Dietary reference values for proteins

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Health Council of the Netherlands

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executive summary

The Health Council of the Netherlands has derived new dietary reference values for protein intake for children and adults of various ages, including women who are pregnant and those who are breastfeeding. Dietary reference values comprise the average requirement, the population reference intake (which is derived from the average requirement), adequate intake, and the tolerable upper intake level. Nutrient requirements correspond to the intake that prevents symptoms of deficiency, and that mitigates the risk of chronic disease as much as possible.

This advisory report is a partial advisory report within the scope of the evaluation of Dutch dietary reference values. The Health Council considers that harmonisation of reference values across the EU is preferable. Accordingly, the Council's Committee on Nutrition has evaluated the extent to which the European Food Safety Authority's (EFSA) dietary reference values can be adopted. It also examined four other reports on dietary reference values that are useful for formulating healthy diets: The Dutch dietary reference values for protein of 2001, the reference values of protein of the WHO, the German-speaking countries and of the Nordic countries.

Dietary reference values are useful when formulating a prudent dietary pattern

The dietary reference values for protein are relevant to the Netherlands Nutrition Centre's public information on nutrition, for example. Furthermore, healthcare professionals such as dietitians and physicians can use these dietary reference values when advising individuals about healthy dietary patterns or diets. Dietary reference values are also used to monitor nutrient adequacy in the Dutch population.

Protein is necessary for maintenance and growth

Proteins fulfil essential bodily functions. They are building materials for the body (such as muscles). They are also involved in the immune system, in the transport of substances within and between cells, and as enzymes. Protein is also a source of energy. A variety of factors need to be considered when determining the protein requirement. A key factor for all groups is the amount of protein needed to maintain a normal body composition. In addition, increased protein intake is indicated for growth in children and pregnant women, for example, or for the production of breast milk.

The EFSA's dietary reference values converted to the Dutch situation

The committee has adopted the EFSA's dietary reference values expressed as grams of protein per kilogram of body weight per day for all groups. These dietary reference values are usually converted into a protein requirement expressed as grams per day. Units known as ‘reference weights’ are used for this purpose. As the Dutch are taller (thus slightly heavier) than the average European, the reference weights used in the committee’s calculations differed from those used by the EFSA. Accordingly, for almost all groups, the protein requirement expressed as grams per day is higher than the EFSA’s values. In accordance with the EFSA’s scientific opinion, the committee has not set any tolerable upper intake levels. In the case of adults, the EFSA considers an intake of twice the recommended dietary allowance to be safe.

Limited changes and no higher dietary reference value for older adults

There are only marginal differences between the revised values and the currently applicable dietary reference values for protein in the Netherlands. The new dietary reference values (expressed as grams of protein per day) are generally slightly higher than the 2001 values. This is because the Dutch population has since become taller and, therefore, slightly heavier. The committee conducted a separate examination of the dietary reference values for protein in adults aged 60 and above. This was because of the ongoing scientific debate on this issue, and the fact that some countries derived a higher dietary reference value for this group. The committee conducted an analysis of intervention studies that were published up to and including April 2020. More than sixty percent of these studies showed that increased protein intake had no effect on lean body mass (lean body mass is a measure of muscle mass). The same applies to increased protein intake in combination with increased physical exercise, in relation to muscle strength. Increased protein intake has likely no effect on muscle strength if there is no concomitant increase in physical exercise. Also, increased protein intake has likely no effect on physical function. Accordingly, the committee takes the view that there is insufficient convincing evidence for a higher dietary reference value in older adults.

01 introduction

1.1 Background and request for advice

Dietary reference values provide information about the amounts of nutrients that healthy individuals with a healthy weight should consume. This relates to, for example, vitamins, minerals, proteins, carbohydrates, and fats. The Dutch dietary reference values are derived by the Health Council of the Netherlands.[1] The Health Council considers that harmonisation of reference values across the EU is preferable. In the case of most nutrients, the dietary reference values that have been derived for Europe as a whole may also be applicable to the Netherlands. Dietary reference values are usually established for larger regions. For instance, the United States and Canada have established joint dietary reference values,[2] while the WHO's/FAO's[3] (World Health Organization/United Nations Food and Agriculture Organization) dietary reference values are also intended for use in a wide range of countries. The Health Council is evaluating the dietary reference values published by the European Food Safety Authority (EFSA) between 2010 and 2019, to determine whether these could also be applied to the Netherlands. The first advisory report on this topic was issued in 2018. It addressed dietary reference values for 27 vitamins and minerals for non-pregnant, non-lactating adults.[4,5] This second advisory report deals with the dietary reference values for protein.

This advisory report addresses the question of whether the EFSA's dietary reference values for protein for children and adults of various ages, as well as for women who are pregnant and those who are breastfeeding can be adopted for the Netherlands. It also concerns the question of which other dietary reference value might be suitable if a given the EFSA dietary reference value cannot be adopted by the Netherlands. There is a scientific debate about whether the population reference intake for protein should be higher for older adults than for younger adults. A great deal of research has recently been published on this topic.[6-11] Unlike the EFSA, the Nordic and German-speaking countries set an adjusted, higher dietary reference value for older adults.[12,13] For this reason, the present advisory report specifically addresses the question of whether there is sufficient scientific support for a higher dietary reference value for older adults.

The evaluation of the dietary reference values for protein was carried out by the Council's permanent Committee on Nutrition. A list of the committee's members can be found at the end of this advisory report. The standing committee has reviewed a draft of this advisory report, and the President of the Council has presented it to the State Secretary for Health, Welfare and Sport.

1.2 Dietary reference values and their application

In the Dutch dietary guidelines 2015, the Health Council specified the recommended intake levels for foods and beverages. Its aim was to prevent the ten most important chronic diseases in the general population.[14] Dietary reference values do not focus on foods and beverages as such, but on the substances that they contain – vitamins, minerals, energy, proteins, fats, carbohydrates and dietary fibre. Most dietary reference values focus on preventing nutrient-specific symptoms of deficiency. Accordingly, they are supplementary to the Dutch dietary guidelines 2015.

Dietary reference values comprise the average requirement, the population reference intake (which is derived from the average requirement), adequate intake, and the tolerable upper intake level (see box). Nutrient requirements correspond to the intake that prevents symptoms of deficiency, and that mitigates the risk of chronic diseases as much as possible. A tolerable upper intake level is only derived if there is sufficient evidence that a high intake (or chronically high intake) can produce adverse effects.

Dietary reference values refer to the average conditions in larger population groups. Dietary patterns can account for any differences in requirement between individuals in those population groups (for example, some nutrients can influence each other's absorption in the body), as are personal characteristics such as height, weight, body composition, physiological and genetic characteristics, and growth rate.

The dietary reference values are important for public education on nutrition, for example of the Netherlands Nutrition Centre's. Furthermore, healthcare professionals such as dietitians and physicians can use these dietary reference values when advising individuals about healthy eating habits. Dietary reference values are also used to monitor nutrient adequacy in the Dutch population.

Types of dietary reference values

There are different types of dietary reference values:

1. The *average requirement* refers to the intake level that would meet the personal requirements of 50% of people, but not those of the other 50%.
2. The *population reference intake* is the level considered sufficient for almost everyone in the population group in question. This level can only be determined if sufficient scientific research data have been found to estimate an average requirement. In theory, the population reference intake is the intake level that is adequate for exactly 97.5% of the relevant group. However, due to uncertainties in the research on which average requirements and population reference intakes are based, it is better to use the phrase ‘almost everyone in the population group in question’.
3. *Adequate intake* is an intake level that can be assumed to meet the needs of virtually everyone in the population group in question. This type of dietary reference value is derived if the average requirement and, as a result, the population reference intake as well, cannot be determined.
4. The *tolerable upper intake level* is the highest intake level at which no harmful overdosage effects are to be expected to result from long-term exposure. The tolerable upper intake level is not the ideal intake level. This is because an increase in intake above the population reference intake or adequate intake is not expected to provide further health gains, and a higher intake than the tolerable upper intake level is potentially unhealthy.

