



The prize of  
healthy food

# Preface

## There is good and there is bad news

Where does my food come from, what is in it and what did it take to get it on my plate? In society at large, there is a growing awareness about the influence of dietary patterns on the development of diseases and health. And so we see an acceleration of the emergence of technologies that help people track what they eat. We see fast food and snacks being banned from schools and sports canteens. However, these positive developments cannot hide some sobering facts: Unhealthy eating is one of the main causes of non-communicable diseases and premature death of large groups of people. In the Netherlands almost fifteen percent of the adult population suffers from obesity, which is two and a half times more than in the eighties.

## There is a price but there is also a prize

In this report, it is estimated that total cost related to dietary risks in the Netherlands amounted to € 8.8 billion in 2017 of which € 6 billion were direct costs related to diagnosis, treatment, and care. The remaining € 2.8 billion was related to indirect costs such as costs associated with loss of productivity due to absenteeism. These facts show that from a personal and social perspective, as well as an economic perspective, there is a price to eating unhealthy; and the other way around: there is a prize, a reward, to prioritizing healthy food and eating habits.

## Market failures all over the place

This report shows that the goal of eating healthily is not as straightforward as it may seem. Foods vary vastly in nutrients and energy. At the same time the daily need for individuals depends on age, gender and activity. Processed food is not necessarily more healthy or less healthy than organic food. Often our choices are still based on taste and price than on health.

People need a lot of context and information to make conscious, wise and balanced decisions relating to daily food. Reality is that many people do not have this knowledge. And as the consequences of a healthy or unhealthy choice emerge in the distant future, it is hard to be rational all the time. In the context of this report we call this a market failure, a situation where the allocation of goods and services by a free market is not efficient, leading to a net social welfare loss. This report points out more market failures that form impediments to a healthy food market and, in the end, a healthy society. We make suggestions to overcome these market failures.



## Contributing to the SDGs

Healthy food is high on the political and societal agenda, also because food production is one of the strongest levers for environmental sustainability. We see this reflected in the Green Deal, the European Union's action plan to achieve a sustainable, circular future by 2050. Healthy food is also an important element in the Sustainable Development Goals of the United Nations that call upon governments, companies and individuals to contribute to a fair, equal and sustainable society.

As PwC we want to contribute to achieving the SDGs and contribute to solving important problems. This report concludes that a healthy society is within reach when we all – government, industry and consumers, contribute by accelerating the exciting but still cautious initiatives to switch to more healthy food.

I invite you to take a look at why PwC believes this is achievable.

Renate de Lange

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# At a glance



## Eat what you need

When we think about food as healthy or unhealthy, it is important to know that our bodies require nutrition, not food. This **nutritional requirement** is different for every person and is determined based on different factors such as body mass, body composition, age, gender, physical activity level and other physiological factors.

## Balance is the key

The nutritional requirements can be fulfilled via macro and micronutrients. All the essential nutrients have a role to play within the body, but the energy can only be derived from carbohydrates, proteins and fats. For a **balanced diet**, the total energy derived from the diet throughout the day should not exceed the energy expenditure of a body and the diet should also meet the prescribed minimum and maximum limits<sup>1</sup> for individual macro and micronutrients. Every nutrient has a range within which it should be consumed.

**Processed and organic food** can both fit into a healthy diet. For processed foods, the level and type of processing determines the nutritional value. In general, highly processed foods are energy dense, contain more ingredients and also a higher amount of salt, sugar and fats compared to minimally processed foods. They are also cheaper than minimally processed foods and are often perceived as more tasty and this can be an incentive for compulsive eating.

## Practice what you preach

When we compare the **nutritional requirement and the dietary guidelines** from The Netherlands Nutrition Centre with actual food consumption, we see that people consume more than the required fats, saturated fats, salt and alcohol and less than the required alpha-linolenic fatty acid. There is also an over- and underconsumption of other micronutrients for different age groups. In spite of this our consumption pattern has improved since 2010, especially trans-fats consumption which has decreased from excess to well within the range.

## Choose Wisely

In the Netherlands, dietary risks are one of the top three risk factors leading to non-communicable diseases (NCDs) such as stroke, heart disease, cancer, and diabetes. It is important to eat according to prescribed nutritional and dietary requirements since “unhealthy eating” is, alongside smoking, alcohol consumption, and physical inactivity, a modifiable risk factor for NCDs.

We also see that on average, a **healthier diet can be costlier than an unhealthy diet**. However, with proper planning and nutritional knowledge, it is possible to have a healthy diet at lower costs.

## Health is Wealth

Our research shows an **estimated economic burden**, associated with unhealthy eating, to be € 8,8 billion. This includes both the direct costs (€ 6 billion) resulting from healthcare expenditure and indirect costs due to absenteeism (€ 2,8 billion).

## Towards a Healthy Future

The **societal costs** associated with unhealthy eating are significant and individuals do not take these costs into consideration before buying food. There is market failure in the food market that is evidenced by information asymmetry, deliberate misinformation, and unequal market power concentration. This market failure needs to be overcome to move to a healthier future.

In order to move towards a healthier society, **the government, knowledge institutions, food producers and consumers** all have to take steps to accomplish this. Cooperation within the European Union is crucial.





# Eat what you need

Our bodies require nutrition, not food

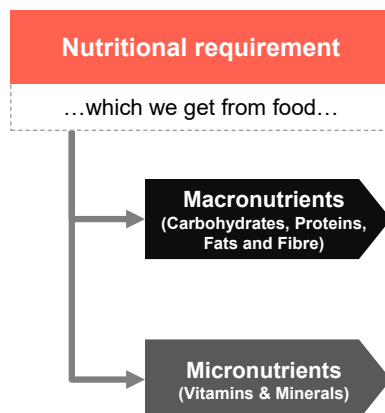
Nutrients are substances which are used by our bodies to survive, grow and reproduce. We get these nutrients from the food we eat each day. Therefore, to understand the difference between which food is healthy or unhealthy for our bodies, we must first understand the concept of nutritional requirement (Figure 1)<sup>1</sup>.

Our bodies have a nutritional requirement in order to provide energy and carry out other important processes and functions such as breathing, cell repair, bone structure maintenance and strength and immunity against infections.

To perform these processes, some nutrients are synthesized in sufficient quantities by our body and are therefore non-essential nutrients, while other nutrients must be provided through diet and are called essential nutrients. The essential nutrients are carbohydrates, fats and proteins, vitamins and minerals<sup>2</sup>. Water can also be classified as an essential nutrient.

**Depending on the quantity required, nutrients are classified as either macronutrients or micronutrients**

Figure 1: Nutrients can be classified as macro and micronutrients



Macro means large and the nutrients required in larger quantities are called macronutrients. These include, carbohydrates, fats and proteins (Figure 2). One of the major functions of the macronutrients is to provide energy to our body. Fibre is also a carbohydrate, but it does not provide energy, only the digestible carbohydrates provide energy. Alcohol also provides energy, but it is not an essential nutrient.

Figure 2: Breakdown of macronutrients and their intake limits. These values are for an average body weight and physical activity level.

Breakdown of Macronutrients			
Macronutrients			
Carbohydrates		Min limit	Max limit
	Digestible carbohydrates	40en%*	70en%
	Fibre	14g per 1000 kcal	NA**
Fats		20en%	40en%***
Proteins		8en%	25en%

\*en% means energy percentage

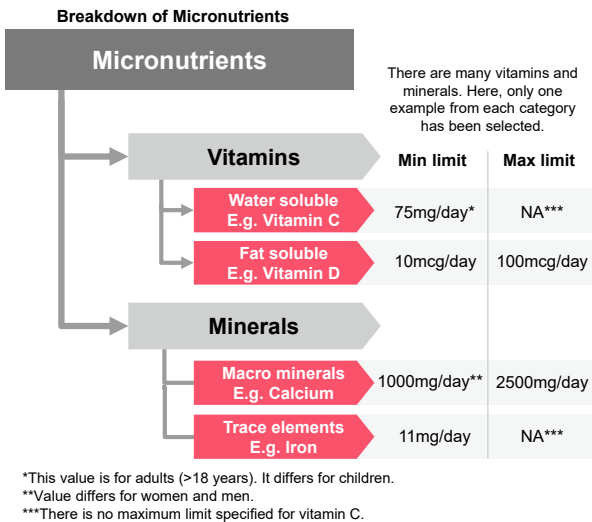
\*\*Maximum limit for fibre has not been specified

\*\*\*For tendency to overweight, the maximum limit is 35 en%

- 1 Every nutrient has a range within which it should be consumed, this range can be assessed at the website of the Voedingscentrum (<https://www.voedingscentrum.nl/Assets/Uploads/voedingscentrum/Documents/Professionals/Pers/Factsheets/Factsheet%20Aanbevelingen%20vitamines,%20mineralen%20en%20spooorelementen.pdf>)
- 2 Within the main categories of nutrients i.e. carbohydrates, fats, proteins, vitamins and minerals, there are sub-categories which are essential and non-essential both. Such as some amino acids or fatty acids are essential, and some are not. Here, by mentioning the main categories, the term essential is used in a broader sense.

Micronutrients are required in smaller quantities and their requirement or consumption is measured in milligrams or micrograms per day. These nutrients consist of vitamins and minerals (Figure 3). Minerals are again classified as macrominerals and microminerals, where micro minerals are also known as trace elements. They do not provide energy but play an important role in various functions and processes. For example, vitamin D aids in absorption of calcium, helping to form and maintain strong bones. Vitamin C is required for the development of the skin. Calcium is necessary for proper structure of bones and teeth. Iron helps provide oxygen to the muscle.

**Figure 3: Breakdown of micronutrients and their intake limits**

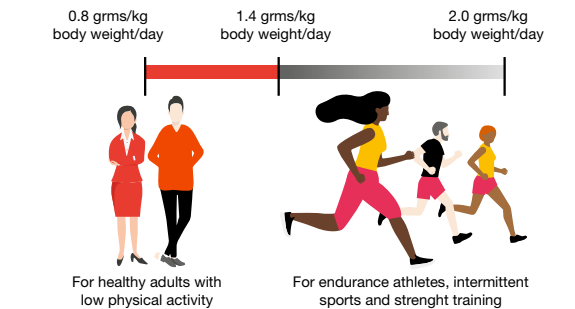


Note: Only 4 micronutrients are shown here, more information on intake limits can be obtained from the health council's advisory report on vitamins and minerals [4].

