Towards an adequate intake of vitamins and minerals

Gezondheidsraad
Health Council of the Netherlands

To the Minister of Health, Welfare and Sport

Subject : Presentation of advisory report T*owards an adequate intake of vitamins and minerals*
Your reference : VGP/VV 2646726
Our reference : I-169/RW/db/822-O
Enclosures : 1
Date : April 27, 2009

Dear Minister,

On 26 January 2006 your predecessor asked the Health Council of the Netherlands for advice as part of the government's review of current policy on micronutrients. I am pleased to present the final advisory report on these nutrients. The Health Council submitted advisory reports on folic acid, vitamins A and D and iodine last year.

A committee of experts was set up to investigate the intake and status of the other micronutrients and assess the implications for policy, taking account of the previous advisory reports and new European regulations, in order to provide you with advice on achieving adequate micronutrient intake. Two of the Health Council's standing committees, the Standing Committee on Medicine and the Standing Committee on Nutrition, have reviewed the findings.

The committee concludes that a good and varied diet is in principle sufficient to provide enough micronutrients to the general healthy population and to exclude the risk of excessively high intake. Measures such as supplementation advice and fortification need to produce health benefits; for that reason only certain groups at risk require additional supplies of some micronutrients in addition to a varied diet. These include in particular folic acid for women around the time of conception, vitamin D for young children, people who have dark skin or who do not go outdoors enough, women who are pregnant or breastfeeding, women who wear a veil, women aged 50 and over and men aged 70 and over, vitamin K for infants, and finally vitamin B_{12} for vegans.

P.O.Box 16052
NL-2500 BB The Hague
Telephone +31 (70) 340 70 18
Telefax +31 (70) 340 75 23
E-mail: rianne.weggemans@gr.nl

Visiting Address
Parnassusplein 5
NL-2511 VX The Hague
The Netherlands
www.healthcouncil.nl

Gezondheidsraad
Health Council of the Netherlands

Furthermore, the committee draws your attention to the lack of a monitoring system for fortified foods. In the light of European legislation on voluntary fortification, a system of this kind is essential so that the intake of micronutrients can be properly monitored.

It is not yet clear whether this is the final word on micronutrient intake in the Netherlands for the time being. Too little is still known about micronutrient intake among people of Turkish, Moroccan or Surinamese origin and on the intake of these substances by people with a low energy intake, particularly elderly people. It has also not been established whether low iron status among women of childbearing age (whether or not they are pregnant) has adverse health effects. Further research is needed to clarify the situation with regard to these specific groups.

I fully support the committee's conclusions.

Yours sincerely,
(signed)
Professor D. Kromhout
Vice-President

P.O.Box 16052
NL-2500 BB The Hague
Telephone +31 (70) 340 70 18
Telefax +31 (70) 340 75 23
E-mail: rianne.weggemans@gr.nl

Visiting Address
Parnassusplein 5
NL-2511 VX The Hague
The Netherlands
www.healthcouncil.nl

Towards an adequate intake of vitamins and minerals

to:

the Minister of Health, Welfare and Sport

No. 2009/06E, The Hague, April 27, 2009

The Health Council of the Netherlands, established in 1902, is an independent scientific advisory body. Its remit is “to advise the government and Parliament on the current level of knowledge with respect to public health issues and health (services) research...” (Section 22, Health Act).

The Health Council receives most requests for advice from the Ministers of Health, Welfare & Sport, Housing, Spatial Planning & the Environment, Social Affairs & Employment, Agriculture, Nature & Food Quality, and Education, Culture & Science. The Council can publish advisory reports on its own initiative. It usually does this in order to ask attention for developments or trends that are thought to be relevant to government policy.

Most Health Council reports are prepared by multidisciplinary committees of Dutch or, sometimes, foreign experts, appointed in a personal capacity. The reports are available to the public.

The Health Council of the Netherlands is a member of the European Science Advisory Network for Health (EuSANH), a network of science advisory bodies in Europe.

The Health Council of the Netherlands is a member of the International Network of Agencies for Health Technology Assessment (INAHTA), an international collaboration of organisations engaged with *health technology assessment*.

This report can be downloaded from www.healthcouncil.nl.

