). Also shown is the fraction of all cases of salmonellosis which can be attributed to various food sources. For an account of the methods used, please refer to Van Pelt et al. 1999a and 1999b.

Textbox 4.5: Outbreaks of foodborne infections in the Netherlands.

In the Netherlands, explosive outbreaks of food infections and intoxications are investigated by the local health departments (GGDs) and, where there is reasonable cause to suspect that an offence has been committed, by the Food and Consumer Product Safety Authority (VWA). The VWA investigation will usually centre on the infected food and the place of its preparation. Under the *Infectieziektewet* (Infectious Diseases Act), doctors are obliged to notify the Health Care Inspectorate (IGZ) if two or more related cases of foodborne infection or intoxication are presented. All cases in which the patient is employed in the food industry or (residential) care services should be reported to the Inspectorate as well. However, it is known that the number of reports made represent only a small proportion of the actual number of food-related outbreaks. In most cases, only the larger explosive outbreaks, those associated with a particular restaurant, those linked to social events and those which result in serious illness, hospital admission or death are reported (Van Duynhoven et al., 2001, 2003). Nevertheless, a greater proportion (25% - 40%) of the incidents reported to the Health Care Inspectorate relate to a single household. Private households fall outside the regulatory responsibility of the VWA, which will therefore not investigate such incidents.

prepared in a restaurant or cafeteria. The pathogen thought to be responsible for symptoms was identified in 12% to 18% of the outbreaks investigated by the VWA, the most frequently observed being *Bacillus cereus* and *Salmonella* spp. Where samples of the suspect food were available for analysis (20-30% of explosive outbreaks), it was possible to identify the pathogen in a far greater number of cases, i.e. 35-55% (Van Duynhoven *et al*., 2001, 2003).

The number of outbreaks reported to the Health Care Inspectorate in each year between 1999 and 2002 ranged from 60 to 100, with some four hundred people affected each year. *Salmonella* spp. was most frequently reported as the responsible pathogen, followed by *Campylobacter* spp. However, it should be noted that samples of the food and of the faeces of the victims are rarely investigated for viruses or parasites.

In recent years, it has become increasingly clear that noroviruses form a more significant cause of foodborne infections in the Netherlands than had previously been assumed (De Wit *et al*., 2003; Van Duynhoven *et al*., 2001, 2003. See also *textbox 4.6*).

4.2.4 Factors which influence microbial food quality

Pathogenic micro-organisms usually occur in specific types of food. Most organisms are often found in particular products and not in others. This is because the micro-organism requires certain conditions in order to survive or reproduce. Some micro-organisms, such as parasites, have a specific life cycle which depends entirely upon a certain host species. For example, the tapeworm *Taenia saginata* has a cycle which is restricted to humans and cattle.

Textbox 4.6: Noroviruses as food contaminants.

Noroviruses (NoV; formerly described as 'Norwalk-like viruses and 'small-round-structured viruses') are RNA viruses which belong to the *Norovirus* genus of the *Caliciviridae family*. NoV are known to cause gastroenteritis in humans, and are a notorious cause of outbreaks in people of all ages. NoV will give rise to actual symptoms in 30-50% of all persons exposed to the virus, regardless of age. However, the highest incidence is seen among children. Following an average incubation time of one to three days, fever, nausea, headache and diarrhoea will appear as the most conspicuous clinical symptoms. There will be no blood or mucus in stools. The symptoms generally persist for approximately two days in persons of (otherwise) good health, but can sometimes last much longer, particularly in children under the age of one year (median 6 days, Rockx *et al.*, 2002) and elderly people.
Virus shedding is via vomit and faeces, and can continue for up to three weeks following the onset of symptoms. Persistent infections in persons with compromised immunity have recently been reported, as have some deaths associated with outbreaks of NoV, particularly in residential care facilities. However, the scale of these phenomena has not been subject to targeted research. There are some indications to suggest that susceptibility to NoV may be genetically determined.
The NoV are particularly contagious, whereby secondary infections are common. This may lead to gastroenteritis spreading rapidly where people live in close proximity, such as residential care homes and cruise ships. The high infectivity and resistance of NoV, and the widespread contamination of surfaces due to aerosols of virus-laden vomit, explain why the infection, once established in a particular setting, can persist for a long time. NoV can be introduced into a vulnerable group by infected individuals (regardless of whether or not they exhibit symptoms), or via infected water or food. Shellfish and fresh fruit have often been implicated, but in fact outbreaks involving many types of hand-prepared, hand-harvested and/or uncooked food have been described. The role of zoonotic transmission (i.e. from humans to animals or vice versa) remains unclear. This route has never been demonstrated, although viruses similar to NoV have been detected in pigs and cattle.
The large-scale international spread of NoV in food has been described. A newly identified risk is that of the creation of recombinant (new) viruses by simultaneous infection of a host with two related NoV strains. In 2002, a significant increase in outbreaks of illness was reported throughout much of Europe, caused by a new NoV strain. This emerged simultaneously in several countries in January 2002, and supplanted the endemically prevalent strains as the main cause of outbreaks by the summer of the same year.
The prevention of NoV infection seems particularly important in products which are eaten raw, or after minimal processing, (particularly shellfish, fruit and vegetables), and on the further processing of food following heat treatment. In the case of shellfish, it has been established that the current EU directives are not fully adequate. Work has commenced on the development of quality indicators for viral infection. In the case of agricultural produce, the quality of irrigation water and strict hygiene during harvesting are of particular importance, as is the further processing of the produce. Subsequent infection of food can only be prevented with strict hygiene, which includes guidelines for the exclusion of infected persons from food preparation areas. Current HACCP protocol should be carefully re-evaluated in terms of the protection they provide against viral infection. One problem in this regard is that the detection of viruses in food products other than shellfish is still in its infancy. For the time being, tracing the causes of foodborne viral infections must therefore rely on active surveillance, for which the monitoring of outbreaks in combination with molecular classification presents an adequate means of investigating infections with a common source. For further information, refer to Koopmans & Duizer (2004).

Appendix 7 includes a list of the pathogenic micro-organisms associated with certain categories of foods. The table clearly shows that pathogenic bacteria, parasites (helminths, protozoa) and prions are particularly associated with meat and animal products. Most viruses have only humans as hosts. They can be transferred to vegetables, fruit and shellfish via faecal contamination. Some viruses have recently been shown to be 'zoonotic', i.e. they can be transmitted from humans to animals and vice versa. They include the hepatitis-E virus. The noroviruses form a special case, in that they often appear as post-contamination on prepared food, transmitted via infected food handlers (see *textbox 4.6*).

In general, foods which are cooked or heated during preparation pose a lesser risk than those eaten raw. When food enters the kitchen in a raw state, there is some risk of cross-contamination, whereby other components of the meal (e.g. salad) will be contaminated. This risk can be markedly higher than that posed by food which has been inadequately heated, and is also far more difficult to manage.

Whether the food we eat contains pathogenic micro-organisms depends on good safety management throughout the entire chain, from primary production to preparation in the kitchen. Food production chains are complex, are becoming longer and have a greater geographic distribution than in the past. The import and export of raw materials used in the primary production process, of prepared foods and of the necessary ingredients are becoming increasingly important, and the dietary preferences of the Dutch consumer are changing all the time. Pathogenic micro-organisms can be introduced into food at various points of the supply chain. Similarly, there are often opportunities to prevent or reduce contamination. Any consideration of food safety must therefore encompass the entire chain, from primary production to preparation and storage of meals. We now offer a brief account of the current information relating to the occurrence of pathogens in various stages of the food production chain, how they enter that chain, and how the risks can be (better) managed.

a. The food production chain

Primary production

The basic requirement for the safe production of foods is that contamination of primary products, whether agricultural, horticultural or dairy products, should be avoided as much as possible. As *appendix 7* illustrates, it is the foods of animal origin which are most prone to infection by a wide range of pathogens. Much attention has therefore been devoted to the safety of this product group in the past, and a relatively large body of information concerning the incidence of pathogens is available (see for example *textbox 4.7*).

In the Netherlands, some pathogens have since long been effectively controlled by means of targeted prevention programmes. Further to the relevant European Union directives, Dutch cattle have been officially declared free of *Brucella abortis* and *Mycobacterium bovis*. Similarly, *Trichinella spiralis* has not been found in Dutch pigs since 1979 (Van Pelt & Valkenburgh, 2002). Ongoing surveillance programmes are conducted in order to monitor this situation. A positive test result is now extremely rare. In recent years, special attention has been devoted to the infection of cattle with the BSE prion. The prevalence in the Netherlands is extremely low: in 2001, over 530,000 beef cattle were tested with only twenty positive results (six of which related to cows which already displayed symptoms consistent with those of BSE). The animals which tested positive were removed from the food chain (Huntley *et al*., 2002).

Textbox 4.7: Monitoring/surveillance of zoonotic pathogens in farm animals.

In 1997, the RIVM joined the Food and Consumer Product Safety Authority (VWA) in implementing a monitoring programme examining trends in the prevalence of zoonotic pathogens in farm animals. Each year between 1997 and 2002, approximately eight hundred groups of animals (flocks of chickens kept for egg production, and chickens intended for consumption, herds of pigs, dairy cows and veal calves) were tested for *Salmonella* spp., *Campylobacter* spp. and/or verocytotoxin producing
E. coli O157. The results for 1998 to 2002 were reported (Bouwknegt *et al.*, 2003, 2004) and show that the estimated prevalence of Salmonella in both types of poultry fell significantly during the period, from 20% to just over 10%. Salmonella was found in approximately 30% of the pig herds tested. The prevalence in dairy cows and veal calves was below 10% throughout the study period. *S.* Enteritidis (a serotype which can be transmitted via eggs) was the most prevalent serotype among the laying hens, while (from 2000) *S. paratyphi* B var.Java was the most prevalent strain in broiler chickens, occurring in 33% of the flocks that tested positive in 2002. This strain accounts for relatively few cases of illness in humans, but has multiple resistance to antibiotics (flumequine and ciprofloxacin in particular). The dominant pathogen in pigs was *S.*typhimurium, with increasing prevalence of the multiresistant phage type DT104 in the study period. The prevalence of Campylobacter in broiler chickens fluctuated between 15% and 30%. The estimated prevalence of *E. coli* O157 in dairy cows increased from 8% to 14% between 2000 and 2002. An increase in this pathogen was also seen in veal calves during the study period, possibly due to the disproportionately high number of 'rosé' calves in the sample. These are associated with an elevated risk of *E. coli* infection, whereby the current shift in consumer preference from white veal to rosé may result in an increased infection risk for humans.
In addition, the RIVM conducts thematic research into other pathogens, including viruses (rota-, noro- and hepatitis-A) and protozoa. Detailed information about zoonotic pathogens in the Netherlands can be found in the annual report to the European Commission, as required by the EU 'Zoonosis Directive' (Anon., 1992, Van Pelt & Valkenburgh, 2002).

There is also a number of pathogens which are not yet under control, such as Campylobacter (see also *textbox 4.7*) or which have only recently been identified, such as the hepatitis E virus. Better management of these pathogens will result in a reduction of the burden of disease within the Dutch population. The action to be taken often includes ensuring the segregation of farm animals from those living in the wild and from the environment. However, this is inconsistent with society's desire for more 'animal-friendly' production, which means that an increase in the prevalence of certain pathogens is more likely than any decrease in the foreseeable future. There is also some risk of the re-emergence of pathogens which have been brought under control but which continue to exist in wild animals. These include trichinellas.

The safety of the food available in the Netherlands is only partly determined by the hygiene status in the primary production process. A large proportion of the food consumed in the Netherlands is actually imported from other countries, while the greater part of Dutch food manufacturing is exported elsewhere. It remains very difficult to obtain good quantitative information concerning the import and export flows, and even more difficult to obtain information concerning the prevalence of pathogens in or on imported products (see also *textbox 7.2* in *chapter 7*). Accordingly, it is very difficult to make firm statements with regard to the health risks faced by Dutch consumers.

The prevention of contamination in the primary production process is clearly the preferred approach, but can be hampered by practical problems. It therefore may become appropriate to implement additional measures further along the food chain, although this should not detract from efforts to prevent contamination at the source.

Processing
The processing of primary products into foods that are marketed (slaughtering, processing industry) presents opportunities to extensively reduce the levels of pathogens which reach the final consumer product. A familiar example is the pasteurization of milk, which effectively eliminates a range of pathogens, notably *Mycobacterium bovis*, STEC O157 and Campylobacter. In combination with comprehensive hygiene protocols (GHP, GMP and HACCP), the processing stage represents an effective barrier. In recent years, the decontamination of certain types of meat has been advocated as an effective intervention. This may be appropriate for chicken meat and for beef intended for the production of raw or rare-cooked products such as steak tartar and hamburgers. Most decontamination methods do not result in the complete eradication of pathogens, but they do account for a considerable reduction in the number of pathogens in meat. This could account for a marked reduction in the health risk.

In terms of public health, minimally processed refrigerated foods also demand specific attention. Such products form a suitable environment for the survival and multiplication of spore-forming bacteria such as *Bacillus cereus.* Post-contamination of these products with pathogens such as *Listeria monocytogenes* can also present problems. Modifications to preservation methods, packaging materials, etc., also demand ongoing adjustments to the monitoring programmes. Monitoring the effectiveness of measures implemented during processing usually relies on general hygiene indicators, such as the total number of viable bacteria, or the presence of specific groups such as the *Enterobacteriaceae*. Statistics relating to these indicators are readily available, but there is little direct information relating to the prevalence of pathogens during processing. For example, in 1999 the former Inspectorate for Health Protection and Veterinary Public Health (KvW), now named Food and Consumer Product Safety Authority (VWA), conducted 187,000 microbiological analyses. Of these, 102,000 (55%) focused on non-pathogenic bacteria (as indicators of hygiene and process control), 60,000 (32%) on toxin-forming bacteria, and 25,000 (13%) on infectious pathogens, 9,000 of which were specifically testing for *Listeria monocytogenes*. A comparison with *table 4.4* suggests that the VWA's research is therefore primarily intended to reveal incidents in which the set standards have been exceeded. The lack of any standards for the main infectious pathogens in unprocessed, raw foods and beverages is, indirectly, the cause of the paucity of information with regard to their prevalence. Targeted surveillance programmes should be implemented to rectify this situation (see also *textbox 4.8*).

Distribution
During the distribution of food and food products, the observance of general hygiene guidelines, including the use of effective refrigeration, is extremely important. Here too, much of the research conducted to date, whether by the government or the

industry itself, has been geared to ensuring compliance with hygiene indicators although there has also been some specific research into the prevalence of certain specific pathogens. For some years, the VWA has been conducting a surveillance programme to establish which pathogens are to be found in which products, and at what levels. Since 1999, the prevalence of a number of known pathogens in various types of food products has been monitored. To date, details of such contamination have been established for a considerable number of product groups of all types (animal, vegetable and composite). (For further information, see Ware(n)chemicus, 2000). One ongoing programme is the 'chicken monitoring' study (see *textbox 4.8*).

Textbox 4.8: Monitoring chicken products in retail trade by the Food and Consumer Product Safety Authority (VWA).

In 1986, the former Inspectorate for Health Protection and Veterinary Public Health (KvW) commenced a monitoring programme to determine the average percentage (per year) of chicken products contaminated with Salmonella spp. (including *S.* enteritidis) and thermophilic *Campylobacter* spp.
Since 1996, this information has been collected according to an international standardized protocol, for the purposes of the mandatory report within the framework of the European 'Zoonosis Directive'. Since 2002, the study has also examined the Salmonella isolates to determine the degree of resistance to certain antibiotics and/or growth promoters.
Each year, 1600 samples are collected from the various categories of direct suppliers (supermarkets, butchers and poulterers) according to their proportionate market share. In 2002, Salmonella was found in 13.4% of the samples (with S. Enteritidis in 0.3%). Campylobacter was found in 31.3% of the samples (Van der Zee & Wit, 2003). Over 50% of the Salmonella isolates were of the strain *S. paratyphi* var. Java, a serotype that rarely causes illness in humans, but which has multiple resistance against antibiotics (especially flumequine and ciprofloxacin). A comparison with the results of preceding years shows that the prevalence of Salmonella contamination is gradually decreasing. That of Campylobacter fluctuates from year to year, but does not yet show any permanent downwards trend.

Consumer exposure

The consumer or more generally, everyone who is involved in the purchase, storage and preparation of food, whether professionally or at home, is the final link in the chain, and an important one. It must be possible for the consumer to opt for safe food, particularly in the case of the high-risk groups. Pregnant women, for example, may choose to prevent listeriosis and toxoplasmosis by avoiding all raw meat, soft cheese, smoked fish and fresh products which have been stored for too long. The consumer can prevent many problems by ensuring that food is stored and prepared properly. Many foods are cooked or heated prior to consumption, which reduces the number of practically all pathogens to a negligible level. However, this effect can be undone if inadequate measures to prevent cross-contamination between raw ingredients and prepared foods (e.g. transmission of Campylobacter) are taken, or if the person preparing the food is himself or herself a source of pathogens which will contaminate the food (as in the case of noroviruses). Recent research (Griffiths *et al.*, 1998; Clayton *et al.*, 2002; EFFI, 2002; Redmond & Griffiths, 2003) has clearly shown that, despite adequate knowledge, unsafe food-handling practices are common, both in the home and in professionally-run kitchens. Food preparers generally state that they consider their food-handling practices to be less hazardous than those of others, a commonly encountered and biased view of one's own abilities (Weinstein, 1989; see also *section 8.2*). In theory, a substantial health gain can be achieved in the consumer phase, although in practice it will be difficult to change the consumer's hygiene habits. Recommendations in this regard have been presented in various hygiene codes, including those targeting the domestic kitchen. Accordingly, ongoing hygiene education to promote the safe storage and preparation of food continues to be necessary. It would be appropriate to devote renewed attention to this topic in the school setting. However, very little is known about the effects of information and education on actual behaviour.

Based on research into outbreaks of foodborne infections and intoxications, it is possible to form an impression of where the main problems arise (see *table 4.3*). It would appear that the majority of reports made to the VWA relate to food prepared on commercial premises. The Health Care Inspectorate (IGZ) handles a greater number of reports relating to foodborne infections in the domestic setting or in health care institutes such as residential care facilities. It should be noted that the reports are subject to a high degree of selectivity, with the emphasis on cases of illness which can be readily associated in time and place, with the suspect food having been consumed in a location other than one's own home.

Table 4.3: The origin of foods implicated in outbreaks of foodborne infections and intoxications, 1999-2002 (Van Duynhoven et al., 2003).

Preparation site	Reports to VWA	Reports to IGZ	Weighted percentage
Commercial	1,631	102	57%
Domestic	20	93	16%
Institute	35	27	5%
Other	300	22	11%
Unknown	81	50	10%
Total	2,067	294	100%

b. Setting standards and comparing intervention opportunities

In recent years, efforts to ensure food safety have seen a shift in focus, from inspection of the end product to process control. Process control according to the HACCP system (Hazards Analysis Critical Control Points) is intended to provide adequate management of all relevant risks. Additional microbiological 'guideline values' have been formulated for the purposes of verification of process control. The primary risk management activities focus on the 'Critical Control Points' (CCPs), such as preventing inadequate heating and post-contamination.

In the Netherlands, a number of standards have been set with regard to certain pathogenic micro-organisms, see *table 4.4*. Most relate to end product control. The standards do not apply to unprocessed, raw foods and beverages, although these are responsible for the majority of cases of illness. For several years, efforts have been ongoing to harmonize the criteria for micro-organisms in food and/or the production environment throughout the European Union. These standards will focus on both the end products and the safety of the preparation processes, in a system based on HACCP principles and suitable for batch control, verification and validation. The criteria are expected to come into effect in 2006 or 2007 (Anon., 2003c).

Table 4.4: Standards for pathogenic micro-organisms in foods (art. 4, BBI Commodities Act).

Micro-organism	Criterion
Salmonella spp	Not detectable in 25 g or ml
Campylobacter spp	Not detectable in 25 g or ml
Listeria monocytogenes	Not detectable in 0.01 g or ml
Staphylococcus aureus	No more than 100,000 per g or ml
Bacillus cereus	No more than 100,000 per g or ml
Clostridium perfringens	No more than 100,000 per g or ml

N.B. These standards do not apply to raw, unprocessed foods and beverages.

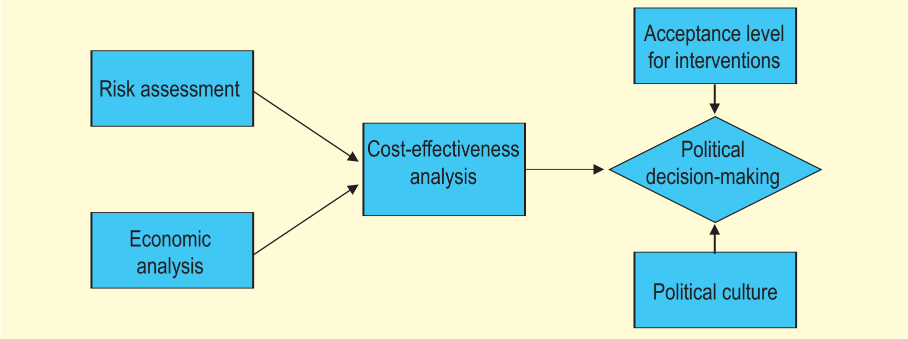
In 1997, the Product Board for Poultry and Eggs implemented a number of action plans intended to reduce the prevalence of Salmonella and Campylobacter in poultry for consumption, and that of Salmonella in eggs. However, the objectives agreed with the Ministry of Health, Welfare and Sport – reduction in contamination of end products to less than 10% of flocks for Salmonella and to less than 15% of flocks for Campylobacter within two-and-a-half years – were not achieved. Supplementary measures were therefore agreed in 2000, accompanied by additional targets. In a letter dated 15 December 2003, the Minister of Health, Welfare and Sport and the Minister of Agriculture, Nature and Food Quality announced in the Regular Consultation Meetings on the Consumer Goods Act in the Netherlands, that, in anticipation of EU legislation, the standards stated in *table 4.4* would henceforth apply to all poultry sold for consumption.

As we saw in *chapter 2*, a number of dietary factors, such as too much saturated fat and inadequate consumption of fruit and vegetables, have a marked impact on health due to their association with a number of chronic diseases. The quantitative information gives an indication of the health gain to be made through preventive interventions which succeed in lowering the number of Dutch people facing one or more of the stated risk factors. It further offers an impression of the relative importance of preventive interventions (measures and activities) targeting each of the risk factors individually.

This type of quantitative information is not available with regard to the determinants of foodborne infections. Although it is indeed known how often certain product groups are contaminated with certain pathogens, this does not provide any insight into the Dutch consumer's exposure to pathogens in food, since this will be determined by a number of variables which have not – or can not – be quantified. The variables include the prevalence of contamination in prepared foods, the number of pathogens in or on the contaminated food, the frequency of consumption and the quantities consumed. It is not possible to measure all these factors, a fact which renders the model-based approach increasingly important. This attempts to describe the dynamics of contamination in food chains using mathematical models, whereupon the likely effect of an intervention can be assessed: the 'microbiological risk assessment'. The models developed can be linked to economic models to provide an indication of the cost-effectiveness of the proposed measures. Over the past ten years, risk assessment models have been under development both in the Netherlands and elsewhere, with the prime focus on *Salmonella* spp. in chicken and eggs, *Campylobacter* spp. in chicken, STEC O157 in beef and *Listeria monocytogenes* in food products for immediate consumption (see Nauta *et al*., 2001; 2003, Anon. 2003b, and http://www.who.int/foodsafety/micro/jemra/en/). One example is the CARMA project, which has been subsidized since 2001 by the Dutch Ministry of Health, Welfare and Sport (the Food and Consumer Product Safety Authority) and the Ministry of Agriculture, Nature and Food Quality (see *textbox 4.9*).

Textbox 4.9: The CARMA project: Campylobacter Risk Management and Assessment.

The objective of the CARMA project is to advise the Dutch government on the effectiveness and efficiency of measures intended to reduce the incidence of campylobacteriosis among the Dutch population. The project is multidisciplinary, involving the input of microbiologists, epidemiologists, mathematical modellers, economists and social scientists.
Poultry is a significant source of Campylobacter infection in humans, but it is not the only source. Campylobacter is also to be found in other farm animals, in surface water, on raw vegetables and on fish products. Many Dutch people are infected during a trip abroad. CARMA aims to compare the significance of each of these possible infection routes. In the case of the infection route through chicken (meat), there will be an extensive study to determine the costs and likely effects of proposed measures. This will involve collecting all relevant information, which will then be used to build mathematical and economic models. The project will also examine the attitudes of various social groups to the Campylobacter problem and its possible solutions. The structure of the project is shown in the figure below. For further information, see Bogaardt *et al*., 2004 and www.rivm.nl/carma.



The risk assessment model is focussed on the production chain for poultry products (primary production, slaughter, preparation), and includes an exposure model, a dose-response model and an integration module to estimate the number of Campylobacter Infections per year. The model will then be used to assess the effect of interventions at various points in the exposure chain. The results of the risk model form the input for an economic model, in which the extent of health loss and associated costs due to campylobacteriosis are calculated. The model will also calculate the potential health gain and reduction in costs which can be achieved. Based on this information, the cost-effectiveness ratio can be calculated, showing the net costs of each year of (healthy) life expectancy gained, or those of each case of disease or death averted. This enables a comparison of various types of intervention.

A new instrument which can be used to establish standards for foodborne pathogens is the 'Food Safety Objectives' (FSOs). The FSO concept is currently the topic of considerable international discussion. FSOs set limits on the occurrence of pathogens in food at the moment of consumption, this being directly linked to an explicitly stated 'Appropriate Level of Protection' further to the World Trade Organization's Sanitary and Phytosanitary Agreement. Risk assessment is an important aid to the formulation and substantiation of FSOs, which are emphatically not intended as instruments for monitoring or enforcement. Rather, they are 'design principles' for safe food preparation which should be entirely in line with previous safety criteria. In practice, 'performance objectives' and 'performance criteria' will be derived from the FSOs, indicating the degree of control required to manage the risk of a particular hazard in a particular process phase (e.g. a reduction by a given factor). The process criteria (such as time-temperature combinations for cooking or heating) can then be formulated. It is these process criteria that lend themselves well to (ongoing) monitoring. FSOs should be seen as a supplement to existing hygiene codes such as the 'Good Hygiene Practices' and the HACCP system. The HACCP instruments traditionally used to verify the process will therefore remain in effect.

4.2.5 The most important foodborne pathogenic micro-organisms in terms of possible health gain

Based on the foregoing, we may state that the prevalence of pathogenic micro-organisms in food is still considerable, as is the health loss attributable to foodborne infections and intoxications. The question is then: what are the main pathogenic micro-organisms which must be addressed in view of both incidence and the severity of the health effects observed? In other words, for which of the micro-organisms is the greatest potential health gain to be achieved by means of supplementary measures?

The main foodborne pathogens responsible for gastroenteritis, in terms of incidence, are: *Campylobacter* spp., *Salmonella* spp., (toxins of) *Clostridium perfringens* and the noroviruses. Between them, these are responsible for almost half of all cases of gastroenteritis and related deaths further to foodborne infections and intoxications (see *appendix 6*). Effective reduction or elimination of these pathogens would, in theory, result in the avoidance of between 280,000 and 380,000 cases of gastroenteritis per year, and the associated 10 to 100 deaths. Similarly, reduction or elimination of *Toxoplasma gondii* infections could result in several hundred fewer cases of congenital and ocular toxoplasmosis, and the associated mortality. Given the serious nature of their effects, infections involving *L. monocytogenes* are also significant despite the relatively low incidence of this pathogen. The toxins of *S. aureus* and *B. cereus* may be significant in terms of health gain, but their actual significance remains unclear and it is not possible to give any accurate estimate of the number of avoidable cases of illness.

However, this is not to suggest that attention should be focused on these pathogens alone. Even where the number of cases of illness is small, measures are indicated if the effects are serious or can lead to death, especially if they can be implemented at relatively low cost. Examples include measures to reduce the incidence of STEC O157 (see *table 4.7*) and *Enterobacter sakazakii*. The process of prioritization will also depend on criteria such as costs, trends, avoidability, risk perception (as determined by such factors as the likelihood of explosive outbreaks) and the health gain already made and maintained in the past. The RIVM commenced a structural analysis of these criteria in 2004.

The actual disease burden or health loss attributable to the presence of micro-organisms in our food can be calculated in terms of DALYs (Disability Adjusted Life Years). This unit of measurement comprises two factors: the life-years lost due to premature death, and the years lived in poor health (see *appendices 8 and 12*). The health loss is, by definition, also the health gain to be achieved if adequate preventive measures are implemented and activities undertaken to negate exposure entirely.

With some 300,000 to 750,000 cases of illness (mainly gastroenteritis), approximately 25,000 visits to the GP, and 20 to 200 deaths per year, foodborne infections account for a health loss of between 1,000 and 4,000 DALYs per annum (see calculation in *appendix 8*). This is more than can be attributed to tuberculosis, and comparable to problems such as (bacterial) meningitis and bacterial STDs, as shown in *table 4.5*. If the estimated incidence of non-identified pathogens is included in the figures, the disease burden could well rise to between 3,000 and 10,000 DALYs per year, comparable to that attributable to AIDS or upper respiratory tract infections, but still lower than that due to pneumonia, acute bronchitis and acute bronchiolitis. Despite the relatively low mortality rate, the calculations (see *appendix 8*) indicate that deaths do make a substantial contribution to the overall disease burden.

For the time being, the calculation of DALYs attributable to foodborne infections is based on the effects of gastroenteritis. Other, non-enteric symptoms or consequences of (specific) foodborne infections have not been taken into account at this stage. In the case of campylobacteriosis, for example, the inclusion of the secondary effects would

Table 4.5: Disease burden due to various infectious diseases.

Disease	Incidence (per year)	Mortality (per year)	DALYs
Pneumonia and acute bronchitis/bronchiolitis	640,000	7,000	74,000
Influenza	1,000,000	370	14,000
Acute urinary tract infections	720,000	12	11,000
Sepsis	No reports	820	11,000
Upper respiratory tract infections	400,000	24	8,400
AIDS	1,700	130	5,400
Foodborne infections and intoxications*	300,000-750,000	20-200	1,000-4,000
Meningitis (bacterial form)	930	91	2,600
Bacterial STD	27,000	23	2,400
Tuberculosis	830	91	1,300

* by known pathogens.
Source: The National Public Health Compass (http://www.rivm.nl/vtv/data/kompas/gezondheidstoestand/svm/daly/daly_huidig_48ziekten.htm, consulted on 4 March 2004, rounded to two significant figures).

undoubtedly lead to a higher calculated disease burden. As shown in *table 4.6*, one case of campylobacteriosis in every 1,000 to 2,000 leads to the development of Guillain-Barré syndrome, being the equivalent of approximately 60 extra cases of illness and approximately two deaths a year, and hence an additional disease burden of 299 DALYs (Havelaar *et al*., 2000, Mangen *et al*., 2004). Another secondary complication of campylobacteriosis is reactive arthritis, which accounts for 1,400 additional cases of illness each year and to an extra disease burden of 126 DALYs. With a health loss of 1,185 DALYs, the problem of campylobacteriosis is therefore comparable to those of tuberculosis, bacterial STDs and bacterial meningitis (1,300, 2,400 and 2,600 DALYs respectively), as mentioned in *table 4.5*. Between 30-80% of Campylobacter infections are attributed to contaminated food (see *appendix 6*).

Table 4.7 shows that another foodborne pathogen, STEC O157, is directly or indirectly responsible for approximately 90% of the disease burden due to Haemolytic Uraemic Syndrome (including the consequent end stage renal disease; Havelaar et al., 2003). The difference in severity between the various symptoms and conditions caused by these two organisms is made clear by the comparison of the average disease burden per 1,000 cases of gastroenteritis: 15 DALYs for Campylobacter and 55 DALYs in the

Table 4.6: Annual disease burden and costs of illness attributable to campylobacteriosis (all sources) in the Netherlands (Mangen et al., 2004)

Clinical symptoms	Total	Gastroenteritis	Guillain-Barré	Reactive arthritis Syndrome	Inflammatory bowel disease
Incidence		80,000	60	1.400	10
Mortality		30	2	-	-
DALY[1]	1.185	634	298	126	127
YLD	752	234	266	126	127
YLL	433	400	32	n.a.	n.a.
Costs (M€)	20.6	15.1	3.4	0.1[2]	2.0
Direct medical	6.5	1.6	3.2	0.08	1.7
Indirect[3]	14.0	13.5	0.2	0.03	0.3

[1] Disability Adjusted Life Years (DALYs) are the sum of lost years of life due to premature mortality (YLL) and years spent in ill health, weighed according to the severity of the disease (YLD).
[2] Mainly the loss of work productivity due to gastroenteritis.
[3] Costs underestimated due to lack of data.

Table 4.7: Annual disease burden attributable to diseases caused by Shiga toxin producing Escherichia coli 0157 (all sources) in the Netherlands (Havelaar et al., 2003)

Clinical symptoms	Total	Gastroenteritis	Haemolytic Uraemic Syndrome	End Stage Renal Disease
Incidence		2100	22	3
Mortality		0.6	2	1
DALY	116	14	59	43
YLD	30	7	1	22
YLL	86	7	58	21

case of STEC O157. Some 50-90% of all STEC O157 infections are attributed to contaminated food (see *appendix 6*).

Table 4.6 also shows that the social costs of campylobacteriosis amount to approximately 21 million euros per annum, of which approximately two thirds is accounted for by short-term absence from work due to gastroenteritis. No calculation of the total costs of all foodborne infections and intoxications has yet been made, but extrapolation of the figures for campylobacteriosis suggests that the costs could be in the tens of millions, perhaps even in excess of one hundred million euros per year. Van den Brandhof *et al*. (2004) estimate the costs of gastroenteritis in the Netherlands (regardless of cause) to be 345 million euros per year. The costs of foodborne infections and intoxications involving known pathogens would then be in the order of 23 to 58 million euros per year. If the estimated incidence of non-identified pathogens is then included in the calculation, the costs rise to some 70 to 150 million euros per year.

4.2.6 Summary and conclusions

Pathogenic micro-organisms are primarily found in foods which enter the kitchen without having undergone a prior heating stage, and especially those of animal origin. Contamination is mainly introduced during primary production, but post-contamination and multiplication of pathogens during processing and preparation are also important. The pathogens which are transmitted in food can also take other routes, especially that of contact with other people or animals, or through the environment. Foreign travel also increases the risk. Accordingly, it is extremely difficult to determine the relative part played by food in comparison with other infection routes.

In most cases, foodborne infections and intoxications lead to gastroenteritis, although other more serious conditions and even death can result. Each year, there are 4.5 million episodes of gastroenteritis in the Netherlands, of which an estimated 300,000 to 750,000 cases are due to known pathogens in contaminated food. Approximately 25,000 cases lead to the patient seeking medical advice. There are between 20 and 200 deaths attributable to gastroenteritis each year. The disease burden due to known foodborne gastro-intestinal pathogens is 1,000 to 4,000 DALYs per year, being more than that attributable to tuberculosis and comparable to bacterial meningitis and bacterial STDs. The costs run into many tens of millions of euros each year. If a proportion of the episodes of gastroenteritis due to an unknown cause are assumed to be due to food, each of these figures increases by a factor of three approximately, whereupon the disease burden of foodborne infections and intoxications is roughly comparable to that of AIDS or infections of the upper respiratory tract.

Other serious diseases, of which 10 to 100 cases each year are attributed to contaminated food, include Guillain-Barré syndrome, Haemolytic Uraemic Syndrome, (congenital) toxoplasmosis and listeriosis. These diseases further contribute to the disease burden, although this contribution has been quantified only partly.

The main foodborne agents of gastroenteritis are *Campylobacter* spp., *Salmonella* spp., (toxins of) *Clostridium perfringens* and the noroviruses. Between them, these are responsible for almost half of all cases of gastroenteritis and the consequent deaths. The greatest health gain is therefore to be made by reducing the bacterial infection in food products of animal origin (Campylobacter, Salmonella, *Clostridium perfringens)* and by improving hygiene practices during food preparation (bacteria and noroviruses). Measures should therefore seek to reduce the levels of contamination in the product supplied to the consumer, and to ensure adequate hygiene during storage and preparation. The prevention of cross-contamination between food components and contamination by infected food-handlers is crucial. Although attention must in the first instance be focused on the pathogens listed above, an integrated food safety policy must consider all relevant pathogens in all products.

The safety of foods is based on process management according to the HACCP system (e.g. adequate heating and the prevention of post-contamination). HACCP systems are being developed to manage and control all relevant risks. The criteria relating to the microbiological safety of food must centre on the validation and verification of such systems. There are currently few standards for pathogens. Most current standards are concerned with inspection of the end product. They do not apply to unprocessed, raw foods and beverages, while it is known that these products are responsible for the greatest health loss. New developments in the international arena will give rise to more explicit ‘Food Safety Objectives’. These should be based on the policy objectives which set out the desired level of consumer protection.

The consumer forms the important final link in the chain. Good food-handling practices, including proper storage, heating and good hygiene in the kitchen, can substantially reduce the health risks. However, it is the manufacturer who is responsible for supplying safe food, and for ensuring effective hazard control during the production and processing stages. It is here that control measures will generally be more effective.

4.3 HARMFUL CHEMICAL CONSTITUENTS IN OUR FOOD

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4.3.1 Introduction

Our food can contain various chemical constituents which are harmful to health. Over the years, legislation has been developed in the Netherlands, and more particularly in the European Union, which has helped to eradicate these substances from food, or to reduce their level to one at which health risks are absent or considered negligible.

Nevertheless, various incidents which placed food safety at risk have occurred in recent years. In 1998, Brazilian citrus fruit pulp used in animal feed was found to contain high levels of dioxins. In 1999, chicken meat and eggs in Belgium were also found to contain high levels of dioxins and PCBs, and the toxic substance DON (deoxynivalenol), produced by fungi, was found in cereal products. In the same year shrimp catches were shown to be contaminated with antimicrobial substances such as chloramphenicol and furazolidone, while in 2002, palm oil and some vitamin preparations were found to be contaminated with PAHs (polycyclic aromatic hydrocarbons). In early 2002, it was found that potato products, particularly fried products, contain a relatively high level of the hazardous substance acrylamide. In the same year, the contamination of pig feed with the hormone medroxyprogesterone acetate (MPA) was discovered, caused by the use of contaminated molasses, and in 2003 the use of a new and illegal growth promoter (a boldenone derivative) was shown in beef cattle.

Each of these cases involved either an exceeding of existing safety standards or the discovery of new potential risks, although no actual adverse health effects were identified. The outcome of the 'Sterrenmix' affair of 2001 was very different. Dozens of people developed nausea and some suffered convulsions having drunk a herbal tea made from star anise. This was found to have been prepared using the Japanese strain of star anise which contains the nerve toxin anisatin, rather than the harmless Chinese strain usually used in the product.

The overall health impact of these incidents remained limited, thanks to rapid action on the part of government and the private sector, together with effective public information. However, public confidence in food safety was eroded. It is clear that ongoing attention must be devoted to chemical food safety. At the same time, we must ask where the main health risks lie, and hence what the priorities must be.

[#] With contributions by H.P. van Egmond, L.A. van Ginkel, H. van Loveren, M.N. Pieters, A.G.A.C. Knaap

In the following sections, we offer an overview of the various types of harmful chemical constituents (*section 4.3.2*), of the current legislation (*section 4.3.3*) and of the factors which influence chemical food quality (*section 4.3.4*). We then examine certain specific constituents, the control of which will enable substantial health gain to be made (*section 4.3.5*).

4.3.2 Harmful chemical constituents in food: a general overview

Chemical constituents which are potentially harmful to health can be classified into two main groups:

1. Substances which occur naturally in or on foods, such as:
   - Allergens.
   - Toxins produced by fungi (mycotoxins).
   - Shellfish toxins (phycotoxins).
   - Plant toxins (phytotoxins).
   - Nitrates.

2. Substances which do *not* occur naturally. These can be further subdivided into:
   - Those which are deliberately added to foods, such as preservatives, colourings and flavourings.
   - Those which result from deliberate human action, such as residues of pesticides or veterinary medicines.
   - Those which enter food unintentionally, such as process contaminants and environmental contaminants.

Appendices 9 and *10* include a summary of the main groups of chemical contaminants in both categories. The columns of the table show:
- The foods in which the substance is to be found, and its origin.
- The health effects of high or prolonged exposure to the substance.
- Whether any legislative standard for exposure or content level exists and, if so, whether this is based on any risk assessment.
- Whether there is indeed any exposure above the standard in practice, whether any health effect can be observed and, if so, to what extent.
- Whether exposure can be influenced or controlled.
- The information sources.

In this section, we examine a selection of these substances or groups of substances, being those subject to specific attention in relation to potential health effects.

a. Naturally occurring chemical substances

Allergens

The main allergenic foods are shellfish (shrimps, lobster, crab, mussels), eggs, fish, milk, peanuts, other nuts, soy, and wheat (gluten). In addition, there is a long list of food constituents which can give rise to incidental problems. Food allergies can result in a wide range of symptoms, including gastro-intestinal problems, skin conditions and respiratory difficulty, which can be life-threatening. The prevalence of food allergies in the general population is currently estimated to be 2%, the figure being three times higher (6%) among children. Contrary to popular belief, food components with a low molecular weight, such as colourings, do not cause food 'allergies', although they may be responsible for food 'intolerance' (see *textbox 4.10*).

The use of genetically modified crops forms a special case. Genetic modification may involve the addition of new proteins to the product concerned, and hence new sources of food allergy. This is an essential point for attention during the evaluation of such crops before being allowed onto the market, both today and in the future. For further details, please refer to *section 4.1 (textbox 4.1)*.

There are major differences between individuals with regard to food allergies. These differences are partly genetic. Furthermore, the developing immune system can be affected by immunologically active factors. The exact moment of the individual's first contact with food allergens can greatly influence whether he or she will develop a full-blown allergy. Accordingly, it is far from simple to establish any threshold values below which no effects will be seen. In the case of eggs, it has been reported that consumption corresponding with 10 to 190 mg ovalbumin can cause severe reactions in persons with an allergy requiring the administration of medication. Research into

Textbox 4.10: Food allergy and intolerance.

Allergenic substances represent a special category of potentially harmful food constituents, because the health risks attaching to these substances (primarily proteins) are restricted to persons who are oversensitive, i.e. 'allergic', to them. If the human body is exposed to 'foreign' proteins, this will generally result in a response by the immune system. In normal circumstances, there is no perceptible immune response to proteins in food, due to 'oral tolerance'. However, in some individuals, the ingestion of certain foods can lead to immunological reactions. We can then speak of a food 'allergy' (Taylor & Lehrer, 1996; Van Loveren, 2002).

There may also be other, non-immunological, reactions to food constituents. This phenomenon is known as food 'intolerance', the mechanisms of which vary and can be based on irritation, pharmacological action, the disruption of normal enzyme activity, or could even be psychosomatic. Sometimes, the symptoms of food intolerance are very similar to those of a 'real' allergy, but the responses are usually mild and are rarely life-threatening. The compounds responsible for food intolerance include colourings (tartrazine, azo-dyes), or substances such as benzoic acid and sulphur dioxide. The general public perception is that food allergies are extremely common. This is not strictly true, since some of the effects seen will be due to food intolerance.

allergies to cow's milk revealed responses following exposure in the range from 1 microgram to 6 grams of protein. One fatal incident has been reported involving exposure to 60 mg casein, a milk protein. The exact quantity of peanut allergen that is required to evoke a reaction in persons with a peanut allergy varies from 0.1 to 50 mg (Van Loveren, 2002).

Health gain can be achieved if persons who are over-sensitive to certain food constituents are able to effectively avoid exposure to those constituents. This requires good information and the effective labelling of food products.

Mycotoxins
In 1999, relatively high levels of deoxynivalenol (DON), a *Fusarium* mycotoxin of the trichothecene group, were found in wheat products. Policy measures and interventions on the part of the processing industry have since reduced the concentration of DON in these products considerably, whereupon human ingestion of DON has been cut by over half. A recent risk assessment showed that, based on the current estimated intake, 5% of 1-year-old children experience delayed growth of 9% or more (Pieters *et al*., 2001, 2002, 2004). Given the expected reversibility of this effect, we may conclude that the current exposure to DON is unlikely to cause any adverse health effects. Mycotoxins which are primarily found in corn play a part in the development of various veterinary diseases, such as 'hole-in-the-head syndrome' in horses and pulmonary oedema in pigs. In the Netherlands, the 99th percentile of average lifetime exposure to ochratoxin A, a substance which has attracted considerable attention due to its supposed genotoxicity, remains well under the provisional 'Tolerable Weekly Intake' (TWI) established by the WHO. Accordingly, we may conclude that there is no health risk (Bakker & Pieters, 2002). Levels of aflatoxin B1 in food products in the Netherlands are usually reasonably low. Analyses of the meals consumed in a day enables the average daily intake to be established at <0.03 ng/kg bodyweight per day (Sizoo & Van Egmond, 2004). According to the WHO's estimates of increased cancer risk (1998), this level would give rise to one additional case of cancer in the Netherlands every sixteen years.

Phycotoxins
'Paralytic Shellfish Poisoning' (PSP) toxins are regularly found in shellfish harvested from European coastal waters, but to date not in the Dutch coastal areas. Cases of 'Diarrheic Shellfish Poisoning' (DSP) have occurred a few times in Europe in recent decades, but again none have been reported in the Netherlands. However, DSP toxins have regularly been found in shellfish in Dutch coastal waters, leading to the temporary closure of the catchment areas in the Wadden Sea in 2002, and to other incidental measures. 'Amnesic Shellfish Poisoning' (ASP) toxins were first identified as recently as 1987, during an outbreak of food poisoning in Canada which involved 105 acute intoxications and three deaths. In recent years, the presence of ASP toxins has become a persistent problem in scallops from Scottish and Irish waters, and other regions. In 2002, the European Commission therefore introduced specific legislation and limits for this type of shellfish. Similar measures have been taken with regard to 'Azaspiracid

Shellfish Poisoning' (AZP) toxins, which in 1995 caused the illness of eight people in Ireland who had eaten mussels.

During the past decades there has been an increase in the number of incidents involving shellfish toxins, although it is not clear whether this is due to the increased attention for their effects (Van Apeldoorn *et al.,* 2004). Health gains can be achieved in this area through research into the pathogenic mechanisms of the toxins themselves, into the dynamics of algae growth, and the monitoring of all shellfish.

Phytotoxins
Food-poisoning by phytotoxins (e.g. through eating poisonous berries, toadstools and certain types of potato) has long been a familiar phenomenon but can also emerge quite suddenly, as in the 'Star anise' herbal tea incident of late 2001. Nevertheless, there is relatively little information regarding the presence of phytotoxins in foods or the significance of such presence. Similarly, there is little regulatory legislation. That which does exist is not based on firm scientific evidence (Speijers & Van Egmond, 1999).

The pyrrolizidine alkaloids form a large group of chemical substances. There are approximately two hundred different types or compounds which occur in many herbs, herbal preparations and teas. In high doses, several types have been shown to cause liver damage and liver tumours in test animals (Speijers & Van Egmond, 1999). Anisatin is a neurotoxic compound which was responsible for the 'Star anise' tea incident described above, involving a double-figure number of intoxications. The toxin, which was present in the tea due to confusion between different strains of anise, produced nausea, vomiting, lowered heart rate, fainting, convulsions and hallucinations in its victims (Johanns *et al*., 2002).

Nitrate/nitrosamines
Methemoglobinemia ('blue baby syndrome') caused by exposure to nitrite (derived from from nitrate) is a problem which continues to demand attention in view of the availability of nitrate-rich vegetables and the possible contamination of private drinking water sources. There is some evidence to suggest that this condition is more likely to occur if, in addition to the ingestion of high levels of nitrate, the subject has some physiological abnormality of the gastro-intestinal tract (WHO, 2002). There are no indications to suggest that methemoglobinemia occurs in Dutch children. Nevertheless, the national Nutrition Centre recommends that children younger than six months should not be fed (freshly prepared) nitrate-rich vegetables.

Nitrite, which is formed in the body from nitrate, can react with the amines in fish products to become nitrosamines (especially N-nitrosodimethylamine; NDMA). Zeilmaker *et al*. (2004) have estimated the exposure to NDMA resulting from simultaneous ingestion of nitrate-rich vegetables and fish. They did so using an *in vitro* model in which a nitrite solution was brought into contact with fish. Information derived from the model was then combined with that from the Food Consumption Survey (VCP-3).

However, the matrix effects relating to the vegetables and the effect of vitamin C, both of which could result in lower nitrosamine formation, were not taken into consideration in this study. Provisional experimental results indicate that, under conditions which more closely emulate the actual situation (the 'fish-plus-food' matrix), the formation of nitrosamines is approximately an order of magnitude lower than that estimated on the basis of fish and nitrite alone. Based on these results and an extremely conservative estimate of the elevated risk of cancer due to N-nitrosodimethylamine (NDMA), we may provisionally conclude that the average lifetime exposure to nitrosamines formed further to simultaneous exposure to nitrate-rich vegetables and amines in fish may lead to a number of additional cancer cases in the Netherlands, this number being in the order of a few tens to approximately 100 per year.

b. Non-naturally occurring chemical substances

Veterinary medicines

An important issue raised by *antibacterial agents* is that of resistance. Many of the antibiotics used in food-producing animals are also used in human medicine. The farm animals' long-term exposure to low concentrations of these antibiotics can result in the emergence of resistant bacterial strains which could also pose a risk to humans.

A special category is that of the *growth promoting substances* ('hormones'), which may be divided into naturally-occurring steroids (oestradiol, testosterone, progesterone) and the synthetic analogues of these substances (e.g. trenbolone, zeranol) or other substances which promote growth (such as the beta-agonists). The problems caused by the use of diethylstilbestrol (DES) in the early 1980s led to a complete ban on the use of growth-promoters in Europe from 1988 (EC, 1996). However, their use is still permitted in other meat-producing countries such as the United States, Australia and some countries in South America. Moreover, despite the ban, growth promoters are used in Europe to a substantial and increasing degree (Nielen *et al.*, 2003).

In general, the exogenous (and illegal) administration of natural hormones does not result in levels which are measurably higher than those found naturally, i.e. within the physiological range of the animals concerned (FAO, 2000). Although oestradiol is regarded as genotoxic, the WHO (2000b) assumes that any carcinogenic effect is probably due to its hormonal properties. Given that no significant additional intake has been established (compared to the normal intake of naturally-occurring oestradiol) it seems likely that exposure to illegally administered natural hormones does not pose a risk to the consumer. In the case of the non-naturally-occurring growth promoters, the situation is somewhat less clear. Little is known about the toxic properties of most of the synthetic analogues of steroid hormones which are used. However, an incident in Spain has shown that the consumption of liver derived from cattle to which the beta-agonist clenbuterol has been administered can produce acute symptoms such as cardiac arrythmia and neurological effects, which in some cases were serious enough to require hospital admission (Salleras *et al.*, 1995).

Process contaminants
During the (domestic) cooking process, and particularly the frying or barbecuing of meat and fish, a hard crust will form on the surface of the product. This crust consists of the products of the pyrolysis of the natural juices in the product, with a high content of amino acids, sugars and fats. Important constituents of this 'crust', which is often considered desirable in terms of flavour, are polycyclic aromatic hydrocarbons (PAHs) and heterocyclic amines, both of which have been shown to be toxic and carcinogenic in laboratory animals (Nagao & Sugimura, 2000). A conservative estimate has been made of the increased cancer risk posed by benzo(a)pyrene (B[a]P), one of the best known and most harmful PAHs, whereby lifelong intake of 5 ng/kg bodyweight per day is associated with a risk of $1{:}10^6$ (Kroese *et al*., 2001). Assuming that the carcinogenic potential of all PAHs in food is approximately ten times greater than that of B[a]P alone (SCF, 2002), we can calculate that an average exposure of the Dutch population equivalent to 80-210 ng per person per day will result in one or two additional cases of cancer each year.

The frying or baking of potato and flour products, whether in the industrial process or in the domestic situation, can result in the formation of small quantities of acrylamide on the product surface. This substance is known to be neurotoxic and is thought to be carcinogenic. In early 2002, Swedish researchers identified acrylamide in products such as potato crisps, chips and biscuits, findings which were later confirmed worldwide. In the Dutch situation, estimated exposure rates and information regarding cancer risks have been used to calculate that the presence of acrylamide in food products may lead to between 75 and 130 additional cases of cancer per year (RIVM/RIKILT, 2002; Konings *et al*., 2003).

Environmental contaminants: heavy metals
In the Netherlands, environmental legislation and other measures have resulted in a marked reduction in the levels of heavy metals in the environment in recent years. However, there may still be some minor health impact in a few cases. Lead inhibits the biosynthesis of haemoglobin and is neurotoxic, particularly in children, as has been demonstrated by extensive epidemiological research conducted in the past (IPCS, 1995). The main source of lead is currently the lead water pipes still present in some older houses (particularly in the historic city centres). Under the terms of the Water Supply and Transport Directive of 9 January 2001, the standard for lead in drinking water (measured 'at the tap') is to be reduced from 25 micrograms per litre to 10 micrograms per litre, with effect from 1 January 2006. This means that all lead water pipes must be replaced before that date. The average background exposure of the population to lead, and hence the blood lead level, will then fall to well below the internationally agreed threshold limit value, under which no neurological effects will occur.

Organic mercury is neurotoxic and is harmful to the foetus (ATSDR, 1999). In the 1970s, high levels of organic mercury in fish caused a severe outbreak of acute illness in Minamata, Japan. Levels of mercury in fish have shown a downwards trend for some years, due to the international measures taken to reduce mercury emissions. Recently, the European Food Safety Authority published a report on methyl mercury (EFSA, 2004), which concludes that in the Netherlands, the average intake of methyl mercury in fish is well below the revised 'Provisional Tolerable Weekly Intake' (PTWI) published by the WHO in 2003, of 1.6 μg/kg bodyweight per day. This is due to the relatively low consumption of fish in the Netherlands, and to the fact that the type of fish in which relatively high concentrations of methyl mercury are found – such as tuna and swordfish – is not eaten in great quantities.

Environmental contaminants: dioxins and related compounds
'Dioxins' is the collective name for chlorinated dibenzo-p-dioxins (PCDDs) and chlorinated dibenzofuranes (PCDFs). The term is also often used to include the dioxin-like polychlorinated biphenyls (PCBs). These substances enter the environment by a number of routes, such as processes of combustion. They then enter food products via the raw materials used in the food and animal feed industries, particularly animal oils and fats. Dioxins are extremely persistent and accumulate in fatty tissue. Even extremely low concentrations have been shown to damage the immune system and fertility of laboratory animals; they impair the development of the nervous system and are (non-genotoxically) carcinogenic.

Dioxin levels are generally expressed as toxicity equivalents (TEQs), based on the most toxic compound of the dioxin group, i.e. 2,3,7,8-TCDD. In May 2001, the European Commission's Scientific Committee on Food (SCF) advised that the maximum tolerable intake of dioxins should be set at 2 pg TEQ per kg bodyweight per day expressed as 'WHO-TEQ'. In its 'Opinion' the SCF stated that, in view of the long half-life of these substances, it preferred not to express the maximum tolerable intake as a daily average, but as a weekly average of 14 pg WHO-TEQ per kg bodyweight (SCF, 2001). Given the accumulation of dioxins in fatty tissue, the weekly value must be seen as the average maximum tolerable intake per week during a person's entire lifetime, whereby a higher level of intake, provided it is incidental and short-term, is unlikely to have any adverse health effect (SCF, 2001).

Exposure to dioxins and the dioxin-like PCBs in food will occur primarily through animal products such as dairy products, meat and fish (see also *chapter 7, section 7.2*). In recent years, a considerable reduction in exposure through these products has been achieved (see *figure 4.4*). Nevertheless, it has recently been shown (by Freijer *et al.*, 2001; Baars *et al.*, 2004) that approximately 8% of the Dutch population continue to exceed the tolerable weekly intake of dioxins, as established by the SCF and the WHO (SCF, 2001; WHO, 2002) by a factor of three to four maximal, with less than 1% having an intake of more than three times the TWI. Because a considerable safety margin has been taken into account in establishing the Tolerable Weekly Intake, it is unlikely that this section of the population faces any additional health risk.

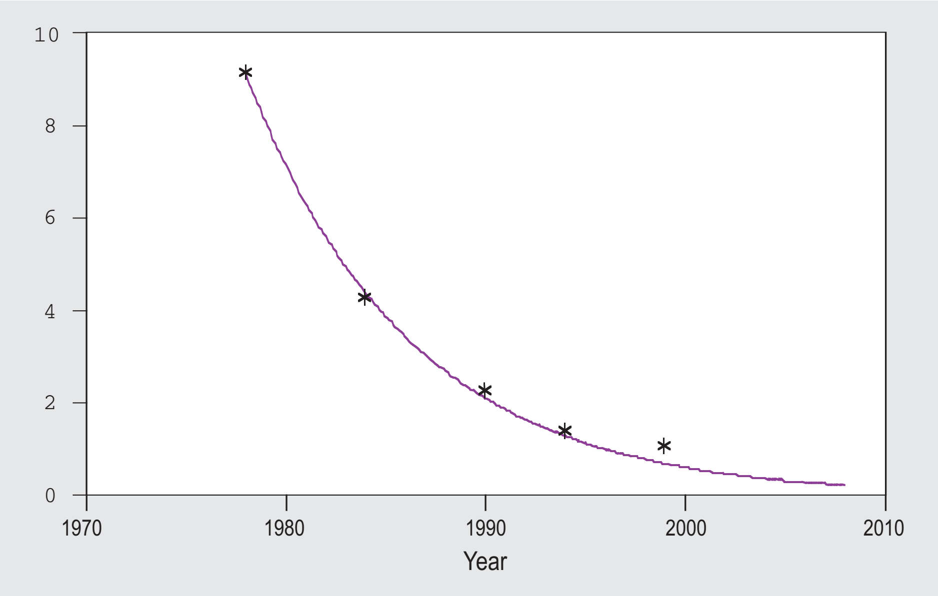

Figure 4.4: Reduction in the Dutch population's exposure to dioxins and dioxin-like PCBs in food, expressed in pg WHO-TEQ/kg bodyweight/day (Zeilmaker et al., 2002).

A special consideration is the presence of dioxins in human milk, which may pose a threat to babies being breastfed. There are indications that infants exposed to relatively high concentrations of dioxins and PCBs in human milk tend to score worse in tests of neurological and cognitive development than those with lesser or no exposure. However, it should be noted that breastfed children still score better than those who are bottle-fed (Koopman-Esseboom, 1995; Vreugdenhil, 2003; see also *chapter 7, section 7.2*).

The presence of dioxins and related compounds in human milk (due to the accumulation in fatty tissue) offers a suitable method of measuring women's body load of these substances. Further to the reduction in exposure via food, the concentrations of dioxins and PCBs in human milk have fallen by approximately 50% over the past ten to fifteen years (Zeilmaker *et al.*, 2002).

4.3.3 Risk assessment, admission policy and setting standards

The majority of the substances and groups of substances discussed in this chapter and in *appendices 9* and *10* are subject to legislative standards. In most cases, the standards are derived on the basis of scientific risk assessments. This section examines the assessment process in more detail.

Risk assessment

The process of assessing the risk posed by a particular substance involves four stages:

1. Identification of the hazard.
2. Characterization of the hazard.
3. Assessment of exposure.
4. Characterization of the risk.