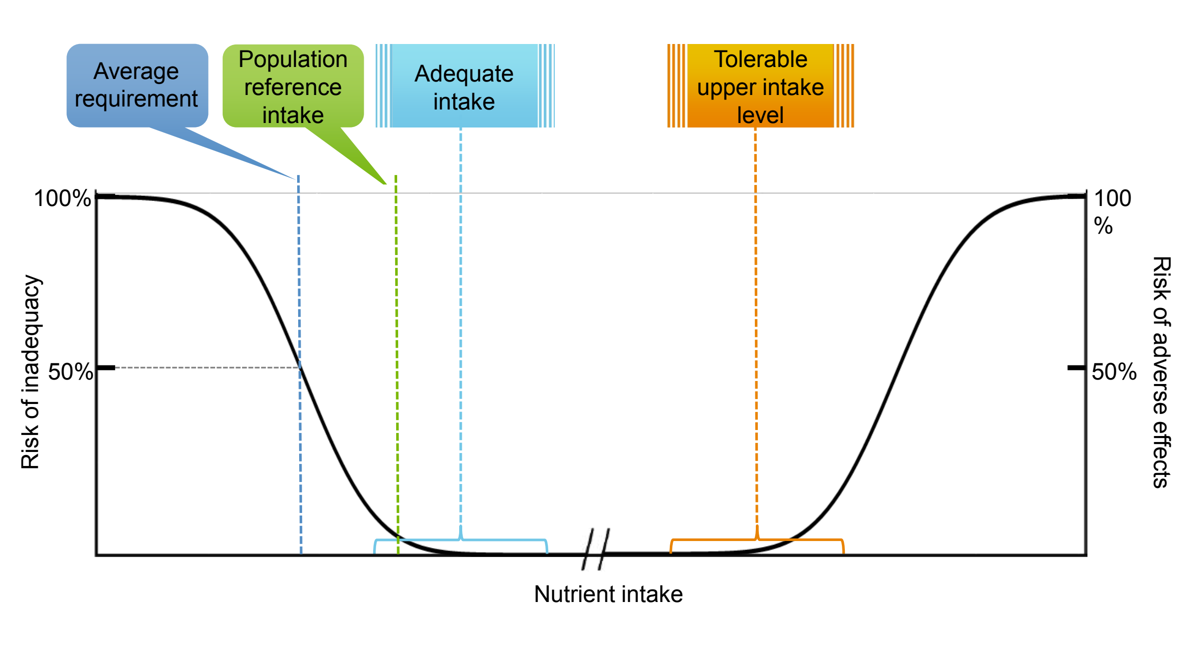

Figure 1. The types of dietary reference values in relation to nutrient intake (X axis) and the probability that this intake is too low or too high (Y axis)

1.3 Focus of advisory report

The committee applies a number of basic principles when formulating dietary reference values.

- When deriving each dietary reference value, it is assumed that the intake levels for the other nutrients are adequate. In relation to dietary reference values for protein, the intake of energy, carbohydrates, and vitamin B6 is especially important.
- The dietary reference values are aimed at healthy individuals with a healthy body weight, who do not require any treatment by a physician that involves special nutritional measures. This advisory report does not explore the question of whether obese individuals, those with chronic diseases, or vulnerable older adults have a different protein requirement.
- The dietary reference values are aimed at individuals with an average level of physical exercise. Individuals who engage in extremely high levels of sporting activities may have higher protein requirements, but this advisory report does not address that point.

Nor does this advisory report address the question of whether the variation in protein consumption throughout the day is important in relation to the dietary reference value. As yet, insufficient research has been conducted in this area. In accordance with the EFSA, the committee has not derived any dietary reference values for specific amino acids.
The EFSA has not derived any dietary reference values for amino acids (including essential amino acids), because amino acids are always consumed in the form of protein. In this context, the EFSA notes that additional research data is needed to estimate the amino acid requirements.

1.4 Comparison of five reports

The committee has evaluated the EFSA dietary reference values for protein. In doing so, it also included four other reports on dietary reference values that it considered most relevant to the Dutch situation:

- The Health Council's currently applicable dietary reference values for protein (2001)[15]
- *Protein and amino acid requirements in human nutrition* by the World Health Organization (WHO), the United Nations' Food and Agriculture Organization (FAO), and the United Nations University (UNU) (2007)[3]
- *Nordic Nutrition Recommendations* by the *Nordic Council of Ministers* (NCM) (2012)[12]
- *Referenzwerte für die Nährstoffzufuhr* by the DACH countries (Germany, Austria, and Switzerland) (2017)[13,16]

The Health Council's dietary reference values from 2001 are relevant, as these are the dietary reference values that are being applied in the Netherlands up to and during this advisory process.[15] With regard to protein, the World Health Organization's dietary reference values have been internationally prominent for many decades.[3] The EFSA's dietary reference values are largely based on this report. Two other reports are relevant in this regard, as they relate to dietary reference values for larger European regions. These are the *Nordic Nutrition Recommendations* by the Nordic Council of Ministers (NCM) for the Nordic countries (Norway, Sweden, Finland, Denmark, Iceland, Greenland, Faroe Islands, Åland),[12] and the *Referenzwerte für die Nährstoffzufuhr* for the German-speaking countries (referred to as the DACH countries): Germany (D), Austria (A) and Switzerland (CH).[16]

Harmonisation is the key basic principle here. Accordingly, the committee has checked whether there are serious objections (from a scientific point of view) to the method used by the EFSA to derive the protein requirement for the various age groups and population categories.[17] The committee also considered whether there is a special Dutch context that would require the Netherlands to adopt dietary reference values that differ from those for the average European. The committee has not carried out a systematic literature update, with the exception of literature pertaining to older adults. This is because a substantial amount of research into this group has recently been released that was not available to the EFSA at the time (in 2012).

1.5 Reading guide

In Chapter 2, the committee explains some basic principles concerning the dietary reference values for protein. There is also an explanation of the methodology used by the committee to evaluate the EFSA dietary reference values for proteins. Chapters 3 and 4 describe the findings from this evaluation, which are reported in more detail in the background documents. *Evaluation of dietary reference values for protein* and *Systematic review of health effects of dietary protein in older adults*, which can be found at www.healthcouncil.nl. Chapter 5 summarises the revised dietary reference values for the Netherlands.

02
protein consumption and dietary reference values for protein

Proteins fulfil essential bodily functions. The process of formulating the protein requirement makes use both of research into the prevention of protein deficiency and of research into the prevention of chronic diseases. The committee uses different reference weights than those used by the EFSA, partly because the Dutch are taller (thus slightly heavier) than the average European.

2.1 Protein requirement

Proteins are a large group of molecules, and consist of chains of amino acids. Proteins are important for almost all processes of life. In the gastrointestinal tract, the proteins contained in food are broken down into amino acids. Once they have been absorbed into the body, these amino acids can be re-used to build body proteins. In addition to acting as building materials for the body (including muscles), proteins in the body fulfil specific functions, such as the transport of substances within and between cells, enzyme action, hormone and receptor functions (communication between cells and their environment), and within the immune system. Amino acids are also a source of energy. Amino acids are classified as either 'essential' or 'non-essential'. Essential amino acids cannot be made by the body, so they have to be present in sufficient quantities in the diet.

Amino acids

The essential amino acids are phenylalanine, histidine, isoleucine, leucine, lysine, methionine, threonine, tryptophan, and valine.

The non-essential amino acids are alanine, arginine, asparagine, aspartic acid, cysteine, cystine, glutamine, glutamic acid, glycine, hydroxyproline, proline, serine, and tyrosine. In the case of six of the non-essential amino acids, certain diseases can lead to insufficient synthesis of six of the non-essential amino acids. In that case dietary supplementation is required. These so-called semi-essential amino acids are arginine, asparagine, glutamine, glycine, proline, and serine.

