Dietary reference values for vitamins and minerals for pregnant women

To: the Minister of Health, Welfare and Sport,
the Minister for Medical Care and Sport and
the State Secretary of Health, Welfare and Sport
No. 2021/27, The Hague, 22 June, 2021

Health Council of the Netherlands

contents

executive summary

The Health Council of the Netherlands has derived new dietary reference values for vitamins and minerals for pregnant women. 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 dietary reference values across the European Union is desirable. 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 parallel with this advisory process on dietary reference values for pregnant women, the Health Council of the Netherlands has also formulated dietary recommendations for pregnant women.

Evaluation of the EFSA's dietary reference values

The Nutrient requirement corresponds to the intake that prevents symptoms of deficiency and mitigates the risk of chronic diseases as much as possible. The Committee has looked at whether there are any serious objections from a scientific point of view to the method used by the EFSA to derive the requirements (additional requirements) of pregnant women. Other leading international reports on dietary reference values have also been taken into consideration. From the parallel advisory process on dietary recommendations for pregnant women for some nutrients (namely vitamin D and calcium), additional documentation was available about intervention studies into calcium and vitamin D supplements and maternal or child health outcomes.

The evaluation shows that the EFSA's derivation method can be adopted in many cases. There were four nutrients for which the Committee would prefer a different derivation method to that used by the EFSA (namely folate, copper, calcium and iodine). It is not going to deviate, however, from the EFSA in the case of iodine because the difference from the EFSA's reference value was less than 10%. When the difference is less than 10%, the Committee has decided to adopt the EFSA reference value after all in the interests of European harmonisation. For calcium, the Committee only deviates from the EFSA regarding the second half of the pregnancy, because of additional evidence from the report *Dietary recommendations for pregnant women*, that is being published at the same time as this advisory report.

Among the vitamins and minerals, there are two nutrients for which no dietary reference values have been set for pregnant women in the Netherlands: chromium and fluoride.
The Netherlands has also not derived dietary reference values for either of these nutrients for adults. EFSA, on the other hand, does have a reference value for fluoride.

Strength of the evidence

The Committee assessed the level of evidence for the derivation of the requirements (additional requirement) of pregnant women for each

nutrient. For seventeen nutrients, the Committee found the level of the evidence to be strong or acceptable because the studies on which the derivation was based were of sufficiently good quality and/or there was a plausible rationale (e.g. increased energy requirement due to pregnancy, weight gain or physiological changes). For eight nutrients, the level of evidence for the derivation was weak.

Advisory report

The Committee considers seventeen of the updated dietary reference values for pregnant women to be suitable for application. They have sufficient scientific underpinnings or there are no indications for deficiencies in the general population. Of these seventeen dietary reference values, five are the same as for women who are not pregnant: vitamins D and K1, iron, magnesium and potassium. For calcium, the reference value for women at up to 20 weeks of pregnancy is the same as the reference value for women who are not pregnant, but from 20 weeks of pregnancy onwards it is slightly higher for women aged 25 and over than for women of that age who are not pregnant. The remaining eleven dietary reference values are higher than those for women who are not pregnant.

Table 1 Dietary reference values to be applied for pregnant women in the Netherlands

Nutrient	Population reference intake or adequate intake level
Vitamin A	750 µg RAE/d
Thiamine	0.1 mg/MJ (1.0 mg/d) Trimester: 1st: 0.9 mg/d; 2nd: 1.0 mg/d; 3rd: 1.1 mg/d
Riboflavin	1.9 mg/day
Niacin	1.6 mg NE/MJ (16 mg NE/d) Trimester: 1st: 15 mg NE/d; 2nd: 16 mg NE/d; 3rd: 17 mg NE/d
Vitamin B6	1.8 mg/d
Folate*	400 µg DFE/d (AI)
Vitamin B12	3.3 µg/d
Vitamin C	85 mg/d
Vitamin D	10 µg/d (AI)
Vitamin K1	70 µg/d (AI)
Calcium through to the 20th week of pregnancy Calcium after the 20th week of pregnancy**	ages 18-24: 1,000 mg/d; age ≥ 25: 950 mg/d 1,000 mg/d (AI)
Iron	16 mg/d
Iodine	200 µg/d (AI)
Potassium	3.5 g/d
Copper	1.0 mg/d
Magnesium	300 mg/d
Zinc	9.1 mg/d

AI: adequate intake; d: day, DFE: dietary folate equivalent, g: grams, mg: milligrams, MJ: megajoules, NE: niacin equivalents, RAE: retinol activity equivalents, µg: micrograms

* This is the reference value for folate (expressed in DFE) that applies throughout the pregnancy. In addition, the dietary supplementation recommendation for synthetic or natural folic acid applies from 4 weeks before to 8 weeks after conception.

** It is recommended that all pregnant women should achieve the adequate intake level of 1,000 mg/d from the 20th week of the pregnancy onwards.

Considerations when using dietary reference values for pregnant women

The dietary reference values are based on healthy women with a healthy pregnancy who do not require medical treatment requiring special nutritional measures.

The dietary reference values for vitamins and minerals for pregnant women are relevant for public information on nutrition, for example from the Netherlands Nutrition Centre. Furthermore, healthcare professionals such as dieticians and physicians can use these dietary reference values when advising individuals about healthy eating habits or diets. Dietary reference values are important tools for establishing a healthy dietary pattern, but if a woman's intake is lower than the population reference intake or adequate intake, it does not necessarily mean that the person's intake is insufficient for them. Additional data (e.g. from blood tests) is needed to establish this. One exception is calcium from 20 weeks' pregnancy onwards: the Committee recommends that all pregnant women should achieve the adequate intake.