Sub 1. In the first of these phases, the harmful properties of the substance are identified, based on toxicological information. In the ideal situation, the results of studies involving human subjects are used. However, in practice such results are rarely available and, even where they are available, will often relate to the acute hazards rather than those which could emerge after long-term, regular (daily) intake. In the vast majority of cases, the toxic properties of a substance are therefore established using laboratory animals.

Sub 2. In the second phase, that of defining the hazard, the toxic properties of the substance are further characterized. In line with the adage coined by Paracelsus (1493-1541): 'All substances are poisons; there is none which is not a poison. The right dose differentiates a poison from a remedy, the approach involves quantifying the hazard (or hazards) of human exposure to the substance concerned wherever possible. Necessarily, this will also involve animal tests, for such purposes as establishing the dose-effect relationship for a specific toxic effect, and studying what happens to the substance in the body. Based on this information, it is then possible to establish the quantity of the substance that can be ingested daily during an individual's lifetime with no adverse health effects: the ADI – 'acceptable daily intake', or the TDI – 'tolerable daily intake'. Unlike the ADI, the TDI is used for contaminants, since the word 'acceptable' is considered inappropriate for substances which are not deliberately added to foods. In both cases, however, the procedure is identical in that it looks at the total intake of the substance in question, regardless of the product in which the substance is to be found (Janssen & Speijers, 1997; Benford, 2000).

Sub 3. The third phase is that of establishing human exposure to the substance as accurately as possible, based on data concerning the levels of the substance to be found in certain foods and statistics relating to the consumption of those foods. In addition, the contribution of other possible sources is also taken into consideration. Accurate information about the consumption of certain foods, and especially the distribution of consumption among the various population groups, is essential. Based on this information, any exceptionally sensitive or vulnerable groups (such as the children or the elderly) can also be identified. In determining exposure via food, the national Food Consumption Survey is an indispensable instrument.

Sub 4. Once the exposure of the population (or sections thereof) has been adequately established, the fourth phase – characterizing and evaluating the risks of that exposure – can be undertaken. This involves comparing the exposure and its distribution to the established threshold limit value of safe intake (ADI or TDI). Where necessary (and possible) the results can be differentiated according to the various risk groups.

Admission policy

Based on these risk assessments, the responsible authorities will take measures whereby the risks posed by the presence of the substance in food can be rendered controllable. This is the focus of the 'admission policy', which applies to all substances which are deliberately added to food products or are used during the production process. Increasingly, the form and content of the admission policy are determined at European level. In practice, it will be possible to ban the use of a certain substance (such as illegal growth promoters in cattle), or to establish upper limits for the maximum permissible level of the substance in or on various foods and food products (product standards). In most cases, control systems will be linked to such measures (Benford, 2001).

Establishing the ADI and TDI intake standards

As described above under sub 2, the ADI or TDI for a particular substance is derived from the dose-effect relationship of that substance: at what dosage does a certain effect appear? In practice, the dose at which no adverse effect is caused will be sought: the so-called 'No Observed Adverse Effect Level' (NOAEL). This threshold value is the starting point from which the ADI or TDI for that substance are derived. Because the NOAEL is usually established by means of tests on laboratory animals, and it remains uncertain how the results of such tests translate in terms of human exposure, so-called uncertainty factors are used when establishing the intake standards for humans. These factors take into account the seriousness of the effect, and whether any particular groups are at higher risk than others. Over the years, considerable international consensus has been reached with regard to the establishment of intake standards. The Scientific Panels of the EFSA (European Food Safety Authority) and formerly the Scientific Committee on Food (SCF) provide advice about intake standards on a European level. These intake standards serve as the basis for the product standards set by the European Commission (see below). The *Codex Alimentarius* Commission is a global organization which makes recommendations with regard to both intake standards and product standards. The scientific basis of the *Codex* is provided by various expert committees, including the Joint WHO/FAO Expert Committee on Pesticide Residues (JMPR) and the Joint WHO/FAO Expert Committee on Food Additives and Contaminants (JECFA).

The 'threshold value' approach is not used in the case of genotoxic carcinogens. This is because, in theory, just one molecule of these substances can damage DNA to such an extent as to cause uncontrolled cell growth, resulting in the development of a tumour. Based on this hypothesis (which is however not universally supported), there is therefore no dose for genotoxic carcinogens at which no effect can be observed, whereupon the threshold value approach is inapplicable. Accordingly, the 'Virtually Safe Dose' (VSD) concept has been adopted for these substances, being the dose at which the incidence of cancer remains restricted to a level which is generally considered to be acceptable. The Dutch government has defined the Virtually Safe Dose as the dose at which the lifelong exposure of 10^6 persons would lead to one additional case of cancer (the $1:10^6$ lifelong additional risk norm; VROM, 1989). In the Netherlands, the VSD is calculated using a linear extrapolation model, the input for which are the results of carcinogenicity studies on laboratory animals, with the substance concerned being administered at varying doses throughout their entire lifetime (Janssen & Speijers, 1997).

From intake standard to product standard
A product standard indicates the maximum quantity of a substance (residues of pesticides or veterinary medicines, food additives, contaminants, etc.) which is permitted to be present in a certain food or food product. The product standards are based on intake standards (ADI of TDI) alongside such considerations as:

- The average consumption of the product in question.
- Extremes in the consumption of the product (there may be ‘devotees’ whose consumption far exceeds the average).
- Vulnerable groups.
- The presence of the substance in other products, i.e. the distribution of the intake standard between various food products.

A number of technical and social considerations must also be taken into account when establishing the product standards, such as:

- Controllability and enforcement opportunity for the set product standard.
- Good agricultural/veterinary/industrial business practice.
- Culture, eating habits, traditional foods (ingredients).
- Cost-effectiveness and advantages (the ‘cost-benefit’ ratio).
- Economic interests: the situation in the EU and neighbouring countries, important trading partners.
- Consumer risk perception.

In some cases, the product standard may represent a level of protection which is more stringent or more lenient than that of the intake standard due to these practical considerations, the difference being considered acceptable and/or unavoidable in terms of policy. Clearly, product standards play an important part in (international) trade. Indeed, the *Codex Alimentarius* has a major influence on the activities of the World Trade Organization (Codex Alimentarius, 2003).

The development of standards over time
Knowledge of the harmful effects of substances will increase over time, whereupon it becomes appropriate to modify those standards. For example, the standards for mercury have now been divided into two categories: inorganic mercury for which relatively high intake standards now apply, and the far more toxic organic mercury, which is subject to a much lower intake standard. Similarly, as knowledge of the toxicological effects of dioxins increased, the intake standards were adjusted accordingly, along with the product standards which are based not only on the intake standards, but also on the consumption patterns that are subject to change over time too.

Another example is the artificial sweeteners used in many so-called ‘light’ products, especially soft drinks. As consumption of these products increases (i.e. by children), sooner or later a consumption level will be reached at which the ADI is exceeded. In this eventuality, the product standard must be lowered accordingly.

When standards are exceeded
Intake standards (ADI, TDI) are threshold limit values and are defined as the maximum quantity of a particular substance (expressed in micrograms (µg) or milligrams (mg) per kg bodyweight per day) that a person may ingest daily during the whole of his or her live without experiencing any adverse health effects. In the case of substances which have a harmful effect only after prolonged exposure, and for which the intake standard is derived from the most sensitive effect after long-term administration, a short-term and relatively minor exceedance of the intake standard will have no immediate adverse effects. Dioxins form a good example, being extremely persistent in the body and having effects which become manifest only once a certain body burden has reached. However, there are also substances whose adverse effects are apparent after single or short-term exposure. Examples include cyanide and some phycotoxins (see *appendix 9*). Exceeding the standard for this type of substance can therefore have an adverse health effect. In general, it is desirable to make an assessment of the possible risks of every instance of intake in excess of the standard. In practice however, given the above-mentioned considerations regarding the chronic and acute effects, it will be necessary to assess on a case-by-case basis whether a specific excessive intake can actually lead to adverse effects and, if so, whether measures are required to mitigate or obviate those effects.

The process of deriving product standards from intake standards is usually based on ‘worst case scenarios’ (overestimation) with regard to assumptions about dietary pattern and about the level that, as a result of using the substance, can occur in the product concerned. By doing so, in effect, an additional safety margin is incorporated. This also means that in, most cases, a short-term exceedance of the product standard will not result in any adverse health effects. However, the fact that standards are being exceeded is an indication that something has gone wrong in the production chain, and that appropriate measures should be taken.

4.3.4 Factors which influence chemical food quality

Production/import/processing/distribution

Column 5 of the tables presented in *appendices 9* and *10* shows how the chemical food quality for each type of substance can be maintained, and where responsibility for doing so lies (see also *chapter 5*). In general, primary responsibility for the quality of agricultural products (arable or livestock) rests with the individual manufacturer or farmer. In addition, the food industry bears considerable responsibility with regard to monitoring the levels of health-threatening substances in products of animal or vegetable origin, regardless of whether those substances occur naturally or not. This is, of course, also true of imported products, for which an effective 'tracking and tracing' system is essential in order to determine the source of any potential problem. A constant concern for quality, with continuous quality management throughout the food manufacturing chain ("from farm to fork") is therefore absolutely indispensable. Fortunately, we may state that, partly due to the application of the various hygiene codes (GAP, GVP, GMP and HACCP[1], the various parties in the food manufacturing chain are fully aware of their responsibilities. In recent years, they have implemented self-regulation systems and measures in order to provide the highest possible assurance of food safety. (For further details, please refer to the websites of the various Product Boards.)

In practice, the various actors will fulfil their quality control responsibilities in different ways. The farmer, for example, must ensure correct usage of pesticides. A thorough inspection of raw materials by importers and processors can prevent contamination with substances such as DON, dioxins or PAHs. The reduction or elimination of process contaminants such as acrylamide is primarily the responsibility of the food-processing industry.

Regulation and enforcement

In a complex society such as that of the Netherlands, in which food manufacturing is almost entirely anonymous, it would be foolish to believe that all actors involved in food manufacturing will comply with all rules at all times. Moreover, it is inevitable that less scrupulous people will occasionally seize the opportunity to pass on raw materials, 'semi-finished' products or foods without worrying unduly about the possible adverse health effects of contamination. It therefore remains essential to maintain close supervision of the entire food production chain.

The central government is responsible for passing the necessary laws and regulations, and is also responsible for ensuring compliance with that legislation. Given the huge number of foods and food products that are imported, produced and consumed in the Netherlands every day, it is physically, logistically and economically impossible for the regulatory authorities to inspect every single product. They must confine themselves

1 GMP/GAP/GVP: Good Manufacturing/Agricultural/Veterinary Practice
HACCP: Hazard Analysis Critical Control Points

to taking random samples. Moreover, most foods are perishable: they have a limited shelf life. Many chemical analyses require a certain amount of time to complete, whereupon the results often will become available only after the batch of food concerned has been distributed or – worse still – consumed.

The government has delegated responsibility for inspection and enforcement to the Food and Consumer Product Safety Authority (VWA). At the level of primary production, the General Inspectorate (AID) of the Ministry of Agriculture, Nature and Food Quality also has an important part to play (see *chapter 5*).

The consumer
In addition to the clear responsibility borne by the food manufacturer (in the broadest sense of the term) with regard to the quality and safety of the products supplied, the consumer also has a clear responsibility in terms of responsible food handling, storage and preparation practice. Education and upbringing are important in this regard. Apart from observing necessary (and largely self-evident) hygiene precautions (see also *section 4.2*), the consumer should be aware of various food-related facts. For example, it is not sensible to eat any green parts of a potato, because this indicates the presence of the toxin solanine. Similarly, consumers should be aware that barbecuing meat or fish introduces a far greater number of potentially harmful substances (such as PAHs and other products of combustion) than any veterinary medicines administered during the production phase.

An additional complication of calling the 'consumer' to account for food safety is the way in which the cultural and demographic make-up of the Netherlands is changing due to the influx of ethnic groups. Some groups have different eating habits and demand products other than those traditionally available on the Dutch market.

4.3.5 The main chemical substances in food in terms of potential health gain

Section 4.3.2 presents an overview of the wide range of substances, of extremely diverse origins, which can occur in food and which have a potential adverse health effect. *Sections 4.3.3* and *4.3.4* describe the Dutch system of admission, setting standards and inspection which, in principle, offers a high degree of protection against exposure to such harmful substances in food. In this section, we address the question of whether there are certain groups of substances which demand extra attention in view of a disproportionately high level of risk. The assumed risk is based on actual health effects observed in the past, or on levels of exposure which are so high as to make such effects 'not improbable'.

In order to render the wide range of possible effects more manageable, we distinguish between: (1) acute effects, (2) carcinogenic effects, (3) other chronic effects and (4) allergenic effects. *Acute effects* are relatively easy to recognize, particularly where they are specific or where an incident of group exposure is involved. The *carcinogenic effects* can rarely be traced back to a single source, although in some cases it is theoretically possible to calculate an effect. The *other chronic effects* are also difficult to attribute to a particular source, but in theory will only emerge after considerable, long-term exposure in excess of the established standards. *Allergenic effects* can usually be traced to a source, which will often be a common food. Here, the effects vary between individuals far more than in the other three types. The remedy is therefore for the person concerned to avoid the food in question.

When the stated criteria – 'actual health effects' and 'not improbable health effects' – are applied to the substances listed in *section 4.3.2* and the effects are then classified according to the four categories mentioned above, we arrive at *table 4.8*. Health effects observed in an industrialized country other than the Netherlands have also been included in this overview.

In a number of cases, the table also presents an estimate of the potential health gain which could be achieved if exposure were to be reduced to zero. This health gain is expressed in DALYs (Disability Adjusted Life Years) so that the various types of health effect (disease, intoxication, death) can be grouped together and compared. (For a full description of the DALY concept and the calculation method used, please refer to *appendix 12*.)

Table 4.8: Substances and groups of substances presenting additional risks: type of effect(s) and potential health gain through avoidance of exposure.

Group of substances	Type of effect				DALYs to be gained
	Acute	Carcinogenic	Chronic other	Allergenic	Designated as order of magnitude due to the uncertainty
Various proteins in foods				Shellfish, fish, milk, nuts, wheat.	Ca. 1,000
Mycotoxins		Aflatoxins			Aflatoxin B1< 1
Phycotoxins	DSP, ASP				Ca. 10-70
Phytotoxins	Anisatin				< 1
Nitrate/nitrite		Nitrosamines			Nitrosamines Ca. 100-500
Growth promoters	Clenbuterol				Ca. 1
Process contaminants		PAHs, Acrylamide			PAHs 5-10; Acrylamide 300-700

Textbox 4.11 describes how DALYs are calculated for the main substances and groups of substances. However, in most cases, it is not possible to give more than a very approximate estimate of the number of deaths and disability years for which these substances account. Weighing factors rely on analogy with conditions with a broadly

comparable profile in terms of seriousness and duration. Accordingly, the figures should be seen as 'order of magnitude' estimates and are presented as such. Nevertheless, it thus becomes possible to compare the effects of various substances, the results of such a comparison being presented in *table 4.8*.

Textbox 4.11: Calculation of DALYs shown in table 4.8.

Allergenic substances

- 2% of the (adult) Dutch population suffer from some form of food allergy. Let us suppose that 10% are unaware of the cause, cannot therefore avoid it, and have more or less permanent symptoms of illness. This gives the total of 32,000 disability years (0.2% of 16 million). The chosen weighing factor is 0.03 (for light-to-moderate asthma). The health loss is therefore 0.03 x 32,000 = approx. 1,000 DALYs.

Mycotoxins

- DON: In 2004, it was calculated that 95% of one-year-old children may have suffered a (temporary) growth retardation of <9%. Ten percent is regarded as being on the critical limit. Fewer than 5% could therefore be above that limit. The effect is small, and cannot be quantified in DALYs using the current method.
- Aflatoxin B_1: The average daily intake of aflatoxin B_1 in the Netherlands is approximately 0.03 ng/kg bodyweight per day. In theory, this will result in one additional case of cancer every sixteen years. Assuming premature death representing an average loss of five life-years, this is the equivalent of approximately 0.3 DALYs.

Phycotoxins

- The ASP incident in Canada has been taken as the reference. There were three deaths representing, say, an average loss of twenty life-years = 60 DALYs. There were 105 acute intoxications. Given serious but temporary effects (comparable to a serious transitory disease such as pneumonia), we can apply a weighing factor of 0.1 to the year profile. This gives a health loss of 0.1 x 105 = 10.5 DALYs.

Phytotoxins

- The 'Star anise' herbal tea incident has been taken as the reference. There were no fatalities. Assuming 30 intoxications and a weighing factor of 0.01 (comparable to one episode of influenza within one year), the health loss is then 0.01 x 30 = 0.3 DALYs.

Nitrate/nitrite

- Nitrosamines: Based on conservative estimates, combined exposure to vegetables which are rich in nitrates and fish can result in tens to approximately one hundred additional cancer cases per year. Assuming premature death with an average loss of 5 life-years, the resultant health loss is approximately 100 to 500 DALYs.

Growth promoters

- The clenbuterol incident has been taken as the reference. There were no deaths, but there were a number of hospital admissions due to cardiac arrhythmia and neurological symptoms. Assuming ten cases and a weighing factor of 0.1 (comparable to a serious transitory disease such as pneumonia) the health loss then becomes 0.1 x 10 = 1 DALY.

Process contaminants

- Acrylamide. Based on extrapolations from animal experiments, the current exposure level in the Netherlands may lead to an additional 75-130 cancer cases each year. Assuming that each case will result in premature death and an average loss of five life-years, the health loss can be calculated as 375-650 DALYs.
- PAHs. Based on animal experiments to establish the increased cancer risk posed by benzo(a)pyrene, the current oral exposure to PAHs in the Netherlands could account for one or two cases of cancer per year. Applying the same criteria as for acrylamide (above), this represents a health loss of 5-10 DALYs.

Other environmental contaminants

- 8% of the Dutch population exceed the intake standards for dioxins and dioxin-like PCBs, as set by the EU and the WHO. No health effects are to be expected.
- 5% of the Dutch population are exposed to non-dioxin-like PCBs (indicator PCBs) at levels which may cause health effects (immunological effects) in the long term. However, there is currently insufficient information to allow any further quantification.

In terms of DALYs, the allergenic substances and some of the carcinogenic substances, such as acrylamide and the nitrosamines, stand out. In the case of acrylamide and nitrosamines, however, only premature deaths have been calculated. The other disability factors have been disregarded, being deemed to be of far lesser significance. The estimates relating to these carcinogens are extremely approximate and may be too high, since they have been extrapolated from the results of animal experiments based on conservative hypotheses. Moreover, as previously noted, there is no accurate data regarding the possible mitigating effect of diet and vitamin C on nitrosamine formation.

De Hollander *et al.* (1999) calculate the health loss in terms of neurocognitive development deficit caused by lead in drinking water to be 7950 DALYs (5th-95th percentile 1,000 – 19,000) based on the situation in 1990. At the time, this estimate was regarded as particularly high, while the replacement of lead water pipes in old town centres will serve to reduce the figure yet further. Given the current uncertainties surrounding this estimate and the prospect of all health effects being obviated from January 2006, lead has not been included in *table 4.8*.

In order to place the estimated DALYs in perspective, we present the figures calculated for several diseases in the Netherlands. According to the most recent estimates (for 2000, published in Van Oers, 2002) the list is led by coronary heart disease at approximately 350,000 DALYs. Other conditions causing health loss include rheumatoid arthritis (approx. 70,000 DALYs), schizophrenia (approx. 20,000 DALYs) and urinary tract infections (approx. 10,000 DALYs).

What interventions will result in health gain?

In the foregoing sections, we have attempted to give an approximate estimate of the possible health loss caused by substances which occur in food, expressed in DALYs. The health loss due to incidental episodes of contamination with phycotoxins and phytotoxins may seem negligible, but is based on actual observations in humans. The calculated health loss due to carcinogenic substances is greater (a few hundred to approximately one thousand DALYs), but so is the degree of uncertainty surrounding these figures. The highest number of DALYs attributable to effects which have actually been observed in humans (approximately 1,000) is accounted for by the allergenic food constituents.

The health loss is, by definition, also the health gain that can be achieved if adequate measures are implemented. What are those measures?

Acute effects:

- Continuous monitoring of the levels of known contaminants (such as phycotoxins) in products.
- Research into unknown substances and the illegal use of known substances such as growth promoters.
- Alertness with regard to clustered intoxications.
- Information and education of the medical profession and the public.

Carcinogenic effects:
- Continuous monitoring of the levels of known contaminants (such as mycotoxins, PAHs, acrylamide) in products.
- Greatest possible reduction in the levels of these substances.
- Monitoring of preparation processes in both domestic and commercial settings (acrylamide, PAHs).

Other chronic effects:
- Continuous monitoring of the levels of known contaminants (such as mycotoxins, PAHs, acrylamide) in products.

Allergenic substances:
- Alertness on the part of the medical profession and the individual consumer.
- Information and education of the medical profession and the public.

It is clear that effective enforcement and the prompt identification of problems will be the key to minimizing the health loss due to the presence of chemical contaminants in food. Responsibility in this regard rests with the government and the food producer. The fact that the calculated health loss shown above is not much higher indicates that current enforcement practice is reasonably effective. At the same time, we know that various uncertainties exist. Little is known about various (new) substances such as brominated flame retardants. Moreover, it is usually difficult to establish any clear connection between the less specific chronic effects and substances in food.

4.3.6 Summary and conclusions

The Dutch government has already implemented an effective set of measures to ensure that no hazardous concentrations of substances can occur in food products. The system includes a) prior evaluation to ascertain whether a substance should be allowed ('admitted') onto the market (particularly relevant for food additives, pesticides and veterinary medicines), b) standard setting which establishes the maximum quantity of a substance allowed in foods (usually calculated on the basis of risk assessment), and c) inspection and enforcement activities. Moreover, the *producer* must control raw materials and processes to ensure that no inadmissible levels of contaminants occur in food products. The *consumer* is able to avoid the consumption of hazardous substances by making careful choices and by applying correct food-handling practices.

As far as can be established, the current system of admission, setting standards and inspection has resulted in health risks due to chemical substances in food in the Netherlands being no more than a marginal consideration. Given the sheer number of potential contaminants and the diversity of the possible effects, the situation could have been very different without the policy now in place.

Nevertheless, there remain a number of points for attention with regard to chemical food safety. In terms of potential health risk, and hence also the possibility of achiev-

ing health gain, the main substances and groups of substances are:
- Certain mycotoxins in cereal crops, phytotoxins in herbal preparations, phycotoxins in shellfish and some growth promoters. These will generally account for acute effects. The possible health gain is in the order of 10-70 DALYs.
- Substances such as nitrosamines (formed from nitrate/nitrite and amines in fish), some mycotoxins on plant-based products, and some process contaminants (PAHs and acrylamide), for which the potential health gain is between a few hundred and approximately 1,000 DALYs.
- Allergenic substances, particularly in foods such as shellfish, fish, nuts, milk and wheat. The possible health gain with regard to these substances is estimated to be approximately 1,000 DALYs.

In order to maintain safety with regard to chemical substances in food and to achieve future health gain, a number of actions must be taken:
- Maintain the current system of admission, setting standards and inspection, making further improvements where necessary. Extra attention should be devoted to substances with a particularly small margin between exposure and actual effects. This is important in view of the globalization of world trade, which makes the situation even more delicate.
- Continue research into hitherto unknown substances and into improved risk assessment methods (particularly the use of the ‘Benchmark’ approach and probabilistic exposure and effect estimation).
- Improve the dissemination of information about potentially hazardous food constituents, food allergies and intolerance, and about proper domestic food preparation methods.

4.4 FOOD SAFETY IN PERSPECTIVE

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Shifts in focus

Public and political attitudes to food safety have been somewhat variable in recent decades. This is particularly true with regard to chemical food safety. In the 1970s and 1980s, for example, there was a certain ‘chemophobia’, largely caused by improved technology which enabled us to detect even very low levels of various hazardous substances in our everyday environment. Especially, the presence of carcinogenic substances caused considerable commotion. It was later established that such hazardous substances could also occur in the food we eat, perhaps further to the contamination of raw materials, the production process or the environment. It became necessary to set up an effective system of monitoring and control to ensure chemical food safety, and to reassure the public that the government was indeed taking steps to do so.

[#] With contributions by F. van Knapen, M.P.G. Koopmans and J.H.J. Reimerink

In the late 1980s and early 1990s, concern for chemical food safety seemed to decline as the media and the general public shifted their focus to various foods which were purported to be beneficial for health. This development also permeated politics and public health policy for a long time. However, the series of food-related incidents and crises which occurred over the past five years, served to return chemical food safety to a prominent place on the agenda. The result was a general feeling of insecurity on the part of the consumer, who lost confidence in the food industry and in the government's effectiveness as the guardian of food safety. This was one of the factors which prompted the foundation of the Netherlands Food and Consumer Product Safety Authority (VWA), following the establishment of the European Food Safety Authority (EFSA).

It is interesting to note that (micro-)biological food safety considerations seem to have attracted rather less public attention (with a few exceptions such as BSE). Although Dutch government policy recognizes microbial food infections as a persistent, recurrent and serious problem, the public does not appear unduly concerned. This comparative indifference is not justified by the figures expressing the resultant health loss, as presented in this chapter. It is clear that consumer risk perception is an important factor here. The realistic threat of a food infection today is, apparently, regarded as less serious than the theoretical risk of cancer at some point in the distant future. The rationale and mechanisms underpinning this perception are explained in *chapter 8*. If the consumer's attention is to be drawn to microbial food infections, the risks they present and – in particular – what the consumer can do to avoid those risks, the government must devote due attention to these aspects in its public communication.

Is our food now safer than ever before?

Experts frequently state that our food is indeed safer now in 2004 than at any time in the past. However, we must ask whether this assertion is supported by the facts presented in this chapter. A summary of the current situation with regard to microbiological food safety is given in *section 4.2*, while *section 4.3* presents that for chemical food safety. In each case, we have attempted to quantify the actual health loss (or the potential health gain) as accurately as possible. The combined disease burden and mortality are expressed in DALYs per annum, thus rendering the outcomes comparable with each other or with the health loss attributable to other diseases.

The overall annual health loss attributable to microbiological food infections involving known gastro-intestinal pathogens is in the order of 1,000 to 4,000 DALYs. Compared to other infectious diseases, microbiological food infections are therefore in seventh place on the list of the causes of health loss in the Netherlands, between AIDS and bacterial meningitis (see *table 4.5*). If we also include the unknown gastro-intestinal pathogens and the non-enteric pathogens, the health loss is approximately three times greater, at 3,000 to 10,000 DALYs. The 'ranking' is then fifth place, comparable to infections of the upper respiratory tract. Chemical food contamination accounts for an estimated health loss of approximately 2,000 DALYs per year (see *table 4.8*). The total estimated health loss for both types of food contamination is therefore of the same order of magnitude, and therefore more or less comparable. However, a number of reservations apply, as mentioned below.

An important difference between the information relating to microbiological food safety and that concerning chemical food safety is the degree of uncertainty involved. The 'uncertainty factor' applies to both the manifestation of actual health effects (disease, death) and the reliability of the calculations. In the case of microbial food infections, the health effects are usually acute and their cause is readily identifiable by means of clinical tests. Moreover, the effects are an integral feature of the general population, and are not isolated incidents. Here the uncertainties are mainly those of the food-attributable fraction, the degree of under-reporting (not all persons affected will seek medical attention) and the contribution of as yet unknown foodborne pathogens to the 4.5 million episodes of gastroenteritis occurring each year in the Netherlands. The calculation of the health loss is therefore based on limited microbiological information, whereby it is likely to be an underestimate.

In the case of chemical food safety, the situation is clearly very different. Firstly, the association between clinically observable health effects and the consumption of contaminated food is often far more difficult, or even impossible, to ascertain. In fact, it has only been demonstrated for a limited number of substances which are known to cause acute effects, such as the allergens occurring in food (which are estimated to account for health loss of approximately 1,000 DALYs), some naturally-occurring toxins and residues of certain veterinary medicines (fewer than 100 DALYs combined). Of these, only exposure to food allergens is a persistent and perhaps growing problem in the population, while extreme exposure to other substances causing acute effects is likely to be short-term and incidental, usually resulting from standards having been exceeded (whether accidentally or deliberately) or to unusual climatic conditions.

No actual effects have been measured for the remaining chemical substances listed in *table 4.8* in terms of food contamination, but there is a theoretical risk. In most cases the risks are long-term, such as an elevated likelihood of developing cancer or other chronic conditions. Although the estimated theoretical health loss is again approximately 1,000 DALYs, (total 400-1,200 DALYs), the uncertainty surrounding the degree of exposure and the dosage-effect calculation is usually very high. With the exception of the consumption of nitrate-rich leafy vegetables and fish, exposure mainly involves food incidents in which the standards are exceeded temporarily. It is useful to remember that the standards are based on chronic exposure. Similarly, the calculation of the cancer risk posed by genotoxic carcinogens (such as nitrosamines, PAHs, aflatoxin and acrylamide) is somewhat conservative (due to the hypotheses applied) and may therefore represent an overestimate of the actual risk.

We must conclude that the actual health loss due to microbiological contamination of food differs from that attributable to chemical contamination of food, even though losses as expressed in DALYs are, at first sight, similar. While actual health effects that are structural in nature have been *underestimated* in the case of microbiological food infections, they are relatively low in the case of health effects due to chemical contamination (which are mostly due to the allergenic substances). Moreover, the calculations are mainly based on food incidents involving short-term exposure, whereby the theoretical risks (of cancer and other chronic effects) are likely to have been *overestimated*.

It is no simple matter to determine whether current levels of microbiological contamination of food and the related health effects can be described as 'safe' or 'unsafe'. The problem is persistent, and the health losses are substantial. Nevertheless, clear improvements have already been made in some areas, such as the occurrence of Salmonella in animal products, Toxoplasma in pork, and the monitoring of (the absence of) a number of pathogens in Dutch livestock. It therefore seems justified to conclude that our food has become slightly safer in recent decades. If we further consider the relative scarcity of effective refrigeration systems in the past and the generally lower standards of hygiene that once prevailed, it is not unreasonable to state that our food is now safer than ever before, at least from the microbiological perspective. However, further action is still required, recommendations for which are made in *section 4.2* and *chapter 10*.

We may also conclude that our food is safe in terms of chemical constituents. Whether it is actually 'safer than ever before', as so frequently claimed, is difficult to establish without access to comparably accurate statistics from past eras. However, the falling levels of certain chemical food contaminants measured in recent decades suggest that this is indeed the case. It seems hardly necessary to state that this is largely due to the current system of admission, setting standards and inspection and enforcement. It is therefore all the more regrettable that the food-related incidents which do occur from time to time, while seldom any threat to public health, have eroded the impression of chemical safety. The social disquiet seen when an 'incident' escalates into a 'crisis' could be expected to reduce consumer confidence in food safety. However, recent research has shown that there are no indications of any persistent or growing lack of consumer confidence in food safety (Timmers & De Jonge, 2004).

Nevertheless, food-related incidents do serve to demonstrate the vulnerability of our food supply. The globalization of food manufacturing and sales markets continues to render the food manufacturing chain longer, more complex, more difficult to control, and hence more susceptible to incidents. The impact of those incidents will also become greater, in direct proportion to the new global level of scale, and will therefore threaten consumer confidence to a comparable degree. Accordingly, the current system of admission, setting standards and inspection and so on must not only be maintained, control of the entire food chain must be improved and expanded. This will demand better knowledge of the various food flows and of the circumstances under which food is produced.

Controversial issues

A number of issues frequently associated with microbiological and/or chemical food safety have not been covered in *sections 4.2* and *4.3*, because to date they remain controversial. The topics falling under this heading include the alleged health risks posed by phytoestrogens in plant-based food products, the effects of organic farming in terms of food safety, and the so-called 'hygiene hypothesis'. We conclude this chapter with a brief consideration of these topics.

Phytoestrogens

There are certain substances which occur naturally in fruit and vegetables and which are known to have a hormonal effect. They may therefore influence human hormone levels when consumed. These substances are known as phytoestrogens. The two main chemical classes into which they fall are the isoflavones and the lignans. Both show a close structural similarity to natural oestradiol, and can therefore bind to the humane oestradiol receptor (Adlercreutz & Mazur, 1997; Kuiper *et al*., 1998). This can cause both antagonistic (inhibitive) and agonistic (stimulatory) effects. Accordingly, both health-promoting and health-threatening effects have been ascribed to the phytoestrogens, and indeed both types of effect have been supported in part by epidemiological research as well as *in vitro* and *in vivo* studies (Adlercreutz *et al*., 1992; Adlercreutz, 1995; Welshons *et al*., 1987). A recent RIVM report (Bakker, 2004) summarizes the possible 'benefits and risks' of phytoestrogens to human health, with particular reference to osteoporosis, thyroid function, menopausal symptoms, fertility, the immune system and cancer. In most cases however, the effects are far from clear. For example, phytoestrogens have been claimed to protect against breast cancer in humans. However, both antagonistic and agonistic effects have been noted in laboratory animals (Bouker & Hilakivi-Clarke, 2000; Luijten *et al*., 2004).

Given that the binding of phytoestrogens to the oestradiol-receptor displays a much lower affinity than that of natural oestradiol (up to one thousand times lower, depending on the exact substance concerned) the possible effect would not appear to be particularly marked. However, some concern has been caused by the fact that the plasma-values of phytoestrogens, as measured after consumption of foods rich in isoflavones (e.g. soy) or lignans (e.g. linseed), can be many times greater than that of natural oestradiol. A number of fertility problems have been noted in sheep which have been exposed to high levels of phytoestrogens in their diet. To date, however, no hard evidence of adverse effects in humans has been produced, but neither has any convincing (clinical) evidence of beneficial effects (RVZ/RIKILT, 2001; Bakker, 2004).

Organic farming

Organic farming involves the avoidance or reduced use of pesticides, and a style of livestock husbandry that allows animals to range freely in the open air. Although it would not be appropriate (or possible) to examine all the supposed advantages and disadvantages of organic farming in this report, there are aspects of food safety which are relevant to the topics addressed (see *textbox 4.12*). Only very limited information concerning the safety of biological products is available, and it is therefore not possible to reach any firm conclusions.

Textbox 4.12: Organic farming.

Many individual consumers and societal groups advocate a transition from the current forms of intensive livestock farming and crop production to 'organic farming'. Their motives are many and varied, ranging from concern for animal welfare to that for the environment. The policy document 'Organic Farming 2001-2004' (Ministry of Agriculture, Nature and Food Quality) states the ambition of having approximately 10% of all farmland worked according to biological methods by the year 2010.
It is often suggested that organic farming increases the risk of environmental contaminants, mycotoxins and phytotoxins entering food products of vegetable and animal origin, and will also increase the risk of food intoxications due to microbiological contamination. This argument is based on the reduced use of pesticides and veterinary medicines, and the fact that animals are allowed to range freely in the open air.
One example which illustrates the potential microbiological problem is the risk of *Toxoplasma gondii*. Based on serological population research, Kortbeek *et al*. (2004) conclude that the immune status of young Dutch people has been lowered substantially following the complete exclusion of *Toxoplasma gondii* from its primary source, pork. If pigs are once again kept outdoors, they will once again become infected (Kijlstra *et al*., 2004). Pregnant women form the group at highest risk of serious effects from an infection. They now have far lower acquired immunity to toxoplasmosis. This indicates an increase in the incidence of congenital toxoplasmosis in the coming years if pigs are allowed to range freely. However, there are other risk factors implicated in toxoplasmosis, including gardening without gloves or travelling to countries with a high infection rate, such as those of southern Europe.
An example of a potential chemical contamination problem is that the reduced use of crop protection agents during the production and storage of grain will encourage fungal growth, which may cause increased levels of mycotoxins. Moreover, the avoidance or sparing use of pesticides in crop production could lead to higher infection or predation rates, and hence to higher levels of phytotoxins further to the 'stress response'.

The hygiene hypothesis

Increasingly, a connection is made or inferred between the reduction in the number of microbiological infections achieved through better environmental hygiene, and the increase in sensitivity to food allergens. This connection goes by the name 'the hygiene hypothesis' (see *textbox 4.13*).

When discussing the hygiene hypothesis, however, it is essential to avoid any confusion with the notion that we should deliberately expose children to infections, perhaps by refusing to have them vaccinated, refusing antibiotics, or applying less stringent standards for microbiological food safety. Further research is needed to ascertain the exact mechanisms at work, the extent to which the immune system is influenced and how the results of such research can be applied in practice.

Textbox 4.13: The hygiene hypothesis.

Allergies form an increasing public health problem in the western world. A propensity to the development of an allergy ('atopy') is now seen in approximately 30% of the western population, but to a far smaller degree in the non-industrialized countries. Although genetic factors go some way towards explaining susceptibility to allergies (in about 30% of cases), genetic factors clearly cannot explain the rapid rise in allergy-related conditions in the wealthier countries which has been seen during recent decades. The 'hygiene hypothesis' therefore assumes a connection between the increased sensitivity to allergic conditions on the one hand, and the decrease in the incidence of microbiological (food) infections on the other, due to our living environment becoming more and more hygienic. Although not all studies are in full concordance, the majority of epidemiological studies tend to confirm this observation (Strachan, 1989; Matricardi *et al.*, 2000, 2002). Nevertheless, the hygiene hypothesis remains controversial, and the mechanism underlying this possible effect has not been explained. It was originally postulated that a certain phase in the maturation of the immune system of young children was the deciding factor: the development of a mixed Th1/Th2 response. At birth, the immune system is immature, and develops mostly type-2 helper cells (Th2). During the first two years of life, the development of type-1 helper cells (Th1) is stimulated by exposure to bacterial, mycobacterial and viral infections. If many of these infections are avoided entirely through improved hygiene, vaccinations and the use of antibiotics, it is assumed that the Th1 response will not be adequately stimulated. The development of a Th2 response will continue unimpeded, with the related production of IgE and the likelihood of allergic reactions thereafter. This hypothesis appears to be contradicted by the observation that countries with a high standard of hygiene have seen a substantial increase in not only the Th2 diseases (allergies), but also in the Th1-related autoimmune diseases such as type 1 diabetes, arthritis and multiple sclerosis over the past decades. However, a significant contribution to understanding the underlying mechanisms has recently been made by Yazdanbakhsh *et al.* (2002), who have discovered a new cell type: the regulatory T-cell or T_{reg}. This cell type can act as a sort of natural 'brake' on both Th2 and Th1 diseases, such as allergies and multiple sclerosis. This finding was recently confirmed by the RIVM using a mouse-model (Reimerink *et al.*, in preparation). A relatively harmless virus infection contracted at a very young age was shown to protect against the development of allergy in later life.

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5 WHAT IS THE DUTCH GOVERNMENT DOING TO ENSURE SAFE FOOD ?

M.C.M. Busch

5.1 Introduction

The Dutch government regards it as an important public task to ensure that the food products available in the Netherlands are safe. The consumer must be confident that food products meet high standards of safety. The responsibilities in this regard are arranged as follows. The *government* [1] creates the preconditions for the private sector by means of laws and regulations, including the setting of standards, and conducts supervisory activities. Within the bounds of these preconditions, the *private sector* bears primary responsibility for food safety. As the final link in the chain, the *consumer* is expected to handle food in a responsible manner (LNV & VWS, 2001).

This chapter examines the relevant initiatives and activities undertaken by the Dutch government in recent years, and how these activities relate to the developments and problems described in *chapter 4*. This chapter focuses on the efforts made by national government, which are placed in the context of international food safety policy wherever possible. The efforts and activities relating to food safety of other actors (such as product boards, industry and trade federations, the Dutch Consumers' Association, research institutes, municipal or regional health services, etc.) are not considered in detail here, and are mentioned only where relevant to national policy and its implementation.

The contents of this chapter are largely based on parliamentary documents, including policy documents, progress reports and letters (see *table 5.1*). *Section 5.2* sets out the government's policy objectives and priorities. This is followed by a brief account of the instruments and measures used to achieve these objectives in *section 5.3*. *Section 5.4* then examines the activities undertaken by the State Inspectorate concerned with food safety, while *section 5.5* considers the extent to which government efforts address the main threats described in *chapter 4*. The final section (*5.6*) presents the summary and conclusions.

[1] Government responsibility for food safety matters is shared equally by the Ministry of Health, Welfare and Sport (VWS) and the Ministry of Agriculture, Nature and Food Quality (LNV). The Ministry of Health, Welfare and Sport is responsible for consumer protection and hence for the safety of products, general hygiene requirements, legislative requirements for the chain as a whole, and for the control of zoonotic diseases which pose a threat to human health. The Ministry of Agriculture, Nature and Food Quality is responsible for the requirements covering the production phase, the quality management arrangements of individual companies, inspection of veterinary health and welfare, and for the control and inspection of products and processes (Folbert & Dagevos, 2000).

5.2 Policy: objectives and priorities

Food safety is an important policy objective of the Dutch government. This section examines in more detail the objectives and priorities which have been stated in policy documents and official letters during the past twenty years (see *table 5.1*).

Table 5.1: Most important policy documents on food safety published in the past 20 years[2].

Document	Ministry	Year
Nota Voedingsbeleid[a]	WVC[h], also on behalf of LNV [i] and EZ[j]	1983
Nota Voedingsbeleid, 1e voortgangsrapportage[b]	WVC, also on behalf of LNV and EZ	1987
Nota voedingsbeleid, 2e voortgangsrapportage[c]	WVC, also on behalf of LNV and EZ	1993
LNV-beleidsprogramma 1999-2002. 'Kracht en Kwaliteit'[d]	LNV	1999
Visienota 'Voedsel en Groen'[e]	LNV and VWS [h]	2000
Beleidsnota voedselveiligheid 2001-2004 'Veilig voedsel in een veranderende omgeving' [f]	LNV and VWS	2001
Brief met standpunt op Gezondheidsraadadvies voedselinfecties [g]	VWS and LNV	2002

[a] 'Policy Document on Nutrition'
[b] 'Policy Document on Nutrition, First Progress Report'
[c] 'Policy Document on Nutrition, Second Progress Report'
[d] 'LNV policy programme 1999-2002. 'Strength and Quality'
[e] 'Vision Document 'Food and Greenery'
[f] 'Policy Document on Food Safety 2001-2004 'Safe food in a changing setting'
[g] Letter outlining standpoint regarding advisory report from Health Council of the Netherlands on foodborne infections
[h] VWS: Ministry of Health, Welfare and Sport [formerly WVC: Ministry of Welfare, Health and Cultural Affairs]
[i] LNV: Ministry of Agriculture, Nature and Food Quality
[j] EZ: Ministry of Economic Affairs

1983-1999: building the safety system

The government's 1983 policy document on nutrition (see also *section 3.1*) was concerned with all aspects of food safety and a healthy diet in the Netherlands. With regard to safety, the document stated that the consumer is dependent upon both the government and the manufacturers for the safety of his or her diet, and that adequate policy measures in this area are, and will remain, of great importance. The document went on to state that, in the light of the food safety incidents which occur from time to time, there is no justification for any easing of active government control. However, the priority at this time is to promote good eating habits, since it is thought that this approach will achieve the greatest health gain. "The safety aspect often receives a disproportionately large share of publicity, which distracts attention from the major importance of the individual's choice of food in terms of health," the policy document stated (here in translation; see also *chapter 3*).

2 In addition to the published policy documents, the annual budget plans of the Ministry of Health, Welfare and Sport (VWS) and the Ministry of Agriculture, Nature and Food Quality (LNV) also devote attention to food safety policy. However, because the descriptions in the annual reports are somewhat general and are themselves based on the policy documents (to which they refer), it has been decided not to include these reports as a separate source. A number of other letters and reports on food safety matters have been submitted to parliament, particularly in recent years. Because these relate to specific matters rather than general policy, they too have been omitted from the table.

Two subsequent Progress Reports presented the results of the policy efforts and announced new developments. The First Progress Report, like the original policy document, acknowledged that the food products available in the Netherlands meet stringent safety standards, singling out only the chance of infection with harmful micro-organisms as a problem. Protection against such contamination was therefore given high priority. Policy remained geared towards measures which would reduce or prevent food contamination wherever possible. The Second Progress Report once again expressly stated that Dutch food is safe. This was attributed to an improved regulatory infrastructure in which the set standards and effective inspection activities were in balance.

A few particular aspects were to be given extra attention. On the subject of chemical contaminants, and more specifically the veterinary medicines residues policy, these include the subjects of antibiotics and growth promoters, and the subsectors of milk, poultry and fish farming products.

In the latter half of the 1990s, policy focused on reducing microbiological contamination. In 1997, following the identification of two cases of BSE (bovine spongiform encephalopathy, popularly known as 'mad cow disease') in the Netherlands, this problem also became a spearhead of policy.

1999-2002: revision and updating of policy due to food incidents

The 1999 dioxin affair in Belgium led to food safety being placed at the top of the Dutch political agenda (and indeed that of the European Union). The Dutch government commissioned a report of the dioxin incident (Berenschot, 1999), which explored opportunities to improve coordination and communication. The report stated that the current laws and regulations and the arrangements for inspection, detection and communication were complex, a finding endorsed by the government (VWS *et al*., 2000). However, the government did not consider the report's conclusions to justify any reassignment of public sector responsibilities, and produced a response which stated that the food products available to the Dutch consumer demonstrated a 'high level of quality and safety'. Nevertheless, because this standpoint was not in line with general public opinion, it was acknowledged that communication between the government and the public would present challenges for the foreseeable future. The Berenschot report did lead to a number of measures intended to improve working processes, coordination and communication[3].

[3] Measures included the establishment of a 24-hour reporting organization, offering direct contact with a reporting station at the Ministry of Health, Welfare and Sport and one at the Ministry of Agriculture, Nature and Food Quality. These ministries and the Ministry of Housing, Spatial Planning and the Environment set up departmental food safety commissions, responsible for ensuring an adequate response in both normal and crisis situations. An interdepartmental committee with representatives from all three ministries was also formed to improve the coordination of existing structures and approaches with regard to food and food safety. This committee was also expected to monitor relevant trends, and ensure an appropriate response on the part of their respective organizations. The Netherlands Nutrition Centre was asked to devise and implement a long-term communication programme on the topic of food safety.

There then followed three policy documents in quick succession, each devoting considerable attention to the safety aspect. The Ministry of Agriculture, Nature and Food Quality's *Kracht en Kwaliteit* ('Strength and Quality') document of 1999 emphasized the vulnerability of the agro-food sector in terms of falling consumer confidence. The consumer's demands on food were becoming ever more exacting, with regard to both safety as well as specific aspects of the production process such as animal welfare and environmental effects. In many cases, the consumer's expectations exceeded the legislative requirements. The Ministry of Agriculture, Nature and Food Quality wished to address this situation by developing integrated quality systems for the food industry, which would cover all critical phases of the production process and which would result in standards of safety higher than those provided by the statutory minimum standards. Given its vulnerability, extra attention was devoted to the meat industry and specifically to animal feed which forms a critical link at the beginning of the production chain. Alongside the aim of protecting the consumer against food contamination, the government also made the restoration of consumer confidence an explicit aim.

The various topics were further elaborated in the vision document *Voedsel en Groen* ('Food and Greenery'), published by the Ministry of Agriculture, Nature and Food Quality in 2000. This document describes the ideal situation of a 'sustainable' Dutch agro-food complex which is a fully integrated part of society and which leads the way in Europe. Here, 'sustainable' entails taking into account the health and safety of humans, animals and ecosystems. The dimensions are therefore product safety, sustainable production methods and the sustainability of the production setting (the landscape). This document also announced the formation of a 'Netherlands Food Authority' (the present Food and Consumer Product Safety Authority), an organization which would provide independent scientific and technical support to the policy. A more detailed account of the work of the Food and Consumer Product Safety Authority (VWA) is given in *section 5.4*.

In 2001, the Ministry of Health, Welfare and Sport and the Ministry of Agriculture, Nature and Food Quality published the joint policy document *Veilig voedsel in een veranderende omgeving* ('Safe food in a changing setting'), presenting proposals for government policy for the period 2001 to 2004. This document states that the objective of food safety policy is "to maintain and enhance a high level of consumer health protection by means of clear food safety standards". The primary aim was to ensure that the consumer can be confident that the food products available meet high safety requirements. However, it was acknowledged that it will not be possible to achieve the 'zero risk' situation, a fact that calls for clear and transparent communication with and information to the consumer. The document went on to promise further efforts in this regard during the years to come. It announced action in terms of policy and organization pertaining to food safety, with particular regard to improvement of risk assessment and the setting of standards, coordination of laws and regulations and greater opportunity for emergency measures to be implemented (especially in the primary production sector), the updating of the 'chain guarantee systems' and, as previously mentioned, the establishment of the Food and Consumer Product Safety Authority. These proposals were incorporated into a joint Action Plan for both ministries and are examined in further detail in *section 5.3*.

In 2002, the ministers of Health, Welfare and Sport and of Agriculture, Nature and Food Quality produced an official response to the Health Council's advisory report on foodborne infections (*Gezondheidsraad*, 2000). The ministers proposed addressing the problem of foodborne infections 'on a broad front', with the focus on the effective reduction of pathogens in food products of animal origin throughout the production chain. Although it was acknowledged that it will never be possible to eliminate pathogens entirely, a tightening of existing measures was announced with regard to such aspects as the detection of pathogens at various points in the production chain. The measures are listed in *section 5.5*.

In summary, we may state that a clear shift in policy was apparent in the late 1990s, with the government's responsibility for food safety being reaffirmed. Prior to this, although the importance of ongoing efforts was acknowledged (particularly with regard to microbiological contamination), top priority was given to promoting healthy eating habits. At the time, the government was satisfied with the outcome of its efforts in the field of food safety (VWS, 1998). It was the Belgian dioxin crisis that eventually led to the realization that policy had to be made yet stricter and that the relevant organizational structure had to be modernized. Alongside effective consumer protection, good communication with the public became a key objective of food safety policy.

5.3 Measures targeting food safety

This section offers a general description of the measures and instruments which the Dutch government has applied over the past twenty years to address its policy objectives and priorities (see foregoing section). In particular, we consider the measures announced in the 2001 policy document 'Safe food in a changing setting'. Van der Doelen's classification of instruments as 'legislative', 'communicative' or 'economic' has been applied (Van der Doelen, 1993; see also *chapter 3*).

Legislation has always had a key role

Laws and regulations are the main instruments at the government's disposal with regard to consumer protection in general, and with regard to food safety in particular. The First Progress Report further to the policy document on nutrition (1987) notes that, "the interests of ensuring food safety are of such importance that the instrument of legislation must play a key role; primary responsibility rests with the government, for whom regulation remains essential. Self-regulation and information will play a secondary role in this area."

Over the years, an extensive system of laws and regulations has been developed to address matters of food safety. Since the Netherlands became a member of the European Union in 1957, almost all national legislation in this area has been based on European directives. There is now a considerable degree of harmonization throughout the European Union, which means that the member states are required to observe European statutes[4]. In this context, it is important to mention that the so-called 'General Food Law' came into effect on 21 February 2002. This European Parliament and Council regulation, which was adopted on 28 January 2002, establishes the general principles of both European and national food-related law. Member states were given until 1 January 2005 to modify their national regulations accordingly.

A complex set of laws and regulations were developed and are now in place. The 2001 policy document 'Safe food in a changing setting' notes that it is the very complexity of the laws and regulations, whose development was partly influenced by European regulations, which hinders the effective application of food safety supervision. Besides the *Warenwet* (Commodities Act), which is the key legislative instrument, there are several other relevant statutes: the *Gezondheids- en Welzijnswet voor dieren* (Animal Health and Welfare Act), the *Vleeskeuringwet* (Meat Inspection Act), the *Destructiewet* (Dry Rendering Act), the *Bestrijdingsmiddelenwet* (Pesticides Act), the *Landbouwkwaliteitswet* (Agricultural Produce Quality Control Act) and the *Kaderwet Diervoeders* (Framework Act on Animal Feeds). A brief description of each is given (in Dutch) on the website of the Netherlands Nutrition Centre at *www.voedingscentrum.nl*. There is also a considerable body of legislation which establishes how these various statutes are to be implemented in practice[5]. The 2001 policy document cites optimization of legislative coordination as one of the spearheads of policy. Legislation covering food and food safety will therefore be further streamlined and integrated, with due regard for developments in European regulations.

Another 'sticking point' identified by the 2001 policy document is that legislation does not provide adequate measures for use in a crisis situation. Accordingly, creating greater opportunities for emergency measures to be implemented, particularly in the primary production sector, is cited as a further spearhead of policy. The intention is that emergency measures in the primary phase should have a firm legislative basis, whereby they will be established as a public sector responsibility. This will entail some modification to the existing arrangements in cases where product boards have some responsibility. The legislation will also ensure that emergency measures become effective immediately, once they have been announced in the media. The 'Framework Act on Animal Feeds' (LNV & VWS, 2003b) is an example of recent legislation which has been framed around these intentions. The act provides a facilitative 'framework' for

4 As a member state of the European Union, the Netherlands does of course have a say in the matter, and thus contributes to the development of European policy.

5 Government responsibility for regulation can also be delegated. For example, the government has given product boards and professional organizations (representing a certain sector or a certain professional group) the status of a 'public law professional organization' (PBO), which entitles them to impose binding regulations for products or production methods within the relevant sector.

further national regulations covering animal feed products, whereby responsibility for all related interests may be exercised by the government. In addition to the regular administrative measures (such as administrative enforcement), it will also be possible to implement emergency measures, subject only to an announcement in the media. The Act therefore also represents a re-assignment of responsibilities with regard to animal feeds, between the Ministry of Agriculture, Nature and Food Quality and the Product Board for Animal Feed.

Setting standards: the development of intake, product and process standards

The establishment of set standards represents an extremely useful instrument at the disposal of the government. "[The system of standards] offers a clear framework within which the private sector can exercise its own responsibility with regard to safe products", according to the 2001 policy document 'Safe food in a changing setting'. In most cases, the standards are based on risk assessment, i.e. an estimate of the health risk to consumers at various levels of exposure to a chemical substance or a microorganism[6] (see also *chapter 4*). Many chemical substances are now subject to *intake standards* which state the quantity of that substance which may be ingested, based on an 'acceptable' or 'tolerable' daily intake. The standards are themselves based on a scientific interpretation of toxicological data. There are also *product standards,* which determine the maximum quantity of a certain chemical substance which is permitted in a given product. These standards are based on the applicable intake standards and a defined dietary pattern. In establishing product standards, policy objectives will often be taken into consideration. Product standards play an important part in terms of international trade, and have long been established at the international level, either by the European Union or by the *Codex Alimentarius* Commission[7]. Most food safety incidents either involve incidents where standards were exceeded, or the complete lack of any product standard.

In the case of microbiological safety, the main instruments are the *process standards,* which play an important part in controlling the growth of pathogenic microorganisms. Examples include the various hygiene requirements and HACCP (Hazard Analysis Critical Control Points; see *section 4.2*). Due to the increasing complexity and scope of some processes, random sampling and inspection of the safety of a product is no longer enough.

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6 In addition to the setting of standards, there are other measures which the government can apply where a risk has been established, in order to regulate the safety of food products throughout the chain. It can, for example, impose an outright ban on the use of certain substances, whereby the problem is addressed at its source.

7 The Codex Alimentarius Commission was founded in 1962 by two United Nations organizations, the FAO and the WHO. It is an intergovernmental organization which has 167 member countries (at January 2003), including the Netherlands. The European Commission is one of the official observers. Among the objectives of the Codex are to protect public health and to promote fair trade in food products. Its main task, however, is to develop and maintain regional and global standards, guidelines and recommendations with regard to food safety and hygiene, processing and storage, quality, labelling and packaging. Since its foundation, the Codex Alimentarius Commission has produced thousands of standards which have been adopted worldwide.

The 2001 policy document 'Safe food in a changing setting' stresses the importance of thorough risk assessment in maintaining food safety. It goes on to concede that there remain several sticking points with regard to the setting of standards, criteria and risk assessment procedures. With regard to the setting of standards, the document states that product standards will be extended, both nationally and internationally. Efforts to control Salmonella will focus on pork and eggs, while *STEC O157* in beef and *Listeria monocytogenes* will also be subject to greater attention. Mycotoxins will be controlled by means of standards applying to both food products and animal feeds, with the immediate focus on ochratoxin, tricothenes (including DON), zearalenon and fumonisin. In addition to the product standards, process standards will also be extended. The government wishes to expedite the introduction of HACCP at all stages of the production chain, including the primary sector and slaughterhouses. The importance of HACCP as a process standard is to be discussed further at European level. Some member states have yet to be persuaded of the value of HACCP in de primary sector.

Communication and public information given greater attention following food incidents

The government is responsible for risk communication. It is expected to inform parliament and the general public (consumers and the industry) about the risks identified and its response to those risks. The official report examining the Belgian dioxin crisis (see *section 5.2*) noted that poor communication was one of the sticking points with regard to food safety. This prompted various initiatives intended to improve communication and thus restore consumer confidence. The ministries of Health, Welfare and Sport, Agriculture, Nature and Food Quality, and Housing, Spatial Planning and the Environment made agreements concerning the coordination of their communications in the event of an incident, and about who would act as spokesman to the press and public. It was decided that special communication channels – telephone helplines and Internet sites – would be opened to the public in the event of an incident. Various other activities were commenced with a view to strengthening the lines of communication between the government and the consumer. The Nutrition Centre was asked to implement a long-term communication programme and has since started several communication projects. The question of whether it is possible to provide consumers with information about the origins and processing history of a product by means of barcodes is being investigated. The Ministry of Agriculture, Nature and Food Quality has set up a consumer consultation platform in order to increase consumer involvement in policy matters[8]. The creation of this platform is further to agreements at

8 The platform was founded in 2002 further to the Ministry of Agriculture, Nature and Food Quality's desire to gain a better understanding of the concerns and preferences of consumers, information which is essential in formulating effective policy. The platform comprises twenty members and meets three times a year to discuss topics selected by the members themselves. Each topic is subject to a public opinion survey. The meetings have resulted in several creative suggestions for new policy. A the time of writing, the platform had discussed six topics: where does my meat come from; opting for fruit and vegetables; genetic modification and food; fish, but only if it is safe; the price of sustainable food production and food in ten years time. The topics scheduled for discussion in 2004 were: risk perception; from sustainable production to consumption; and natural quality. After each meeting, the ministry selects a number of suggestions for possible inclusion in policy. For further information (in Dutch), see www.minlnv.nl/consumentenplatform.

European level, whereby the public is to be more closely involved in formulating policy on food from 2005.

The Food and Consumer Product Safety Authority (VWA; see section 5.4) has also been given an important part to play with regard to communication about food and food safety. In late 2003, the Authority entered into a cooperative agreement with the Nutrition Centre which sets out the responsibilities of each party concerning communication about safety. The purpose of the resulting partnership is to ensure that the consumer receives full, clear information, whereby the approaches adopted by the two organizations will be mutually supported. The VWA's main concern is the protection of public health, while that of the Nutrition Centre is consumer education about diet and nutrition. The VWA advises the government, and many of its communication activities concern actual research results and proven high-risk products. The communication activities of the Nutrition Centre are concerned with aspects of both health and safety and are often designed to address the individual consumer. They explain the consequences of food safety problems and make recommendations for the actions that can be taken, including food preparation behaviour in the domestic setting.

In addition to consumer information about the importance of good hygiene when storing and preparing food, the government also uses information to promote hygiene and good production methods on the part of the private sector and those who prepare food professionally, whether in commercial outlets or in hospitals, schools, staff canteens, etc.