In the body, proteins are continuously being broken down and synthesised in a process known as '*protein turnover*'. A given quantity of amino acids is lost during each conversion cycle. The nitrogen contained in these amino acids is excreted from the body in the urine, in the form of urea. A small amount of nitrogen is also lost through the stools and the skin (flakes, perspiration, and hair). Aside from maintaining a normal body composition (e.g. retaining muscle mass), protein is required for growth (building muscle and bone). Any protein that is not directly used for body composition or growth is used as an energy source – the body does not accumulate protein reserves.

The process of formulating the protein requirement makes use both of research into the prevention of protein deficiency and of research into the prevention of chronic diseases. The prevention of protein deficiency is based on the minimum protein intake required to maintain a normal body composition and to support adequate growth, based on an adequate energy intake and normal levels of physical exercise. Nitrogen balance studies play a key part here. These measure nitrogen intake (in the diet) and nitrogen loss (in urine and faeces, for example). They determine the nitrogen level at which nitrogen intake corresponds exactly to nitrogen loss (i.e. they are in balance). Nitrogen makes up about 16% of protein, so the quantity of protein can be directly estimated by multiplying the quantity of nitrogen by 6.25. Studies are also conducted into growth (healthy growth) in foetuses, growth (healthy growth) in children, and the composition of breast milk. When attempting to determine whether the protein requirement can be derived from the quantity of protein that mitigates the risk of chronic diseases as much as possible, researchers generally use prospective cohort studies and randomised controlled trials (RCTs). A prospective cohort study examines the relationship between diet and chronic disease, by monitoring a group of individuals for an extended period of time. In randomised controlled trials (RCTs), the participants are divided into random groups. One of these groups receives the treatment whose effect the researchers plan to measure, while the other group serves as a control.

2.2 Protein consumption and dietary sources of protein

The National Institute for Public Health and the Environment's (RIVM) 2012-2016 Dutch National Food Consumption Survey shows that, in the Netherlands, the average daily intake of protein increases with age (up to middle age) and is highest (98 grams per day (g/d) in men between the ages of 31 and 50. Women between the ages of 31 and 50 have an average protein intake of 72 g/d (see Figure 2). Average protein intake, expressed as kilograms of body weight per day, decreases with age. In children between the ages of 1 and 3, this is 3.1 grams per kilogram of body weight per day (g/kg/d), while in older adults between the ages of 71 and 79 it is approximately 1.0 g/kg/d. Expressed as a percentage of the energy supply, protein consumption contributes an average of 15% to the total amount of energy. This is slightly higher in adults (16 percent of total energy intake) and slightly lower in children (13 percent of total energy intake).[18]

Proteins are mainly derived from meat (or meat products), dairy, bread, grains, rice, and pasta. In 2001, the average Dutch person ate twice as much animal protein as vegetable protein (67% versus 33%).[19] The 2012-2016 National Food Consumption Survey shows that the ratio of animal to vegetable products in peoples' dietary pattern has shifted slightly (see Figure 3): A total of 61% percent of this protein was of animal origin, and 39% was of vegetable origin.[20]

The intake of protein increases with age up to middle age

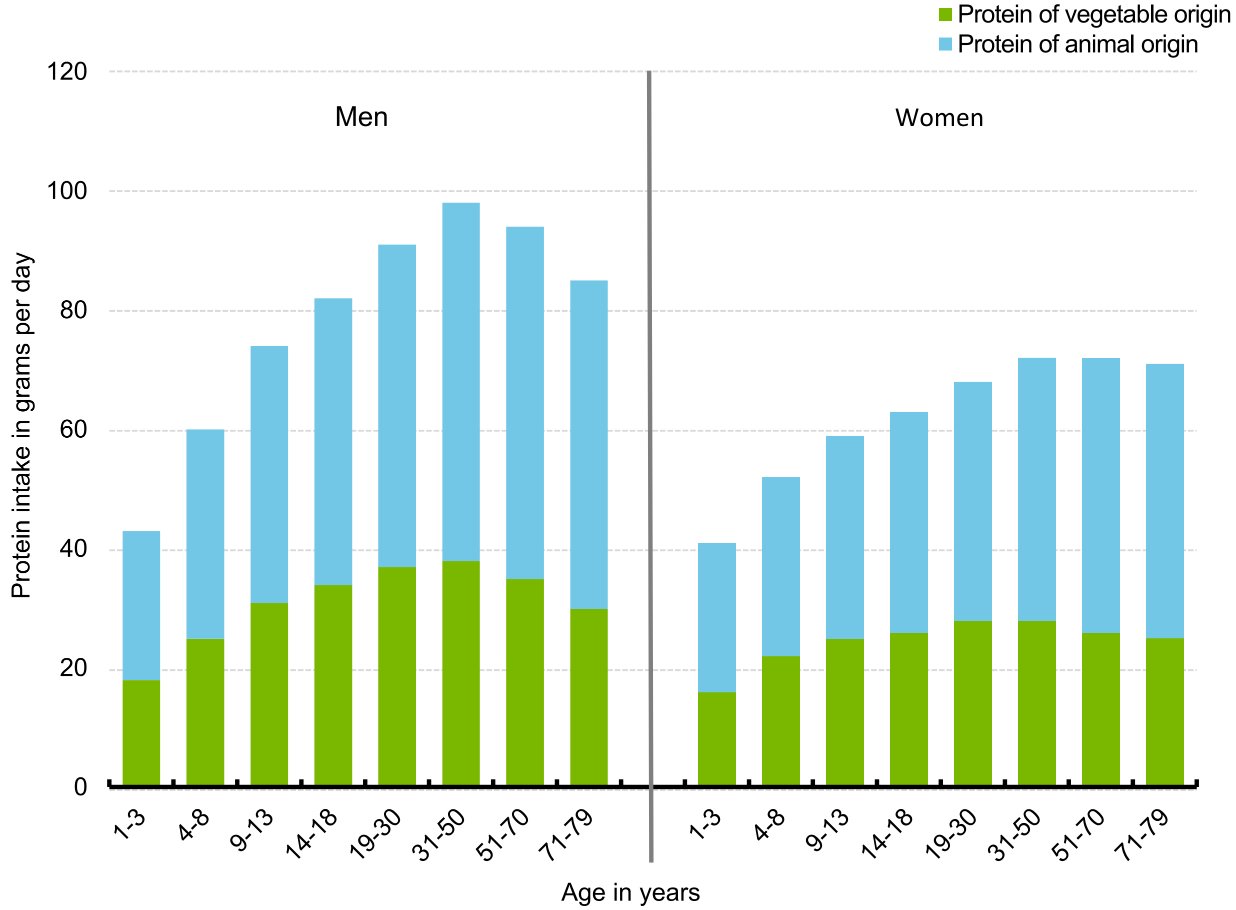

Figure 2 Protein intake in grams per day by age and gender among 4,313 Dutch people[a] aged 1 to 79, based on the 2012-2016 National Food Consumption Survey; National Institute for Public Health and the Environment (RIVM) (based on www.wateetnederland.nl)[18]