Preferred citation:
Health Council of the Netherlands. Towards an adequate intake of vitamins and minerals. The Hague: Health Council of the Netherlands, 2009; publication no. 2009/06E.

ISBN: 978-90-5549-761-4

A brief outline of the advisory report

This advisory report considers how an adequate intake of vitamins and minerals, known as micronutrients, by the general healthy Dutch population can be achieved. The earlier advisory reports on folic acid, vitamins A and D and iodine are taken into account.

A varied diet is the starting point for an adequate intake of micronutrients

A varied diet is the starting point for realising an adequate intake of micronutrients. This is true for the general, healthy population. The Committee on Micronutrients is of the opinion that measures such as supplementation advice and fortification are desirable only if they are beneficial to health. From this standpoint, only certain groups at risk need additional supplies of some vitamins or minerals, in particular: vitamin K for infants, folic acid for women around the time of conception, vitamin D for young children, people who have dark skin or who do not go outdoors enough, women who are pregnant or breastfeeding, women who wear a veil, women aged 50 and over and men aged 70 and over, and finally vitamin B_{12} for vegans.

It is essential that excessively high intake is prevented

In order to prevent excessively high intake, people who want to take supplements or consume fortified foods should be advised that their intake from these sources should not exceed the level of the recommended dietary allowance per day of the micronutrient(s) in question in addition to the micronutrients they obtain from food. Intake above the recommended dietary allowance does not provide any additional health benefits; in fact, long-term intake above the safe upper level of intake can be damaging to health. In this context the committee recommends an ongoing evaluation of micronutrient intake. To this end it is essential that a monitoring system be set up to track the composition and consumption of fortified foods.

Other measures that should be given priority

The committee considers that not enough is known about the micronutrient intake of people of Turkish, Moroccan or Surinamese origin. Investigating this should be a high priority. The same applies to research into any harmful effects on health of low iron status among teenage girls and women of childbearing age, irrespective of whether they are pregnant.

Contents

Summary

The background to this advisory report

Regulations and research undergo rapid development

European legislation, regulations and research in the field of vitamins, minerals and trace elements, known as micronutrients, undergo rapid development. That is why the Minister for Health, Welfare and Sport has asked the Health Council of the Netherlands for advice in connection with a review of policy in this area.

The aim of the policy is to ensure that as many people as possible consume adequate quantities of micronutrients, while, at the same time, minimising the risk that people exceed the safe upper level of intake.

In this final advisory report, the specially constituted committee (the Micronutrients Committee) presents advice on what is needed for the general, healthy population. The committee takes its earlier advisory reports on vitamins A and D, folic acid and iodine into account. The micronutrient intake of people with medical problems is not covered by this advisory report.

What micronutrients is the daily diet short of, or are supplied in excess?

Some population groups may not obtain adequate quantities of certain micronutrients, although the consequences of this for health are often unclear.

The daily diet of most children and adults of Dutch origin supplies enough thiamin, riboflavin, vitamins B_6 and C, phosphorous, potassium, magnesium, copper and zinc.

Much less is known about the micronutrient intake of women who are pregnant or breastfeeding, people of non-Western origin, individuals with a low energy intake or with an unusual dietary pattern. However, there are indications that:

- the riboflavin and calcium intake of people of Turkish, Moroccan or Surinamese background may be too low,
- the vitamin B_{12} status* of 12 to 25 per cent of elderly people is too low,
- the iron status of 20 per cent of children of asylum-seekers, approximately 35 per cent of women of childbearing age and almost 50 per cent of pregnant women is too low, and
- the vitamin E and selenium intake of young children may be too low.

It is unclear whether excessively low intake or status are associated with adverse effects on health. A low status is not the same as a deficiency of vitamins, minerals or trace elements, which needs to be treated.

There is also a small group of the population who are at risk of having a micronutrient intake above the safe upper level of intake as a result of taking supplements. These levels of intake can have adverse effects on health.

* For example, the concentration of a micronutrient in the blood.

What needs to be taken into account when adopting measures to ensure adequate micronutrient intake?

There is no standard approach. A multi-stage plan can be used to determine how micronutrient intake can be guaranteed

The committee's four previous advisory reports show that it is impossible to devise one standard approach to select the right measure for a micronutrient. Each of the micronutrients examined is unique in respect of excessively low or high intake and associated risks for the various population groups. A multi-stage plan can be followed when considering measures (Figures 1 and 2).