Subsidies and financial incentives
Besides laws and regulations (including the setting of standards) and communication (education and information), the government also has access to economic policy instruments which can assist in regulating food safety. The government's 2001 policy document 'Safe food in a changing setting' announced financial incentives to encourage the private sector to take part in a supply chain quality management system. Companies requiring additional inspections because they do not form part of a certified supply chain quality management system will be charged for the work involved. A system of administrative fines is to be introduced for breaches of the Commodities Act, regardless of whether the company concerned forms part of a supply chain quality management system (see also section 5.4).

The government also intends to implement measures with regard to infrastructure, research and information provision. In recent years, for example, funds have been devoted to improving the monitoring system for food safety. Implementation of the enhancements commenced in 2003.

To summarize, we may state that the national food safety policy relies for the most part on laws and regulations, including set standards. In recent years, however, the government has also made increasing use of communications and economic instruments. The list of legislative orders and bans, together with the financial incentives, are directed mainly at the production, distribution and processing industries, while information is targeting distribution, processing and the consumer. Dutch national policy is increasingly in keeping with European policy on food and food safety.

5.4 Supervision of food safety

Supervisory function enhanced by creation of Food and Consumer Product Safety Authority (VWA)

The government is responsible for drawing up guidelines, standards and regulations, and is also responsible for ensuring compliance with these regulations on the part of the private sector. Traditionally, this has always been a State Inspectorate's task. Today, the public body responsible for supervision and regulation is the Food and Consumer Product Safety Authority (VWA), established in 2002 by merging of the former Inspectorate for Health Protection and Veterinary Public Health (KvW) and the National Inspection Service for Livestock and Meat (RVV)[9]. The VWA monitors, inspects and controls the entire production chain and all production processes. Their controllers and inspectors visit abattoirs, fish auctions, factories, catering establishments and other organizations on a daily basis, conducting on-the-spot product inspections, taking samples for further analysis and inspecting lots of meat and fish. The Inspection Service for Livestock and Meat is also concerned with the prevention and control of veterinary disease. The tasks and responsibilities of the inspectorates are established by national and international laws and regulations. From 2005, for example, the EU's General Food Law renders the Food and Consumer Product Safety Authority responsible for the traceability of products. The intention is that the two divisions will merge and will eventually work as a single regulatory authority.

The creation of the Food and Consumer Product Safety Authority (VWA) was the Dutch government's response to a number of incidents in the late 1990s, and to the creation of the European Food Safety Authority[10]. By merging the former food inspectorates and by integrating supervision, research and recommendations, the government aims to enhance the supervisory function. The VWA should conduct its public tasks from a central position, being responsible for all supervision, research (risk assessment) and communication (see also the preceding section). The Food and Consumer Product Safety Authority's purview is that of human and veterinary health protection and

9 There are three further public inspectorates: the *Algemene Inspectiedienst* (General Inspectorate) and the *Plantenziektenkundige Dienst* (Inspectorate of Plant Health) which form part of the Ministry of Agriculture, Nature and Food Quality, and the *Inspectie Milieuhygiëne* (Inspectorate for the Environment) which forms part of the Ministry of Housing, Spatial Planning and the Environment. There are also a number of private sector organizations to which regulatory tasks have been delegated. These include the *Kwaliteitsdienst Diervoeders* (Product Board for Animal Feed) and the *Centraal Orgaan voor Kwaliteitsaangelegenheden in de Zuivel* (Controlling Authority for Milk and Milk Products). The activities of these organizations are subject to government supervision.

10 The European Food Safety Authority (EFSA) was founded in 2001. The EFSA has an authoritative, coordinating role with regard to risk assessment, research and risk communication activities. Its creation provides uniformity in the interpretation and action further to food risks on the part of the European Union member states, each of which was required to set up a national food safety authority.

product safety and encompasses entire production chains, the use of the end product, and all intermediate processes. The Authority forms part of the State Inspectorate of Health and, in addition to ensuring compliance with legislative ordinances, must also research and advise on situations which pose a (potential) hazard to health. The objectives of the Food and Consumer Product Safety Authority are stated as: "to make a real and demonstrable contribution to the reduction and/or proactive management of health and safety risks, and to maintain and/or restore public confidence in the safety of food and other consumer products" (VWA, 2002, here in translation). Although it remains necessary to exercise close control of the entire chain, it is seen as increasingly important to ensure the reduction of the known existing dangers and risks.

Strengthening the independent status of the Food and Consumer Product Safety Authority

In 2003, the Food and Consumer Product Safety Authority (VWA) was transferred from the Ministry of Health, Welfare and Sport to become an agency of the Ministry of Agriculture, Nature and Food Quality. The two ministers justified this move in a letter to the Lower House, stating that the organizational position of a control apparatus covering the entire chain is more appropriate to the responsibilities of the Ministry of Agriculture, Nature and Food Quality, which is also concerned with the chain as a whole (LNV & VWS, 2003a). The letter went on to state that a functional separation between supervision (i.e. inspection tasks) and risk assessment (i.e. advisory and research tasks) was considered essential in order to ensure the independent position of the Authority's advisory role. This would further emphasize the fact that research undertaken by the Authority is conducted entirely without influence on the part of ministers or inspection services. However, close cooperation between the various units of the Food and Consumer Product Safety Authority would remain essential. A draft bill was scheduled to be presented to parliament in the first half of 2004, to establish the legislative position of the independent advisory and research roles.

Private sector responsibilities

One principle of current regulatory practice is that companies themselves will accept greater responsibility and will implement certain self-regulation measures. The Food and Consumer Product Safety Authority would then become the 'supervisor of supervisory systems'. The strategic spearheads are: supervision of the entire production chain in addition to the inspection of individual companies, imported products presenting specific risks, the individual branches of chain organizations lacking an adequate internal food safety policy, and those parts of the sector in which hygiene codes have not yet been implemented, or have been implemented only recently (VWA, 2002).

The Food and Consumer Product Safety Authority has various sanctions at its disposal. Where shortcomings are found, the Authority can issue a formal warning, impose a fine, or can implement legal proceedings. If an immediate danger to public health exists, the Authority can order a company to recall products which have already been sold. However, unlike its counterparts in some other countries, the Food and Consumer Product Safety Authority cannot shut down a company 'on the spot'.

Long-term vision of VWA, 2004-2007

In late 2003, the Food and Consumer Product Safety Authority published its 'long-term vision' for the period 2004-2007. This document provides the outline for the Authority's activities during the years ahead, and states the following strategic principles:

- Risk assessment is to address both the facts and consumer perception
- Prevention and a proactive policy are encouraged as a means of achieving risk reduction
- Rights and responsibilities are to be re-evaluated

The document goes on to list many topics which are to be given priority. They include potential new risks such as new zoonotic and veterinary diseases, new mycotoxins and phytotoxins, and new allergens. Specific attention is also to be devoted to animal feeds, foodborne infections and intoxications, import, tracking and tracing, enhancement of the position of the supervisory function within the policy cycle, effectiveness in crisis situations, and the development of risk communication.

To summarize: measures to ensure that the private sector complies with the requirements of food safety legislation have been in place for many years. Various developments and incidents have made it clear that the government must also invest in risk assessment and communication. The prompt identification of potential hazards is extremely important, and there must be proactive measures as well as repressive measures. The Food and Consumer Product Safety Authority (VWA) was set up further to European policy, and combines the familiar supervisory tasks with those relating to risk assessment and risk communication. It will continue to strive to become a thoroughly authoritative organization in all spheres.

5.5 Efforts targeting the main threats to food safety

5.5.1 Microbiological hazards

As we saw in *chapter 4* (*section 4.2),* foodborne infections remain a persistent problem in the Netherlands, with Salmonella, Campylobacter, the noroviruses and *Clostridium perfringens* jointly responsible for over 50% of food-related illnesses. However, further to integrated food safety policy, it is considered important that the government does not restrict its attention to these pathogens alone.

Government concern for microbiological hazards to food safety is long established. Both progress reports further to the Nutrition policy document of 1983 state that microbiological hazards should be treated as a matter of priority. The measures implemented in the 1990s were largely concerned with improving hygiene within the production process (such as the introduction of HACCP). Both the 'Food and Greenery' document and the food safety policy document of 2001 propose further measures to prevent foodborne infections. During the past few years, investments have been made in risk assessment models focusing on Salmonella in poultry and eggs, Campylobacter in chicken meat, STEC 0157 in beef and *Listeria* in pre-prepared ('chilled') products.

In its response to the Health Council's advisory report (2000) on foodborne infections, the government stated that the problem should now be tackled 'on a broad front' (VWS & LNV, 2002). Priority would be given to Salmonella in eggs, poultry and pork, Campylobacter in poultry, *Listeria monocytogenes* in raw milk products and other products, and *E. coli* in beef. The measures implemented included a ban on the supply or trading of any eggs contaminated with Salmonella, while various hygiene codes were revised to preclude the use of raw eggs in uncooked products such as bavarois and tiramisu. A (temporary) warning was issued with regard to poultry. At the time of writing, the introduction of decontamination methods (techniques which kill bacteria in raw products before they reach the shops) was under consideration, subject to certain conditions. The government has also been actively involved in formulating official 'food safety objectives' (FSOs), based on thorough risk analyses. These would serve to reduce the risk of infection via raw foods of animal origin. The Dutch government intends to produce a set of food safety objectives for Salmonella in poultry and pork some time before 2010 (the target date set by the European Union), whereby the objectives will include Campylobacter. The response to the Health Council's report also promised further funding for research, since too little is known about the spread, incidence, health effects and costs of food contamination. The results of this research will be used to formulate further intervention strategies.

The policy document 'Living longer in good health' (2003) announces a ban on the sale of poultry infected with Salmonella or Campylobacter, effective from 2007, provided this can be reconciled with EU legislation.

To summarize, we may state that the Dutch government is fully aware of the importance of efforts to counter microbiological hazards, and has indeed implemented various measures and initiatives to reduce the incidence of food infections. It has done so as part of general policy, and with policy targeting some specific pathogens, including Salmonella and Campylobacter (see also *chapter 4*).

5.5.2 Chemical hazards

As stated in *chapter 4 (4.3)*, the incidence of death and disease which can be directly ascribed to chemical food contamination is relatively low compared to that due to microbiological contamination. Nevertheless, it is essential that there be a continuing focus on preserving an adequate maintenance level with regard to the chemical risks. Additional attention should be devoted to allergenic substances.

Concerning food-related allergy, the Dutch government mainly targets the consumer, who should be thoroughly and objectively informed about food constituents which can provoke an allergic reaction. The Netherlands Nutrition Centre is responsible for consumer information concerning hypersensitivity to food and product composition, and has compiled lists of products which may contain components to which the consumer is sensitive or allergic. This information is based on the 'ALBA' database of allergens which is maintained by the Netherlands Organization for Applied Scientific Research (TNO) and funded by the government. (At the time of writing, the future of this database was uncertain).

The policy document *Langer gezond leven* ('Living longer in good health') (2003) also devoted attention to food allergies and food intolerance. The increased prevalence of such conditions prompted the government to request the Health Council to produce an advisory report. In addition, the Food and Consumer Product Safety Authority was scheduled to produce a report in 2004 on ways in which EU labelling legislation could be better enforced, thus ensuring that product labels provide more complete information to consumers with an allergy. The Ministry of Health, Welfare and Sport will also produce an integrated action plan with regard to food allergies and intolerance (VWS, 2003). In short, the Dutch government's policy documents devote considerable attention to the topic of food hypersensitivity.

5.6 Summary and conclusions

Examination of the policy documents studied for this report allows us to draw the following conclusions:

Food safety has always enjoyed government attention. Many laws and regulations have been passed, and many standards established. However, following a number of incidents in the late 1990s, it was acknowledged that policy should be made yet more stringent, and that the organizational structure with regard to food safety regulation was in need of reform. The emphasis would then be placed on food safety throughout the entire production chain, rather than only that of the end product. Alongside consumer protection, open communication with the general public was established as a key objective. National policy is increasingly being developed in line with that at European level, and is indeed increasingly determined by the European Union. The government believes that supervision will be rendered yet more effective following the establishment of the national Food and Consumer Product Safety Authority (VWA).

In recent years, the Dutch government has implemented various measures and initiatives addressing the main problems in terms of microbiological and chemical food contamination, as listed in *chapter 4*. It has done so in its general policy, aimed at reducing foodborne infections, and by means of policy targeting specific pathogens such as Salmonella and Campylobacter, two of the most important pathogens in the Netherlands. In terms of chemical hazards, the main focus has been on *food hypersensitivity*, i.e. allergenic food constituents.

A comparison of the policy documents in terms of their attention to a healthy diet on the one hand, and food safety on the other, leads to two notable findings. Firstly, we see that the two aspects were addressed in tandem during the 1980s, but increasingly became seen as two separate issues. Secondly, the relative importance attached to these aspects has fluctuated over the years. In the early 1980s, for example, the government called for greater attention to be devoted to a healthy diet, while in the late 1990s, the focus was on food safety.

Although we can state that the Dutch government has shown clear and systematic concern for both a healthy diet and food safety, this does not answer every possible question about its policy. For example, the documents say little about the effectiveness of past policy measures, nor do they state clear results with regard to the proposed measures. Similarly, it is not yet clear whether current policy takes sufficient account of likely future developments (see *chapter 9*). This aspect has not been addressed in this chapter.

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6 HOW HEALTHY AND SAFE ARE FUNCTIONAL FOODS AND DIETARY SUPPLEMENTS ?

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6.1 Introduction

There is a category of food products which demand special attention in terms of their alleged health-promoting effects and their safety aspects: so-called functional foods and dietary supplements. Given increasing consumer interest in the relationship between diet and health, such products have been gaining popularity for some time. The industry has taken advantage of this trend by offering an ever-larger range of products which are claimed to have a beneficial effect on health. Within the general group of functional foods and dietary supplements, we can distinguish between traditional foods with a modified composition, and products offered in a pharmaceutical form i.e. pills, potions, capsules, drops and powders. As yet, no uniform terminology applies to such products, nationally or internationally. The former products are known under such names as *functional foods, specific health promoting foods* or *food products with health claims*. The latter are also described as *nutraceuticals, health products* or *dietary supplements with health claims.* For the sake of convenience, we shall use the terms ‘functional foods’ and ‘health products’. In this report, functional foods will be defined as ‘traditional foods or beverages that contain certain ingredients or components of ingredients to a greater or smaller extent, on the basis of which the manufacturer claims that the modified product has certain positive effects on the user’s health which surpass the nutritional health effects of the original product’ (after VWS, 2002). Examples of functional foods include milk with added calcium, yoghurt with added bifidobacteria, and margarine with added plant sterols. Health products may be defined as products which are usually offered in pharmaceutical form or in a form emulating that of pharmaceutical products, but which are not classified as a prescription drug. Manufacturers market these products with a wide range of claims stating or implying potential positive health effects (VWS, 2002). Health products include such products as dietary supplements and herbal preparations.

An important question with regard to both categories is whether they do indeed have any beneficial health effect and whether they can achieve any health gain. Equally important is the question of whether they are safe. In many cases, the positive effect of such products has yet to be (adequately) demonstrated. Moreover, the use of these products may represent certain risks, such as overdosing when the consumer ingests several products on a daily basis, each containing the same health-promoting ingredient.

With contributions by M.I. Bakker and A.G.A.C. Knaap

This chapter seeks to answer these questions. *Section 6.2* lists some of the functional foods and health products currently available in the Netherlands. *Section 6.3* examines the regulatory legislation in place. We then examine the potential health gain represented by these products (*section 6.4*), the potential health risks (*section 6.5*) and the use of functional foods and health products containing vitamins and minerals in the Netherlands (*section 6.6*). *Chapter 7* goes on to present a qualitative comparison of the likely health gains and health risks of some selected functional foods and health products. The criteria applied in making this comparison are described in *section 6.7*. The current chapter closes with a summary, conclusions and recommendations (*section 6.8)*.

Table 6.1: Overview[1] of the main categories of functional foods currently available in the Netherlands.

Categories of functional foods with:	Intended health promoting effect[2]	Example of added specific ingredient	Examples of products
Reduced (saturated) fat content	• Nutrient claim, effect not specified[3]	N.A.	skimmed and semi-skimmed dairy products, margarine, 'light' chips
Reduced sugar content	• Prevents caries • Nutrient claim, effect not specified[4]	Cyclamate, aspartame, saccharin, sorbitol, xylitol	'Light' soft drinks, sweets, chewing-gum
Polyunsaturated fatty acids	• More favourable serum lipids pattern	Linoleic acid, α–Linolenic acid	Margarines, oils, baking and frying products
Phytosterols or phytostanols	• Lowers serum cholesterol	Phytosterol and phytostanol	Margarine, yoghurt, and drinking yoghurt
Vitamins and minerals	• 'Optimal' intake of vitamins and minerals (prevents deficiencies) • Boosts resistance • Calcium, vitamin D: for strong bones	Vitamin A (in the form of carotenoids), vitamin B_2, vitamin B_2, vitamin B_6, nicotinic acid, vitamin B_{12}, vitamin C, vitamin E, vitamin D, vitamin K, iron, calcium	Fruit juices, soft drinks, dairy products, cakes, breakfast cereals, sweets
Dietary fibre	• Stimulates bowel function • Prebiotics[5]: improves the microbiological balance in the large intestine	Soya polysaccharides, gum arabic, resistant starch, α–cellulose, inulin, oligosaccharides	Breakfast cereals, fruit nectars, bread
Bacterial cultures (probiotics[6])	• Improves the microbiological balance in the large intestine • Boosts resistance	Bifidobacteria, lactobacilli	Yoghurt (drink)

[1] The above overview is for the purpose of illustration, it is not comprehensive.
[2] The health promoting effect as claimed by the manufacturer.
[3] Nutrient claims such as '0% fat' can suggest that use of the product leads to a lowering of serum cholesterol or a reduction in body weight.
[4] Nutrient claims such as 'sugar-free' can suggest that the product leads to a reduction in body weight.
[5] Prebiotics = dietary fibre that has a favourable effect on the growth of 'good' bacteria in the large intestine, producing a shift towards a healthier intestinal flora.
[6] Probiotics = products with live 'good' bacteria that have a favourable effect on the microbial balance in the large intestine, producing a shift towards a healthier intestinal flora.

6.2 Overview of functional foods and health products

Among the first traditional foods to have their composition modified were the skimmed and semi-skimmed versions of dairy products, and margarines having a modified fat composition. These products were first made available in the 1960s. During the 1980s, one of the recommendations of the (then) Dutch Nutrition Council was to reduce fat consumption and particularly that of saturated fats (*Richtlijnen Goede Voeding* [Guidelines for Good Nutrition]; see *chapter 2*). This prompted the development of other food products in which some of the fat or carbohydrate (sugar) content had been replaced by ingredients that provide less energy, or none at all: the 'light' products. In the 1990s, Asian (and particularly Japanese) influences prompted the western world to consider the health-promoting effects of individual foods. The term 'functional foods' was introduced.

Manufacturers then started to add bio-active substances and bacterial cultures with an (alleged) positive health effect to their food products. At the same time, a growing number of vitamin and mineral tablets and herbal preparations were introduced, each claiming to have a beneficial effect on health. *Tables 6.1* and *6.2* provide an overview of the various product groups currently available in the Netherlands. It seems likely that sales of functional foods and health products will continue to increase in the years ahead, and that the range of products will also increase in scope (see also *chapter 9*).

Table 6.2: Overview[1] of the main categories of health products currently available in the Netherlands

Categories of health products	Intended health promoting effect[2]	Examples of products
Dietary supplements that contain one or more vitamins and/or minerals	• 'Optimal' intake of vitamins and minerals, prevents deficiencies • Boosts resistance • β-Carotene, vitamins E and C: antioxidant effect[3] • Prevents diseases • Stimulates bodily functions	Preparations containing vitamins and/or minerals
Dietary supplements that contain other well defined ingredients or bio-active substances	• Stimulates bodily functions • Prevents diseases • Promotes weight loss • Promotes recovery following illness	Preparations containing creatine, carnitine, alpha-lipoic acid, amino acids, conjugated linoleic acid (CLA)
Dietary supplements that are partly or entirely biological in origin, or that are derived from biological sources	• Stimulates bodily functions • Prevents diseases • Strengthens the immune system	Preparations containing oils, (including fish oils), garlic, brewer's yeast, fibres, flavonoids
Herbal preparations	• Stimulates bodily functions • Strengthens the immune system • Improves memory	Preparations containing Saint John's Wort, Ginkgo biloba, Ginseng

1 The above overview is for the purpose of illustration, it is not comprehensive.
2 The intended health promoting effect as claimed by the manufacturer.
3 Antioxidants neutralize free radicals (particles with an unpaired electron) that are formed during normal metabolism, thereby preventing them from causing damage.

6.3 Legislation

6.3.1 Functional Foods

The legislation under which a functional food falls depends on the exact nature of the product in question. Does it contain a new substance? Has it been enriched with vitamins and/or minerals? Is it a food product to which another known substance has been added? Different legislation applies to each of these three groups.

Legislation for 'novel foods'

Foods and food ingredients (thus also including functional foods) which are deemed to be 'new' (under the criteria established for this purpose) are known as 'novel foods' and since 1997 have fallen under European Regulation 258/97 (see *textbox 6.1*). The best-known example of products that fall under this regulation and are currently available in the Netherlands is the margarine with added plant sterols, 'Becel Pro Activ'.

Legislation for foods enriched with vitamins and minerals

Manufacturers of food products enriched with vitamins or minerals must observe the current provisions of the national *Warenwetbesluit 'Toevoeging micro-voedingsstoffen aan levensmiddelen* (Commodities Decree on the Addition of Micronutrients to Foods; see *textbox 6.2*). Before any such product can be offered for sale in the Netherlands, it must be registered with the *Voedsel en Waren Autoriteit* (Food and Consumer Product Safety Authority). A European regulation for enriched products is currently in preparation (see *textbox 6.2* and *table 6.3*).

Textbox 6.1: EU Regulation 258/97 on 'novel foods'.

European Regulation 258/97 'concerning' novel foods and novel food ingredients' came into effect in 1997. Under the terms of this legislation, the manufacturers of food products containing ingredients which have never previously been available on the European market are obliged to demonstrate the safety of those products prior to any market introduction in Europe. The 'novel foods' concerned are mainly those with specific bio-active components and the exotic foods. Since April 2004, products that have been prepared using genetically modified organisms and products that consist of genetically modified organisms fall under a separate regulation. With regard to the safety aspects, manufacturers are required to submit an application in the form of a dossier prepared according to EU guidelines. This dossier can be submitted for assessment in any of the member states, whereupon the European Commission and all other member states will be informed of the results of the safety assessment. The 'novel food' under consideration will be assessed according to chemical-analytical, nutritional, microbiological, toxicological and epidemiological safety criteria. If one or more member states does not accept the assessment and the recommendations of the assessing member state, the European Commission will seek the scientific opinion of the European Food Safety Authority (EFSA; see: www.efsa.eu.int). This provision has been in place since April 2003, prior to which the 'second opinion' was provided by the EU Scientific Committee on Food (SCF).
In the Netherlands, the EU legislation prompted the establishment in 1999 of the Committee on the Safety Assessment of Novel Foods as part of the Health Council of the Netherlands. This committee comprises experts in various fields and is charged with assessing the applications for novel food marketing authorization submitted in the Netherlands. Its official recommendations are then submitted to the responsible person, being the Minister of Health, Welfare and Sport (see also www.gr.nl).

Textbox 6.2: Legislation covering foods enriched with vitamins and/or minerals.

The Commodities Decree on the Addition of Micronutrients to Foods has been in force in the Netherlands since 1996 and applies to foods enriched with vitamins and/or minerals. Under the provisions of this legislation, the following vitamins and minerals may be artificially added to a food product "in such quantities as to render the total content at least 15% and no more than 100% of the recommended daily intake of the nutrient in question": vitamin A (as carotenoids), vitamins B_1, B_2, nicotinic acid, B_6, pantothenic acid, B_{12}, biotin, vitamins C, E, K, calcium, magnesium, iron, manganese, phosphor, chromium, molybdenum, sodium, potassium and chloride. The addition of other vitamins (vitamin A as retinoids, vitamin D, folic acid) and minerals (copper, zinc, selenium, iodine) is prohibited. Further to European harmonization, the Dutch Commodities Decree on Margarine was repealed in 1999, whereupon there was no longer any legal requirement to add vitamins A and D to margarine products. However, the industry has since entered into a voluntary agreement to add vitamins A and D on a voluntary basis. Since May 2003, it has also been permissible to add vitamin D to yellow lipid-based spreads, provided the resultant content is no more than 50% of the recommended daily intake for the elderly, and that the product in question carries a statement that it is suitable for persons aged over 60 (*Staatscourant*, 2003). In the case of iodine, the regulation makes a specific exception for salt used in bread and in the conservation of certain (meat) products.

The proposed European Regulation on Enriched Foods (262/2003) currently in preparation seeks to harmonize the member states' individual legislation with regard to the addition of vitamins, minerals and certain other substances to foods. A list of 'approved' substances has already been compiled, although the permitted minimum and maximum content had not yet been established at the time of writing this report. At the request of the European Commission, the Scientific Committee on Food (SCF) has established certain safe maximum limits, known as the 'Tolerable Upper Levels' (UL), for a number of vitamins and minerals, based on scientific risk assessment (see *table 6.3*). The UL is the level of daily intake (via the regular diet, functional foods and supplements) above which undesirable effects may occur. The European Food Safety Authority (EFSA), which is now responsible for providing scientific advice on food-related matters, is to undertake a similar assessment for other vitamins and minerals. Together with certain other parameters, the ULs will then be used to establish the maximum levels to which vitamins and minerals may be added to certain specified foods to ensure that consumption of those foods as part of a varied diet will present no risk to the consumer.

Legislation for foods enriched with substances other than vitamins and minerals

Health-promoting substances which were already being added to products available in Europe prior to 1997 are deemed to be 'known' substances. Manufacturers may add such substances (excluding vitamins and minerals) to the traditional products, and may market these products without any prior safety assessment or registration. European legislation covering foods to which amino acids, trace elements, essential fatty acids and/or dietary fibre have been added is currently in preparation. The Netherlands currently operates a policy which permits enrichment with amino acids, which is based on the Health Council's advisory report *Veiligheid van aminozuursuppletie* (The Safety of Amino Acid Suppletion) (*Gezondheidsraad*, 1999).

6.3.2 Health products

Dutch legislation for health products is available for vitamin preparations through the *old* Commodities Regulation on *Vrijstelling vitaminepreparaten* (Exemption for vitamin preparations), the *new* Commodities Decree on *Voedingssupplementen* (Dietary Supplements), and the Commodities Regulation on *Voedingssupplementen* (Dietary Supplements). Vitamin preparations must contain at least 20% of the recommended daily intake. Maximum levels are imposed for vitamins A and D. Products which comply with the old regulation are permitted to remain on the market until 1 August 2005.

A further Commodities Decree exists for *Kruidenpreparaten* (Herbal Preparations). In general, the main requirement is that preparations must not contain amounts that will be harmful to public health. The definition of 'harmful to public health' is further specified in the text of this legislation in the form of comprehensive lists of prohibited ingredients and plant species. Since 1 January 2003, the manufacturer or distributor of herbal preparations must be able to substantiate any health claims made using objective data obtained from scientifically accredited sources. While all health products have the appearance of medicinal preparations, they are not permitted to include any ingredient or constituent which is registered as a 'medicine'.

The first steps towards European harmonization of legislation covering dietary supplements have been made by means of Directive 2002/46/EC, which requires certain amendments to be made to individual member states' legislation in this area. At present, the directive covers only vitamins and minerals. Like that for enriched food products (see *textbox 6.2*) the EU regulation establishes which vitamins and minerals are permitted (see *table 6.3*) and in what chemical form. However, the minimum and maximum doses to be permitted have yet to be established.

Further European legislation is being prepared to cover supplements which contain ingredients other than vitamins and minerals (e.g. trace elements, essential fatty acids, dietary fibre, amino acids, herbs and other biologically active substances such as garlic and brewer's yeast). With regard to herbal preparations, the directive on *Traditionele Kruidengeneesmiddelen* (Traditional Herbal Remedies) (2003/63/EG) is of particular significance. It is intended to simplify the registration process for traditional herbal preparations.

With regard to supplementation with amino acids, and until such time as European legislation takes effect, the Netherlands will observe the recommendations of the Health Council in its report *Veiligheid van aminozuursuppletie* (The Safety of Amino Acid Suppletion) (*Gezondheidsraad*, 1999). All other products which do not fall under specific regulations or decrees will remain, like 'common' foods, subject to the provisions of the Commodities Act. This means that such health products will also be subject to commodities decrees such as *Bereiding en behandeling van levensmiddelen* (Preparation and processing of foods) and *Etikettering van levensmiddelen* (Labelling of foods).

Table 6.3: List of vitamins and minerals which are permitted to be added to foods (EU Regulation 262/2003) and dietary supplements (Directive 2002/46/EC), with 'Recommended Daily Allowance' (RDA) and 'Tolerable Upper Level' (UL). The figures relate to adults between 19 and 50.

Vitamin	RDA[1]	UL[2]	Mineral	RDA	UL
Vitamin A (μg RE[a])	m: 1000	3000	Calcium (mg)	1000	2500
	f: 800				
β-Carotene (μg)	see[b]	not derived	Magnesium (mg)	m: 300-350	250[g]
Vitamin D (μg)	2.5[c]	50		f: 250-300	
Vitamin E	m: 11.8-13	300	Iron (mg)	m: 9-11	in preparation
(mg α TE[d])	f: 9.3-9.9			f: 15-16	
Vitamin K (μg)	not derived	not derived	Copper (mg)	1.5-3.5	5
Vitamin B_1 (mg)	1.1	not derived	Iodine (μg)	100[h]	600
Vitamin B_2 (mg)	m: 1.5	not derived	Zinc (mg)	m: 7-10	25
	f: 1.1			f: 6-9	
Nicotinic acid	m: 17	10 (nicotinic acid)	Manganese (mg)	1-10[i]	not derived
(mg NE[e])	f: 13	900	Sodium (mg)	in preparation	in preparation
		(nicotinamide)	Potassium (mg)	in preparation	in preparation
Pantothenic acid (mg)	5	not derived	Selenium (μg)	50-150	300
Vitamin B_6 (mg)	1.5	25	Chromium (mg)	not derived	not derived
Folic acid (mg)	0.3	1[f]	Molybdenum (mg)	not derived[j]	0.6
Vitamin B_{12} (μg)	2.8	not derived	Fluoride (mg)	in preparation	inpreparation
Biotin (μg)	not derived	not derived	Chloride (mg)	in preparation	in preparation
Vitamin C (mg)	70	in preparation	Phosphorus (mg)	700-1400	in preparation

[1] RDA (recommended daily allowance) = level of daily intake that is adequate for virtually the entire population. The RDA is based on the dietary standards published by the Health Council of the Netherlands in 2003 (vitamin B_6, B_{12}, folic acid), in 2000 (calcium, vitamin D, B_1, B_2, nicotinic acid, pantothenic acid, biotin) and in 1989 (vitamin A, E, C, magnesium, copper, zinc, selenium, iron, phosphorus). 'Not derived' means that insufficient data is available for a value to be derived.

[2] UL (tolerable upper level) = the level of daily intake above which there is a risk that undesirable effects could occur, as derived by the Scientific Committee on Food (SCF). Opinions on Tolerable upper intake levels for vitamins and minerals, updated April 2003: http://europa.eu.int/comm/food/fs/sc/scf/out80_en.html. 'Not derived' means that insufficient data is available for a value to be derived.

[a] RE: retinol equivalents, [b] 6 μg β-carotene = 1 RE. The RDA calculation was only carried out for total vitamin A, [c] 5 mg in the absence of exposure to sunlight, [d] α-tocopherol equivalents, [e] nicotinic acid equivalents (nicotinic acid + nicotinic acid amide + 1/60th of the amount tryptophan). This composite measure, as also used by the Health Council of the Netherlands, was adhered to for nicotinic acid. The UL defined by the SCF is divisible into two measures: 10 mg for free nicotinic acid and 900 mg for nicotinamide, [f] the UL applies to the synthetic form of folic acid, [g] the UL was only derived for the amount of magnesium added to foods. No account was taken of the amount of magnesium ingested via the daily diet, [h] no data are available from the Health Council's Dietary Standards; the figure indicates the average requirement for adult individuals, as recommended by the SCF, [i] there are no data available from the Health Council's Dietary Standards; the figure indicates acceptable intake levels, as recommended by the SCF, [j] the current intake of 0.1 mg per day seems adequate.

6.3.3 Claims

As explained in the foregoing section, functional foods and health products are covered by the Dutch Commodities Act. This expressly prohibits claims of any *medical* effect being made for these products. It is therefore illegal to state that a food product or supplement can prevent, treat or cure any disease or condition. However, claims relating to nutrient content and nutrient function are permitted, as are health claims (De Roos & Katan, 2003; see also *textbox 6.3*).

Dutch legislation with regard to claims

Legislation covering the claims made on behalf of functional foods and health products has led to some confusion, due to the distinction drawn between medical claims and health claims. It is permissible to state that a product or supplement will maintain or promote (general) health, but it is not permissible to state that it will help to prevent illness or disease. Claims regarding disease prevention are currently classified as medical claims. The distinction is vague and often difficult to understand. In order to establish where the boundary between permissible claims and impermissible claims actually lies, there are two systems of self-regulation in place in the Netherlands. However, both have some shortcomings (see *textbox 6.4*). The Health Council has produced an advisory report on this topic (*Gezondheidsraad*, 2003). According to the Health Council, it is difficult to make a scientifically grounded distinction between medical claims and health claims because there is no clear difference between 'the promotion and maintenance of health' and 'the prevention of illness or disease'. Similarly, according to the Health Council, the distinction between functional foods and dietary supplements on the one hand, and medicines on the other is also indistinct. Both types of product can positively influence the risk factors of disease, which is much the same thing as reducing the risk of disease. The Health Council is therefore of the opinion that, if the consumption of a product will reduce the risk of developing a disease or condition, it is preferable that the risk reduction be expressly stated. It has therefore recommended that claims relating to risk reduction should be permitted for functional foods and health products, provided such claims can be scientifically substantiated, and that the current form of general health claims should be abandoned.

Alongside the lack of clarity with regard to the distinction between health claims and medical claims, there is also doubt concerning the validity of the health claims. Which are true (scientifically proven) and which are not? The Commodities Act does not lay down any rules for the substantiation and assessment of health claims. In 1998, however, the Netherlands Nutrition Centre took the initiative regarding the adoption of a *Gedragscode* (Code of Conduct) based on the definition of health claims given in the notes which accompany the Act. This voluntary code establishes the manner in which alleged health effects should be subject to scientific appraisal, and offers manufacturers the opportunity to submit their products for testing (in order to assess specific health claims) at cost price. To date, few manufacturers have taken advantage of this scheme because they are still not allowed to state on the product itself that the claims made have been scientifically assessed. As a result, the consumer still lacks information regarding which products have been scientifically tested and which health claims can be regarded as reliable. In its report, the Health Council advised the government to devote attention to this matter. It considers it important for claims to be subject to proper assessment, and that the assessment should be conducted by an independent and impartial organization.

New European legislation

The European Commission is preparing a draft regulation (165/2003) for nutrition and health claims made on behalf of functional foods and health products. It is expected that this regulation will provide an adequate solution to the problems inherent in the current Dutch system with regard to claims, as outlined above. The European regulation will permit two types of claims: nutrition claims and health claims

Textbox 6.3: Permitted and prohibited claims for food products.

Current situation
Current Dutch legislation permits three types of claim to be made for foods:

- *Nutrient claim*
  A general statement indicating the quantity of a particular nutrient to be found in the product (e.g. 'low fat', 'high in fibre').
- *Nutrient function claim*
  A statement of the quantity of a nutrient in the product, together with an explanation of the function of that nutrient in the body (e.g. 'rich in calcium, which is required for the development of bones'.
- *Health claim*
  A statement which asserts, or which aims to create the impression, that a food product has special properties likely to promote or maintain good health (e.g. 'helps to reduce cholesterol'; 'promotes mobility of the joints').

Medical claims are not permitted:
A medical claim is a statement or suggestion of the product's ability to prevent, treat or cure a human disease, illness or condition, or which alludes to such ability. The use of such statements and suggestions is prohibited under the Commodities Act.

Future situation
The proposed new European Regulation (165/2003) covering nutrition and health claims made on foods, deals with the following types of claim:

- *Nutrition claim*
  Any claim which states, suggests or implies that a food has particular nutrition properties due to (a) the energy (caloric value) it 'provides', 'provides at a reduced or increased rate' or 'does not provide' and/or (b) the nutrients or other substances it 'contains', 'contains in reduced or increased proportions', or 'does not contain'.
- *Health claim*
  Any claim that states, suggests or implies that a relationship exists between a food category, a food or one of its constituents, and health.
- *Reduction of disease risk claim*
  Any health claim that states, suggests or implies that the consumption of a food category, a food, or one of its constituents significantly reduces a risk factor in the development of a human disease.

Textbox 6.4: Systems of self-regulation to distinguish between permissible and impermissible claims for functional foods and health products.

The Dutch food industry has implemented a system of self-regulation in the form of the *Leidraad Code Aanprijzing Gezondheidsproducten* (Guideline Code for the Promotion of Health Products; CAG), compliance with which is supervised by an independent council (see www.koagkag.nl). Under the code, health-related claims made for functional foods or health products are permitted only where 'there is absolutely no question of a claim which directly or indirectly asserts or infers a medical effect'. The CAG includes a list of almost one thousand health-related statements which serve as a guideline for preparing advertising content. The list is intended to establish the boundary between permissible and impermissible claims. However, from the consumer's point of view, it remains difficult to distinguish between 'for good blood pressure' (not allowed) and 'good for the blood pressure' (allowed).

Furthermore, a second form of self-regulation exists in the form of the *Nederlandse Reclame Code* (Netherlands Code of Advertising). Anyone who believes that an advertising statement contravenes this code may lodge a complaint with the Advertising Code Commission. Among its many provisions, the code states that 'advertising must be legal, decent, honest and truthful'. Accordingly, the Advertising Code Commission may investigate whether a statement contravenes the legal prohibition of medical claims under the Commodities Act.

(see *textbox 6.3*). Claims relating to reducing the risk of disease will be regarded as health claims, and will be permitted as well under certain conditions. The most important factor is that claims may only be made if they are supported by adequate scientific evidence. The scientific testing of the claims has been delegated to the European Food Safety Authority (EFSA).

6.4 Potential health gain

6.4.1 Who is likely to benefit from the use of functional foods and health products ?

In general, *healthy* consumers who adhere to the *Richtlijnen Goede Voeding* (Guidelines for Good Nutrition) will have no need for functional foods or health products, the consumption of which will result in little or no health gain for these consumers. However, in certain situations and for specific groups the use of functional foods and health products may represent health gain. An account of these situations is given below, whereby a distinction has been made between 'suppletion of a sub-optimal micronutrient status' and 'the reduction of disease risk and of disease burden'.

Suppletion of a sub-optimal micronutrient status
There are some groups of the Dutch population for whom the everyday diet does not provide the desired quantity of micronutrients. Additional intake of a specific vitamin is therefore advised for these groups (see *table 6.4*). In addition, it is standard practice to add iodine to baker's salt, cooking salt, table salt and pickling salt in order to ensure an optimal intake of iodine by the general population by means of the consumption of bread, bread replacers, and certain meat products. Additional micronutrients may also be useful for those who lack a properly balanced diet. Elderly people represent one group which is acknowledged to be at particular risk, especially those in long-term residential care (see *chapter 2*), largely due to poor appetite which leads to insufficient intake of food and nutrients. In terms of energy supply, the effects will not be particularly marked, since the group has a generally inactive lifestyle and hence a lower energy requirement. However, the requirement for micronutrients remains the same, whereupon there is a higher risk of suboptimal nutritional status. Similarly, disease and/or long-term use of prescription drugs can increase the requirement for certain micronutrients. Other possible at-risk groups include vegans, those following a macrobiotic diet and others whose intake of animal products is extremely low (Dagnelie, 2003). They are exposed to various risks, such as a vitamin B_{12} deficiency. Heavy drinkers are also seen as a high-risk group, since they generally have a less varied eating pattern. Moreover, alcohol restricts the absorption of vitamin B_1 in the intestines. Both elderly people and ethnic women who rarely venture outdoors run the risk of vitamin D deficiency due to lack of sunlight. Finally, those persons who avoid certain foods due to allergy or who follow a strict weight-reduction diet may develop a deficiency of certain micronutrients.

Table 6.4: Micronutrients for which supplementation in certain groups of the Dutch population is currently advised.

Subgroup	Micronutrient	Dose	Action	Remarks
Breastfed infants of up to three months	Vitamin K	25 µg/day	Blood clotting	Supplementation standard after birth. Supplementation not required when infants are bottle-fed because formula contains vitamin K.
Breastfed infants and children aged up to four years	Vitamin D	5 µg/day	Building bones and teeth	10 µg/d recommended for dark-skinned children who do not play outside much. Supplementation not required when infants are bottle-fed because formula contains vitamin D. When switching to ordinary milk, however, supplementation becomes necessary.
Women trying to become pregnant	Folic acid	400 µg/day	For the prevention of neural tube defects	Use: from 4 weeks prior to conception until 8 weeks afterwards.
Pregnant and lactating women	Vitamin D	5 µg/day	Building the child's bones and teeth	
Senior citizens: women aged 50 and above men aged 60 and above	Vitamin D	2.5-10 µg/day	Maintenance of bone mass	Supplementation recommended due to diminished capacity of ageing skin to synthesize the vitamin, reduced time spent outside, and lower absolute food intake. The dose is dependent on age and gender.

Reduction of the risk of disease and of disease burden

Nutrition can influence both the likelihood of developing certain diseases and the disease burden attributable to those diseases. Further to the Health Council's conclusions with regard to the claims which may be made for food products (see *section 6.3.3*), 'reducing risk' means the same as 'maintaining and/or improving health'. The use of certain functional foods or health products may indeed reduce the risk of (chronic) diseases. For example, products containing polyunsaturated fatty acids, products containing reduced levels of *trans* fatty acids, and products enriched with plant sterols and stanols have been shown to improve serum lipid status, thus reducing the risk of coronary heart diseases. Research is currently being conducted into the effects of specific food constituents in terms of the development and/or prevention of chronic diseases. Good examples include the studies on the effects of folic acid and flavonoids in reducing the risk of cancer and cardiovascular diseases, and the studies on the stimulating effects of prebiotics and probiotics on the large intestine function. Recently, prebiotic fibres have been added to baby food preparations in order to render the intestinal flora of bottle-fed babies closer to that of their breastfed counterparts, this being considered more optimal. Another recent development is the addition of inulin, a dietary fibre, to bread. This is also believed to have a positive effect on intestinal flora. Indeed, this claim has successfully withstood an assessment based on the Nutrition Centre's *Gedragscode* (Code of Conduct), accordingly the Centre accepts that the health-promoting effect has been satisfactorily proven. An example of the way in which disease burden can be reduced is the effect of certain probiotics on the duration of an episode of acute diarrhea in young children. Meta-analyses reveal a proven, albeit minor, reduction of one day (Van Niel *et al.,* 2002).

Unfortunately many functional foods and health products are promoted by means of claims which have not been scientifically proven, with regard to their ability to counter a number of common health problems. For example, foods are marketed that are claimed to improve resistance, reduce overweight, and cure insomnia, fatigue or memory loss (see *textbox 6.5*). In many cases, such claims are misleading for the consumer.

Textbox 6.5: Examples of claims made for specific ingredients in health products, found in free local papers.

Specific ingredient	Claim
Chromium	'Chromium helps you resist sweets' 'Lose weight without a struggle'
Coenzyme Q10	'Q10 gives your heart and gums new strength' 'A Q10 supplement may promote health and zest for life'
Selenium	'Selenium helps relieve painful joints'
Ginkgo biloba	'At last – a remedy for cold hands and feet ' 'Improved sexual performance' 'Now it is possible to restore your weak memory'

6.4.2 Health gain in practice

The degree of health gain that can actually be achieved *in practice* is likely to differ somewhat from that suggested by the results of the research phase. This is due to a number of reasons:

Dosage and usage
In clinical studies, the dosage, frequency of use, and the period of use for any functional food or dietary supplement are carefully controlled. In the everyday situation, consumers are free to use the products as and when they wish, and it is possible that they will not do so in strict accordance with the instructions or recommendations provided regarding the dosage, frequency and period of use. This may result in any health gain being reduced or obviated. An initial indication of this effect is given by the post-launch monitoring study conducted by Unilever into the user profile of its margarine products enriched with plant sterols. The study, ordered by the European Commission (SCF, 2002), revealed that consumers regularly use less margarine than is recommended. As a result, the effect on the LDL cholesterol level may also be lower than expected.

Interindividual differences

Other important factors that will affect the final health gain are the differences between individuals in terms of lifestyle (e.g. amount of regular exercise taken), nutritional status and habitual dietary pattern. It is possible that various compensatory mechanisms will be seen in practice (perhaps a person will start eating greater quantities of other foods). In a clinical trial situation there will either be controls for these mechanisms or they will play a less prominent part due to the greater uniformity of the study group. Due to these interindividual differences, the degree of health effect will vary from person to person. Accordingly, a positive health effect resulting from the use of certain products and as established in clinical trials, may not be seen in practice.

Consumer information

In order to achieve the greatest possible health gain, it is essential to ensure that the target group is reached. The consumer must receive good information, so that the product is known and is recognized as being of potential benefit by the intended target group. Moreover, efforts should be made to ensure that the product is not used by those who do not belong to the intended target group, while it is similarly important to ensure that consumers do not lose sight of the importance of traditional healthy foods, such as fruit and vegetables, wholemeal bread and traditional dairy products.

6.5 The converse situation: possible risks to public health

In addition to the potential beneficial health effects, the consumption of functional foods and health products can also bring risks. These are set out below.

Health risks of high doses often unknown

The bio-active substances currently being added to functional foods and health products are also found in the traditional diet. In most cases they occur naturally in foods, at low levels. Certain herbal ingredients included in health products have also been used for many years. Given that the traditional diet is generally regarded as safe, it may be assumed that exposure to these substances is also safe. However, this is not necessarily the case if the functional foods and health products which have been enriched with these specific substances are consumed *in addition to* the regular, traditional diet. Consumers may then be exposed to considerably higher doses. Simultaneous use of several products containing the same bio-active substance(s) can result in a higher dose being ingested, the effect known as ‘accumulation’. It could also be that the dose per product is higher.

Health products in particular may contain (extremely) high levels of certain substances. The question then arises as to whether the ingestion of such high doses is safe. To answer this question requires systematic research into the toxicity of the substances in question, whereupon the safe upper level can be established. To date, most herbs and bio-active substances have not been subject to such research and hence no safe upper levels are derived (the exceptions include a number of vitamins and minerals: see *table 6.3*). The possibility of adverse health effects further to the consumption of products which contain these substances therefore cannot be excluded. A good example is provided by the herbal preparations containing ephedra-alkaloids, which are marketed as slimming pills, as natural 'pep pills' or as a 'smart drug'. Ephedra-alkaloids are known to affect the functioning of the central nervous system. The ingestion of even small quantities increases the risk of hypertension, stroke, heart attack and psychoses. Simultaneous use with other stimulants, such as caffeine, may represent an undesired hazardous combination. The Dutch government has banned the sale of herbal preparations containing ephedra-alkaloids. Such preparations are now subject to the regulations governing medicinal products (VWS, 2004).

Risk of overdose

The risk of overdose is currently greatest in the case of vitamins and minerals. This is partly because the range of functional foods and dietary supplements which contain vitamins and minerals has increased greatly, and partly because there are dietary supplements available to consumers which contain extremely high levels of vitamins and minerals (see *table 6.5*). In order to assess the risk of overdosing on vitamins and minerals due to the consumption of functional foods and dietary supplements, the following section presents an estimate of the intake of these nutrients in the regular diet, in functional foods and in dietary supplements. The overall intake is then compared to the safe upper levels (UL) which have recently been established for a number of vitamins and minerals (see *table 6.3*). In the future, plant sterols and stanols may also present a risk of overdose, since the range of products containing these substances has recently been expanded to include cholesterol-lowering yoghurt and milk.

Not all health products meet legal requirements

A major problem attaching to health products is that of the availability (and hence consumption) of uncontrolled, banned products obtained via the Internet. Most of these products are supplied from overseas. Imports through the normal channels, by companies based in the Netherlands, are subject to supervision by the Food and Consumer Product Safety Authority. However, this is impossible in the case of direct sales via foreign websites. Consumers mistakenly believe that products from, say, the United States will have been tested there. The Food and Drug Administration (FDA) does not concern itself with products intended for export and not actually consumed in the United States. Consumers face an unknown risk in this situation. In 2001, the Dutch Inspectorate for Health Protection and Veterinary Public Health conducted a study of suppliers of health products being offered on the Internet (Van Korven, 2001). The study identified 153 suppliers and went on to examine 3644 preparations being offered by 62 companies. Many did not meet the legal requirements in place in the Netherlands. Approximately 10% of the vitamins was dosed in too high levels. Of the herbal preparations examined, 118 were classified as 'high-risk', with 16 actually banned outright in the Netherlands. High levels of zinc and selenium were also found in some products. Forty-six percent of the 62 companies studied made medical claims which are prohibited in the Netherlands. Other problems with health products include the contamination of these products with for instance heavy metals and polycyclic aromatic hydrocarbons.

Risk of interactions

The use of high doses of certain substances in functional foods and health products can affect the absorption and metabolism of other nutrients or prescription drugs. A physiological imbalance may also occur. Examples of effects on the absorption include the reduced absorption of ß-carotene (resulting in a lowered serum ß-carotene level) further to the ingestion of plant stanols and sterols, and the mutual interaction of minerals and trace elements (iron, copper, zinc, magnesium, calcium) during the process of absorption. If functional foods and health products are used simultaneously with certain prescription drugs, there may be interactions at the metabolic level. This may cause the effect of the drug to be reduced or perhaps even enhanced. One example is Saint John's Wort, which is known to interfere with the effect of prescription anti-depressants. Physiological imbalance may occur following the ingestion of high doses of antioxidants such as ß-carotene and vitamins C and E. This high intake can disrupt the antioxidant process, and the component in question can actually begin working as a pro-oxidant. This phenomenon has been demonstrated in two large-scale trials, the ATBC trial and the CARET study, in which high levels of ß-carotene were administered to smokers (Omenn *et al*., 1996; ATBC, 1994). Both studies were halted prematurely because the combination of smoking and high ß-carotene intake was found to result in an increased incidence of lung cancer and death among smokers.

6.6 Consumption of functional foods and dietary supplements containing vitamins and minerals in the Netherlands

As may be seen from *sections 6.4* and *6.5*, the positive effects on health offered by functional foods and dietary supplements with extra vitamins and minerals can be accompanied by potential risks in terms of an overdose of vitamins and minerals. It is important to gain an understanding of the possible extent of overdosing and the risk to public health if we are to arrive at a balanced consideration of the potential health gain of these products, versus their potential health loss (see *chapter 7*). To this end, it is therefore necessary to quantify the Dutch population's consumption of vitamins and minerals via functional foods, dietary supplements and the regular diet.

In the case of functional foods and dietary supplements, no suitable recent intake data is available. In principle, the national VCP ('Dutch National Food Consumption Survey') ought to be able to provide data regarding functional foods and dietary supplements. However, the most recent full survey was held in 1997/98, at which time the enrichment of products with vitamins and minerals had only recently been authorized (in 1996). It seems probable that the intake of vitamins and minerals has increased markedly in recent years, due to the emergence and burgeoning popularity of functional foods and dietary supplements. A national VCP was conducted in late 2003, but was restricted to persons aged between 19 and 30. At the time of writing, the results of this survey were not available. However, studies conducted by TNS NIPO, NIVEL and Consumers' Association panels do provide some more recent information concerning the frequency with which the public make use of functional foods and dietary supplements (Van de Pol & Duijser, 2003; De Jong *et al*., 2003). Based on the available information, we present below an *estimate* of the intake of a number of vitamins and minerals, both in the regular diet and by means of functional foods and dietary supplements. We also examined which vitamins and minerals exceeded the safe upper level (UL). *The results should be regarded as indicative.*

6.6.1 Functional foods containing vitamins and minerals

Supply

Between July 1996 and December 2001, the Inspectorate for Health Protection and Veterinary Public Health registered 288 food products to which micronutrients had been added. The majority (52%) had been enriched with B vitamins, followed by those with added vitamin C (12%), vitamin E (9%), calcium (6%) and iron (4%). In 15% of cases, the resulting content was greater than the recommended daily intake, particularly that of vitamin C. A considerable number of products had been subject to the addition of substances which, at that time, were not permitted in the Netherlands: 71 contained additional folic acid, 15 contained vitamin D, 17 contained zinc, 8 contained copper and 5 contained added selenium. There were sixteen registrations for which it was not clear whether the added vitamin A was in the form of ß-carotene or retinoids (Konings, 2001). Because manufacturers do not 'de-register' products when they are withdrawn from the market, it is not known whether all the products concerned are still available on the Dutch market. In 1998, almost 4% of the 1199 coded products examined by VCP-3 (third Dutch National Food Consumption Survey; 1997/98) fell into the category 'enriched products'. A further investigation conducted by the RIVM in July 2002 found 145 articles in a major national supermarket chain to which one or more micronutrients had been added (Jansen *et al*., 2004). The B-vitamins (together 46%) and vitamin C (16%) were found most frequently, followed by calcium (12%), vitamin E (10%), and iron (8%).

Consumption

According to VCP-3 (1997/98), almost 7% of the total Dutch population consume one or more enriched food products. The lowest level of consumption was noted among those aged 50 and above (4%), with the highest level among children from 1 to 12 years of age (14%). The product group most widely consumed is that of the fortified cereals, followed by beverages with added vitamins. On average, the enriched products provide consumers with 5-20% of the recommended daily intake of calcium, iron, and vitamins A, B_1, B_2, B_6 and C in the diet. If the data on consumers is extrapolated to the level of the entire population, this means that enriched products in 1997-1998 contributed between just under 0.5% and over 1% to the overall intake of vitamins and minerals (Anonymous, 1999).

6.6.2 Dietary supplements containing vitamins and minerals

Supply

In 2002, the Dutch Consumers' Association made an inventory of the vitamin supplements (both with and without minerals) available in the Netherlands. Supplements containing only minerals were not included. A total of 369 products were identified. The levels of the vitamins and minerals in dietary supplements was found to vary enormously per unit. *Table 6.5* shows the percentage of dietary supplements in which the dose per unit exceeds the UL. The percentage is highest for vitamin B_6 (16%). The dosages of several other vitamins and minerals also exceed the UL. The degree to which the UL is exceeded varies markedly. High, or extremely high, excesses were found in dietary supplements which contain minerals: selenium (up to 11 x UL) and molybdenum (83 x UL). Excess levels ranging from slight to substantial (up to 5 x UL) were noted for the vitamins. All supplements in which the unit dose exceeds the UL can, if consumed daily, present a health risk. For example, consumption of selenium in excess of the UL can result in selenium-intoxication, with damage to the peripheral nervous system, and deformities of the nails, teeth and hair. Intake of vitamin B_6 in excess of the UL can result in neurotoxic effects.

Table 6.5: Percentage of the dietary supplements available in the Netherlands in 2002 which were found to contain levels of vitamins or minerals in excess of the UL, and the extent to which the UL was exceeded.

Vitamin/ Mineral	UL	Number of products containing the vitamin/mineral in question	Percentage products containing the vitamin/ mineral in question in which dose >UL	Highest dose per unit expressed in multiples of the UL
Vitamin A	3000 µg RE[1]	116	2	1.3
Vitamin D	50 µg	154	0	0.4
Vitamin E	300 mg αTE[2]	162	2	3.7 (1.3*)
Vitamin B_6	25 mg	199	16	5
Folic acid	1 mg	172	0	0.8
Calcium	2500 mg	129	0	0.1
Magnesium	250 mg	118	1	4.1 (1.0*)
Copper	5 mg	113	0	0.6
Iodine	600 µg	89	1	370 (0.3*)
Zinc	25 mg	134	1	18 (1.6*)
Selenium	300 µg	108	6	520 (11.3*)
Molybdenum	0.6 mg	61	5	83

[1] RE: retinol equivalents (retinol and retinyl esters)
[2] αTE: α-tocopherol equivalents
* One supplement contained extremely high doses of several vitamins and minerals. Therefore, for some vitamins and minerals, the next highest dose is given between brackets.

Consumption

The various VCPs (Dutch National Food Consumption Surveys) reveal that the proportion of the Dutch population taking dietary supplements increased from 20% in 1992 to 24% in 1998. According to the 1997/98 survey, young children mainly take vitamin A and D supplements. Consumption is lowest among young people aged 10 and 16: if they take a dietary supplement at all, it is most likely to be a multi-vitamin preparation. Overall, women take dietary supplements more often than men (20% women against 14% men). Elderly people tend to do so more often than those aged between 22 and 50 (Voedingscentrum, 1998). In 2000, 20% of the respondents on the NIVEL/Consumers' Association panel used a multivitamin preparation on a daily basis. Within this panel it was found that women take dietary supplements more often than men, and age was shown to be a determinant of the usage of some products, findings confirmed by a survey of the TNS NIPO respondents panel (Van de Pol & Duijser, 2003; De Jong *et al*., 2003).

Two realistic 'worst case' scenarios

In order to determine the possible extent of (over) exposure to vitamins and minerals, we now present two realistic 'worst case' scenarios, based on the current availability of functional foods and dietary supplements with vitamins and minerals in the Netherlands.

1) Intake via regular diet, functional foods and dietary supplements by adult Dutch males

The first scenario has been worked out for men in the age group 22 to 50, because this group represents the 'biggest consumers' in terms of quantity. The calculations rely on information taken from three different database sources. The average daily intake established by the 1997/98 Food Consumption Survey has been taken as the starting point. To this, we have added the information derived from the RIVM supermarket investigation of functional foods enriched with vitamins and minerals (Jansen *et al*., 2004). For the most commonly occurring vitamins and minerals in enriched products, all of the common products from the 1997/98 Food Consumption Survey have been replaced by a similar functional food product if that product was found in the supermarket in question. One example is the substitution of the product 'acid drops' by fruit-flavoured sweets enriched with a number of vitamins. A so-called realistic 'worst case' scenario approach has been applied; all acid drops have been replaced by enriched sweets, while products targeting only children were excluded from the calculations. Also, the intake of dietary supplements has been estimated using the information derived from the 2002 Consumers' Association study (Consumentenbond, 2002), in which the average quantity of a vitamin or mineral per unit (tablet/capsule) was established. The estimate is based on the assumption that consumers will take one unit per day. The results are shown in *table 6.6*, which also compares the intake levels to the recommended daily intake and the safe upper level. The table reveals that the contribution to the total intake made by dietary supplements is (far) greater than that of the functional foods. In all cases, the total average intake from (ordinary and enriched) foods and supplements is higher than the recommended daily level, particularly in the case of the B vitamins and vitamin C. However, the ULs are not exceeded.

Table 6.6: Average daily intake of several specified vitamins and minerals (Dutch men aged 22-50) via the regular diet, functional foods (based on a realistic 'worst case' scenario) and dietary supplements (one unit per day). The intake is calculated using information derived from the 1997/98 Food Consumption Survey, an inventory of functional foods in a Dutch supermarket, and a Consumers' Association study of dietary supplements. The total intake is expressed in mg/d and is shown in comparison to the recommended daily allowance (RDA) and safe upper level (UL).