The Dutch consume more protein from animal origin than from vegetable origin

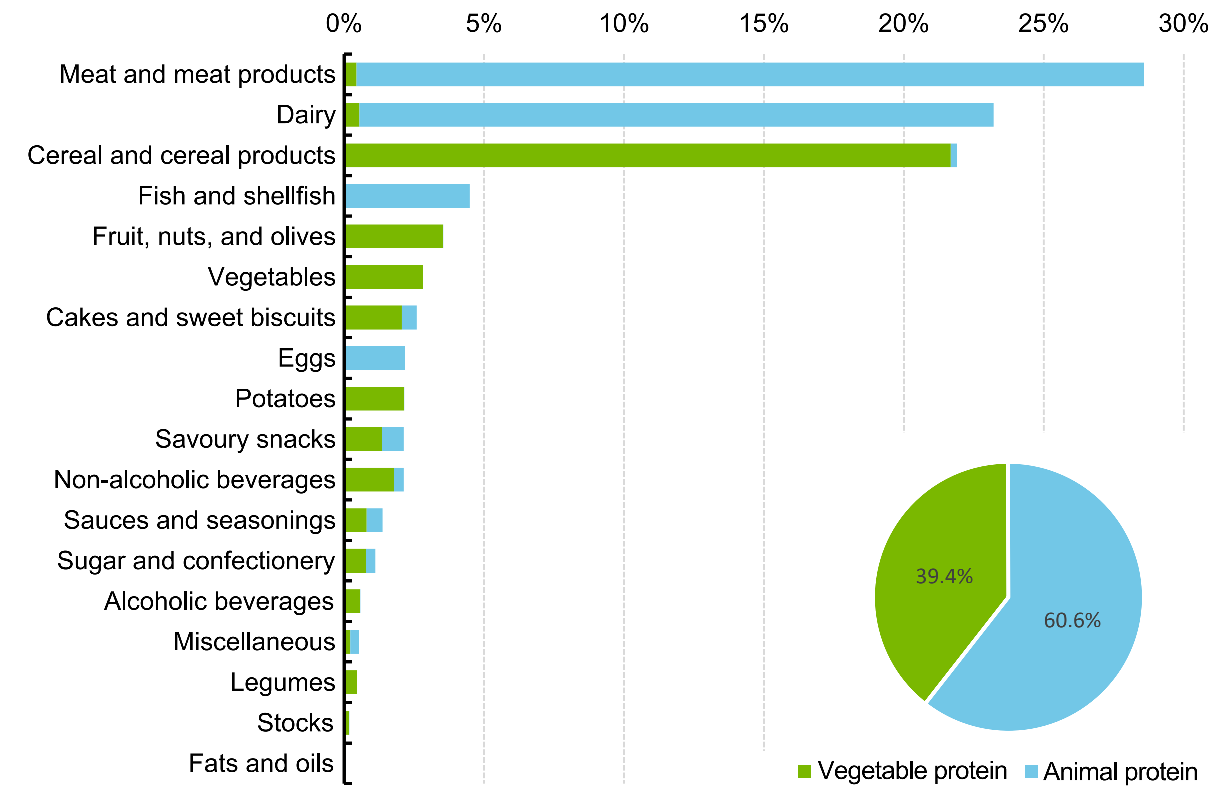

Figure 3 Average percentage contribution of product groups to the total habitual protein intake for adults (aged from 19 to 79) in the Netherlands (based on the 2012-2016 National Food Consumption Survey; adapted with permission). The meat (or meat products) group also included meat substitutes (comprising 0.3% of the total habitual protein intake).20

[a] This sample does not include pregnant women, lactating women, and institutionalised older adults.

2.3 Reference weights

2.3.1 The EFSA reference weights

Dietary reference values for protein are primarily expressed as grams of protein per kilogram of body weight per day. Based on the so-called reference weights, the dietary reference values for protein can then be converted into grams per day. Reference weights are established for each age group or category. With regard to adults, the EFSA has used the median weight of European men and women (1993) as reference weights..[21] In the case of children, the EFSA uses the median weight of European children (2012).[22]

2.3.2 New reference weights for the Netherlands

Adults

With a view to harmonisation, the committee has based its work on the EFSA's age groups. However, when calculating the reference weight, the committee adopted a different approach to the EFSA. With regard to the dietary reference value in grams per day, it has opted to use the Dutch figures for height, because the Dutch are taller (thus slightly heavier) than the average European. In addition, the committee used an 'ideal' weight for the purposes of calculation. This differs from the EFSA's approach, which uses the median of actual weight measurements in its calculations.

The committee used two representative samples to determine the average height of adult Dutch people:

- 'Measuring the Netherlands' (in Dutch: Nederland de Maat Genomen; NL de Maat)[a] that included 4,500 adults aged from 30 to 70, from seven municipalities, randomly selected from the register of residents and measured in 2009-2010.[23,24]
- The LASA study (*Longitudinal Aging Study Amsterdam*)[b] included 1,437 older adults (aged from 60 to 90) from Amsterdam, Zwolle and Oss (and the surrounding areas) who were measured in 2009-2010.[25,26]

Both studies measured the participants' heights (i.e. these were not self-reported by the participants). These data replace the average heights measured in the 1990s, which were used in the previous advisory report on dietary reference values for protein (2001).

In the 30 to 40, 40 to 50, 50 to 60, and 60 to 70 age groups, height has increased since the 1990s by 1.8%, 2.3%, 2.9%, and 1.0% respectively in men and by 2.0%, 1.8%, 2.1%, and 1.5% in women. In 2009/2010, no height data were available for the 18 to 30 age group. The committee has equated the percentage increase in height for this group to the percentage

[a] The NL-de Maat study was carried out by the National Institute for Public Health and the Environment (RIVM) at the instigation of the Ministry of Health, Welfare and Sport

[b] The LASA study was funded by a grant from the Ministry of Health, Welfare and Sport, Long-Term Care Department

increase in the adjacent age group (30 to 40). The heights that were measured in 2001 were then increased by this percentage.

Data for the 60-70 age group were available in both the NL de Maat cohort and the LASA cohort. The men in NL de Maat were 0.8 cm (0.48%) taller than those in the LASA cohort, and the women were 0.7 cm (0.43%) taller. With regard to the 60-70 age group, the committee used the heights measured in the NL de Maat cohort. This was because relatively few older adults with a migrant background are represented in the LASA cohort sample. The heights of individuals in the 70 to 90 age group (LASA cohort) were subsequently increased by 0.48% for men and 0.43% for women.

The committee determined the reference weight on the basis of a healthy or 'ideal' weight for a given height. For adults, the *body mass index* was used (BMI, a person's weight in kilograms divided by the square of their height in metres, expressed in kg/m^2). Using the median of the actual measured weight, as the EFSA does, means that the reference weight would be too high, due to the growing number of overweight individuals. The committee uses a healthy BMI of 22 kg/m^2 for the 18 to 50 age group, a healthy BMI of 23 kg/m^2 for the 50 to 70 age group, and a healthy BMI of 24 kg/m^2 for the over-70s. These cut-off points are substantiated by a large-scale study into the relationship between BMI and mortality risk. The lowest mortality risk for the older age groups corresponded to a higher BMI than for the younger adults.[27] The reference weights (in kg) are calculated by squaring the average heights (in m) and multiplying by the corresponding 'healthy' BMI.[a]

Children

In child healthcare (post-natal clinics), growth charts are being used to track children's growth and check that it was robust and healthy. The growth charts for the Netherlands were developed by the Netherlands Organisation for Applied Scientific Research (TNO). The height data that is currently being used was collected during the Fifth National Growth Study (2009).[28,29] In recent decades, however, as in many other countries, Dutch children (just like adults) have become increasingly overweight for their height. This means that the most recent weight data cannot be used as a reference for healthy growth. Accordingly, the weights currently being used in growth charts are those recorded during the Third National Growth Study (1980), when overweight in children was less prevalent.[30]

The committee used the heights of Dutch children to derive the reference weights for children.[29] These are based on a sample (from 2009) that is also part of the EFSA's European dataset.[22]

[a] In the case of the EFSA dietary reference values that were issued after the dietary reference values for protein, the EFSA used an ideal BMI of 22 kg/m^2 for all adults in its calculations of the reference weight, instead of the median weight.

