Dietary reference values for energy

To: the State Secretary of Health, Welfare and Sport
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Health Council of the Netherlands

contents

summary

The Health Council of the Netherlands has derived new dietary reference values for energy for infants, children and adults of various ages, including women who are pregnant and those who are breastfeeding. 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 in the Netherlands. The committee's evaluation also took into account six reports from other national and international organisations that are relevant to the Netherlands.

An average requirement for energy

The energy requirement is expressed in kilocalories or kilojoules. Energy is needed for all life processes, to maintain body weight and for physical activity. Additional energy is indicated for growth in infants, children and pregnant women. Women who are breast-feeding also need energy to produce breast milk.

The dietary reference values for energy are provided as average requirements. The average energy requirement is suitable for applications at group level and is relevant to public education on nutrition, for example as provided by the Netherlands Nutrition Centre.

Energy requirement varies widely between people

The energy requirement varies widely from person to person. Age, body weight and physical activity pattern are major influencing factors. For this reason, the average energy requirement is not suitable for application to individuals. If necessary, a dietician can estimate an individual's energy requirement based on prediction equations when issuing personal dietary advice. However, these equations can also underestimate or overestimate the personal energy requirement. It is therefore always important to monitor body weight for control purposes.

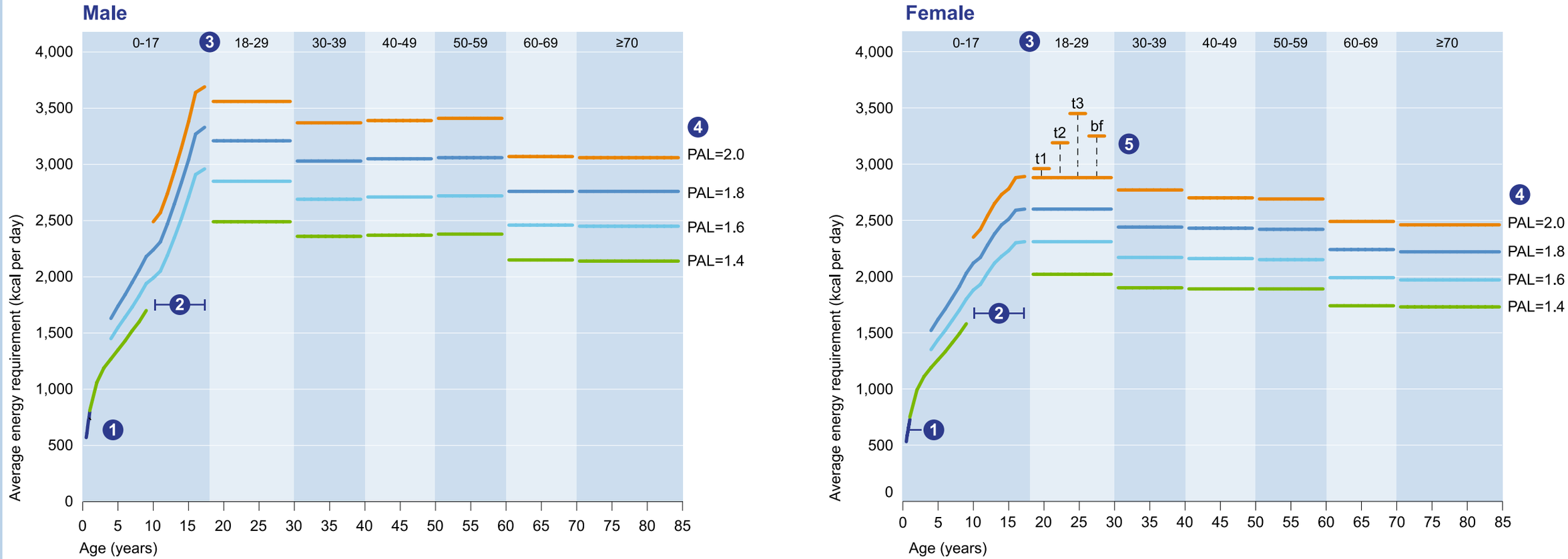
EFSA's dietary reference values converted to the Dutch situation

In determining the average energy requirement for adults, children and infants, the committee has adopted EFSA's approach. Like EFSA, it also gives the average energy requirement for adults and children for a number of levels of physical activity. The committee uses different reference weights, however, because the average Dutch person is taller and therefore slightly heavier than the average European. The average additional energy requirement for

pregnant women is slightly higher than EFSA's estimate, as the committee, based on research published after the EFSA report, assumes an optimal weight gain of 13.8 kg as opposed to the 12 kg used by EFSA. The average additional energy requirement for women who are breast-feeding is lower than the value used by EFSA, as the committee does not add any energy costs for breast milk synthesis. Figure 1 (on the next page) shows the average daily energy requirements for the different groups.

Changes compared to 2001 values

The committee now sets average energy requirements for a number of levels of physical activity, whereas in 2001, an average requirement was set for a single (average) level of activity. The committee bases its approach on more recent prediction equations for resting energy expenditure, more recent reference values for height and weight and a more recent estimate of optimal weight gain in pregnancy. The additional energy requirement during pregnancy has now been specified for each trimester, whereas a single value was derived for the entire pregnancy in 2001. The additional energy requirement for women who are breastfeeding is lower than in 2001. This is because the committee now assumes that, although energy is required for the milk itself, the energy costs of the metabolic processes involved in breast milk production are zero and that, in the first months after the birth, more energy is released due to the breakdown of fat mass. An average requirement was previously set for infants aged 0 up to and including 5 months. However, no value is provided now, as the baby drinks as needed in this period, and the average composition of breast milk is considered optimal. For infants aged 6 months to 1 year, the average energy requirements are now specified for each month, with separate values for males and females.



1
No average energy requirement is derived for infants aged 0 up to and including 5 months. Also, no PAL value is applied in the first year of life.

2
For these ages, no value is derived for PAL = 1.4 (the green line).

3
The average energy requirements jump at the boundaries of the age groups, whereas in reality, of course, the transition is gradual. From the age of 18, a single value is used for each age group.

4
The PAL value (PAL = physical activity level) indicates how active a person is. The higher the PAL value, the more active a person is and the more energy they use. The PAL values stated are in keeping with normal activity patterns in Western society:
1.4 = low active; 1.6 = moderately active;
1.8 = active; 2.0 = very active.

5
The additional energy requirements for pregnant women and those who are breastfeeding are shown for women aged 18 to 29 and for a PAL value of 2.0 by way of illustration. The same additional energy requirements apply to the other PAL values and are applicable to all women who are pregnant or breastfeeding (regardless of age). The additional energy requirements for each trimester (t) of pregnancy and during breastfeeding (bf) are:
t1: +80 kcal/day; t2: +310 kcal/day; t3: +570 kcal/day; and bf: 370 kcal/day.

Figure 1 Average daily energy requirements for men and women by age and physical activity level (PAL value)

01 introduction

1.1 Background

Dietary reference values provide information about the amounts of energy and nutrients that healthy individuals with a healthy weight should consume to stay healthy. 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 derived by the European Food Safety Authority (EFSA) can also apply 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 dietary reference values derived by the United Nations Food and Agriculture Organization, the World Health Organization and the United Nations University (FAO/WHO/UHN)[3] are also intended for use in a wide range of countries. The Health Council is evaluating the dietary reference values published by EFSA between 2010 and 2019, to determine whether these could also be applied to the Netherlands. Three advisory reports have been issued on this topic to date: *Dietary reference values for vitamins and minerals for adults,*[4] *Dietary reference values for proteins*[5] and *Dietary reference values for vitamins and minerals for pregnant women*.[6] This fourth advisory report concerns the dietary reference values for energy.

This report addresses the question of whether EFSA's dietary reference values for energy can be adopted for the Netherlands. It also concerns the question of which other dietary reference value might be suitable if the EFSA reference value cannot be adopted.

The evaluation of the dietary reference values for energy 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 Energy

1.2.1 Daily energy requirement and energy intake

The energy requirement is the amount of energy from food (caloric intake) needed for all life processes (such as the beating of the heart and regulating the body temperature), to maintain body weight and for physical activity. Additional energy is also indicated for growth in infants, children and pregnant women. Women who are breastfeeding need energy to produce breast milk. The energy requirement generally refers to the amount of energy that is consistent with optimum long-term health.