### Nutritional requirement is different for every person

Nutritional requirements are not the same for everyone. It differs from person to person depending on various factors such as body mass, body composition, physical activity level, age, gender, ethnicity, bioavailability (fraction of a nutrient absorbed), infections and rehabilitation and other special conditions such as pregnancy, lactation and growth (in children)[5].

**Figure 4: Protein requirement for athletes is different than for healthy adults. Please refer to official guidelines [6] to know your own protein requirements.**



For example, protein requirement for athletes is different than for a healthy adult with low or moderate physical activity (Figure 4).

### There are prescribed limits for both macronutrients and micronutrients

All nutrients have a prescribed minimum and maximum intake values. These values are called dietary reference values and are developed by scientific bodies such as European Food Safety Authority (EFSA) at the EU level and by the Health Council in The Netherlands. These values support public health and also help in developing labelling laws and identifying populations at risk of over- or under- nutrient consumption. Figures 2 and 3 show the minimum and maximum intake values for macro and micronutrients.

For micronutrients, the minimum and maximum intake limit are presented as milligrams per day or micro grams per day. However, in case of macronutrients, the intake limits for energy providing macronutrients i.e., digestible carbohydrates, fats and proteins are provided in relation to the total energy requirement (see Figure 2). For fibre, the minimum intake level depends on the amount of kilocalories (kcal) consumed i.e., fourteen grams of fibre intake is recommended for every 1000 kcal.

Nutritional requirement and energy requirement go hand in hand

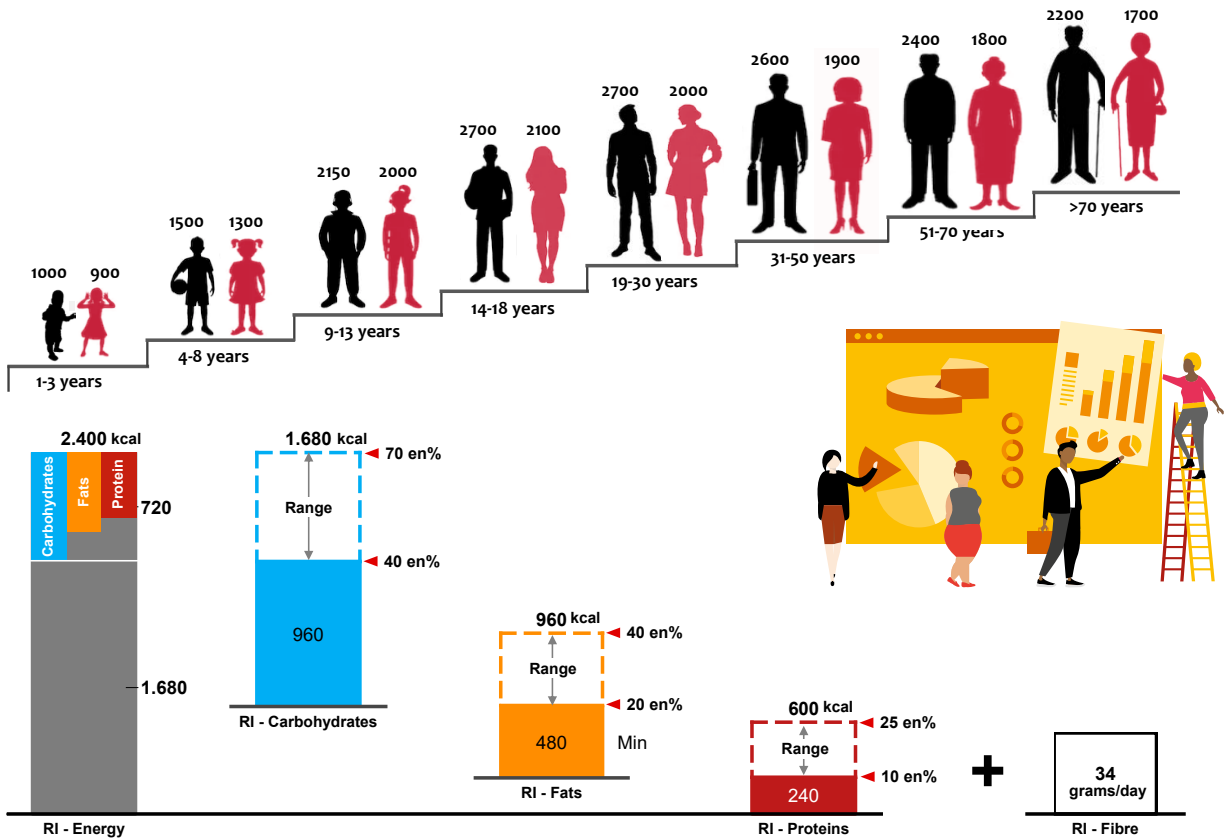
Along with meeting the individual requirements for nutrients, the total energy requirement must also be met. As shown in Figure 4, for carbohydrates, fats and proteins, the total energy derived from them must not exceed the energy expenditure of the body as well.

For example, if the total energy requirement is 2400 kcal, by consuming a minimum of carbohydrates (40en%), fats (20en%) and proteins (8en%), you fulfill the individual nutrient requirement. However, when summed up as a percentage of energy, you have consumed only

1680 kcal. This means you have a calorie deficit (1680 kcal<2400 kcal) and your body will lose weight. On the other hand, by consuming a maximum of carbohydrates (70en%), fats (35en%) and proteins (8en%), the individual nutrient requirement has not been exceeded but the total energy requirement has been exceeded by 840 kcal<sup>3</sup>. This means you have a calorie surplus and the excess calories get stored as fats.

Therefore, along with focusing on individual nutrient requirements, the total energy requirement must also be followed.

Figure 5: 2400 kilocalorie energy requirement is used as an example here. Intake range for energy providing macronutrients (coloured) as a percentage of total energy requirement; en% means energy percentage. Note: Fibre does not provide energy.



3 See appendix A for calculation.



# Balance is the key

By diversifying your food choice, nutrients lacking in one food can be compensated by other foods

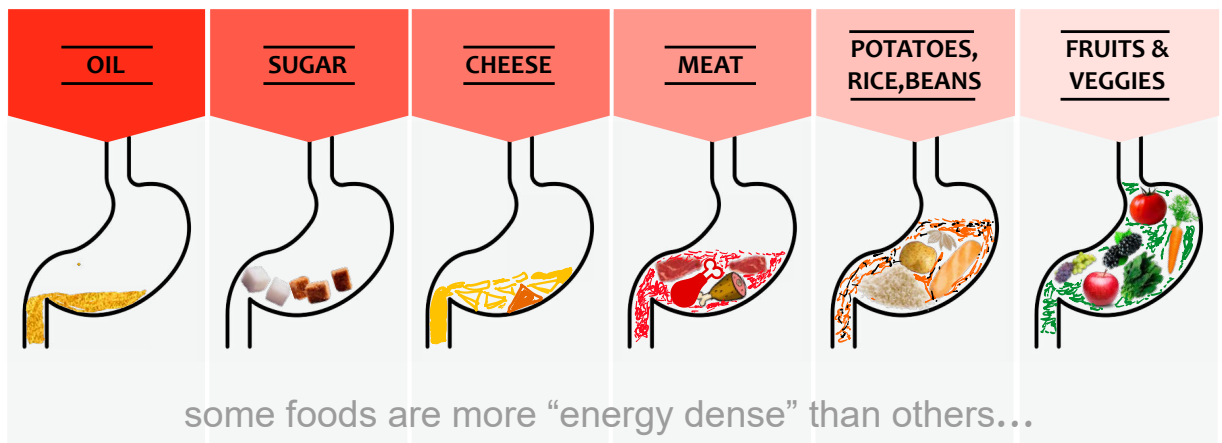
Foods vary in the number of nutrients and the energy they contain. Some foods have relatively higher variety and quantity of nutrients per gram and some foods have relatively more energy or kcal per gram. This is because the energy (kcal) present in macronutrients varies and hence energy density varies depending on the nutritional composition.

There are approximately four kcal of energy per gram of carbohydrates or proteins<sup>[7]</sup>, and there are nine kcal of energy per gram of fats. There are seven kcal of energy per gram of alcohol<sup>4</sup>. By consuming one gram of fats we consume more energy than by consuming a gram of carbohydrates or proteins. In other words, we consume more energy by having a bite of cheesecake than a bite of apple.

Therefore, we need to have a balance in what we choose to eat and must also be aware of the nutritional content of food. But, this requires rational decision making, which is difficult because humans fail to incorporate long-term risks into their decision-making processes.

Figure 6: Foods high in sugar or fats seem light on the stomach but provide more kcal.

## What 500 KCALs look like?



4 There are different ways for calculating the energy content of foods. According to the 'Atwater general factor system', these are the values. Using the 'Atwater specific factor system', depending on type of food (plant based or animal based) energy value differ slightly.





## Do processed foods and organic foods fit into a balanced diet?

To answer this question, it is crucial to first understand the different levels at which the food is processed and how the level of processing affects food. It is important also to keep in mind that it is not just the level of food processing but also the processing techniques which impact the nutritional content of the food.

Almost all the food we eat today is processed. Any change in a food which alters its original form can be termed as processing of food. The amount of processing varies from food to food, ranging from minimal to high. Foods are minimally processed, moderately processed and highly processed. A potato picked from a field is unprocessed, when this potato is washed and cut into pieces it is minimally processed. When it is made into French fries it is moderately processed and when potato chips are made from it, it can be classified as highly processed. As the level of processing increases, additional ingredients are added, resulting in changes in its nutritional content.

Now, there are certain advantages and disadvantages of food processing. The main advantages of food processing are to improve shelf life<sup>5</sup>, taste and nutritional quality, reduction in wastage, and increased food availability. By drying fruits, the water content is reduced and hence fruits can be stored for a longer time and transported.