	Average intake			Total intake		
Vitamin/ mineral	Via regular diet (mg/d)	Via FFs (mg/d)	Via dietary supplements (mg/d)	mg/d	Number of times the RDA	Number of times the UL
Vitamin A	1	0.1	0.6	2	2	0.6
Vitamin B_1	2	0.4	16	18	17	- [1]
Vitamin B_2	2	0.4	15	17	15	-
Vitamin B_6	2	0.4	17	19	13	0.8
Vitamin C	75	6	285	366	5	-
Vitamin D[2]	4	0.1	4	8	3	0.2
Vitamin E[3]	15	3	48	66	-	-
Magnesium	381	3	66	445	1.4	0.3[4]
Calcium	1065	42	113	1220	1.2	0.5
Iron	13	0.1	8	21	2	-

[1] -: UL not derived
[2] In µg/d
[3] In mg α-tocopherol equivalents/d (vitamin E in dietary supplements often consists entirely of α-tocopherol)
[4] Calculated for the total intake of FFs and supplements (excluding the regular diet) since the UL was derived for the amount of magnesium added to foods (excluding the regular diet).

2) Intake via regular diet and dietary supplements by the Dutch population

As may be seen from *table 6.5*, a number of dietary supplements contain extremely high levels of vitamins and/or minerals. To establish whether the UL is exceeded when taking such supplements in addition to the regular diet, and if so by how much, we have worked out a second scenario. Here, the total intake (via the regular diet and one dietary supplement) of a number of vitamins and minerals included in the Consumers' Association study has been calculated for the entire Dutch population. The calculation is based on the daily consumption of a dietary supplement with an average dose or a high dose (90th percentile of all dietary supplements containing the particular vitamin/mineral, as included in the Consumers' Association survey) in combination with the regular diet (see *table 6.7*). Unlike *table 6.6*, *table 6.7* does not consider the functional foods since their contribution to overall intake is small. Moreover, the information presented in this table relates to the entire Dutch population, rather than only men aged 22-50. (Although this group has the greatest overall consumption, it also has the lowest intake of dietary supplements). The total intake of vitamins and minerals by the Dutch population, assuming daily consumption of one dietary supplement with an average or high dose (90th percentile) per unit alongside the regular diet, is expressed as a multiple of the RDA and the UL. As shown by *table 6.7*, the total intake of vitamins through the regular diet in combination with a dietary supplement exceeds the RDA in all cases, with the exception of folic acid. The degree of excess is greatest in the case of the B vitamins (B_1, B_2, B_6 en B_{12}). For vitamin B_6 the UL is also exceeded when taking a high-dosage dietary supplement alongside the regular diet. No ULs have been established for vitamins B_1, B_2 and B_{12} due to the paucity of available information. Studies of these vitamins suggest that the intake levels calculated here are unlikely to give rise to any adverse health effects. However, in the absence of systematic toxicity studies, undesired health effects cannot be completely discounted, particularly when taking high-dosage dietary supplements. The RDA of minerals is exceeded in half the cases, although the degree to which this is the case (up to two times the RDA) is much smaller than for the vitamins. The UL for minerals is not exceeded.

Table 6.7: Total daily intake of vitamins and minerals by the Dutch population, assuming daily use of one dietary supplement with an average or high dose (90th percentile) per unit, in addition to the average intake by means of the regular diet. The calculated daily intake, via the regular diet and a dietary supplement, is also expressed as a multiple of the recommended daily allowance (RDA) and the safe upper level (UL).

		Daily use of one dietary supplement with an average dose per unit in addition to the regular diet		Daily use of one dietary supplement with a high dose per unit in addition to the regular diet	
Vitamin/ mineral	Average intake via regular diet (mg/d)	Intake of one dietary supplement with and average dose (mg/d)	Total intake via regular diet and dietary supplement expressed in number of times the RDA / UL	Intake of one dietary supplement with a high dose (90th percentile) (mg/d)	Total intake via regular diet and dietary supplement expressed in number of times the RDA / UL
Vitamine A	1	0.6	2 / 0.6	1	2 / 0.7
β-Carotene	0.8	0.1	- / -[1]	0.3	- / -
Vitamin B_1	1	16	16 / -	50	47 / -
Vitamin B_2	1	15	15 / -	50	47 / -
Vitamin B_6	2	17	12 / 0.7	50	34 / 2
Folic acid	0.2	0.2	0.8 / -[2]	0.4	1.3 / -[2]
Vitamin B_{12}[3]	2	33	12 / -	50	18 / -
Vitamin C	79	285	5 / -	1000	14 / -
Vitamin D[3]	4	4	3 / 0.2	5	3 / 0.2
Vitamin E[4]	7	48	4.8 / 0.2	134	12 / 0.5
Potassium	3434	21	- / -	44	- / -
Phosphorus	1471	64	0.1 / -	125	0.1 / -
Copper[3]	1100	18	0.4 / 0.2	50	0.5 / 0.2
Selenium[3]	42	0.1	0.4 / 0.1	0.1	0.4 / 0.1
Zinc	9	0.8	1.3 / 0.4	1	1.3 / 0.4
Iodine[3]	89	0.1	0.9 / 0.1	0.2	0.9 / 0.1
Magnesium	309	66	1.2 / -[5]	108	1.3 / -[5]
Calcium	992	113	1.1 / 0.4	203	1.2 / 0.5
Iron	11	8	2 / -	14	2 / -

[1] -: Not derived
[2] Calculation not possible as the UL was derived for the amount of synthetic folic acid (excluding the regular diet)
[3] In µg/d
[4] In mg α-tocopherol equivalents
[5] Calculation not possible as the UL was derived for the amount of magnesium added to foods (excluding the regular diet)

6.7 Criteria for weighing health gain against health risk

6.7.1 Health gain

In weighing the potential health gain against health risk, it is essential to have information concerning the quantity of scientific evidence in favour of any health gain. Here, 'health gain' is defined as the degree to which the Dutch population will be healthier, due to the reduction in incidence of disease or death *or* an improvement in physical function and/or the quality of life (see *figure 6.1*). In order to determine an actual health gain, we must establish a direct relationship between the product under consideration and one of the health outcomes (as indicated by the red arrow in *figure 6.1*), or an indirect relationship between the two (the blue arrows). This can only be achieved by means of adequate research.

For functional foods and health products, this direct or indirect relationship has not been satisfactorily demonstrated in most cases. *Chapter 7* provides an account of a few 'sample' foods, dealing with the extent to which such relationships have been subject to research in the past. The relationship between a product and a health outcome (whether directly, or indirectly by means of an effect on a health intermediary) is assumed to have been adequately investigated and established only when there is 'convincing' or 'reasonable' evidence, as defined by the World Health Organization. According to the WHO, it is possible to distinguish the following types of evidence based on studies in humans (WHO, 2003):

1) Convincing evidence: the results of several epidemiological studies, including prospective observational studies and, where relevant, randomized double-blind clinical trials, all point in the same direction. These are studies in which the health effect of the product is tested with sufficient distinguishing power, over a sufficiently long period, among a group of volunteers and/or patients in controlled conditions. Such studies should be conducted among populations which represent the intended target group of the functional food or health product being tested. Moreover, the relationship between the product and the health outcome must be biologically plausible.
2) Reasonable evidence: the results of various epidemiological studies point in much the same direction, although there may be a number of grey areas due to too few studies having been conducted, a lack of distinguishing power, or too short a duration, etc. Here too, relationships must be biologically plausible.
3) Possible evidence: the only information available has been derived from cross-sectional or case control studies.
4) Insufficient evidence: the results of a few studies suggest a relationship, but further research is required.

When weighing possible health gain against health risk, it is also necessary to know the dosage range of the active ingredient (and the corresponding quantity of the

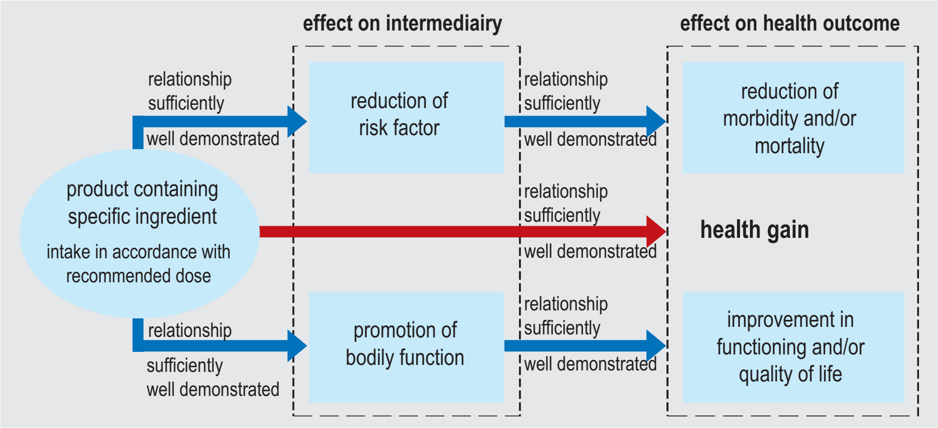

Figure 6.1: Illustration of relationships between product, intermediary and health outcome which must be adequately proven before there may be any question of health gain.

product) which is likely to have an effect on health: the intended effective dosage range. This information is necessary to determine whether there is any overlap between the intended effective dosage range and the range at which health risks will emerge.

6.7.2 Health risks

A weighing of health gain against health risk will also require information about any toxic effects and the dosage at which such effects will become apparent. To arrive at such information requires investigations to establish the acute toxicity (the level at which a single dose is toxic in the short term) and chronic or semi-chronic toxicity (the degree to which the substance is toxic when administered over a longer period). With this information to hand, it is possible to establish the safe upper level of intake (such as the UL for vitamins and minerals). The UL is calculated using a method comparable to that used to calculate the acceptable daily intake (ADI) (see *section 4.3.3*). Information derived from human studies is more frequently available to support the calculation of the UL, accordingly the uncertainty factor applied is usually smaller than that used in establishing the ADI. The UL of a vitamin or mineral is the maximum quantity that a person can ingest every day for his or her entire lifetime without experiencing any adverse health effects. An intake in excess of the UL could result in health risks, whereby such an intake is defined as the 'at-risk dosage range' (see *chapter 7, figure 7.2*). In the case of food constituents such as vitamins and minerals, there is also a second 'at risk dosage range', being that *below* the RDA, at which adverse effects may appear as the result of deficiencies (see *chapter 7, figure 7.2*).

6.7.3 Pitfalls

A number of considerations must be taken into account when weighing the possible health gain against the possible health risk offered by functional foods and health products.

- The literature frequently considers the effect of a specific nutrient or non-nutrient with regard to a specific health outcome, as in the case of dietary fibre and fat. However, it is difficult to ascribe the health effects observed to one particular product. Rather, they are due to the overall dietary pattern and thus the total intake of fat and fibre. It is therefore difficult to quantify the health gain represented by a specific functional food or health product, as is the case for products enriched with linoleic acid or additional dietary fibre.
- Data to support 'convincing evidence' is not always available. In many cases, the clinical studies conducted examine the effect of the products on intermediary indicators, and not on health outcomes such as death and disease. This is the case for studies into the effects of plant sterols, which have been shown to have a clear effect on serum LDL cholesterol levels (effect on intermediary indicator, see *figure 6.1*). However, there have been no studies examining the effect of plant sterols on coronary heart diseases (the health outcome, see *figure 6.1*). Because several other studies conclude that there is indeed a direct relationship between serum LDL cholesterol and coronary heart diseases (i.e. the relationship between intermediary and outcome), it is assumed that the consumption of, say, margarines enriched with plant sterols will indeed reduce the incidence of coronary heart disease, and that there is therefore a relationship with the health outcome.
- In the ideal situation, research into the effects of an ingredient of a product should take into account its bioavailability (the degree to which the active ingredient is actually absorbed into the body), as is already the case in clinical trials of pharmaceutical products. Bioavailability can vary substantially between products, whereupon the amount of the active ingredient that enters the body will also vary. As a result, the situation can arise in which two products (e.g. milk and breakfast cereals) contain equal doses of the same substance, yet one may be effective, and the other less so or not at all (Clifton *et al.*, 2004). In practice, this aspect is rarely considered.
- Alongside these matrix effects, the dosage level and the combination of added nutrients must also be considered. Added ingredients can indeed result in potential health gain, but some products contain such small amounts that they will have little or no effect. Combining nutrients, or failing to do so, may also limit their effects. Some minerals 'compete' with each other in the intestines, and the addition of for example extra calcium to a product has little point if vitamin D is the limiting factor.
- Finally, it should be noted that some positive effects will be experienced only by specific subgroups, as in the case of functional foods containing plant sterols. The consumption of such products is only useful for those with an elevated cholesterol level, and is certainly not relevant to the population as a whole. In fact, undesirable effects could occur, such as in this case a reduction in the serum ß-carotene level, the long-term consequences of which remain unknown.

See *chapter 7* for details of the weighing of health gain against health risk in some functional foods and health products.

6.8 Summary and conclusions

This chapter addresses functional foods and health products, including the dilemma between health and safety. The interaction between the consumer and the food industry have placed functional foods and health products in the spotlight. The consumer has shown interest in food products which are both convenient and healthy. The industry has addressed this interest by developing products which promote good health. It seems likely that the sales of functional foods and health products will continue to rise, and that an even greater range of such products will become available. Clear legislation and further research in this field are therefore required in order to protect consumers.

Various types of product claims are currently permitted in the Netherlands. However, in many cases there is insufficient evidence on which to base a clearly formulated claim, whereupon consumers can be misled. In addition to positive health effects, which will usually be confined to specific target groups, the consumption of these products can also bring certain health risks. Take, for instance, various high-dosage dietary supplements that are currently on the market. Moreover, interactions can occur in some cases.

New European legislation regarding functional foods and dietary supplements is currently being prepared. Under current proposals, health claims may only be used if they have been scientifically proven. A consistent assessment methodology must be developed for this purpose. Safe upper levels for vitamins and minerals are now being established to prevent excess intake (overdose). At present, little is known about the actual consumption of functional foods and health products. This renders it difficult to assess the health effects at population level. In order to elucidate this situation, recent quantitative consumption data for ordinary food products, functional foods and health products must be obtained. Accordingly, it is extremely important that the functional foods and health products are included in future food consumption surveys. Wherever possible, this information should be compared to that relating to the respondents' nutritional and health status, and to other lifestyle factors. Only then will it be possible to establish by means of intake calculations whether the safe upper levels are indeed being exceeded, and whether any specific health risks have arisen for the Dutch public as a whole, or by certain sub-groups.

This chapter concludes with an account of the criteria to be observed when making any qualitative assessment of the positive effects (health gain) versus possible negative effects (health risk) of functional foods and health products. The criteria for establishing a health gain include sufficient evidence for a positive effect on a given health outcome. The intended effective dosage range must also be known. Systematic toxicity studies are required to determine the health risk, and a safe upper level of intake should be derived. A qualitative consideration of a number of functional foods and health products is presented in *chapter 7*.

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7 HEALTH GAIN AND HEALTH LOSS: Healthy diet and safe food in a broader context

7.1 Introduction: what questions are to be posed ?

As the preceding chapters make clear, there are various fronts on which health gain can be achieved through a better diet. *Chapter 2* examined the composition of the Dutch diet (with regard to five important dietary factors relating to the intake of fatty acids and the consumption of fruit and vegetables). *Chapter 4* considered microbiological and chemical contamination, while *chapter 6* focused on specific health-promoting foods ('functional foods') and health products.

Where possible, the potential health gain to be achieved was calculated or estimated in quantitative terms. (In *chapter 2* it was possible to do so, in *chapter 4* it was only partially possible to do so; in *chapter 6* it was not possible at all). To be more accurate, these chapters usually presented a calculation of the *health loss* currently experienced, compared to the ideal situation, for example the mortality or incidence of disease directly attributable to the fact that a large proportion of the Dutch population eat less than the recommended quantity of fruit and vegetables. The health loss is assumed to be equivalent to the health gain which can be *theoretically* achieved given appropriate interventions. In some cases (*section 2.4*), various intervention scenarios were formulated: one for the *maximum theoretical health gain*, and one for the *realistically feasible health gain*, which is usually smaller.

The quantifiable health loss or health gain is usually expressed in various ways:

- The number of new cases of a disease ('incidence') attributable to the factor.
- The number of deaths attributable to the factor.
- The number of DALYs (Disability Adjusted Life Years), derived from the figures for incidence and mortality (see *appendix 12*). This is also referred to as the 'total health loss'.

In most cases, these figures are presented on an annual basis. In the case of some important dietary factors (and other lifestyle factors: see *section 7.4*), we have also calculated the overall effect over a period of twenty years, or the effects on life-expectancy over an even longer period. These approaches are more realistic, in that they take the 'replacement effect' into account. If one cause of death is considerably reduced through interventions, the probability of the people thus 'spared' becoming ill or dying from another cause gradually increases. A more detailed explanation of this phenomenon is to be found in *chapter 2* and *appendix 12*.

This chapter places the calculated health loss and potential health gain figures in a broader perspective. The following three questions are posed:

1. Where a particular food or food product (e.g. fish) has both a beneficial health effect (such as a favourable fatty acid composition) and a potential risk (dioxin con-

tent), how do these two effects compare to each other?
2. How do the calculated effects of dietary factors compare to the mortality and disease caused by other lifestyle factors?
3. What is the overall picture with regard to the health loss due to an unhealthy diet, unsafe food and other causes?

To answer the first of these questions, we elaborate a number of examples in *section 7.2*. In *section 7.3,* we examine a number of functional foods and dietary supplements (see also *chapter 6*), in an attempt to weigh the health promoting effects against the risks. The second question is addressed by comparing the health effects of a number of important dietary factors (as presented in *chapter 2*) against those of other lifestyle factors such as smoking, physical activity and alcohol consumption (*section 7.4*). Finally, *section 7.5* deals with the third question by comparing the effects presented in *chapters 2* and *4* with each other and with the total health loss caused by major diseases in the Netherlands.

7.2 Health versus safety in common foods

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7.2.1 Approach

As described in *section 2.2*, recommendations have been formulated for the optimum intake of fatty acids, fruit and vegetables, and wholegrain products. Advice is also provided with regard to breastfeeding. These recommendations are based on the beneficial health effects of these foods and food constituents. However, these 'healthy' foods can also contain substances which may be threats to health. As stated in *chapter 4*, the levels of microbiological and chemical contaminants in foods are minimized by means of legislation and inspection. However, food producers do not always manage to remain within the stated maximum limits. If people adopt a *healthier* diet (more fruit and vegetables, wholegrain cereal products, fish, breastfeeding) there is also a greater *risk* of ingesting the undesirable contaminants. How are we to arrive at an appropriate balance between health and risk?

One way of doing so is to make a quantitative comparison of the positive health effects of eating healthy foods and the health risks posed by the contaminants they may contain. This quantification is no simple undertaking, for several reasons:
(1) The nature of the health effects varies considerably, from acute illness and intoxications to long-term chronic disease.
(2) The certainty with which a food factor can be directly associated with a particular health effect can vary greatly. In general, the effects calculated on the basis of epidemiological studies are seen as 'harder' than those extrapolated from animal tests.

[#] With contributions by A.J. Baars, A.H. Havelaar, Y.T.H.P. van Duynhoven, F.M. van Leusden

Nevertheless, we shall attempt to make a quantitative comparison here. In doing so, we use the concept of 'Disability Adjusted Life Years' (DALYs), being the total of life-years lost due to a given cause and the life-years spent with a disease, weighed according to the severity of the disease (see *appendix 12*). Using this method, it becomes possible to bring together adverse health effects of very differing nature under one heading. In *chapter 2*, the health loss attributable to a series of dietary factors is expressed as 'DALYs to be regained', while a similar exercise for a number of microbiological and chemical contaminants is undertaken in *chapter 4*.

Apart from the technical problems involved in making any accurate quantitative estimates, there are also differences regarding the question of who is responsible. For example, the risk attached to low consumption of fruit and vegetables is largely the responsibility of the consumer, being a matter of personal choice. However, the consumer has no influence over the levels of nitrate or dioxins in food products. Accordingly, it is the aspect of safety for which the government has developed comprehensive legislation. The objective is to ensure that public exposure to avoidable contaminants is reduced to such a level as to render the health risks negligible (see also *chapters 4* and *5*). The perception of risk is also relevant here: risks that individuals consciously choose to accept are regarded as far less serious than those over which one has no personal influence (*chapter 8*).

Table 7.1: Examples of foods for which increased consumption is recommended, with their associated health risks.

Food	Recommended consumption	Protects against	Risks from	Possible adverse effects
Fish (especially fatty species: herring, eel, salmon, mackerel)	Eat fish at least 1x per week	Cardiovascular diseases by improved fatty acid composition (ω-3-fatty acids)	Dioxins and PCBs, organic mercury (especially in predatory fish, such as tuna, swordfish)	Especially chronic toxicity
Fruit and vegetables	200 grams per day of each	Cardiovascular diseases, some cancers	Phytotoxins and phytoestrogens in various plants Nitrate in leafy vegetables, from fertilizers Pathogenic Micro-organisms on raw vegetables	Acute/Chronic toxicity Methaemoglobinemia, carcinogenicity by nitrosamines Gastroenteritis
Wholegrain cereal products (bread, breakfast cereals)	At least 3 g fibres/MJ (or approx.10 g/day)	Obesity, cardiovascular diseases, type 2 diabetes	Mycotoxins: DON on cereals	Acute/chronic toxicity
Human milk	Breastfeeding until at least 6 months after birth	Child: middle-ear inflammation, asthma, cognitive development; Mother: pre-menopausal breast cancer	Dioxins and PCBs,	Chronic toxicity

This chapter presents and elaborates several examples of foods for which the consideration of 'healthy' versus 'safe' is appropriate. The examples are derived from the topics and recommendations described in *chapters 2* and *4*, and are shown in *table 7.1*.

7.2.2 Results of the comparison

Table 7.2 shows the possible health-promoting and health-threatening effects which may occur in association with the consumption of each of the four example food products, according to the recommendations.

Fish

The *health gain* to be achieved in terms of avoidable illness and mortality from cardiovascular disease if everyone in the Netherlands were to eat fish at least once a week has been calculated to be approximately 82,000 DALYs (see *chapter 2*). This is comparable to the total health loss due to road traffic accidents or breast cancer (see *table 7.5*).

The *health-threatening risk factors* attaching to the consumption of (oily) fish are the environmental contaminants dioxins, PCBs and organic mercury (see *chapter 4*). It was not possible to estimate the actual health loss attributable to any of these contaminants in DALYs. However, qualitative indications can be given.

Exposure of the general population to *dioxins and PCBs* mainly takes place via the diet, and most especially in products of animal origin. On average, the consumption of fish contributes approximately 16% to the total intake of dioxins and approximately 27% to that of PCBs. However, there is considerable deviation: the oily fish varieties such as herring, eel, salmon, mackerel and tuna, contain extremely variable levels of dioxins and PCBs, and in some cases these levels can be quite high (Leonards *et al*., 2000). Moreover, the level of fish consumption also varies considerably. The real 'afficionados' who eat fish at least twice a week (approximately 6% of the population), may have a dioxin intake which is one-and-a-half or two times the average intake derived from a regular diet (calculation based on: Freijer *et al*., 2001; Bakker *et al*., 2003). The application of product norms to fish results in only a limited reduction in dioxin intake (2 to 8%, assuming fish consumption once per week; Hoogenboom *et al*., 2001).

As stated in *chapter 4*, approximately 8% of the population exceed the intake norms for dioxins and PCBs on a longer-term basis. However, because the effects of dioxins and related substances will only become manifest following long-term exposure at a level well above the intake norm (which incorporates a substantial safety margin), even those who eat fish more frequently are unlikely to experience any marked adverse health effects (see also *textbox 7.1*). Recent years have seen a reduction in the average intake of organic mercury in fish, bringing the level well below the international norm.

Table 7.2: Comparison of possible health gain and possible health loss for four groups of foods.

Food: effect	Gain in DALYs[1]	Risk factor/contaminant: effect	Loss in DALYs
• Fish: reduction in cardio-vascular diseases via ω-3 unsaturated fatty acids	• 82,000	• Dioxins, PCBs: various effects • Organic mercury: neurotoxicity	• Probably low • Low/absent
• Vegetables: reduction in CHD, lung cancer • Fruit: reduction in CHD, CVA, stomach-, lung-, and breast cancer	• 47,000 • 95,000	• Phytotoxins: various effects • Phytoestrogens: effects unclear • Nitrate -> nitrite: methaemoglobinemia • Nitrate -> nitrosamines upon combination with fish: cancer • Foodborne infections: especially on raw vegetables	• Probably low • Probably low • Low • Approx.100-500 DALYs • Approx. 50-200 DALYs
• Wholegrain cereal products: fibre reduces obesity, type 2 diabetes, cardiovascular diseases	• > 10,000 *(appendix 12)*	• DON: possible transient growth retardation	• Effect transient, cannot be quantified
• Breastfeeding: in infants reduction in inflammation of the middle ear (by up to 50%), asthma, disorders of the lower respiratory tract; promotes cognitive development; in mother reduction of pre-menopausal breast cancer	• Approx. 1,000-2,400, asthma and inflammation of the middle ear *(appendix 12)*	• Dioxins in human milk: small effect on neurological and cognitive development; early start to build-up of body load • HIV transmission	• Low • Can be prevented by screening and treatment

[1] In all cases, this involves DALYs on an annual basis. As in section 7.5, the figures used here for the DALYs from *chapter 2* are those for the maximum scenario, since these correspond to the total disease burden attributable to the factor in question.

The conclusion is therefore that the health risk posed by possible contamination of (oily) fish is marginal when compared to the substantial health gain which can be achieved through regular consumption.

Fruit and vegetables

First, we consider the *health gain* (in terms of avoidable illness and mortality from cardiovascular diseases and various types of cancer) that can be achieved were everyone to consume the recommended quantity of fruit and vegetables (200 grams per day of each). This health gain is calculated to be approximately 95,000 DALYs for fruit and 47,000 DALYs for vegetables. This is in the same order of magnitude as the health loss due to insufficient consumption of fish (see *section 2.4* and *table 7.2)*.

Textbox 7.1: Organic pollutants in farmed salmon.

In an article in Science (January 2004), Hites *et al.* describe the presence of persistent organic pollutants (POPs) in wild and farmed salmon from Europe, North and South America. The authors conducted extensive research, analysing some six hundred individual samples. Their conclusion was that farmed salmon generally contains higher levels of POPs than the wild equivalent, and that farmed fish from Europe is more heavily contaminated than that from the Americas. In weighing the beneficial effects of consumption of oily fish (due to the presence of the n-3 fatty acids) against the negative health effects attributable to the presence of POPs, the researchers focused on dioxins, PCBs, toxaphene and dieldrin in particular. Based on the American Environmental Protection Agency's risk estimates with regard to the possible development of cancer, and the assumption that such risks are cumulative, the researchers recommended that farmed salmon should not be eaten more than once or twice a month.

This recommendation has come under fire from various quarters. The World Health Organization stated that the article provides no reason to revise its standpoint on the consumption of fish. In February 2004, the European Food Safety Authority pointed out that the finding of the study (i.e. that farmed salmon contains higher levels of POPs) is not new and that the levels of contamination described in the article remain below the current legislative norms. The EFSA also concluded that the article was misleading and that the risk assessment procedure used, and in particular its focus on cancer, was not in keeping with the approach generally applied in Europe.

There are four groups of *health-threatening substances* which can be found in or on fruit and vegetables: the phytotoxins, the phytoestrogens, nitrates and pathogenic micro-organisms (see *chapter 4*). In the case of *phytotoxins* and *phytoestrogens* (the latter can also have a protective effect), it has not been possible to arrive at any estimate of the health risk in terms of DALYs. It is assumed that any effect will not be particularly great.

In the case of *nitrate in leafy vegetables* (particularly spinach, endive/chicory and lettuce), there are two possible effects: (1) the effects of nitrite in babies (methaemoglobinemia, or 'blue baby syndrome') and children, and (2) those of the carcinogenic nitrosamines, formed when nitrites combine with amines derived from fish. Methaemoglobinemia is now extremely rare in the Netherlands. A provisional estimate (involving a high degree of uncertainty) of the health loss attributable to nitrosamines is approximately 100-500 DALYs.

The risk of foodborne infection with *pathogenic micro-organisms* is greatest when consuming fruit and vegetables which are subject to minimal preparation, such as washed and sliced lettuce, bean shoots, fruit salads and fresh herbs. Micro-organisms can be transferred to such products during the application of manure, and are not eradicated by means of further processing (heating; see *textbox 7.2* and *section 4.2*). In 2000, an episode of gastroenteritis could be traced to the contamination of taugé seeds with a rare strain of Salmonella. In England and Wales, 4.3% of cases of food-related gastroenteritis over a seven-year period were attributed to unprocessed fruit and vegetables. In the Netherlands, 5.5% of outbreaks of foodborne infections reported in 2003 were attributed to this cause (see *textbox 7.2*). Assuming that this represents an average of 5% of all cases of gastroenteritis, the health loss is approximately 50-200 DALYs (being 5% of the total of 1,000 to 4,000 DALYs lost due to gastroenteritis caused by known foodborne pathogens: see *chapter 4.2*).

Textbox 7.2: Foodborne infections caused by minimally processed fruit and vegetables.

In addition to artificial fertilizers, the production of fruit and vegetables (whether in the open field, in greenhouses or using hydroponic methods) involves the use of organic manure, combined with irrigation. This can result in infection with pathogenic micro-organisms. The plants have antimicrobial substances on their surface, but any damage (as in pre-sliced products) will negate this natural resistance whereupon there is a greater likelihood of bacteria growing within the product, even during the chilled storage phase.

Dutch hygiene codes contain instructions for the use of manure and organic fertilizers which greatly reduce the likelihood of contamination with harmful micro-organisms from animal or human reservoirs. Moreover, there are clear instructions with regard to personal and commercial hygiene precautions, helping to prevent contamination after harvest and during transport. However, a substantial proportion of the fruit and vegetables consumed in the Netherlands is imported from abroad, both from EU member states (52%) and from developing countries (48%). In many of these countries, legislation and hygiene codes may be less stringent. As yet, no suitable disinfection method is available.

Between 1992 and 1999, a total of 1408 food-related outbreaks of gastroenteritis were reported in England and Wales. Of these, 4.3% (n=60) were attributable to the consumption of salads, fruit and vegetables. A rising trend is also to be seen in the Netherlands. In 2002, salads, fruit and vegetables were implicated in 5.5% of the outbreaks reported to the Inspectorate for Health Protection and Veterinary Public Health (Van Duynhoven *et al.*, 2003). One notable vegetable-related food infection was recorded in 2000, involving an epidemic of a rare strain of Salmonella identified during routine weekly analysis of Salmonella isolates by the RIVM's National Salmonella Reference Laboratory. At the same time, the Inspectorate for Health Protection and Veterinary Public Health found the same strain of Salmonella – *S. enteritidis* phagotype 4b – during a routine quality inspection at the premises of a Dutch bean sprouts producer. The most probable cause was infected seeds (Van Duynhoven *et al.*, 2002).

For a more comprehensive account of pathogenic micro-organisms and other infectious agents which can occur in food, refer to *chapter 4, section 4.2*.

The conclusion is therefore that the positive effects of eating fruit and vegetables far outweigh the potential risks. Nevertheless, the Netherlands Nutrition Centre advises against feeding vegetables rich in nitrates to children under six months of age, and further advises that such vegetables should not be eaten more than twice a week by people of any age. It recommends that fish should be eaten with vegetables other than those rich in nitrates (such as those with high levels of vitamin C).

Wholegrain cereal products

The health-promoting and health-threatening effects related to the consumption of wholegrain cereal products are shown in *table 7.2*. Here, we assume the recommended daily intake of no less than 3 grams of fibre per MegaJoule energy, which is approximately 30 grams per day. The consumption of dietary fibre, for instance via products as brown bread and breakfast cereals, is known to have a protective effect against obesity, diabetes mellitus type 2 and cardiovascular diseases (see *chapter 2*). This is over and above the health-promoting properties of the nutrients and macronutrients in bread and breakfast cereals. A provisional estimate of the health gain to be achieved were the entire Dutch population to consume the recommended level of dietary fibre is in excess of 10,000 DALYs (see *appendix 12*).

The *health-threatening factors* attaching to cereal products are the mycotoxins produced by fungal growth, of which DON (deoxynivalenol, see also *section 4.3*) recently has become the most prevalent. In 1999, elevated levels of DON were found in grain samples. The most sensitive effect attributable to DON is probably delayed childhood growth. During the period in question, the consumption of cereal products led to the intake standard (TDI) of DON to be exceeded by an estimated 80% of children aged one year. However, partly due to the reasonably short period of exposure, it has been concluded that a possible retardation of growth is not expected to lead to permanent health effects (Pieters *et al.*, 2002). It is difficult to quantify such an effect in DALYs.

The conclusion is that, given current practices, the advantages of consuming cereal products far outweigh the negligible harmful effects of contamination by mycotoxins, even for young children. This nevertheless implies that those responsible for control and inspection in all phases of production must remain alert, and that adequate measures be taken to reduce fungal growth during production and storage. This matter is now being addressed by European Union legislation.

Human milk and breastfeeding

The *beneficial health effects* of breastfeeding are well documented. Under normal circumstances, human milk contains all the macronutrients and micronutrients required by the infant, and contains them in exactly the right proportions. Accordingly, mothers are advised to continue exclusive breastfeeding for at least the first six months (WHO, 2001). Breastfeeding helps in the optimal development of the immune system and the central nervous system. It protects infants against various illnesses and conditions, including inflammation of the middle ear and lower respiratory tract infections. It also promotes cognitive development. Moreover, breastfeeding protects the mother against pre-menopausal breast cancer (Anderson *et al.*, 1999; Hanson *et al.*, 2003; see also *chapter 2*). A *provisional* estimate of the health gain in terms of the avoidance of asthma and inflammation of the middle ear is in the order of 1,000 to 2,400 DALYs (see *appendix 12*).

The *health-threatening factors* attaching to breastfeeding are the same as those for fish: the fat-soluble environmental contaminants such as dioxins and PCBs. It has not been possible to make an estimate of the health loss in terms of DALYs for any of these contaminants. A further risk factor is HIV transmission.

As stated elsewhere, dioxins and PCBs have lipophilic properties and are therefore stored in fat tissue in the body. They are not degraded (to any marked degree) and are not excreted. Accordingly, like other highly lipophilic compounds, they are to be found in human milk. During the past 10 to 15 years, the concentrations of dioxins in human milk have declined by approximately 50% in various Western European countries (the Netherlands, Belgium and Germany) (Van Leeuwen & Malisch, 2002). This may be ascribed to the falling concentrations in the regular diet, and is a trend which is expected to continue (Zeilmaker *et al.*, 2002; Freijer *et al.*, 2001; Bakker *et al.*, 2003). Various studies indicate that exposure of infants to relatively high concentrations of dioxins and PCBs in human milk is associated with lower scores in tests of neurological and cognitive development (Koopman-Esseboom, 1995; Vreugdenhil, 2003). However, the effects are not marked and may be regarded as being of little clinical relevance. Moreover, children who are breastfed still score better in these tests than those who were bottle-fed (Vreugdenhil, 2003).

Vertical transmission of HIV seroprevalence can occur through human milk, as well as during childbirth itself. Some 10 to 20 HIV+ babies are born in the Netherlands each year, usually to mothers from the HIV-endemic regions. Screening during pregnancy and simple interventions can reduce this number to (almost) zero (Op de Coul *et al.*, 2003).

We may therefore conclude that, although it is not possible to fully quantify the comparison, the positive effects of breastfeeding do exceed the negative effects.

What lessons can be drawn from these examples ?
A direct comparison of the health-promoting and health-threatening aspects of the same foods provides some interesting information. Overall, the conclusion is that the health-promoting effects in terms of health gain are very much greater than the risks. Only the estimates relating to the risk of foodborne infections from raw vegetables and from nitrosamines (formed in the stomach from nitrite in vegetables and amines in fish) are in any sense substantial, but remain very much lower than the calculated health gain.

Nevertheless, it is appropriate to make one final remark regarding this quantitative comparison. The health-promoting aspects largely rely on a personal choice of food products, and all aspects that influence that choice. The health-threatening factors generally involve constituents over which the consumer has no influence, and for which the government has taken responsibility for control in order to provide the highest possible level of protection. From this perspective, it is hardly surprising that the quantitative ‘risk aspect’ is very much lower than the ‘health-promoting’ aspect.

The general conclusion must therefore be that the consumer who eats healthy foods in the recommended quantities need have no concerns about the risks posed by contamination. In order to maintain this situation, the government must ensure ongoing controls and inspection activities, adapted as necessary in the face of changing circumstances.

7.3 Health versus safety in functional foods and health products

C.J.M. Rompelberg, N. de Jong

Criteria for a balanced comparison

This section examines several categories of functional foods and health products in terms of the potential health gain versus the potential risks. Contrary to the previous sections, here, it is not possible to make any quantitative comparison, since the information required to do so is not available. An outline framework for a qualitative approach, which is illustrated with a number of examples, is set out below.

In the ideal situation, both the health-promoting properties and risks factors (or absence thereof) would be documented for all functional foods and health products. Due to the lack of adequate legislation, this is often not the case. *Figure 7.1* presents a classification of the various functional foods and health products, based on the strength of the scientific evidence of any beneficial health effect or health risk. For both the beneficial effects and the risks, a distinction is drawn between those which have been subject to systematic research and those which have not. Where research has established an effect, this effect may be related to a health outcome, or to an intermediary factor (see also *section 6.7*). We then arrive at a matrix with twelve cells. In each cell or group of cells, the result of the comparison of health gain against health loss can then be represented as follows:

- *Green: a positive balance.* The beneficial health effect (on one health outcome) and the absence of any risk has been adequately established
- *Red: a negative balance.* No beneficial effect but some risk has been adequately demonstrated.
- *Yellow: a positive or negative balance.* Both some beneficial effect and some risk have been established. The result of the comparison will largely rely on the quantitative assessment. If the risk is deemed to be acceptable in proportion to the beneficial effect, the scales tip in favour of the positive.
- *White: a neutral balance.* No relationship with a health outcome or intermediary factor has been established, but neither has any risk been shown to exist.

For the remaining cells, *no such balanced comparison is possible*. Here, various situations can be identified:

- *Light grey:* a relationship with an intermediary health factor has been established, but no direct relationship with a health effect. There may or may not be some risk.
- *Dark grey:* the health gain and/or the health risk have not been investigated.

Examples of each category are given below.

Health gain	Health risk		
	Systematically investigated no risk	risk	Not systematic investigated
Systematically investiga • relationship ingredie health outcome establ	+	+ / -	?
Systematically investiga • relationship ingredie intermediary factor e	?	?	?
Systematically investiga • no relationship estab	0	-	?
Not systematically inves	?	?	?

Figure 7.1: Schematic representation of a classification (by health gains and health risks) of functional foods and health products, based on the availability of scientific studies and their results. Each cell shows the result of weighing health gains against health risks as represented by the symbols: + (positive), - (negative), +/- (examine on a case-by-case basis), 0 (neutral) and ? (unknown). Some examples are discussed in the text.

The green cell

In the ideal situation, a functional food or health product would fall into the green cell. However, only a few products actually do so. Examples include health products which contain folic acid, intended for women who wish to become pregnant and expectant mothers (particularly in the early stages of pregnancy).

The ability of these products to protect against neural tube defects in the foetus has been adequately demonstrated (Czeizel & Dudas, 1992; MRC Vitamin Study Research Group, 1991). A safe upper level (UL) of 1 mg/day has been set for synthetic folic acid (see *chapter 6, table 6.3*). With an intake of folic acid supplements in line with the recommended dose of 400 µg/day (see *chapter 6, table 6.4*), it may be assumed that the total intake remains within the effective and safe range (see *figure 7.2*). The possibility of overdose remains low, since the addition of folic acid to foods is not permitted in the Netherlands (although it does seem to take place regularly in practice; see *chapter 6*).

The red cell

This cell includes such products as the vitamin and/or mineral supplements which contain a dose per unit which is at or above the UL. In this dosage range, there is no increase in the health-promoting effect (which is only to be seen for doses that are just adequate to prevent deficiency disorders), but there could be some adverse effect. Such substances would be grouped on the right of *figure 7.2*. Examples include the supplements containing *vitamin* B_6 in dosages above the UL of 25 mg/day. It is fre-

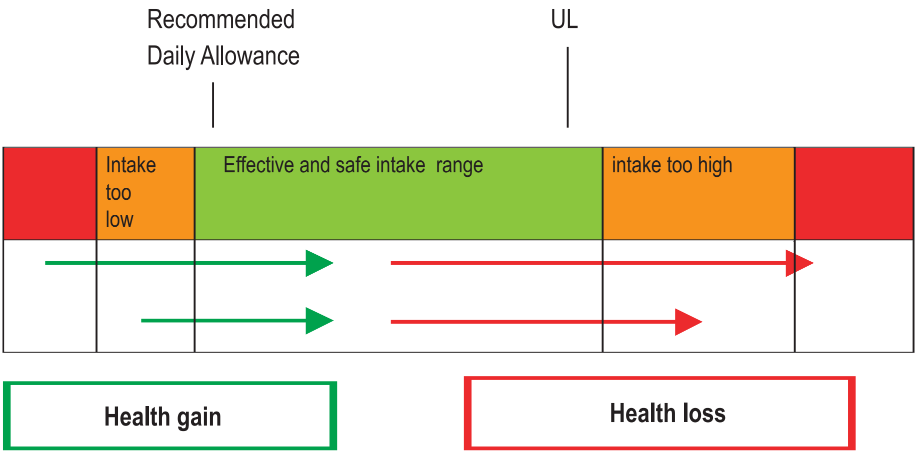

Figure 7.2: Intake of vitamins and minerals in relation to health effects. In the event of sub-optimal intake (below the recommended daily allowance), suppletion up to the green intake area will result in health gain. Higher intakes (above the UL) result in health loss.

quently claimed that additional vitamin B_6, taken in combination with extra folic acid and vitamin B_{12}, will result in a lowering of the homocysteine levels, and hence a reduction in the risk of vascular diseases. Clinical trials, however, have produced conflicting results on this point (HLTC, 1998). In terms of the toxicity of vitamin B_6, clinical trials indicate that sustained intake of 100 mg/day can lead to minor neurological symptoms, while doses in excess of 500 mg/day can result in severe neurological effects (SCF, 2000). Sustained, long-term use of supplements containing doses higher than the UL therefore pose a realistic risk of neurotoxic effects, and that risk is exacerbated if, in addition to the supplement, functional foods containing vitamin B_6 are also consumed.

The yellow cell

The consumption of functional foods enriched with *plant sterols and stanols* has been shown to have both a positive and a negative effect. The positive effect is that of a reduction in serum LDL cholesterol levels, which reduces the risk of coronary heart diseases. This effect is now considered to have been adequately proven, although the evidence is indirect. (There is sufficient evidence to support the relationship between the ingredient and the intermediary factor of serum LDL cholesterol level on the one hand, and similarly hard evidence to support the relationship between serum LDL cholesterol level and the incidence of coronary heart disease on the other; Katan et al., 2003; Law, 2000). The effect is of particular significance to those who have an elevated cholesterol level. The exact effective minimum intake remains unknown, but an intake of 1 g/day has been shown to be effective.

The negative effects include a reduction in the serum β-carotene level, this reduction being in direct proportion to the quantity of the products consumed. Although the long-term effects are currently unknown, this finding has led to the recommended upper limit for the daily intake of plant sterols and plant stanols being set at 3 g/day. An intake above this level does not result in any further reduction in the serum LDL cholesterol level, but does further reduce the serum β-carotene level.

We may therefore conclude that, for individuals with an elevated cholesterol level, the effect on serum LDL cholesterol level confers such benefits that a daily intake of 1-3 g will result in a health gain which outweighs the health risk (reduction of serum β-carotene levels).

The white cell

The products which can be placed in this cell include the functional foods to which artificial sweeteners such as cyclamate, aspartam, saccharine and acesulpham K have been added. Despite considerable research, no consensus has yet been reached with regard to the relationship between these substances and their intended beneficial health effect, i.e. the prevention of overweight and/or dental caries. The safety of these products has been subject to systematic investigations and an acceptable daily intake (ADI) has been established. Provided intake remains at or below the ADI, there will be no health effects and the balance of health gain versus health risks is therefore neutral.

The light grey cells

These cells represent the products for which a clear relationship between the active ingredient and an intermediary health factor has been established, but (as yet) no direct relationship with a health outcome. In such cases, it is not yet possible to arrive at a balanced consideration of health gain versus health risk. Examples include *dietary supplements containing* β-*carotene*.

These supplements have been shown to reduce oxidative damage. However, no positive effect on a health outcome, such as cardiovascular diseases, cancer or infectious diseases, has yet been proven (Fairfield & Fletcher, 2002; Lonn & Yusuf, 1999; Vivekananthan *et al.,* 2003). On the other hand, intake of high doses of β-carotene can indeed lead to adverse health effects. Two large-scale studies examining the effects of a high intake of β-carotene (20 mg per day as a supplement) by smokers resulted in a higher incidence of lung cancer and mortality: the very opposite effect to that expected (Omenn et al., 1996; ATBC, 1994). No UL for β-carotene has been established.

The dark grey cells

The products falling into these cells have been subject to no systematic investigations, whether in terms of efficacy or safety. A balanced comparison is therefore not possible. The products concerned include various *herbal preparations*. The increasing supply of such products in shops or via internet websites, together with the lack of adequate legislation, gives rise to an undesirable situation. An additional problem relating to the herbal preparations is their possible contamination with PAHs (polycyclic aromatic hydrocarbons) and other pollutants. Some other products in this category have been shown to have some beneficial health effect, but have not yet been subject to proper safety assessment. They include the *probiotics* containing certain lactobacilli, which have been shown to reduce the duration of diarrhoea episodes in young children (Van Niel *et al*., 2002). However, one of the questions that remains to be answered is whether they increase the risk of opportunistic infections (Borriello *et al.,* 2003).

Conclusion

Based on the scientific literature currently available, we may conclude that some functional foods and health products do indeed represent a potential health gain, without any (considerable) risk. However, the converse is true of other products: there is no evidence of a tangible health benefit, but health risks can occur.

For many functional foods and health products investigations have been limited to substantiating a positive or negative health effect (or to confirming the absence of the latter), or they have failed to substantiate either effect. In order to arrive at a balanced comparison of potential health gain versus potential health risk, particularly in the case of the latter category, it is therefore necessary to require manufacturers to properly substantiate both the efficacy and the safety of their products. In addition, more information concerning the intake of these products is required.

To ensure that any potential health gain is actually realized, the consumer must be given adequate information about which products are available and which are appropriate for use in his or her individual situation. It is important that consumers be prevented from using functional foods, and more especially dietary supplements, that are intended for other target groups. Furthermore, consumers should be prevented from losing sight of the importance of a healthy and varied traditional diet.

7.4 Healthy diet compared with other lifestyle interventions

W.M.M. Verschuren, R.T. Hoogenveen, P.G.N. Kramers, D. Kromhout, M.C. Ocké

In *chapter 2* (*section 2.4*) we examined the health gain that could be achieved through improvements in the consumption of five dietary factors (saturated fatty acids, *trans* fatty acids, fish, fruit and vegetables) and through the reduction of overweight. In this section, we compare the results presented in *chapter 2* with calculations relating to three other lifestyle factors: smoking, physical activity and alcohol consumption.

7.4.1 Calculations for three lifestyle factors

Scenarios and health outcomes

As in the method adopted in *section 2.4,* the health effects of smoking, physical activity and alcohol consumption are calculated for three 'scenarios': the reference scenario, a maximum ('Utopian') scenario and a middle scenario. The *reference scenario* reflects the current situation. The *maximum scenario* describes the health loss that can theoretically be attributed to unhealthy behaviour, and hence the health gain that can - in theory - be achieved if the entire Dutch population were to adopt the healthiest possible behaviour. The *middle scenario* calculates the health gain that could be achieved through interventions which are considered realistic and feasible. The characteristics of each scenario are shown in *table 7.3*. A full list of the initial age range and gender distribution by risk factor category, together with the relative risks used (RRs), is given in *appendix 12*. Parallel to *section 2.4,* the results are presented as (1) the directly attributable health loss, per annum, in terms of disease, death and DALYs; (2) the cumulative health loss over a 20-year period, and (3) the effect in terms of total life expectancy and disease-free life expectancy. For further details of the input statistics, the calculation method, the mathematical model used and the units in which outcomes are expressed, please refer to *section 2.4* and *appendix 12*.

In the case of *smoking*, the initial distribution (smokers, ex-smokers, non-smokers) used in the reference scenario is based on the statistics published by STIVORO in 1998. In the maximum scenario, no one smokes. In the middle scenario, 20% of smokers become ex-smokers, and 20% of the ex-smokers achieve the equivalent status of 'never smoke'. This scenario is based on the objective stated in the Ministry of Health, Welfare and Sport's policy document *Langer Gezond Leven* ('Living longer in good health'; VWS, 2003a), i.e. a reduction in the number of smokers from 31% to 25% of the total population by 2007 (see *table 7.3*). The 20-year modelling incorporates 'transition probabilities', whereby some people may stop smoking (reference scenario and middle scenario), while others take up the habit (reference scenario only). As a result, the prevalence of smokers declines during the period considered by the model (see *appendix 12*).

In the case of *alcohol consumption*, the initial distribution used in the reference scenario is based on the POLS health survey conducted by Statistics Netherlands (CBS) in 2001. In the maximum scenario, all drinkers will become teetotal, while in the middle scenario all drinkers will become 'light' drinkers. This middle scenario is still very 'Utopian' compared to the objective stated in the Ministry of Health, Welfare and Sport's annual budget for 2004 (VWS, 2003b), which calls for a reduction in 'problem drinkers' from 9% to 8% of the population. The precise effects of alcohol consumption are less clear cut than those of the other factors. Complete abstinence (the maximum scenario) is likely to reduce the incidence of cancer, but increases the risk of cardiovascular diseases compared to 'moderate consumption' (the middle scenario). Accordingly, the maximum scenario does not necessarily represent greater health gain than the middle scenario, as is the case in all other factors. Alongside the physical health effects of alcohol consumption considered here (cardiovascular diseases and cancer), the psychological and social effects of problem drinking also have a major impact on public health (alcohol dependency, alcohol-related accidents). Such aspects are beyond the scope of this report.

For *physical activity*, the initial distribution used in the reference scenario is based on statistics published by the Prevention and Health division of the Netherlands Organization for Applied Scientific Research (TNO-PG) in 1998. The maximum scenario assumes that everyone meets the standard of minimum thirty minutes' moderate to intensive physical activity at least five times a week. In the middle scenario, the proportion of the population which is 'inactive' (i.e. takes no exercise at all) is reduced by 4 percentage points compared to the reference scenario, while the proportion meeting the standard is increased by 10 percentage points. This is in line with the policy objective stated in the Ministry of Health, Welfare and Sport's annual budget for 2004 (see *table 7.3*; VWS, 2003b). The 20-year modelling incorporates transition probabilities whereby people can either become more active (reference scenario and middle scenario) or less active (reference scenario only). We then see a slight increase in the number of 'inactives' in the reference scenario, and a decrease in the middle scenario (see *appendix 12*).

The directly attributable health loss

Figure 7.3 shows the health loss that is, in theory, directly attributable to the three lifestyle factors (maximum scenario), and the realistic health gain which could be achieved (middle scenario). The figure represents incidence (new cases of disease) and mortality for both the maximum and middle scenarios, concerning the three diseases

Table 7.3: Summary of the assumptions in the three scenarios and of the diseases for which a relationship has been calculated, for lifestyle factors such as smoking, physical activity and alcohol consumption. The policy objectives have been inserted for the purpose of comparison.

Lifestyle factors	Associated diseases	Current situation, average (reference scenario)	Recommendation (maximum scenario)	'Practically feasible' (middle-scenario)	Policy objective
Smoking	Coronary heart diseases, heart failure, stroke, COPD, cancer of lung, oesophagus, larynx, bladder, kidney, pancreas, oral cavity	Approx. 35% initial value	No-one smokes	20% reduction in smoking	20% reduction in smoking by 2007
Alcohol use	Coronary heart diseases, stroke, cancer of the oesophagus, breast, larynx, oral cavity	Excessive alcohol consumption 11% (men) and 6% (women)	No-one drinks alcohol	Everyone becomes a 'moderate drinker'	Decline in 'problem drinkers'from 9% to 8%
Physical activity	Coronary heart diseases, stroke, diabetes, cancer of the colon, breast cancer	Approx. 45% normactive	Everyone is normactive	Increase in normactive individuals by 10 percentage points; decline in inactive individuals by 4 percentage points	Increase in normactive individuals by 10 percentage points; decline in inactive individuals by 4 percentage points

for which calculations have been performed. For more detailed statistics, please refer to *appendix 12*.

First of all, we see that incidence is approximately three to four times higher than mortality, except in the case of smoking. With regard to the latter, the difference is smaller because cancer is an important component and most forms of cancer have a higher mortality than cardiovascular diseases or diabetes. For cancer a less than two-fold difference between incidence and mortality is observed in all cases.

With regard to both smoking and physical activity, the difference between the maximum and middle scenarios is approximately a factor of 5. This means that, given the basic principles adopted for each scenario, only some 20% of the attributable disease burden could be avoided in practice. The effect of these two lifestyle factors is broadly comparable, particularly in terms of new cases of disease (approximately 30,000 in the maximum scenario and 6,000 in the middle scenario).

In the case of alcohol consumption, the picture is more complex. In the current situation, the gains are 16,000 cases of disease and 5,000 cases of mortality relative to a situation in which everyone is abstinent. The situation in which everyone drinks moderately (middle scenario) is more favourable than the current situation, and very much more favourable than the maximum scenario.

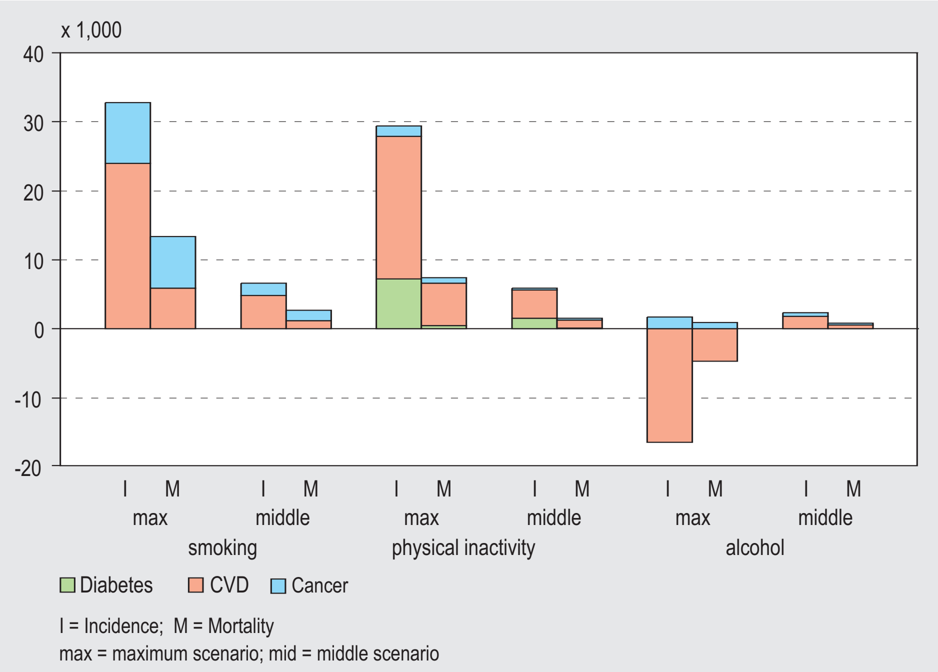

Figure 7.3: Theoretical attributable health loss (maximum scenario) and health gains that are considered feasible (middle scenario) for smoking, physical inactivity and alcohol consumption; incidence and mortality are shown as the numbers of cases for the three disease groups.

As a net effect, the three lifestyle factors smoking, alcohol consumption and physical activity together are responsible (in the maximum scenario) for approximately 20% of the cases of mortality and disease caused by cardiovascular diseases, 30-35% of the cases of mortality and disease caused by the forms of cancer considered here, and 16% of the cases of mortality and disease due to diabetes (caused by insufficient physical activity alone). When we calculate the combined effect, the three lifestyle factors appear to be responsible for approximately 15% of the total mortality (see *appendix 12 for detailed statistics*).

The cumulative health loss over a 20-year period
As explained in *section 2.4*, this approach is more realistic than the directly attributable health loss approach, since it takes the dynamics over time into account. *Figure 7.4* presents a summary of the statistics calculated by this method.

A comparison of the directly attributable health effect with the 20-years cumulative effect shows that in the *maximum sce*nario (on the left of the figure), the incidence over twenty years is slightly higher than the directly attributable health loss multiplied by twenty, but mortality is somewhat lower. This is comparable to the findings for the five dietary factors, as presented in *section 2.4*. The higher incidence reflects the ageing of the modelled cohort, while the lower mortality rate indicates that death will generally occur after a variable number of years with the disease in question.

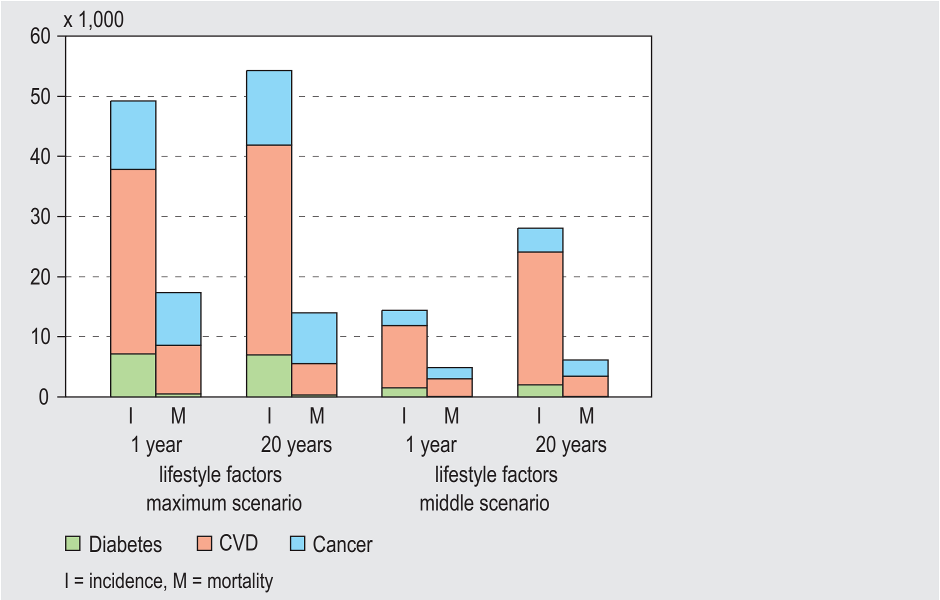

Figure 7.4: Health loss or health gain to be achieved for smoking, physical inactivity, and alcohol consumption together, in the maximum scenario and middle scenario respectively, as directly attributable and cumulative over 20 years. The figures over the 20-year period have been divided by 20, for the purpose of comparison. Incidence and mortality are shown as the numbers of cases in three disease groups.

In the *middle scenario*, the picture is slightly different. Here, the health gain after twenty years is greater than twenty times the gain obtained using direct attribution in terms of mortality avoided, but even more so in terms of incidence. This also indicates that the fraction of the maximum calculated loss (in the maximum scenario) which in practice seems avoidable (according to the middle scenario) is more favourable over the 20-year period: approximately 45% compared to approximately 30% over the one-year period.