Like the other dietary reference values, the energy requirement is established for groups, but the requirement can vary from person to person within a group. An individual person's energy requirement is determined by many different factors. Age, gender, body weight and,

most importantly, physical activity pattern have a considerable impact on the energy requirement. Other factors that (potentially) influence the energy requirement, such as body composition, hormones, medication and conditions or diseases, are not addressed in this report.

Humans meet their energy requirement by eating and drinking.
The macronutrients in food – proteins, fats and carbohydrates – provide energy. The amount of energy is expressed in kilocalories (kcal) or kilojoules (kJ), whereby 1 kcal is equal to 4.184 kJ. In this report, all amounts of energy are reported in kcal. Proteins and digestible carbohydrates provide 4 kcal per gram, fats provide 9 kcal per gram and non-digestible carbohydrates (dietary fibre) provide an average of 2 kcal per gram in mixed food. If a person consumes alcohol, this also contributes towards their energy intake (7 kcal per gram of alcohol).

1.2.2 Components of energy expenditure

Energy expenditure indicates how much energy a person uses in a specific period. Energy expenditure can be determined in different ways and in different circumstances. Some methods measure the total daily energy expenditure, while other methods measure specific components of energy expenditure, which can be used to estimate the total daily energy expenditure.

Total energy expenditure is the amount of energy a person uses in a 24-hour period. Total energy expenditure roughly consists of three components:

1. Resting energy expenditure, or resting metabolic rate. This is the amount of energy needed to maintain basic bodily functions, such as breathing, blood circulation and consciousness. The resting metabolic rate is measured in a situation where the person is awake and the influence of external factors, such as movement, recent food intake and ambient temperature, is zero or as low as possible. The person is thus not exerting any physical effort, is fasting and is not hot or cold.
2. Energy expenditure for physical activity. This is the amount of energy needed for all physical movement. Examples include activities of everyday life, such as getting dressed and undressed, walking to the supermarket, intensive exercise, such as running and swimming, and also small (sometimes subconscious) movements, such as fidgeting. Chewing and swallowing movements a person makes when eating and drinking also fall under this category. The degree of physical activity has a considerable impact on the energy requirement. Because one person may be much more active than another, energy expenditure for physical activity can vary widely. The energy expenditure for physical activity of a very active person can be twice as high as that of a very inactive person.
3. The thermal effect of food. This is the energy used to digest, absorb and transport food in the digestive system. On average, this makes up

10% of a person's energy intake (based on a varied diet).[7]

1.2.3 Measuring or estimating energy expenditure

Measuring energy expenditure provides the most accurate information on actual energy expenditure. Measurements of total energy expenditure under free-living conditions (in other words, the measurement method has no influence on factors such as the physical activity pattern) are preferred, as the level of physical activity has a significant impact on the energy requirement. However, the method used to do this (known as the doubly labelled water method) is very expensive. An alternative is to measure one or more components of energy expenditure, such as energy expenditure at rest, during specific physical activities or after a meal. These measurements are carried out under laboratory conditions and are known as 'indirect calorimetry'. Further information about these methods can be found in the background document to this advisory report entitled *Evaluation of dietary reference values for energy*.[8]

As it is not possible to measure energy expenditure for every individual, prediction equations have been developed that can estimate the total energy expenditure or resting energy expenditure based on factors such as age, gender, body weight and height. These equations are easy to use and, particularly the equations for resting energy expenditure, are widely used around the world. Many equations have been developed in the past few decades. An overview can be found in the background document *Evaluation of dietary reference values for energy*.[8]

Total energy expenditure can be calculated based on data on the estimated resting energy expenditure and the physical activity level. The level of physical activity is generally expressed as the PAL (physical activity level) value. The PAL value is the ratio of resting energy expenditure to total energy expenditure. Multiplying the estimated resting energy expenditure by the estimated PAL value gives the total energy expenditure and therefore the energy requirement. By using different PAL values, the wide variation in physical activity between groups can be accounted for.

Measurements of energy expenditure carried out in infants, children, pregnant women and breastfeeding women, as well as prediction equations specifically developed for these groups, include part of the energy costs associated with *growth* and *lactation* (breastfeeding). This concerns the so-called synthetic cost: the energy needed to produce new body tissue (in the case of growth) or breast milk (in the case of lactation). However, these measurements and predictions do not include the energy deposited as protein and fat in new body tissue or in breast milk.

1.2.4 Explanatory notes on the PAL value

The PAL value indicates how active a person is. The higher the PAL value, the more active a person is and the more energy they use. A PAL value of 1.4 represents a low active, 1.6 a moderately active, 1.8 an active and 2.0 a very active physical activity pattern. A PAL value below 1.4 is also possible. People who spend the entire day sitting and/or lying down (also referred to as 'sedentary behaviour'[9]) have a PAL value of 1.2 to 1.3. A PAL value above 2.0 is also possible, but it is rare. Very high values (2.5 to 5.0) have only been measured in the case of extreme activity, such as during the Tour de France or expeditions to the South Pole. It is unlikely, however, that this level of activity can be maintained for prolonged periods.[10]

Most adults and adolescents have a PAL value between 1.4 and 2.0. Adults and adolescents who carry out sedentary work without the opportunity to move around (such as people with an office-based job) and only carry out light domestic or recreational activities in their spare time, such as dusting, shopping or playing a musical instrument, will have a PAL value of around 1.4. A person must be very active to have a PAL value of 2.0 (or above). This includes people whose work is very physically demanding, but also people who are very active in their spare time. Examples are construction workers and people who are training for a marathon.

Most toddlers and children of primary school age have a PAL value between 1.4 and 1.8. Young children who have just started to walk, still sleep a lot during the day and spend a lot of time 'stuck' in a child seat or pushchair will have a PAL value of around 1.4. A PAL value of 1.4 is also consistent with children of primary school age who spend a lot of time at school sitting down to work, spend around an hour a day playing outside and spend a lot of their remaining time looking at screens. A PAL value of 1.8 relates to children who spend a lot of time playing intensively outdoors, cycle a long way to school every day and/or play a lot of sports.

For both adults and children, there is a wide range of more or less active physical activity patterns between these two extremes (low active to very active). To get an idea of the type of physical activity pattern that corresponds to a specific PAL value, the box labelled 'Daily physical activity patterns for different PAL values' outlines specific examples for adults and children.

A higher PAL value can be achieved in many different ways. A person may be more active at work (for instance, working standing or walking instead of working sitting down), in their method of transport (for example, cycling to school or work instead of travelling by car or train) or by moving more in their spare time (walking, practising sports or playing outside instead of watching TV). Inactive people who adapt their physical activity pattern in

line with the Council's Physical Activity Guidelines (2017)[11, a] will achieve a higher PAL value. However, a physical activity pattern that meets the minimum criteria in these guidelines is not the same as a very active physical activity pattern. By way of illustration: switching to a physical activity pattern that complies with the minimum criteria of the physical activity guidelines would cause the PAL value of an adult with a sedentary physical activity pattern (PAL value of 1.2 to 1.3) to increase by an average of 0.05 to 0.10. The PAL value of sedentary children who start to comply with the physical activity guidelines will rise by an average of 0.05 to 0.20. People who follow the physical activity guidelines can still have a fairly low PAL value (around 1.4). But not all people with a PAL value of 1.4 (low active physical activity pattern) comply with the physical activity guidelines. This is because a PAL value of 1.4 can be achieved through light physical activity alone, whereas a person must also perform physical activities of moderate or high intensity to comply with the guidelines – children for at least one hour a day and adults for at least 150 minutes per week. Moderate physical activities are activities for which the energy expenditure per minute is at least three times as high as at rest (with a MET value of at least 3.0; see box).

The Committee notes that average PAL values can differ slightly between groups (for example, between men and women and between younger and older people), but that the picture is not consistent enough to quantify these differences. It is clear that the differences between people within these groups are much greater.