Different food processing techniques have a different impact on food. For instance, 'flash freezing'<sup>6</sup> is a food processing technique and is effective in preserving the nutritional content in food. In some foods, nutrients can be digested by our body only once the food is processed. For example, boiling a carrot causes it to release beta-carotene which would otherwise be less available during digestion because heating breaks down the plant cell walls. Food fortification, i.e. adding of nutrients to food, can also help address certain nutrient deficiencies. For example by adding iodine in salt, the problem of iodine deficiency has been addressed in some countries.

However, there are several drawbacks to processed food. In some cases, the food loses certain nutrients such as vitamins and minerals. For example, many vegetables lose vitamin C when cooked in water. In case of meat, some studies have reported the release of certain carcinogenic chemicals by cooking of meat<sup>7</sup>. However, most contaminants and undesirable compounds as a result of cooking can be reduced by modifying cooking temperature or by the inclusion of certain additives. On the contrary, not cooking can also lead to health risks, for example, due to microbial contamination.

Nevertheless, as the level of food processing increases, more nutrients are added to food consequently increasing the energy-density of the food. For example, by the addition of oil and sugar to the food.

5 In order to increase the shelf life of a food, it is important that the water content is reduced. By reducing the water content, the growth of vegetative microbial cells, germination of spores, and toxin production by molds and bacteria can be avoided leading to an increased lag phase of the micro-organisms and decreased growth rate.

6 Flash freezing refers to the process whereby foods are frozen in just a few hours. In this case, food items are subjected to temperatures well below water's freezing point.

7 Consequences of cooking our food, European food information council.

**Figure 7: Increase in saturated fat content and energy density, with increasing food processing level**

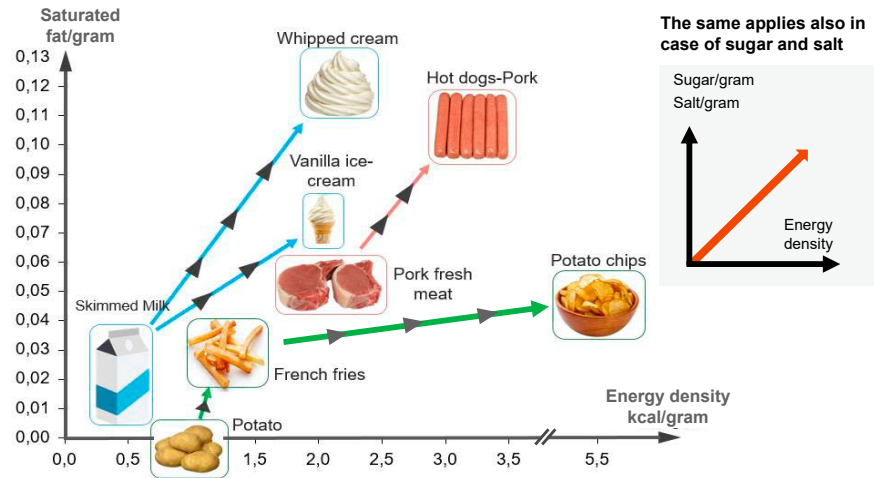


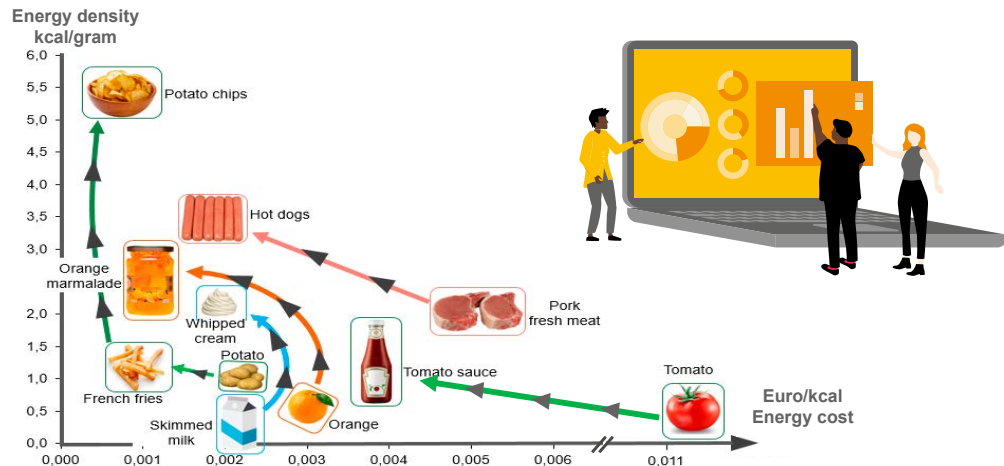
Figure 7 shows that, for selected food products, as the level of processing increases, energy density, fats<sup>8</sup>, saturated fats, salt and sugar content also increase. If we take the example of a potato, a minimally processed potato has a shorter shelf life and more water content. By making potato chips out of it, salt and oils is added (in the least) and water content declines. Also, with the addition of oil, the energy content of the final product increases. Moreover, the processed version of the potato i.e. the potato chips now have a longer shelf life, a better taste and texture and is convenient to consume.

With the increased shelf life, it is now possible to produce them in greater quantities and achieve economies of

scale. The processing of potatoes has not only increased the quantity of energy, fats and salt but has also made the end-product cheaper (Figure 8).

Food processing is not an indicator of unhealthiness. The problem lies in how processed food is understood and perceived. We tend to perceive a potato the same way as potato chips, meat the same way as a hot dog, banana the same way as banana chips, without knowing enough about their nutritional content and ingredients. This is one of the main reasons why processed food is often characterized as unhealthy. Enough care must be taken to distinguish between processed food and junk food.

**Figure 8: As the level of processing increases, energy density in food increase and energy costs decrease.**



<sup>8</sup> All types of fats. Saturated fats is explicitly mentioned in this sentence because its consumption is exceeding the maximum limit, in the Netherlands (see next chapter)



## Processed food maybe addictive as well

Palatable (tasty) foods activate brain reward circuitry in a similar fashion to many addictive drugs, and soaring obesity rates may be correlated to the increased availability and exposure to highly reinforcing comfort foods. Brain-imaging studies show that reductions in dopamine D2 receptors in obese individuals are similar in magnitude to those of drug addicts and might play a modulating role in conferring a particular vulnerability to compulsive eating behaviours. These findings support the belief that people often want to lose weight and be healthier but find it exceedingly difficult to do so.

## And what about 'Organic food'?

There is a common notion that organic foods are healthier. However, from a nutritional point of view, there is no difference in nutritional content between organic and inorganic foods. In some organic foods, an increased phosphorus and nitrogen content was seen, but there is no deficiency for these nutrients among the Dutch/EU population [8].

From a safety perspective, evidence indicates that conventional foods are more likely than organic foods to contain (single and multiple) synthetic pesticide residues [9 to 15]. Some studies have reported that pesticide residues were less likely to be detected on organic (7%) rather than conventional (38%) produce; however, the limit of detection<sup>9</sup> varied between studies. These findings do not mean that organic and conventional foods necessarily contain pesticide residues at concentrations that are a safety concern [8].

In some cases, due to complicated supply chains, safety is also at risk during the transportation and storage of foods. There is a risk of contamination due to improper production practices, temperature abuse, unsanitary cargo areas, improper loading or unloading procedures, damaged packaging, shipping containers in ill repair, bad employee habits, and road conditions. However, the safety regulation in the EU is stringent for both organic and inorganic foods [8]. The issue of organic versus inorganic food is therefore more relevant from a sustainability and animal welfare perspective.



<sup>9</sup> The lowest quantity of pesticide which could be detected by the laboratory method



# Practice what you preach

The Dutch do not follow the dietary guidelines.

The latest available data on food consumption pattern of the Dutch population was recorded between the years 2012 to 2016<sup>10</sup> during the national food consumption survey conducted by the Netherlands National Institute for Public Health and Environment (RIVM).

When we look at the actual consumption and compare it with the nutritional requirement, we notice that the fats consumption (along with saturated fat) is high, and fibre and alpha-linolenic fatty acid consumption is low.

For micronutrients, the consumption of salt (sodium) is high in all age groups and the consumption of vitamin D is below the minimum limit in seniors. Along with these, higher and lower intakes for several micronutrients is seen in different age groups. However, more scientific knowledge is required in order to conclude an adverse health effect due to their malnutrition<sup>11</sup>.

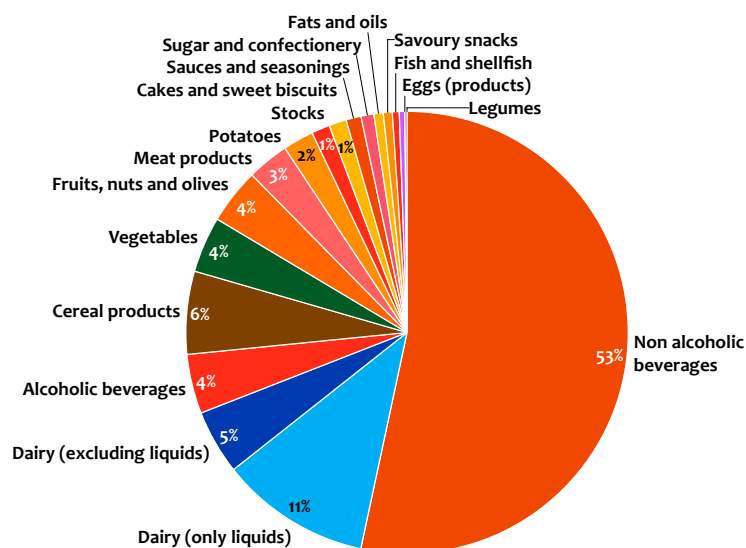
On average, we consume about 3.1 kgs of drinks and foods per day leading to 2192 calories per day<sup>12</sup>.

About two thirds are beverages: 'Alcoholic' and 'Non-alcoholic beverages', such as water, tea and coffee, juice and soda, or dairy beverages. Other food groups with a high contribution to our food intake (grams) are 'cereal (products)', 'vegetables', 'fruit, nuts and olives', 'meat (products)' and 'potatoes'.

## Where do we get our energy from?

Together, they constitute about fifty percent of the energy intake. These food groups are also rich in macronutrients and hence their greater share in energy intake is reasonable<sup>13</sup>.

Figure 9: SEQ Figure \\* ARABIC 10: Contribution of different food groups to an average Dutch diet.