The corresponding healthy weight for these heights was then determined[a] (per age group), based on the Netherlands Organisation for Applied Scientific Research's (TNO) weight-for-height growth charts from the Third National Growth Study.[31]

2.4 Protein quality

The dietary reference values for protein are based on the assumption that protein quality is optimal, i.e. that there is an adequate supply of all essential amino acids. This applies to an omnivorous dietary pattern, which is the average dietary pattern in the Netherlands. The quality of a protein source depends on its digestibility, and on the levels of essential amino acids in relation to the requirement for these amino acids. In general, vegetable proteins are of lower protein quality than proteins of animal origin. However, the consumption of animal protein is under pressure, in relation to a healthy and sustainable diet.[14,32]

In 2001, the Health Council produced estimates for the protein quality of a vegetarian and a vegan dietary pattern, as compared to omnivorous eating habits. Because vegetarian and vegan dietary patterns are of slightly lower protein quality, the dietary reference value for protein for individuals with these eating habits was increased slightly. In the case of individuals with a vegetarian dietary pattern, the population reference intake for protein was 1.2 times higher than for omnivores, while for those with a vegan dietary pattern it was 1.3 times higher.[15] These conversion factors have not been evaluated in the current advisory report. The committee is of the opinion that this subject requires a more extensive and broad-based evaluation. In that context, the committee also wishes to include sustainability aspects. For that reason, it will address the shift from an animal-based diet to a more vegetable-based diet in a separate advisory report. Until then, the committee advises to continue to make use of the conversion factors from 2001.

[a] The Netherlands Organisation for Applied Scientific Research (TNO) has provided additional information that enables growth-chart readings to be made as accurately as possible.

03
revised reference values for adults

For adults, the committee has adopted the EFSA's dietary reference values for protein. This applies to adults of all ages. The committee takes the view that there is insufficient scientific evidence to establish a different (higher) dietary reference value for adults aged 60 and above.

3.1 Dietary reference values for adults up to the age of 59

Nitrogen balance studies play a key part in determining the protein requirement (see also Section 2.1). The amount of protein needed to achieve a good nitrogen balance (and, thus, to maintain a normal body composition) can be determined by measuring how much nitrogen an individual ingests (in their diet) and how much they lose (in urine and faeces, for example). In 2012, in accordance with the World Health Organization, the EFSA derived a dietary reference value for protein from a meta-analysis of nitrogen balance studies in adults that was carried out by Rand et al.[33] Based on this meta-analysis, it was concluded that the average protein requirement for maintaining a nitrogen balance in healthy adults is 0.66 g/kg/d, with a coefficient of variation of 12%. The protein requirement varies from one person to another. Accordingly, the population reference intake is set at a higher value than the average requirement (generally two standard deviations above the average requirement). This gives a population reference intake of 0.83 g/kg/d. The meta-analysis yielded a value of 47% for the efficiency with which dietary protein is converted into body protein. Previous literature had allocated a value of 70% to this efficiency level.

The EFSA concluded that research into health consequences (muscle mass, body weight and weight regulation, insulin sensitivity and glucose control, and bone health) could not be used to deriving the dietary reference value. This was due to the lack of scientific evidence concerning the effects in general, or concerning the effects of a protein intake in excess of the population reference intake for protein, as derived from nitrogen balance studies. The committee concurs with the EFSA's approach and with the associated scientific support. Accordingly, it has adopted the EFSA's dietary reference values, resulting in an average requirement of 0.66 g/kg/d and a population reference intake of 0.83 g/kg/d.

3.2 Dietary reference values for adults aged 60 and above

The nitrogen balance is also the guiding principle for determining the protein requirement for adults aged 60 and above (older adults). In addition, it is important to determine whether older adults need more protein to maintain muscle strength and physical function, for example, to combat vulnerability.

3.2.1 Dietary reference values from the EFSA, the Nordic countries, and the DACH countries

In 2012, the EFSA, like the World Health Organization, concluded that the dietary reference values for protein for adults aged 60 and above do not need to be higher than those for adults up to the age of 60.[17] The meta-analysis by Rand et al.[33], together with another, more recent, balance study[34] revealed no significant differences between adults under or over 60 years of age, in terms of the protein consumption needed to achieve nitrogen balance. In addition, insufficient usable research had been conducted into the relationship between protein intake and other health outcomes (such as muscle mass and bone health) to derive a higher reference value for older adults.[17] According to the EFSA, the same dietary reference values apply to adults of all ages – an average requirement of 0.66 g/kg/d and a population reference intake of 0.83 g/kg/d.

Some groups of European countries have derived a higher dietary reference value for older adults. For a description, see the background document entitled *Evaluation of dietary reference values for protein.* In 2012, the Nordic countries recommended a protein intake of 15-20 percent of total energy intake for older adults aged 65 and above (for younger adults this was 10 to 20 percent of total energy intake). The recommended figure of 15 percent of total energy intake applies to older adults with an average level of physical exercise. The figure of 20 percent of total energy intake applies to older adults with a mainly sedentary lifestyle. The underlying idea is that, in older adults, reduced levels of physical exercise result in a reduced total energy requirement. Thus, to ensure that enough protein is ingested, in absolute terms, the protein requirement increases in relative terms, i.e. relative to the total energy requirement. The values of the recommended intakes in total energy intake percentages are partly derived from a few prospective cohort studies (*suggestive evidence*) into the relationship between protein intake and health outcomes, including muscle mass. The Nordic Council of Ministers also states that maintaining the nitrogen balance at an intake of 0.83 g/kg/d in older adults might take place at the expense of muscle mass, and that nitrogen balance studies would not be a suitable way of demonstrating this effect.[12] The limits of the recommended intake range were then recalculated as grams of protein per kilogram of body weight per day. These gave values ranging from 1.1 for individuals with an average level of physical exercise to 1.3 g/kg/day for those with a mainly sedentary lifestyle.

In 2017, the DACH countries established an adequate intake of 1.0 g/kg/day for older adults above the age of 65. This was based on a combination of nitrogen balance studies and studies of metabolic and functional parameters in older adults.[13]

3.2.2 Derivation for the Netherlands

The committee does not consider the EFSA report to be an adequate foundation on which to base its dietary reference value for older adults. This is because numerous new studies have been conducted in older adults since 2012, particularly protein intervention studies (randomised controlled trials, or RCTs). Similarly, the dietary reference value adopted by the Nordic countries takes no account of these more recent studies. To the opinion of the committee, the DACH countries' methodology did not sufficiently comply with the systematic methodology that the committee aimed to use. Accordingly the completeness and weighting of the research by DACH were not entirely clear. For this reason, the committee has conducted its own supplementary literature review into the relationship between increased protein intake and health outcomes. It has also conducted a search for recent nitrogen balance studies in older adults.

The committee's supplementary literature review of recent nitrogen balance studies in older adults found no new studies that had not already been included in the EFSA report. Thus, the committee concurs with the EFSA's conclusion that there is insufficient data to demonstrate that the requirement needed to achieve nitrogen balance in older adults differs from that in younger adults.

In its supplementary literature review into the effect of increased protein intake on health outcomes, the committee first focused on meta-analyses of prospective cohort studies and intervention studies (RCTs) in older adults. However, these meta-analyses turned out to be unusable as they contain too little information about the total habitual protein intake in relation to the dietary reference value. Accordingly, the individual RCTs that are usable for the purposes of this advisory report were derived from systematic review articles and meta-analyses. The committee found four systematic review articles that included prospective cohort studies,[35-38] but this cohort studies proved insufficiently useful for setting dietary reference values. This was partly because the conclusions of the cohort studies involved insufficiently specific intake levels, or had not taken sufficient account of factors that can distort the results (*confounding*). The committee, therefore, based its approach on the intervention studies.
In the selected intervention studies, the control group's average protein intake was not lower than 0.8 g/kg/d (the population reference intake based on nitrogen balance studies). The health outcomes used were lean body mass, muscle strength, physical function, bone health, blood pressure, glucose and insulin metabolism, blood lipids, kidney function, and cognition. The approaches used in the literature review and the studies evaluated by the committee are described in the background document entitled *Systematic review of health effects of dietary protein in older adults*. The committee has identified six possible conclusions for each health outcome (see Table 1).