The underlying principle of this plan is that a diet in accordance with the Guidelines for a Healthy Diet supplies enough micronutrients for the general population. However, there are some exceptions to this: women need extra folic acid around the time of conception; young children, people who do not go outdoors enough or who have dark skin, women who are pregnant or breastfeeding, women who wear a veil, women aged 50 and over and men aged 70 and over need extra vitamin D; infants need extra vitamin K; and vegans need extra vitamin B_{12} (Tables 5 and 6).

The committee is also of the opinion that measures such as advice on supplements or fortification should only be applied if they provide health benefits.

Intake above the recommended dietary allowance does not provide any health benefits

The new European regulations mean that people who consume fortified foods and supplements may in some cases have an intake well above the recommended dietary allowance. There are no indications that intake at these levels is more beneficial to health than the recommended intake.

The current European regulations on voluntary fortification may be a limiting factor with regard to the fortification of staple foods

The advisory reports on folic acid and vitamin D recommended the Minister to consider fortification of only a limited number of staple foods. The European regulations on voluntary fortification may be a limiting factor with regard to the fortification of staple foods with these and other micronutrients where the recommended intake and the safe upper level of intake are relatively close together:

vitamin A, iodine, selenium, copper and zinc. It is not possible at present to prohibit foods that have been fortified on a voluntary basis from the market. In the case of micronutrients with such a narrow margin, the combination of fortified staple foods with products that are fortified on a voluntary basis increases the risk of exceeding the safe upper level of intake.

What measures should be given priority?

Providing information about the risk groups that need extra micronutrients in addition to a varied diet.

The committee recommends taking a diet according to the Guidelines for a Healthy Diet as the basis for information, and specifying which population groups need extra vitamins and minerals in addition to this diet.

Preventing excessively high intake of micronutrients.

The committee advises people wishing to take supplements or consume fortified foods to ensure that their intake of micronutrients from these products does not exceed the recommended daily intake of micronutrients per day in addition to the micronutrients obtained from the diet. Consuming amounts up to the safe upper level of intake does not offer any health benefits and amounts in excess of the safe upper level can even be harmful in the long term.

Ideally, restrictions should be set at European level on the number of products which can be fortified with micronutrients that have a narrow margin (vitamins A and D, folic acid, iodine, selenium, copper and zinc).

What monitoring activities should be given priority?

High priority should be accorded to determining micronutrient intake by children and adults of Turkish, Moroccan or Surinamese background

The committee recommends that high priority be given to determining the micronutrient intake and status of children and adults of Turkish, Moroccan or Surinamese background. One of the topics that needs to be addressed specifically is the iron intake and status of young children.

Other groups whose micronutrient intake should be investigated

The committee is also of the opinion that it would be desirable for more data to be obtained regarding the micronutrient intake of women who are pregnant or breastfeeding, with investigation into micronutrient status as well where necessary. This also applies to people with a low energy intake, especially elderly people, and individuals whose dietary pattern is unusual. The RIVM (Netherlands National Institute for Public Health and the Environment) will over the coming few years be conducting food consumption surveys of among others individuals of non-western background, women who are pregnant or breastfeeding, and elderly. This may be followed by additional status research.

Monitor the micronutrient intake and the composition of fortified foods continuously

The committee also recommends continuous assessment of micronutrient intake and, where necessary, status, taking account of new developments in science and regulations. It is important to this end to investigate how far fortified products and supplements contribute to the intake of these micronutrients. To this end it is essential that records are kept of the composition and consumption of fortified foods.

What additional research should be given priority?

High priority should be given to research into the effects of low iron status on health among women of childbearing age

The committee recommends giving high priority to investigating whether low iron status among teenage girls and women of childbearing age, whether pregnant or not, is associated with health problems.

Additional research

Other issues which the committee advises putting on the research agenda:

- Investigation as to whether low vitamin B_{12} status among adults and elderly people is also associated with health problems.
- Investigation as to whether low iron status among children is also associated with health problems.