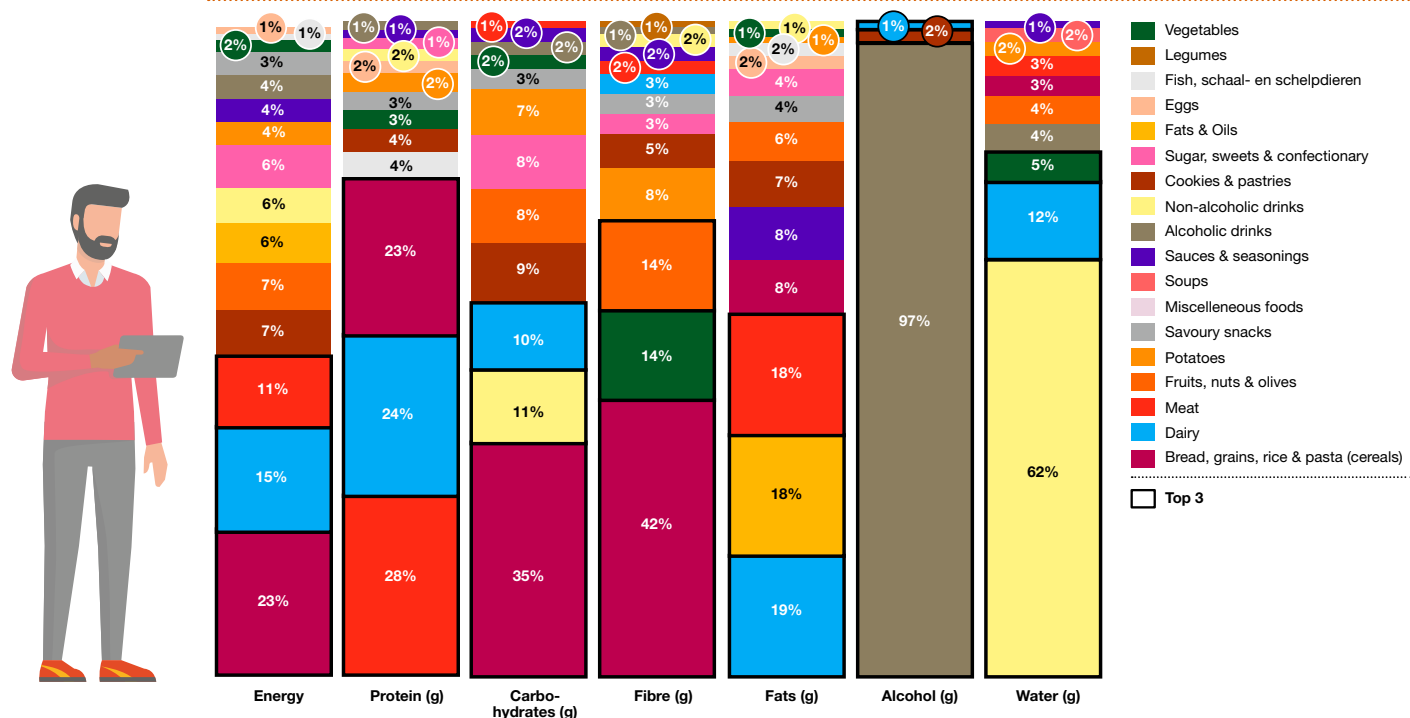
10 Currently, a fresh survey is going on and its results are expected by 2021

11 Further information on macro- and micronutrient consumption level can be obtained from the original website of the food consumption survey. Link: <https://www.waarnednederland.nl/>

12 Averaged for all age groups

13 Macronutrients provide energy

Figure 10: Contribution of different food groups to energy, macronutrients, alcohol and water.



## Where do we get our macronutrients from?

We get most of our carbohydrates from cereals (35%), non-alcoholic drinks (11%) and dairy (10%) (see Figure 10). Non-alcoholic drinks and dairy mostly contribute to the carbohydrates' intake via the sugars (monosaccharides and disaccharides) they contain. Most non-alcoholic beverages such as juices, cold drinks and milk contain free sugars<sup>14</sup>.

The main food groups contributing to our protein's consumption are meat (28%), dairy (24%) and cereal products (23%) (see Figure 10). Animal-based sources have a greater share than plant-based sources.

The overall fats consumption in Netherlands is more than the maximum limit. More importantly, within fats, saturated fats is consumed more than required. Alpha-linolenic acid, which is an essential fatty acid, is consumed less than required. According to an advisory report published by the health council in 2001, excessive consumption of saturated fat is unhealthy and is associated with an increased risk of coronary heart diseases [6]. Most of the saturated fat is coming from meat and dairy products for the Dutch population.

The main food groups contributing to the consumption of fibre are cereals, vegetables and fruits. Fruits and vegetables are a rich source of fibre and in the Netherlands, on average about 131 grams of vegetables and 130 grams of fruits (this food group also includes nuts and olives) are consumed per day. This is below the dietary guideline, which recommends a minimum of 200 grams of fruits and vegetables each.

## But there is hope! Over time, the Dutch food consumption has improved

Looking at our consumption pattern from previous surveys, we have moved towards consuming trans-fats from more than the maximum limit to well within the range. Also, the consumption of alcoholic beverages, fats and oils, sugar and sweets and meat for nine to 69-year-olds has decreased.

**According to a survey, four in ten Dutch people hope that they will eat healthier in the future[16].** By being conscious about our health and total energy requirement and by increasing diversity in our diet especially by consuming more vegetables, fruits and less fats we can be healthier.

<sup>14</sup> The term free sugar includes both the naturally occurring sugars and the sugars added during processing





# Choose wisely

Our food choices are influenced by taste and price rather than health

When we feel hungry or have a 'food craving', different factors such as price, nutritional content, taste, convenience, sustainability and animal welfare influence our food choice. Sometimes, we want to have a quick bite and sometimes we want to go out and enjoy the food at our favorite restaurants. Sometimes, we avoid foods which seem unhealthy to us and sometimes we prefer a cheaper food product over another. In short, there are various biological, economic, physical, social, and psychological 'determinants of food choice' or 'food choice motives'.

**Table 1: Different food choice motives and their examples.**  
[17]

Food choice motive	Examples
Economic	Cost, income, availability
Biological	Hunger, appetite, taste,
Physical	Access, education, skills and time
Social	Culture, family, peers and meal patterns
Psychological	Stress, mood, guilt

According to a study [18] conducted on food choice motives, the top determinants of food choice for the Dutch population in order of importance, were taste, health, and price. The study also captures the importance a certain factor has depending on the situation. For example, 'convenience' was a more important factor in out-of-home contexts (work/school and on the move) than it was at home, whereas 'taste' was more important at home than in out-of-home contexts.

Furthermore, weight<sup>15</sup>, healthiness and naturalness were less important for snack consumption than for main meal consumption. Reflecting on this survey, there is a possibility that our diets in general can be healthier, but excess calories and unhealthy components might sneak in during the indulging or snack moments.

Our main meals might be healthier, but excess calories and unhealthy components might sneak in during the indulging or snack moments.



## Yes, healthier diets are on average costlier than unhealthy ones

As mentioned previously, food processing considerably increases the energy density and quantity of saturated fats, salt and sugar within a food product, while reducing the overall cost per kcal of that product. Therefore, it is cheaper and rewarding<sup>16</sup> to fulfil the energy requirement by consuming such foods. If one relies on convenience foods and processed food all the time, they are more likely to end up consuming excess calories, improper nutritional requirements and an unhealthy diet.

A meta-analysis of 27 existing studies from 10 high-income countries conducted by Harvard school of public health<sup>17</sup> concludes that on average, healthier diets are € 1,35 costlier than unhealthy diets[19].

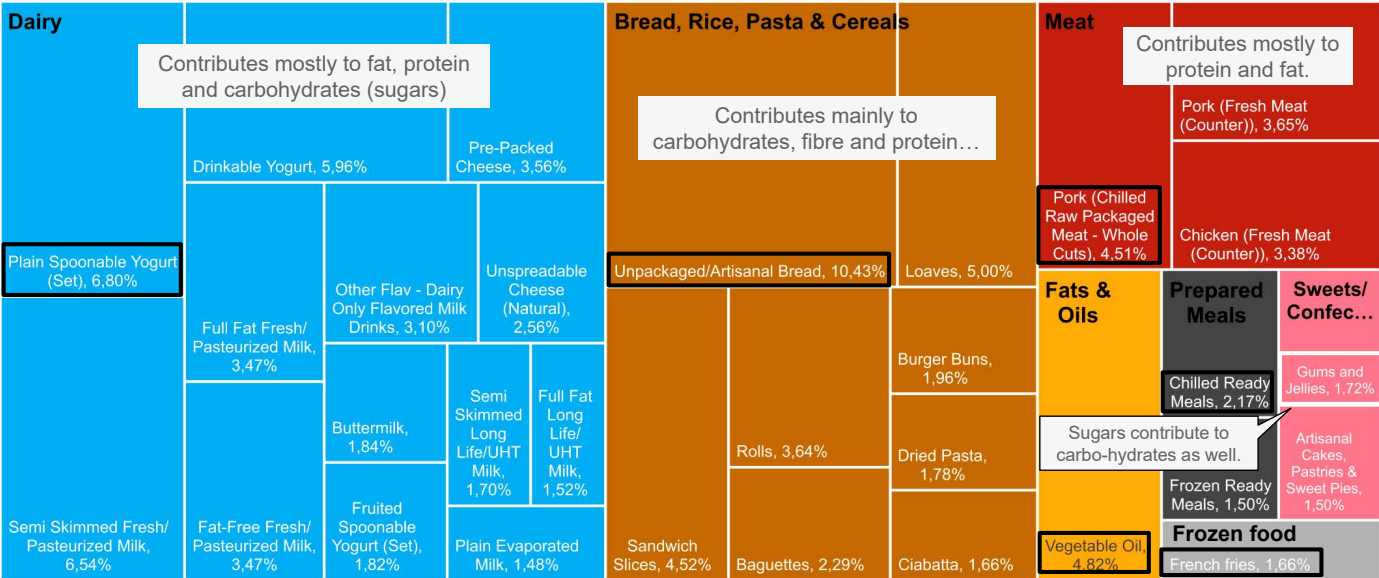
15 Indicates body weight here. The question associated with this in the survey was 'It is important to me that the food I eat on a typical day, help me control my weight'.