01 Introduction

1.1 Background

Dietary reference values give information about the amounts of vitamins, minerals, proteins, carbohydrates and fats that healthy individuals should consume in order 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 dietary reference values across the European Union is preferable. In the case of most vitamins and minerals, the dietary reference values that have been derived for Europe as a whole may 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 WHO's (World Health Organization) and the FAO's (United Nations Food and Agriculture Organization)[3] dietary reference values are also intended for use in a wide range of different countries. That is why the Council is evaluating the dietary reference values published by the *European Food Safety Authority* (EFSA) between 2010 and 2019: to determine whether they 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] The second partial advisory report addressed protein reference values for all population groups and was published in March 2021.[6] This third partial advisory report concerns the dietary reference values for the same 27 vitamins and minerals as the first, but now for pregnant women. The minerals sodium and chloride are not in this set of 27 substances as the EFSA reports on them were published after the first partial advisory report by the Council (2018).[7,8] The Committee will consider at a later date whether a review of these minerals is necessary.

This will be followed by dietary reference values for vitamins and minerals for breastfeeding women, infants and children; dietary reference values for macronutrients (except protein) for all population groups and tolerable upper intake levels for all nutrients.

In this advisory report, the new dietary reference values for vitamins and minerals for pregnant women have been based on an estimate of the intake level required for maintaining the woman's body and enabling, among other things, the desired growth of the embryo/foetus, placenta and uterus, and increased blood volume and fat mass. In parallel with this advisory report on dietary reference values for pregnant women, the Health Council of the Netherlands has also formulated dietary recommendations for pregnant women.[9] It contains recommendations that were formulated based on the preventive effects of dietary factors against pregnancy complications or health risks in the child and on aspects of food safety. These are recommendations about intake levels for foods and beverages, healthy eating habits and some vitamins and minerals.

The two advisory reports on dietary reference values and dietary recommendations complement each other. The dietary reference values relate to the overall intake level of the vitamin or mineral and do not address the question of whether supplements are needed.[3] As far as vitamins and minerals are concerned, the dietary recommendations for pregnant women are based on the scientific evidence about the effects of taking supplements during pregnancy, *in addition to* the normal intake levels from food.[4] Another difference is that the dietary reference values are rarely based on preventing disease, whereas the dietary recommendations for pregnant women are.

The evaluation of the dietary reference values for pregnant women 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 Minister of Health, Welfare and Sport, the Minister for Healthcare, and 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.[10] 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. If the intake level of e.g. a vitamin or mineral is too low, symptoms of deficiency can occur and/or the risk of illness may be elevated. Most dietary reference values focus on preventing nutrient-specific symptoms of deficiency; accordingly, they are supplementary to the *Dutch dietary guidelines 2015*.

The Health Council of the Netherlands is tasked with deriving dietary guidelines, dietary recommendations and dietary reference values based on the latest scientific knowledge. In everyday practice, however, pregnant women need information about dietary patterns that meets not only guidelines and recommendations but also the dietary reference values. The Health Council of the Netherlands is not tasked with working out the dietary reference *values* at the level of the foods within the limits set by the *Dutch dietary guidelines 2015* and the *Dietary recommendations for pregnant women*. That is done by the Netherlands Nutrition Centre (see Figure 1).