Daily physical activity patterns for different PAL values

The tables on the next pages provide a number of sample daily physical activity patterns for adults and children that correspond to different PAL values (PAL = physical activity level). The PAL value is calculated based on the intensity and duration of an activity. The intensity of a physical activity is indicated by a MET value, or the metabolic equivalent, which shows how much energy a specific activity requires compared to the resting energy expenditure (1.0 MET = resting energy expenditure).[12-14] The PAL value therefore relates to the daily energy expenditure, whereas MET values relate to specific activities. Specific examples of each type of activity are given at the bottom of the table with the corresponding MET values.

[a] The physical activity guideline for adults is as follows: 'Engage in physical activity of moderate (or vigorous) intensity, such as walking and cycling, for at least 150 minutes every week, spread over several different days'. The physical activity guideline for children aged 4 up until and including 17 is as follows: 'Engage in physical activity of moderate (or vigorous) intensity for at least one hour every day'.

Table 1 Examples of daily physical activity patterns of adults. The table shows the number of hours a day spent on a specific type of activity (adding up to 24 hours) within the relevant physical activity pattern

Type of activity	Low active (PAL=1.4)[a] *Example 1*	Low active (PAL=1.4)[a] *Example 2*	Moderately active (PAL=1.6) *Example 1*	Moderately active (PAL=1.6) *Example 2*	Active (PAL=1.8) *Example 1*	Active (PAL=1.8) *Example 2*	Very active (PAL=2.0) *Example 1*	Very active (PAL=2.0) *Example 2*
Sleeping	8 hours	8 hours	8 hours	8 hours	8 hours	8 hours	8 hours	8 hours
Sedentary work	8 hours	-	8 hours	8 hours	8 hours	-	8 hours	-
Standing work with light activity	-	-	-	-	-	8 hours	-	-
Standing and walking work	-	-	-	-	-	-	-	8 hours
Commuting to work by car or public transport	1 hour	-	1 hour	-	-	1 hour	-	1 hour
Cycling to work	-	-	-	1 hour	1 hour	-	1 hour	-
Light domestic activities	3 hours	2 hours	2 hours	2 hours	2 hours	1 hour	1 hour	0.5 hours
Moderate domestic activities	-	1 hour	-	-	-	-	-	-
Light recreational activities	1 hour	1 hour	-	1 hour	-	1 hour	-	-
Moderate recreational activities	-	-	2 hours	-	-	-	-	-
Intensive recreational activities	-	-	-	-	1 hour	-	2 hours	-
Activities involving very little physical exertion	3 hours	12 hours	3 hours	4 hours	4 hours	5 hours	4 hours	6.5 hours

[a] If a person is in a sitting, reclining or lying posture, without doing any light activities, the PAL value is reduced by more than 0.1. Sitting, reclining and lying activities that involve little energy expenditure, with the exception of sleeping, are referred to in the specialist literature as ‘sedentary behaviour’.[9]

Examples of activities by adults and corresponding MET values:[12,14]

- sedentary working (MET 1.5): sedentary working or studying;
- activities involving very little physical exertion (MET 1.0 to 1.5): eating, working at a computer, watching TV, reading, listening to music, knitting;
- light domestic activities (MET 1.5 to 3.0): getting dressed and undressed, showering, dusting, doing the dishes, ironing, shopping;
- moderate domestic activities (MET 3.0 to 6.0): cooking, cleaning, hoovering, washing windows, making beds, gardening, mowing the lawn;
- light recreational activities (MET 1.5 to 3.0): playing darts, yoga, sewing, playing a musical instrument, painting standing up, playing card or board games;
- moderate recreational activities (MET 3.0 to 6.0): cycling at an easy pace (<16 km/hour), walking, playing volleyball, going to the gym, gymnastics, golf, dog walking;
- intensive recreational activities (MET >6.0): running, swimming, football, tennis, dancing, cycle racing.

Table 2 Examples of daily physical activity patterns of children. The table shows the number of hours a day spent on a specific type of activity (adding up to 24 hours) within the relevant physical activity pattern

Type of activity	Low active (PAL=1.4)[a,b] *Example 1*	Low active (PAL=1.4)[a,b] *Example 2*	Moderately active (PAL=1.6)[c] *Example 1*	Moderately active (PAL=1.6)[c] *Example 2*	Active (PAL=1.8)[c] *Example 1*	Active (PAL=1.8)[c] *Example 2*	Very active (PAL=2.0)[d] *Example 1*	Very active (PAL=2.0)[d] *Example 2*
Sleeping	12 hours	10 hours	10 hours	9 hours	10 hours	9 hours	9 hours	9 hours
Sedentary working (or studying)	-	3 hours	3 hours	8 hours	3 hours	8 hours	6 hours	8 hours
Travelling to childcare, school or work by car or public transport	1 hour	1 hour	1 hour	-	1 hour	-	1 hour	-
Cycling to childcare, school or work	-	-	-	1 hour	-	2 hours	-	2 hours
Light domestic activities	1 hour	1 hour	1 hour	1 hour	1 hour	1 hour	1 hour	1 hour
Moderate domestic activities	-	1 hour	1 hour	1 hour	1 hour	2 hours	1 hour	1 hour
Light recreational activities	5 hours	3 hours	3 hours	2 hours	1 hour	1 hour	-	-
Moderate recreational activities	1 hour	-	-	-	-	-	1 hour	2 hours
Intensive recreational activities	-	-	1 hour	-	2 hours	-	2 hours	-
Activities involving very little physical exertion	4 hours	5 hours	4 hours	2 hours	5 hours	1 hour	3 hours	1 hour

[a] If a person is in a sitting, reclining or lying posture, without doing any light activities, the PAL value is reduced by more than 0.1. Sitting, reclining and lying activities that involve little energy expenditure, with the exception of sleeping, are referred to in the specialist literature as ‘sedentary behaviour’.[9]

[b] Examples apply to children aged 1 to 9.

[c] Examples apply to children aged 4 to 17.

[d] Examples apply to children aged 10 to 17.

Examples of activities by children and corresponding MET values:[13]

- sedentary working or studying (MET 1.5): sedentary working in class or studying;
- activities involving very little physical exertion (MET 1.0 to 1.5): eating, working at a computer, watching TV, reading, listening to music;
- light domestic activities (MET 1.5 to 3.0): setting the table, doing the dishes, shopping;
- moderate domestic activities (MET 3.0 to 6.0): getting dressed and undressed, hoovering, hanging out washing;
- light recreational activities (MET 1.5 to 3.0): playing with toys, playing card or board games, gaming sitting down, playing a musical instrument;
- moderate recreational activities (MET 3.0 to 6.0): moderately active outdoor play, in-line skating, cycling at an easy pace, aerobics, volleyball;
- intensive recreational activities (MET >6.0): very active outdoor play, trampolining, running, swimming, football, tennis

1.3 Dietary reference values and their application

1.3.1 A single dietary reference value for energy: the average requirement

Only one type of dietary reference value is derived for energy: the average requirement. In the case of a normal distribution, this is the intake level at which 50% of individuals in a group do and 50% do not meet their requirement. A population reference intake or adequate intake is also derived for vitamins, minerals, proteins and essential fatty acids. This level is higher than the average requirement and meets the needs of almost all individuals in a population. The reason for this is that an intake of these dietary substances that exceeds the individual requirement is not harmful provided it remains below the tolerable upper intake level (a different type of dietary reference value). This does not apply to energy: a person's energy intake can vary somewhat from day to day, but should on average correspond to their individual requirement. If it does not, the result is a desired or undesired change in body weight and, in the long term, an increased risk of being overweight or underweight.

As the average requirement is the only type of dietary reference value derived for energy, the Committee uses the term 'average energy requirement' instead of 'dietary reference value' in the rest of this report.

1.3.2 Application of the average energy requirement

Dietary reference values refer to the average conditions in larger population groups. The average energy requirement is therefore suitable for applications at group level. The average energy requirement is relevant for parties that provide public education on nutrition or offer food to large groups of people. For example, the average energy requirement can be used to calculate sample menus for the general population, by organisations such as the Netherlands Nutrition Centre. The average energy requirement can also serve as a basis for the provision of daily food to larger groups, such as the army or nursing home residents.