16 Rewarding here means more tasty and a high sensory appeal.

17 Do healthier foods and diet patterns cost more than less healthy options? A systematic review and meta-analysis.

Figure 11: Retail volume figures for the year 2019. Note: This does not include fruits and vegetables

Top products from each category are outlined



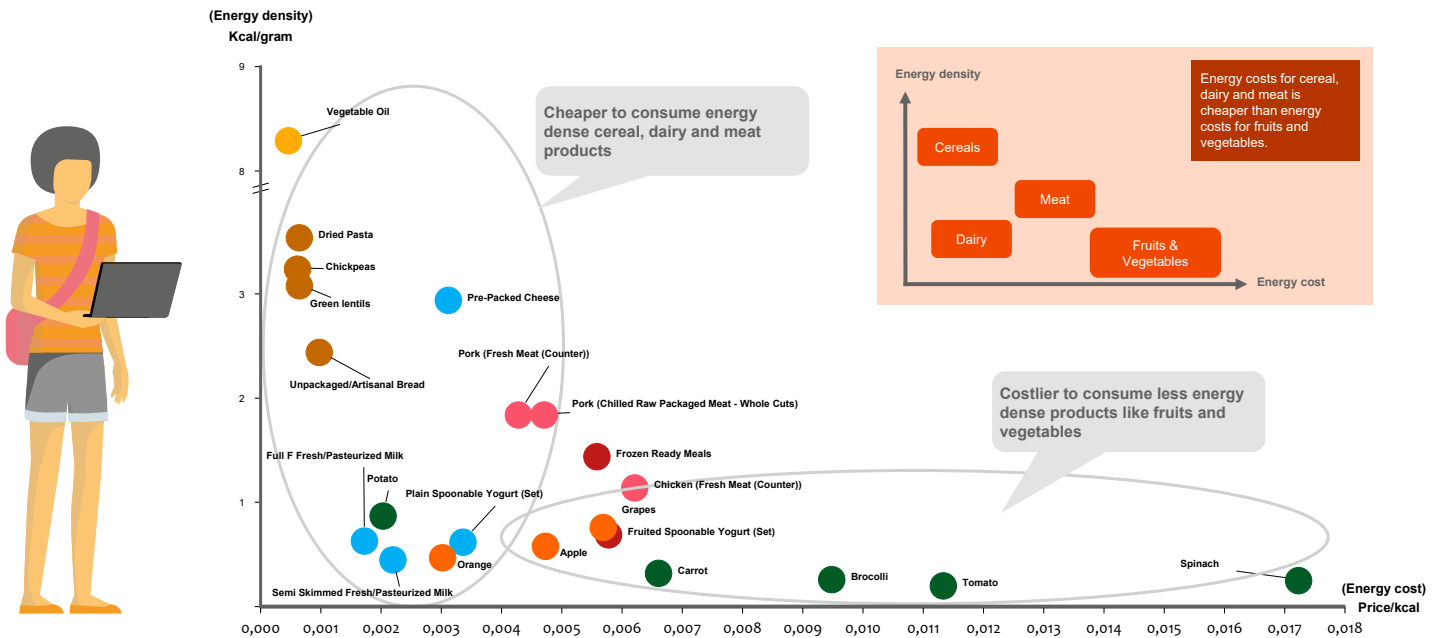
When we look into the retail volume figures (Figure 11) and compare the top products being consumed by the Dutch population along the axes of energy density and energy cost, we see that calories from foods low in fat content and high in fibre content are costlier.

From Figure 12 (see page 16), we can see that energy costs of fruits and vegetables are higher compared to energy dense foods such as cereal products, meat and dairy hence including more vegetables and fruits in our diets can be costlier. However, overall diet costs might reduce when replacing the costlier components of a diet with cheaper and nutritious options such as legumes. Food technology to create nutritious, sustainable and cheap alternatives is emerging nowadays.

In case of a vegetarian diet, the costs can increase due to the quantity of food required to fulfil the same energy requirement. If protein sources are plant-based, then more quantity might be required as the bioavailability<sup>18</sup> of plant-based proteins is lower than that of animal-based proteins [20]. The point here is not to show that a certain protein source is more nutritious than another, but to look at protein requirement from the context of price per gram of protein. Moreover, as we already know, this depends on an individual's nutrient and energy requirement. But, in most cases, it can be expected that a completely vegetarian diet will be more expensive due to the quantity requirement to fulfill the same need.



Figure 12: SEQ Figure \\* ARABIC 13:Energy cost (Euro/kcal) of dairy, meat, bread and pasta is lower compared to vegetables and fruits, while their energy density (kcal/gram) is higher. This implies that it is cheaper to consume energy through these food products.



18 Fraction of a nutrient absorbed.

## But, being mindful and planning our diets can help making healthy eating cheaper

According to a research conducted by Wageningen University [21], average diet costs of the unhealthiest group of people who had 26% adherence to the Dietary guidelines (Schijf van Vijf) was € 11,30, whereas the average diet costs of the healthiest group who had a 60% adherence to these dietary guidelines was € 9,15. This research was based on the premise that a consumer is optimizing his/her diet based on every euro/kcal spent. The National Institute for Family Finance Information (NIBUD) specifies different diets costs per day for different age groups, the highest being € 6,75 for a male between fourteen and fifty age and € 6,96 for a lactating female. These estimates are for food cooked at home and the costs reduce further with the increase in the household size [22] (see appendix F).

Looking at the different analyses, it seems that by being mindful and planning diets, it is possible to fulfil an individual's nutritional and energy requirement for the same or even slightly lower price. Therefore, by creating nutritional awareness, having a better diet plan, enhancing our food cooking skills and gardening one's own food, we can maintain a healthy and cheap diet, avoiding the long-term healthcare related costs from unhealthy eating (to be covered in the next section in detail).



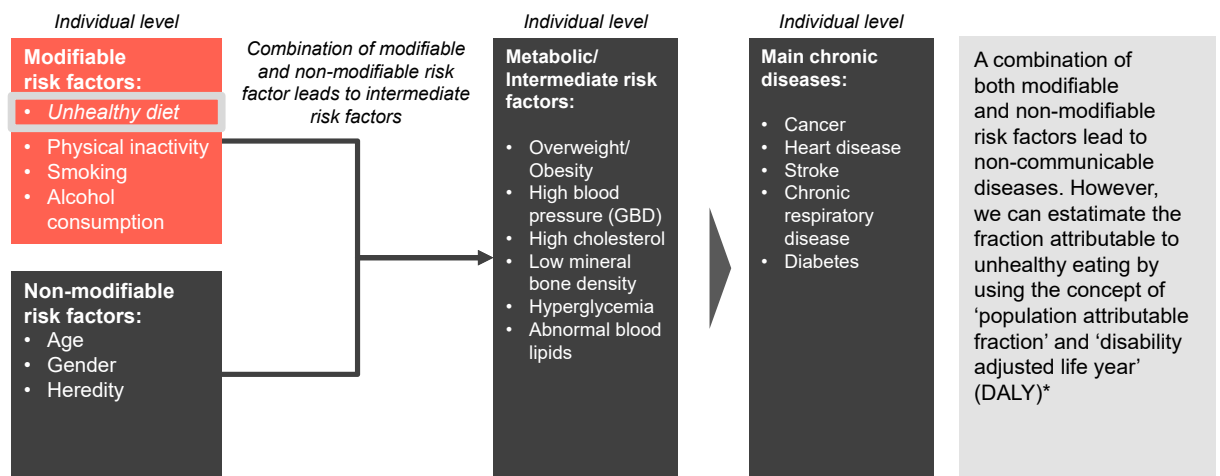
# Health is Wealth

## Unhealthy eating as a risk factor

### Unhealthy eating as a risk factor

Unhealthy eating has an impact on our health and is a behavioral risk factor, along with smoking, alcohol and physical inactivity, for non-communicable diseases (NCDs) such as strokes, heart diseases, cancer, and diabetes.

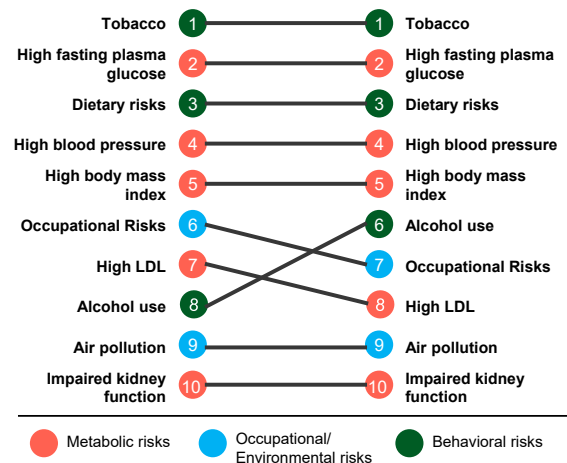
**Figure 13: A combination of both modifiable and non-modifiable risk factors lead to non-communicable diseases (NCDs).**



\* DALY is a measure of years lost due to ill health and early death.  
DALY = Years of life lost due to early death + years lived with disability

Behavioral risk factors are 'modifiable risk factors' because we can change them unlike the 'non-modifiable risk factors' such as age, gender and heredity. A modifiable risk factor or a non-modifiable risk factor or a combination of both can cause NCDs (see figure 14). A higher value of any risk factor indicates a higher likelihood of contracting that disease because of that particular risk factor. 'Dietary risks' due to unhealthy eating ranks third among the top 10 factors contributing to death and disability in the Netherlands [23].

**Figure 14: From 2007 to 2017, dietary risks stand at third position among the top 10 factors contributing to death and disability in The Netherlands.**



Disease burden and economic burden arising from the risk factors

Disease burden is the impact of a risk factor, diseases or injuries, on health. It is usually measured in terms of mortality or morbidity. The most common indicators used to measure the disease burden are Disability Adjusted Life Years (DALY) and Quality Adjusted Life Years (QALY). DALY takes into account the sum of 'years of life lost' (YLL) and 'years lived with disability' to estimate the disease burden of a certain disease for a population group. YLL is a measure of the number of years that people die prematurely due to a specific cause of death (in our case - unhealthy diet), and the YLD is a measure for the occurrence of diseases, taking into account their severity (disability weight). Both the YLL and the YLD are distinguished by sex, age and disease or cause of death (i.e., unhealthy diet). In the Netherlands, a total of 3.59.534 DALYs are lost due to unhealthy eating [24]. Quality adjusted life years (QALY) is the opposite of DALY in terms of what it indicates. QALY is a measure of years in perfect health gained i.e., years lived in perfect health in contrast to DALY which indicates years in perfect health lost.