From science to information

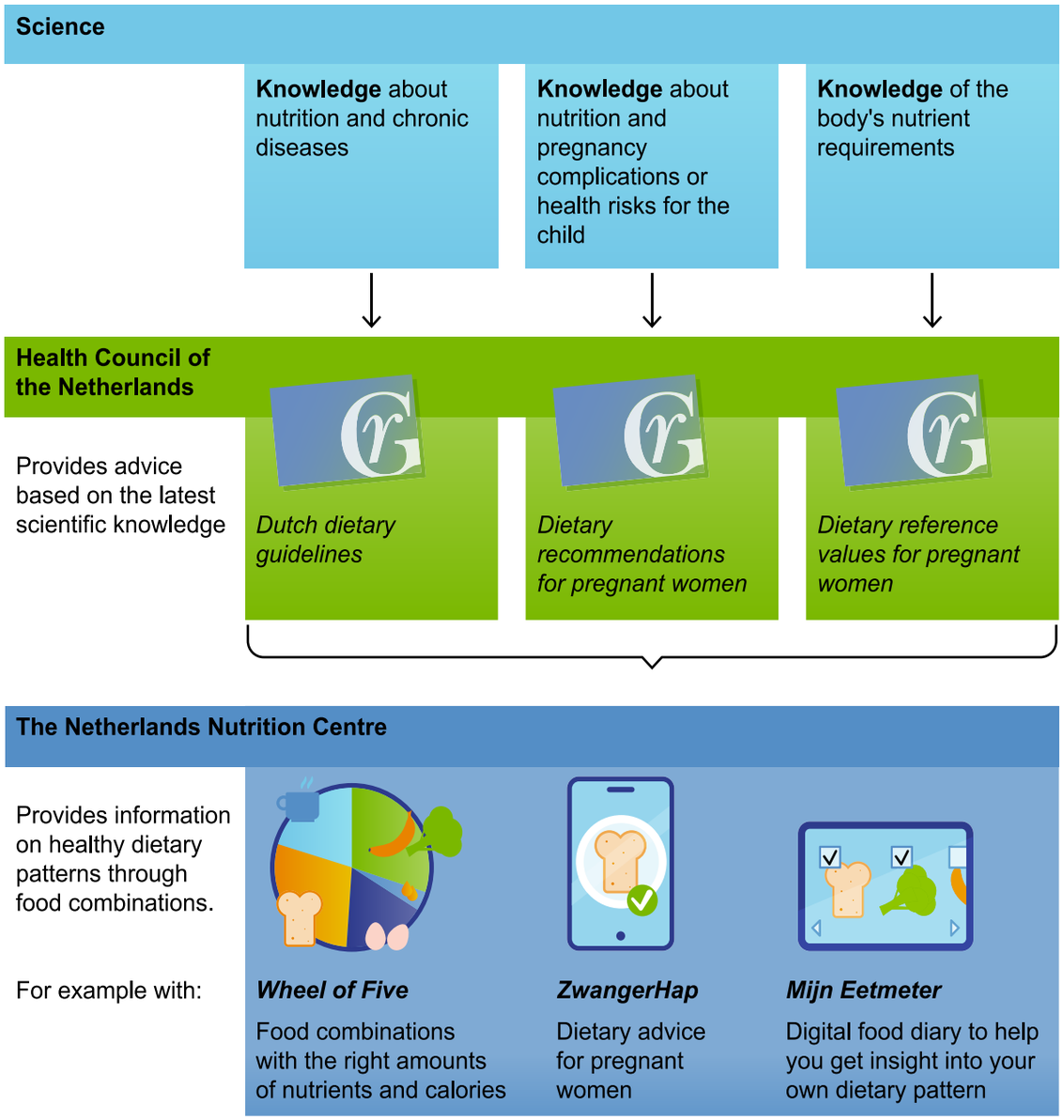

Figure 1 The public education on nutrition provided by the Netherlands Nutrition Centre combines the information from two Health Council advisory reports: the dietary reference values in this advisory report, and the dietary recommendations for pregnant women[9]

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 Figure 2). The nutrient requirement corresponds to the intake that prevents symptoms of deficiency and mitigates the risk of chronic diseases as much as possible. More about the methods for defining dietary reference values can be found in the background document *Deriving and applying average requirements and population reference intakes or adequate intake levels in adults*, which can be found on www.gezondheidsraad.nl.

Applying a population reference intake and an adequate intake is similar in many cases, but if a population reference intake has been established it necessarily means that an average requirement can also be established. In the case of an adequate intake, there is no known average requirement. The dietary reference values give information about the intake levels that the body needs to function properly or avoid illness, as well as about the highest intake levels that are still thought to be safe ('tolerable upper intake level'). This advisory report focuses on dietary reference values that relate to risks of excessively low intake rather than upper intake levels. A tolerable upper intake level is derived if there is sufficient evidence that a high intake level can produce adverse effects. These will be addressed in a later advisory report in line with the EFSA practices.[11] The reason is that the tolerable upper intake levels are aimed

at other adverse effects than the population reference intakes or adequate intakes and a different type of scientific evidence is therefore involved. The Netherlands Nutrition Centre also takes the tolerable upper intake levels into account when developing public education on nutrition for pregnant women, using the EFSA tolerable upper intake levels when doing so.

As stated above, the dietary reference values for vitamins and minerals for pregnant women are relevant for public education on nutrition, for example from the Netherlands Nutrition Centre. Furthermore, healthcare professionals such as dieticians and physicians can use these dietary reference values when advising individuals about healthy eating habits or diets. Dietary reference values are also used to monitor nutrient adequacy in the Dutch population.

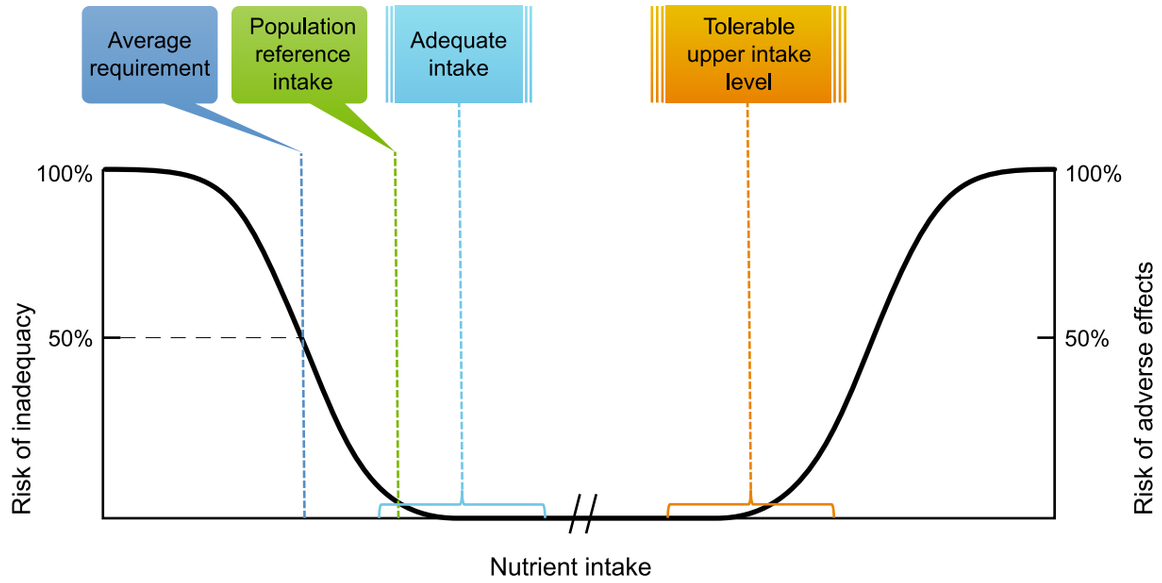

Figure 2 The types of dietary reference values in relation to nutrient intake (x-axis) and the probability that this intake is too low or too high (y-axis)

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 half of all people but not those of the other half.
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 requirements of almost everyone in the population group in question. This type of dietary reference value is determined 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.

1.3 Basic principles when formulating dietary reference values

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. In this advisory report, the Committee focuses on healthy women with healthy pregnancies who do not need medical treatment requiring any special nutritional measures.

This advisory report does not look at the question of whether the need for certain vitamins and minerals is different in obese pregnant women (BMI ≥ 30 kg/m^2) or who had chronic diseases prior to the pregnancy. Not much research has been done on this.

Women with multiple pregnancies have higher requirements than those with single pregnancies. The dietary reference values are based on single pregnancies. Teenage pregnancies are similar to multiple pregnancies in this respect, as the developing adolescent body then has higher requirements than the body of an adult pregnant woman. The dietary reference values specify the requirements of pregnant adult women. It seems likely that the requirements would be higher in cases of teenage or

multiple pregnancies but research into this is limited. Another basic principle is that the derivation of each dietary reference value is based on the assumption that intake levels of all other nutrients are sufficient.

This advisory report is about dietary reference values for pregnant women. Where the Committee refers to women who are not pregnant, this should be taken to mean non-pregnant and non-breastfeeding women of childbearing age.