Unlike other dietary reference values, the average energy requirement cannot be used to monitor the energy intake of the Dutch population. This is because the assumption made here, namely that intake and requirement are independent of each other, does not apply to energy. A person with a higher energy requirement will also consume more energy. The average energy requirement is also unsuitable for applications at individual level. Due to the wide variation in energy requirement from person to person and the potentially undesirable influence of a too high or too low energy intake on body weight, energy intake must correspond to a person's individual energy requirement, not to the average requirement.

1.4 Focus of the advisory report

The average energy requirement is aimed at healthy adults with a healthy and stable weight. The Committee uses the term ‘adults’ to refer to adult men and non-pregnant, non-breastfeeding adult women. For children and infants, this advice is aimed at healthy children with a healthy weight and healthy growth. For pregnant women, the basic assumption is a healthy singleton pregnancy in adult women with a healthy pre-pregnancy weight and optimum weight gain during pregnancy (see Section 3.4 for explanatory notes). For breastfeeding women, the basic assumption is that the woman is exclusively breastfeeding one child and experiences average weight loss in the first six months after giving birth (see Section 3.5).

1.5 Reading guide

In Chapter 2, the Committee briefly describes the method it has used to evaluate the average energy requirement. In Chapter 3, the revised average requirements are shown by age group and gender, along with a brief explanation of how the requirements have been derived. In Chapter 4, an overview is given of the revised average daily energy requirements for the Netherlands, the Committee addresses a number of points of attention regarding the use of the average energy requirement by dieticians and doctors, for example, and an explanation is provided of the differences compared to the average energy requirements that applied until the publication of this report. There is a background document to this advisory report entitled *Evaluation of dietary reference values for energy* (available at www.gezondheidsraad.nl), which gives a more detailed description of how the dietary reference values have been evaluated and derived.[8]

02 methodology

With a view to the harmonisation of dietary reference values across Europe, the Committee adopted the EFSA report on dietary reference values for energy as a starting point. It evaluated whether the EFSA reference values for energy can be applied in the Netherlands based on six other national and international reports.

2.1 Comparison of seven national and international reports

The Health Council considers that harmonisation of reference values across Europe is preferable. The Committee's first step was therefore to evaluate whether EFSA's average energy requirements, as set out in the following report, can be adopted for the Netherlands:

- EFSA's *Scientific Opinion on Dietary Reference Values for Energy*, 2013.[15]

Where the Committee has determined that the EFSA value cannot be used in the Netherlands, it has sought to identify other suitable reference values. In its evaluation of EFSA's average energy requirements, the Committee took into account six reports by other national and international organisations, namely:

- the reference values for energy that applied in the Netherlands prior to this advisory report, taken from the report *Dietary reference intakes: energy, proteins, fats and digestible carbohydrates* by the Health Council of the Netherlands, 2001;[16]
- *Human energy requirements* by the United Nations Food and Agriculture Organization (FAO), the World Health Organization (WHO) and the United Nations University (UNU), 2004, for all countries;[3]
- *Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids* by the US Institute of Medicine (IoM; known since 2015 as the National Academy of Medicine), 2005, for the United States and Canada;[2]
- *Nordic Nutrition Recommendations 2012* by the Nordic Council of Ministers (NCM), 2014, for the Scandinavian countries (Norway, Sweden, Finland, Denmark, Iceland, Greenland, the Faroe Islands and Åland);[17]
- *Referenzwerte für die Nährstoffzufuhr* (Reference values for nutritional intake) by the DACH countries, 2015, for Germany (D), Austria (A) and Switzerland (Confoederatio Helvetica [CH]);[18,19]
- *Dietary reference values for energy* by the UK Scientific Advisory Committee on Nutrition (SACN), 2011, for the United Kingdom.[20]

The Committee largely selected the above reports in line with the approach adopted for the recent evaluations of other dietary reference values in the Netherlands. 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.[16] The Committee considered four other reports to be important because they focus on application in large regions and are relevant to the Netherlands.[2,3,17-19] The Committee did not take into account reports by

SACN in previous evaluations, because these reports focus on application in a single state and not to large regions. Nevertheless, it has decided to include the SACN report on energy in this instance because EFSA often referred to this report in deriving the dietary reference values for energy.

The Committee has assessed for each age group or category whether there are serious objections (from a scientific point of view) to the method used by EFSA to derive the average energy requirements. This assessment is mainly based on a comparison between the EFSA report and the six other reports. The Committee also considered whether there is a special Dutch context that would require the Netherlands to adopt an average energy requirement for the average Dutch citizen that differs from that for the average European. One of the reasons for this is the fact that, on average, Dutch people are taller than other Europeans (Section 2.3). The Committee has not carried out a literature update, because the focus lies on harmonisation with the EFSA report.
The literature put forward by the Committee's experts has been assessed and taken into account in the evaluation.

The Committee's evaluation is described in the background document *Evaluation of dietary reference values for energy*.[8] This document explains EFSA's method of derivation and considerations for each age group or category. The similarities and differences compared to the derivation methods used by the six other organisations are also set out.

The Committee's considerations and conclusions are then described in relation to these derivation methods, in the light of the situation in the Netherlands.

2.2 Age groups and categories

The Committee uses the same age groups and categories as EFSA. As a result, the grouping in this report is different to the grouping in the 2001 report on Dutch dietary reference values for energy, proteins, fats and digestible carbohydrates,[16] but largely in line with the recent advisory reports on dietary reference values for the Netherlands.[4-6] For infants, children and adults, the Committee specifies the average energy requirement by age and gender. Due to the considerable impact of physical activity on the energy requirement, the Committee also specifies the average energy requirement by different levels of physical activity (PAL values) for almost all groups.

2.3 Reference weights

Body weight is one of the factors taken into consideration in most methods for deriving the average energy requirement. Because the average requirement relates to application at group level, 'reference weights' (reference values for body weight) are used. The reference weight is the healthy weight that corresponds to the average height of a group and is calculated on the basis of a healthy body mass index (BMI).
The Committee previously decided to use Dutch instead of European

reference values for body weight, because the average Dutch person is taller and therefore slightly heavier than the average European. The reference values for the Netherlands have been established previously – for more information, see the advisory report *Dietary reference values for proteins*.[5] The reference values for height and weight can also be found in the summary tables in Chapter 4 of this report.

03
average energy requirements for the Netherlands

The Committee has established average energy requirements for different groups. In general, the Committee has adopted EFSA's approach but uses Dutch reference weights.

3.1 Adults (aged 18 and over)

The Committee has adopted EFSA's approach to determine the average energy requirement for adults, but uses the Dutch reference values for height and weight. The average energy requirement has been determined for each gender and age group by multiplying the estimated resting energy expenditure by a PAL value. Resting energy expenditure has been estimated using gender and age-specific prediction equations, based on body weight and height.[21] Due to the significant impact of physical activity on the energy requirement and the wide variation in physical activity between people, the Committee has also specified the average energy requirements (for each gender and age group) for four levels of physical activity (PAL values). These are PAL values that are in keeping with normal patterns of activity in Western society: 1.4 for low active, 1.6 for moderately active, 1.8 for active and 2.0 for very active, in accordance with EFSA.

EFSA does not derive an average energy requirement for adults aged 80 and over due to a lack of anthropometric data, such as height and weight, for this oldest group. The Committee has replaced the highest age group used by EFSA, namely 70 to 79, with 70 and over, because reference values for height and weight are indeed available for Dutch elderly people aged 70 to 90.[5] The Committee has opted to expand the last group instead of adding additional age groups. This is because the amount of data for adults aged 80 and over is more limited, resulting in greater uncertainty about resting energy expenditure, level of physical activity, height and weight. The use of these data would give a less accurate estimate of the average energy requirement of this group.