Table 1. Possible conclusions concerning the effect of increased protein intake on health outcomes, based on intervention studies

Conclusion	Description[ab]
A convincingly beneficial effect	In at least three intervention studies, of which at least 75% of the studies show a beneficial effect, and there are no studies with an unfavourable effect
A likely beneficial effect	In at least three intervention studies, of which 50% to 74% of the studies show a beneficial effect, and there are no studies with an unfavourable effect
A possible beneficial effect	In at least three intervention studies, of which 25% to 49% of the studies show a beneficial effect, and there are no studies with an unfavourable effect
Ambiguous effect	Intervention studies show conflicting results. This involves a combination of both beneficial and unfavourable effects, in which the overall picture does not clearly point in one direction.
Likely no effect	In at least three intervention studies, of which less than 25% of the studies show a beneficial effect, and there are no studies with an unfavourable effect
Too little research	In less than three intervention studies or too few studies with sufficient statistical power

[a] Wherever reference is made to beneficial or unfavourable effects, this concerns statistically significant beneficial effects and statistically significant unfavourable effects.
[b] All categories may include neutral studies (studies which found no statistically significant effects).

Table 2 describes the conclusions for each of the health outcomes that were evaluated. No convincing or likely beneficial effect was found for any health outcomes associated with a protein intake in excess of the population reference intake of 0.83 g/kg/d. Studies do show a possible beneficial effect on lean body mass (a proxy for muscle mass) at constant body weight. Here, it did not matter whether the effect of increased protein intake (compared to no increase in protein intake) alone was investigated or whether this was the effect of increased protein intake combined with physical exercise (usually weight training), as opposed to additional physical exercise alone. A protein intake of up to 1.1 g/kg/d, in combination with extra physical exercise, also had a possible beneficial effect on muscle strength. For the other health outcomes, the effect was ambiguous, unlikely ('likely no effect'), or there were too little appropriate studies to draw a conclusion.

All in all, the committee concludes that the evidence is not sufficiently convincing to justify setting a higher population reference intake for older adults than for adults in general. Less than 40% of the studies indicate that increased protein intake has a beneficial effect on lean body mass. The same applies to increased protein intake in combination with physical exercise, in relation to muscle strength. Accordingly, the majority of studies show no effect. Increased protein has likely no effect on physical function, nor – without extra physical exercise – does it have any effect on muscle strength. There are also too little appropriate studies in older adults to identify any harmful effects of increased protein consumption (on kidney function, for example), although there is only limited evidence for this in the healthy general population.

The committee assumes that the dietary reference value applies to all healthy older adults with a healthy weight. Thus, as with the previous dietary reference values for protein and like the EFSA, the committee has not set an upper age limit. The committee does not rule out the possibility that specific subgroups of older adults, such as vulnerable older adults or malnourished older adults, may indeed benefit from more protein than the population reference intake for older adults in general,[11] but these population groups fall outside the scope of this advisory report.

Table 2. Conclusions concerning the effect of increased protein intake on health outcomes in healthy older adults (average age at least 65)[a]

Health outcome	Conclusion, number of studies, and explanation
Lean body mass (at constant weight).	A possible beneficial effect (7 of the 18 intervention studies reported at least one beneficial effect) There is no evidence to show that protein alone produces different effects from protein+physical exercise
Muscle strength, for the combination of increased protein intake plus extra physical exercise, compared extra exercise alone	A possible beneficial effect (3 of the 8 intervention studies reported at least one beneficial effect)
Muscle strength (for an increased protein intake alone, not in combination with extra physical exercise)	Likely no effect (based on 7 intervention studies)
Bone health	Likely no effect (1 of the 7 intervention studies reported at least one beneficial effect)
Physical function	Likely no effect (based on 12 intervention studies)
Kidney function	Too few studies (6 intervention studies, but without suitable outcome measures)
Cognitive performance	Too few studies (1 intervention study)
Blood pressure	Too few studies (4 intervention studies, mostly with insufficient statistical power)
Glucose and insulin metabolism	Too little research (6 intervention studies, mostly with insufficient statistical power)
Blood lipids	Ambiguous effect (based on 7 intervention studies); both beneficial and unfavourable effects were found, but for different lipid measures

[a] These were intervention studies in which the control group's average protein intake was no lower than 0.8 g/kg/d (the population reference intake based on nitrogen balance studies).

The committee notes that there is a need for nitrogen balance studies (or more such studies) in which both younger and older adults are represented, to better study any age differences in protein metabolism. The committee also feels that there is scope for analyses based on existing prospective cohort studies, in which additional and – with regard to the dietary reference value – more specific categories of protein intake are studied in relation to various health outcomes. In the case of intervention studies that show beneficial effects, it makes sense to subdivide the results by protein intake prior to the study. This approach can provide greater insight into which intake domain is associated with health benefits. In general, little research has been conducted among the most senior older adults (aged about 85 and above).

3.3 Dietary reference values for adults of all ages

The committee has adopted the EFSA's dietary reference values for protein for adults aged 18 and above. This results in an average requirement of 0.66 g/kg/d and a population reference intake of 0.83 g/kg/d.

Table 3. Average requirement and population reference intake for protein for adult men and women aged 18 and above

Adults	Average requirement (g/kg/d)	Population reference intake (g/kg/d)
Protein is necessary for: Maintaining a normal body composition		
Men and women aged 18 and above	0.66	0.83

Abbreviations: g/kg/d: grams per kilogram of body weight per day

04 revised reference values for pregnant women, lactating women, and children

The committee has adopted the EFSA's dietary reference values for protein for women who are pregnant, women who are breastfeeding, and children. Per kilogram of body weight, these dietary reference values are all higher than those for adults. This is because protein is necessary not only for the maintenance of a normal body composition, but also for growth and for the production of breast milk.

4.1 Dietary reference values for pregnant women

The committee has adopted the EFSA's dietary reference values for protein for pregnant women. EFSA uses a two-part factorial model to calculate the protein requirement for pregnant women. First, protein is needed to maintain normal maternal body composition. This allows for an average increase in body weight (of 13.8 kg), due to pregnancy.[3,17] This is considered the optimal weight gain for women who enter pregnancy at a healthy weight.[39,40] As in non-pregnant women, the need to maintain a normal body composition has been derived from nitrogen balance studies[33] in which it was assumed that a pregnant woman's protein balance is at least as efficient as that of a non-pregnant woman.[17] Second, protein is needed for the growing foetus – growth involves the storage/incorporation of an estimated 686 grams of protein in the body of the foetus.[3] The estimated increased protein requirement for the growth of the foetus is calculated by dividing the recorded amount of body protein by the efficiency (47%) with which the mother converts dietary protein into foetal body protein. In total, this leads to an extra average protein requirement of 0.5, 7.2, and 23.0 g/d in the first, second, and third trimester of pregnancy, respectively. The corresponding population reference intakes are calculated by increasing these values by twice the coefficient of variation (a measure of distribution in requirement between individuals) of 12%, resulting in +1 g/d (first trimester), +9 g/d (second trimester) and +28 g/d (third trimester).

The dietary reference values specify the requirements of adult women with a singleton pregnancy. Women with a multiple pregnancy have a higher requirement than those with a singleton pregnancy. Teenage pregnancies are similar to multiple pregnancies in this respect, as the mother's developing adolescent body then has higher requirements than the body of an adult pregnant woman. Although it can be plausibly argued that the protein requirement is higher in multiple pregnancies and teenage pregnancies, the amount of research carried out into these cases is too limited to derive separate dietary reference values for these population groups.

Table 4. Increased protein requirement for pregnant women[a]

Pregnant women	Reference weight (kg)[b]	Average requirement (g/d)	Population reference intake (g/d)[c]
Protein is necessary for: Maintaining a normal maternal body composition, foetal growth, and maternal body growth			
1st trimester	+0.8	+0.5	+1
2nd trimester	+4.8	+7.2	+9
3rd trimester	+11	+23.0	+28

Abbreviations: g/d: grams per day, kg: kilogram

a This table shows the increased protein requirement that needs to be added to the requirement of non-pregnant women.

b This assumes a weight gain in the middle of each trimester, based on a total weight gain of 13.8 kg.

c The population reference intake is calculated using twice the coefficient of variation (which is 12%).