To measure the economic burden of diseases, the cost of illness approach is most commonly used by researchers. The cost of illness approach isolates the costs related to specific diseases, and then uses the Population Attributable Fraction (PAF) to indicate the health impact from a specific determinant/risk factor (e.g., unhealthy diet). It is important to know that it is not possible to completely exclude or isolate a risk factor because a health condition might also result from non-modifiable risk factors or from the accrued damage from the past which can no longer be removed. However, these calculations do provide a good indication of the influence of a risk factor on a given outcome.

Two other approaches exist to capture the economic burden of diseases - (1) Value of lost output: Economic growth approach, and (2) Value of statistical life approach. Table below shows the definition and health impacts captured under each approach.

Table 2: Approaches to calculate the economic burden of non-communicable diseases<sup>19</sup>

Approach to measure economic burden of diseases	Description
Cost of illness	Commonly used method that sets out to capture the economic impact of disease. It views the cost of NCDs as the sum of several categories of direct and indirect costs. The categories typically considered in this approach are: personal medical care costs for diagnosis, procedures, drugs and inpatient and outpatient care; non-medical costs, such as the costs of transportation for treatment and care; nonpersonal costs like those associated with information, education, communication and research; and income losses.
Value of lost output: Economic growth approach	This method estimates the projected impact of NCDs on aggregate economic output (GDP) by considering how these diseases deplete labour, capital and other factors to production levels in a country. The WHO's EPIC model simulates the macroeconomic consequences of NCDs by linking disease to economic growth. It does this by modeling the two main factors of production, labour and capital, as depending negatively on NCDs.
Value of statistical life	This method reflects a population's willingness to pay to reduce the risk of disability or death associated with NCDs. By placing an economic value on the loss of health itself, this approach goes beyond the impact of NCDs on GDP alone.

19 Harvard public health: Global economic burden of non-communicable diseases source.

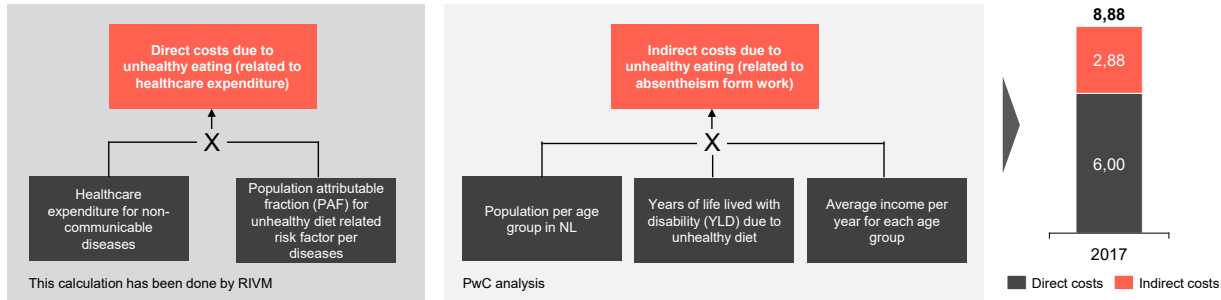


## The total (societal) cost of unhealthy eating is € 8,88 billion for the Netherlands

Since we intend to capture the economic burden of eating unhealthy, in terms of the direct healthcare costs and indirect costs related to absenteeism from work during the sickness period, we choose the cost of illness approach to calculate the total costs. Moreover, this

aligns with the approach of RIVM (National Institute for Public Health and the Environment, The Netherlands).<sup>20</sup> Using the cost of illness approach, depicted graphically below (see figure 16), we estimate the total costs attributable to dietary risks (sum of both direct and indirect costs associated with unhealthy eating) to be € 8,88 billion for the year 2017.

Figure 15: For the year 2017, direct and indirect costs together amount to € 8,88 billion

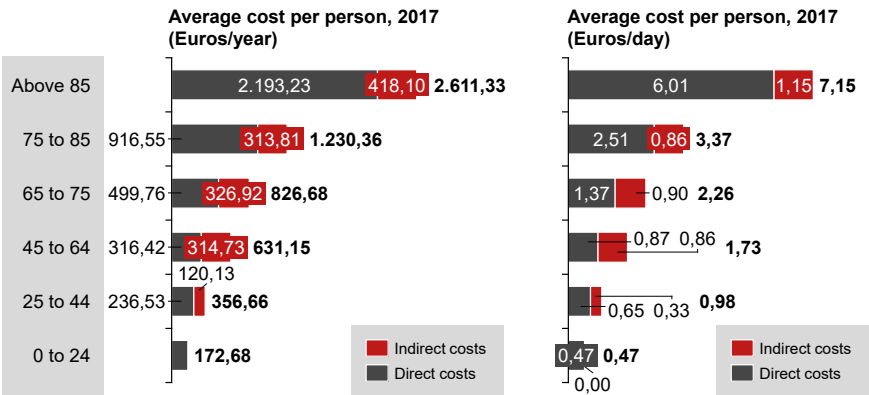


### Direct costs

Direct costs refer to all visible costs associated with diagnosis, treatment, and care. The ‘Volksgezondheid Toekomst Verkenning’, a report<sup>21</sup> published by the Ministry of Health, Welfare and Sports in 2018, estimates the direct costs attributable to dietary risk in the Netherlands to be six billion euro.

These calculations were made using the morbidity population attributable fraction (PAF)<sup>22</sup>, categorised according to age, sex and disease, combined with health care expenditures in relation to age, sex and condition.

Figure 16: Direct and indirect costs associated with unhealthy eating for different age groups



20 RIVM VTV Methodology for Trend Scenario for Dutch Public Health Foresight Report (VTV) 2018.

21 Dutch Public Health Foresight Report (VTV) 2018.

22 Many risk factors can be responsible for mortality or morbidity. PAF gives the fraction that can be attributed to a certain risk factor (see appendix G for more details).

### Indirect costs

The indirect costs are the costs associated with loss of productivity due to absenteeism. Based on our calculations, these amount to € 2,88 billion. These costs are calculated by taking into account morbidity and the average income per age group (see appendix G). The total costs of unhealthy eating vary per age group since the disease incidence and average income also vary per age group. As the age increases, the costs of unhealthy eating also increase. A possible explanation for this could be that age is a non-modifiable risk factor for diseases like cancer and heart failures (non-communicable diseases). It is also proven that saturated fat consumption increases with age [26], which would add to the unhealthy eating risk factor.

Moreover, it is interesting to note that approximately 50 percent of the Dutch population is above the age of 43 years. As shown in Figure 16, the average cost of unhealthy eating for this part of the population (i.e., average cost for all the people above the age of 45 yrs) is € 3,63 per day. This means that on average a Dutch person above the age of 45 years costs € 1325 per year due to his/her unhealthy eating habits. Intangible costs such as costs associated with pain and suffering are excluded in our cost estimation.

The costs of unhealthy eating arising from individuals' poor nutritional choices are borne by society as a whole through taxes, lost productivity, and an overburdened health care system. If we take into account long-term effects (and the societal costs of unhealthy eating) into our decision making, we would have a completely different world and a well-functioning food market. However, we now see that there is a negative externality within the food market, and this means that there is a market failure, based on economic theory.





# Every failure is a lesson

There is a market failure in the food market

According to economic theory, market failure is a situation where the allocation of goods and services by a free market is not efficient, often leading to a net social welfare loss. In other words, a market failure occurs when the pricing mechanism fails to account for all of the costs and benefits necessary to provide and consume a good. There are multiple reasons that can cause market failure. They are negative externalities, information failure, inequality, merit goods, missing and incomplete markets and market power.



In case of the food market we see different reasons that cause market failures:

**Negative externalities:** The negative externalities arise from the fact that individuals are not accounting for the societal costs resulting from their unhealthy eating habits. Information asymmetry: Individuals do not have complete knowledge of healthy food and unhealthy food. Besides, there is deliberate misinformation in the form of marketing of unhealthy food.

**Inequality:** The risks of unhealthy dietary patterns are not equally spread throughout the society. People with lower socioeconomic status are more likely to get affected by unhealthy eating.

**Market power concentration:** There is market power concentration at different parts of the 'farm to fork' value chain<sup>23</sup>, with few companies dominating at some steps. This suppresses competition and hence innovation. So, yes, based on more than one reason, there is a market failure within the food market.

For this research the negative externalities and the information asymmetry are relevant. We do not delve into detail with regards to the other two market failures (inequality and market power concentration) since these are related to fundamental structuring of the food market, and not specifically to the "healthy food" portion of the value chain.

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23 Futures of food provision, Agrifood publication by PwC

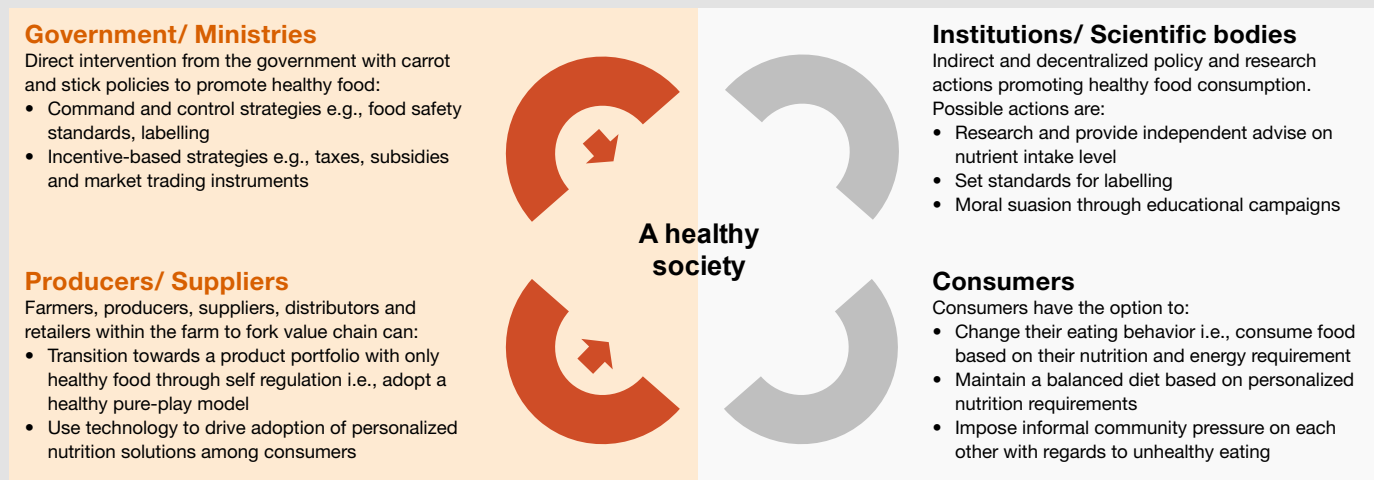
## How to overcome the ‘healthy food’ related market failures ?