The effects on life expectancy and calculated DALYs

When we consider total lifespan, we find that if the levels of all lifestyle factors were as defined in the *maximum (utopian) scenario*, the average life expectancy for all Dutch adults aged 40 would increase by 1.7 years, and the disease-free period by 3 years (*table 7.4)*. The latter refers to the diseases included in the model. This extension of (healthy) life expectancy is relatively modest because mortality and diseases that substitute for the prevented diseases come to play a more significant role over time. In the middle scenario, life expectancy rises by one year, and the disease-free period by 1.6 years. The impact of smoking is greater than that of the other two lifestyle factors. This difference is greater than that shown in *figure 7.3* because the calculation of overall life expectancy and DALYs also includes chronic lung disorders (Chronic Obstructive Pulmonary Disease; COPD).

The calculated DALYs on an annual basis are also shown in *table 7.4*. These figures are based on the incidence and mortality figures derived using the directly attributable approach. Therefore it is in line with the expectations that the health gain in the middle scenario is only some 20% of the health gain/loss in the maximum scenario (for smoking and physical activity, but not for alcohol consumption: see *figure 7.3*).

7.4.2 Comparison of lifestyle factors with diet and BMI

Figure 7.5 presents a comparison of the results for the above lifestyle factors with the analysis of the five dietary factors and overweight (BMI) as discussed in *chapter 2*. In the maximum scenarios, we see that the total incidence of disease is broadly compa-

Table 7.4: Calculated effect, in DALYs, and effect on life expectancy and disease-free life expectancy of Dutch adults aged 40, in the maximum and middle scenarios.

Factor	DALYs / annum		Life expectancy Total		Life expectancy free of disease	
Scenario	Maximum	Middle	Maximum	Middle	Maximum	Middle
Smoking	353,000	71,000	1.2	0.6	2.0	0.9
Physical inactivity	52,000	32,000	0.7	0.3	1.3	0.5
Alcohol consumption	-62,000	23,000	-0.2	0.2	-0.4	0.2
Three lifestyle factors together	445,000	123,000	1.7	1.0	3.0	1.6
Five dietary factors together	246,000	128,000	1.2	0.6	2.0	1.0
Overweight (BMI)	216,000	56,000	0.8	0.3	2.3	1.0

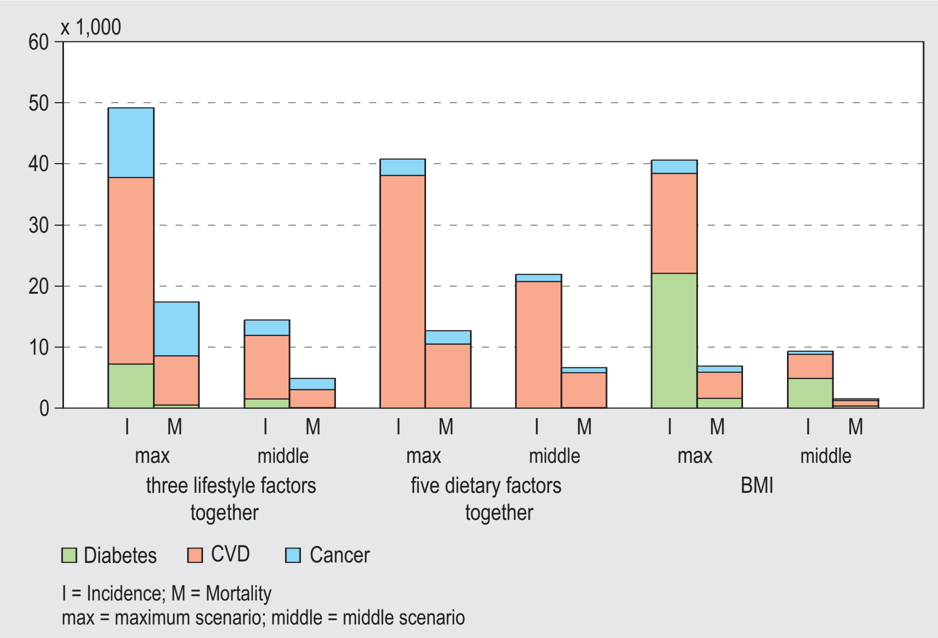

Figure 7.5: Health loss and health gain to be achieved for three lifestyle factors together, five dietary factors together and overweight (BMI), in the maximum and middle scenarios respectively, directly attributable. Incidence and mortality are shown as the numbers of cases in three disease groups.

rable in each case (combined lifestyle factors, combined dietary factors and overweight (BMI)). In the case of mortality, the differences are greater. The combined lifestyle factors are the most common cause of death, followed by the combined dietary factors, then BMI. The number of deaths is proportionally higher where cancer is a significant contributor, as in lifestyle factors (primarily smoking). This is because cancer is the most fatal of the three types of disease considered. In the middle scenarios comparison, it is the combined dietary factors which offer the greatest potential gains. As previously stated, the difference between the attributable health loss (maximum scenario) and the health gain considered realistically feasible through interventions (middle scenario) is approximately a factor of two in the case of the dietary factors, while for the lifestyle factors and BMI it is in the order of a factor 4 to 5. Accordingly, assuming that the assumptions in the middle-scenario are correct, we can conclude that smoking, insufficient physical activity and overweight remain more obstinate problems than a sub-optimal diet.

The overall aim is, of course, to live for as long as possible in good health. The figures in *table 7.4* demonstrate that the three lifestyle factors together account for the greatest gain or loss of (disease-free) life expectancy, followed by the five dietary factors together, and then overweight (BMI). Only in the middle scenario, and only in terms of DALYs, are the lifestyle factors and dietary factors more or less comparable. This once again indicates that a relatively large proportion of the theoretical health loss can be negated by appropriate interventions targeting the dietary factors.

7.5 DALYs lost through dietary factors and other causes

P.G.N. Kramers

In *section 7.4*, we set the dietary factors discussed in *chapter 2* alongside other lifestyle factors, using the same model-based approach. Here, we once again adopt a broader perspective and compare all the health effects quantified in this report against each other, placing the results of such a comparison in the perspective of the total health loss in the Netherlands. In doing so, we restrict ourselves to a single unit of measure, i.e. the Disability Adjusted Life Year (DALY). As further explained in *appendix 12*, the DALY is extremely useful in enabling various sorts of health effect to be brought under a single heading, and thus rendered directly comparable. The components of mortality and disease (where due to the same cause) are combined within this summary measure.

Analogous to the presentation used by the Public Health Status and Forecasts (Van Oers, 2002), *table 7.5* offers a semi-quantitative account of the number of DALYs lost to various causes. The second column shows the estimates for the five dietary factors considered in *chapter 2*. Each is the estimate attaching to the maximum ('Utopian') scenario, being the loss of DALYs which is directly attributable to the factor concerned. Columns 3 and 4 show the figures relating to the microbiological and chemical contaminants discussed in *chapter 4*. The fifth column shows estimates for the other lifestyle factors, as set out in *section 7.4*, once again assuming the maximum scenario. Column 6 shows some estimates relating to environmental risks to health, after De Hollander & Melse (2004) and Van Oers (2002). For the purposes of comparison, the rightmost column presents the figures (in DALYs) relating to some of the 52 diseases listed in the 2002 Public Health Status and Forecasts (Van Oers, 2002). This column therefore presents the overall disease burden due to, say, coronary heart diseases, while the other columns show the disease burden which is attributable to the specific risk factor concerned, e.g. overweight. This attributable disease burden can then be divided among various diseases: overweight, for example, can contribute to coronary heart diseases, diabetes and various forms of cancer.

The final column of *table 7.5* clearly illustrates the major differences in the disease burden due to the most prevalent diseases (which usually also account for high mortality, although this is not always the case: see, for example, depression), and those which are less prevalent at population level. The pattern presented by the various risk factors in the other columns is particularly interesting, in that the total for the dietary factors, as well as the totals for the lifestyle factors smoking, physical activity and BMI, are all in the highest category of 'more than 100,000 lost DALYs.' This may be expected, since these factors clearly contribute to many of the diseases which themselves are to be seen in the two highest categories.
In the range of 10,000 to 100,000 lost DALYs, we see the individual dietary factors (in column 2), the contribution of each of which is in the same order of magnitude as that of, say, road traffic accidents, breast cancer and schizophrenia. The 1,000 to 10,000

Table 7.5: Health loss in DALYs per year caused by dietary factors and energy balance (as discussed in previous chapters), and other lifestyle factors, environmental factors, and disease categories.

CLASS: number of DALYs lost	DIET			OTHER		DISEASES
	Dietary factors	Micro biological infection	Chemical contamination	Other lifestyle factors	Environmental factors	Selection from 2002 Public Health Status and Forecast report
>300,000	Unhealthy diet, total[1]			Three lifestyle factors together [2], smoking		Cardiovascular diseases, cancers total
100,000-300,000	Five dietary factors together, Energy balance[3]			Insufficient physical activity		Coronary heart diseases, depression, lung cancer, diabetes, alcohol dependence[4]
30,000 - 100,000	Too much *trans* fatty acids, too little fruit, vegetables, fish			Alcohol consumption[4]		Traffic accidents, breast cancer
10,000-30,000	Too much saturated fat				Particulate matter in outdoor air	Schizophrenia, prostate cancer, influenza
3,000-10,000		Gastroenteritis caused by micro-organisms in food			Passive smoking	Upper respiratory tract infections, HIV/AIDS, gastric and intestinal ulcers
1,000-3,000					Radon (indoors)	Bacterial meningitis, bacterial STD[6], tuberculosis
300-1,000		Campylobacter in food[5]	Allergenic substances, acrylamide			
< 300		STEC 0157[6]	PAHs[6], other substances		Various substances	

1 Here, unhealthy diet relates to the health loss due to dietary composition (five modelled dietary factors together, in relation to cardiovascular diseases and the relevant types of cancer), plus the proportion of the disease burden attributable to overweight (due to a positive energy balance). .

2 This relates to the combined effects of smoking, insufficient physical activity, and excessive alcohol consumption on cardiovascular diseases, diabetes mellitus and the relevant types of cancer.

3 Energy balance is the 'dietary factor' which accounts for the development of overweight. The disease burden of overweight is modelled using BMI as the indicator. Overweight is also caused by insufficient physical activity, which falls under 'other lifestyle factors' in this table.

4 In the lifestyle column, the result for alcohol is that of the middle scenario. This is because, with regard to the modelled diseases, this scenario will yield the highest gain (drinking moderate amounts of alcohol is more beneficial in terms of cardiovascular diseases than total abstinence). In addition, 'alcohol dependence' is included in the last column. This means that, in terms of DALYs, the somatic and psychosocial repercussions of excessive alcohol consumption involve a large health loss. This loss is even larger than the health loss due to 'sub-optimal consumption' with regard to cardiovascular diseases and cancer.

5 The number of DALYs lost as a result of Campylobacter in food is less than the total stated in chapter 4, Part B. (Chapter 4 addresses Campylobacter from all sources).

6 HIV: Human Immunodeficiency Virus; AIDS: Acquired Immune Deficiency Syndrome; STD: Sexually Transmitted Diseases; STEC: Shiga toxin-producing Escherichia coli; PAHs: Polycyclic Aromatic Hydrocarbons.

range includes the foodborne infections, the contribution of which is therefore in the same order of magnitude as some of the more common infectious diseases such as upper respiratory tract infections (excluding influenza) and HIV/AIDS. With the exception of allergens, all chemical food contaminants fall (far) below the 1,000 DALY limit. Allergenic substances must be considered as a separate group due to their marked individual quantitative effect. As shown in the sixth column, there are some environmental factors which contribute more to health loss than food contaminants do.

As stated, columns 2 to 6 present the total disease burden which is attributable to a specific risk factor or determinant, which is therefore equivalent to the health gain which could, *in theory*, be achieved by means of effective interventions targeting that risk factor. As stated in *chapter 2* and *section 7.4* however, this is not always the health gain that is *realistically fea*sible. Moreover, the picture presented here is somewhat simplified in that no account is taken of the long-term effects of diseases that substitute for the prevented diseases. Accordingly, *table 7.5* is intended as a general overview which enables a direct comparison of the order of magnitude of the various effects on an annual basis.

7.6 Summary and conclusions

The most important message emerging from this chapter is that the (theoretical) health loss due to an unhealthy diet is many times greater than that caused by unsafe food. We can quantify this assertion as follows (based on DALY calculations):

- The health loss due to unfavourable dietary composition (the five dietary factors together: 245,000 DALYs) and overweight (215,000 DALYs) is in each case two orders of magnitude greater than that attributable to microbiological food contamination, which is no more than 4.000 DALYs.
- The latter is higher still than the total health loss due to chemical contamination, which is no more than approximately 2,000 DALYs. The greater proportion of this health loss is attributable to allergens and to theoretical calculations of cancer risks, which may well have been overestimated.
- The health loss attributable to an unhealthy diet (the five dietary factors plus a positive energy balance) is comparable to that caused by smoking. The health loss due to unfavourable dietary composition and to overweight is in each case in the same order of magnitude as that calculated for other important lifestyle factors, such as lack of exercise. It is also in the same order of magnitude as the health loss due to a number of major diseases, including coronary heart diseases, lung cancer and depression.
- The health loss due to microbiological food contamination is in the same order of magnitude as that calculated for a number of other important infectious diseases, and also for some environmental factors such as passive smoking.

The conclusion that the health aspect is of far greater importance than the safety risks continues to apply when examining a single food or food product, such as dioxins in fish or nitrates in vegetables.

The relatively minor health loss due to unsafe food is at least partially due to the long tradition of effective food safety policy in the Netherlands. A crucial factor has been the government's direct involvement in the improvement of food safety as a matter of public responsibility, often in collaboration with the food industry itself. This has rendered the process of improving food safety far easier than that of improving eating habits, in which the choices to be made largely fall to the individual consumer.

The conclusion that the health loss due to an unhealthy diet is many times greater than that due to unsafe food is confirmed by Rougoor *et al*. (2003) in a report published by the Ministry of Agriculture, Nature and Food Quality. Moreover, that report devotes considerable attention to the 'hygiene hypothesis' which assumes a link between the increase in allergic conditions (including food allergies) and immune-system-related disorders on the one hand, and the decrease in exposure to infectious agents in food and the environment on the other. Rougoor *et al.*, therefore state that we should not strive for 'maximum' food hygiene, but rather for 'optimum' food hygiene. Whether this view is indeed founded, and what it will actually mean in practice, should be established by means of further research (see also *section 4.4*).

Based on the current health loss, government policy must prioritize the promotion of a healthy diet. Here, 'healthy' refers to both composition and quantity, the latter of course with regard to energy use and combating the development of overweight. If we look at current developments alongside the calculated health loss, overweight emerges as a particularly conspicuous and unfavourable trend. As elaborated in *section 2.4*, a continuation of the current trends in the five dietary factors and in overweight will eventually lead to a fall in life expectancy (assuming that all other factors remain unaltered). Substantial and effective action is therefore required to turn the tide. Food safety policy will clearly take second place, and besides enforcement will involve measures to address new trends and to achieve 'optimization', with the emphasis on reducing microbiological contamination.

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8 WHAT DETERMINES CONSUMER EATING BEHAVIOUR AND RISK PERCEPTION ?

8.1 Introduction

Chapters 6 and *7* described how one and the same food can contain both constituents which are beneficial to health and those which are potentially harmful. For the foods in question, an attempt was then made to assess these two aspects cohesively, and to weigh one against the other as effective as possible, in quantitative terms.

Another important factor which must be considered in the context of healthy diet and safe food is that of the consumer's own perceptions. The consumer's own beliefs with regard to food safety will influence his or her eating behaviour (a healthy or unhealthy choice of foods). Conversely, eating behaviour (e.g. food preferences) will influence the perception of food safety. Therefore, if we wish to arrive at useful recommendations in both areas, we must also examine the relationship between eating behaviour and consumer risk perception.

This chapter sets out the underlying theories and mechanisms which determine (eating) behaviour (*section 8.2*) before going on to consider the specific elements of risk perception which are relevant to food safety (*section 8.3*). A number of conclusions and recommendations, based on a more integrated consideration of the two areas, are presented in the concluding part of this chapter (*section 8.4*)

8.2 The consumer and the determinants of eating behaviour

J. Brug

8.2.1 What determines behaviour ?

The reasons people have for eating a particular type of food – or choosing not to do so – are termed the 'determinants of eating behaviour'. An understanding of these determinants is essential if we are to develop interventions designed to alter eating behaviour (Meertens *et al*., 2000). *Section 8.2* presents a summary of current knowledge about the determinants of eating behaviour. Eating behaviour is complex behaviour. We do not merely eat 'food', but a very wide range of foods and food products which we select from an almost endless range of alternatives, combining and preparing them in various ways. This combination of 'sub-behaviours' eventually determines our eating behaviour, and each sub-behaviour has its own determinants. The determinants can vary according to the type of food (e.g. fruit versus dairy produce), by gender or demographic group, by location (at home or in the workplace) and even by the time of day (breakfast or evening meal).

Nevertheless, the determinants of behaviour can be grouped into a few general categories. The following summary is based on a broad model of the determinants of health behaviour, the 'Theory of Triadic Influence' (Flay & Petraitis, 1994). This theory distinguishes three levels, or 'tiers' of determinants: proximal, distal and ultimate. 'Proximal' refers to factors which are personal to the individual and which have a direct influence on behaviour. 'Distal' primarily refers to the specific social and physical context in which the behaviour arises. 'Ultimate' refers to the preconditions at greater distance, like the more general socio-cultural environment. These categories can also be seen in the conceptual model included in *chapter 1*, *figure 1.2*. Here, the proximal determinants are termed 'personal factors', the distal appear as 'food supply' and 'social environment', while the ultimate determinants are shown as the 'autonomous developments'. The remainder of this section explains the determinants of eating behaviour using this Triadic theory classification.

8.2.2 Proximal determinants

Our eating behaviour is most directly influenced by the so-called 'cognitions': intentions and motivations, beliefs, feelings and perceptions. Of these, 'behavioural intention' is the most direct cognitive determinant of behaviour. According to the most widely accepted socio-psychological theories, behavioural intention is influenced by four categories of sub-determinants: attitudes, perceived social influences, perceived behavioural control and personal norms (Brug, 2000; Armitage & Conner, 2000). In addition, awareness and knowledge can also determine the behavioural intentions.

Attitude

Attitude is 'the way that people think and feel about a given topic'. Investigations have shown that 'attitude' influences dietary choice (Brug & Van Assema, 2001). Taste and hedonistic considerations are probably the most important elements. Studies by Westenhoefer and Pudel (1993) demonstrate that eating is one of the most pleasurable activities: only sex and parties are higher on the 'pleasure list'. People tend to eat things that they consider to have a pleasant taste and avoid things they expect not to taste good. There is some natural, innate preference for sweet flavours, but all other tastes are almost entirely acquired and can therefore, in theory, be 'unacquired'. However, some tastes are more easily acquired than others. We are generally quick to appreciate flavours which are associated with high-calorie foods (Birch, 1999). Explanations for this phenomenon may be found in terms of evolution: a preference for energy-rich food will increase the chances of survival in times of food shortages. It is somewhat less easy to develop a preference for vegetables. Apart from the aspects of taste and enjoyment, other elements of 'attitude' play a part here: expectations and preconceptions concerning cost, ease of preparation and similarities to the diet to which one is accustomed (Glanz *et al.*, 1998; Brug & Van Assema, 2001). Eating is largely characterized by habitual behaviour (Verplanken & Aarts, 1999; Verplanken & Faes, 1999). In the Netherlands, for example, people opt for a typical Dutch breakfast of a few slices of bread with cheese or jam, a glass of milk and a cup of tea, with no reconsideration of how their choice of breakfast tastes, or of what further repercussions it might have. Expectations regarding the effects of certain foods on health and risk perceptions may also influence attitude (Baranowski *et al.*, 1999; see also *section 8.3*). Health considerations are of particular importance if the expected (perceived) health consequences are severe, likely and can become manifest in the short term.

Attitudes are thus determined by a consideration (rational or otherwise) of the pros and cons of certain behaviours. Attitudes can, however, be changed, for example by means of targeted information or advertising which (a) presents new expectations regarding the benefits to be derived from a certain product, ("Our low-fat cheese was already healthy – now it is tasty too!"), (b) reinforces the perceived positive aspects ("New improved flavour") or (c) attempts to rebut the perceived disadvantages ("Our low-fat cheese no longer has a low-fat taste").

Perceived social influences

The social influences experienced by the individual can be classified in three categories: 'subjective norms', 'descriptive norms' and 'perceived social support'. *Subjective norms* are the assumed expectations of others that we consider important: if, for example, someone believes that his partner or parents expect him to eat less fat, it is more likely that he will indeed try to do so. *Descriptive norms* are determined by what we think that other people who are important to us would do. If a person believes that his partner or parents eat low fat diets, it is more likely that he will do likewise or at least try to do so. Finally, people are also more inclined to eat healthily if they feel that they are being actively encouraged to do so: the phenomenon known as *social support*.

Research into various types of eating behaviour reveals that people's actual behaviour is more closely related to descriptive norms than to subjective norms (Brug *et al.*, 1994, 1995). In *changing* eating behaviour, social support seems to be important. Information and advertising generally rely on influencing descriptive norms: public information brochures and videos will often present 'role models', with stories or pictures of people who have, for example, opted to eat more fruit. The role models in advertising are often celebrities: actors, sports personalities and pop stars. However, research has shown that people are far more likely to model their own eating behaviour on those in their own immediate social setting, such as friends and family (Oenema & Brug, 2003). Peer education, in which health information is presented by people within the target group itself, makes use of this phenomenon (Kalampakorn, 2000).

Perceived behavioural control

Perceived behavioural control is the assessment of one's own abilities and opportunities to adopt or change a certain behaviour. People are motivated to do something provided they believe that they will be successful. For example, those who do not think that they can manage to eat less in order to lose weight will be far less likely to try in the first place. Perceived behavioural control is often context specific. People who experience a low level of perceived behavioural control find it difficult for instance to eat less fat when at a party, when eating out, at weekends, or when eating alone.

Research has shown that the level of perceived behavioural control is an important determinant of various types of eating behaviour (Conner & Armitage, 2002). Information and advertising often address perceived behavioural control in that they emphasize the ease of a certain course of action. However, perceived behavioural control can also be facilitated by making healthy eating habits an easier option in practice, for example by clearly labelling healthy and less healthy choices (Kreuter *et al.*, 1997) or by improving the availability of healthy foods, as in programmes which distribute free fruit to school children (Klepp *et al.*, 2005).

Personal norms

Behaviour which includes a certain moral or ethical component is influenced by both social norms and personal norms (Armitage & Conner, 2000). This also applies to certain eating behaviours. Some people may, for example, become vegetarian, others may decide to eat only biological produce, while personal moral considerations will cause a third group to deliberately avoid genetically modified products. Campaigns which promote these types of eating habits generally appeal to the individual's personal norms. Sometimes, this coincides with expectations concerning health (see under 'attitudes', above).

Awareness and knowledge

In addition to the factors mentioned thus far, awareness of one's own eating behaviour seems to be an important determinant (Brug *et al.*, 1998). Most people do not know exactly what they eat. Some 90% of the Dutch public, for example, believe that they do not eat too much fat, while in practice a considerable majority eat more than the recommended levels (Brug *et al.*, 1998). This lack of awareness regarding one's own consumption results in there being little motivation to change one's eating habits. Studies have shown that creating awareness about one's own consumption is the first essential step in the process of behavioural change. Information and education campaigns attempt to increase awareness by such means as simple question-and-answer tests with which a person can evaluate his or her own eating behaviour. The main aim of 'computer-tailored nutrition education' is also to raise awareness of personal eating habits (Brug *et al.*, 2003).

Knowledge is rarely cited as a separate determinant of eating behaviour. Studies reveal that knowledge alone is generally regarded as a weak determinant of behaviour (Meertens *et al.*, 2000). However, it is important that people acquire accurate knowledge about such things as the risks of an unhealthy diet, the fat and fibre content of foods, the recommended quantities of fruit and vegetables to be consumed, or low-fat methods of preparation. Such knowledge can be essential for a balanced consideration of the pros and cons of certain food choices (attitude), or if the skills required to eat healthily are to be acquired (behavioural control). In the complex field of diet and nutrition, however, the process of acquiring such knowledge has been rendered more difficult by the sometimes contradictory messages regarding the health and safety aspects of foods (see also *chapter* 7). Another specific point for attention here is knowledge about preparation methods. As the popularity of pre-prepared meals and 'fast food' increases, knowledge of preparation methods may decline.

8.2.3 Distal determinants

What we eat is not only determined by what we want to eat, based on taste preferences and other cognitions, but also by the environment in which we live (Booth *et al.*, 2001). A distinction can be made between the physical environment and the social environment.

Physical environment
The *availability* and *accessibility* of foods is an important determinant of eating behaviour. The range offered in the local supermarket, or the menu of a staff restaurant or school canteen, will determine what is eaten. Studies indicate that, because fast food chains and soft drinks manufacturers have gained access to schools in the United States, they have had a clear influence on the eating and drinking habits of students. Price is also an important factor in this context. Food that is inexpensive is more readily accessible.

'Environmental interventions' can help to promote a healthier choice of food and diet. For example, a wide range of affordable healthy products can be made available, or the healthy foods can be made more recognizable by means of labelling in supermarkets, staff restaurants and school canteens.

The physical environment also plays an important part in determining *habitual behaviour* since habits are often triggered by environmental cues. One possible strategy to induce habit change involves the formation of an 'implementation intention' (Verplanken & Faes, 1999). Implementation intentions are specific action plans on when, where and in what circumstances one would like to consume a healthy food product (e.g. 'on weekdays, during the morning break, I will buy and eat an apple'). In this way, people introduce new environmental cues (i.e. the coffee break) to induce a specific action (i.e. eat an apple).

Social environment
Alongside the physical environment, the *social environment* is also of importance. This is perhaps most evident in the case of children, who often have less autonomy in choosing what to eat. For example, studies have shown that rules about what may and what may not be eaten in the family situation partly determine the food choices of children and adolescents (Fischer & Birch, 1999; De Bourdeaudhuij & Van Oost, 1996). Recent studies also demonstrate that the more general (i.e. not food specific) parenting style may also influence the eating behaviour of children (Kremers *et al.*, 2003). Children from households with a so-called authoritative approach to child rearing

(characterized by emotional support, a reasonable degree of autonomy, and clear two-way communication) have been shown to eat more fruit than those raised in the authoritarian style, as well as those raised in the 'laissez-faire' way.

In this context, social economic status (SES) is also relevant (Droomers, 2002). The SES is usually determined by such factors as education, income and profession. In the Netherlands, as in many other countries, clear differences in nutrition behaviours have been observed between different SES groups. Lower SES groups are more likely to have less favourable diets. People of lower SES tend to eat less fruit and vegetables, for example, and are more likely to be overweight.

From distal determinants to proximal determinants

The Triadic theory assumes that the distal determinants influence eating behaviour via the cognitions. For example, in an environment in which fruit and vegetables are expensive or difficult to obtain, this could negatively influence attitudes with respect to fruit and vegetables. In such a situation, other people will also be less inclined to eat fruit and vegetables, which in turn will affect the descriptive norms. Moreover, if fruit is difficult to obtain, this will have an adverse influence on the perceived behavioural control (Wardle *et al.*, 2004). Lastly, certain dietary rules and parenting styles within a family can lead to the development of subjective social and personal norms.

The influence of SES on eating behaviour is also likely to be indirect, working via such factors as the availability and accessibility of healthy foods (e.g. price), knowledge regarding a healthy diet, and perceived social influences.

In recent years, the public health researchers and practitioners in the Netherlands and elsewhere have devoted increasing attention to the influence of environmental factors on individual health and risk behaviour, and hence on public health (Booth *et al.*, 2001; Ernsberger & Koletsky, 1999; Wooley & Garner, 1991). Efforts to prevent overweight provide a good example. For many years, health education focused on influencing risk behaviour by means of interventions targeting the individual. However, since society is evolving in such a way as to present many more opportunities for the consumption of energy-dense foods, with fewer opportunities and incentives for exercise, the situation calls for other types of intervention that include more than just education and information. Such a broader approach was most probably a key success factor in efforts to counter smoking, whereby a combination of health information directed towards smoking prevention and cessation, pricing policy, and legislation on smoke free areas, with cooperation between health institutes, the government and academia. A similar strategy and the involvement of the food industry may be needed to stop the obesity epidemic.

8.2.4 Ultimate determinants

Our choice of food is ultimately restricted by biological factors, and by the cultural and economic structure of the country in which we live (Capaldi, 1996). The *biological factors* determine what is actually edible, for example which plants are suitable for human consumption. They also determine our innate preference for sweet flavours and our aversion to bitter flavours. Within these biological boundaries, *cultural factors* determine what is regarded as edible (e.g. raw herring in the Netherlands, raw fish in Japan, whale meat in Iceland), and which types of taste preferences are prevalent (e.g. curry in India, chilli peppers with tomato in Mexico). Finally, *macro-economic factors* determine the type and quantity of food available.

The ultimate determinants of eating behaviour are generally non-modifiable, or can be changed only with extreme difficulty. Accordingly, they offer no direct point of departure for interventions designed to encourage healthy eating. However, interventions must take the ultimate determinants into account, and the ultimate determinants can indeed help in defining which interventions are to address which target groups.

Table 8.1: Determinants of behaviour and possible interventions.

Determinant of behaviour	Examples of intervention strategies
Proximal	
Attitudes	Confirming existing benefits, or introducing new, as yet unknown benefits. The negation or refutation of existing, anticipated drawbacks. Expectations regarding taste, convenience, and health are of particular importance in this regard.
Perceived social influences	Use ‘everyday’ role models in information to promote healthy behaviour. Use of so-called ‘peer education’.
Perceived behavioural control	Make it easier to eat healthily by increasing the availability, accessibility, and recognizability of healthy foods. Tagging and labelling can help to enhance recognizability.
Personal norms	Advertizing or health education can respond to moral motives.
Awareness	Feedback about personal food consumption, e.g. by means of computer-tailored nutrition advice.
Knowledge	The provision of good quality, non-contradictory information about products and methods of preparation.
Distal	
Physical environment	Enhance the availability and accessibility of healthy food choices, e.g. by labelling healthy food, and via school fruit programmes.
Social environment	Advertizing or health education can respond to parents (raising children) or to habit behaviour in low SES groups.
Ultimate	
Economic factors	Trade policy

8.2.5 Conclusions with regard to interventions

The foregoing discussion of behavioural determinants has considered various types of intervention. These interventions and the relevant principles for policy are summarized in *table 8.1*, arranged according to the type of determinant concerned. The actual consequences in terms of policy targeting a healthier eating behaviour are discussed in *section 8.4*, in the light of existing knowledge about, and the consequences of, risk perceptions of food safety. Moreover, in *chapter 2* (*section 2.5*) an attempt is made to translate this knowledge into everyday practice, as faithfully as possible, with the emphasis on the main dietary and nutrition problems and the relevant recommendations.

8.3 The consumer and the perception of food safety

M.A. Koelen, S. Lijklema

8.3.1 Introduction

Viewed objectively, food in the Netherlands and in neighbouring countries is possibly safer today than it has ever been (see *chapter 4*). However, the consumer does not always seem to share this view. This is hardly surprising given that food quality has regularly attracted negative media coverage: Salmonella in eggs, hormones and antibiotics in meat, dioxin in milk and poultry, and BSE in beef cattle. On the one hand, such coverage can lead to panic reactions, as in the Belgian 'toxic cola affair' of 1999. On the other, a succession of similar incidents can give rise to complacency. In every case, it is a question of how the consumer *perceives* the health risks related to food, and the extent to which he or she *accepts* those risks. Perception is largely a matter of the degree to which citizens see the risk as a substantial threat, while acceptance is more a question of whether or not they consider the existence of the risk to be acceptable. The two terms overlap, and what they have in common is that they are determined by many more factors than a mathematical risk assessment alone. For example: can we influence the risk? Do we know what uncertainties are involved? Do we derive any pleasure or advantage from the activity to which the risk attaches? This section considers the way in which these and other questions influence our perception and acceptance of risks.

8.3.2 'Objective' risk assessment

The Health Council of the Netherlands defines risk as "the possibility of harmful effects to human health, the environment or property, in combination with the nature and extent of those harmful effects" (Gezondheidsraad, 1995). Technical risk analyses can produce ‘calculations’ of a greater or lesser degree of accuracy which reveal the statistical probability of a certain severe or less severe (health) effect actually occurring. The principles used in such calculations are discussed in *chapters 4* and *5*.

Risk perception begins with the afore-mentioned two elements of risk: probability and effect. In the best case scenario, the *probability* can be quantified and a firm figure established (e.g. a 1 in 100,000 probability that a certain food will cause gastroenteritis). In most cases, the probability is small or extremely uncertain (e.g. the risk of developing vCJD (variant Creutzfeld Jacob Disease) from BSE-infected beef, or that of developing colorectal cancer due to the consumption of nitrates in vegetables). In terms of the *effect*, it is the severity of that effect which is an important factor in determining perception. Cancer and BSE are both very much more severe or frightening than a bout of gastroenteritis. The uncertainty regarding the probability and severity of any possible effect strongly determines the perception and acceptance of risk (Rogers, 1983; Janz & Becker, 1984; Milne *et al*., 2000). Various studies have shown that people are inclined to overestimate those risks with a low probability but with very severe effects (Combs & Slovics, 1979; Tversky & Kahneman, 1973). BSE provides a good example: at present, the probability of infection seems small, but vCJD is an extremely serious and fatal condition.

8.3.3 Other characteristics of risks

There are various other characteristics of risks which determine their perception and acceptance. These aspects have mainly been investigated by means of psychometric studies. A review study conducted by Powell (1998) reveals numerous risk characteristics, a number of which are listed below. (See also *table 8.2* for a summary of the main factors).

- C*atastrophality* is a term coined to describe situations in which the effects are concentrated in time and place: an epidemic, an aircraft crash, or a Legionella outbreak such as happened at a flower show in Bovenkarspel in 1999. The term also reflects the severity (life-threatening) nature of the effects. A risk with a high ‘disaster factor’ is perceived as very severe.
- *Controllability* of the risk relates to the degree in which a person feels able to control the risks or its consequences. The risk itself may be extremely high, but if the person believes himself able to control that risk it is perceived as less serious. A risk over which one has absolutely no personal control (such as contaminants in food) is perceived as very severe. Here, we must also mention the tendency for people to assess risks as being somewhat lower for themselves than for others (*‘unrealistic optimism’*; Weinstein, 1980, 1987, 1989; Sparks & Sheperd, 1994; Frewer *et al*., 1998).
- *Voluntariness:* risks are perceived as less severe and more acceptable if exposure is of one’s own free will. Star (1969) concludes that people who voluntary undertake a hazardous activity (such as skiing) are willing to accept a risk that can be calcu-

lated to be one thousand times higher than when exposed to a risk involuntarily (as in food contamination). Risks related to a hazardous lifestyle are also perceived to be far less serious than those presented by, say, technological hazards.
- *Reversibility:* risks are perceived as less serious if the effects can be reversed.
- *Advantages of 'high-risk' activities*. Frewer (1999, 2000) states that people will be more readily inclined to accept risks, or will perceive them as less serious, according to the advantages or pleasure linked to the activity concerned. Such advantages must be enjoyed by those who are exposed to the risk, or must accrue to the environment, rather than being restricted to the private sector, individual companies or certain demographic groups, except where the latter are disadvantaged in some way. Investigations have revealed that there is generally an inverse relation between perceived risk and perceived advantage (Alhakami & Slovic, 1994).

To summarize, we see that each (food-related) risk will have its own specific characteristics which account at least in part for risk perception and acceptance. The consumption of too much fat, for example, is controllable and voluntary. It is regarded as pleasurable, and the consequences are not immediately perceived as fatal. The BSE risk, on the other hand, is very different. Although the 'calculated risk' of developing a fatal disease through a foodborne infection is much smaller than through eating too much fat, it is nevertheless perceived as much more serious.

8.3.4 Characteristics of risk observation

In addition to the characteristics of the risks themselves, there are various aspects related to the observation of risks which affect perception and acceptance. People are exposed to a large amount of information every day. According to Tversky and Kahneman (1973) they apply a number of simple criteria (heuristics) to render this information manageable, but there is always a degree of personal selectivity. In assessing risks, the extent to which one can imagine an incident or the extent to which associations or examples can be brought to mind, will be important (Tversky & Kahneman, 1973; Uitdewilligen *et al.*, 1993). This is related to the characteristics of the risk itself (see above) and also the extent to which the information ties in with earlier observations (confirmation), or the frequency with which the risk is brought to the consumer's attention (e.g. by means of extensive media coverage). The literature cites various other characteristics of observation which affect this process. These are listed below and also summarized in *table 8.2*:

- *Positive and negative messages ('framing').* Studies reveal that negative information ('this is dangerous') is regarded as more reliable than positive information ('there is no risk'). This may well be due to the fact that in an evolutionary context, information about risks is more important in terms of *survival* (Siegrist & Cvetkovich, 2001).
- *State of mind*. If the recipient of the information is in a negative state of mind, he is likely to process information in a more analytical and systematic way. He will adopt a more critical approach, attaching greater weight to the negative aspects.

With a more positive state of mind, the recipient will be more inclined to process the information in an intuitive manner, with greater attention for the positive effects.

- *Knowledge about the risk.* Here, 'knowledge' refers to both the recipient's personal knowledge and his estimation of the knowledge offered by scientists and other experts. If the scientific knowledge is regarded as 'good', the sense of anxiety and concern will be mitigated. However, scientific knowledge with regard to various food-related topics is subject to uncertainties, and the information available may be incomplete or even contradictory, at least in the eyes of the consumer. For example, many people are concerned about genetically modified foods. They are unable to form an overall view of the consequences, either today or in the future, and believe that science has so far failed to conduct adequate research into the effects. Studies also reveal that experts assess risks in much the same way as anyone else. That they sometimes arrive at different conclusions, with a lower assessment of risk, can be due to a personal interest in the technology, and a more positive view of the controllability of risks (Sjöberg, 2001; Rowe & Wright, 2001).
- *Trust* in the organizations responsible for risk management will also influence the perception and acceptance of risks (Frewer, 1999; Frewer *et al*., 2003; Rohrmann, 2000; Slovic, 2001; Trautman, 2001). This trust is based on assumed competence and objectivity, the degree to which the source of the information takes account of the interests of the immediate stakeholders (fairness), and the consistency of the information provided (Frewer, 1999; Poortenga *et al*., 2000; Bier, 2001). Trust is, however, fragile. It is built gradually, but can be completely destroyed by a single incident. Once mistrust has taken hold, it will often increase by itself (Slovic, 1993). Frewer (1999, 2000) concludes that development or loss of trust in a source of information is largely a question of whether the information provided later proves to be true or false. Trust in an organization or source of information is particularly important if the recipients of the information have little personal knowledge concerning the risk (Siegrist & Cvetkovicz, 2001).

In terms of the perception and acceptance of risks, exposure to information about the risk is usually seen as the most important factor. The media and the way in which the information is 'framed' are crucial here. This can lead to 'social amplification' (Kasperson *et al*., 1988), whereby a combination of the risk attributes described above and extensive media coverage can elevate risks, that are objectively estimated or calculated to be relatively minor, to the status of a 'crisis' accompanied by considerable social disquiet. This effect can be exacerbated if the feeling exists that the current situation is merely a forerunner of some new and unknown threat. Sometimes this is accompanied by serious economic losses. The instances of the incidents cited in the introduction to this section are good examples. Furthermore, a study conducted by Frewer *et al.* (2002), revealed that the risk perception of the British public with regard to genetically modified foods was more negative in times of extensive media coverage.

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Table 8.2: Summary of the factors which play a role in risk perception (as described in the text).

Factor	A risk is perceived as being greater and less acceptable if:
Catastrophality	The consequences are more severe, and are more concentrated in time and place
Controllability	Control is out of the individual's hands
Voluntariness	Exposure is involuntary
Reversibility	The effects are irreversible
Observed benefits	No benefits are attached to the risk
Framing	There is more negative information about it
State of mind	The state of mind is more negative
Knowledge, understanding, familiarity	The risks are unknown, both to the individual and to experts
Trust	People are less inclined to trust the information

8.3.5 Individual differences in risk perception

A number of studies provide information about the link between demographic factors and risk perception. In general, women appear to assess risks to be greater than men do (Flynn *et al*., 1993; Slovic, 1987; Frewer, 2000; Frewer *et al*., 2002). Jussaume and Judson (1992) found that people with children under 18 are more inclined to purchase 'residue-free' foods. Certain ethnic groups, individuals belonging to the lower social-economic status groups (assessed by education and occupation) and those with a below-average income also sometimes assess risks to be more serious than do others. According to Frewer *et al.* (2002) this effect may be due to the fact that these groups are generally less involved in the decision-making processes regarding risks. In this context, Källmen's investigations (2000) into personal characteristics is also interesting. People whit low anxiety levels, who have an internal 'locus of control' (the perceived ability to influence ones own situation) and have a high degree of perceived self-efficacy, tend to assess both personal and general risks lower than others do.

Moreover, individuals have different experiences with risks, which may either increase or decrease concerns. This is partly related to the question of whether prior exposure to a hazard was voluntary or involuntary. Involuntary risk activities tend to increase concern. For voluntary activities no significant relationship between experience and the level of concern has been found. People generally are less concerned about voluntary risks which, moreover, are more often associated with certain (expected) advantages. It may also be that a person has undertaken a voluntary activity precisely *because* he or she was less concerned about the risks (Barnett & Breakwell, 2001).

8.3.6 Cultural factors

According to the 'cultural theory of risk' (Knox, 2000; Bouyer *et al*., 2001), socio-cultural factors also determine which risks are given greater or lesser attention. For example, the consumption of meat has a different meaning in certain cultures: Jews and Muslims are not permitted to eat pork, while Hindus do not eat beef. In the western culture, attitudes to meat are influenced by opinions regarding the way in which humans should interact with nature and the environment. The intense response to crises such as BSE, swine fever, foot-and-mouth disease and fowl pest may be seen as an expression of growing resistance to the large-scale bio-industry and animal feed cycle (Miles & Frewer, 2001; Vis & Koelen, 2002). In other words, concern is by no means always about personal health risks.

8.3.7 Conclusions with regard to risk communication

The characteristics of risks and risk observation listed in this section demonstrate that the overestimation or underestimation of risks is a phenomenon which will be difficult to avoid in practice. Clearly, risk perception and acceptance rely on a far greater number of factors than a calculated figure alone. Moreover, we must note that the calculations themselves are subject to varying degrees of accuracy and will always involve subjective choices, such as the specific health effect being considered (Slovic, 2001). *Figure 8.1* presents a schematic representation of the influence of the various factors on risk assessment and risk perception.

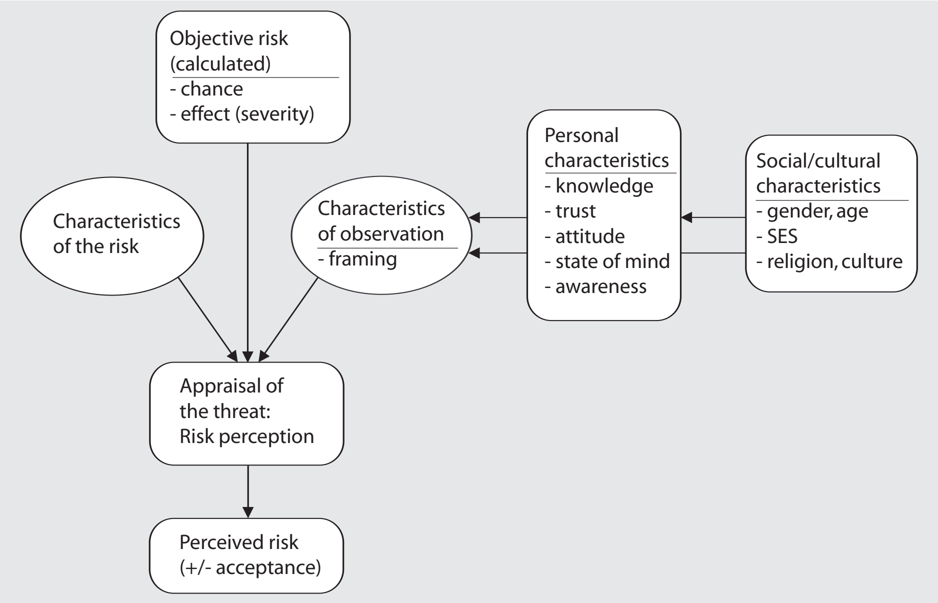

Figure 8.1: Risk and risk perception.

Risk communication can be used by governments or food manufacturers to influence the public's perception and acceptance of risks. It can be used to counter the undesirable (e.g. economic) consequences of certain risk perceptions. The immediate objectives of risk communication include:

(1) Raise trust in the government or other actors
(2) Awareness raising, providing information and education
(3) Encouraging responsible, safe behaviour

Communication is, however, interactive. For instance, one objective might be to gain an understanding of people's motives for adopting given positions, thereby arriving at a joint approach for further communication. In any event, effective risk communication requires sound understanding of the factors discussed above. For a comprehensive account of the guidelines for risk communication in general, we refer to Powell (1998), Bier (2001), and Lundgren & McMakin (1998). We examine a number of aspects in detail below.

Raising trust

Communication is pointless if there is no trust in the communicator. For example, if public concern about food safety increases, while at the same time there is a decrease in confidence that the government and the industry have technological developments under control. In such a situation, negative risk perceptions will be reinforced. Communication can only enhance trust and confidence under certain conditions. Trust in the sources of information is bolstered by the suggestion of competence, objectivity, justice, consistency and openness. The sources are seen as least trustworthy when they overstate or misrepresent the information, if they have a clear vested interest, or if their motives appear to be those of self-protection.

Awareness, information and education

Assuming that trust and confidence exist, or can be created, the next step in the risk communication process is that of providing factual information and awareness raising. A number of guidelines for effective risk communication can be summed up as follows (Powell, 1998):

- *Be truthful, open and complete.* The information must address the nature of the risk, the advantages and disadvantages, possible alternatives, the choices that have to be made and the degree of scientific uncertainty that exists. It is important to take into account the differences between experts and the general public in terms of perception and wording.
- *Be proactive*. Provide information from the earliest possible moment.
- *Assume that perceptions are realistic*. Use the feelings and concerns of the public as one of the starting points of the discussion. Take concerns other than those related to risk, such as ethnic objections, into account. Place the risk in its social and political context (Frewer, 1999; Miles & Frewer, 2001).
- *Provide specific and personally relevant information.* Information which is too general will easily give rise to distorted perceptions. People may then feel more at risk than they really are, which will lead to panic reactions. Alternatively, the phenomenon of 'unrealistic optimism' may occur, whereupon the risk will be ignored because people consider themselves to be at less risk than others.
- *Tell people what they themselves can do*. If people realize that preventive action can be taken and will be effective, there is a greater likelihood that they will act accordingly.

Encouraging safe behaviour

If the purpose of risk communication is to encourage safe behaviour, the determinants of behaviour have to be taken into account (see also *section 8.2*). Whether and how people display preventive *behaviour* or change behaviour in the face of a risk is described in the 'Protection Motivation' theory (Rogers, 1975, 1983; Neuwirth *et al.*, 2000; Milne *et al.*, 2000). Protection motivation is a behavioural intention which is regarded as a good indicator of subsequent behaviour. According to the theory, the decision to adapt one's behaviour in the face of a risk will depend on two appraisal processes: (a) threat appraisal and (b) coping appraisal in which the options to diminish the threath are evaluated. The process of *threat appraisal* involves all the elements discussed in *sections 8.3.2* to *8.3.6 (*see also *figure 8.2)*. The process of *coping appraisal* is a function of three simultaneously occurring assessments. The first considers the perceived effectiveness of preventive behaviour (response efficacy), the second considers the person's self-efficacy to perform that behaviour, and the third relates to the costs in terms of money, time and effort (response costs) that will be involved in doing so. Each of the various elements within these processes can form a barrier to effective behavioural modification by means of risk communication. For example, 'unrealistic optimism' may lead a person to trivialize his or her own susceptibility to the risk: "let other people be careful, I don't have to." This may form a major barrier to effective risk communication. Some strategies for influencing behaviour are presented in *section 8.2*.

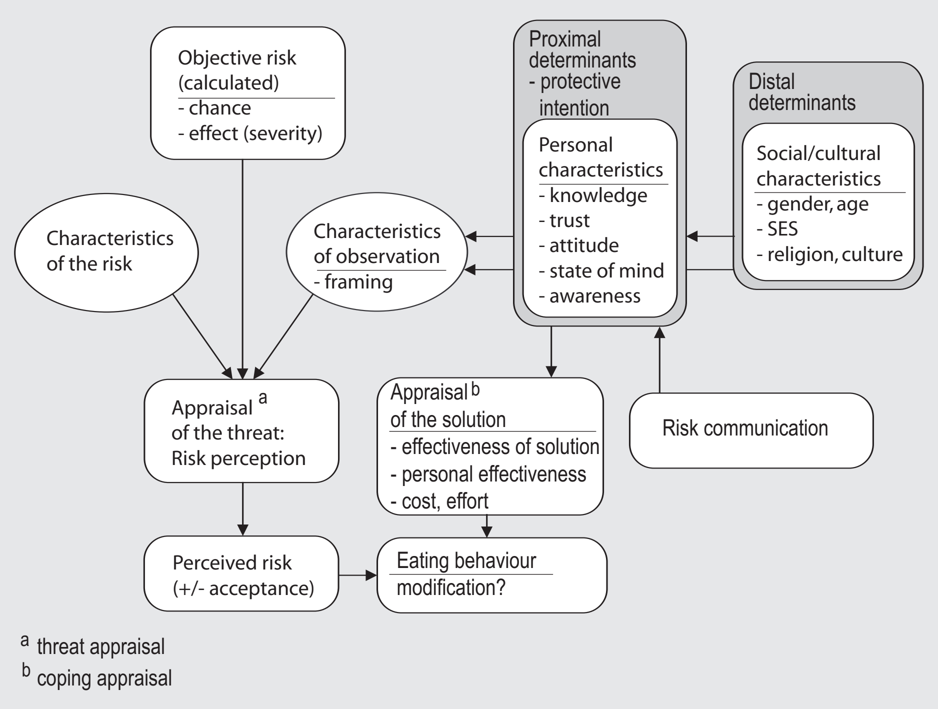

Figure 8.2: Risk communication, risk perception and (eating) behaviour.

8.4 Conclusions and recommendations

Eating behaviour

Eating behaviour is complex behaviour which is very difficult to change for the better. As described in *section 8.2*, eating behaviour is determined by personal factors (the proximal determinants), of which behavioural intention is the most direct. Behavioural intention is determined by factors such as attitude, which is the result of a balanced consideration of the expected advantages and disadvantages. Expectations in terms of taste, enjoyment, convenience and cost are the most important factors, alongside 'force of habit'. Expectations of beneficial health effects will also influence attitude, but this effect is less marked, and decreases if more time will elapse before the beneficial health effects become apparent. Furthermore, 'convenience' plays a major part in perceived behavioural control, another important sub-determinant of behavioural intention.

The physical environment (distal determinants) has at least an equally important influence. This influence is mostly indirect, via the personal determinants. Issues such as the availability and accessibility of foods will help to determine people's attitudes. These issues, in addition to habits, will therefore allow interventions addressing the above-mentioned aspects, such as taste, enjoyment, convenience and cost. The social environment (setting) can be important as well, particularly for children and the lower SES groups.

Modifications to the food supply can therefore influence both important environmental factors (availability, accessibility) and, indirectly, the main personal factors (behavioural intention, attitude). The purpose of doing so should be "to make the healthy choice the easy choice". Success in such an undertaking is most likely to be achieved by means of improvements in taste, convenience and pricing, whereby the products should preferably fit within existing eating habits. Some examples of this are, in part, previously observed changes to eating behaviour with regard to products such as brown bread, semi-skimmed and low-fat dairy produce and 'light' versions of many foods and beverages.

The chance that such interventions will be successful can be further enhanced by positively influencing other individual determinants such as awareness and knowledge at the same time, by means of education and information. This is important in terms of enabling people to assess their own eating behaviour, and to gain a better understanding of the short-term and longer-term health effects of various foods. Both aspects will help determine a person's willingness to change his or her eating behaviour. Here, the assessment of negative health effects forms a link with the aspects of risk perception and acceptance, as described in *section 8.3*.

Risk perception and risk communication

As we saw in *section 8.3*, the perception and acceptance of a risk does not rely on a calculated statistic alone, but on many other factors. It is almost inevitable that the consumer will overestimate or underestimate the risk, based on both the characteristics of the risk itself and the characteristics of the observation. The observation of the risk will depend in part on the same personal characteristics which also determine eating behaviour.

With regard to the characteristics of the risk itself, it seems that an extremely severe health effect ('catastrophality') tend to be more important than a low statistical probability. Other factors, such as controllability, voluntariness and expected advantages also play an important role in this respect. With regard to the characteristics of observation, the context ('framing') of the message is the main factor, although individual differences and cultural factors may also play some part.

It is said that the expectations regarding negative health effects of food products only have a limited influence on eating behaviour as well (see *section 8.2*). Only where the (perceived) health effect is extremely severe (as in BSE or cancer), or in the case of acute health effects (foodborne infections, food allergies), is behaviour likely to be modified to a great extent. However, this is not a 'black and white' distinction, particularly with regard to the effects that will only become apparent over a very long period of time. The presence of carcinogens in food products, if subject to enough media coverage, can decimate the sales and consumption of those products and can give rise to a 'food crisis'. By contrast, excess consumption of unhealthy fats, despite representing an equally severe (objective) health risk and being subject to equal media coverage, continues unabated. Is, in the latter case, the perceived severity of the effect not so great, or do other characteristics of the risk and/or its observation play a greater role here? Risk communication with the consumer is one of the most important means by which such phenomena can be understood.

Good risk communication must be interactive and public perceptions must be taken seriously. Good risk communication can be used to create or to restore trust and confidence in the government or other actors, and can also be used to ensure better information and consumer education. Raising awareness and increasing the consumer's knowledge can have a positive effect on eating behaviour, given that both aspects help to determine attitude, the main determinant of behavioural intention.

Risk management

Good risk communication is also an important instrument in risk management. The report *Nuchter omgaan met risico's* ('Dealing sensibly with risks') (RIVM, 2003; Klinke & Renn, 2002) provides a framework for effective risk management. This framework, also known as the 'risk ladder', sets out a number of different strategies for discussion and decision-making to be used when dealing with increasing levels of uncertainty regarding the risk involved, and with increasing levels of social complexity.

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9 WHAT WILL THE FUTURE BRING ?

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9.1 Introduction

Foregoing chapters have discussed how healthily Dutch people eat and the status of food safety in the Netherlands. But what will the future bring? To answer this question, interviews with sixteen experts in various fields were held (see *appendix 3*). The experts were asked about their expectations with regard to changes in eating behaviour and to the food supply during the coming five to ten years. They were then asked to indicate which factors underlie these changes and what the effects will be on the safety and the health-promoting aspects of our diet. Finally, where possible, the experts stated how these changes would eventually influence public health. The interviews were conducted according to a set structure (shown in *figure 9.1*), in which the developments in eating behaviour and food supply were of pivotal importance. Depending on the specific expertise of the interviewee, greater or lesser attention was devoted to each aspect. A summary of the interview was presented to each interviewee for assessment. The summaries of all interviews, the main conclusions and the possible principles for policy were later discussed by the same experts during two workshops. This chapter describes the results of the interviews and the workshops, using the structure of the model shown in *figure 9.1*. This is followed by the recommendations for policy and finally the summary and conclusions.

9.2 External factors

Many factors which are beyond the direct influence of the manufacturer or individual consumer are reflected in developments in eating behaviour or the food supply. This involves developments in a variety of fields, both in the Netherlands or on a larger scale, such as socio-demographic, socio-cultural, economic and scientific developments, as well as changes to legislation. The external factors described in this section were explicitly cited by the experts as explanations for changes in eating behaviour or the food supply. Incidentally, it cannot be claimed that any single external development will have a specific effect on one certain development in eating behaviour or the food supply. The reality is usually more complex because many factors influence each other.

[#] With contributions by C.F. van Kreijl, M.C.M. Busch

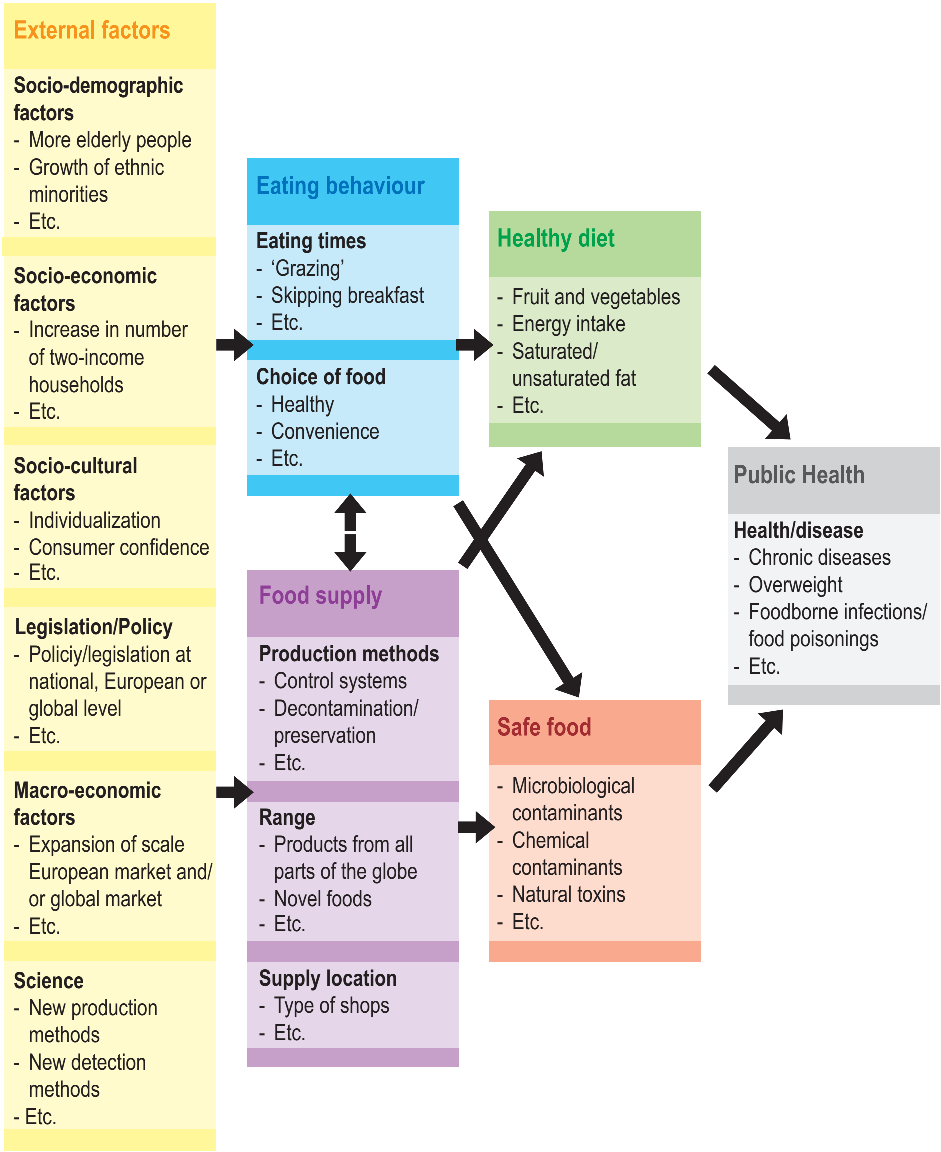

Figure 9.1: Diagrammatic model used in the interviews to chart the expected developments in eating behaviour and the food supply, and the effects on public health. This diagram is based on the conceptual model from chapter 1.