4.2 Dietary reference values for lactating women

The committee has adopted the EFSA's dietary reference values for protein for women who are breastfeeding. When calculating the protein requirement for lactating women, the EFSA used a model that was comparable to that used for pregnant women. First, protein is needed to maintain a normal body composition. As with non-pregnant women, this requirement was derived from nitrogen balance studies[33], which worked on the assumption that a lactating woman's protein balance is just as efficient as that of a non-lactating woman.[17] Second, protein is required for breast milk production. Here, it is assumed that daily milk production will be 734 ml in the first month, rising to 897 ml in the sixth month after giving birth (and to 578 ml for the sixth to the twelfth month after giving birth). The extra average requirement is calculated by multiplying these amounts by the corresponding protein concentration in breast milk, which decreases over time during the first four months. The estimated increased protein requirement for the production of breast milk is calculated by dividing this value by the efficiency (47%) with which the mother converts dietary protein into breast milk protein. The average requirement plus twice the coefficient of variation (which is 12%) gives the population reference intakes. These are specified for the first six months after giving birth (+19 g/d) and the second six months after giving birth (+13 g/d).

Women who are giving full breastfeeding to several children at the same time have a higher protein requirement than those who are giving full breastfeeding to just one child. The guiding principle for dietary reference values is where a mother is feeding just one baby (giving full breastfeeding). The requirement is also higher in lactating teenage mothers than in adult lactating women because the teenage body is still developing. The dietary reference values specify the needs of adult lactating women with one child. Although it can be plausibly argued that teenage mothers and those who experience multiple births have a higher requirement, the research into these cases is too limited to formulate separate dietary reference values for these population groups.

Table 5. Increased protein requirement for lactating women[a]

Lactating women	Average requirement (g/d)	Population reference intake (g/d)
Protein is necessary for: Maintaining a normal body composition and for breast milk production		
One month after giving birth	+16.2	+19
Two months after giving birth	+15.6	
Three months after giving birth	+14.8	
Four months after giving birth	+14.3	
Five months after giving birth	+14.4	
Six months after giving birth	+15.5	
>Six to twelve months after giving birth	+10.0	+13

Abbreviations: g/d: grams per day
[a] This table shows the increased protein requirement that needs to be added to the requirement of non-pregnant women and non-lactating women.
[b] The population reference intake is calculated using twice the coefficient of variation (which is 12%).

4.3 Dietary reference values for children

4.3.1 Dietary reference values for protein for children of up to six months of age

The committee concurs with the EFSA's decision not to derive a dietary reference value for children of up to six months of age. It concludes that the composition of breast milk (where the mother is giving full breastfeeding) meets the requirement. The protein requirement of infants is also taken into account when determining the composition of formula. The composition of formula (and follow-on milk), which is regulated by the European Union, is based on an EFSA scientific opinion.[41]

4.3.2 Dietary reference values for protein in children from six months to 18 years of age

The committee has adopted the EFSA's dietary reference values for protein for children above the age of six months. The protein requirement for children is also calculated using a two-part factorial model. First, protein is needed to maintain a normal body composition. This requirement was estimated on the basis of nitrogen balance studies in children. The average requirement needed to maintain a normal body composition has been equated to the value used for adults (0.66 g/kg/d). Second, protein is required for body growth. The estimated protein requirement for growth is calculated by dividing the growth in body protein by the efficiency (58%) with which the mother converts dietary protein into body protein. In children, the population reference intake for protein gradually decreases from 1.31 g/kg/d at six months of age to 0.83 g/kg/d at 18 years of age. EFSA has converted the requirement in grams per kilogram of body weight to grams per day, based on a dataset of median weights of children from different European countries. Because Dutch children are taller, and therefore heavier, the committee has carried out its own conversion, using national figures derived from the Fifth National Growth Study. The committee notes that in children (unlike adults) there is an added uncertainty regarding the protein requirement at any given age. This is due to the substantial differences in growth between children in a general sense, as well as to the age at which their growth spurt occurs.

Table 6. Average requirement and population reference intake for protein in children from six months to 18 years of age

Age (in years)	Average requirement (g/kg/d)		Population reference intake (g/kg/d)[a]	
Protein is necessary for: Maintaining a normal body composition and for growth				
	Boys/Girls		Boys/Girls	
0.5	1.12		1.31	
1	0.95		1.14	
1.5	0.85		1.03	
2	0.79		0.97	
3	0.73		0.90	
4	0.69		0.86	
5	0.69		0.85	
6	0.72		0.89	
7	0.74		0.91	
8	0.75		0.92	
9	0.75		0.92	
10	0.75		0.91	
	Boys	Girls	Boys	Girls
11	0.75	0.73	0.91	0.90
12	0.74	0.72	0.90	0.89
13	0.73	0.71	0.90	0.88
14	0.72	0.70	0.89	0.87
15	0.72	0.69	0.88	0.85
16	0.71	0.68	0.87	0.84
17	0.70	0.67	0.86	0.83

Abbreviations: g/kg/d: grams per kilogram of body weight per day

[a] The population reference intake is calculated using twice the coefficient of variation, which is a combination of the coefficient of variation for maintaining normal body composition (47%) and the coefficient of variation for growth (58%).

05
summary of the revised dietary reference values for the Netherlands

There are only marginal differences between the revised values and the currently applicable dietary reference values for protein. In general, the revised dietary reference values are slightly higher. The dietary reference values (expressed as grams of protein per day) are higher. This is because the Dutch population has become taller and, therefore, slightly heavier. In accordance with the EFSA, the committee has not set any tolerable upper intake levels. This is because there is no evidence that a protein intake of up to twice the population reference intake is harmful to healthy individuals. In children of up to one year of age, a high protein intake (20 percent of total energy intake or more) should be avoided, to prevent kidney problems.

5.1 There are only marginal differences between the revised dietary reference values and the currently applicable values

The 2001 dietary reference values for protein were largely based on a 1985 WHO report.[42] The EFSA's approach is based on a 2007 WHO report,[3] which revised part of the 1985 approach based on a broader body of research data and on new scientific knowledge. For the purposes of the new Dutch dietary reference values for protein, the EFSA's approach has largely been adopted with regard to dietary reference values that are expressed per kilogram of body weight. There are only marginal differences compared to the preceding set of Dutch dietary reference values. For adults, the average requirement needed to maintain a normal body composition has increased from 0.6 to 0.66 g/kg/d, while the population reference intake has increased from 0.8 to 0.83 g/kg/d. For children, dietary reference values have now been derived per year of life rather than per age group, as in the past. The number of categories defined for pregnant women and lactating women has also increased. For example, the Health Council of the Netherlands previously applied a single dietary reference value for the entire pregnancy, but this has now been subdivided into trimesters. For pregnant women in their third trimester, the dietary reference value is now considerably higher (+28 g/d versus the previous value of +10 g/d).

The committee used Dutch reference weights to convert protein quantities into grams per day. It has adopted the EFSA's age groups, and new Dutch reference weights have been established for these groups. For all age groups, the reference weight has increased slightly to reflect the fact that the Dutch have grown taller over the past 20 years, despite of the fact that, for the purposes of calculations, a lower 'ideal' BMI was used (for adults) than in 2001. As a result, the dietary reference values expressed in grams per day have also increased slightly.