1.4 Reading guide

In Section 2, the Committee explains the methodology used for evaluating the EFSA dietary reference values for pregnant women. Section 3 describes the findings of the evaluation, which are reported in greater detail in the background document *An evaluation of the EFSA's dietary reference values (DRVs) for vitamins and minerals for pregnant women*, which can be found on www.gezondheidsraad.nl. In this section, the Committee also discusses which dietary reference values merit being applied to pregnant women in the Netherlands, what the differences are between the values for women who are and are not pregnant, and what the differences are between the current and previous values for pregnant women in the Netherlands.

02 evaluation of the EFSA dietary reference values

The Committee notes that the way EFSA derives the requirements (additional requirements) for pregnant women can generally be accepted. The Committee has only decided to deviate from the EFSA for folate, copper, calcium and vitamin D. The level of evidence for deviating is not equally strong for all substances: there are eight nutrients for which the scientific basis is weak.

2.1 The method of derivation for pregnancy

The underpinnings for the dietary reference values for pregnant women vary. Sometimes a specific reference value is derived for pregnant women on the basis of studies of pregnant women (total requirement). More often, additive models are used in which an additional requirement during pregnancy is added to the reference value for women who are not pregnant (the additional requirement). In other cases, the reference value for non-pregnant women is applied to pregnant women. The choice of derivation method depends on the available research, with research into overall requirements based on studies of pregnant women being preferred in principle.

Comparison of six reports

The Committee has evaluated the EFSA dietary reference values for pregnant women based on a comparison with the five other reports on dietary reference values that it considered most relevant to the Dutch situation:

- dietary reference values of vitamins and minerals for pregnant women issued by the Health Council and applicable until this advisory process[12-16]
- *Nordic Nutrition Recommendations* by the *Nordic Council of Ministers* (NCM)[17]
- *Referenzwerte für die Nährstoffzufuhr* by the DACH countries (Germany, Austria and Switzerland)[18]
- *Dietary Reference Intakes* by the American *Institute of Medicine* (IOM[a])[19-24]
- *Vitamin and mineral requirements in human nutrition* by the World Health Organization (WHO) and the United Nations Food and Agriculture Organization (FAO)[3]

The Health Council's dietary reference values are relevant because they were the dietary reference values that applied in the Netherlands up to and during this advisory process.[12-16] Two other reports are relevant in this regard, as they relate to dietary reference values for larger European

[a] Since 2016, the *Institute of Medicine* has become part of the National Academies of Sciences, Engineering and Medicine under the name *Health and Medicine Division*.

regions. These are the *Nordic Nutrition Recommendations* for the Scandinavian countries by the Nordic Council of Ministers (NCM)[17] and the *Referenzwerte for die Nährstoffzufuhr* for the German-speaking countries, referred to as the DACH countries: Germany (D), Austria (A) and Switzerland (CH).[18] The *Dietary Reference Intakes* for the United States and Canada by the American Institute of Medicine (IOM), describe the thorough derivation of dietary reference values for the USA and Canada.[19,20,23,24] The report entitled *Vitamin and mineral requirements in human nutrition* by the WHO and FAO[3] is also intended for application in various countries. These are aimed primarily at non-Western countries with physically active, relatively young populations where clinical deficiencies due to inadequate nutrition do sometimes occur; the recommendations may therefore differ from the dietary reference values for Western countries.

This advisory report takes the process of evaluation for the EFSA dietary reference values for adults as its basis.[4] Because of the focus on evaluating the EFSA reports, the Committee did not carry out an update of the literature; this was also the case for the dietary reference values for adults. However, information that became available through the parallel advisory process on *Dietary recommendations for pregnant women* was used.[9] This specifically concerns intervention studies looking at calcium and vitamin D supplementation during pregnancy. This supplementation research did not result in any alterations for vitamin D. With regard to calcium during the second half of the pregnancy, the type of reference value has been adjusted compared to EFSA and the distinction between age groups has been dropped.

Weighting the reports

Because harmonisation is a key basic principle, the Committee has looked at whether there are any serious objections from a scientific point of view to the EFSA method of deriving the requirements (additional requirements) of pregnant women.[25-52] The background document to this advisory report contains the thorough evaluation of EFSA's method of deriving the requirements (additional requirements) of pregnant women. In it, the Committee first describes for each nutrient whether and to what extent EFSA's requirements (additional requirements) for pregnant women differ from the five other reports and what the possible reason for this might be. Three questions were central to this (Figure 3):

- Is there a specific context in the Netherlands that raises objections to using EFSA's requirement (additional requirement) for pregnant women?
- Are there any objections to the scientific basis for EFSA's requirement (additional requirement) for pregnant women?
- Does the reference value as proposed by the Committee deviate from EFSA's reference value by more than 10%?