In chapters 1 and 2 of this report, we have highlighted the importance of understanding this nutritional content and also showed how nutritional requirements differ for each individual. In chapter 4, we also calculated and showed the total societal costs resulting from the negative externalities in the food market due to unhealthy eating.

To overcome the information asymmetry problem, consumers should be provided with information related to the nutritional content of food products. To overcome the negative externalities, the societal costs resulting from unhealthy food patterns should be internalised. We are convinced each stakeholder has a role to play based on their mandate or available purview of actions.

## Who will move first?

Figure 17: Stakeholders and their strategies to drive the transition towards a healthy future.



**The Dutch Ministry of Health, Welfare and Sport** can implement several ‘carrot’ and/or ‘stick’ policies – both economic and non-economic – to internalize the negative externalities within the food market or to incentivize healthy food demand.

**The producers and suppliers of food** on the other hand can already transition their portfolios towards production and distribution of healthier food products. They can also use technology to drive adoption of personalized nutrition solutions among consumers. In this way, they engage in nudging consumers towards a healthier diet.

**Institutions and scientific research bodies** like the Voedingscentrum and Health Council of The Netherlands can support the government with the setting of standards for both front of pack and back of pack labelling. They can also engage in moral suasion through educational campaigns in schools, workplaces and other avenues of public engagement. At the moment, they provide food based dietary guidelines that advise on nutrient intake levels. These guidelines must stay up-to-date and compliant with the European Food Safety Authority (EFSA) guidelines.

**Consumers** can cause demand-side shifts by changing their consumption behavior. This can be a result of the nudging mechanisms used by the government or food retailers. Or, this can be a result of the informal community pressure that is building up around consumption of unhealthy food. They can also be driven to consume healthy by technological innovation such as mobile applications that provide personalized nutritional advice by linking with the wearable technologies that are also used by the consumer to monitor his/her health.

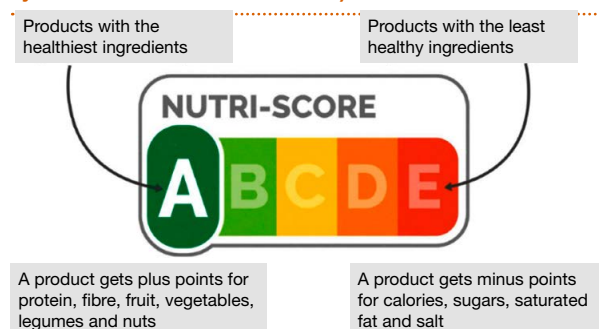
In this context, the question is – who will move first? Will policy makers drive a healthy world through regulatory changes? Or, will the industry (supply side) drive this change? In both cases, we expect demand pull to be strong in the coming years, putting immense pressure on suppliers to respond. Institutions will continue to play a supporting role through information provisioning and moral suasion.



## The government moves first

If the government moves first, there are several strategies (both command & control based and incentive-based) that can be deployed. A command-and-control (CAC) approach to public policy is one where, in order to bring about socially desirable, political authorities simply mandate the behavior in law. In the context of healthy food provisioning, this could mean relying on nutritional and labelling standards that bring about improvements in the ratio of nutritional density to energy density in food.

**Figure 18: Front-of-pack labelling examples (UK traffic light system and Nutri-score in France)**



### Labelling standards

EU, US, UK and several other countries have regulations on the provision of food information to consumers on the back of the pack (covering a list of the nutrient content) for most pre-packaged food. However, front-of-pack labelling systems (like the UK traffic light system and Nutri-score in France, see Figure 18) should also be considered because they generally provide information regarding nutrients that contribute to diet related risk factors. For example, the UK traffic light system highlights the amount of energy, carbohydrates, saturated fatty acids, sugars and salt within a food product. It also shows what the proportion of each nutrient is with respect to their allowed/recommended values.

### Incentives for the Industry

Compliance costs to meet these standards will make (healthy) diets more expensive. Hence, the government will also have to provide economic incentives for companies to move towards production of healthier/nutritionally dense food. This can be done using taxes, subsidies and market trading instruments (e.g., with carbon emissions, we have the Emissions Trading Scheme (ETS) at an EU level). Table 4 provides an overview of the types of taxes that can be implemented, along with their advantages and disadvantages.

### Taxes are logical, but challenging

A tax on specific nutrients e.g., fats tax seems logical because of its targeted nature. However, taxing nutrients or ingredients is highly challenging: not all fats are unhealthy, and taxing foods according to fat content would lead to items such as (healthy) nuts incurring very high taxes. This is problematic not only for consumers but also for specialty food retailers (e.g., cheese vendors) whose limited variety of products would be disproportionately taxed as was the case in Denmark. Therefore, some countries e.g., Hungary have implemented a tax on food items/groups. The challenge with such a tax is that the classification of any food item as 'taxable/ unhealthy' is almost always contestable. Hence, policy makers face the task of identifying which incentive-based taxation instrument works best in The Netherlands.

### Cross border coordination

In this scenario, where the government moves first with incentive-based strategies, companies can suffer from the fact that their investments (planned based on the previous regulatory regime) become less profitable. For firms that are active in international markets, their products originating from The Netherlands can become more expensive, while competitors benefit from lower production costs in other countries. Hence, an uneven playing field will be created internationally.

To create a level playing field for international companies operating in The Netherlands, the government will face the challenge of promoting cross-border cooperation to encourage similar measures in other countries. If that does not work, policy makers may consider providing exemptions or rebates for companies active in international markets. However, such moves can be perceived as state aid by the European Commission. A viable alternative would then be to introduce a border correction mechanism with European markets. The feasibility of such a border correction mechanism needs to be assessed depending on the market size and substitutability of food products produced in The Netherlands and exported to European markets.



## The industry moves first

### Self regulation

The industry has several possibilities to help the Dutch society in moving towards a healthier state. Firms do not need to wait for a regulatory push, either via standards or incentive-based measures. For example, in the past (between 2003 – ‘10), the Margarine, Carbohydrates and Oils (in Dutch: MVO) Product Board initiated the Responsible Fatty Acid Composition Taskforce that realized a reduction in trans fatty acid content within Dutch food. According to MVO, this form of self-regulation resulted in a reduction of trans fatty acids from a half to one percent of total energy intake, leading to companies having a healthier food product range. Demand side shifts towards healthy consumption and research/marketing activities led by institutes such as the Voedingscentrum and the Health Council could cause similar movement and further self-regulation within the industry in the upcoming decade.

### Personalized products

Technological developments from other industries (e.g., Internet of Things, wearable devices etc.) are creating opportunities for food companies to provide more personalized/customized products, solutions and/or services to consumers. For example, companies like Nourished and Pure Genomics (along with 23&Me) are providing personalized nutrition services to consumers (mainly via healthcare providers at the moment). Sales executives of traditional animal feed companies are being supported in the back-end by their technical advisors and nutrition experts, when they go to have conversations with farmers. In this way, they can provide customized feed formulas that take into account the life stage, health condition and growth of the animal.

Hence, it is not difficult to imagine a future where the industry takes first steps towards creating a healthier future. In such a future, market parties have to be able to compete with ‘traditional’ food producers. To achieve this, technological innovation is needed to drive down production costs. The government will have to catch up in this scenario to provide incentives to food companies via subsidies for healthy food related production technologies.

### Providing insights

Firms can also nudge society towards consumption of healthy food by leveraging data to generate health related insights on the end-consumer side and nutritional content or food safety related insights on the production side. Retailers like Albert Heijn are already using their personal labels to indicate the amount of sugar within each product (on their shelves in the supermarket). To successfully generate data-driven insights that can be used for nudging, the industry should adhere to strict guidelines and governance principles with regards to data ownership and usage.

We advise companies to anticipate the upcoming movement or migration towards a more healthy future, either driven by governments, or by consumers, or by competition from the private sector. One thing is certain – the movement will happen. Perhaps indirectly, via a greater concern for sustainability while health clings on. In the meantime, we appeal to governments to take up their role as guardians of health as a public good having crucial external effects: good for a healthy workforce that can drive productivity and earnings in the Dutch economy; healthy, happy and participating citizens; and finally, reduced healthcare costs. An altogether affordable price to pay for the prize of healthy food.



# Meet the healthy team



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# Appendix



## A. Calculation of energy intake for figure 4 Consuming the minimum of energy providing macronutrients:

$$(0,4 \times 2400) + (0,2 \times 2400) + (0,08 \times 2400) = 1680$$

Consuming the maximum of energy providing macronutrients:  $(0,7 \times 2400) + (0,4 \times 2400) + (0,35 \times 2400) = 3240$ .

## B. Table for nutrients, sub categories and their Recommended Dietary Allowances

Based on the nutrient intake and risk of an adverse supply level, values are proposed as average requirement, adequate intake, recommended dietary intake and tolerable upper limit. For all the nutrients and their sub categories, these values are formulated. (see table) + (can also add more information about this in the appendix) (can also include here the DRV graph)

## C. Methods to calculate the Burden of disease

### Disability adjusted life years (DALY)

DALY is a measure of years in perfect health lost i.e., it is the cumulative number of years lost due to ill health, disability or early death. One disability adjusted life year is equal to the sum of 'years of life lost' and 'years lived with disability'.