5.2 Tolerable upper intake levels for protein

Like the EFSA (and WHO), the committee has not set a tolerable upper intake level for protein. The lack of a tolerable upper intake level is due to the fact that, in healthy individuals, there is insufficient evidence that a higher (or chronically higher) protein intake is associated with any harmful effects. Food consumption surveys have shown that many people's protein intake is well above the dietary reference value for protein. In the case of adults, the EFSA considers an intake of twice the population reference intake to be safe. The tolerable upper intake level of 25 percent of total energy intake (as derived from the Health Council's 2001 advisory report) will lapse, and no new tolerable upper intake level will be introduced in its place. However, the EFSA does recommend that in children of up to one year of age, a high protein intake (20 percent of total energy intake or more) should be avoided, to prevent kidney problems. The committee endorses this recommendation.

5.3 Considerations when using dietary reference values for protein

Dietary reference values for protein are relevant for public information on nutrition, for example by the Netherlands Nutrition Centre. Furthermore, healthcare professionals such as dietitians and physicians can use these dietary reference values when advising individuals about healthy eating habits or diets. Because the population reference intakes are considered to reflect a sufficient intake in almost the entire population, (97.5%), these dietary reference values are used for applications at the level of the individual. If a person's protein intake is equal to or higher than the population reference intake, then this can be considered adequate. However, if an individual's intake is lower than the population reference intake it does not necessarily mean that this specific individual's protein intake is inadequate. After all, the average requirement is lower than the population reference intake, and the average requirement is considered to be adequate for half of the population group concerned. The needs of individuals vary (see Section 1.2). However, if a specific individual's protein intake is lower than the population reference intake, it is very difficult to determine whether that individual is getting sufficient protein. For instance, there are no blood or urine tests for protein that can be used to verify this. It is possible to retrospectively conclude that an individual's protein intake in the preceding period was probably too low. Nevertheless, if muscle mass or (in the case of children) muscle growth is reduced in otherwise healthy individuals, that reduction can also be accounted for by other factors, such as a recent decline in physical exercise (in the case of adults). For this reason, the population reference intake is used for applications at the level of the individual. If a person's protein intake is higher than the population reference intake, then this can be considered adequate. If an individual's protein intake is lower than the population reference intake then the best course of action would be to increase it.

At the population level, dietary reference values can be used to assess whether the population's intake level is adequate. The average requirement is used for this purpose, if that is available. This is the case with protein. Ideally, the distribution of the population's intake level is compared to the distribution based on the average requirement and the population reference intake. Alternatively (using the rule of thumb), if the intake level is 10% lower than the average requirement, then it may be too low.

5.4 Dietary reference values – a broader view

Dietary reference values are formulated on the basis of healthy individuals with a healthy weight. However, many individuals in the Netherlands are overweight and even obese. Also, many adults, especially older adults, have one or more chronic diseases. In the Dutch Public Health Foresight Study (VTV), the National Institute for Public Health and the Environment (RIVM) states that in 2015 half of all Dutch people had at least one chronic condition.[43] While certain diseases, medicine use, underweight and overweight may influence the requirement for specific nutrients, this particular area is poorly understood. If no specific dietary guidelines or recommendations have been found for a certain specific group of adults, the dietary reference values for adults (healthy adults) are usually applied. The dietary reference values are also applied when assessing the intakes of representative population groups, which include individuals with a healthy weight as well as those who are underweight or overweight. While the committee has not investigated this matter, it is conceivable that overweight or obese individuals will have a different protein requirement. This is because overweight or obese individuals not only have more fat tissue, they also have more muscle mass.

Table 7. Summary of revised dietary reference values for protein for boys/men

Age (in years)	Average requirement (g/kg/d)	Population reference intake (g/kg/d)	Reference weight (kg)[ab]	Reference height (cm)	Average requirement (g/d)	Population reference intake (g/d)
0.5	1.12	1.31	7.6	68.0	9	10
1	0.95	1.14	10.1	76.7	10	12
1.5	0.85	1.03	11.6	82.8	10	12
2	0.79	0.97	12.9	88.4	10	13
3	0.73	0.90	15.2	97.8	11	14
4	0.69	0.86	17.3	105.5	12	15
5	0.69	0.85	19.6	113.2	14	17
6	0.72	0.89	22.0	119.9	16	20
7	0.74	0.91	24.5	126.2	18	22
8	0.75	0.92	27.4	132.5	21	25
9	0.75	0.92	30.5	138.5	23	28
10	0.75	0.91	33.5	143.7	25	30
11	0.75	0.91	36.9	149.0	28	34
12	0.74	0.90	41.3	155.2	31	37
13	0.73	0.90	46.5	161.8	34	42
14	0.72	0.89	52.2	168.5	38	46
15	0.72	0.88	58.3	175.2	42	51
16	0.71	0.87	65.7	179.1	47	57
17	0.70	0.86	67.2	181.0	47	58
18-29	0.66	0.83	75.6	185.0	50	63
30-39	0.66	0.83	73.1	182.3	48	61
40-49	0.66	0.83	73.8	183.2	49	61
50-59	0.66	0.83	75.4	181.1	50	63
60-69	0.66	0.83	72.7	177.8	48	60
≥70	0.66	0.83	73.6	175.1	49	61

Abbreviations: cm: centimetre, g/d: grams per day, g/kg/d: grams per kilogram of body weight per day

[a] The reference weight for children is calculated on the basis of heights measured in a sample of Dutch children (Fifth National Growth Study; 2009)29 compared to the corresponding weights from the Third National Growth Study (1980).31

[b] The reference weight for adults is calculated by squaring the average height (in metres) of Dutch people (in 2009-2010)23-25 and multiplying this by a body mass index of 22 kg/m2 for adults aged 18 to 50, 23 for adults aged from 50 to 70, and 24 for adults aged 70 and above.

Table 8. Summary of revised dietary reference values for protein for girls/women

Age (in years) and/ or age group	Average requirement (g/kg/d)	Population reference intake (g/kg/d)	Reference weight (kg)[ab]	Reference height (cm)	Average requirement (g/d)	Population reference intake (g/d)
0.5	1.12	1.31	7.2	66.4	8	9
1	0.95	1.14	9.5	75.0	9	11
1.5	0.85	1.03	11.0	81.5	9	11
2	0.79	0.97	12.3	87.1	10	12
3	0.73	0.90	14.7	97.0	11	13
4	0.69	0.86	16.9	104.9	12	15
5	0.69	0.85	19.1	112.1	13	16
6	0.72	0.89	21.5	118.8	15	19
7	0.74	0.91	24.1	125.3	18	22
8	0.75	0.92	26.9	131.3	20	25
9	0.75	0.92	30.1	137.3	23	28
10	0.75	0.91	34.0	143.5	26	31
11	0.73	0.90	38.4	149.7	28	35
12	0.72	0.89	43.2	155.7	31	38
13	0.71	0.88	47.6	160.8	34	42
14	0.70	0.87	51.0	164.5	36	44
15	0.69	0.85	53.2	166.9	37	45
16	0.68	0.84	57.8	168.3	39	49
17	0.67	0.83	58.3	169.2	39	48
18-29	0.66	0.83	64.6	171.0	43	54
30-39	0.66	0.83	63.1	169.3	42	52
40-49	0.66	0.83	62.8	169.0	41	52
50-59	0.66	0.83	63.8	166.5	42	53
60-69	0.66	0.83	62.9	165.4	42	52
≥70	0.66	0.83	63.2	162.2	42	52
Pregnant women						1[st] trimester +1 2[nd] trimester +9 3[rd] trimester +28
Lactating women						0 up to and including 6 months pp +19 6-12 months pp +13

Abbreviations: cm: centimetre, g/d: grams per day, g/kg/d: grams per kilogram of body weight per day, pp: post partum

[a] The reference weight for children is calculated on the basis of heights measured in a sample of Dutch children (Fifth National Growth Study; 2009)29 compared to the corresponding weights from the Third National Growth Study (1980).31

[b] The reference weight for adults is calculated by squaring the average height (in metres) of Dutch people (in 2009-2010)23-25 and multiplying this by a body mass index of 22 kg/m2 for adults aged 18 to 50, 23 for adults aged from 50 to 70, and 24 for adults aged 70 and above.

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