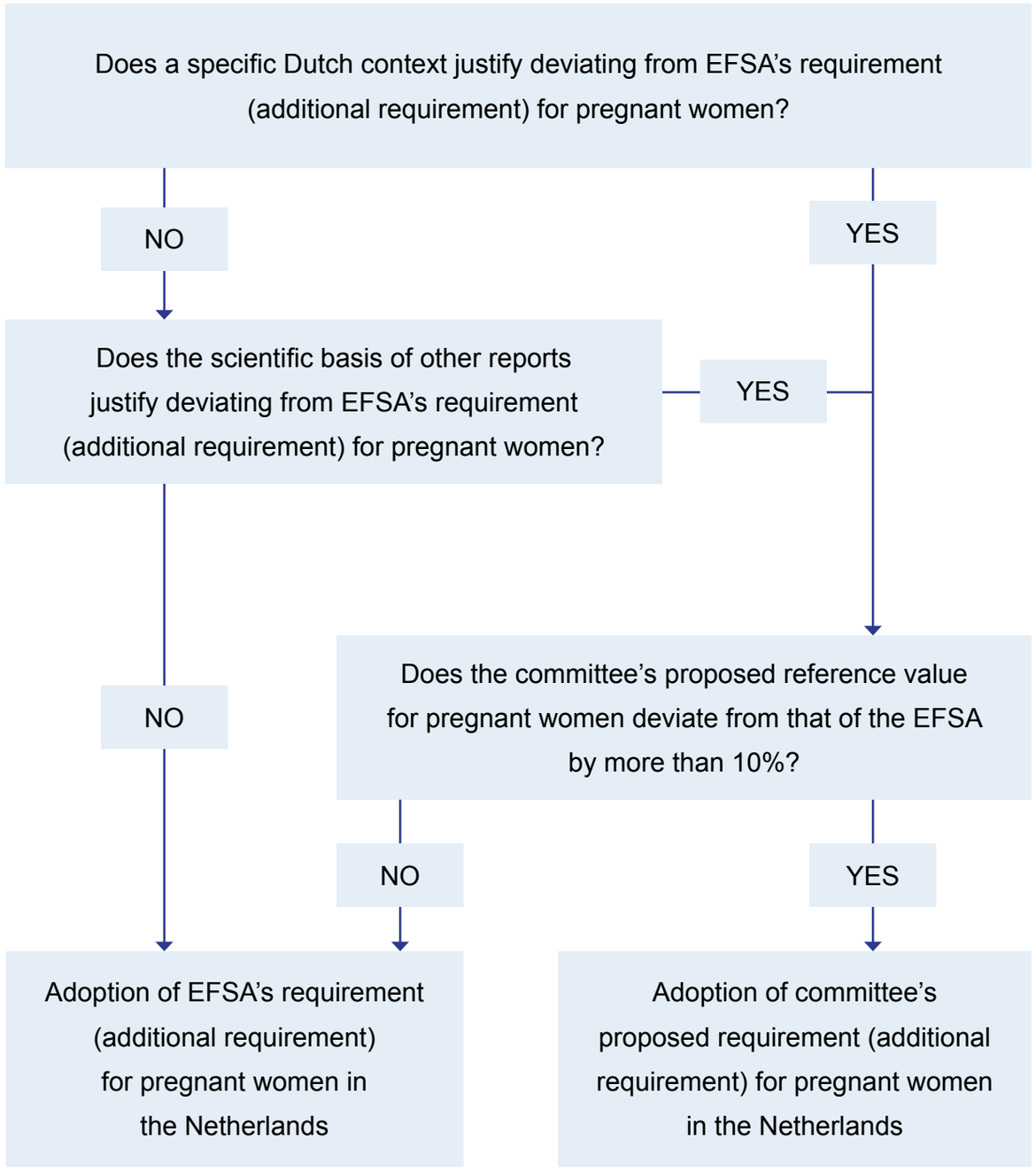

Figure 3 Flowchart for assessing EFSA's requirements (additional requirements) for pregnant women

For a small fraction of the nutrient list, the Committee has weighed up the scientific research for deriving the baseline or additional requirements of pregnant women differently than EFSA and would prefer a different reference value. However, if the preferred reference value subsequently differs from EFSA's by less than 10%, the Committee will adopt the EFSA figure nevertheless, as the Committee attaches great value to harmonisation.

This assessment shows that the EFSA derivation for the reference value based on pregnancy can be adopted in many cases. There were four nutrients for which the Committee would prefer a different derivation method to that used by the EFSA (namely folate, copper, calcium and iodine). In practice, however, it does not deviate from the EFSA in the case of iodine as the difference from the EFSA's reference value was less than 10%. For calcium, the Committee only deviates from the EFSA regarding the second half of the pregnancy, because of additional evidence from the advisory report entitled *Dietary recommendations for pregnant women*.[9] Another difference is that the Committee has not derived a reference value for fluoride for pregnant women – as is the case for non-pregnant adults – whereas the EFSA has done so (see further in Section 3).

2.2 Level of evidence

The Committee then determined the level of evidence for the derivation method of the requirements (additional requirements) of pregnant women. This sometimes concerned a dietary reference value derived specifically for pregnant women and sometimes an additional part for pregnant women. When a reference value for women who are not pregnant is adopted for those who are, the Committee has not reassessed the strength of the evidence for that reference value (as this has already been done in the advisory report on 'Dietary reference values for vitamins and minerals for adults'), but it has considered the arguments for adopting the reference value for pregnant women. The Committee distinguishes three levels of evidentiary strength: derivation methods that are strongly substantiated, acceptably substantiated and weakly substantiated.

The Committee considers derivation methods to be strongly substantiated when based on high-quality studies of the requirements (additional requirements) of pregnant women. The Committee considers derivation methods to be acceptably substantiated when based largely on studies of acceptable quality examining the requirements (additional requirements) of pregnant women. These include derivation methods based on a plausible rationale, e.g. based on increased energy requirement due to pregnancy (as in the case of thiamine and niacin), weight gain (as in the case of riboflavin, vitamin B6 and choline) or physiological adaptations such as increased absorption (as in the case of calcium, iron and potassium). The Committee considers derivation methods to be weakly substantiated when based largely on poor-quality studies and where there are no studies at all into the requirements (additional requirements) of pregnant women.