- Investigation to ascertain whether the possibility that the intake of riboflavin and calcium by people of Turkish, Moroccan or Surinamese background and vitamin E and selenium by children in general is too low is confirmed by status research and, where necessary, research into any health effects.
- Expanding the Dutch food composition database by adding information about the vitamin K content of foods.
- Research into the safe upper intake levels of micronutrients for children (little or no research has so far been carried out into this topic).
- Assessment of the Dutch micronutrient dietary reference values by comparing the current values with those applied in the United States, Australia and New Zealand and with new dietary reference values that may have been established by then in the European Union and Scandinavia. A start has been made on this point in this advisory report, which uses more recent American, Australian and New Zealand dietary reference values for those micronutrients with Dutch dietary reference values which had been drawn up in 1989. The safe upper levels of intake used in this advisory report are those drawn up at European level in 2006.

Chapter 1

Introduction

1.1 Background

The Ministry of Health, Welfare and Sport (VWS) wants to develop a new policy in the context of European regulations, ensuring that as many people as possible in the population have an adequate intake of micronutrients. However, it wants to simultaneously minimise the risk of people consuming amounts in excess of the established safe upper level of intake. With that aim in mind, the Minister of Health, Welfare and Sport has asked the Health Council of the Netherlands for advice in the context of reviewing its policy on the fortification of foods with micronutrients such as vitamins, minerals and trace elements* (Annex A). This advisory report is the last in a series of five reports on micronutrients. It deals with micronutrients that have not been considered in the previous reports. The previous reports covered folic acid, vitamin D, iodine and vitamin A.[1-4] This advisory report looks at intake among the general, healthy population; people with a medical condition are beyond the scope of this report.

This advisory report was produced by the Committee on Micronutrients (Annex B), which also produced the aforementioned reports. The difference between this report and the previous reports is that here the committee concentrates mainly on the question of what measures should, in the light of the current state of scientific knowledge, be given priority in order to ensure an adequate

* Trace elements are minerals which are required in quantities not exceeding a few milligrams.

intake of micronutrients? The committee has based its deliberations on the series of advisory reports on micronutrients.

1.2 Several measures with the same aim

Several measures exist to ensure that as many people as possible in the population have an adequate intake of micronutrients, within safe margins. Eating a varied diet is at the top of the list, and consumers can be informed in this respect by means of information and labelling. If this diet is inadequate, then a combination of the following measures (restoration, substitution, fortification and supplementation) can be considered:[5]

- Restoration involves adding micronutrients to foods that are lost during the production process, storage and/or sale. Additions are made up to the level that was originally present in the edible part of the food or the raw material from which it was made.
- Substitution means replacing a food with a different food that is as similar as possible in terms of appearance, consistency, taste, colour and odour or that serves the same purpose for its use.
- Fortification means adding one or more micronutrients to a food to a level that is higher than that which naturally occurs in the food or the raw material used to produce the food in order to prevent or correct a proven deficiency in one or more micronutrients in (parts of) the population. Fortification can, in theory, be voluntary or mandatory. In the case of voluntary fortification, the manufacturer decides whether or not to fortify a product, which therefore means that specific products are fortified. The government may consult producers to encourage voluntary fortification. In the case of mandatory fortification, staple foods are fortified. Mandatory fortification is not legally feasible in the Netherlands; this has been the position since the mid-1980s when an organic baker successfully opposed the mandatory use of iodised salt in breadmaking. However, the government can make arrangements for fortification via an agreement with manufacturers. The Commodities Act specifies how much of a particular micronutrient can be added to which products.[6]
- Supplementation means taking a supplement containing micronutrients as an addition to diet.

1.3 The original policy in the area of micronutrients

Prior to 1994 there were no statutory regulations in the Netherlands on the addition of micronutrients to dietary supplements. The addition of these substances to food was prohibited until 1996 with the exception of iodine, vitamin A and vitamin D.[7]

The Dutch government was forced to review its policy in the early 1990s, mainly as a result of pressure due to free trade. Other European countries had long since approved the addition of vitamins to foods. A second reason for changing the policy was that it was apparent that not all groups of the population had a daily diet* that met their requirements for various micronutrients. It was however also important to prevent an excessive intake of certain micronutrients. This is particularly true for micronutrients that have a 'narrow margin', where the dietary reference value (or recommended dietary allowance) and the tolerable, or safe, upper level of intake are quite close together; this is the case for folic acid, selenium, copper, zinc, vitamin A, vitamin D and iodine.