In this advisory report, the Committee does not present a single average energy requirement for each gender and age group. Instead, it presents four average energy requirements based on four PAL values.
This provides an indication of the distribution of the average energy requirement within the population, given the variation in physical activity. The Committee reached this decision due to the lack of sufficient recent and reliable data on physical activity patterns and the corresponding PAL value of different age groups in the Netherlands. It is therefore impossible to accurately estimate the overall average PAL value of the average Dutch person. The Committee considers data from other countries, such as the United States,[22-24] to be insufficiently representative. Furthermore, it does not consider measurements of physical activity carried out in our country 20 to 40 years ago[25,26] to be representative of current physical activity patterns, because technological developments in recent decades mean that, on average, people now spend more time sitting and/or work and take part in sports in different ways.

The revised average daily energy requirements for adults in the Netherlands are shown in Table 3 (men) and Table 4 (women).
The Committee notes that the average energy requirements jump at the boundaries of the age groups, whereas in reality, of course, the transition is gradual. The seemingly abrupt decreases in average energy requirement between some age groups (see also Figure 1 in the summary) is due to the way in which the energy requirements have been derived (per age group and not per year of age). Some of the youngest adults in the 18 to 29 age group will still be in the growth phase, which means that the average energy requirement for these youngest adults is expected to be higher than the average for the whole age group (and more in line with the average energy requirement of children aged 17), whereas the average energy requirement of the oldest adults within this age range will be slightly lower. A similar situation will apply to adults aged 70 and over: the average energy requirement of a 90-year-old will be, on average, lower than that of a 70-year-old. These transitions will be limited in scope, however, certainly compared to the differences that can exist between the individuals in these groups. Almost all international reports use broader age ranges for adults. The Committee therefore saw no reason to adopt a different approach for the Netherlands.

Table 3 Average energy requirement per day for adult males in the Netherlands[a,b,c]

Age (years)	Resting energy expenditure (kcal/d)[d]	Average requirement (kcal/d) at PAL=1.4	Average requirement (kcal/d) at PAL=1.6	Average requirement (kcal/d) at PAL=1.8	Average requirement (kcal/d) at PAL=2.0
18 up to and including 29	1,781	2,490	2,850	3,210	3,560
30 up to and including 39[e]	1,683	2,360	2,690	3,030	3,370
40 up to and including 49[e]	1,695	2,370	2,710	3,050	3,390
50 up to and including 59[e]	1,702	2,380	2,720	3,060	3,410
60 up to and including 69	1,535	2,150	2,460	2,760	3,070
70 and over	1,530	2,140	2,450	2,760	3,060

kcal/d = kilocalories per day; PAL = physical activity level

[a] Energy needed for: vital functions and maintaining body weight.

[b] Average energy requirement = estimated resting energy expenditure x PAL value.

[c] The average energy requirements have been rounded to the nearest 10.

[d] Resting energy expenditure has been estimated using the Henry prediction equations (2005)[21] based on the average height and reference weight for each gender and age group. Like EFSA, the Committee has used the prediction equations for 18-to-30-year-olds for adults aged 18 to 29, the prediction equations for 30-to-60-year-olds for adults aged 30 to 39, 40 to 49 and 50 to 59 and the prediction equations for ≥60-year-olds for adults aged 60 to 69 and ≥70.

[e] The Committee notes that there is very little difference in the average energy requirements for 30-to-60-year-olds, but has decided not to merge these age groups due to the traceability of the values.

Table 4 Average energy requirement for adult women in the Netherlands[a,b,c]

Age (years)	Resting energy expenditure (kcal/d)[d]	Average requirement (kcal/d) at PAL=1.4	Average requirement (kcal/d) at PAL=1.6	Average requirement (kcal/d) at PAL=1.8	Average requirement (kcal/d) at PAL=2.0
18 up to and including 29	1,441	2,020	2,310	2,600	2,880
30 up to and including 39[e]	1,354	1,900	2,170	2,440	2,770
40 up to and including 49[e]	1,350	1,890	2,160	2,430	2,700
50 up to and including 59[e]	1,346	1,890	2,150	2,420	2,690
60 up to and including 69	1,243	1,740	1,990	2,240	2,490
70 and over	1,232	1,730	1,970	2,220	2,460

kcal/d = kilocalories per day; PAL, physical activity level

[a] Energy needed for: vital functions and maintaining body weight.

[b] Average energy requirement = estimated resting energy expenditure x PAL value.

[c] The average energy requirements are rounded to the nearest 10

[d] Resting energy expenditure is estimated using the Henry prediction equations (2005)[21] based on the average height and reference weight for each gender and age group. Like EFSA, the Committee has used the prediction equations for 18-to-30-year-olds for adults aged 18 to 29, the prediction equations for 30-to-60-year-olds for adults aged 30 to 39, 40 to 49 and 50 to 59 and the prediction equations for ≥60-year-olds for adults aged 60 to 69 and ≥70.

[e] The Committee notes that there is very little difference in the average energy requirements for 30-to-60-year-olds, but has decided not to merge these age groups due to the traceability of the values.

3.2 Infants (aged zero to one year)

3.2.1 Infants aged zero up to and including five months

The Committee has adopted EFSA's decision not to derive an average requirement for infants up to and including five months of age (in other words, up to six months). The energy requirement of these youngest infants is equal to the amount of energy from breast milk, because breast milk is generally assumed to be the optimal diet for this age group.[27,28,a] The energy content of infant formula, which is laid down in European legislation, is also based on the composition of breast milk.[27,28] Moreover, infants of this age generally drink as needed. As a result, it is not necessary to derive a reference value for infants who receive breast milk or formula. Unlike EFSA, the Committee does determine an average requirement for infants aged six months (see 3.2.2.). The reason for this is that solid food starts to play a role in energy intake from the age of six months.

3.2.2 Infants aged 6 to 11 months

The Committee has adopted EFSA's approach to determine the average energy requirement for infants aged 7 to 11 months. It also uses this approach to determine the average energy requirement for infants aged six months. In doing so, the Committee applies the Dutch reference values for body weight and weight gain.

The average energy requirement is calculated as total energy expenditure plus energy deposited in new body tissue for growth. Total energy expenditure is estimated using the prediction equation derived from doubly labelled water measurements of total energy expenditure in

[a] For the most part, breast milk is assumed optimal for young infants, but there are supplementation recommendations with regard to the supply of vitamin D and vitamin K.[29,30]

exclusively breastfed infants.[31] The amount of energy captured in new body tissue has been calculated by multiplying three factors:

1. the average increase in protein and fat deposited in growing tissue per gram of weight gain (in g/d),
2. the energy density of protein (5.65 kcal/g) and fat (9.25 kcal/g) and
3. the average increase in body weight.[32] As the increase in protein, fat and body weight differs with age (see the background document[8]), the average energy requirement is calculated per month of life, in accordance with EFSA.

Table 5 shows the revised average energy requirements for infants aged 6 up to and including 11 months in the Netherlands.

Table 5 Average energy requirement per day for infants aged 6 up to and including 11 months in the Netherlands[a,b,c]

Age (months)	Average requirement (kcal/d) for boys	Average requirement (kcal/d) for girls
6	580	540
7	620	590
8	670	620
9	720	660
10	750	690
11	800	730

kcal/d = kilocalories per day

[a] Energy needed for: vital functions, maintaining body weight and growth.

[b] Average energy requirement = total energy expenditure + energy in growing body tissue.

[c] The average energy requirements have been rounded to the nearest 10.

3.3 Children (aged 1 up to and including 17 years)

The Committee has adopted EFSA's approach to determine the average energy requirement for children, but uses the Dutch reference values for body weight and height.

The average energy requirement of boys and girls aged 1 to 17 is specified for each year of life. The average energy requirement has been calculated by multiplying three factors:

1. estimated resting energy expenditure;
2. level of physical activity (PAL value);
3. a multiplication factor of 1.01 for the energy costs of growth.[3]

Like in adults, resting energy expenditure has been estimated using gender and age-specific prediction equations, based on body weight and height.[21] For children aged four and over, the average energy requirement has also been established for a number of levels of physical activity. For children aged 4 to 9, the PAL values 1.4, 1.6 and 1.8 have been used. For children aged 10 to 17, the PAL values 1.6, 1.8 and 2.0 have been used. For children aged 1 to 3, a single PAL value has been applied (1.4), because differences in physical activity patterns between children are very small in this age group.[20] The PAL values have been chosen on the basis of the series of most common PAL values in children mainly from the United States and the United Kingdom (in accordance with EFSA). As the most common PAL values differ by age, the PAL values for children have

been specified for each age group. The Committee does not consider it possible to establish the current average PAL values for children in the Netherlands, as not enough recent data are available.