Table 1 Overview of the level of evidence for the derivation of the requirements (additional requirements) for pregnant women

Level of the scientific basis for the derivation	Nutrient	Model for deriving the reference value for pregnancy
Strong	Vitamin E	pregnant AI = non-pregnant AI (EFSA)
	Calcium after the 20th week of pregnancy	AR and PRI not adopted from the EFSA (HCNL; this advisory report)
	Iodine	Total requirement (IOM)
Acceptable	Vitamin A	Additive model (EFSA)
	Vitamin B6	Additive model (EFSA)
	Vitamin B12	Additive model (EFSA)
	Vitamin C	Additive model (EFSA)
	Folate	Additive model (HCNL))
	Copper	Additive model (IOM)
	Phosphorus	pregnant AI = non-pregnant AI (EFSA)
	Thiamine	Additive model (EFSA)
	Niacin	Additive model (EFSA)
	Riboflavin	Additive model (EFSA)
	Choline	Additive model: scaling (EFSA)
	Calcium through to the 20th week of pregnancy	pregnant PRI = non-pregnant PRI (EFSA)
	Iron	pregnant PRI = non-pregnant PRI (EFSA)
	Potassium	pregnant AI = non-pregnant AI (EFSA)
	Selenium	pregnant AI = non-pregnant AI (EFSA)
	Zinc	Additive model (EFSA)
Weak	Biotin	pregnant AI = non-pregnant AI (EFSA)
	Vitamin D	pregnant AI = non-pregnant AI (EFSA)
	Vitamin K1	pregnant AI = non-pregnant AI (EFSA)
	Pantothenic acid	pregnant AI = non-pregnant AI (EFSA)
	Magnesium	pregnant AI = non-pregnant AI (EFSA)
	Manganese	pregnant AI = non-pregnant AI (EFSA)
	Molybdenum	pregnant AI = non-pregnant AI (EFSA)

Abbreviations: AI: Adequate intake, EFSA: European Food Safety Association, HCNL: Health Council of the Netherlands, IOM: Since 2016, the Institute of Medicine has become part of the National Academies of Sciences, Engineering and Medicine under the name Health and Medicine Division.

03 the revised dietary reference values for pregnant women

According to the Committee, seventeen dietary reference values are relevant to pregnant women for public education on nutrition and for monitoring the nutrient intake of groups of pregnant women in the population. These dietary reference values have sufficient scientific underpinnings and/or there is evidence that any deficiencies may have health effects.

3.1 Dietary reference values for pregnant women in the Netherlands

Dietary reference values that merit being applied

The Committee has assessed which dietary reference values merit being applied for pregnant women in the Netherlands. An important consideration here is the evidentiary strength of the reference value, both of the part that specifically addresses the additional requirements of pregnant women and of the underlying dietary reference values for women who are not pregnant. Another factor is whether there is any evidence that deficiencies could lead to health problems in pregnant women. On that basis, the Committee has subdivided dietary reference values into those that may and may not merit being applied to pregnant women in the Netherlands.

Seventeen dietary reference values merit being applied for pregnant women in the Netherlands (Table 2). These are:

- Iodine. This dietary reference value is based on studies of pregnant women that show a certain elevated requirement (total requirement).
- Vitamins A, B6, folate, B12 and C, thiamine, riboflavin, niacin, copper and zinc. These are based on dietary reference values for women who are not pregnant that show a certain increased requirement for pregnant women (an additive model), either in research or through a plausible rationale.
- Iron and potassium. There is a scientific basis for these dietary reference values, demonstrating that the reference values for women who are not pregnant can be applied to those who are.
- Calcium. There is a scientific basis for the dietary reference value for calcium, demonstrating that the reference values for women who are not pregnant can be applied until the twentieth week of pregnancy to those who are. There is strongly substantiated evidence from supplementation studies that calcium supplements from the twentieth week of pregnancy onwards reduce the risk of hypertension, preeclampsia and premature birth.[9] The distribution of calcium requirements for this population group of pregnant women is unknown. For this reason, there is no average requirement from 20 weeks of pregnancy onwards and consequently no population reference intake and an adequate intake is stated instead. This ‘adequate intake’ (for want of a more appropriate term) has a slightly different meaning than

what an adequate intake normally involves, as the Committee is recommending specifically that all women should achieve this adequate intake from 20 weeks of pregnancy onwards.

- Vitamin D. It is very important for both the mother and her child that a sufficient intake of vitamin D is maintained during the pregnancy. Research available from the advisory report on *Dietary recommendations for pregnant women* has for example found strong evidence of a beneficial effect of vitamin D supplements on the risk of a baby being small for gestational age at birth, on the risk of asthma and asthma-like symptoms and wheezing for the baby, and on gestational diabetes.[9]
- Vitamin K1 and magnesium. Little information is known about requirements (additional requirements) of pregnant women for these substances but there are sufficiently substantiated reference values for women who are not pregnant. The Committee recommends that these should be applied to pregnant women as well.

Of the 17 Dutch dietary reference values for pregnant women that merit being applied, 9 are entirely identical to the EFSA reference value for pregnant women. For calcium, the reference value through to 20 weeks of pregnancy is the same as the EFSA dietary reference value; for the remainder of the pregnancy, the Committee has chosen a different type of reference value. For six dietary reference values (vitamin A, vitamin B12, vitamin C, vitamin D, copper and zinc), the differences with the EFSA's dietary reference values for pregnant women arose because the reference values for non-pregnant women were not adopted (Health Council advisory report 2018[4]). In addition, the new Dutch reference value for folate is lower than the EFSA reference value.

Dietary reference values that do not merit being applied

There are eight dietary reference values that the Committee considers do not merit being applied to pregnant women. What the Committee means by this is that they have little relevance for pregnant women in the general population in everyday practice because deficiencies of these nutrients do not appear to occur. In four cases (pantothenic acid, biotin, manganese and molybdenum), the reference value is based on weakly substantiated dietary reference values for women who are not pregnant, combined with a requirement (additional requirement) for pregnant woman that is based on weak evidence and where, furthermore, no information is known about deficiencies that cause or may cause health problems in the pregnant woman or the embryo/foetus. The dietary reference values for phosphorus and selenium are based on a weakly substantiated reference value for women who are not pregnant, with an acceptable scientific basis stating that the reference value for women who are pregnant is no different to that for those who are not. The dietary reference value for vitamin E is based on a weakly substantiated reference value for women who are not pregnant, with a strong scientific basis stating that the reference value for women who are pregnant is no different to that for those who are not.

The dietary reference value for choline for women who are pregnant is based on a combination of a weakly substantiated reference value for women who are not pregnant, with an acceptable scientific basis stating that the reference value for women who are pregnant should be a little higher. For phosphorus, selenium, vitamin E and choline too, there is no information available about deficiencies that cause or could cause health problems in the pregnant woman or the embryo/foetus.