9.2.1 Socio-demographic factors

The changing composition of the population will undoubtedly have an effect on the future demand for foods. One change which is particularly conspicuous is the increased representation of seniors and ethnic groups in society. According to the forecasts, in 2009, 15% of the Dutch population will be 65 years or older, being almost

2.5 million people (CBS, 2003). Moreover, approximately 12% of the population will be of non-western ethnic origin, compared to 10% in 2003 (CBS, 2003).

9.2.2 Socio-cultural factors

The increase in employment participation on the part of women will also be reflected in eating behaviour. In 2003, 55% of couples formed two-income households (CBS, 2003). The expectation is that this number will continue to increase. Another socio-cultural development which will play a role is individualization.

In addition, the great demand for information and the availability thereof in society will lead to an increase in the quantity of information provided about food. This will not just affect the information that is currently printed on packaging, but also information about production methods (e.g. 'animal friendly'), health-promoting properties, origin, etc. The importance of this information will increase because there is an ongoing development whereby eating is increasingly seen as a signal of identity; the immaterial aspects of food will therefore become more important.

It is also expected that the 'distance' between consumers and food will become larger. This is the consequence of the presence of food being taken more for granted, the greater physical distance to the production of foods, and decreasing knowledge about food and nutrition. Most information about nutrition now reaches the consumer via the media in the form of food industry advertisements, and this situation is expected to continue. These advertisements will often encourage greater consumption of energy-rich foods. A decreasing amount of information about diet and food will come from such intermediaries as parents, teachers or information officials who endorse a more responsible diet, whereupon children in particular will be more susceptible to new influences and the advertised products. This development will have an effect on eating behaviour.

A cultural shift is expected within the food manufacturing companies. The large companies in particular increasingly become aware of the requirement to do business in a socially responsible manner. Sustainability and, in particular, health will become important aspects which will be used in the profiling of the products.

9.2.3 Legislation/Policy

More legislation will be established at European level and less at national level. It is anticipated that this will have both positive and negative effects for the Netherlands. A positive effect is that matters will now also be addressed on a larger scale. A possible negative effect, according to the experts, is that harmonization of legislation with regard to food components could result in higher permissible levels than those currently allowed in the Netherlands. In this type of decision, the Netherlands could actually become a guiding country. The formulation of legislation at the European level will, however, proceed very slowly. This may pose a danger to public health with regard to the emergence of 'new' threats, because the legislation will lag behind the developments.

A specific change which is currently being prepared by the European Union concerns legislation relating to health claims (see also *chapter 6*). This legislation will ensure that claims may only be made if they are subject to scientific evidence. This is expected to lead to greater acceptance of specific health-promoting foods (also called 'functional foods' by many experts), because it will then be possible to 'separate the wheat from the chaff'. Another important regulation which seems to be forthcoming is a European law which permits certain (new) methods in the food production process, such as decontamination.

Of course, the policy of the national government will also have an influence on the food supply and on eating behaviour. On the one hand, a number of experts believe that the government will reduce its direct involvement yet further, whereupon the responsibility of the manufacturers and of the citizen will become more important. If this trend continues, the short-term effects will be limited according to the experts. In the longer term, however, it will have major consequences, as illustrated by the epidemic of overweight which has already begun. The experts do not believe that government withdrawal will have a major effect on the aspect of food safety, because this will be partly compensated by the food companies themselves. After all, manufacturers do not wish to suffer any damage to their image. On the other hand, some experts believe that the government will actually involve itself more in food and nutrition. The expectation is that priorities in government policy in the field of food safety will, in future, be determined more by worldwide problems than by those only seen in the west.

9.2.4 Macro-economic factors

The experts believe that the expansion of scale and globalization of food production will continue. This could have an effect on food safety in particular (see *section 9.4.2*). The manner in which the economy will develop in the years ahead, currently an uncertain factor, will also have an influence on eating behaviour and the food supply.

9.2.5 Science

Developments in science will also influence our diet and its health effects. Greater knowledge will become available about the health-promoting aspects of dietary patterns and of specific food components. This knowledge is expected to prompt further discussion about whether an adequate intake of a certain bio-active substance can be achieved by means of the 'normal' diet, or whether certain foods should be enriched with the substance. If so, which foods? An example of a substance for which this discussion is already ongoing is folic acid, but it is conceivable that further bio-active substances will be subject to discussion in the future. In addition, knowledge about the health-promoting aspects of diet will be applied in the production and promotion of foods. The importance of diet in terms of health is also beginning to penetrate the medical world, resulting in more prevention activities targeting eating behaviour.

Apart from more knowledge about the health-promoting aspects, we may expect greater knowledge about the harmful effects of the substances contained in our diet. For example, an increasing number of hazardous chemicals will be identified and detected (in smaller quantities). This will affect the setting of standards with regard to admissible quantities in foods.

In the context of scientific developments, many experts cite the growing knowledge about the human genome and its relation to nutrition. This knowledge will lead to customized nutritional advice, to the development of functional foods which are tailored to persons with a certain genetic profile, and to risk evaluations which take genetic sensitivity into account. However, this is not expected to have any role in eating behaviour or the food supply during the coming five to ten years.

In addition, more knowledge will emerge concerning the practical applicability and effectiveness of possible (new) preservation techniques and decontamination methods. All these new preservation methods, technologies, etc. could, the experts believe, potentially contribute considerably to improving the safety and health-promoting properties of our diet. Whether this will actually be the case depends on consumer acceptance, which will be influenced by the degree to which the consumer is involved from the start in the introduction of a new method or technique.

9.2.6 Miscellaneous factors

Two developments of entirely different kinds are climate change, which can affect the ecology of microorganisms, and increasing hygiene. It has been claimed that improved hygiene results in too little stimulation of the immune system, which may lead to an increase in disease burden due to conditions such as food allergies (see also *section 4.4*).

9.3 Developments in the food supply and eating behaviour

The experts expect that current trends in the food supply and in eating behaviour will continue over the coming five to ten years. Although supply and demand have a mutual influence, many experts are of the opinion that the influence of the supply side on eating behaviour is greater than that of consumer demand on the supply. The following sections discuss the developments in the food supply and eating behaviour separately.

9.3.1 Developments in the food supply

During the years ahead, a number of developments may be expected, both within the food industry and within the food supply. New techniques will be used in the production of foods, and there will be a larger range of food products which address consumer food choices. There will also be changes in terms of the provision of consumer information and in the locations at which the food supply is made available.

Production methods
Alongside the manufacture of new products which may entail new production methods, ensuring the safety and quality during the production will become a more important aspect within the organization and its control systems. Related to this are the changes expected in preservation and decontamination. Reasons for these changes include the consumer's preference for products containing fewer preservatives, the expansion of scale and consequent longer production lead times, and forms of microbiological contamination which cannot be countered using the existing methods. First of all, efforts will be made to use lower doses of the traditional preservatives. Moreover, greater use will be made of alternative preservation techniques. The application of alternative natural preservatives does not yet seem possible, given that most of those that have currently been investigated either have an extremely selective effect or adversely influence the sensory qualities of a product. However, the use of new milder preservation techniques such as ultra-high pressure, electron radiation ('e-beam') and 'pulsed-electric-field' (PEF) is expected to increase, as a replacement for pasteurization treatments. The main motivation for applying these techniques is not so much food safety, but the desire to improve freshness and sensory quality, as products will no longer have to be heated. Because these techniques are, in general, expensive, the experts believe that in the short term they will only be applied to the more expensive products.

Until recently, decontamination methods could not be used without special dispensation. The experts anticipate that their use will soon be permitted in order to kill some or all of the pathogenic microorganisms, particularly those in primary animal products, such as Campylobacter and Salmonella in poultry. These techniques will primarily be used on the surface of raw products. Examples of decontamination methods include the application of lactic acid, acetic acid, peroxides, high-intensity light pulses (HIL) and UV light. The last two mild decontamination techniques will primarily be used on products with relatively smooth surfaces.

Range of products

The range of foods which fit in with a healthy dietary pattern or which have a healthy image is expected to increase in size. This development is due in part to the trends cited above, that more knowledge will become available with regard to the health-promoting aspects of the diet, and that more large companies are aware of the requirement to do business in a socially responsible manner. This latter trend will continue within all food sectors, since no one wishes to be ‘bottom of the class’. In the snack sector, for example, there is already a discussion about improving and/or reducing the fat content of products. If there is increasing societal pressure to take greater account of the sustainability or health aspects of foods, there will be greater motivation for doing business in a socially responsible manner. This will lead to an increased supply of products which are appropriate to a responsible dietary pattern. However, the experts do not expect the range of unhealthy products to decrease in size. The market for ‘healthy’ products will remain limited, largely due to the high level of investment required and the higher prices which must then be passed on to the consumer. At the same time, the ‘unhealthy’ products will continue to offer companies large profits. So, doing business in a socially responsible manner will become more important, but the maximization of profits will remain the main objective.

On the one hand, the increase in the number of ‘healthy’ products will involve a rise in the number of existing products whose nutritional composition has been improved, such as pre-prepared meals with larger portions of vegetables than is now usual. On the other hand, an increase in the range of functional foods is expected, both those targeting specific conditions (such as high blood pressure and overweight) and those addressing specific target groups or situations. According to one expert, however, the market for functional foods will be severely restricted once the draft text of the legislation governing health claims is ratified, since this precludes claims for ‘general health or well-being, behavioural benefits, psychological benefits or weight management’. There may also be an increase in the range of functional foods due to the inclusion of the same bio-active substance in several types of products. Competitors will copy and market successful products more quickly, a phenomenon known as the ‘me too’ trend.

Another important expectation with regard to the range of products is a further growth in the number of different products available. An increasing number of products from all over the world will come within reach, while the range of (partially) pre-prepared meals will be expanded to include ‘world cuisine dishes’. Moreover, there will be greater variation within one and the same product group. The supermarket dairy section has recently undergone an enormous expansion. This development will also be seen within other product groups. It is therefore expected that there will be many more products on the market which contain a high quantity of salt and/or sugar or artificial sweeteners. The range of products with a particularly pronounced flavour, which are either energy-rich or prompt greater consumption, will therefore increase. A number of experts believe that there will be less variety in various basic products. One example is the number of apple varieties available, which has declined in recent years.

Two developments are identified with regard to packaging and serving units. There is a trend whereby portion sizes, particularly those of energy-rich products, are increasing. Similarly, products are packaged in such a way that the consumer is more inclined to consume larger quantities. This trend is partly due to the fact that, further to expansion of scale and globalization, multinational companies operating in Europe will adopt the marketing strategies which have proven successful in the United States. At the same time, there is also a trend towards smaller packaging units, such as small packets of crisps and pre-sliced vegetables for one person.

Consumer information

The consumer has a growing need for information about the foods he or she consumes. The improved control systems of the manufacturers ensure that some of this information is available, and information technology makes it possible to communicate that information to the consumer. However, the form of the communication must be designed within a joint process involving the government, the consumer, retailers and manufacturers. Options include information on product labels, information provided via the internet, or by means of specific logos or special in-store displays.

Location of supply

In recent years, it has become ever easier to obtain food practically anywhere and at almost any hour of the day. The experts believe that this trend is not likely to continue at the same rate in the decades ahead. However, there will be an increase in the number of larger supermarkets, prompted largely by the desire for the convenience of ‘one-stop shopping’. Regional products will also be available in these new outlets. As the counterpart to these large-scale supermarkets, there will also be a trend towards the purchase of food in local, small shops (including non-western speciality retailers) or directly from the source, such as a ‘hobby farmer’. The non-western shops will be particularly popular among the ethnic population, given that the large companies do not yet address this market.

The desire for more convenience when purchasing foods will also lead to a slight increase in the supply of food products via the internet, and deliveries to the door (mobile shops and frozen products). Finally, a slight increase in the number of shops selling only one brand is expected.

9.3.2 Developments in eating behaviour

An important, general development in eating behaviour is that consumers will display several, disparate behaviours. Previously, consumers could be placed in clearly definable 'pigeonholes'; in future they will be less consistent in their behaviour. For example, there will be consumers who eat fast food one day, but who prepare an extensive sit-down meal the next. It is also expected that the favourable changes in eating behaviour will be very gradual. This is because eating behaviour is difficult to change for the better, as illustrated by the effects of current education campaigns, and because the Dutch are creatures of habit (see also *chapter 8*). Nevertheless, there will be developments in eating behaviour which will not apply to the entire population, but which will be of greater or lesser importance in terms of health within certain groups. They include changes in the eating moments and the choice of foods.

Eating moments

It is expected that eating moments will not be confined to the main mealtimes. Because food is available practically everywhere and at any time, a greater number of consumers will eat throughout the day, a phenomenon known as 'grazing'. However, this will not be at the expense of the three main meals: the majority of the population (at least 75%) will adhere to the traditional mealtimes. Among the lower socio-economic status groups, it will however be more common for people to skip breakfast. In combination with other risk factors, this practice can have an additional adverse effect within these groups. Another trend is that not all members of the household will sit down to the table together at mealtimes or for between-meal snacks, particularly on weekdays. Further to the ongoing individualization of society and the increasing number of two-income households, eating will become a much more individual undertaking, with each member of the household eating at whatever moment suits him or her best.

Food choice

In terms of food choice, several contradictory trends may now be observed which will continue in the future. For example, there will be more biological foods and more artificial foods, as well as more fast food and more slow food. However, the experts cluster the main trends together as a tendency towards more convenience, health, variety and enjoyment. In addition, force of habit is cited as the fifth main influence on eating behaviour: clearly, this factor stands in the way of rapid changes. The price-quality ratio will also continue to play a role, certainly if the economic recession continues.

The trend towards healthy food products will manifest itself in various ways, including increased consumption of functional foods and increased use of liquid fats rather than hardened fats. However, a further decrease in the consumption of vegetables is expected, particularly among young people. The choice of healthy foods is a particularly important point for elderly people who are more concerned about their health. Alongside the traditional healthy products, their food choice will rely more on functional foods and enriched products. Nevertheless, although the trend towards greater consumption of functional foods will continue, their use is not expected to become a 'hype'. It is predicted that the majority of the Dutch population will remain reasonably traditional in their eating habits, and will only turn to functional foods where a specific health problem exists. The high price of these products means that their purchase is largely confined to those from the higher socio-economic groups.

One expert stated that post-war generations will be more open to the use of functional foods. Because this generation of consumers has, in general, experienced few great setbacks in their lives, such as a war, their attitude is that they are entitled to everything, and hence also to solutions to all their health problems. However, this standpoint was not endorsed by the other experts.

The desire for more convenience will lead to more consumption outside the home and, as stated in the section examining food supply, to increased purchase of products demanding little preparation time. This trend is primarily attributable to the group of two-income households, who have little time to prepare meals but who have more money to spend. The tendency towards convenience is also expected to be seen among other groups, such as senior citizens and singles.

The trend towards greater variety is partly due to the increasing penetration of non-western foods as a standard part of the 'Dutch' dietary pattern. This may be ascribed to the increase in the number of citizens of ethnic origin, as well as the increasing propensity to travel and globalization.

The desire for greater enjoyment will lead to increased consumption of high-quality products, particularly at weekends when there is more time to prepare an extensive meal. It will also lead to greater consumption of products with an extremely distinct taste: very sweet, very salty, more fried than boiled. This trend will be particularly marked among children and young people, often prompted by advertising. The trends towards health, convenience, variety and enjoyment will also be combined within the same food choice of the same consumers. This will manifest itself, for example, in more 'healthy' convenience food.

9.4 Effects on public health

During the coming five to ten years, both major and minor changes are expected in terms of food supply and eating behaviour. What will be the effects of these changes on the health-promoting aspects of the diet, on the safety of food, and eventually on public health?

9.4.1 Will the Dutch diet be healthier ?

Some of the expected developments in food supply and eating behaviour will have favourable effects on the Dutch diet. This is true of the increase in the number of products with improved nutritional quality. In view of the increasing consumption of convenience foods, changes to the composition of these products will also have a favourable effect on the quality of the diet.

The increased range of functional foods, and the resultant increase in the consumption of health-promoting bio-active substances may have a favourable effect on the diet of some specific target groups. However, the experts expect these foods to be consumed by only a minority of the population, and for a limited period.

We may therefore speak of a positive development in that there will be a larger range of foods which are appropriate to a responsible dietary pattern. However, unfavourable developments in the food supply and eating behaviour are also expected: developments which, furthermore, are likely to have a greater effect for the majority of the population. These developments are discussed in the following paragraphs.

Although there is an increasing range of convenience food which is appropriate to a responsible dietary pattern, it is unlikely to have any favourable effect on public health unless extra efforts are made by the government and the private sector. When using convenience food, people eat less vegetables than recommended. Moreover, most convenience food contains relatively low quantities of dietary fibre and has a high salt, fat or sugar content.

In general, the range of flavoursome and, above all, energy-rich products (with little fibre) is increasing, and this is reflected in the consumption of such products. In addition, portion sizes are becoming larger. This, together with a lower energy requirement resulting from decreased physical activity, means that, apart from the nutritional quality of the food, the energy intake is too high. Much of the food consumed by children, teenagers and members of the lower socio-economic status groups in particular is energy-rich and has a pronounced flavour, such as very salty, very sweet, more fried than boiled. Another reason to expect a less healthy eating pattern is the increase in 'grazing' behaviour. This in itself need not have a negative effect provided 'healthy' products are consumed. However, it is expected that grazing will entail the consumption of more 'unhealthy' products.

The consumption of energy-dense products will increase particularly in times of economic recession. The consumer will then switch to less expensive products. Within a number of food groups, these are the 'unhealthier' foods, such as products with little fibre or with a high content of saturated fats. Because recessions are, in general, temporary in nature, the health effects are estimated to be slight.

9.4.2 Will food become safer ?

The majority of experts expect that objective safety, measured using the standards currently in place, will either remain constant or will improve. However, the improvement will at best be marginal, given that food is already considered safe.

One argument in favour of greater food safety is that manufacturers devote increasing attention to this aspect and, as previously stated, have or will implement a greater number of control systems. Companies which fail to do so will be less able to justify their existence. The control systems enable contaminations or situations in which the standards are exceeded to be identified earlier, whereupon interventions can serve to limit the damage. The increasing attention for control systems will not be confined to the production processes of the companies concerned, but will also entail quality requirements for suppliers. Not all products will be checked but, based on business confidence, an increasing number of quality contracts will be entered into between manufacturers and their suppliers, involving random checking only, with the supplier doing whatever is necessary to guarantee quality. The experts agree that this system will not provide a 100% guarantee of product safety. Past incidents show that even certified companies might be involved. Incidents can continue to occur in future due to (human) error or a deliberate breach of the rules. However, these systems and the improved detection methods will render problems visible at an earlier stage, which may allow these problems to be tackled more quickly in future.

Alongside these control systems, the use of decontamination techniques will also help to increase food safety. It is expected that this will enable the number of contaminations of poultry with Salmonella and Campylobacter to be greatly reduced. After all, if products supplied to the catering industry or to the consumer at home, for example, contain fewer microbiological contaminations, or none at all, then there will be fewer cross-contaminations or food borne infections.

Because companies increasingly devote attention to food safety, an increase in consumption outside the domestic situation and greater purchase of pre-prepared meals will improve food safety. With regard to the storage and preparation of food at home however, no favourable developments are expected, and food safety will remain a problem (see *section 4.2*). This is particularly due to the fact that the consumer's knowledge about food and safety is diminishing, due to a general decline in the transfer of knowledge about food and nutrition. Communication and the transfer of information will be essential in the context of food safety, certainly with regard to new techniques. For example, where a food is packaged in a tin but does not have a particularly long shelf life, this packaging method demands clear information to the consumer because the consumer will assume that the shelf life is similar to that of other canned products.

Alongside these generally favourable developments in food safety, a number of experts expect some critical points to remain, and some new problems to emerge. The large-scale nature of the food industry may lead to micro-organisms previously unknown in the Netherlands being imported, and may result in a longer average lead time of products which will increase the probability of the growth of undesired micro-organisms. There will also be products imported from countries which have a lower level of food safety control. However, due to the development of better control systems which accompanies the expansion of scale, it must be possible to limit the consequences of these developments, for example by imposing more stringent requirements on suppliers and by carrying out a greater number of checks.

There may also be an increase in the number of new infections with viruses and bacteria. New preservation techniques and the reduction in preservatives will lead to better quality (improved texture, nutrient content and sensory properties). However, the majority of new preservation techniques, like the conventional techniques, are concerned with the bacteria responsible for decay. Little is currently known about how these techniques can control viral infection. Given that, in general, viruses do not survive well outside body cells, this is not seen as a major future problem. A number of experts believe that a potential risk attaches to the storage in the shop of pre-prepared meals which have only to be warmed up at home. This is particularly the case if the temperature during the chilling and storage phases is not optimal, for example because the products are held in open containers. In the United States, this situation has already led to an increase in the occurence of *Clostridium perfringens*. It is also conceivable that the milder preservation techniques will occasionally be insufficient to counter pathogenic bacteria. Finally, climate change may also be responsible for an increase in fungal growth, with a danger of the formation of mycotoxins. The consumption of these mycotoxins can lead to liver damage and cancer (see *section 4.3*).

One expert believes that an increase in the number of biological products will have no influence on food safety. In these products, some problems will occur less often, while others will occur more often, but the overall effect will remain similar to that of the regular products.

For the group of people using functional foods, the larger range of these food products may result in too high a dose of a certain bio-active substance being consumed. In fact, the same danger may occur with natural flavourings, because these are also increasingly added to foods beyond the usual natural matrix. The expectation and hope is that this can be addressed by means of legislation requiring a reduction in the permitted dose, or a reduction in the number of products to which the bio-active substance may be added. However, while no such legislation is in place, this situation may cause problems (see also *chapter 6*).

The increase in the use of functional foods may also create problems which are not always directly realized. The addition of a certain bio-active substance can, for example, alter the pH, and hence encourage the growth of bacteria. One example is orange juice with extra calcium. To date, the problems associated with bio-active suppletion do not appear to be serious.

One point for attention further to these developments in food safety is that of consumer confidence. Increased knowledge, control systems and the large-scale market will render potential threats or incidents more visible. The large-scale nature of the (prevented) incidents makes them particularly newsworthy to the media. Considerable media attention devoted to threats or incidents which have been promptly identified and effectively resolved, can positively influence perception with regard to food safety. However, most experts expect that media attention will represent a negative influence for the time being.

9.4.3 Effects on public health

As stated in foregoing sections, there will be a larger range of products which are in keeping with a healthy diet. The large supply and consumption of products which are less appropriate to a healthy diet, having high energy content, high salt and/or sugar content, too little fibre and too few vegetables, will however result in the diet of many Dutch people becoming 'unhealthier' (see *textbox 9.1*). This dietary pattern, in combination with the trend towards less physical activity, will have an unfavourable effect in terms of the prevention of chronic diseases, such as cardiovascular diseases and diabetes. Accordingly, it is expected that the downwards trend in chronic diseases will continue to level out in future.

Even in the short term, the effects of this dietary pattern, involving the wrong choices from the large range of products available, portions which are too large and little awareness of what one is eating, will result in a high energy intake against an ever decreasing energy requirement due to decreasing physical activity. This will become visible as a marked increase in overweight within the population. A number of groups are at higher risk in this regard, notably teenagers and young children.

In addition, the group of elderly people, which is becoming larger, may also be identified as a risk group. At a very advanced age, the sense of taste is reduced, which may lead to reduced overall consumption. This, together with a decrease in the absorption of nutrients, can lead to inadequate nutrition in this group (see also *chapter 2*).

Will the larger range of 'healthy' products have absolutely no effect? Examples from the past, such as the introduction of semi-skimmed dairy products, have made a posi-

Textbox 9.1: Important developments in eating behaviour and the food supply which will determine whether diet becomes healthier or unhealthier.

+ More products in which the nutritional quality has been improved (e.g. in terms of amount and type of fat)
+ More functional foods
+ More healthy convenience foods
- Greater supply and consumption of energy-rich products
- Larger portion sizes
- Greater consumption of convenience foods (very salty, very sweet, few vegetables)
- More 'grazing'
- More people who skip breakfast (including low SES groups)

Teenagers, children and persons with a lower socio-economic status (SES) form a risk group due to their high consumption of energy-rich products and products with a pronounced flavour.

tive contribution to public health, the experts believe. It is quite conceivable that there will be more of this type of product modifications or substitutions in the future, further to the food industry's application of new knowledge about the relationship between diet and health. The improvement of nutritional quality without requiring a major change to eating behaviour could therefore have a major effect on public health. However, whether this actually happens depends in part on consumer demand, and on the extent to which the government can exert pressure on this demand and/or on the supply side.

The expected effects on public health of the increase in the number of functional foods available will, the experts believe, be limited due to the fact that the majority of the Dutch population will not quickly adopt the use of the new functional foods. The consumption of these products will largely remain restricted to persons with a higher socio-economic status. As a result, and because other healthy products in a number of food groups are more expensive, there is a risk that socio-economic health differences could become greater. It is expected that the functional foods will also be used by the 'trend followers'. However, these people are likely to find a new trend to follow quite soon, so they will not be long-term users.

The experts also state that, within the group of functional food users, the consumption of the bio-active substance will indeed produce a favourable effect on a particular risk factor, but that the use of the functional foods will not necessarily result in longer life expectancy. This is because little or no research has been carried out into the longer-term effects of functional foods. Another reason for this observation is that some of the users will combine the consumption of functional foods with poor eating habits. Accordingly, little positive effect on public health is expected.

Textbox 9.2: Important developments in eating behaviour and food supply which determine whether food will become more safe or less safe.

+ Better control systems
+ More industrially prepared products, in combination with control systems
+ More use of decontamination methods
+ More information to the consumer, e.g. about preparation at home

+/- Milder preservation techniques

- More imported products
  - New bacteria and viruses will be imported
  - Less effective control systems and inspections in some countries
  - Longer product supply lead time
- New products with new problem areas, e.g. storage of pre-prepared products in shops
- More products with the same additions, e.g. many products containing the same bio-active substance or natural flavouring
- More products with higher levels of contaminants, as a result of harmonization of legislation
- More contaminated products as a result of government withdrawal
- Reduced priority for safety during economic recession
- No important developments in terms of the risk of microbiological contamination during the storage and preparation of food in the domestic situation (remains a problem).

Another important conclusion is that our food will remain as safe as it is today, or will become slightly safer, whereupon any additional public health benefit from extra efforts in this area will be minimal (see *textbox 9.2*). Points for attention remain microbiological contamination in the domestic situation, and possible new threats. One of these new threats is the accumulation of a bio-active substance. It is not possible to state exactly what the effects of this accumulation will be in terms of public health. That depends on the added bio-active substance in question. Little scientific research has been carried out in this field.

It is expected that these new threats, such as the accumulation effects of contaminations due to the import of products from abroad, could possibly have an influence on food safety in the short term, but that these effects will eventually be mitigated by legislation and regulation, provided these are put in place.

The group most at risk from microbiological contamination is that of the elderly. The generation which went through the Second World War is more inclined to save leftovers from the meal. In addition, resistance decreases with age, and the pH of the stomach alters. This group is therefore at greater risk of serious consequences from intestinal conditions due to microbiological contamination. The increase in the number of elderly people means that, in absolute terms, a greater number of problems associated with microbiological contamination may be expected.

An area which remains relatively unexplored, but which may be important to public health, is the role of viruses. The majority of viral infections result from transfer from person to person. However, due to globalization and perhaps also new preservation techniques which may not always kill viruses, viruses can easily spread across the entire world. Little is known about the extent to which diet or the bio-industry play a part in this.

To summarize, despite positive developments in terms of a healthier food supply and eating behaviour, and despite likely improvements to food safety, the larger range and consumption of foods which are less appropriate to a healthy diet will eventually have an adverse effect in terms of the number of people with overweight or chronic diseases. Especially young children, teenagers and persons with a lower socio-economic status form a risk group in this regard. To a lesser degree, the elderly also form a risk group in terms of possible inadequate nutrition and problems due to microbiological contamination.

9.5 Principles and recommendations for policy

Compared to the public health problems which the current food policy is designed to address (see *chapters 3* and *5*), the experts do not foresee any major new public health problems or new risk groups. The future developments outlined above therefore do not reveal any major hiatus in food policy. However, it is necessary to consider whether current policy should be intensified, and if so, how.

The experts attending one of the workshops assigned priority to the potential diet-related public health problems and the relevant principles for policy which arise from the projections made (see *appendix 11*). The discussion concluded that greater priority should be given to promoting a healthy diet than to food safety, since food safety is already considered to be very high. Eighty percent of all points were given to healthy diet. However, this does not detract from the necessity of efforts designed to maintain the current level of food safety, nor from the fact that new problems demand an active response. In terms of healthy diet, the most important problem was seen to be an unfavourable energy balance. This was followed by an unfavourable fatty acid composition, and a low consumption of fruit and vegetables, with the resulting low intake of fibre. With regard to food safety, the problems cited were (in order of assigned importance): microbiological contaminations, consumer confidence and the accumulation effects of vitamins, minerals and bio-active substances in functional foods or dietary supplements.

With regard to the principles for policy listed in *appendix 11*, major effects are generally expected from policy geared to changes in the food supply. However, this does not mean that policy measures should be restricted to this area. Indeed, a combined approach addressing both behaviour and the supply – and taking external factors such as the socio-cultural and economic setting into account – has the greatest likelihood of success. For this reason, the importance assigned to principles for policy on the supply side and those on the behaviour side was almost equal.

The principles and instruments for policy are described in greater detail below. First, the principles and instruments with regard to the promotion of a healthy diet will be discussed, followed by those targeting food safety. Finally, the principles with regard to consumer confidence are considered.

9.5.1 Healthy diet: principles for policy addressing supply

One of the principles for policy is the improvement of the nutritional composition of products. This applies to the energy content, to the quantity of fruit and vegetables incorporated in the product, and most importantly to the fatty acid composition. The increasing knowledge concerning diet in relation to health can be further applied in the food production sector.

A major effect on public health can be expected if the knowledge concerning diet in relation to health is applied to improve the composition of 'existing' products. Here, we may think of the reduction of the amount of added salt, the reduction of portion sizes, and the increase in the quantity of vegetables in each serving unit. The effect of these measures requires little behavioural change, and the entire population can be reached – including the lower socio-economic groups, elderly people and young people. An example from the past in which a similar approach had an effect on public health is the replacement of *trans* fatty acids in table spreads; without any change in behaviour on the part of the consumer, the intake of *trans* fatty acids was reduced (see *section 2.5*). In the future, the improvement of convenience food can be an important strategy since the consumption of such products will, after all, increase. Measures may include increasing the quantities of fruit and vegetables included in these products and the use of improved fat types in fried products. Although there are already initiatives to improve the composition of products, extra pressure on the food industry from the government and from society is required to stimulate such initiatives further. The government can do so by entering into voluntary agreements with the various parts of the food sector, i.e. manufacturers, the catering industry, etc.

The consumer's food choice can also be favourably influenced by lowering the price. By means of subsidies in certain settings, such as in schools or workplace canteens, the price of, for example, high-fibre products or fruit and vegetables could be lowered in order to favourably influence the fibre intake. When asked whether it would be appropriate to recommend increasing the price of 'unhealthy' products, the experts differed in opinion. There could be a good effect, but it also raises various objections such as practicality and ethical justifiability.

In order to promote the consumption of fruit and vegetables, the experts recommend various measures, including ensuring better availability, and developing products which are more convenient to use. Solutions must be sought for the aspects which the consumer experiences as an obstacle, such as the inconvenience of preparing unwashed, unpeeled and unsliced fruit and vegetables, and the poor image ('not cool') that the consumption of fruit has compared to that of snacks.

9.5.2 Healthy diet: principles for policy addressing behaviour

As stated above, policy with regard to the promotion of a healthy diet must not only target the food supply, but must also address individual food choice. To allow the consumer to select more nutritionally adequate food in future, a number of principles for policy can be illustrated. Firstly, attention could be devoted to increasing knowledge about nutrition. The current trend is that children's knowledge about nutrition is primarily derived from advertisements. To counterbalance this, schools should offer more education about nutrition. Nevertheless, knowledge alone will not result in a different choice of food. This requires a broader approach.

Changes must also be made to the nutrition information provided. To date, we have seen that communication with the consumer about healthy nutrition is extremely difficult, and has done little to bring about the desired changes in eating behaviour. It is necessary to seek other forms of information, for example less complex information messages, more positive coverage, less traditional statements, a more accessible approach, and a move towards customized information via new channels. In doing so, new knowledge regarding behavioural change must be applied.

Education can also be offered with simple information on packaging, for example stating whether a product is appropriate to a healthy diet or not. Such an approach could be used to offer the consumer some 'handholds' in his or her food choice. An additional effect is that the food industry would be encouraged to make healthy foods available on the market.

9.5.3 Safe food: principles for policy addressing supply

Possible principles for policy to promote food safety, are the 'weak points' in the chain. Examples include the limited control of products which are directly imported from abroad, microbiological contamination of products of animal origin, and contamination due to the use of new production methods. The task of the government could be to conduct research into such matters, and then implement measures in order to resolve these weak points. Of course, inspection will remain important in order to guarantee safety.

9.5.4 Safe food: principles for policy addressing behaviour

Alongside changes on the supply side, changes in eating behaviour can be used to promote food safety too. Because a greater quantity of convenience food will be consumed, it is likely that in the future greater gains can be made with education concerning the storage of food rather than with education about the risks during food preparation.

9.5.5 Perception

A point for attention within policy addressing food safety is consumer perception. The expectation is that the activities geared towards making food safer and healthier will also have a favourable influence on perception, particularly if the processes are more transparent and the information more honest. It will however be necessary to take action with regard to the manner in which information about food safety, as well as that concerning a healthy diet, is communicated to the consumer (see also *chapter 8*).

9.6 Summary and conclusions

The experts expect that the current trends in food and nutrition will continue over the next five to ten years. Despite an increase in the number of products that fit in a healthy dietary pattern, such as foods with a better fatty acid composition or a specific health-promoting component, the overall range of foods will not be any healthier. Assuming a further decrease in energy requirement, people will eat too often and, more especially, too much. Convenience will also play a major role, leading to the more frequent selection of products with short preparation times, and to an increase in eating outdoors. One result of the preference for convenience food, without any changes to its composition, will be a less healthy diet, especially given the excess intake of salt and sugar, with too few vegetables. If both the government and society exert extra pressure on the food sector as a whole to make convenience food healthier, this unfavourable development can be reversed.

In addition, our food is expected to remain as safe as it is today, or possibly slightly safer, largely due to better control systems and the use of decontamination techniques on products of animal origin. However, (microbiological) contamination will remain a point for attention. This is related to incorrect storage and preparation habits on the part of the consumer, and to potential new threats, such as accumulation effects or the import of (new) contaminants in products from abroad. The new threats may emerge more often in the short term. However, it is expected that the amendment of legislation and stricter supervision will eventually reduce the risks. However, unbalanced (media) coverage of the risks could have a negative influence on the perception of food safety.

The developments in the dietary pattern outlined above, in combination with an ongoing lack of physical activity, are expected to have a negative effect on public health, especially in terms of the number of people with overweight and chronic diseases. Teenagers, young children and persons with a lower socio-economic status are at particular risk.

The expected developments do not reveal any great hiatus in the current dietary policy. According to the experts consulted, policy can however be intensified, especially with regard to the energy balance, the fatty acid composition of the diet, and the consumption of fruit and vegetables. In terms of food safety, action must be taken to address the threats which already exist and those which will emerge in the future. In general, the greatest effects on public health are expected from policy geared towards modifications to the food supply, such as the nutritional composition of foods. However, a combined approach addressing both the food supply and eating behaviour has the greatest chance of success.

Taking all expected developments into consideration, there is a major challenge for the government, the food industry and the consumer in the Netherlands. They must join forces to make the diet healthier and the food safer.

REFERENCE

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10 GENERAL SUMMARY AND CONCLUSIONS

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The foregoing chapters have provided a detailed overview of current knowledge with regard to healthy diet and food safety in the Netherlands. Separate analyses of the health and safety aspects of diet and food were given, along with a consideration of the coherence between the two. If we now look back on all the information presented, a number of questions are raised. Where are we now, and where are we going? What are the priorities for policy and action? Where do the opportunities lie? What has the government done, and what has it not done? What is still needed? This concluding chapter attempts to provide critical answers to these questions (*sections 10.1 to 10.5*). Finally, *section 10.6* lists a number of significant lacunae in current knowledge, with recommendations for further research.

10.1 Where are we now and where are we going ?

a. Healthy diet: ... where are we now ?

Chapter 2 revealed that our current eating habits are predominantly unhealthy. Not only do we eat too much (and therefore become overweight), but also the composition of the diet is still too far removed from the recommended healthy diet. The main problems in this regard were identified as:

1. Overweight and obesity as a result of an improper energy balance (energy intake too high with respect to energy expenditure). Obesity is an important risk factor for diabetes mellitus type 2, but also for cardiovascular diseases, gall bladder diseases, disorders related to impaired mobility and various forms of cancer. Moreover, the trend is currently unfavourable, whereby the increase in prevalence among young children is the greatest cause for concern.
2. Unfavourable fatty acid composition of the diet. This increases the risk of cardiovascular diseases. Despite product improvements by the manufacturers and an increase in fish consumption, only 5% of the Dutch population adheres to the recommended fatty acid composition.
3. Insufficient consumption of fruit and vegetables. This increases the risk of coronary heart diseases, stroke and some forms of cancer (lung, breast and stomach cancer). Here too there is an unfavourable trend, with a 15-20% reduction in consumption over a ten-year period.

An unhealthy diet accounts for considerable health loss:

Overweight and obesity contribute approximately 50% to both the incidence of, and mortality due to, diabetes mellitus type 2. An unfavourable dietary composition is responsible for approximately 25% of the incidence and mortality due to cardiovascular diseases. Among the adult Dutch population aged twenty and above, the total annual health loss due to overweight and unfavourable dietary composition (calculated separately for each factor) is approximately 40,000 new cases of late onset diabetes, cardiovascular diseases and cancer (40,000 new cases due to overweight as well as 40,000 new cases due to unfavourable dietary composition; the distribution of diseases differs between both factors). Unfavourable dietary composition contributes approximately twice as much to the total mortality as overweight: 10% against 5% of the annual deaths in the Netherlands. If disease and mortality are considered in combination, using a weighing factor for the severity of the disease, the health loss due to overweight and obesity is 215,000 DALYs, while that due to unfavourable dietary composition is 245,000 DALYs.

In addition to this directly attributable health loss, the contribution of the five dietary factors (saturated fats, *trans* fat, fish, fruit and vegetables) and overweight was also calculated by means of a dynamic model in which a 20+ population is simulated in twenty yearly stages. The results of this calculation confirm those of the 'directly attributable health loss' approach, particularly with regard to the *incidences of diseases*. The *mortality* attributable to the five dietary factors and overweight is somewhat lower, mainly because this dynamic calculation provides for a number of years' delay (depending on the disease) between incidence and death. A third calculation method used was the translation of disease burden and mortality in terms of life expectancy. The effect on the average life expectancy of all Dutch people who are forty years of age, is a loss of 1.2 years in the case of unfavourable dietary composition and 0.8 years in the case of overweight.

In calculating the total health loss due to an unhealthy diet, the figures cited above for overweight and unfavourable dietary composition cannot simply be added together. Overweight is caused in part by a lack of physical activity, while the diet-related component (excessive energy intake) partially overlaps that of dietary composition. The exact extent of this overlap is unknown. Of the five modelled dietary factors, fruit and vegetables can help in weight reduction due to their high fibre content and low energy density. The consumption of an excess quantity of energy-rich food is, however, not included in the modelled diet scenarios. Other investigators have recently published high mortality figures (23,000 per year) attributable to 'all factors of an unhealthy diet' (Rougoor *et al*., 2003). The authors have based their findings partly on data published by the RIVM (Van Oers, 2002), which have since been adjusted downwards in the current report, particularly with regard to saturated fats (see also *chapter 2*, *section 2.4*). Moreover, the high mortality figures have to be regarded with a degree of scepticism in the light of the overlap between the health factors and dietary factors used by the authors, as well as that between overweight and unhealthy dietary composition as a whole.

Health gain to be achieved, in theory and in practice:
The health loss is also the health gain that can be achieved, in theory, if the entire Dutch population would suddenly achieve a normal body weight (BMI <25) and adhere to all the recommendations for a good diet. However, even a partial reduction

in overweight and partial improvements to the diet can yield a substantial health gain in practice (see *chapter 2*, *section 2.4).* The results of small-scale intervention experiments targeting overweight and obesity reveal a health gain matching the middle scenario: a loss of 3 kg of body weight, being 1 BMI unit. This represents a health gain of approximately one quarter of the total incidence and mortality (56,000 DALYs) attributable to overweight. Dietary interventions matching the middle scenarios (also proven feasible based on small-scale interventions) can reduce the incidence of disease and mortality attributable to dietary composition by one half (128,000 DALYs). Overweight seems a more difficult problem to resolve than that of suboptimal dietary composition, given the unfavourable trend and the more limited health gain to be achieved.

b. Healthy diet: ... and where are we going?

Current and future trends:

The trends in fish consumption and the intake of saturated and *trans* fatty acids have been favourable in recent years. In the case of fat intake, this is largely due to product modification by the private sector. However, the trends in the consumption of fruit and vegetables have been unfavourable. When we look to the future, the expectation of the experts (*chapter 9*) is that the current developments in the food supply and in eating behaviour will continue during the coming five to ten years. Despite the forecast increase in the number of products which are appropriate to a healthy dietary pattern (e.g. products with better fatty acid composition and fewer energy-rich products), the overall range of foods available will not become any healthier. This is due to a number of factors, including the consumer's increasing preference for 'convenience' food, which does not yet meet the recommendations for a healthy diet. It is also expected that the prevalence of overweight and obesity will increase yet further. Given the current trend, a 50% increase in obesity by 2020 seems likely, whereby this will remain the fastest growing diet-related public health problem. If the cited trends continue, life expectancy based on our calculations for forty-year-olds (assuming that all other factors remain unaltered) will start to fall for the first time in many years.

Functional foods and dietary supplements:

Although semi-skimmed, low-fat and 'light' products have helped to improve our diet during recent decades, the functional foods containing specific bio-active ingredients are not the solution to the problems of an unhealthy diet. The consumption of functional foods and dietary supplements can only lead to a limited health gain for specific risk groups such as children or elderly people with a suboptimal micronutrient status (*chapter 6).* Moreover, the consumption of this type of product also raises a realistic probability of health loss due to the intake of an excess quantity of the bio-active ingredient, for instance via products in which doses are too high or through the cumulative effect of using various products simultaneously. Furthermore, the experts expect only a limited increase in the consumption of these products, partly due to the higher price and partly due to the smaller target groups (see *chapter 9*).

c. Safe food: ... where are we now?

From the information presented in *chapter 4*, it may be concluded that our food is currently relatively safe and that it has indeed become demonstrably safer in a number of respects during the past decades. This can be ascribed in part to the successful policy of the government and the private sector. Accordingly, there is only a limited additional health gain to be achieved in quantitative terms, as described in *chapters 4* and *7*. The most important problems remaining are:

1. Microbial foodborne infections. Each year, there are hundreds of thousands, and probably more than one million, cases of gastroenteritis attributable to contaminated food. Foodborne infections caused by known pathogens are also responsible for several hundred cases of severe disease, such as toxoplasmosis and Guillain-Barré syndrome, with between 20 and 200 people dying from the consequences of a food infection each year.
2. Food allergies. It is estimated that 2% of the adult population suffer from some form of food allergy, while the figure rises to 6% among children. Most cases involve allergenic constituents in common foods such as shellfish, milk, fish, wheat, peanuts, etc. It remains unclear whether the number of people with a food allergy is increasing, and to what extent the prevalence is influenced by a cleaner human environment (the hygiene hypothesis). The health problems caused by food allergies can be rendered reasonably controllable by means of adequate labelling of foods.
3. Food incidents. Adequate risk assessment and risk communication with the consumer are the main problems. For good risk communication, an understanding of the consumer's perception of risk is essential, and that perception must be taken seriously. Moreover, good risk communication can serve to maintain or restore consumer confidence.

Unsafe food accounts for limited health loss:

Expressed in DALYs, the estimated health loss due to foodborne infections involving known pathogens is approximately 1,000 to 4,000 per annum. This is comparable to the health loss caused by AIDS or bacterial meningitis. However, this figure is probably an underestimate, given the difficulty of quantifying the contribution made by food to the large number of gastroenteritis cases involving unidentified pathogens.

A rough estimate of the annual health loss attributable to food allergies is 1,000 DALYs. However, allergies must be regarded as a special case, given the specific target group involved. The effects are partly genetically determined, and hence vary considerably between individuals. They can also be avoided by means of a careful choice of foods. In the case of many other chemical constituents or contaminants in food, the health effect is not directly observable, and is therefore mainly theoretical in nature. Moreover, the theoretical risk is frequently an overestimate, because exposure in excess of the norm will generally be only short-term, and due to the safety factors and/or conservative method of risk assessment used (the latter is particularly relevant in the case of genotoxic carcinogens). The estimated theoretical annual health loss attributable to chemical substances is therefore approximately 500 to 1,000 DALYs.

The food incidents which have taken place in the Netherlands in recent years caused little or no health loss. However, each eroded consumer confidence in the government as the guardian of our food safety, and also eroded confidence in the integrity of the food industry. Contrary to some suggestions, there are no indications of any persistent or increasing lack of consumer confidence in food safety (Timmers & De Jonge, 2004). Disquiet is greatest during food crises, and even then is partly due to poor communication. Better assessment of the actual health risk, together with more open and transparent communication of that risk to the consumer, can reduce or prevent any erosion of confidence. Unfortunately, however, adequate methods of risk assessment are not always available, and the consumer's risk perception remains a more important factor within risk communication than the objectively calculated risk itself.

d. Safe food: ... and where are we going?
The experts' general expectation is that our food may become slightly safer than it already is (*chapter 9*). This will be mainly due to further improvement of the food chain control systems in all sectors, and to the expected application of microbial decontamination methods to products of animal origin. However, the experts do not expect any decrease in microbial foodborne infections due to improper storage and preparation practice by consumers in the domestic situation. Rather, it is assumed that the consumer's knowledge of food preparation and hygiene standards will decrease.

In addition, new threats may emerge due to the globalization of food production and sales markets. These new threats will continue to demand attention. Food safety will therefore become more vulnerable. The visible effects could be new incidents which will not be of any greater frequency, but which will be of greater volume. These incidents will give rise to an even greater requirement for adequate methods of monitoring and risk assessment, and for effective risk communication with the consumer. Risk communication must not only prevent any erosion of consumer confidence, but must ensure that the government gains or regains the public's trust by remaining alert to incidents and by communicating openly and honestly about them.

10.2 Where do the priorities lie ?

The priorities for policy will be determined by several factors, such as the potential health gain to be achieved, the current trends and expectations for the future, the feasibility of interventions, a well-considered balance between measures targeting healthy diet and those targeting food safety, the costs of the measures, etc.

Potential health gain:
If we consider the diet as a whole, the annual health gain to be achieved through improvements to the diet is many times greater than that possible through further improving food safety (*chapter 7)*. In terms of favourable dietary composition alone, i.e. disregarding overweight, the maximum achievable health gain is approximately 40 to 100 times greater than the total health loss due to unsafe food (245,000 against 2,500-6,000 DALYs). Even the dietary interventions which are considered feasible will result in a health gain which is many times greater (middle scenarios: 128,000 DALYs).

This considerable difference also applies at the level of individual foods, as investigated for fish, fruit and vegetables, wholegrain cereal products and human milk (breastfeeding). The health gain achievable at consumption levels which meet the current nutrition recommendations (maximum scenario) varies from approximately 1,000 to 2,400 DALYs (for breastfeeding) to almost 100,000 DALYs (fish, fruit). Compared to these figures, the risks presented by known contaminants, where quantifiable, are in most cases a factor of 100 lower or totally negligible. For specific health-promoting foods (so-called functional foods) and dietary supplements, it is in most cases not yet possible to make this type of quantitative comparison. This is mainly because the positive health effects (health claims) have often not been proven, and because in most cases there is insufficient information concerning the possible negative effects of overconsumption. Moreover, the current consumption levels of products of this type in the Netherlands have not yet been clearly established.

The comparison presented in *chapter 7* shows that the health loss due to unhealthy diet is similar to that due to smoking. Regarding unfavourable dietary composition (the five dietary factors together), this is in the same order of magnitude as that accounted for by positive energy balance (dietary factor for overweight) and too little physical activity. Expressed in DALYs, the descending order is: lifestyle (three lifestyle factors together: 445,000), smoking ≈ healthy diet (350,000 and 300,000-400,000), dietary composition (five dietary factors together: 245,000), positive energy balance (215,000), and insufficient physical activity (150,000).

Trends, forecasts and the feasibility of interventions:
The current trend in overweight and obesity is unfavourable, while the trends in dietary composition, depending on the factor under consideration, are both favourable and unfavourable. If we assume that these trends will continue unabated in the future then, like the middle scenarios, they can be projected to provide a calculation of the achievable health gain (for the favourable trends) or health loss (unfavourable trends). Such a calculation would provide a more accurate indication of the potential health gain or health loss if policy remains unaltered. This calculation has not been made in the context of this report, but it would provide useful supplementary input for future decision-making with regard to priorities for policy. At present, the prioritization incorporates current and future trends, mainly in a qualitative sense, together with the results of the dietary interventions considered feasible (middle scenarios).

Priorities for policy:
Based on the above, but disregarding aspects such as the costs of interventions for the time being, the main priorities in terms of healthy diet and safe food can be identified as follows:

Priority 1: The promotion of a healthy diet, with two sub-priorities:

- **Reduction of overweight and obesity**
  The calculations presented show that the maximum health gain which can be achieved through reducing overweight is not greater than the maximum health gain to be achieved through a *healthy* dietary composition. Nevertheless, the reduction of overweight is currently of the highest urgency, for various reasons. Firstly, the trend is unfavourable. Overweight and obesity continue to rise, and the increase is greatest among children and young people, which portends an even greater increase in overweight-related problems in the future. Secondly, the seriousness of the obesity problem has not been adequately recognized for some time, despite warnings of a rising trend having been issued by the scientific community as long ago as the early 1980s. Only in the last few years has obesity been subject to attention at the international and national political level. The World Health Organization (WHO) has recently declared obesity a global spearhead of policy, partly in relation to diabetes. Thirdly, the health loss which can be regained through feasible weight interventions is relatively minor (25%). Great social efforts are therefore required to ensure that the extent of the overweight problem in the Netherlands does not increase further, and to prevent the American or British situation becoming a reality here too.

- **Promotion of a healthy dietary composition**
  It would not be appropriate for dietary policy to focus solely on reducing overweight. A good fatty acid composition, regular consumption of fish and adequate amounts of fruit and vegetables can prevent just as many cases of cardiovascular diseases and cancer as efforts to attain a good body weight. When we look at the health gain considered feasible in small-scale experiments, the effect of a good dietary composition (all five dietary factors together) is actually more than twice as great as that of reduced overweight. Some of these factors (saturated fatty acids, *trans* fatty acids and fish consumption) now show a favourable trend, while the consumption of fruit and vegetables remains a cause for concern. In addition, there are a number of vulnerable groups for whom specific dietary problems demand attention: the promotion of breastfeeding for infants, and the problem of undernutrition and vitamin deficiencies among the very elderly, for example.

Priority 2: The maintenance and, where necessary, improvement of the current high level of food safety
It is clear that – based on the current situation – the health loss due to unsafe food is many times smaller than that due to an unhealthy dietary pattern. This is largely because an effective system of measures and control addressing food safety has been

developed over the past few decades. Clearly, this system must be maintained. However, it is legitimate to ask what level of maintenance effort will be required in the future, in the light of current and new problems.

Priority 3: Better risk assessment methods and better risk communication with the consumer
Food incidents of greater or lesser extent will continue to occur in the future. Malpractice ('villains'), human error ('idiots') and new surprises ('mistakes by Mother Nature') will always be with us, whereby the zero-risk situation is unattainable. However, in order to limit the impact of incidents, a better assessment of the actual health risk is required, as is better communication to and with the consumer about the risks. As the uncertainty regarding knowledge of the risks and the degree of social complexity (number of conflicting interests involved) increases, a more open social discussion will be required.

10.3 Where do the opportunities lie ?

Having identified the priorities, we must then ask what the most promising strategies to address these priorities will be. This will largely be determined by our knowledge of the factors which influence the dietary problems concerned, the relevant principles for policy that can be derived from this knowledge, the feasibility and returns of the measures, the costs involved, etc. Here, we must take into account the successes and failures of the past, as well as scientific knowledge about behavioural change and risk perception.

The approach to a healthier diet will be different to that intended to prevent smoking
According to the modern views on health promotion, prevention is more effective when an integrated approach is adopted. Such an approach not only addresses people directly about their behaviour, but also alters the physical and social environment in such a way as to support or discourage certain types of behaviour. This kind of integrated strategy was probably the success factor in the United States' approach to the smoking problem. Here, it was decided to adopt a combination of health education designed to help people stop smoking, pricing policy, measures restricting smoking in public places, legislation, and a modification of social norms. This involved cooperation between health institutes, the government, the private sector and the scientific field, with interventions targeting the settings which are important to both children and adults (e.g. schools and the workplace).

Much can be learned from the interventions to counter smoking, but there are also marked differences between smoking and diet. In the case of smoking there is a clear and unequivocal message: smoking is bad for the individual and for others in the vicinity. While overweight can occasionally cause inconvenience for others, perhaps due to increased absenteeism from work due to illness or greater pressure on medical and nursing resources, the main consideration with regard to our eating behaviour is that eating remains essential to survival, and will rarely if ever cause any damage to the health of others. Accordingly, the government's relationship with the private sector is different. In the case of smoking, the health-promoting government is opposed to the economic interests of the tobacco industry. In the case of food and diet, the health-promoting government needs the private sector to produce healthy products which are appropriate to a healthy dietary pattern, while the same government also has to contend with an industry producing and promoting unhealthy food products. Moreover, the healthy diet message is more complex than the non-smoking message, because the consumer must choose from a large and diverse range of foods which may have both favourable and unfavourable health effects. Nevertheless, the comparison with smoking does demonstrate how intensive and creative the investments in healthy diet will have to be in order to bring about successful changes.

Principles for a healthier diet

Chapter 8 demonstrates that policies addressing a healthy diet should focus on factors which influence eating behaviour on the one hand, and factors that influence the food supply on the other. In the case of eating behaviour this involves personal factors like attitudes to food and the perceived influence of the social environment. In the case of the food supply, the main factors are the diversity and quality of the range of foods produced, as well as their availability and accessibility.

These two categories of factors are not unrelated. The food supply and other environmental factors appear to have a (largely indirect) influence on eating behaviour, via people's attitude to certain foods. This attitude results from a consideration of the assumed advantages and disadvantages, with expectations regarding taste, enjoyment, convenience and cost, and existing eating habits, being by far the most important determinants. Modifications to the food supply can therefore influence important environmental factors (availability, accessibility) and at the same time indirectly influence major individual factors (attitude). The most promising approach to achieve this seems to be by means of improvements to the aspects of taste, convenience and price, preferably in a way which is in keeping with existing eating habits. Examples are provided by the changes to eating behaviour achieved in the past with regard to brown bread, semi-skimmed and low-fat dairy produce, and the 'light products'.

The likelihood of such interventions proving successful can be further enhanced by using information and education to simultaneously address other personal factors, such as awareness, knowledge and skills. This is important in enabling the consumer to make an accurate assessment of his or her own eating behaviour, and to gain a better understanding of the short-term and long-term health effects of certain foods. Both will help to determine the willingness to alter eating behaviour.

Principles for safer food

Here, the accent will be primarily on factors which influence the safety of the food supply, but some attention must also be devoted to the consumer's eating behaviour (storage and preparation practice). In terms of the safety of the food supply, the entire food chain is important, from the raw material to the consumer product offered in the shops. The most promising approach is to increase food safety in the animal food chain, for example by including germicidal treatment methods, by good hygiene in the primary production phase and in the last phase of processing or preparing the food. In addition, improved quality control of (new) raw materials and production chains provides the best opportunities for further improvement of food safety.

With regard to storage and preparation practice, important opportunities are offered by greater knowledge and safety-awareness on the part of both professional food providers and consumers. Here too, information and education will therefore form important supplementary instruments for a successful approach to improving food safety.

Translation into promising strategies for each priority, and consequences for the relevant actors

The next question is how the optimum principles for policies regarding both eating behaviour and the food supply, as identified above, can be translated into promising strategies addressing the previously mentioned priorities concerning healthy diet and safe food. Of course, it must also be asked what the consequences for the relevant actors will be.

First of all, it appears that each of the previously mentioned policy principles is important, to a greater or lesser degree, to the priorities stated, as is made clear by the brief explanation of each priority offered below. The main differences are in the way they affect each of the various actors. After all, the private sector, the consumer and the government each have a specific role in promoting healthy diet and safe food. Successful strategies must take this into account, and will therefore demand different activities on the part of each actor. This is examined in greater detail in *section 10.5*.

Reduction of overweight and obesity:

Efforts to counter overweight and obesity must seek to encourage physical activity and reduce the consumption of foods (energy-rich foods). The current trends underline the importance of physical activity. On the diet side, three changes are required to ensure the success of this strategy: (i) modifications to the product supply, (ii) changes in temptation originating from the environment (setting), and (iii) a radical change in the attitude and eating behaviour of the consumer.

Promoting a healthy dietary composition:

Here, the principles for a successful strategy are mostly on the food supply side, but some also relate to the consumer's choice of food. The greatest opportunities seem to be in terms of a healthier food supply which is also tasty and affordable, and which matches existing eating habits as closely as possible. The 'healthy choice' can then be made the 'easy choice'. In doing so, the same three changes required to tackle obesity (cited in the previous paragraph) will be required. Pressure from the social environment must bring about a change in attitude whereby unhealthy eating habits are seen as ‘not done’.

Maintaining and, where necessary, improving the current high level of food safety:
Here, the emphasis is more on a safer food supply. In particular, the reduction of microbiological contamination of foods of *animal* origin and better hygiene practices in the preparation of food can result in substantial health gain. In addition, better information about foods can enable the individual consumer to make an appropriate choice, whereupon the intake of allergens and other harmful substances will be avoided or reduced to the greatest possible extent.

Better risk assessment methods and better risk communication with the consumer:
Alongside adequate protection measures, better risk assessment and risk communication will form the cornerstone of a successful policy geared towards risk management and crisis management, particularly in (future) food incidents and crises. The further raising of safety standards has little relationship with the existence or restoration of consumer confidence. Rather, effective risk communication is based on two-way traffic, and attempts to win trust by being open and honest. In this process, the feelings and concerns of the public must be taken seriously, and the action that people themselves can take must be explained (see *chapter 8*).