The revised average daily energy requirements for Dutch children are shown in Table 6 (boys) and Table 7 (girls).

Table 6 Average energy requirement per day for boys (aged 1 to 17) in the Netherlands[a,b,c,d]

Age (years)	Resting energy expenditure (kcal/d)[e]	Average requirement (kcal/d) for PAL=1.4[f]	Average requirement (kcal/d) for PAL=1.6[f]	Average requirement (kcal/d) for PAL=1.8[f]	Average requirement (kcal/d) for PAL=2.0[f]
1	573	810	–	–	–
2	752	1,060	–	–	–
3	842	1,190	–	–	–
4	898	1,270	1,450	1,630	–
5	956	1,350	1,550	1,740	–
6	1,014	1,430	1,640	1,840	–
7	1,071	1,520	1,730	1,950	–
8	1,135	1,600	1,830	2,060	–
9	1,172	1,660	1,890	2,130	–
10	1,233	–	1,990	2,240	2,490
11	1,271	–	2,050	2,310	2,570
12	1,356	–	2,190	2,470	2,740
13	1,455	–	2,350	2,650	2,940
14	1,562	–	2,520	2,840	3,150
15	1,675	–	2,710	3,040	3,380
16	1,800	–	2,910	3,270	3,640
17	1,829	–	2,960	3,330	3,690

kcal/d = kilocalories per day; PAL = physical activity level

[a] Energy needed for: vital functions, maintaining body weight and growth.

[b] Average energy requirement = estimated resting energy expenditure x PAL value x growth factor. The growth factor is 1.01 (or 1%).

[c] The average energy requirements have been rounded to the nearest 10.

[d] The derived average energy requirements for each year of age apply to boys who have just reached that age. For instance, the average requirement for boys aged two applies to boys aged two years and 0 months. For boys aged two years and six months, the average requirement will lie between the values for boys aged two and three years.

[e] Resting energy expenditure is estimated using the Henry prediction equations (2005)[21] based on the average height and reference weight for each gender and age group. For boys aged 9 and 10, the Committee has taken the average of the energy expenditure calculated using the prediction equations for 3-to-10-year-olds and that for 10-to-18-year-olds, as the numbers obtained by that method are more in line with the expected increase in energy requirement at this age.

[f] The average requirement includes energy for growth.

Table 7 Average energy requirement for girls (aged 1 to 17) in the Netherlands[a,b,c,d]

Age (in years)	Resting energy expenditure (kcal/d)[e]	Average requirement (kcal/d) for PAL=1.4[f]	Average requirement (kcal/d) for PAL=1.6[f]	Average requirement (kcal/d) for PAL=1.8[f]	Average requirement (kcal/d) for PAL=2.0[f]
1	529	750	–	–	–
2	699	990	–	–	–
3	786	1,110	–	–	–
4	838	1,190	1,350	1,520	–
5	888	1,260	1,440	1,620	–
6	940	1,330	1,520	1,710	–
7	995	1,410	1,610	1,810	–
8	1,052	1,490	1,700	1,910	–
9	1,101	1,560	1,780	2,000	–
10	1,165	–	1,880	2,120	2,350
11	1,196	–	1,930	2,170	2,420
12	1,256	–	2,030	2,280	2,540
13	1,310	–	2,120	2,380	2,650
14	1,351	–	2,180	2,460	2,730
15	1,378	–	2,230	2,510	2,780
16	1,424	–	2,300	2,590	2,880
17	1,431	–	2,310	2,600	2,890

kcal/d = kilocalories per day; PAL = physical activity level

[a] Energy needed for: vital functions, maintaining body weight and growth.

[b] Average energy requirement = estimated resting energy expenditure x PAL value x growth factor. The growth factor is 1.01 (or 1%).

[c] The average energy requirements have been rounded to the nearest 10.

[d] The derived average energy requirements for each year of age apply to girls who have just reached that age. For instance, the average requirement for girls aged two applies to girls aged two years and zero months. For girls aged two years and six months, the average requirement will lie between the values for girls aged two and three years.

[e] Resting energy expenditure is estimated using the Henry prediction equations (2005)[21] based on the average height and reference weight for each gender and age group. For girls aged 9 and 10, the Committee has taken the average of the energy expenditure calculated using the prediction equations for 3-to-10-year-olds and that for 10-to-18-year-olds, as the numbers obtained by that method are more in line with the expected increase in energy requirement at this age.

[f] The average requirement includes energy for growth.

3.4 Pregnant women

The Committee has adopted EFSA's approach, although it uses a different optimum weight gain during pregnancy (13.8 kg) to EFSA (12 kg).

For pregnant women, the average *additional* energy requirement during pregnancy is specified instead of the *average* energy requirement. For women who start pregnancy at a healthy weight, the Committee assumes based on recent research that a weight gain during pregnancy of 13.8 kg is optimal with a view to the risk of pregnancy complications.[33,34]
This reference value has also been applied by the Committee in previous advisory reports that specify dietary reference values for pregnant women[5,6] and is used by the Nordic countries (NCM).[17] The optimum weight gain during pregnancy is higher in women who are underweight and lower in women who are overweight prior to pregnancy.[33]

The additional energy requirement includes the energy needed for growth of the foetus, growth of the pregnant woman and the resulting change in resting metabolism in the pregnant woman. This additional requirement is calculated by adding two factors:

1. the increase in total energy expenditure during pregnancy (measured using the doubly labelled water method[35];
2. the energy deposited in newly formed body tissue of the mother and the foetus.

Over the entire pregnancy, 686 grams of protein (with an energy density of 5.65 kcal/g) and 4.3 kg of fat (9.25 kcal/g) are stored in new body tissue.[35] As the amounts of protein and fat that are deposited in new body tissue, and therefore the increase in body weight, differ in each trimester, the additional requirement has been specified per trimester.

Table 8 shows the additional daily energy requirement for pregnant women in the Netherlands per trimester. The average additional energy requirement in the first trimester is limited. The Committee emphasises that pregnant women do not need to 'eat for two'. This advice certainly applies in the first trimester, but also in the second and third trimesters. Eating substantially more can lead to greater than the optimum weight gain (particularly fatty tissue) during pregnancy.

The additional energy requirements stated here apply to women with a singleton pregnancy. This is in accordance with all of the reports consulted. The additional energy requirements are likely to be higher in women with a multiple pregnancy. Available research in this area is too limited to be able to determine how much higher the additional energy requirement will be in a multiple pregnancy.[36]

The average increase in total energy expenditure during pregnancy has been measured compared to the pre-pregnancy period. This estimate therefore includes the average change in physical activity during pregnancy (at group level). The Committee stresses that an individual's additional energy requirement can deviate significantly from this group average, mainly because the degree of change in the physical activity pattern during pregnancy differs widely from woman to woman.

Table 8 Additional energy requirement per day for pregnant women in the Netherlands[a,b,c,d,e]

Trimester	Additional requirement (kcal/d)
1	+80
2	+310
3	+570

kcal/d = kilocalories per day

[a] Energy needed for: vital functions, growth of the foetus and growth of the mother.

[b] Additional energy requirement = cumulative increase in resting energy expenditure + energy costs of growth.

[c] The additional energy requirements have been rounded to the nearest 10.

[d] This table shows the average *additional* energy requirement for pregnant women, which must be added to the average energy requirement for adult women (Table 4) or, in the case of teenage pregnancies, to the average energy requirement for girls (Table 7).

[e] The additional energy requirement per trimester is calculated on the basis of the average weight gain halfway through the trimester in question, based on an optimum total weight gain of 13.8 kg (for pregnant women with a healthy BMI).