The aforementioned developments led to the introduction of the Commodities Act Regulation on the Exemption of Vitamin Preparations in 1994[8] and the Commodities Act Decree on the Addition of Micronutrients in 1996.[9] The Commodities Act Regulation on the Exemption of Vitamin Preparations permits the addition of micronutrients to supplements provided that they are contained at levels that are not harmful[8]. The Commodities Act Decree on the Addition of Micronutrients permits the fortification of foods with micronutrients that do not have a narrow margin. Fortification with folic acid, selenium, copper, zinc and vitamins A and D remains prohibited, but iodine fortification of a limit number of products is still permitted. These seven micronutrients can be added as part of a restoration or substitution process.** Exemption from these provisions was permitted only if it could be demonstrated that the addition of the substances in question was not harmful to public health and that it met an actual need.[9,10]

1.4 Developments that require a new policy

At present (in 2009) new developments have made a revision of the policy on micronutrients necessary. Since 1996 the use of micronutrients with a narrow margin to fortify foods in the Netherlands was only permitted where a dietary

* Unless otherwise specified, the word ‘diet’ is used to cover intake from foodstufffoods and supplements.
** See Annex E for definitions.

need existed. This restriction was abolished in 2004.[11] Requests for exemption from the ban on adding micronutrients can only be rejected if it can be demonstrated that placing the specific product on the market would endanger public health.

This is why the Netherlands has had to discontinue the absolute prohibition on fortification with substances such as folic acid and vitamin D.[12,13] The addition of vitamin A to foods remains prohibited.[14]

European harmonisation

The policy on supplements and voluntary fortification of foods is due to be harmonised throughout the European Union between 2009 and 2012. The 2002 European Union directive on supplements and the 2006 European Union regulation on voluntary fortification of foods will be fleshed out at the same time*.[15-19] However, in both cases the texts will take the form of framework legislation laying down the principles, but not the details. Both the regulation and the directive specify, among others, the forms in which micronutrients can be added to supplements and foods.

It was not yet known at the time of drafting this advisory report what minimum and maximum amounts of micronutrients were to be permitted as additions to supplements and foods. The recommended daily amount to be indicated on the label had also not yet been determined. A regulation is to be adopted on this subject. It will also specify the minimum level at which the label may state that the food contains, or is rich in, a particular micronutrient**. The regulation deals with voluntary fortification of foods[19], which by definition does not resolve the problem of possible deficiencies. However, the regulation does allow European Union member states to maintain or introduce mandatory fortification of foods, provided that this is safe.

* The dietary supplements directive has already been incorporated into the Dietary Supplements Commodities Decree and the Dietary Supplements Regulation Commodity Decree.[15-17]

** The new European Union health claims regulation states that a label may indicate that a food is a source of a micronutrient if it contains 15% of the recommended daily amount of the micronutrient per 100 g, 100 ml or portion size, and that it is rich in the micronutrient if the corresponding figure is 30%. Under Dutch legislation pursuant to this regulation, manufacturers may continue to claim that a food is rich in a micronutrient if it contains more than 20% of the recommended daily amount during the transitional period laid down in the European regulation.

New insights

Dutch policy needs to be reviewed, not only because of changes to European regulations but also in the light of new scientific insights. It has been suggested that some sections of the population might gain considerable health benefits from consuming certain micronutrients at levels (well) above the current dietary reference values. However, high doses of this kind could cause unwanted side effects. It is essential to balance the positive and negative effects on health for groups that would benefit from a higher intake as well as for those who do not.

1.5 Issues addressed

In its request for advice (see Annex A), the Ministry first asked the Health Council to draw up an inventory of: (1) essential micronutrients that were not provided in sufficiently high concentrations by an everyday diet; (2) what the optimum level of supply of these nutrients was; and (3) the best way in which this optimum level of supply could be achieved (restoration, substitution, fortification or supplementation, bearing in mind any associated health effects).