10.4 What has the government done and what has it not done ?

Healthy diet
As long ago as the 1980s, the Dutch government acknowledged that the dietary pattern has a marked influence on public health, and set itself the objective of encouraging a healthy (or healthier) choice on the part of the consumer. Dietary policy was primarily geared towards the prevention of cardiovascular diseases and cancer. At the time, the priority was on the role of fatty acids in the development of cardiovascular diseases. Investments were made in a regular Food Consumption Survey, and guidelines for good nutrition were produced. The general aim (to encourage a healthy choice) has since been further defined to form quantitative policy targets for the general population, and since the mid-1980s for specific demographic groups as well.

Based on the realization that the consumer must be allowed more or less complete freedom of choice from the range of foods available, the role the government has adopted for itself is primarily that of creating preconditions, and providing information and encouragement. It wishes to ‘seduce’ the consumer into making a healthy choice, and has ever more emphatically chosen to do so in cooperation with other actors including the private sector. It has been increasingly emphasized that the final responsibility for making the healthy choice lies with the consumer himself or herself.

It is only since the publication of the policy document *Langer gezond leven* ('Living longer in good health') in 2003 that there has been any explicit policy with regard to overweight and obesity. Investments are now being made in research and knowledge development, and a national campaign has been launched.

Since the latter half of the 1990s, various measures have been implemented and initiatives launched to increase the consumption of fruit, vegetables and high-fibre products. However, the campaign *Goede voeding wat let je* ('Good nutrition – what's stopping you?') did not lead to increased consumption of fruit and vegetables. On the contrary, a reduction in consumption has been seen. The promotion of breastfeeding has been part of dietary policy for many years, but until recently there was no quantitative target or public campaign.

Safe food

Food safety has always been subject to government attention. Partly in a European context, a considerable body of legislation has been passed and numerous standards have been adopted. Further to a number of incidents in the late 1990s, it was acknowledged that policy must be made yet more stringent and that the regulatory organization should be modernized. The emphasis was then shifted to the safety of the entire food chain, rather than that of the end product alone. Alongside consumer protection, open communication with the consumer as well as reversing the erosion of consumer confidence became the main objectives. National policy developments are increasingly in line with European policy, by which they are very strongly influenced. The Dutch government further complied with European developments by establishing the Food and Consumer Product Safety Authority (VWA), thus rendering supervision more effective while also improving communication with the consumer.

With regard to microbiological food safety, the general policy of recent years has been concerned with reducing foodborne infections, with specific policy targeting a number of selected pathogens such as Salmonella and Campylobacter. In the field of chemical hazards, particular attention has been devoted to food hypersensitivity (allergenic food constituents).

Relative efforts directed to a healthy diet as against food safety

If we compare policies addressing a healthy diet to those targeting food safety, the first observation is that the two topics were addressed in tandem during the 1980s, but much less so in later years. The two areas of policy became more or less independent. The second observation is that the government called for greater attention to healthy diet in one period (e.g. the early 1980s), and to food safety in another (e.g. in the late 1990s, partly under pressure from recent incidents).

The exact degree to which policy addressing a healthy diet has been effective remains unclear, but it has certainly been less effective than that targeting food safety. In recent decades, food safety policy has been reasonably successful. It is now justifiable to ask what level of regulation and effort is required to maintain the current high level of protection. However, it is not yet clear whether current food safety policy is adequately prepared for all future developments (see *chapter 9*).

What has the government not done, or not done well enough ?
The analysis in this report leads to the conclusion that the promotion of a healthy diet (i.e. prevention of overweight and encouragement of a healthy dietary composition) deserves a higher priority than has hitherto been the case. However, this must not be at the cost of the current protection level for food safety. While healthy dietary composition has been a feature of government policy for some time, obesity has become an explicit priority of prevention policy only in the government's most recent policy documents. However, by adopting this prioritization, the government now runs the risk that the considerable influence that a healthy dietary composition has on chronic conditions such as cardiovascular diseases, diabetes and cancer is in danger of being overlooked.

In the area of obesity (and healthy diet) the government has now opted for a preventive approach, working alongside a broad coalition of stakeholders, to address both lifestyle and environmental factors which encourage a good diet and sufficient physical activity. In the discussions with parliament, the emphasis has been firmly on the consumer's personal responsibility and on the voluntary cooperation of the private sector. This is contrary to the causal analysis of the experts, who place a strong emphasis on the physical and social environment including factors such as the excessive and omnipresent food supply, and the social pressure exerted by advertising and the individual's direct personal sphere. The consumer is in effect confronted by an environment which encourages unhealthy eating behaviour, and which therefore presents a message diametrically opposed to that of the government. It remains unclear what strategy can be used to make the consumer more resistant to these influences. The government could and should do far more in this regard, perhaps by imposing conditions for a healthy diet in a more explicit manner.

10.5 What is still needed ?

What is now required in order to address the four priorities successfully, and what is the role of the three parties most closely involved: the private sector, the consumer and the government?

1. The private sector

The private sector must do more in terms of healthy and safe food. This is possible by such means as:

Healthier food supply and less advertising for unhealthy products:
The cause of the increase in obesity is, in addition to insufficient physical activity, the excessive supply of (energy-rich) food in shops, school and workplace canteens, and

advertising for unhealthy foods. Convenience, taste, price and habit are the main factors which determine the consumer's eating behaviour, and which the private sector can use to promote a healthy diet. The recently revised policy of the Federation of Netherlands Food Producers (VAI/FNLI, 2004) and the accompanying code of conduct with regard to advertising and promotional activities, does not do enough to address these points and can therefore be improved:

- The private sector should be (even) more restrained with regard to advertising (particularly that targeting children) and in the sale of unhealthy products in shops and especially in school, workplace and sports club canteens.
- At the same time, the private sector should do more than has hitherto been the case to ensure better availability of foods which are appropriate to a healthy dietary pattern, and having portion sizes which are not too large.
- Healthy foods should be cheaper, or in any event no more expensive than existing products, when introduced onto the market in order to reach large groups of consumers. In particular, ways should be sought to reduce the price of fruit and vegetables and other high-fibre products such as wholegrain cereal products.

Improved product composition and innovative product modifications:
There are many opportunities to make the 'healthy choice' the 'easy choice' by means of product modification, without requiring the consumer to make drastic changes to eating habits or choice of foods. Indeed, some product modifications require absolutely no change in consumer behaviour. Examples from the past include the addition of iodine to salt and the modified fatty acid composition of margarines. The consumer's choice need not be restricted, but there are excellent possibilities to offer a varied package of foods to appeal to every taste.

- Examples for the future include the addition of more vegetables to convenience foods (such as pizzas and pre-prepared meals) and to the menus of restaurants, the use of improved fat types for fried products, and the development of functional foods and dietary supplements for specific risk groups.

Improvement of food safety, partly in the light of new circumstances:
Two aspects will be of particular importance in the future: the enhancement of food safety in the animal food chain (by such means as good hygiene in the primary production phase and in the final preparation phase) and improved quality control of (new) raw materials and production chains.

- Manufacturers of animal products must do more to reduce contamination with pathogens.
- A large proportion of foodborne infections can be prevented by good storage practice and hygienic preparation of animal products in professional kitchens. The prevention of cross-infection between animal products and other food types is of particular importance.
- Raw materials and food ingredients should be traceable throughout the entire production chain, in order to enable the cause of any incident or calamity to be identified as quickly as possible. Fruit and vegetables may present a particular challenge in this regard, due to globalization.

- New technological developments which will improve food safety, such as the decontamination of foods of animal origin to reduce foodborne infections, should be introduced as quickly as possible provided they have been shown to be effective and to be free of any harmful side effects.
- The private sector should continue the policy line of removing food which is considered unsafe from the shops as quickly as possible, and of communicating openly about such product recalls.

Improved provision of consumer information:
Clear information by such means as labelling addressing health and safety aspects can help the consumer to make a good choice, both from the point of view of a healthy diet and that of food safety (allergy).

- New and inventive forms of education, information and labelling are required to make it easier for the consumer to quickly obtain the desired information about a food. The current forms of labelling do not work as well as they could.
- The information and education should take the consumer's risk perception into account.

2. The consumer

Consumers must become more aware of the advantages of a healthy diet, the disadvantages of overweight and an unhealthy diet, and the importance of hygienic food preparation. Hereto, a considerable change in the consumer's attitude is required. This demands:

A 'cultural turnabout':
The consumer and his or her entire social environment must become aware that *healthy* food can also be enjoyable, and that *an unhealthy diet and overweight* can be responsible for considerable health loss and inconvenience. Such a 'cultural turnabout' should not, however, be based on a stigmatization of people suffering from overweight.

- The consumer is personally responsible for his or her behaviour and, taking personal health into account, must actively choose to avoid overeating and to engage in sufficient physical activity.
- In doing so, the consumer can adopt a number of simple rules from the nutritional guidelines as the guiding principles (do not eat too much, eat a varied diet, use liquid fats in the kitchen, eat sufficient quantities of fish, fruit and vegetables, and wholegrain cereal products).
- The consumer must also critically assess new health claims made by the private sector and new risk warnings from the scientific field. This will be facilitated if consumer organizations represent interests more directly, since the consumer acting alone will not be able to do so.
- The consumer must realize that 100% safe food does not exist, and that he himself forms the final link in the food safety chain. The consumer is directly responsible for the observance of the safe storage periods for food, good hygiene in the kitchen

to prevent cross-contamination, and ensuring that animal products in particular have been adequately heated.

Alongside awareness and information, skills are also important:
The consumer can only take responsibility if he has sufficient knowledge about healthy diet and safe food. But knowledge alone is not enough, skills are also needed. Given the importance of diet to public health, investments must be made.

- For the consumer to be able to fulfil his role, he will have to acquire the skills required to put the knowledge into practice, including the ability to resist seductive advertising or social pressure. Education, information, awareness and the promotion of confidence in one's own skills are required.
- This places a considerable emphasis on consumer and educational organizations, but also requires the market parties to provide clear, objective and comprehensive information about the composition, nutritional value and health effects of products.
- Consumer organizations must remain alert to food safety aspects but must also place an equal, if not greater, emphasis on unhealthy diet and the manner in which the food supply, advertising, education and information, the social and physical environment and the consumer contribute in this regard.

3. The government

Healthy diet, efforts to counter obesity and the promotion of food safety are collective interests. The government therefore has a task to fulfil:

Legislative measures can also be useful in promoting a healthy diet:
In the area of healthy diet, the government is very much more restrained and leaves more to the social field of influence than in the area of food safety. In food safety, there is extensive use of legislation, sanctions, control and supervision. In the area of healthy diet, voluntary agreements and education are the preferred policy instruments. This can be explained in terms of the principle of health protection which applies to food safety, but the analysis in this report makes it clear that the promotion of healthy diet also requires strong pressure from the government and society.

- If incentive policy instruments or voluntary agreements with the private sector provide insufficient returns, legislation can also be an essential resource, with regard to advertising targeting children for example, or the food supply available in school canteens and public places. The approach used to counter smoking can provide an example.

New safety risks demand a new approach:
In the field of food safety, the government's attention is focused increasingly on the safety of the entire food chain, with responsibilities for all parties including the consumer, and on crisis management. In addition, the maintenance of consumer confidence in food safety has been high on the political agenda in the last few years. The government cannot limit itself to a strategy which is only concerned with increasing

food safety by means of ever stricter standards and safety norms, but must implement a broader strategy in order to maintain consumer confidence in food safety.

- In the event that the health risks of certain microbiological or chemical contaminants in food are extensive or uncertain, or where the social interests are great, it is important to conduct a broad social discussion. By involving the consumer more closely in the social decisions which must be taken, and by increasing the transparency of government policy, greater support for the food safety policy can be obtained.
- In order to provide greater substantiation for the health claims made for functional foods, and to protect the consumer against false claims, manufacturers must be required to provide more substantial evidence in future. European legislation in this regard is currently in preparation. The methodology for the quantitative comparison of beneficial and adverse effects must also be further developed.
- In view of the globalization of food supply flows, better methods must be developed to ensure the traceability of food sources. This is particularly so in the case of imported foods, both from within and beyond the European Union. The government can expedite this process with incentive measures, legislation and adequate supervision.

10.6 Gaps in the knowledge and recommendations for monitoring and research

Nutrition and food research in the Netherlands ranks highly at the international level. This report was only made possible by the availability of a large number of information sources, which allowed the main question regarding the positive and negative health aspects of the Dutch diet to be answered, at least in outline. However, many questions remain unanswered, or only partially answered. This is due to gaps in the current knowledge and a lack of continuity in the provision of information on the one hand, and due to the scope of the report and new topics which will demand attention in future on the other.

The large and increasing importance of diet in terms of public health demands an appropriate monitoring and research strategy. The guiding principle of the following recommendations is the question of which type of research is necessary to monitor the current status of diet and health in the Netherlands, and which research can help to alleviate the problems identified in the field of unhealthy diet and unsafe food.

The National Food Consumption Survey and related databases remain essential in keeping a finger on the pulse

To implement an adequate dietary policy it is necessary to have information regarding the food consumption and nutritional status of the Dutch population as a whole, as well as those of certain demographic groups. Three National Food Consumption Surveys have been conducted in the past (1987-1988, 1992 and 1997-1998). Without the information gained in these surveys, this report could never have been written. In the light of changing policy requirements, socio-demographic developments, trends in eating habits and developments in research methods, a new food consumption survey system is now needed. In 2003, the Dutch Ministry of Health, Welfare and Sport commissioned a limited food consumption survey (NFCS-2003) as the first move towards a new system. The results of this survey became available at the end of 2004. It is, however, unclear when and in what form the new food consumption survey system will be implemented. For the future, it is important that the food consumption data remain available on a regular basis. In this light, a number of revisions are also desirable:

- In order to investigate the causes of the current increase in overweight, the National Food Consumption Survey should devote greater attention to the monitoring of body weight and body fat. Efforts should also be made to establish whether it is possible to measure energy expenditure or the level of physical activity at the same time.
- The scope of the National Food Consumption Survey should be expanded to include the topic of functional foods and health products. To date there has been little or no insight into the consumption of functional foods and (high dosage) dietary supplements. The risks involved are insufficiently known and the expectation is that consumption will increase.
- As in the limited 2003 survey, future National Food Consumption Surveys should be adapted to render them suitable for examining issues of microbiological and chemical food safety. Special attention is required with regard to the origin, method of production and preparation of foods, and the number of days during which information relating to diet is collected.
- The food consumption of a number of specific demographic groups is not adequately known because some groups included in the previous surveys are not representative or are not adequately represented. Accordingly, there is a requirement for specialized consumption surveys among specific demographic groups such as ethnic minorities and expectant mothers.

Monitoring, research and risk assessment rely on supporting databases such as the Netherlands Food Composition Table (the ‘NEVO table’) and the databases of harmful chemical constituents and micro-organisms in food (the KAP and KRIS databases). To make the best possible use of the information derived from the National Food Consumption Survey, it is necessary to ensure good coordination with these supporting databases, and the quality and continuity of these databases must be guaranteed. However, the financing of these databases is currently problematic.

Research into the relationship between diet and health: new spearheads

The findings and policy recommendations of this report are based to a large degree on national and international scientific research into the effects of diet on health. However, much remains unclear about the strength of the evidence for the health effects of specific dietary factors. Continuation and encouragement of this research is therefore desirable.

- The influence of dietary factors and of physical activity on the energy balance is an important research theme in view of the increase in overweight.
- The influence of diet on health has not been subject to the same degree of research for all dietary factors; encouragement of this research can reduce current uncertainties (such as that concerning the influence of fruit and vegetables) and can identify new food constituents which may have a positive or negative influence on health.
- Given the increasing knowledge of the genetically determined characteristics of humans, in the future further questions will be asked with regard to the individual validity of dietary recommendations. In terms of dietary policy, it is therefore important to have a knowledge of the interaction between dietary factors and genetic characteristics, and about their influence on health.

Research into food safety: many questions remain unanswered

There are still many gaps in knowledge in the field of food safety. Despite intensive research into microbiological food contaminations, the significance in terms of public health is not yet adequately clear. For example, the cause of two thirds of all cases of gastroenteritis remains unknown, as does the contribution of food in this regard compared to that of other sources. Our understanding of the emergence of severe diseases and death due to foodborne infections is also fragmentary. Accordingly, further improvement of surveillance is required, complemented by specific etiological studies. For the purposes of quantitative risk assessments, a broad overview of the incidence of pathogenic micro-organisms in the food chain is needed, particularly in terms of the number of such micro-organisms in or on contaminated products and the degree of variation therein. Special attention must also be devoted to the shifts resulting from trends such as organic farming, climate change and technological developments such as mild preservation techniques. Given the complexity of the risk assessments which results from the length and expanse of the food chain as a whole, the research strategy must focus on the most vulnerable parts of the chain, or on those parts in which considerable health gain can be achieved. Examples cited elsewhere in this report include:

- Various pathogenic micro-organisms such as zoonotic bacteria, viruses and toxinogenic bacteria.
- The zoonotic transmission of viruses.
- Quantity and safety of imported food.
- Risk management for unprocessed, raw foods and beverages.
- Risk perception and consumer behaviour in relation to hygienic food preparation.

There are also gaps in the knowledge regarding chemical food constituents and contaminants. For example, there are many questions concerning the assumed increase in food allergies and food intolerances. These make a stimulatory research strategy desirable. Aspects such as the possible relationship between hygiene (lifestyle), immune status and food allergy should be addressed. In addition, the Health Council of the Netherlands is soon to issue an advisory report on food allergy. As in the case of the National Food Consumption Survey, it is important to ensure the continuity of the relevant databases, such as the allergens database ALBA, which plays a vital role in providing consumers with information about the presence of allergenic substances in foods.

For some time, it has been acknowledged that better assessment of the actual health risks raised by food incidents and food crises is necessary. The use of the benchmarking approach could enable better use to be made of the available dose-effect information, and hence better risk assessment. Using the probabilistic exposure and effect assessment it will be possible to quantify both the uncertainties and the likelihood of effects becoming manifest among the population with a greater degree of accuracy.

Research into the chemical contamination of food has thus far been almost exclusively conducted on individual substances, while there is also concern about the cumulative effects of the contaminants in the total diet. This is a new – and expensive – line of research which can only be conducted in the international context.

Research into better detection methods to trace the current generation of genetically modified foods or ingredients is not so much desirable from the point of view of food safety, but is more important in terms of answering the consumer's demand for information about the presence of genetically modified organisms or derived ingredients in foods.

Research into the balance between positive and negative health effects is primarily of importance with regard to new foods, but also for recommended common foods

In the case of new foods such as functional foods and dietary supplements, a balanced comparison of the positive and negative health effects is difficult or impossible to achieve due to the paucity of information. In the case of the recommended common foods, such a comparison leads to the conclusion that the health advantages outweigh the disadvantages many times over. However, a number of aspects remain which should be subject to further specific research:

- Research is required into the health effects and health risks of new foods, such as the bio-active ingredients in functional foods and dietary supplements.
- Certain recommended common foods can also have adverse health effects, particularly for 'heavy users' or other vulnerable groups. A more accurate assessment of this phenomenon should be made.

An integrated consideration of the health effects of the diet demands improved mathematical modelling

In this report, the health effects of a healthy or unhealthy diet, other lifestyle factors and intervention scenarios have been quantified using mathematical models. Both the robustness of the input data and the modelling method itself should be improved. In any event, the following should be subject to further research:

- How the selection of epidemiological information can be optimized.
- How the calculated results of the intervention scenarios can be compared and

interpreted more effectively
- How the uncertainty of the outcomes can be assessed and expressed most clearly.

Research into the determinants of the consumer's eating behaviour and the food supply by the private sector and other actors should be given high priority

Despite uncertainties and lacunae in the knowledge, much is known about healthy and safe food. Nevertheless, many people find it difficult to put the various messages about healthy diet and food safety into practice. Moreover, the number of people with overweight continues to increase. Further research into the factors which influence eating behaviour is therefore essential in rendering dietary policy more effective and should be accorded high priority. The same applies to research into the possibilities (and impossibilities) for encouraging the private sector and other actors to offer a healthier and safer range of foods.

Research into the effectiveness and costs of dietary interventions falls outside the scope of this report but is nevertheless of major importance in terms of policy

An exhaustive evaluation of the experimental, small-scale dietary interventions and of the cost aspects involved did not form part of this report's original terms of reference. However, aspects of the interventions and their costs are relevant in terms of policy. Further to this report, there is therefore a requirement for:
- An inventory and analysis of successful interventions and experiments, both in the Netherlands and elsewhere, targeting overweight and healthy diet, together with an evaluation of the possibilities for implementing similar interventions on a larger scale.
- Research into the costs of interventions designed to promote a healthy diet and safe food (or the costs of *not* implementing measures), so that these can be included in determining policy.

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Appendix 3: List of interviewees (chapter 9) and other experts consulted

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Appendix 4: Glossary of abbreviations

Institutes and organizations

AID	General Inspectorate, Ministry of Agriculture, Nature and Food Quality
CA	Codex Alimentarius
CBL	Central Bureau for the Food Industry
CBS	Statistics Netherlands
CVZ	Health Care Insurance Board
DG SANCO	Direction Général Santé et de Protection des Consommateurs (EC)
EFSA	European Food Safety Authority
EC	European Commission
EPA	Environmental Protection Agency (USA)
EU	European Union
FAO	Food and Agriculture Organization
FDA	Food and Drug Administration (USA)
GR	Health Council of the Netherlands
IARC	International Agency for Research on Cancer (WHO)
IGZ	Health Care Inspectorate
IKZ	Comprehensive Cancer Centre South
IPCS	International Programme on Chemical Safety (WHO)
JECFA	Joint WHO/FAO Expert Committee on Food Additives and Contaminants
JMPR	Joint WHO/FAO Expert Committee on Pesticide Residues
KvW	Inspectorate for Health Protection and Veterinary Public Health
KWF	National Cancer Fund (Koningin Wilhelmina Fonds)
LEI	Agricultural Economics Research Institute (Wageningen University)
LNV	Ministry of Agriculture, Nature and Food Quality
NIVEL	Netherlands Institute for Health Services Research
PGD	Alcoholic Beverages Marketing Board
RIKILT	Institute for Food Safety (Wageningen University and Research Centre)
RIVM	National Institute for Public Health and the Environment
RVZ	Council for Public Health and Health Care
SCF	Scientific Committee on Food (EC)
SZB	Foundation for the Promotion of Breastfeeding
TNO-PG	Netherlands Organization for Applied Scientific Research, Prevention and Health Division
VAI	Netherlands Food Industry Federation
VCV	Nutrition, Medicines and Consumer Safety Division (RIVM)
VROM	Netherlands Ministry of Housing, Spatial Planning and the Environment
VTV	Centre for Public Health Forecasting (RIVM)
VWA	Food and Consumer Product Safety Authority
VWA	Food and Consumer Product Safety Authority
VWS	Ministry of Health, Welfare and Sport
WHO	World Health Organization
WTO	World Trade Organization
WUR	Wageningen University and Research Centre
WVC	Ministry of Welfare, Public Health and Culture (until 1995)
ZonMW	Netherlands Organisation for Health Research and Development

Databases and research programmes

ALBA	Allergens Database
ATSDR	Agency for Toxic Substances and Disease Registry (USA)
CARMA	Campylobacter Risk Management and Assessment
EPIC	European Prospective Investigation into Cancer and Nutrition
ISIS	Infectious Diseases Surveillance Information System
KAP	Quality of Agricultural Products Database

KRIS	Inspectorate for Health Protection and Veterinary Public Health/RIVM Risk Information System
LSI	Laboratory for Surveillance of Infectious Diseases
MORGEN	Monitoring of Risk Factors and Health in the Netherlands
POLS	Integrated Survey on Household Living Conditions (CBS/Statistics Netherlands)
NEVO	Netherlands Food Composition Table
NKR	Netherlands Cancer Registry
VCP	Food Consumption Survey

Miscellaneous

ADI	Acceptable Daily Intake
AGF	Potatoes, vegetables and fruit (industry organization)
ASP	Amnesic Shellfish Poisoning
AZP	Azaspiracid Shellfish Poisoning
B(a)P	Benzo(a)pyrene
BMI	Body Mass Index
BSE	Bovine Spongiform Encephalopathy
CAG	Code of Conduct for the advertising of health products
CCP	Critical Control Points
CHZ	Coronary heart diseases
CLA	Conjugated linoleic acid
CMR	Continuous Morbidity Registry
COPD	Chronic Obstructive Pulmonary Disease
CVA	Cerebral Vascular Accident
DALY	Disability Adjusted Life Year
DDT	Dichlorodiphenyltrichloroethane
DES	Diethylstilbestrol
DHA	Docosahexaenoic acid
DON	Deoxynivalenol
DSP	Diarrhetic Shellfish Poisoning
En%	Energy per cent
EPA	Eicosapentaenoic acid
FSO	Food Safety Objectives
GAP	Good Agricultural Practices
GBI	Health-promoting Institute
GE	Gastroenteritis
GGD	Municipal (or regional) Health Authority
GGM	Genetically modified micro-organisms
GGO	Genetically modified organisms
GHP	Good Hygiene Practices
GMM	Genetically modified micro-organisms
GMO	Genetically modified organisms
GMP	Good Manufacturing Practices
GVO	Health Information and Education
GVP	Good Veterinary Practices
HACCP	Hazard Analysis Critical Control Points
HAV	Hepatitis A virus
HCB	Hexachlorobenzene
HDL	High density lipoprotein
HEV	Hepatitis E virus
HIL	High-intensity light pulses
HIV	Human Immunodeficiency Virus
Hg	Mercury
HUS	Haemolytic Uraemic Syndrome
HVZ	Cardiovascular diseases
LDL	Low density lipoprotein

mg	Milligram
µg	Microgram
MJ	Megajoule
MKZ	Foot and mouth disease
MPA	Medroxyprogesteronacetate
MRL	Maximum Residue Limit
NDMA	N-nitrosodimethylamine
NOAEL	No Observed Adverse Effect Level
NoV	Noroviruses
NSP	Neurotoxic Shellfish Poisoning
PAH	Polycyclic Aromatic Hydrocarbon
PAR	Population Attributive Risk
Pb	Lead
PBO	Statutory Industrial Organization
PCB	Polychlorbiphenyl
PCDD	Polychlorinated dibenzo-p-dioxin
PCDF	Polychlorinated dibenzofuran
PEF	Pulsed Electric Field
POP	Persistent Organic Pollutant
PSP	Paralytic Shellfish Poisoning
PTWI	Provisional Tolerable Weekly Intake
RDI	Recommended Daily Intake
RE	Retinol equivalent
RNA	Ribonucleic acid
ROO	Regular Consultation on Overweight
ROW	Regular Consultation on the Consumer Goods Act
RR	Relative risk
SES	Socio-economic Status
STD	Sexually transmitted disease
STEC	Shiga-toxin producing *Escherichia coli*
TCDD	2,3,7,8-Tetrachlorodibenzo-p-dioxin
TEQ	Toxicity equivalent
TDI	Tolerable Daily Intake
TWI	Tolerable Weekly Intake
UL	(Tolerable) Upper Level
vCJD	Variant Creutzfeld Jacob Disease
VSD	Virtually Safe Dose
YLD	Years Lived with Disabilities (disease)
YLL	Years of Life Lost

Appendix 5: Disease symptoms associated with pathogenic (micro-)organisms in food

	Severity of the disease symptoms			
Organism	Mild[1]	Severe[2]	Chronic[3]	Mortality[4]
Bacteria - infectious				
Aeromonas spp.	GE5			Low
Arcobacter spp.	GE			Low?
Brucella melitensis/abortus/suis	Influenza	Brucellosis	Brucellosis	Medium
Campylobacter spp.	GE, ReA[6]	GBS[7]	GBS, IBD[8]	Medium
Coxiella burnettii		Endocarditis, hepatitis		Medium
Enterobacter sakazakii		Sepsis and meningitis in neonates		High
Escherichia coli – Shiga-toxin producing	GE, HC[9]	HUS[10]	ESRD[11]	Medium
Escherichia coli – other	GE			Medium
Francisella tularensis		Tularemia		
Listeria monocytogenes		Abortion, stillbirth, meningitis		High
Mycobacterium avium ssp. *avium*			COPD[12]	Low
Mycobacterium bovis		Extra pulmonary tuberculosis		Unknown
Mycobacterium avium ssp. *paratuberculosis*		Possible association	with Crohn's disease	Low
Salmonella (para)typhi		Typhoid (and paratyphoid)		Medium
Salmonella spp. - other	GE, ReA			Medium
Shigella spp.	Dysentery	HUS		Medium
Vibrio cholerae	Cholera			Low
Vibrio – marine species	GE	Sepsis, wound infection		High (*V. vulnificus*), Medium (other)
Yersinia enterocolotica	GE, ReA			Medium
Bacteria – toxin producing				
Bacillus cereus	GE (especially vomiting)			Low
Clostridium botulinum		Botulism		High
Clostridium perfringens	GE			Low
Staphylococcus aureus	GE			Low
Viruses				
Adenovirus	GE			
Astrovirus	GE			
Enteroviruses	GE	Neurologic symptoms	Diabetes	Medium
Hepatitis A virus	GE	Jaundice		High, in adults
Hepatitis E virus		Jaundice		High, in pregnant women
Norovirus	GE			Unknown
Rotavirus	GE (children)	Malabsorption intussusception		Low
Sapovirus	GE			Low
Prions				
BSE prion			nvCJD[13]	Very high

Continue table appendix 5

Organism	Severity of the disease symptoms			
	Mild[1]	Severe[2]	Chronic[3]	Mortality[4]
Protozoa				
Cryptosporidium parvum	GE			Low, high in individuals with compromised immunity
Cyclospora cayatenensis	GE			Low
Giardia lamblia	GE (chronic)		Growth retardation	Low
Entamoeba histolytica	Dysentery	Dysentery	Abcess, granuloma	Low
Toxoplasma gondii	Lymphadeno-pathy, vision disorders	Abortion	Blindness, mental retardation	High (congenital)
Helminths				
Anisakis simplex	Abdominal pain, stomach pain	Perforation of the stomach, allergy	Liver disease	Low
Echinococcus granulosis			Liver disease/lung disease, space-occupying processes	Medium/high
Echinococcus multilocularis			Liver disease/lung disease, space-occupying processes	High
Fasciola hepatica			Liver disease/lung disease, space-occupying processes	
Taenia saginata	GE			None
Taenia solium	Muscle pain	Neurocysticercosis (encephalitis/meningitis)	Epilepsy	Low
Trichinella spiralis	GE, oedema	Trichinellosis, myocarditis, neurologic symptoms	Muscle disease	Low to high dependent on dose

1 Usually self-limiting, at most resulting in a visit to the GP
2 Usually requires treatment, can result in admission to hospital
3 Prolonged or intermittent disease symptoms
4 Given ideal treatment, low: < 1:1000; medium: 1:100 - 1:1000; high: > 1:100, very high: (virtually) always fatal.
5 Gastroenteritis
6 Reactive arthritis
7 Guillain-Barré syndrome
8 Inflammatory bowel disease
9 Haemorrhagic colitis
10 Haemolytic uraemic syndrome
11 End Stage Renal Disease
12 Chronic Obstructive Pulmonary Disease
13 New variant Creutzfeld-Jacob Disease

Remarks:
Tables of this kind are always arbitrary, to a certain extent. Infection with a given species of pathogen can produce a wide range of symptoms, some of which may be quite common while others are rarely seen. Some symptoms are severe in nature, others less so. In drawing up the table, an attempt was made to restrict its contents to those symptoms and clinical disorders which cause the greatest disease burden. At the present time, it is not possible to provide quantitative evidence to support this selection. However, the table does make clear that pathogens in food often give rise to gastroenteritis. It also shows that other, often severe, symptoms can also occur. The probability of this may be quite small, nevertheless, the disease burden involved can be substantial (*section 4.2.5*).

Appendix 6: Gastroenteritis (GE) in humans in the Netherlands, number of cases confirmed by laboratory testing, visits to GPs, total incidence, and proportion attributable to food

GE pathogen	Laboratory-confirmed cases, estimated inc./year	Visit to GP (NIVEL 1996-1999)[ref. 1]		In general population (Sensor 1999)[ref. 2]		Food attributable fraction	Number of food-related cases of gastroenteritis
		% positive	annual incidence	% positive	annual incidence		
				Crude/standardized[6]	Based on standardized percentage		Rough estimates due to uncertainties in the fractions + incidences
Campylobacter spp.	5,000-6,000[1]	10.5	23,000	1.3 / 2.4	107,000	0.3-0.8[8]	32,100-85,600
Salmonella spp.	3,000-4,000[1]	3.9	8,600	0.4 / 1.2	53,500	>0.9	48,200-53,500
Shigella spp.	300-500[1]	0.1	(<1,000)	0.0 / 0	(1,000-10,000) [ref. 3]	0.1-0.5	100-5,000
Shiga-toxin producing *E. coli* O157	40-60[2]	0.1	(<500)	0.0 / 0	(1,250 (90-6,700) [ref. 4]	0.5-0.9	625-1,125 (45-6,000)
Other path. *E. coli*	No data	-		-		Unknown	Unknown
St. aureus toxins	No data	-		5.6 / 5.3[7]	(236,000)[7]	1	(236,000)[7]
Bacillus cereus	No data	-		1.8 / 0.8[7]	(35,700)[7]	1	(35,700)[7]
Clostridium perfringens	No data	-		2.3 / 3.3	147,000	1	147,000
Yersinia enterocolotica	100-250[1]	0.7[5]	(<500)	0.4 / 1.5[5]	(1,000-10,000) [ref. 3]	>0.9	900-10,000
Adenovirus (40/41)	approx. 2,000[3]	2.2	4,800	3.8 / 1.1	49,100	Unknown	Unknown
Astrovirus	No data	1.5	3,300	2.0 / 1.4	62,400	Unknown	Unknown
Rotavirus group A	2,400-3,100[3]	5.3	11,700	7.3 / 4.3	191,800	0-0.1 [ref. 5]	0-19,200
Sapovirus	No data	2.1	4,600	6.3 / 2.4	107,000	0-0.1 [ref. 5]	0-10,700
Norovirus	No data	5.0	11,000	16.1 / 11.2	499,500	0.1-0.2 [ref. 5]	50,000-100,000
Crypt. parvum	No data	2.1	4,600	2.0 / 1.8	80,300	Unknown	Unknown
Cyclospora spp	No data	0.1		0.0 / 0	.(<500)	Unknown	Unknown
Giardia lamblia	200-400[4]	5.4	11,900	5.0 / 3.7[7]	(165,000)[7]	<0.3 [ref. 6]	(0-50,000)[7]
Ent. histolytica	No data	1.1	2,400	0.1 / 0.2	8,900	Unknown	Unknown

1 Based on data from the Laboratory Surveillance of Infectious Diseases 1999-2000 (Yersinia 1991-1996), allowing for the degree of coverage of the regional laboratories (ref. 7)
2 Based on data from the intensified surveillance of STEC O157, 1999-2000, allowing for the degree of participation of the laboratories (85%)
3 Based on data from the Virologische Weekstaten laboratory surveillance system 1999-2000, allowing for the degree of coverage of the virological laboratories (38%) (ref. 8)

[4] Based on data from the eight laboratories in the Infectious Diseases Surveillance Information System (ISIS) in 1999-2000
[5] No pathogenic serotypes found
[6] 1st percentage is the crude percentage found in faeces, 2nd percentage gives the percentage standardized by age, gender and cohort
[7] Since the pathogen was found in the faeces of gastroenteritis-free controls as often / more often it will not always have been the causative agent of the GE, so there is some overestimation
[8] To date, in studies carried out at national or international level, no more than 30-80% of the infections can be explained by the identified risk factors (they are not all food-related)

References: 1 - De Wit *et al*., 2001a; 2 - De Wit *et al*., 2001b; 3 - Gezondheidsraad, 2000; 4 - Havelaar *et al*., 2000; 5 - De Wit *et al*., 2003; 6 - De Wit *et al*., 2001; 7 - Van Pelt *et al*., 2003; 8 - Van den Brandhof *et al*., 2002 (see *chapter 4*).

Notes:
Many foodborne infections cause patients to suffer from symptoms such as vomiting or diarrhoea, often also referred to as gastroenteritis. On the basis of two recent epidemiological studies of gastroenteritis in the Dutch population (Sensor, 1999) and as presented in the GPs practices (NIVEL, 1996-1999) estimates are derived for the incidence and the micro-organisms responsible (De Wit et al., 2001a,b), see the first three columns of the table; annually, there are about 4.5 million episodes of gastroenteritis (283 per 1,000 person years, which is roughly equivalent to 1 person in 4), of which approx. 220,000 prompt individuals to consult their GP (on average, 5% of all patients). The major gastro-intestinal pathogens in the Netherlands are noroviruses, which were found in 11% of patients. Other major pathogens were rotavirus, *Giardia lamblia* (both found in approx.. 4% of all patients), sapoviruses, *Campylobacter* spp. and *Cryptosporidium parvum* (each in approx. 2% of all patients). In GPs' practices, bacteria play a more prominent role, with *Campylobacter* spp. being found most frequently (10% of patients), followed by *G. lamblia*, rotavirus, noroviruses (each in approx. 5% of patients) and *Salmonella* spp. (found in 4%). However, while up-to-date, reliable information is available about gastroenteritis in the Netherlands, it cannot be used to determine the percentage of cases caused by infected food. This is of interest as there are numerous transmission routes for pathogens that cause gastroenteritis, such as exposure to infected individuals, infected pets, farm animals, and contaminated water. Nevertheless. A rough estimate can be made of the extent of the problem of food-infections in the Netherlands, by combining data and with the aid of assumptions (see 'Food attributable fraction' column in the table, for notes see table E of the Gezondheidsraad report (2000) on food infections).

Appendix 7: Association of pathogenic (micro-) organisms with various types of food

Organism	Starch containing products	Fruit and vegetables	Meat and meat products	Dairy products	Fish and shellfish	Remarks
Bacteria - infectious						
Aeromonas spp.					X	
Arcobacter spp.			Cattle, Pig, chicken			
Brucella melitensis/ abortion/suis				X		Dutch cattle officially declared free, import; reservoirs sheep, goat, cattle, pigs
Campylobacter spp			Chicken, cattle, pigs, sheep	Untreated milk		
Coxiella burnettii						Other countries: goat cheese
Enterobacter sakazakii				Baby milk powder		
Escherichia coli- Shiga-toxin producing			Cattle	Untreated milk		
Francisella tularensis						Import, reservoir, especially rodents
Listeria monocytogenes			Meat products	Soft cheese	Smoked fish	Post-contamination of prepared foods
Mycobacterium avium ssp. *avium*			Pig			No birds, association with pigs uncertain
Mycobacterium bovis			Cattle	Untreated milk		Dutch cattle officially declared free, import and reactivation of old infections
Mycobacterium avium ssp. *paratuberculosis*			Cattle	Milk		Effect of pasteurization of milk uncertain
Salmonella (para)typh						Import, reservoir man
Salmonella spp.– other		Sprouting vegetables	Chicken, pig, cattle, egg			
Shigella spp						Import, reservoir man
Vibrio cholerae						Import, reservoir man, fresh water and salt water
Vibrio – marine species					X	Import, reservoir seawater
Yersinia enterocolotica			Pig			
Bacteria – toxin producing						
Bacillus cereus	Rice, pasta	Spices				
Clostridium botulinum	Potatoes	X	X		X	
Clostridium perfringens			Cattle, pig, chicken			
Staphylococcus aureus				Cheese, pastries	Shrimps	Post-contamination of (heated) foods
Viruses						
Adenovirus						Unknown
Astrovirus						Unknown
Enteroviruses						Unknown
Hepatitis A virus					Shellfish	
Hepatitis E virus			Pig			

Continue table appendix 7

Organism	Starch containing products	Fruit and vegetables	Meat and meat products	Dairy products	Fish and shellfish	Remarks
Norovirus	Bread, pastries		X		Shellfish	Post-contamination of (heated) foods
Rotavirus						
Sapovirus						
Prions						
BSE prion			Cattle			
Protozoa						
Cryptosporidium parvum		Raw vegetables	Cattle		Shellfish	
Cyclospora cayatenensis		Soft fruit				
Giardia lamblia		Raw vegetables	Cattle (possible)		Shellfish	
Entamoeba histolytica						Import
Toxoplasma gondii		Raw fruit and vegetables	Cattle, pig, sheep	Goat's milk		
Helminths						
Anisakis simplex					Herring	
Echinococcus granulosis						Reservoir dog
Echinococcus multilocularis		Forest fruit				Reservoir dog, fox
Fasciola hepatica						Import, reservoir sheep
Taenia saginata			Cattle			
Taenia solium						Import, reservoir pig
Trichinella spiralis						Import, reservoir pig, horse, wild pig

Appendix 8: Calculation of the disease burden attributable to foodborne infections and intoxications

This appendix offers a general estimate of the disease burden attributable to foodborne infections and intoxications, according to the structure used in the Centre for Public Health Forecasting report (Van der Maas & Kramers, 1997). For further information, see *textbox 2.5* and *appendix 12*. In the Public Health Forecasting report for all infectious diseases, a distinction is drawn between diseases with a complicated course, and those with an uncomplicated course. The weighing factors applied are based on annual profiles, i.e. a year in which an episode of the disease is experienced. For conditions of the stomach and intestines, the duration of an uncomplicated episode is taken to be one week, while that of a complicated episode is two weeks. In deriving the weighing factors, a year with one episode of uncomplicated course was assigned a weight of 0.00, while a year with one episode of complicated course was assigned a weight of 0.03. It is assumed that a complicated course is synonymous with a visit to the general practitioner. As may be seen from *appendix 6*, there are approximately 25,000 medical consultations further to food infections and intoxications, representing a disease burden of 750 DALYs per annum. The Centre for Public Health Forecasting report assumes that one death due to gastroenteritis will represent an average loss of 8.5 life years, being the equivalent of 170-1,700 DALYs per annum where the mortality rate is between 20 and 200. In total, the disease burden is therefore 1,000-2,500 DALYs per annum.
The calculation method used in *tables 4.5* and *4.6* deviates slightly from the method described above. Here, the derivation of weighing factors does not rely on annual profiles but on the actual duration of the illness. This method has been used in various situations, including the 'Global Burden of Disease' study (Murray, 1994), and in an estimate of the disease burden due to environmental pollution published by the RIVM (De Hollander *et al*., 1999). The weighing factors in this approach are 0.066 for an uncomplicated course and 0.39 for a complicated course. Assuming the same durations as stated above, the disease burden for an uncomplicated course is then 350-900 DALYs, while that for a complicated course is 380 DALYs, a total of 700-1,300 DALYs. If the disease burden due to mortality is included, the estimate then becomes 900-3,000 DALYs. In fact, there are indications that deaths due to bacterial food infections occur at an earlier average age than suggested by the figures produced by Statistics Netherlands (CBS). Mangen *et al*. (2004) calculate an average loss of 14.3 life years due to campylobacteriosis. This would result in a total loss of 290 to 2,900 life years, plus 700 to 1,300 disease-year equivalents, or approximately 1,000 to 4,000 DALYs. There is therefore considerable uncertainty with regard to the disease burden due to foodborne infections and intoxications, partly due to methodological factors and partly to the restricted information available (for relevant literature, see *chapter 4*).

Appendix 9: Naturally occurring, potentially harmful chemical food constituents

Category, substance	Food	Possible health effects (in humans, or (italics) *in experimental animals*)	Existing legal standard	Exposure, possible exceedance of standards	Possibility to influence exposure	Remarks, sources
'Normal' food constituents						
Allergenic substances	Shellfish, fish, milk, nuts, wheat etc.	Immunological: allergenic reactions, from mild to life threatening	N.A.	N.A.	Labelling, education	Taylor & Lehrer, 1996; van Loveren, 2002; (see *textbox 4.10*)
Mycotoxins: toxic substances formed by moulds on crops						
Aflatoxins (B1, B2, G1, G2 and metabolite M1)	Especially on nuts, maize, figs, when drying is insufficient or storage conditions too warm; metabolite M1 in milk via peanut chunks in animal feed	Liver cancer (in combination with hepatitis) *Liver abnormalities, tumours, genotoxic carcinogen*	EU standards for cereals, nuts (and groundnuts), maize, spices, milk (metabolite M1); standards for baby food in preparation	Exposure below the standard; the average daily intake of aflatoxin B1 in the Netherlands is approx. 0.03 ng/kg body weight per day.	Monitoring	Richard *et al.*, 2003; Sizoo & van Egmond, 2004; WHO, 1998
Ochratoxin A	Cereals, coffee, wine, raisins and other plant-based products, milk and meat via animal feed products	Kidney damage and urinary tract tumours ('Balkan endemic nephropathy'); *immunogenic; genotoxic carcinogen*	EU standards for cereals and raisins, standards for coffee, grape juice and wine in preparation	Exposure well below the human health-based limit value	Monitoring	Richard *et al.*, 2003; Bakker & Pieters, 2002
Deoxynivalenol (DON)	Wheat and other cereals	Gastro-intestinal effects, headache, dizziness; *growth retardation, immunosuppressive, neurotoxic*	Provisional EU recommendation; EU standards in preparation	In 1999 several mg/kg in breakfast cereals.	Monitoring by VWA and food industry	Pieters *et al.*, 2001, 2002, 2004 (in press)
Patulin	Apple and apple products	*Haemorrhages, oedema, genotoxic?*	EU standards for apple juice/apple sauce	Exposure below the standard	Monitoring	WHO, 1996

Continue table appendix 9

Category, substance	Food	Possible health effects (in humans, or (italics) *in experimental animals*)	Existing legal standard	Exposure, possible exceedance of standards	Possibility to influence exposure	Remarks, sources
Zearalenone	Maize, wheat	Oestrogenic effect	In preparation	Exposure below the standard	Monitoring	WHO, 2001
Fumonisins	Maize	*Possible oesophageal and liver cancer*	In preparation	Exposure below the standard	Monitoring	WHO, 2001
Phycotoxins; toxic substances formed by algae, and which accumulate in shellfish and fish						
PSP (Paralytic Shellfish Poisoning)	Shellfish	*Blocks nerve conduction, at extremely low concentrations: tingling sensations, respiratory paralysis, mortality*	EU regulations	Regularly in Europe, not in Dutch fishing grounds		Van Apeldoorn *et al.*, 2004
DSP (Diarrhetic Shellfish Poisoning)	Shellfish, such as mussels, oysters	Acute gastro-intestinal effects	EU regulations	DSP episodes occurred several times in Europe in recent years	Monitoring; autumn 2002 Wadden Sea fishing grounds temporarily closed	Van Apeldoorn *et al.*, 2004
ASP (Amnesic Shellfish Poisoning)	Shellfish and fish around ocean shores	Stomach cramps disorientation, memory loss; mortality	EU regulations	Episode in 1987 in Canada: 3 deaths, 105 intoxications	Monitoring; 2002 catch limits for scallops in Scotland	Van Apeldoorn *et al.*, 2004
NSP (Neurotoxic Shellfish Poisoning)	Mainly fish, tropical and subtropical areas	Neurotoxic effect, various effects	None		Monitoring	Van Apeldoorn *et al.*, 2004
Azaspiracids	Shellfish, such as mussels, oysters	Acute gastro-intestinal effects	EU regulations	Episode in 1995 in Ireland	Monitoring	Van Apeldoorn *et al.*, 2004
Phytotoxins; toxic substances that are formed in plants (and toadstools)						
Glycoalkaloids	Nightshade family: potato, tomato, thornapple	Gastro-intestinal effects, respiratory disorder, *coma, mortality*	No standards, although there is an admission requirement for potatoes on the Recommended Varieties List.	Sporadic high exposure	Certain parts of the potato should not be eaten	Speijers & van Egmond, 1999

Continue table appendix 9

Category, substance	Food	Possible health effects (in humans, or (italics) *in experimental animals*)	Existing legal standard	Exposure, possible exceedance of standards	Possibility to influence exposure	Remarks, sources
Pyrrolizidine alkaloids	Various herbal teas	*Effects in the liver, carcinogenic*	NL; EU in preparation	Sporadic high exposure	Monitoring	Speijers & van Egmond, 1999
Anisatin	Incorrectly prepared star anise tea	Nausea, neurotoxicity, epilepsy, hallucinations, various acute symptoms	EU decision on conditions governing use.	Episode in 2001 in the Netherlands: star aniseed species not intended for consumption was accidentally incorporated into star anise tea.	Monitoring	Johanns *et al*., 2002
Nitrate, naturally occurring in leafy vegetables						
Nitrate, the problem is the formation of nitrite from nitrate in the body, and the possible formation of nitrosamines from nitrite and amines (fish)	Leafy vegetables (especiallyendives, spinach, lettuce), drinking water; increased in both through use of artificial fertilizer	Methemoglobinemia in infants ('blue babies', especially with bottle feeding); *genotoxic carcinogenic (nitrosamines)*	NL: certain vegetables; EU: lettuce, spinach, drinking water	Exposure via drinking water, below standard; sporadic incidents where standards were exceeded, involving private sources	Restrictions on the consumption of nitrate-rich vegetables; avoid using certain wells	WHO, 2002; Zeilmaker *et al*., 2002; Zeilmaker *et al*., 2004

Appendix 10: Not naturally occurring, potentially harmful chemical food constituents

Category, substance	Food	Possible health effects (in humans, or (italics) *in experimental animals*)	Existing legal standard	Exposure, possible exceedance of standards	Possibility to influence exposure	Remarks, sources
Substances deliberately added to foods						
Food additives	Many foods, for flavour, smell, colour, consistency or shelf life	Various	Admission subject to legal regulations; approx.1,800 additives in use; in EU positive list	No problem, due to admission policy	Admission policy	WHO, 200a; Barlow *et al.*, 2002
Substances that are present in the diet as a result of human actions during food production						
Pesticides that are no longer admitted (DDT, drins, HCB, etc.)	Residues in crops (import), human milk	Persistence in the environment and the marked accumulation in fatty tissue; *neurotoxic, immunotoxic and teratogenic.*	Prohibited, still occasionally used in third world countries	Slight; concentrations have dropped markedly in recent years	Monitoring	Van Kasteren, 2000; Richard *et al.*, 2001; Fiolet & van Veen, 2001
Pesticides that have been admitted	Residues in crops	Given the current situation of sporadic incidents where standards are exceeded, no effect is anticipated; *Various effects in experimental animals*	Approx. 400 active substances admitted; maximum residue limits (MRL) established (NL, EU, Codex)	In 2001, from 2,900 samples 3.5% (the Netherlands) and 13% (import) involving incidents where standards were exceeded (especially grapes, cucumber, pineapple)	Admission policy, 'Good Agricultural Practice', monitoring by random sampling	Van der Schee, 2002; KAP, 2003
Veterinary medicines						
Antibacterial agents	Residues in meat	Development of resistance by (possible) human pathogens in farm animals	EU regulations	N.A.	Admission policy; monitoring by random sampling	EC, 1996

Continue table appendix 10

CCategory, substance	Food	Possible health effects (in humans, or (italics) *in experimental animals*)	Existing legal standard	Exposure, possible exceedance of standards	Possibility to influence exposure	Remarks, sources
Growth promoting substances (naturally present in the body, e.g. oestradiol; analogues, e.g. trenbolone; others, e.g. clenbuterol)	Residues in meat	At current levels of exposure, natural growth promoters have no effect; incident involving clenbuterol: heart rhythm disorders, neurological effects; hormonal effects.	Prohibited in Europe in 1988, following the DES affair; nevertheless increasingly used	Residues are regularly detected; sporadic high exposure when injection site is consumed	Monitoring by random sampling; illegal operations mean that it is not always clear which substances should be searched for	EC, 1996; FAO, 2000; WHO, 2000b; Nielen *et al.*, 2003; Salleras *et al.*, 1995
Process contaminants						
Polycyclic aromatic hydrocarbons (PAHs)	For example, in plant-based oils; also as products of pyrolysis when frying and baking in domestic kitchens	Proven or possible carcinogenic (genotoxic); most of the information relates to benzo(a)pyrene; it is estimated that the carcinogenic potential of all PAHs in food amounts to about 10x that of benzo(a)pyrene	EU standards for PAHs in preparation	Current oral exposure in the Netherlands to PAHs, about 100-200 ng per person per day	Management of the industrial process; research into processes by industry and government; avoid overcooking food in domestic kitchens	Baars *et al.*, 2001; Kroese *et al.*, 2001; SCF, 2002
Chloropropanols	Acid hydrolysis of plant-based proteins	*Possible carcinogen but not genotoxic*	EU standards for 3-monochloropropandiol in soy sauce	Occasional high concentrations in soy sauce	Monitoring; research into processes by industry and government	Schlatter *et al.*, 2002
Heterocyclic amines	Products of pyrolysis, when frying and baking in domestic kitchens	*Genotoxic carcinogen*	None	Exposure or actual effects unknown	Avoid overcooking food in domestic kitchens	Nagao & Sugimura, 2000

Continue table appendix 10

Category, substance	Food	Possible health effects (in humans, or (italics) *in experimental animals*)	Existing legal standard	Exposure, possible exceedance of standards	Possibility to influence exposure	Remarks, sources
Acrylamide	Deep-frying and baking of potato and flour products in industrial processes or in the domestic situation (crisps, chips, biscuits)	*Carcinogenic; neurotoxic*	None	Theoretical risk calculated at 75-130 cases of cancer per year in the Netherlands	Research into conditions of acrylamide formation; monitoring, process management	RIVM/RIKILT, 2002; Konings *et al.*, 2003
Environmental contaminants						
Lead	Drinking water, via lead water pipes	Inhibits haemoglobin synthesis and the development of the nervous system	As of 1-1-2006 standard for lead in drinking water to be reduced, means that all lead water pipes must be replaced; EU standards for various foods	Exposure reduced by measures; estimate for early 1990s: effect in several thousand children	Environmental measures (lead-free petrol)	IPCS, 1995; De Hollander *et al.*, 1999
Mercury	Mercury (organic) in fish	Organic mercury: neurotoxic		Intake via fish consumption well below the standard (WHO: 1.6 ug/kg body weight per day)	Environmental measures	ATSDR, 1999; EFSA, 2004
Dioxins and dioxin-like polychlorobiphenyls (PCBs); see *textbox 4.11*	Oils and fats of animal origin, human milk	Adverse effect on the development of the central nervous system; persistent and accumulate in body fat; *harmful to the immune system and fertility, carcinogenic*	EU standards for dioxins in foods and animal feed	In 1998/99 intake of dioxins and dioxin-like PCBs in 8% of the population was above the EU/WHO intake standard	Environmental measures: strict standards governing emissions from waste incineration; monitoring of oils and fats, monitoring of animal feeds	Freijer *et al.*, 2001; SCF, 2001; WHO, 2002; Baars *et al.*, 2001; 2004

Continue table appendix 10

Category, substance	Food	Possible health effects (in humans, or (italics) *in experimental animals*)	Existing legal standard	Exposure, possible exceedance of standards	Possibility to influence exposure	Remarks, sources
Non dioxin-like PCBs ('indicator' PCBs)	Oils and fats of animal origin, human milk	Adverse effect on the development of the central nervous system; *deleterious to the thyroid gland and the immune system*	Consumer Goods Act standards for the seven 'indicator' PCBs; EU: risk assessment by EFSA in preparation	Intake in 5% of the population such that health effects could appear in the long term	PCB-containing equipment banned by the end of 2003; monitoring of oils, fats and animal feed; environmental measures	Bakker *et al.*, 2003
Bromine-containing fire retardants (such as PBDEs)	Products of animal origin, human milk, via increasing use in all kinds of products	*Effects on the liver, thyroid, immune system, embryonic development*	None	Little is known about exposure in the Dutch situation; in Sweden, the concentration in human milk increased until 1997, after which it declined	Alternative fire retardants	De Winter-Sorkina *et al.*, 2003

Appendix 11: Prioritizing principles for policy

List of possible principles for policy which has been ranked by experts according to priority. Each expert awarded a total of 100 points (see chapter 9).

Public health problem	Possible principles for policy	Points
In relation to a healthy diet		
1. Energy balance	a. Supply *e.g. convenience foods, portion sizes, energy dense products, easy availability, price* b. Eating behaviour *e.g. incorrect choice of foods, eating too much, too often*	
2. Fatty acid composition	a. Supply *e.g. snacks* b. Eating behaviour *e.g. opting for liquid fats*	
3. Fruit and vegetable consumption	a. Supply *e.g. convenience foods* b. Eating behaviour *e.g. reduced consumption of fruit and vegetables by teenagers*	
4. .... (fill in details)	a. Supply b. Eating behaviour	
Subtotal healthy diet		
In relation to safe food		
1. Microbiological contamination and foodborne infections	a. Supply *e.g. more mild preservation, new products, globalization, new bacteria and viruses* b. Eating behaviour *e.g. food storage habits and food preparation practice in the domestic kitchen*	
2. Cumulative effects of vitamins, minerals, bio-active substances	a. Supply *e.g. greater supply of functional foods, 'me too' principle, alongside the usual products on the shelves* b. Eating behaviour *e.g. incorrect choice of foods, eating too much*	
3. Chemical contamination	a. Supply *e.g. new products, globalization, fraude*	
4. Consumer confidence	b. Behaviour	
5. .... (fill in details)	a. Supply b. Eating behaviour	
Subtotal safe food		
Total number of points		

Appendix 12: Background to the calculations and model results in chapters 2 and 7

Contents of appendix 12:

12.1 Calculation of the directly attributable health loss

The directly attributable health loss (or gain) has been calculated for each disease by multiplying the so-called 'potential impact fractions' (PIFs; Gunning-Schepers, 1988) by the effect measure involved. The PIFs describe the proportional reduction in the number of new cases of a disease due to alteration of the risk factor distribution according to the alternative scenario (compared to the reference scenario). The formula used is:

$$\mathrm{PIF} = \textstyle\sum_i (RR_i - 1)\,(\,p_{ref}(i) - p_{alt}(i)\,)\;/\;(\,1 + \sum_i (RR_i - 1)\,p_{ref}(i)\,)$$

where i: index over risk factor classes, $p_{ref}(i)$, $p_{alt}(i)$: prevalence fractions in risk factor classes according to the reference and alternative distribution respectively; RR_i: relative risks of incidence of the disease for risk class I with increased risk compared to the class with normal risk (so, $RR_1=1$). When adopting the alternative distribution in which everyone falls into the class with lowest risk (maximum scenario) the well-known formula for the Population Attributive Risk (PAR) emerges, whereupon the PIF becomes the PAR. The formula for calculating a PAR is:

$$PAR = [P_e(RR\text{-}1)] / [P_e(RR\text{-}1) + 1]$$

where P_e is the fraction of the population within which the risk factor is present. In the case of attribution to a combination of risk factors, the prevalences are considered to be mutually independently distributed, and the relative risks multiplicative, i.e. no interaction. In the case of incidence, the effect measure chosen is the number of new cases of a disease, while for mortality the effect measure is the number of deaths, and for DALYs it is the number of lost life years, adjusted for quality of life. Mortality figures are calculated by multiplying the incidence figures by the proportion of cases of the disease which later result in death. The adjusted life years are calculated by multiplying the incidence figures by the sum of the lost healthy life years during the course of the disease and the total number of lost life years following death. The duration of the disease and the remaining life expectancy at death are calculated according to the 'life table' method. All calculations are first carried out specified by age and gender. The age-specific attributable figures thus achieved are then aggregated across the age categories. The division of the attributable figures by the total effect figures (new cases of disease, mortality figures and lost DALYs respectively) results in the proportional attributions presented.