3.5 Lactating women

The Committee has adopted EFSA's decision to establish an average *additional* energy requirement instead of an *average* energy requirement for lactating women. The Committee also agrees with EFSA's decision to establish the additional energy requirement for women who exclusively breastfeed (no formula) in the first six months after giving birth. Like EFSA, the Committee does not set an additional requirement after this

six-month period. This is because the amount of breast milk the children drinks then depends on energy intake from solid food. The ratio of breast milk to solid food in this period varies widely from child to child.

The Committee has adopted EFSA's approach to establishing the additional energy requirement for breastfeeding women, with the exception that it bases its calculation of energy required for the production of breast milk solely on the energy content of breast milk and does not, like EFSA, also add the energy costs associated with the production of breast milk. These synthetic costs are included in measurements of resting energy expenditure. A number of longitudinal studies show that resting energy expenditure during lactation, compared to the period before conception or after stopping breastfeeding, varies between -4% and +7%, so around the level of no change (see the background document[8]). As a result, the Committee deems it preferable not to add energy costs for breast milk production. By doing so, it is adopting the same approach as SACN (2011)[20] in the UK and IoM (2005) in the US.[2]

Consequently, the additional energy requirement has been calculated based on two factors:

1. the energy value of breast milk;
2. the energy released by weight loss during the lactation period.

The additional body tissue (particularly fatty tissue) that the woman has built up for the pregnancy is, in principle, burned again post pregnancy. This provides energy. The additional energy requirement is therefore calculated as the energy value of breast milk minus the energy released from body tissue as a result of weight loss. On average, infants drink 807 grams of breast milk per day (with an energy density of 0.67 kcal/g).[35,37] During the first six months after giving birth, a breastfeeding woman loses an average of 0.8 kg per month in weight (6.5 kcal/g).[35,38] The additional daily energy requirement for breastfeeding women in the Netherlands is shown in Table 9.

The established additional energy requirement applies to women with a healthy weight (at the start of pregnancy), who gained an average amount of weight during pregnancy and who exclusively breastfeed one child for the first six months after giving birth. The additional energy requirement of women who exclusively breastfeed more than one child at the same time (for instance, twins) will be higher.

Weight loss is undesirable for breastfeeding women who are underweight (BMI lower than 18.5 kg/m^2). The additional energy requirement for this group corresponds to the energy value of breast milk and is therefore higher than for women who are of a healthy weight or overweight.

Women who partially breastfeed have, on average, a lower additional energy requirement than women who exclusively breastfeed, because the

baby also gets energy from infant formula and/or solid food. The reduction in the amount of breast milk the baby drinks as a result, and therefore the reduction in the mother's energy requirement, depends on the amount and type of these other foods. The Committee therefore does not derive an additional energy requirement for women who are partially breastfeeding.

Table 9 Additional daily energy requirement for lactating women in the Netherlands in the first six months after giving birth[a,b,c,d]

Period	Additional requirement (kcal/d)
0 to 6 months	+370

kcal/d = kilocalories per day

[a] Energy needed for: vital functions, maintaining body weight and breast milk.

[b] Additional energy requirement = energy value of breast milk – energy released by the burning of body tissue.

[c] This table shows the average *additional* energy requirement for lactating women, which must be added to the average energy requirement for adult women (Table 4) or, in the case of teenage mothers, to the average energy requirement for girls (Table 7).

[d] The additional energy requirement has been calculated on the basis of the average reduction in body weight during the first six months after giving birth (0.8 kg/month).

04
overview of average energy requirements and explanatory notes

4.1 Revised average energy requirements

An overview of the revised average energy requirements for the Netherlands can be found in Table 10 (boys and men) and Table 11 (girls and women). These figures replace the figures derived by the Council in 2001.

4.2 General points to consider when applying the average energy requirement

Dietary reference values, and thus the average energy requirement, apply to healthy people with a healthy weight. In order to maintain a healthy, desirable body weight, an individual's energy intake must correspond to their own energy requirement. In groups that are underweight or over-weight, the energy required to maintain the status quo will be lower or higher. Weight gain or weight loss may also be desirable, in which case the energy intake will need to be respectively higher or lower than the energy requirement. This advisory report does not address dietary advice to achieve weight change. A dietician can provide appropriate advice on this subject.

4.2.1 Estimating the level of physical activity (PAL value)

In order to apply the average energy requirement to a specific group, for instance when formulating nutritional advice, it is essential to select the PAL value that best suits the average physical activity pattern of that group (see also the box in Section 1.2). Unfortunately, research shows a moderate correlation between the PAL value and the reported physical activity pattern.[20,39] This implies that it can be difficult to estimate the correct PAL value. The Committee therefore considers it sufficient to specify the energy requirement for four activity levels (PAL values). Using more PAL values would give a false sense of accuracy.

Depending on the purpose for which the average energy requirement is being used, the PAL value that corresponds to the current or desired physical activity pattern can be adopted. It is important to be aware that the desired (optimal) PAL value, for example, a PAL value in keeping with the Physical Activity Guidelines (2017),[11] is higher than the actual PAL value for a large proportion of the population. If the energy requirement is calculated on the basis of this desired PAL value, but the actual level of physical activity is lower, the energy requirement will be overestimated. Over time, an excessive energy intake will lead to potentially undesired weight gain.

4.2.2 Energy requirement of the individual

The Committee emphasises that the *individual* energy requirement can vary considerably from the *average* energy requirement, due to factors such as variation in body weight and physical activity from person to person. This is why it is stated back in Section 1.3.2. that the average energy requirement is not suitable for application to individuals. Nevertheless, certain health care professionals will sometimes need

estimates of the energy requirement. For instance, a dietician can use the energy requirement to advise individuals on a healthy diet. In that case, the individual energy requirement needs to be estimated.

A rough estimate of an individual's energy requirement can be obtained as follows: a person's resting energy expenditure is estimated using a prediction equation based on factors such as gender, age, height and weight. The Henry prediction equations (2005)[21] can be used for this purpose, but other equations are also available for specific groups. Multiplying the resting energy expenditure by the PAL value that corresponds to a person's physical activity pattern results in the energy requirement. If applicable, the energy costs of growth or breastfeeding need to be added. It is important to remember that this type of individual estimate can still vary considerably from a person's actual energy requirement due to margins of error in the predicted resting energy expenditure and the estimated PAL value. The uncertainty in the estimate of the individual energy requirement is smaller if the resting energy expenditure is measured, as happens in some healthcare institutions: in that case, only the estimated PAL value still has a margin of error. In a period in which body weight is stable – in which case it is assumed that the energy intake and energy requirement are in balance – the energy intake also gives an estimate of the energy requirement of that person. A dietary assessment, a method used to estimate energy intake, can, however, also result in substantial underestimates or overestimates.

The foregoing demonstrates that the process of estimating an individual's energy requirement involves a great deal of uncertainty. That is why it is always important to monitor body weight (and body composition). If a person's body weight differs from their expected weight based on the estimated energy requirement and recommended energy intake, the energy requirement may have been overestimated or underestimated, or they may have deviated from the recommended diet, or both.

In the case of children, it is important to bear in mind that there is additional uncertainty when it comes to the energy requirement at a specific age due to the considerable differences in growth rates between children in general and considerable differences in the age at which the growth spurt occurs.

4.3 Differences between current and previous average energy requirements

Adults and children

Compared to the Council's 2001 report,[16] the way in which the average energy requirements have been derived for adults and children has changed in three respects:

- This report sets out the average energy requirements for a number of levels of physical activity. In 2001, a single average energy requirement was derived for each age group based on the average PAL value for each group. However, the Committee does not consider it possible to

establish the average PAL value per group for the current situation in the Netherlands, because not enough recent data are available. Older data are no longer representative of the current physical activity pattern.

- Although the average energy requirements, both previously and now, have been established by multiplying the resting energy expenditure by a PAL value, this report uses more recent prediction equations for resting energy expenditure (Henry 2005[21]; in accordance with EFSA) than the previous report (Schofield 1985[40]).
- The prediction equations for resting energy expenditure use Dutch reference weights. These reference weights have been revised based on recent data,[5] which has involved a switch to the age ranges used by EFSA.

These differences mean that it is not useful to compare the new average energy requirements for adults and children to the previous values.