No dietary reference value

There are two nutrients for which no dietary reference values have been set for pregnant women in the Netherlands: chromium and fluoride.
The Netherlands also has no dietary reference values for either of these nutrients for adults. This is the case for chromium because it is unclear whether chromium is an essential nutrient. The body cannot make essential nutrients itself, or not in sufficient quantities, so it is important to get enough of them through the food. No dietary reference values have been set for fluoride because oral hygiene products in the Netherlands contain fluoride, meaning that fluoride intake from food is not needed for preventing caries. For neither nutrient is there any evidence of specific requirement (additional requirement) or of deficiencies during pregnancy.

Table 2 Dietary reference values that merit being applied for pregnant women in the Netherlands

Nutrient	Average requirement	Population reference intake[a]	Adequate intake[a]
Vitamin A	580 µg RAE[b]/d	750 µg RAE[b]/d	
Thiamine	0.072 mg/MJ	*0.1 mg/MJ* *(1.0 mg/d)* Trimester 1st: 0.9 mg/d 2nd: 1.0 mg/d 3rd: 1.1 mg/d	
Riboflavin	1.5 mg/d	1.9 mg/d	
Niacin	1.3 mg NE[c]/MJ	*1.6 mg NE[c]/MJ (16 mg NE[c]/d)* Trimester 1st: 15 mg NE/d 2nd: 16 mg NE/d 3rd: 17 mg NE/d	
Vitamin B6	1.3 mg/d	1.8 mg/d	
Folate[d]			400 µg DFE[e]/d
Vitamin B12	2.4 µg/d	3.3 µg/d	
Vitamin C[f]	-	85 mg/d	
Vitamin D[g]			10 µg/d
Vitamin K1			70 µg/d
Calcium, <20 weeks' pregnancy	ages 18-24: 860 mg/d age ≥25: 750 mg/d	ages 18-24: 1,000 mg/d age ≥25: 950 mg/d	
Calcium, ≥ 20 weeks' pregnancy[h]	-		1,000 mg/d
Copper	0.8 mg/d	1.0 mg/d	
Iodine			200 µg/d
Iron	7 mg/d	16 mg/d	
Magnesium			300 mg/d
Potassium			3.5 g/d
Zinc	7.0 mg/d	9.1 mg/d	

Abbreviations: g/d = grams per day, mg/d = milligrams per day, µg/d = micrograms per day, – = not stated in the report

[a] For most applications, the population reference intake and the adequate intake are the same.

[b] Retinol activity equivalents (RAE): 1 µg RAE = 1 µg retinol = 12 µg β-carotene = 24 µg other carotenoids.

[c] Niacin equivalents (NE): 1 mg NE = 1 mg niacin = 60 mg tryptophan.

[d] This is the reference value for folate (expressed in DFE) that applies throughout the pregnancy. In addition, the dietary supplementation recommendation for synthetic or natural folic acid applies from 4 weeks before to 8 weeks after conception for preventing spina bifida.

[e] DFE = dietary folate equivalent: 1 µg DFE = 0.6 µg folic acid in fortified foods or folic acid that is taken as a supplement with food = 0.5 µg folic acid taken as a supplement on an empty stomach.

[f] The EFSA has not derived an average requirement for pregnant women but has instead added an additional requirement on top of the population reference intake.

[g] Applicable in situations where there is only minimal vitamin D production in the skin. When there is vitamin production in the skin, the intake level may be lower. Pregnant women are advised to take a supplement of 10 µg vitamin D per day.

[h] It is recommended that all pregnant women should achieve the adequate intake level of 1,000 mg/d by the 20th week of pregnancy.

3.2 Considerations when using dietary reference values

All vitamins and minerals play important roles in the body. Dietary reference values are important tools for establishing a healthy dietary pattern, but they also have their limitations. One limitation is that little or no underlying data is available for deriving dietary reference values for some of the nutrients, especially for pregnant women in particular. Based on the available data, the Committee therefore split the dietary reference values into two groups: those that do and do not merit special application in relation to pregnancy.

In this advisory report, the Committee has focused on harmonisation with the EFSA but has always critically considered whether there are sufficiently weighty arguments for not adopting EFSA's method of derivation of dietary reference values. Most of the dietary reference values that merit being applied represent an increase compared to the previous Dutch reference values.

Because the population reference intakes and adequate intakes are considered to reflect a sufficient intake level in almost the entire population (in the case of a population reference intake, this covers 97.5%), these dietary reference values are used for applications at the level of the individual: if a person's intake is equal to or greater than the population reference intake or adequate intake (and lower than the tolerable upper intake level), it can be considered to be sufficient. However, if a person's intake is lower than the population reference intake or adequate intake, it does not necessarily mean that this specific individual's intake is inadequate. An intake level of the average requirement is sufficient for half of the population group in question; requirements differ between individuals. If an individual's intake is lower than the population reference intake but higher than the average requirement, it is still sufficient for more than half of all individuals. Whether the intake level is sufficient for the specific individual concerned can only be determined with additional data about their 'nutritional status', e.g. from blood tests or urine tests.

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 available). 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 more than 10% lower than the average requirement, then it may be too low.

For many substances, it is reasonable to assume that the requirement will increase as the pregnancy progresses and the foetus grows. However, due to the lack of literature, a single value is usually set for the entire pregnancy. This is often (but not always) the value for the requirement by the end of the pregnancy. It therefore often means an overestimate of the

requirement at the start of the pregnancy. There are two substances where a distinction is made according to trimester because the energy requirement increases during pregnancy and the dietary reference value for them changes as a result: thiamine and niacin. There is one substance for which a distinction is made according to age (calcium during the first half of pregnancy), as this is also the case for the dietary reference values for women who are not pregnant.

3.3 Differences in dietary reference values for women who are and are not pregnant

Of the seventeen dietary reference values in total that merit being applied to pregnant women in the Netherlands, six are the same as the reference values for women who are not pregnant: vitamins D and K1, calcium (only for the first half of the pregnancy), iron, magnesium and potassium. The remaining eleven are higher than the dietary reference values for women who are not pregnant (Table 3).