In the attribution of health loss (or gain), the same model parameters are used as in the 20-year through-calculation of the Chronic Diseases Model (see *section 12.2*), i.e. the initial risk factor class prevalence fractions, the one-year disease incidence fractions and the relative risks. These calculations do not use risk factor class transition figures as in the 20-year modelling. Other differences compared to the 20-year modelling are that the risk for one particular disease is only dependent on the presence of the risk factor, not on other diseases. For example, in the 20-year calculation, overweight (BMI) has both a direct effect on coronary heart diseases and an indirect effect via diabetes mellitus type 2. In the attribution, only the direct effect is taken into account.

Note: The supplementary DALY estimates for breastfeeding and childhood asthma presented in *section 7.2* do not present the attributable numbers of new cases of disease, but are based on the number of existing cases of disease (see *appendix 12.7*).

12.2 Description of the Chronic Diseases Model

In the Chronic Diseases Model (Hoogenveen *et al.*, 1998), a population group is distributed over the various risk factor classes, and according to whether or not the members of that group suffer from the diseases under consideration. These distributions are age and gender specific. The demographic composition used is based on statistics published by *CBS* (Statistics Netherlands); the initial prevalence rates and incidence rates of the diseases are based on the records and reports of general practitioners. Other sources have been used in the case of cancer: the *IKZ* (Comprehensive Cancer Centre South) for the initial distribution and the *NKR* (Netherlands Cancer Registry) for incidence risks (see Van Oers, 2002). The initial distributions of the risk factors are specified based on the current prevalences within the Dutch population or on the basis of the expected or desirable distributions. The initial distributions for all risk factors are assumed to be independent (see *appendix 12.4*).

The model covers a specified number of years, in this case 20 years. In each successive year, a proportion of the population will move from one class to another.

- Changes in the age classes occur because of ageing.
- Changes in the risk factor classes can be specified (based on knowledge of behavioural relapses or of changes related to ageing, for example).
- Changes in disease status (e.g. the change from being well to being ill) are dependent on disease-specific incidence risks in combination with the relative risks of disease for the various classes of the risk factor concerned. Both the presence of a certain lifestyle factor as well as the presence of a disease can be a risk factor. The lifestyle factor can therefore increase the risk of disease both directly and indirectly. For example, consumption of fish influences the risk of acute myocardial infarction and other coronary heart diseases. People suffering from another coronary heart disease have a higher risk of acute myocardial infarction. Due to this indirect effect, the relative risks in later life are, in some cases, slightly lower than those present at a younger age (see *appendix 12.5*).
- The disease-specific incidence risks are derived from general practitioners' reports and the cancer registries. The relative risks used are based on the literature (see *appendix 12.5*). Where relevant and possible, these figures are age and gender specific. The relative risks used are assumed to be multiplicative, i.e. that there are no interactions. In the modelling, no account has (yet) been taken of the 'lag times' between a change in a risk factor and the incidence risks of diseases.
- For individuals suffering from one (or more) of the diseases under consideration, changes in vital status are determined by disease-specific mortality risks. In addition, for all individuals, changes in the vital status are determined by mortality risks derived from other causes of death. The disease-specific mortality risks are derived in part from the literature and are in part calculated based on the course of prevalence figures by age. The mortality risks for the diseases considered are therefore indirectly dependent on the risk factors, via the risk factor-dependent incidence risks, and then via the disease-specific mortality risks. Accordingly, the effect of changes in the dietary factors on mortality is delayed.

The health outcomes are the numbers of new cases of disease (incidences) and mortality, and the age-dependent disease and mortality fractions. The latter can be used to calculate the (disease-free) life expectancy. For this calculation, the model must be run for the number of years until all members of the initial cohort have died.

12.3 Explanation of Disability Adjusted Life Years (DALYs)

In various chapters of this report, the health loss due to certain diseases or risk factors is expressed in DALYs. The use of this unit of measure renders various types of health effects, and both disease and mortality, directly comparable.

DALYs (Murray & Lopez, 1996; WHO, 2000, 2002) are made up of two components: the years lost due to premature death and the years spent with a disease. The years spent with a disease are weighed according to the seriousness of the condition, using weighing factors. This renders the years spent with a disease comparable with those lost due to death. For example, if a disease has a weighing factor of 0.5, this means that a year spent with this disease is considered equivalent to half a year lost due to premature death. In this way, the lost life years and the disease year equivalents are enumerated as DALYs. Lost DALYs can be calculated for various diseases using statistical information about mortality rates and incidences/prevalences/seriousness, and can also be calculated for the risk factors based on the fraction of one or more diseases which can be explained by that risk factor (or attributed to the risk factor). DALYs lost due to a particular cause (disease or risk factor) can also be understood in terms of gain which is, in theory, possible through optimum intervention.

In the Netherlands, lost DALYs have been calculated for 49 selected conditions (see www.nationaalkompas.nl). Here, the life years lost have been calculated by multiplying the number of disease-specific deaths per year by the remaining life expectancy at the age in question. The period of illness is expressed as 'disease year equivalents' and calculated by multiplying the prevalence of the disease by the weighing factor for its seriousness.

The weighing factors have been determined as part of a separate study, and have a value between 0 (no health loss) and 1 (maximum health loss, equivalent to death)(Van der Maas & Kramers, 1997). The same procedure was used previously to calculate the DALYs lost due to eight risk factors which, with the exception of smoking, were all diet-related (Van Oers, 2002). De Hollander & Melse (2004; see also Van Oers, 2002) used a comparable method to calculate the DALYs lost due to a number of health-related environmental factors.

A specific problem which is also of interest in this report is that of the weighing of short-term conditions. Because the DALY is based on disease *years,* it is logical to weigh chronic conditions as 'one year spent in condition X'. In the case of short-term conditions, it is possible (a) to weigh the condition as if it were to last a full year, and then to correct the result according to the actual duration (as a fraction of a year), or (b) to adapt the weighing to represent 'a year which includes an episode of, for instance, influenza' (the 'year profile approach'). The first approach is used by Murray & Lopez (1996) and De Hollander & Melse (2004) for environment-related health loss, as well as by Mangen et al. (2004) for foodborne infections. It makes a more precise calculation possible. The second approach is that used by the Centre for Public Health Forecasting

(Van der Maas & Kramers, 1997) and *CVZ* (Health Care Insurance Board)(2003) and has the advantage that account is taken of the fact that the disease will be resolved relatively quickly. In the example of the foodborne infections (see *chapter 4.2* and *appendix 8*) both calculation methods arrive at results in the same order of magnitude.

12.4 Overview of the scenario assumptions and the diseases for which a relationship has been calculated for five dietary factors, overweight and three lifestyle factors

Overview of the scenario assumptions and the diseases for which a relationship has been calculated, for three lifestyle factors (details in 12.5).

Dietary factors and BMI and their classes	Scenario; initial distribution			Diseases to which the risk factor is related
	Current situation, on average (reference scenario)	Recommendation (maximum scenario)	'Feasible' (middle scenario)	
Saturated fatty acids 5 classes with class limits 10, $12^1/_2$, 15, $17^1/_2$ en%	Intake as in 1997/ 1998 (VCP 3): av. approx. 14.5 en%	Everyone meets the recommendation (< 10 en%) and is placed in the class with the lowest intake	All individuals move up one class in a favourable direction with respect to the current situation (on average 2.5 en% lower)	Coronary heart diseases
Trans fatty acids 4 classes with class limits 1, $1^1/_2$, 2 en%	Intake as in 1997/ 1998 (VCP 3): av. approx. 1.8 en%	Everyone meets the recommendation (< 1 en%) and is placed in the class with the lowest intake	All individuals move up one class in the favourable direction with respect to the current situation (on average 0.5 en% lower)	Coronary heart diseases
Fish 4 classes with class limits 0, 2, 4 times per month	Intake as in 1993-1997 (MORGEN): approx. 2-3 x per month	Everyone meets the recommendation (> 1x / week) and is placed in the class with the highest fish consumption	All individuals move up one class in a favourable direction with respect to the current situation (increase 1-2x per month)	Coronary heart diseases, stroke
Fruit 5 classes with class limits 50, 100, 150, 200 grams per day	Intake as in 1997/ 1998 (VCP 3): av. approx. 100 g/day	Everyone meets the recommendation (> 200 grams/day) and is placed in the class with the highest consumption	All individuals move up one class in a favourable direction with respect to the current situation (increase of 50 g/day)	Coronary heart diseases, stroke, cancer of the lung, stomach, and breast
Vegetables 5 classes with class limits 50, 100, 150, 200 grams per day	Intake as in 1997/ 1998 (VCP 3): av. approx. 120 g/day	Everyone meets the recommendation (> 200 grams/day) and is placed in the class with the highest consumption	All individuals move up one class in a favourable direction with respect to the current situation (increase of 50 g/day)	Coronary heart diseases, lung cancer
Body mass index 3 classes with class limits 25 and 30 kg/m^2 (see *textbox 2.1*)	BMI as in 1998-2001 (Doetinchem/ Regenboog) : approx. 50 % > 25 kg/m^2 ; approx. 10% > 30 kg/m^2	At the start of the period considered by the model everyone is of normal weight (BMI ≤ 25 kg/m^2)	Everyone has a reduction of 1 kg/m^2 in the body mass index	Coronary heart diseases, heart failure, stroke, cancer of the colon, breast, uterus, kidney, type 2 diabetes

Overview of the scenario assumptions and the diseases for which a relationship has been calculated, for three lifestyle factors (details in 12.5).

Lifestyle factors and their classes	Scenario; initial distribution			Diseases to which the risk factor is related
	Current situation, on average (reference scenario)	Recommendation (maximum scenario)	'Feasible' (middle scenario)	
Smoking 3 classes: never-, ex- and current smokers	Distribution according to STIVORO, 1998 (approx. 35% smokers); during the period considered by the model, there are stoppers and (re)starters; which causes a drop of 39% → 33 % (m); f approx. stable 30%	All smokers become ex-smokers, all ex-smokers receive same RR as never-smokers; this remains unchanged during the period considered by the model	20% of the smokers become ex-smokers and 20% of the ex-smokers become never-smokers; there are stoppers but no starters during the period considered by the model; which causes a drop of 31% → 14% (m) and 24% → 11% (v)	Coronary heart diseases, heart failure, stroke, COPD, cancer of the lung, oesophagus, larynx, bladder, kidney, pancreas, oral cavity
Physical activity 3 classes <1, 1-4, 5+ days half an hour of moderately intensive exercise; highest class is norm-active (the Dutch norm for healthy physical activity)	Current distribution according to TNO-PG, 1998 (approx. 45% norm-active); during the period considered by the model individuals can become more or less active; which causes an increase in the number of inactive individuals from 14% → 19% (m); or remains stable at approx. 13% (f)	Everyone is and remains norm-active	Norm-active becomes 50%; inactive becomes 8%; during the period considered by the model individuals can become more active; which causes a drop in the number of inactive individuals 10% → 8% (m), 9% → 6% (f)	Coronary heart diseases, stroke, diabetes, cancer of the breast, colon
Alcohol consumption 4 classes: men 0, 1-3 (=moderate), 4-5, 6+; women 0, 1 (=moderate), 2-3, 4+ glasses/day	Distribution according to CBS/ POLS, 1998 (excessive alcohol consumption 11% in men, 6% in women)	No-one drinks alcohol	All drinkers become and remain moderate drinkers; non-drinkers remain non-drinkers	Coronary heart diseases, stroke, cancer of the oesophagus, breast, larynx, oral cavity

12.5 The prevalence distributions and relative risks (RRs) used in the calculations for five dietary factors, BMI and three other lifestyle factors

Saturated fatty acids

Risk classes: energy %: < 10.0, 10.0-12.5, 12.5-15.0, 15.0-17.5, ≥17.5

Calculations have shown how a change in the consumption of saturated fatty acids leads to a change in the cholesterol level (1.08 per energy % increase in the consumption of saturated fatty acids).

Related diseases: myocardial infarction, other coronary heart diseases

Prevalence in the Netherlands: % per age and gender group (source: VCP 3-data).

	Risk classes (energy %)									
	< 10.0		10.0-12.5		12.5-15.0		15.0-17.5		≥17.5	
Age	m	f	m	f	m	f	m	f	m	f
20-30	13	9	27	20	28	37	22	23	11	11
30-40	6	8	20	16	33	32	28	25	13	20
40-50	7	6	18	18	34	28	26	27	16	21
50-60	6	8	21	22	33	25	25	27	16	19
60-70	10	11	18	13	27	29	21	22	24	25
70+	6	7	19	13	29	27	26	28	21	26

RR myocardial infarction (sources include: Clarke et al., 1997; Harris et al., 1988; Menotti et al., 1996; Neaton et al., 1992; Shipley et al., 1991; Stamler et al., 1993).

	Risk classes (energy %)									
	< 10.0		10.0-12.5		12.5-15.0		15.0-17.5		≥17.5	
Age	m	f	m	f	m	f	m	f	m	f
20-25	1.00	1.00	1.08	1.08	1.15	1.15	1.23	1.23	1.35	1.35
25-45	1.00	1.00	1.07	1.06	1.12	1.12	1.17	1.17	1.26	1.25
45-65	1.00	1.00	1.04	1.04	1.07	1.06	1.10	1.10	1.14	1.14
65-80	1.00	1.00	1.02	1.02	1.03	1.03	1.05	1.05	1.07	1.07
80+	1.00	1.00	1.00	1.00	1.01	1.01	1.01	1.01	1.01	1.01

RR other coronary heart diseases (sources include: Clarke et al., 1997; Harris et al., 1988; Menotti et al., 1996; Neaton et al., 1992; Shipley et al., 1991; Stamler et al., 1993).

	Risk classes (energy %)									
	< 10.0		10.0-12.5		12.5-15.0		15.0-17.5		≥17.5	
Age	m	f	m	f	m	f	m	f	m	f
20-25	1.00	1.00	1.08	1.08	1.15	1.15	1.23	1.23	1.35	1.35
25-45	1.00	1.00	1.07	1.06	1.12	1.11	1.17	1.16	1.26	1.25
45-65	1.00	1.00	1.04	1.04	1.07	1.07	1.10	1.10	1.15	1.14
65-80	1.00	1.00	1.02	1.02	1.04	1.04	1.06	1.05	1.09	1.08
80+	1.00	1.00	1.01	1.01	1.01	1.01	1.02	1.01	1.02	1.02

Trans fatty acids

Risk classes: energy %: < 1.0, 1.0-1.5, 1.5-2.0, ≥2.0
Related diseases: myocardial infarction, other coronary heart diseases

Prevalence in the Netherlands: % per age and gender group (source: VCP 3-data)

	Risk classes (energy %)							
	< 1.0		1.0-1.5		1.5-2.0		≥2	
Age	m	f	m	f	m	f	m	f
20-30	22	16	32	27	18	20	29	38
30-40	21	16	32	27	19	20	29	38
40-50	23	19	36	31	20	24	22	25
50-60	26	25	38	34	17	19	20	22
60-70	26	22	41	42	18	20	14	17
70-80	27	20	42	43	21	24	11	13
80+	27	20	42	43	21	24	11	13

RR myocardial infarction (based on: Oomen, 2001).

	Risk classes (energy %)							
	< 1.0		1.0-1.5		1.5-2.0		≥2.0	
Age	m	f	m	f	m	f	m	f
20-25	1.00	1.00	1.05	1.05	1.11	1.11	1.27	1.27
25-45	1.00	1.00	1.05	1.05	1.11	1.11	1.27	1.27
45-65	1.00	1.00	1.05	1.05	1.11	1.11	1.26	1.26
65-80	1.00	1.00	1.05	1.05	1.10	1.10	1.23	1.24
80+	1.00	1.00	1.05	1.05	1.10	1.10	1.23	1.23

RR other coronary heart diseases (based on: Oomen, 2001).

	Risk classes (energy %)							
	< 1.0		1.0-1.5		1.5-2.0		≥2.0	
Age	m	f	m	f	m	f	m	f
20+	1.00	1.00	1.05	1.05	1.11	1.11	1.27	1.27

Fish

Risk classes: number of times fish consumption/month: 0, ≤ 2, 2-4, > 4

Related diseases: myocardial infarction, other coronary heart diseases, stroke

Prevalence in the Netherlands: % per age and gender group (source: MORGEN 1993-1997 data, RIVM).

	Risk classes (number of times/month)							
	0		≤2		2-4		>4	
Age	m	f	m	f	m	f	m	f
20-30	14	13	52	56	11	9	24	22
30-40	8	9	52	52	10	11	30	28
40-50	8	9	50	49	11	12	31	30
50-60	11	12	45	48	11	10	33	31
60+	10	14	47	50	8	7	35	29

RR myocardial infarction (based on: He et al., 2004; Whelton et al., 2004; Bucher et al., 2002).

	Risk classes (number of times/month)							
	0		≤2		2-4		>4	
Age	m	f	m	f	m	f	m	f
20-45	1.33	1.33	1.22	1.22	1.09	1.09	1.00	1.00
45-65	1.31	1.32	1.21	1.21	1.09	1.09	1.00	1.00
65-80	1.29	1.30	1.19	1.20	1.08	1.08	1.00	1.00
80+	1.28	1.29	1.19	1.19	1.08	1.08	1.00	1.00

RR other coronary heart diseases (based on: He et al., 2004; Whelton et al., 2004; Bucher et al., 2002).

	Risk classes (number of times/month)							
	0		≤2		2-4		>4	
Age	m	f	m	f	m	f	m	f
20+	1.33	1.33	1.22	1.22	1.09	1.09	1.00	1.00

RR stroke (based on: He et al., 2004; Whelton et al., 2004; Bucher et al., 2002).

	Risk classes (number of times/month)							
	0		≤2		2-4		>4	
Age	m	f	m	f	m	f	m	f
20+	1.33	1.33	1.22	1.22	1.09	1.09	1.00	1.00

Fruit

Risk classes: g/day: < 50, 50-100, 100-150, 150-200, ≥200

Related diseases: myocardial infarction, other coronary heart diseases, stroke, cancer of the lung, stomach, breast

Prevalence in the Netherlands: % per age and gender group (source: VCP 3-data).

	Risk classes (g/day)									
	< 50		50-100		100-150		150-200		≥ 200	
Age	m	f	m	f	m	f	m	f	m	f
20-30	37	24	15	9	18	22	10	16	20	29
30-40	40	31	13	12	16	19	10	15	21	24
40-50	35	25	15	16	18	17	11	13	21	29
50-60	27	17	12	13	16	21	13	11	32	37
60-70	22	13	10	12	22	17	16	14	30	44
70+	19	8	12	10	21	17	15	16	34	49

RR myocardial infarction (based on: Joshipura et al., 2001).

	Risk classes (g/day)									
	< 50		50-100		100-150		150-200		≥ 200	
Age	m	f	m	f	m	f	m	f	m	f
20-45	1.25	1.25	1.18	1.18	1.12	1.12	1.06	1.06	1.00	1.00
45-65	1.24	1.24	1.17	1.18	1.11	1.12	1.06	1.06	1.00	1.00
65-80	1.22	1.23	1.16	1.17	1.10	1.11	1.05	1.05	1.00	1.00
80+	1.21	1.22	1.16	1.16	1.10	1.10	1.05	1.05	1.00	1.00

RR other coronary heart diseases (based on: Joshipura et al., 2001).

	Risk classes (g/day)									
	< 50		50-100		100-150		150-200		≥ 200	
Age	m	f	m	f	m	f	m	f	m	f
20+	1.25	1.25	1.18	1.18	1.12	1.12	1.06	1.06	1.00	1.00

RR stroke (based on: Joshipura et al., 1999).

	Risk classes (g/day)									
	< 50		50-100		100-150		150-200		≥ 200	
Age	m	f	m	f	m	f	m	f	m	f
20+	1.43	1.43	1.31	1.31	1.20	1.20	1.09	1.09	1.00	1.00

RR lung cancer (based on: IARC, 2003, estimate based on cohort studies).

	Risk classes (g/day)									
	< 50		50-100		100-150		150-200		≥ 200	
Age	m	f	m	f	m	f	m	f	m	f
20+	1.30	1.30	1.22	1.22	1.14	1.14	1.07	1.07	1.00	1.00

RR stomach cancer (based on: IARC, 2003, estimate based on cohort studies).

	Risk classes (g/day)									
	< 50		50-100		100-150		150-200		≥ 200	
Age	m	f	m	f	m	f	m	f	m	f
20+	1.18	1.18	1.13	1.13	1.09	1.09	1.04	1.04	1.00	1.00

RR breast cancer (based on: IARC, 2003, estimate based on cohort studies).

	Risk classes (g/day)									
	< 50		50-100		100-150		150-200		≥ 200	
Age	m	f	m	f	m	f	m	f	m	f
20+	1.22	1.22	1.16	1.16	1.10	1.10	1.05	1.05	1.00	1.00

Vegetables

Risk classes: g/day: < 50, 50-100, 100-150, 150-200, ≥ 200

Related diseases: myocardial infarction, other coronary heart diseases, lung cancer

Prevalence in the Netherlands: % per age and gender group (source: VCP 3-data).

	Risk classes (g/day)									
	< 50		50-100		100-150		150-200		≥ 200	
Age	m	f	m	f	m	f	m	f	m	f
20-30	23	25	20	20	23	24	17	15	17	15
30-40	18	25	23	20	21	24	16	15	22	15
40-50	19	19	21	20	23	26	20	16	17	19
50-60	11	9	19	20	20	24	17	17	33	30
60-70	8	8	14	17	18	20	25	24	35	31
70+	11	10	21	19	18	23	17	19	33	29

RR myocardial infarction (based on: Joshipura et al., 2001).

	Risk classes (g/day)									
	< 50		50-100		100-150		150-200		≥ 200	
Age	m	f	m	f	m	f	m	f	m	f
20-25	1.25	1.25	1.18	1.18	1.12	1.12	1.06	1.06	1.00	1.00
25-45	1.25	1.25	1.18	1.18	1.12	1.12	1.06	1.06	1.00	1.00
45-65	1.24	1.24	1.17	1.18	1.11	1.12	1.06	1.06	1.00	1.00
65-80	1.22	1.23	1.16	1.17	1.10	1.11	1.05	1.05	1.00	1.00
80+	1.21	1.22	1.16	1.16	1.10	1.10	1.05	1.05	1.00	1.00

RR other coronary heart diseases (based on: Joshipura et al., 2001).

	Risk classes (g/day)									
	< 50		50-100		100-150		150-200		≥ 200	
Age	m	f	m	f	m	f	m	f	m	f
20+	1.25	1.25	1.18	1.18	1.12	1.12	1.06	1.06	1.00	1.00

RR lung cancer (based on: IARC, 2003, estimate based on cohort studies).

	Risk classes (g/day)									
	< 50		50-100		100-150		150-200		≥ 200	
Age	m	f	m	f	m	f	m	f	m	f
20+	1.25	1.25	1.18	1.18	1.12	1.12	1.06	1.06	1.00	1.00

Body Mass Index

Risk classes: kg/m^2: < 25, 25-30, ≥30

Related diseases: myocardial infarction, other coronary heart diseases, heart failure, stroke, diabetes mellitus type 2, cancer of the colon, breast, kidney, uterus

Prevalence in the Netherlands: % per age and gender group (source: cohort data from Regenboog project and Doetinchem 1998-2001, RIVM).

	Risk classes (kg/m^2)					
	< 25		25-30		≥ 30	
Age	m	f	m	f	m	f
20-25	79	80	13	17	8	3
25-30	62	68	33	24	5	8
30-35	46	64	46	26	8	10
35-40	49	61	43	28	7	11
40-45	42	61	47	29	11	11
45-50	35	51	52	36	13	13
50-55	30	46	57	39	14	15
55-60	28	42	56	41	16	18
60-65	31	35	55	42	14	23
65-70	32	29	56	50	13	21
70+	37	37	54	43	10	20

Middle scenario prevalences.

	Risk classes (kg/m^2)					
	< 25		25-30		≥ 30	
Age	m	f	m	f	m	f
20-25	85	88	12	10	4	2
25-30	72	73	26	21	2	6
30-35	63	72	33	22	5	6
35-40	64	68	31	23	5	9
40-45	55	71	36	21	9	8
45-50	43	61	39	29	9	10
50-55	46	55	45	33	10	12
55-60	41	52	48	35	11	13
60-65	43	45	48	37	9	18
65-70	44	38	48	47	8	15
70+	49	46	45	38	6	16

RR myocardial infarction (sources include: Fiebach et al., 1989; Hu et al., 2000; MRFIT Research Group, 1986; Rehm et al., 1997; Wilson et al., 1991).

	Risk classes (kg/m²)					
	< 25		25-30		≥ 30	
Age	m	f	m	f	m	f
20-25	1.00	1.00	1.42	1.39	2.55	2.68
25-45	1.00	1.00	1.40	1.40	2.56	2.69
45-65	1.00	1.00	1.32	1.31	2.06	2.09
65-80	1.00	1.00	1.13	1.14	1.39	1.43
80+	1.00	1.00	1.06	1.07	1.22	1.24

RR other coronary heart diseases (sources include: Fiebach et al., 1989; Hu et al., 2000; MRFIT Research Group, 1986; Rehm et al., 1997; Wilson et al., 1991).

	Risk classes (kg/m²)					
	< 25		25-30		≥ 30	
Age	m	f	m	f	m	f
20-25	1.00	1.00	1.42	1.39	2.55	2.68
25-45	1.00	1.00	1.40	1.40	2.58	2.70
45-65	1.00	1.00	1.34	1.33	2.13	2.17
65-80	1.00	1.00	1.15	1.16	1.47	1.51
80+	1.00	1.00	1.07	1.08	1.27	1.28

RR heart failure (sources include: Fiebach et al., 1989; Hu et al., 2000; MRFIT Research Group, 1986; Rehm et al., 1997; Wilson et al., 1991).

	Risk classes (kg/m²)					
	< 25		25-30		≥ 30	
Age	m	f	m	f	m	f
20+	1.00	1.00	1.00	1.00	1.00	1.00

RR stroke (sources include: Fiebach et al., 1989; Field et al., 2001; Njølstad et al., 1996; Hart et al., 2000).

	Risk classes (kg/m²)					
	< 25		25-30		≥ 30	
Age	m	f	m	f	m	f
20-25	1.00	1.00	1.15	1.15	1.45	1.48
25-45	1.00	1.00	1.13	1.14	1.42	1.44
45-65	1.00	1.00	1.11	1.12	1.30	1.32
65-80	1.00	1.00	1.08	1.09	1.20	1.21
80+	1.00	1.00	1.09	1.10	1.24	1.25

RR diabetes mellitus (sources include: Carey et al., 1997; Chan et al., 1994; Field et al., 2001; Kaye et al., 1991; McPhillips et al., 1990; Njølstad et al., 1998).

	Risk classes (kg/m²)					
	< 25		25-30		≥ 30	
Age	m	f	m	f	m	f
20-25	1.00	1.00	1.95	1.91	4.87	6.18
25-45	1.00	1.00	2.60	3.06	8.98	12.38
45-65	1.00	1.00	2.05	2.20	5.32	6.33
65-80	1.00	1.00	1.74	1.84	3.21	3.80
80+	1.00	1.00	1.63	1.66	2.72	2.82

RR colon cancer (sources include: Bergstrom et al., 2001; Calle et al., 1999).

	Risk classes (kg/m^2)					
	< 25		25-30		≥ 30	
Age	m	f	m	f	m	f
20+	1.00	1.00	1.15	1.15	1.33	1.33

RR breast cancer (sources include: Bergstrom et al., 2001; Calle et al., 1999).

	Risk classes (kg/m^2)					
	< 25		25-30		≥ 30	
Age	m	f	m	f	m	f
20-25	1.00	1.00	1.00	1.00	1.00	1.00
25-45	1.00	1.00	1.00	1.00	1.00	1.00
45-65	1.00	1.00	1.00	1.10	1.00	1.21
65+	1.00	1.00	1.00	1.12	1.00	1.25

RR kidney cancer (sources include: Bergstrom et al., 2001; Calle et al., 1999).

	Risk classes (kg/m^2)					
	< 25		25-30		≥ 30	
Age	m	f	m	f	m	f
20+	1.00	1.00	1.36	1.36	1.84	1.84

RR uterus cancer (sources include: Bergstrom et al., 2001; Calle et al., 1999).

	Risk classes (kg/m^2)					
	< 25		25-30		≥ 30	
Age	m	f	m	f	m	f
20+		1.00		1.59		2.52

Smoking

Risk classes: neversmoker, current smoker, ex-smoker

Related diseases: myocardial infarction, other coronary heart diseases, heart failure, stroke, COPD, cancer of the lung, oesophagus, larynx, bladder, kidney, pancreas, oral cavity

Prevalence in the Netherlands: % per age and gender group (source: StiVoRo, 1999).

	Risk classes					
	never- smoker		current smoker		ex-smoker	
Age	m	f	m	f	m	f
20-25	57	60	39	34	4	6
25-30	49	56	43	33	8	11
30-35	48	48	41	36	11	16
35-40	43	42	41	39	16	19
40-45	36	39	44	41	20	20
45-50	36	45	41	36	20	19
50-55	34	51	39	31	27	18
55-60	36	57	36	26	28	17
60-65	30	57	34	24	36	19
65-70	28	64	31	17	41	19
70-75	28	64	31	17	41	19
75-80	31	69	28	14	40	17
80-85	34	76	26	10	40	14
85+	36	84	24	6	40	10

RR myocardial infarction (sources include: Chun et al., 1993; LaCroix et al., 1991; Malarcher et al., 2000; Rehm et al., 1997; Seeman et al., 1993; Stampfer et al., 2000; Wannamethee et al., 1999).

	Risk classes					
	never- smoker		current smoker		ex-smoker	
Age	m	f	m	f	m	f
20-25	1.00	1.00	4.40	4.29	1.77	1.55
25-45	1.00	1.00	4.02	3.99	1.71	1.53
45-65	1.00	1.00	2.43	2.57	1.44	1.37
65-80	1.00	1.00	1.53	1.55	1.24	1.23
80+	1.00	1.00	1.23	1.16	1.09	1.11

RR other coronary heart diseases (sources include: Chun et al., 1993; LaCroix et al., 1991; Malarcher et al., 2000; Rehm et al., 1997; Seeman et al., 1993; Stampfer et al., 2000; Wannamethee et al., 1999).

	Risk classes					
	never- smoker		current smoker		ex-smoker	
Age	m	f	m	f	m	f
20-25	1.00	1.00	4.40	4.29	1.77	1.55
25-45	1.00	1.00	4.05	3.95	1.72	1.52
45-65	1.00	1.00	2.52	2.64	1.46	1.38
65-80	1.00	1.00	1.64	1.66	1.28	1.26
80+	1.00	1.00	1.29	1.20	1.12	1.14

RR heart failure (sources include: Chun et al., 1993; LaCroix et al., 1991; Malarcher et al., 2000; Rehm et al., 1997; Seeman et al., 1993; Stampfer et al., 2000; Wannamethee et al., 1999).

	Risk classes					
	never- smoker		current smoker		ex-smoker	
Age	m	f	m	f	m	f
20-25	1.00	1.00	1.68	1.68	1.30	1.30
25-45	1.00	1.00	1.64	1.68	1.29	1.30
45-65	1.00	1.00	1.50	1.57	1.23	1.26
65-80	1.00	1.00	1.32	1.38	1.15	1.18
80+	1.00	1.00	1.26	1.29	1.13	1.13

RR stroke (sources include: Colditz et al., 1988; Robbins et al., 1994; Malarcher et al., 2000; Wannamethee et al., 1995).

	Risk classes					
	never- smoker		current smoker		ex-smoker	
Age	m	f	m	f	m	f
20-25	1.00	1.00	3.47	3.63	1.43	1.49
25-45	1.00	1.00	3.46	3.60	1.43	1.47
45-65	1.00	1.00	2.59	3.00	1.28	1.28
65-80	1.00	1.00	1.74	1.72	1.13	1.06
80+	1.00	1.00	1.24	1.09	1.01	1.00

RR COPD (sources include: Malarcher et al., 2000; Surgeon General, 1996a; Vogt et al., 1996).

	Risk classes					
	never- smoker		current smoker		ex-smoker	
Age	m	f	m	f	m	f
20-25	1.00	1.00	4.68	3.15	2.00	2.87
25-45	1.00	1.00	4.75	3.22	2.07	2.92
45-65	1.00	1.00	9.80	8.32	7.97	6.34
65-80	1.00	1.00	12.49	10.30	9.85	7.93
80+	1.00	1.00	10.29	5.59	6.91	5.35

RR lung cancer (sources include: Doll et al., 1994; Surgeon General, 1989; Surgeon General, 1996a; Tverdal et al., 1993).

	Risk classes					
	never- smoker		current smoker		ex-smoker	
Age	m	f	m	f	m	f
20-25	1.00	1.00	2.98	3.34	2.27	3.35
25-45	1.00	1.00	7.18	7.30	5.12	4.33
45-65	1.00	1.00	19.64	15.01	9.38	5.08
65-80	1.00	1.00	20.56	13.51	9.60	4.78
80+	1.00	1.00	13.47	9.22	7.76	3.57

RR oesophagus cancer (sources include: Doll et al., 1994; Surgeon General, 1989; Surgeon General, 1996a; Tverdal et al., 1993).

	Risk classes					
	never- smoker		current smoker		ex-smoker	
Age	m	f	m	f	m	f
20-25	1.00	1.00	6.30	6.30	3.20	3.20

RR larynx cancer (sources include: Doll et al., 1994; Surgeon General, 1989; Surgeon General, 1996a; Tverdal et al., 1993).

	Risk classes					
	never- smoker		current smoker		ex-smoker	
Age	m	f	m	f	m	f
20-25	1.00	1.00	11.60	11.60	7.30	7.30

RR bladder cancer (sources include: Doll et al., 1994; Surgeon General, 1989; Surgeon General, 1996a; Tverdal et al., 1993).

	Risk classes					
	never- smoker		current smoker		ex-smoker	
Age	m	f	m	f	m	f
20-25	1.00	1.00	2.70	2.70	1.90	1.9

RR kidney cancer (sources include: Doll et al., 1994; Surgeon General, 1989; Surgeon General, 1996a; Tverdal et al., 1993).

	Risk classes					
	never- smoker		current smoker		ex-smoker	
Age	m	f	m	f	m	f
20-25	1.00	1.00	1.70	1.70	1.40	1.40

RR pancreas cancer (sources include: Doll et al., 1994; Surgeon General, 1989; Surgeon General, 1996a; Tverdal et al., 1993).

	Risk classes					
	never- smoker		current smoker		ex-smoker	
Age	m	f	m	f	m	f
20-25	1.00	1.00	2.77	2.78	1.66	1.66
25-45	1.00	1.00	2.50	2.51	1.58	1.58
45-65	1.00	1.00	2.01	2.01	1.41	1.41
65-80	1.00	1.00	1.51	1.50	1.23	1.22
80+	1.00	1.00	1.15	1.14	1.07	1.06

RR oral cavity cancer (sources include: Doll et al., 1994; Surgeon General, 1989; Surgeon General, 1996a; Tverdal et al., 1993).

	Risk classes					
	never- smoker		current smoker		ex-smoker	
Age	m	f	m	f	m	f
20-25	1.00	1.00	10.50	10.50	3.90	3.90

Physical activity

Risk classes: active, moderately active, inactive

Related diseases: myocardial infarction, other coronary heart diseases, stroke, diabetes mellitus type 2, cancer of the colon, breast

Prevalence in the Netherlands: % per age and gender group (source: Hildebrandt et al., 1999).

	Risk classes					
	active		moderately active		inactive	
Age	m	f	m	f	m	f
20-25	32	40	59	53	8	7
25-30	33	41	57	51	10	8
30-35	33	42	55	48	12	9
35-40	33	43	53	46	13	10
40-45	34	45	51	44	14	11
45-50	36	46	50	43	14	11
50-55	38	47	48	41	14	11
55-60	40	48	46	40	15	12
60-65	41	48	44	38	15	14
65-70	42	47	42	36	16	17
70-75	43	45	40	34	17	21
75-80	44	43	38	33	18	24
80-85	45	42	36	31	19	27
85+	46	40	34	29	20	30

RR myocardial infarction (based on: Surgeon General, 1996b).

	Risk classes					
	active		moderately active		inactive	
Age	m	f	m	f	m	f
20-25	1.00	1.00	1.16	1.16	1.79	1.80
25-45	1.00	1.00	1.16	1.16	1.77	1.77
45-65	1.00	1.00	1.16	1.16	1.73	1.75
65-80	1.00	1.00	1.17	1.17	1.69	1.69
80+	1.00	1.00	1.16	1.16	1.65	1.65

RR other coronary heart diseases (based on: Surgeon General, 1996b).

	Risk classes					
	active		moderately active		inactive	
Age	m	f	m	f	m	f
20-25	1.00	1.00	1.16	1.16	1.79	1.80
25-45	1.00	1.00	1.16	1.16	1.78	1.77
45-65	1.00	1.00	1.16	1.16	1.78	1.78
65-80	1.00	1.00	1.19	1.18	1.83	1.79
80+	1.00	1.00	1.18	1.18	1.80	1.78

RR stroke (based on: Wendel-Vos et al., 2004).

	Risk classes					
	active		moderately active		inactive	
Age	m	f	m	f	m	f
20-25	1.00	1.00	1.21	1.21	2.00	2.20
25-45	1.00	1.00	1.21	1.21	1.98	2.18
45-65	1.00	1.00	1.22	1.21	2.00	2.10
65-80	1.00	1.00	1.23	1.23	2.03	1.99
80+	1.00	1.00	1.23	1.22	2.01	1.99

RR diabetes mellitus (based on: Surgeon General, 1996b).

	Risk classes					
	active		moderately active		inactive	
Age	m	f	m	f	m	f
20-25	1.00	1.00	1.07	1.06	1.36	1.30
25-45	1.00	1.00	1.16	1.16	1.80	1.80
45-65	1.00	1.00	1.16	1.16	1.80	1.80
65-80	1.00	1.00	1.16	1.16	1.80	1.80
80+	1.00	1.00	1.16	1.16	1.80	1.80

RR colon cancer (based on: IARC, 2002).

	Risk classes					
	active		moderately active		inactive	
Age	m	f	m	f	m	f
20+	1.00	1.00	1.14	1.14	1.70	1.70

RR breast cancer (based on: IARC, 2002).

	Risk classes					
	active		moderately active		inactive	
Age	m	f	m	f	m	f
20+	1.00	1.00	1.06	1.06	1.25	1.25

Alcohol consumption

Risk classes: 0 glasses per day, moderate consumption (1-3 glasses/day for men; 1 glass/day for women), excessive consumption (4-5 glasses/day for men; 2-3 glasses/day for women), consumption at hazardous level (6+ glasses/day for men; 4+ glasses/day for women)

Related diseases: myocardial infarction, other coronary heart diseases, stroke, cancer of oesophagus, breast, larynx, oral cavity

Prevalence in the Netherlands: % per age and gender group (source: CBS, data for 1998 obtained directly).

	Risk classes							
	0 glasses p/day		moderate consumption		excessive consumption		consumption of hazardous quantities	
Age	m	f	m	f	m	f	m	f
20-25	16	60	34	35	19	4	31	0
25-30	17	60	39	36	19	4	25	0
30-35	19	58	45	38	18	3	18	0
35-40	19	53	50	43	17	4	13	1
40-45	18	46	53	48	17	5	11	1
45-50	18	41	55	52	17	6	10	1
50-55	18	40	58	52	14	7	9	1
55-60	20	42	61	50	11	7	8	1
60-65	22	47	65	46	7	6	7	1
65-70	25	54	67	41	4	5	5	1
70-75	29	62	67	34	2	4	3	0
75-80	33	72	67	26	0	2	0	0
80-85	36	81	64	19	0	0	0	0
85+	39	89	61	11	0	0	0	0

RR myocardial infarction (based on: Holman et al., 1996).

	Risk classes							
	0 glasses p/day		moderate consumption		excessive consumption		consumption of hazardous quantities	
Age	m	f	m	f	m	f	m	f
20-45	1.00	1.00	0.82	0.82	0.84	0.84	0.88	0.88
45-65	1.00	1.00	0.83	0.83	0.85	0.84	0.89	0.88
65-80	1.00	1.00	0.84	0.84	0.86	0.85	0.89	0.89
80+	1.00	1.00	0.84	0.84	0.86	0.86	0.89	0.89

RR other coronary heart diseases (based on: Holman et al., 1996).

	Risk classes							
	0 glasses p/day		moderate consumption		excessive consumption		consumption of hazardous quantities	
Age	m	f	m	f	m	f	m	f
20+	1.00	1.00	0.82	0.82	0.84	0.84	0.88	0.88

RR stroke (based on: Holman et al., 1996).

	Risk classes							
	0 glasses p/day		moderate consumption		excessive consumption		consumption of hazardous quantities	
Age	m	f	m	f	m	f	m	f
20+	1.00	1.00	0.60	0.58	0.92	0.48	1.79	7.96

RR oesophagus cancer (based on: Holman et al., 1996).

	Risk classes							
	0 glasses p/day		moderate consumption		excessive consumption		consumption of hazardous quantities	
Age	m	f	m	f	m	f	m	f
20+	1.00	1.00	1.80	1.80	2.37	2.37	4.26	4.26

RR breast cancer (based on: Holman et al., 1996).

	Risk classes							
	0 glasses p/day		moderate consumption		excessive consumption		consumption of hazardous quantities	
Age	m	f	m	f	m	f	m	f
20+	1.00	1.00	1.00	1.09	1.00	1.31	1.00	1.68

RR larynx cancer (based on: Holman et al., 1996).

	Risk classes							
	0 glasses p/day		moderate consumption		excessive consumption		consumption of hazardous quantities	
Age	m	f	m	f	m	f	m	f
20+	1.00	1.00	1.83	1.83	3.90	3.90	4.93	4.93

RR oral cavity cancer (based on: Holman et al., 1996).

	Risk classes							
	0 glasses p/day		moderate consumption		excessive consumption		consumption of hazardous quantities	
Age	m	f	m	f	m	f	m	f
20+	1.00	1.00	1.45	1.45	1.85	1.85	5.39	5.39

12.6 Complete results of the calculations for five dietary factors and BMI (*section 2.4*) and for three other lifestyle factors (*section 7.4*).

Diet and BMI in the maximum scenario; calculated health loss due to the fact that the consumption of various fatty acids, fruit and vegetables (separately or in combination), and body weight do not meet the recommendation, or, health gain to be achieved under the maximum (Utopian) scenario.

		Saturated fatty acids	*Trans* fatty acids	Fish	Fruit	Vegetables	Five dietary factors combined	BMI
Directly attributable health loss for population 20+								
Incidence of diabetes	n	0	0	0	0	0	0	22,100
	%	0	0	0	0	0	0	50
Incidence of CVD	n	4,300	6,200	15,500	11,500	6,800	38,100	16,300
	%	3	4	10	7	4	24	10
Incidence of cancer	n	0	0	0	2,000	800	2,700	2,200
	%	0	0	0	5	2	7	6
Mortality due to diabetes	n	0	0	0	0	0	0	1,600
	%	0	0	0	0	0	0	50
Mortality due to CVD	n	1,000	1,500	4,500	3,300	1,700	10,500	4,300
	%	3	4	11	8	4	26	11
Mortality due to cancer	n	0	0	0	1,500	800	2,200	1,000
	%	0	0	0	6	3	9	4
Total mortality	n	1,000	1,500	4,500	4,800	2,500	12,700	6,900
	%	1	1	3	4	2	10	5
DALYs	n	25,100	32,300	82,200	94,600	47,300	245,800	215,600
	%	1	1	4	4	2	11	10
Cumulative health loss after 20 years for population 20+								
Incidence of diabetes	n	-700	-1,300	-3,900	-4,600	-2,300	-11,500	466,900
	%	-0	-0	-0	-0	-0	-1	48
Incidence of CVD	n	96,700	159,700	355,300	281,500	167,800	932,700	518,500
	%	2	4	9	7	4	23	13
Incidence of cancer	n	-700	-1,400	-4,400	46,000	18,900	58,000	43,500
	%	-0	-0	-0	5	2	6	5
Mortality due to diabetes	n	-100	-300	-1,100	-1,000	-500	-2,700	21,700
	%	-0	-0	-1	-1	-1	-3	25
Mortality due to CVD	n	12,000	23,700	70,600	52,400	24,200	164,500	75,500
	%	1	3	8	6	3	18	8
Mortality due to cancer	n	-600	-1,200	-3,600	28,000	15,100	37,600	14,900
	%	-0	-0	-1	5	3	6	3
Total mortality	n	9,500	16,700	45,200	60,300	30,000	147,600	88,300
	%	0	1	1	2	1	5	3
Effects on life expectancy of individuals aged 40								
Total	yrs	0.1	0.1	0.3	0.5	0.3	1.2	0.8
Free of disease	yrs	0.2	0.3	0.5	0.7	0.4	2.0	2.3

Diet and BMI in the middle scenario: calculated health gains for five dietary interventions (separately or in combination) and intervention in body weight, to be achieved under the middle scenario.

		Saturated fatty acids	*Trans* fatty acids	Fish	Fruit	Vegetables	Five dietary factors combined	BMI
Directly attributable health gain for population 20+								
Incidence of diabetes	n	0	0	0	0	0	0	4,900
	%	0	0	0	0	0	0	11
Incidence of CVD	n	1,700	4,100	8,700	4,700	3,000	20,700	3,900
	%	1	3	5	3	2	13	2
Incidence of cancer	n	0	0	0	800	400	1,200	500
	%	0	0	0	2	1	3	1
Mortality due to diabetes	n	0	0	0	0	0	0	300
	%	0	0	0	0	0	0	11
Mortality due to CVD	n	400	1,000	2,500	1,400	800	5,700	1,000
	%	1	3	6	3	2	14	2
Mortality due to cancer	n	0	0	0	600	400	900	200
	%	0	0	0	2	1	4	1
Total mortality	n	400	1,000	2,500	2,000	1,100	6,600	1,700
	%	0	1	2	2	1	5	1
DALYs	n	10,300	21,500	46,200	38,000	21,000	127,900	56,000
	%	0	1	2	2	1	6	2
Cumulative health gain after 20 years for population 20+								
Incidence of diabetes	n	-300	-900	-2,200	-1,900	-1,000	-5,900	141,300
	%	-0	-0	-0	-0	-0	-1	14
Incidence of CVD	n	40,000	105,200	200,000	109,800	72,700	499,600	143,200
	%	1	3	5	3	2	13	4
Incidence of cancer	n	-300	-1,000	-2,400	17,800	8,200	22,500	10,800
	%	-0	-0	-0	2	1	2	1
Mortality due to diabetes	n	-0	-200	-600	-400	-200	-1,400	4,600
	%	-0	-0	-1	-0	-0	-2	5
Mortality due to CVD	n	4,900	15,800	39,200	21,300	10,700	87,500	15,400
	%	1	2	4	2	1	10	2
Mortality due to cancer	n	-200	-800	-2,000	10,800	6,600	14,500	3,600
	%	-0	-0	-0	2	1	2	1
Total mortality	n	3,900	11,100	25,200	23,600	13,100	73,900	20,900
	%	0	0	1	1	0	2	1
Effects on life expectancy of individuals aged 40								
Total	yrs	0.0	0.1	0.2	0.2	0.1	0.6	0.3
Free of disease	yrs	0.1	0.2	0.3	0.3	0.2	1.0	1.0

Lifestyle factors in the maximum scenario; calculated health loss due to smoking, lack of physical activity and alcohol consumption (separately or in combination), or, health gain to be achieved under the maximum (Utopian) scenario.

		Smoking	Physical activity	Alcohol	Three lifestyle factors combined
Directly attributable health loss for population 20+					
Incidence of diabetes	n	0	7,200	0	7,200
	%	0	16	0	16
Incidence of CVD	n	24,000	20,700	-16,400	30,600
	%	15	13	-10	19
Incidence of cancer	n	8,800	1,500	1,700	11,400
	%	23	4	4	30
Mortality due to diabetes	n	0	500	0	500
	%	0	16	0	16
Mortality due to CVD	n	5,900	6,100	-4,700	8,100
	%	15	15	-12	20
Mortality due to cancer	n	7,500	800	900	8,800
	%	30	3	3	35
Total mortality	n	16,000	7,400	-3,800	19,900
	%	12	6	-3	15
DALYs	n	353,300	152,300	-61,800	445,400
	%	16	7	-3	20
Cumulative health loss after 20 years for population 20+					
Incidence of diabetes	n	-14,200	149,400	2,500	139,500
	%	-1	15	0	14
Incidence of CVD	n	482,200	537,600	-370,800	697,700
	%	12	14	-9	18
Incidence of cancer	n	192,700	25,500	43,600	247,800
	%	22	3	5	28
Mortality due to diabetes	n	-2,400	7,000	700	5,400
	%	-3	8	1	6
Mortality due to CVD	n	53,100	110,000	-68,200	105,300
	%	6	12	-7	11
Mortality due to cancer	n	145,200	6,500	25,600	168,500
	%	24	1	4	28
Total mortality	n	185,500	84,200	-26,700	243,100
	%	8	3	-1	8
Effects on life expectancy of individuals aged 40					
Total	yrs	1.2	0.7	-0.2	1.7
Free of disease	yrs	2.0	1.3	-0.4	3.0

Lifestyle factors in the middle scenario; calculated health loss due to smoking, lack of physical activity and alcohol consumption (separately or combined), or, health gain to be achieved under the middle scenario.

		Smoking	Physical activity	Alcohol	Three lifestyle factors combined
Directly attributable health gain for population 20+					
Incidence of diabetes	n	0	1,500	0	1,500
	%	0	3	0	3
Incidence of CVD	n	4,800	4,100	1,800	10,400
	%	3	3	1	6
Incidence of cancer	n	1,800	300	500	2,500
	%	5	1	1	7
Mortality due to diabetes	n	0	100	0	100
	%	0	3	0	3
Mortality due to CVD	n	1,200	1,200	600	2,900
	%	3	3	1	7
Mortality due to cancer	n	1,500	200	200	1,900
	%	6	1	1	7
Total mortality	n	3,200	1,500	800	5,300
	%	2	1	1	4
DALYs	n	70,700	32,200	23,100	122,700
	%	3	1	1	5
Cumulative health gain after 20 years for population 20+					
Incidence of diabetes	n	-4,000	45,700	-1,400	40,600
	%	-0	5	-0	4
Incidence of CVD	n	190,400	166,900	102,900	441,500
	%	5	4	3	11
Incidence of cancer	n	66,000	7,900	7,800	80,400
	%	7	1	1	8
Mortality due to diabetes	n	-600	2,000	-300	1,100
	%	-1	2	-0	1
Mortality due to CVD	n	20,400	33,400	25,100	75,700
	%	2	4	2	8
Mortality due to cancer	n	47,800	1,800	4,000	53,100
	%	8	0	1	9
Total mortality	n	64,100	26,000	22,900	109,800
	%	2	1	1	4
Effects on life expectancy of individuals aged 40					
Total	yrs	0.6	0.3	0.2	1.0
Free of disease	yrs	0.9	0.5	0.2	1.6

Health gain to be achieved for the maximum scenarios (except for alcohol: the middle scenario), for lifestyle combined, diet combined and BMI, for 3 calculation methods.

		Three lifestyle factors, 'Utopian mix'	Five dietary factors combined	BMI	Three lifestyle factors, 'Utopian mix'+ five dietary factors combined
Directly attributable health gain for population 20+					
Incidence of diabetes	n	7,200	0	22,100	7,200
	%	16	0	50	16
Incidence of CVD	n	42,300	38,100	16,300	67,200
	%	26	24	10	42
Incidence of cancer	n	10,600	2,700	2,200	12,100
	%	28	7	6	32
Mortality due to diabetes	n	500	0	1,600	500
	%	16	0	50	16
Mortality due to CVD	n	11,500	10,500	4,300	18,400
	%	29	26	11	46
Mortality due to cancer	n	8,400	2,200	1,000	9,500
	%	33	9	4	38
Total mortality	n	23,000	12,700	6,900	31,000
	%	18	10	5	24
DALYs	n	496,600	245,800	215,600	647,800
	%	22	11	10	29
Cumulative health gain after 20 years for population 20+					
Incidence of diabetes	n	137,000	-11,500	466,900	130,400
	%	14	-1	48	13
Incidence of CVD	n	1,026,600	932,700	518,500	1,678,700
	%	26	23	13	42
Incidence of cancer	n	225,300	58,000	43,500	263,000
	%	25	6	5	29
Mortality due to diabetes	n	4,600	-2,700	21,700	2,900
	%	5	-3	25	3
Mortality due to CVD	n	173,900	164,500	75,500	295,600
	%	19	18	8	32
Mortality due to cancer	n	155,900	37,600	14,900	177,600
	%	26	6	3	30
Total mortality	n	281,300	147,600	88,300	384,800
	%	9	5	3	12
Effects on life expectancy of individuals aged 40					
Total	yrs	2.0	1.2	0.8	3.0
Free of disease	yrs	3.6	2.0	2.3	5.2

Notes to the tables in section 12.6:

In all cases, absolute figures for the number of cases of a disease (incidence) and deaths (mortality) are shown as the difference relative to the reference scenario. Percentages are also given, whereby the absolute figures are divided by the number of new cases of disease or deaths occurring in the reference scenario (x 100). The calculations are based on the *total* of all the various forms of cardiovascular diseases or cancer considered in the calculations, and not merely those diseases for which a relationship with the relevant (dietary) factor exists. In the case of the cardiovascular diseases, these are coronary heart diseases, stroke and heart failure, which together account for approximately 75% of all cardiovascular diseases in terms of mortality. In the case of cancer, the calculations are based on the six forms which are known to have a relationship with diet or overweight: lung, stomach, breast, colon, uterus and kidney (*section 2.4*), plus the five forms which are related to the other lifestyle factors: oesophagus, larynx, bladder, pancreas and oral cavity (*section 7.4*). These represent approximately 60% of all forms of cancer based on mortality statistics.

With regard to *total mortality,* the absolute figures represent the sum of the figures for each of the separate causes of death for which calculations have been made. The percentages are then calculated by dividing this figure by the mortality attributable to all causes. The DALYs are calculated using the figures for disease and mortality. These percentages therefore relate to the total mortality, but the disability component relates only to the diseases included in the model.

Unlike the directly attributable health loss, the modelling over a *20-year period* takes the substitution effect of other causes of death into account: as the prevalence of a certain cause of death is reduced, other causes will occur more often, and vice versa. The 20-year results therefore sometimes include negative figures for diseases which are not related to the risk factor. For example, non-optimal dietary composition seems to result in a lower incidence and mortality due to diabetes, because a greater number of people die from cardiovascular diseases and cancer. The results of the 20-year calculation also clearly demonstrate that the average duration of disease due to cardiovascular disease is longer than that of cancer: for the five dietary factors combined, the incidence of cardiovascular diseases is approximately six times greater than the mortality rate, while in the case of cancer, incidence is only approximately 1.5 times greater.

Life expectancy figures include both the total life expectancy and disease-free life expectancy, for which the number of years spent with the modelled disease has been subtracted from the total life expectancy.

The final table in *appendix 12.6* presents a ‘lifestyle factors, Utopian mix’. This differs from the ‘three lifestyle factors combined’ in the other tables because it incorporates the most favourable situation with regard to alcohol consumption, being the middle scenario. Accordingly, the outcomes are in most cases even more favourable than those for ‘five dietary factors combined’.

12.7 Some supplementary DALY estimates (substantiation of *section 7.2*)

These are provisional estimates which must be regarded as ‘order of magnitude’ indications. For the PAR formula, see *appendix 12.1*.

Consumption of fibre and cardiovascular diseases:

- RR: per 10 gram/day increase (f) or 15 gram (m) there will be a 20-30% lower risk of cardiovascular diseases (Pietinen *et al*., 1996; Rimm *et al*., 1996; Wolk *et al*., 1999; Mozaffarian *et al*., 2003; Bazzano *et al*., 2003).

- Simplified assumption: the upper 50% of the population in terms of intake will have an RR of 0.8. This means that the RR for the lower 50% will be 1/0.8 = 1.25.
- PAR = 0.5x0.25/((0.5x0.25)+1) = 0.11.
- The number of DALYs lost each year to cardiovascular disease is 347,100 (RIVM, 2004); 11% of this figure is approximately 35,000 DALYs.
- Because this is only a rough estimate, the text refers to 'more than 10,000 DALYs'.

Breastfeeding and asthma in children:
- RR = 0.7 for three months exclusive breastfeeding against no breastfeeding (Gdalevich *et al.,* 2001).
- Prevalence three months exclusive breastfeeding = 32%, risk fraction therefore = 68%; 25% do not start breastfeeding. The risk fraction is therefore 25-68%.
- For PAR calculation, reciprocal RR = 1/0.7 = 1.43.
- PARmax = 0.68x(1.43-1)/(0.68x(1.43-1)+1) = 0.23.
- PARmin = 0.25x(1.43-1)/(0.25x(1.43-1)+1) = 0.10.
- Annual prevalence (RIVM, 2004) of asthma at 0-4 years of age (assumed to be the period during which the child is protected): 105 per 1.000, being an absolute figure of 105,000.
- 0.10-0.23 x 105,000 attributable to no breastfeeding = 10,500-24,150.
- With respect to the DALY calculation, the mortality proportion is small and has been disregarded. The weighing factor for asthma is 0.08. The number of DALYs is then 0.08 x 10,500-24,200 = 840-1,940, which has been rounded off to 800-1,900.

Breastfeeding and inflammation of the middle ear:
- RR = 0.77 for middle ear inflammation for breastfeeding versus no breastfeeding (Uhari *et al*., 1996).
- Prevalence of breastfeeding: see above.
- For PAR calculation, reciprocal RR = 1.3.
- PARmax = 0.68 x 0.3/((0.68 x 0.3) + 1) = 0.17.
- PARmin = 0.25 x 0.3/((0.25 x 0.3) + 1) = 0.07.
- Annual incidence of Otitis media according to the second National Study (RIVM, 2004): 0 years: 460/1,000 = 92,000 incidence; 1-4 years: 270/1,000 = 216,000 incidence. Combined: 308,000.
- 0.07-0.17 x 308,000 attributable to breastfeeding = 21,560-52,360.
- With respect to calculating DALYs, no mortality has been included. The weighing factor is assumed to be the same as that for infections of the lower respiratory tract: 0.01. The number of DALYs is then 0.01 x 21,560-52,360 = 216-524, which has been rounded off to 200-500.

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Index

Our food, our health
Healthy and unhealthy diets receive a lot of attention nowadays, and there are good reasons for this. Each year, overweight and unfavourable dietary composition account for thousands of new cases of illness and unnecessary deaths. The number of young people and adults who are overweight is increasing. Foodborne infections and allergic reactions to food constituents also cause some health loss. This report addresses questions such as what is the health loss due to unhealthy diets and unsafe food in the Netherlands? What are the causes of this problem? What effects can we expect to see in the future?

The report shows that, in the Netherlands, a substantial portion of health loss can be prevented by a healthier diet and safer food. This requires an integrated strategy, involving greater activity on the part of all those involved. The main opportunities are to be found on the supply side, i.e. in the hands of the private sector. But the consumer also has an important part to play, by making the proper choices in terms of health. The government must first create the necessary conditions, possibly followed by enforcement where appropriate.

This report is a collaborative publication of the Nutrition, Medicines and Consumer Safety Division and the Public Health and Health Services Division of the National Institute for Public Health and the Environment (RIVM). It is one of a series of reports on Public Health Forecasts in the Netherlands.

The report was originally published in Dutch under the title Ons eten gemeten: Gezonde voeding en veilig voedsel in Nederland [RIVM-report number: 270555009; ISBN 90-313-4411-7; 2004].

See also the RIVM website: www.rivm.nl/en.

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