Infants

This advisory report does not establish an average energy requirement for infants between zero and five months of age, whereas a requirement previously was determined for this group.[16]

The previous report established an average energy requirement of 3 megajoules (717 kcal) per day for infants aged 6 up to and including 11 months, with no distinction between boys and girls. This report specifies average energy requirements per month and separately for boys and girls. This is in accordance with EFSA. If these new values are averaged (663 kcal/day) for the purpose of comparison with the previous report, the average energy requirement is now slightly lower than previously indicated.

Pregnant women

The average additional energy requirement for pregnant women was previously derived as an average over the entire pregnancy (+290 kcal/day), whereas values are now specified for each trimester (+80, +310 and +570 kcal/day for trimesters 1, 2 and 3 respectively). The average of the three new values is almost 10% higher than the additional energy requirement over the entire pregnancy that was previously used.
The average additional energy requirements now relate to a weight gain of 13.8 kg, which for women with a healthy weight is associated with the lowest risk of pregnancy complications. This optimum weight gain is based on recent research.[33,34] An optimum weight gain of 12.0 kg was previously used.

Lactating women

The average additional energy requirement for women who are breastfeeding is now lower: an additional requirement of +370 kcal/day has now been derived compared to the previous +500 kcal/day. The main

reason for this difference is that, at that time, the energy costs associated with breast milk synthesis were added to the energy captured in the breast milk itself. Based on data on the resting energy expenditure of women in the non-lactating and lactating period, which show that the energy costs of the metabolic processes involved in breast milk production are zero, the Committee no longer considers the addition of synthesis costs to be necessary. The remaining difference is explained by the fact that the Committee now assumes that more energy is released in the first few months after giving birth due to the breakdown of mainly fat mass.

4.3.1 Recommendations for follow-up research

Based on its findings, the Committee has the following recommendations for follow-up research:

- Dietary reference values are formulated on the basis of healthy individuals with a healthy weight. However, many individuals in the Netherlands are overweight or even obese. Many adults, and older adults in particular, also have one or more chronic diseases.[41] Being underweight or overweight, having certain diseases and/or using certain medicines can have an impact on a person's energy requirement. Research into this is limited. The Committee feels it is important to carry out more research in this area, to improve public education on nutrition for these groups. For the time being, the dietary reference values for (healthy) adults are generally applied if no specific dietary guidelines or recommendations are available for a specific group of adults. It is also important to monitor body weight in these groups.
- The Committee notes that less research is available on the energy expenditure of older adults (around 70 and over) and that less anthropometric data are available for this group. More data need to be obtained to enable more reliable estimates of the average energy requirements for this oldest group.

Table 10 Overview of average energy requirements per day for boys and men[a]

Age	Reference weight (kg)	Reference height (cm)	Average requirement (kcal/d)	Average requirement (kcal/d) for PAL=1.4	Average requirement (kcal/d) for PAL=1.6	Average requirement (kcal/d) for PAL=1.8	Average requirement (kcal/d) for PAL=2.0
6 months	7.6	-	580	-	-	-	-
7 months	8.1	-	620	-	-	-	-
8 months	8.6	-	670	-	-	-	-
9 months	9.0	-	720	-	-	-	-
10 months	9.4	-	750	-	-	-	-
11 months	9.9	-	800	-	-	-	-
1 year	10.1	76.7	-	810	-	-	-
2 years	12.9	88.4	-	1060	-	-	-
3 years	15.2	97.8	-	1,190	-	-	-
4 years	17.3	105.5	-	1,270	1,450	1,630	-
5 years	19.6	113.2	-	1,350	1,550	1,740	-
6 years	22.0	119.9	-	1,430	1,640	1,840	-
7 years	24.5	126.2	-	1,520	1,730	1,950	-
8 years	27.4	132.5	-	1,600	1,830	2,060	-
9 years	30.5	138.5	-	1,660	1,890	2,130	-
10 years	33.5	143.7	-	-	1,990	2,240	2,490
11 years	36.9	149.0	-	-	2,050	2,310	2,570
12 years	41.3	155.2	-	-	2,190	2,470	2,740
13 years	46.5	161.8	-	-	2,350	2,650	2,940
14 years	52.2	168.5	-	-	2,520	2,840	3,150
15 years	58.3	175.2	-	-	2,710	3,040	3,380
16 years	65.7	179.1	-	-	2,910	3,270	3,640
17 years	67.2	181.0	-	-	2,960	3,330	3,690
18 up to and including 29 years	75.6	185.0	-	2,490	2,850	3,210	3,560
30 up to and including 39 years	73.1	182.3	-	2,360	2,690	3,030	3,370
40 up to and including 49 years	73.8	183.2	-	2,370	2,710	3,050	3,390
50 up to and including 59 years	75.4	181.1	-	2,380	2,720	3,060	3,410
60 up to and including 69 years	72.7	177.8	-	2,150	2,460	2,760	3,070
70 years and over	73.6	175.1	-	2,140	2,450	2,760	3,060

kcal/d = kilocalories per day; PAL = physical activity level

[a] The average energy requirements have been rounded to the nearest 10.

Table 11 Overview of average energy requirements per day for girls and women[a]

Age	Reference weight (kg)	Reference height (cm)	Average requirement (kcal/d)	Average requirement (kcal/d) for PAL=1.4	Average requirement (kcal/d) for PAL=1.6	Average requirement (kcal/d) for PAL=1.8	Average requirement (kcal/d) for PAL=2.0
6 months	7.2	-	540	-	-	-	-
7 months	7.7	-	590	-	-	-	-
8 months	8.1	-	620	-	-	-	-
9 months	8.5	-	660	-	-	-	-
10 months	8.8	-	690	-	-	-	-
11 months	9.2	-	730	-	-	-	-
1 year	9.5	75.0	-	750	-	-	-
2 years	12.3	87.1	-	990	-	-	-
3 years	14.7	97.0	-	1,110	-	-	-
4 years	16.9	104.9	-	1,190	1,350	1,520	-
5 years	19.1	112.1	-	1,260	1,440	1,620	-
6 years	21.5	118.8	-	1,330	1,520	1,710	-
7 years	24.1	125.3	-	1,410	1,610	1,810	-
8 years	26.9	131.3	-	1,490	1,700	1,910	-
9 years	30.1	137.3	-	1,560	1,780	2,000	-
10 years	34.0	143.5	-	-	1,880	2,120	2,350
11 years	38.4	149.7	-	-	1,930	2,170	2,420
12 years	43.2	155.7	-	-	2,030	2,280	2,540
13 years	47.6	160.8	-	-	2,120	2,380	2,650
14 years	51.0	164.5	-	-	2,180	2,460	2,730
15 years	53.2	166.9	-	-	2,230	2,510	2,780
16 years	57.8	168.3	-	-	2,300	2,590	2,880
17 years	58.3	169.2	-	-	2,310	2,600	2,890
18 up to and including 29 years	64.6	171.0	-	2,020	2,310	2,600	2,880
30 up to and including 39 years	63.1	169.3	-	1,900	2,170	2,440	2,710
40 up to and including 49 years	62.8	169.0	-	1,890	2,160	2,430	2,700
50 up to and including 59 years	63.8	166.5	-	1,890	2,150	2,420	2,690
60 up to and including 69 years	62.9	165.4	-	1,740	1,990	2,240	2,490
70 years and over	63.2	162.2	-	1,730	1,970	2,220	2,460

Age	Reference weight (kg)	Reference height (cm)	Average requirement (kcal/d)	Average requirement (kcal/d) for PAL=1.4	Average requirement (kcal/d) for PAL=1.6	Average requirement (kcal/d) for PAL=1.8	Average requirement (kcal/d) for PAL=2.0
Pregnancy trimester 1[b]	-	-	+80	-	-	-	-
Pregnancy trimester 2[b]	-	-	+310	-	-	-	-
Pregnancy trimester 3[b]	-	-	+570	-	-	-	-
Exclusively breastfeeding 0 to 6 months[b]	-	-	+370	-	-	-	-

kcal/d = kilocalories per day; PAL = physical activity level

[a] The average energy requirements have been rounded to the nearest 10.

[b] The value shown is the average *additional* energy requirement.

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Dietary reference values for energy

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