Table 3 Dietary reference values for pregnant women that merit being applied and that are higher than for women who are not pregnant

Nutrient	Average requirement for pregnant women	Average requirement for non-pregnant women	Difference	Population reference intake (or adequate intake) for pregnant women	Population reference intake (or adequate intake) for non-pregnant women	Difference
Vitamin A	580 µg RAE/d	530 µg RAE/d[a]	+50 µg RAE/d	750 µg RAE/d	690 µg RAE/d[a]	+60 µg RAE/d
Thiamine	0.072 mg/MJ	0.072 mg/MJ	-	0.1 mg/MJ (1.0 mg/d)	0.1 mg/MJ (0.9 mg/d)	 +0.1 mg/d
Riboflavin	1.5 mg/d	1.3 mg/d	+0.2 mg/d	1.9 mg/d	1.6 mg/d	+0.3 mg/d
Niacin	1.3 mg NE/MJ	1.3 mg NE/MJ	-	1.6 mg NE/MJ (16 mg NE/d)	1.6 mg NE/MJ (14 mg NE/d)	 +2 mg NE/d
Vitamin B6	1.3 mg/d	1.1 mg/d	+0.2 mg/d	1.8 mg/d	1.5 mg/d	+0.3 mg/d
Folate	n/a	200 µg DFE/d	n/a	400 µg DFE/d (AI)	300 µg DFE/d	+100 µg DFE/d
Vitamin B12	2.4 µg/d	2.0 µg/d	+0.4 µg/d	3.3 µg/d	2.8 µg/d	+0.5 µg/d
Vitamin C	-	50 mg/d	n/a	85 mg/d	75 mg/d	+10 mg/d
Calcium ≥ 20 weeks' pregnancy	n/a	ages 18-24: 860 mg/d age ≥25: 750 mg/d	n/a	1,000 (AI) 1,000 (AI)	1,000 950	0 +50 mg/d
Copper	0.8 mg/d	0.7 mg/d	+0.1 mg/d	1.0 mg/d	0.9 mg/d	+0.1 mg/d
Iodine	n/a	n/a	n/a	200 µg/d (AI)	150 µg/d (AI)	+50 µg/d
Zinc	7.0 mg/d	5.7 mg/d	+1.3 mg/d	9.1 mg/d	7.0 mg/d	+2.1 mg/d

Abbreviations: – : not stated in the rapport, DFE: dietary folate equivalent, mg/d: milligrams per day, MJ: megajoules, NE: niacin equivalents, n/a: not applicable, RAE: retinol activity equivalent, µg/d: micrograms per day

[a] As a consequence of the modified reference weights for the Netherlands,[6] a minor change has been applied for non-pregnant women. The average requirement has been adjusted from 525 to 530 µg RAE/d and the population reference intake from 680 to 690 µg RAE/d.

3.4 Differences between current and previous Dutch dietary reference values

Of the seventeen dietary reference values in total that merit being applied to pregnant women in the Netherlands, five are the same as the previous reference values for pregnant women in the Netherlands: copper and the vitamins folate, C, D and K1. Table 4 lists the dietary reference values of the 12 nutrients that have been changed (entirely or partially) from the previous dietary reference values for pregnant women in the Netherlands. Of these twelve, there are four where the population reference intake or adequate intake has changed by more than 10%:

- the population reference intakes or adequate intakes of riboflavin, iodine and potassium are more than 10% higher than the previous population reference intakes or adequate intakes
- the population reference intake of thiamine is more than 10% lower than the previous population reference intake.

Table 4 The twelve dietary reference values for pregnant women that merit being applied and that have also been modified

Nutrient	2021 population reference intake (or adequate intake) pregnant women	2014 population reference intake (or adequate intake) pregnant women	Difference
Vitamin A	750 µg RAE/d	800 µg RAE/d	-50 µg RAE/d
Thiamine	0.1 mg/MJ (1.0 mg/d) Trimester 1st: 0.9 mg/d 2nd: 1.0 mg/d 3rd: 1.1 mg/d	0.13 mg/MJ (1.4 mg/d)	-0.03 mg/MJ (-0.4 mg/d)
Riboflavin	1.9 mg/d	1.4 mg/d	+0.5 mg/d
Niacin	1.6 mg NE/MJ (16 mg NE/d) Trimester 1st: 15 mg NE/d 2nd: 16 mg NE/d 3rd: 17 mg NE/d	17 mg/d	-1 mg NE/d
Vitamin B6	1.8 mg/d	1.9 mg/d	-0.1 mg/d
Vitamin B12	3.3 µg/d	3.2 µg/d	+0.1 µg/d
Calcium <20 weeks' pregnancy	ages 18-24: 1,000 mg/d age ≥25: 950 mg/d	1,000 mg/d (AI)	ages 18-24: 0 mg/d age ≥25: -50 mg/d
Iodine	200 µg/d (AI)	175 µg/d (AI)	+25 µg/d
Iron	16 mg/d	15 mg/d	+1 mg/d
Magnesium	300 mg/d (AI)	280 mg/d (AI)	+20 mg/d
Potassium	3.5 g/d (AI)	3.1 g/d (AI)	+0.4 g/d
Zinc	9.1 mg/d	9.0 mg/d (AI)	+0.1 mg/d

Abbreviations: AI: adequate intake, DFE: dietary folate equivalent, mg/d: milligrams per day, NE: niacin equivalents, RAE: retinol activity equivalent, µg/d: micrograms per day

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The Committee

Members of the Committee on Nutrition:

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- dr. ir. E. Brink, The Netherlands Nutrition Centre, The Hague
- ir. B.H. Smale, Ministry of Health, Welfare and Sport, The Hague

Scientific Secretaries:

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Preferred citation:
Health Council of the Netherlands. Dietary reference values for vitamins and minerals for pregnant women.
The Hague: Health Council of the Netherlands, 2021; publication no. 2021/27.