By doing so, DALY takes into account both mortality and morbidity.

### Years of life lost (YLL)

YLL is the years of life lost due to early death and can be calculated at an individual level or macro level.

$YLL = N \times L$  ( $N$ =number of deaths;  $L$ =Life expectancy at the time of death)

### Years lives with disability (YLD)

YLD is the years lived with disability. It is calculated as duration of a disease multiplied by its disability weightage. Different diseases can be allotted different weightages on a scale, where 1 indicates the severity of the disability and 0 indicates perfect health. For example,

blindness has a higher disability weight than amputation of finger.

$YLD = I \times L \times DW$  ( $I$ =incidents;  $L$ =Duration of the disease;  $DW$ =Disability weightage)

### DALY example

Suppose a woman expected to live for 80 years, dies at 50, then she would suffer 30 YLL. Say this woman turns blind at the age of 40, then she lives 10 years of life with a disability. If the weightage of this disability is 0,4, then the years lived with disability would be  $10 \times 0,4 = 4$  years. Therefore, the DALY would be the sum of YLL and YLD =  $30 + 4 = 34$  years. Say, a man and a woman both suffer from the same condition, then the total DALY would be  $34 \times 2$  i.e., 68 years.

YLD can also be calculated using the prevalence approach.  $YLD = P \times DW$ , where 'P' is the prevalence and 'DW' is the disability weight.

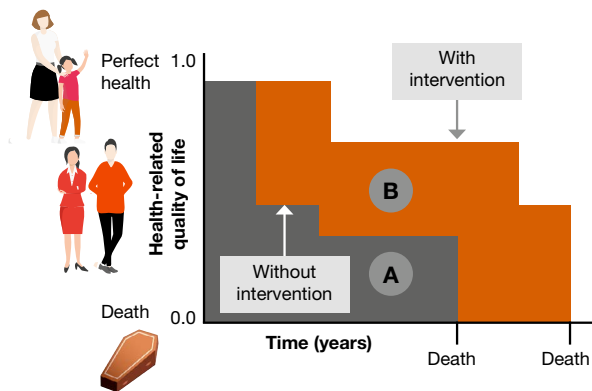
The difference between incidence and prevalence is that incidence refers to the occurrence of new cases in a specific health-related state during a time period, whereas prevalence measures the proportion of subjects who are in the state at a point in time.

DALY is commonly used in the field of 'public health' and 'health impact assessment' in different countries to measure population health. The difference between incidence and prevalence is that incidence refers to the occurrence of new cases in a specific health-related state during a time period, whereas prevalence measures the proportion of subjects who are in the state at a point in time.

### Quality adjusted life years (QALY)

Quality adjusted life years is opposite to Disability adjusted life years in terms of what it indicates. QALY is a measure of years in perfect health gained i.e., years lived in perfect health in contrast to DALY which indicates years in perfect health lost.

QALY is calculated as the product of 'length of life' and 'quality of life'. The 'quality of life' or in other words the 'utility of the person' with a disease is usually calculated on a scale between 0 to 1, where 1 equates perfect health and 0 equates death. Sometimes, if the pain/morbidity is severe, then negative values are also used to measure quality of life. For example, 1 year of life lived in perfect health is 1 QALY or half year lived in perfect health is equal to  $0,5 \times 1 = 0,5$  years. Likewise, 1 year lived with a utility value of 0,6 (for example, bed ridden), then  $QALY = 1 \times 0,6$  year. QALY is usually used in economic evaluation to access the value of medical interventions.



Besides DALY and QALY, there are other economic ways to measure burden of disease. The three common ways to measure the economic burden of disease are Cost of illness approach, the value of lost output: the economic growth approach and the value of statistical life approach.

### Cost of illness approach

This approach calculates the economic burden of diseases by taking into account direct costs, indirect costs and intangible costs. The direct costs include the health sector costs such as costs for diagnosis, treatment, procedures, drugs, inpatient and outpatient care. The indirect costs include costs like those associated with information, education, communication and research; and income and productivity losses. The intangible costs comprise of cost of pain and suffering.

### Value of lost output: The economic growth approach

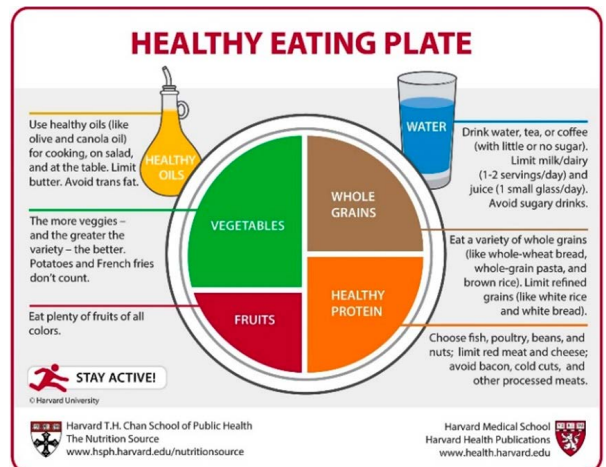
This method estimates the economic burden of disease by linking disease with economic output. It measures this by considering how diseases deplete the factors of production i.e., labor and capital, thus negatively affecting the economic output (GDP) of a country. World Health Organization has developed a model called EPIC to simulate the macroeconomic consequences of NCDs by linking disease to economic growth.

### Value of statistical life approach

This approach estimates the disease burden by placing an economic value on the loss of health or value of life reflected by a populations willingness to pay.

## D. Food based dietary guidelines

The 'food based dietary guidelines' (FBDGs) are the dietary reference values translated in terms of food products in The Netherlands and these are proposed by the health council. Based on these, guidelines, the famous 'Schijf van Vijf' or 'the wheel of five', was developed to educate and provide information in a



simple and understandable way. The 'Schijf van Vijf' also takes into account data from the 'National Dutch food consumption survey', advice from nutritional, health and behavioral experts and the use of computer models. Other countries have their own FBDGs. For example, the Harvard pyramid, or healthy eating plate in the United states, 'voedingsdriehoek' or the food triangle in Belgium, the nutrition circle in Germany etc.



## E. Details about the adverse health impact from malnutrition of macronutrients

In case of proteins, there are certain amino acids which are essential, i.e., our bodies cannot produce these amino acids. We rely on external intake to fulfil our need. A proteins/amino acid deficiency can lead to muscle loss and weakness.

Similarly, for fatty acids, there are certain fatty acids which are essential such as Alphenolenic acid and linoleic acid. In case of fats deficiency, the body may be deprived of these essential fatty acids. Besides, other important processes and functions such as storage of fats-soluble vitamins and maintenance of HDL cholesterol (good cholesterol that cleans up your blood from bad cholesterol) level maybe impaired.

From a Carbohydrates perspective, one of the main functions of digestible carbohydrates is to provide energy to the body by breaking down carbohydrates into glucose. The glucose in the blood is used by cells to create a fuel molecule called Adenosine Triphosphate (ATP). Cells can then use ATP to power several other metabolic tasks.

For digestible carbohydrates (excluding fibre) a deficiency in the short term does not necessarily lead to an adverse health effect since our bodies also have glucose storages<sup>1</sup> in liver and skeletal muscle called glycogen. When our bodies suffer from a carbohydrates deficiency, in the short term the glucose needs can be fulfilled by the help of glycogen storage. Once these reserves start to decrease, the body generates more glucose by a process called 'gluconeogenesis', where our body can create glucose from non-carbohydrates substrates i.e., carbohydrates and proteins<sup>2</sup>.

Further carbohydrates deficiency can lead to ketosis, where the body uses ketones produced out of fats to fulfil the energy needs. The brain can also use ketone as fuel. Presence of excessive ketones in the blood is a condition where the body produces dangerously high levels of ketones and is a complication of type 1 diabetes.

Normally, some people rely on keto diets which are low carb diets to trigger ketosis and burn fats, but this depends on an individual's situation and personal nutritional advise. Usually, a low carbohydrates diet might also cause a fibre deficiency (fibre is also a carbohydrates) which can then lead to problems with digestion and bowel movement.

<sup>1</sup> Under the assumption that sufficient carbohydrates have been consumed previously and stored as Glycogen

<sup>2</sup> Breakdown of proteins of fats

## F. Cost calculations of a diet according to Schijf van Vijf, according to Nibub

	1 person	2 persons	3 persons	4 persons or more
Child 1-3 years	2,78	2,53	2,02	1,77
Child 4-8 years	3,76	3,42	2,74	2,39
Child 9-13 years	6,15	5,59	4,47	3,91
Man 14-50 years	7,42	6,75	5,40	4,73
Woman 14-50 years	6,64	6,04	4,83	4,23
Man 51-69	7,06	6,42	5,14	4,49
Woman 51-69	6,67	6,06	4,85	4,24
Man & woman 70 +	7,02	6,38	5,10	4,47

The more people in the household, the more a meal costs. An advantage is that purchasing and cooking is usually cheaper for more people. The table below shows how much it differs to cook for fewer or more people.

### Expenses depend on your income

What a household spends on food each month also depends on income. The higher the income, the more money is spent on food. Other expenses can also influence the amount that you can spend on food. For example, do you have high housing costs? Then less is left for food or other expenses.

When income rises, a household spends more on expenses than on food. Such as clothing and transportation. Every household makes its own choices in this regard.

### Deviating amounts

The costs may differ because quantities differ. For example, because someone carries out heavy physical work. This is more expensive because that person usually eats more. So there can be "big" and "small" eaters. In addition, the distribution over meals is different for everyone. One breakfast is hearty and almost does not have lunch, the other just the other way around.

## F. Formula for population attributable fraction

For direct costs:

$$\text{PAF} = \frac{\sum_{i=1}^n P_i RR_i - \sum_{i=1}^n P'_i RR_i}{\sum_{i=1}^n P_i RR_i}$$

- $P_i$  = proportion of population at exposure level  $i$ , current exposure;
- $P'_i$  = proportion of population at exposure level  $i$ , counterfactual or ideal level of exposure;
- $RR$  = the relative risk at exposure level  $i$ ;
- $n$  = the number of exposure levels.

For risk factors with continuous rather than discrete exposure levels there is an analogous formula for PAF involving integration of the exposure level distribution [29].

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# Thank you!



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