Following consultation between the Health Council and the Ministry of Health, Welfare and Sport, it was decided to limit the scope of the request for advice to those micronutrients of which the population as a whole may not be receiving a sufficient supply if they are not added to the daily diet. Consequently, separate advisory reports were drawn up on folic acid, vitamin D, iodine and vitamin A.[1-4]

In this last report in the series of five reports the committee considers:

1 what other micronutrients are not obtained in sufficient quantities, or are supplied in excess, by the daily diet;
2 what needs to be taken into account when adopting measures to ensure adequate micronutrient intake; and
3 which of the measures in question should be given priority.

1.6 Scope

The request for advice (Annex A) asked the Health Council to assess all essential micronutrients for which dietary reference values have been laid down in the Netherlands. In addition to the micronutrients that have already been assessed (vitamin A, vitamin D, folic acid and iodine), these are the B vitamins thiamin, riboflavin, niacin, B_6, B_{12}, biotin and pantothenic acid, vitamins C and E, calcium, phosphorus, iron, copper, magnesium, selenium and zinc.

The committee decided in the first instance not to restrict its deliberations to essential micronutrients for which dietary reference values have been established in the Netherlands but to look at all essential micronutrients. Dietary reference values for vitamin K, potassium, sodium, chloride, chromium, fluoride, manganese and molybdenum were laid down between 1997 and 2004 in the United States of America and in 2005 in Australia and New Zealand.* [20-25] The committee did not therefore set new dietary reference values for these substances, though action may yet be taken at a European level (the European Food Safety Authority is working on proposals on behalf of the European Commission).

The committee also refrained from re-assessing the intake of substances on which recent advice has been given - i.e. sodium in the *2006 Guidelines for a Healthy Diet* and folic acid, vitamin D, iodine and vitamin A in earlier advisory reports on micronutrients.[1-4,26] This advisory report therefore discusses only the intake of the following micronutrients: thiamin, riboflavin, niacin, vitamins B_6, B_{12}, C, E and K, calcium, chloride, phosphorus, potassium, magnesium, chromium, fluoride, iron, copper, manganese, molybdenum, selenium and zinc.

The micronutrients covered in the previous reports were taken into consideration both when discussing possible ways of ensuring an adequate intake of micronutrients and when drawing conclusions and drafting recommendations.

Finally, this advisory report relates to the micronutrient intake of healthy individuals. It does not address the situation of people with medical conditions.

1.7 Methodology

The first action taken by the committee was to assess data relating to intake, status and possible health effects. The committee completed this stage of the work by indicating what action should be taken for each individual micronutrient, such as: considering measures, conducting further research into status or into health effects arising from excessively low or high intake. The committee then looked at the process of considering measures aimed at ensuring an adequate intake of micronutrients in the general sense. It took account of the deliberations discussed in previous advisory reports and new European developments in the field of regulation. The last stage of the committee's work was to draw up recommendations as to priorities for the various measures aimed at ensuring adequate micronutrient intake in the Netherlands.

* Cobalt has not been assessed because no intake data is available and this substance may not be added to f oodstufffoods or supplements in Europe.

The advisory report was submitted for review to the Health Council's Standing Committee on Nutrition and Standing Committee on Medicine.

1.8 Structure of the advisory report

Chapter 2 describes how the supply of micronutrients can be evaluated and what the position is regarding the supply of micronutrients in the Netherlands (the first question which the Health Council was asked to address in the advisory report). The main input into this section is made up of existing reports on the priority of micronutrients in respect of status investigation, plus more recent research carried out in the Netherlands. In the case of groups of the population in the Netherlands about which little is known, (review) articles from other countries that were available were taken into consideration. Chapter 3 discusses the factors that can be taken into account when considering measures based on previous advisory reports on folic acid, vitamin D, iodine and vitamin A (the second question which the Health Council was asked to address). In chapter 4 the committee presents its conclusions and recommendations for ensuring an adequate intake of micronutrients (the third question which the Health Council was asked to address).

Chapter 2

The supply of micronutrients

This chapter assesses intake and status (or supply) data for micronutrients that have not been covered by previous advisory reports (Table 1), including effects on health. Firstly, the multi-stage plan in Figure 1 shows how the supply of micronutrients can be assessed. The report then examines what data is available for particular population groups in the Netherlands and what groups need to be analysed using information from other European countries. It then lists the substances for which levels in the daily diet are known, and those for which the only data available relates to levels in supplements. This data is used to assess supply. This chapter concludes with a summary of what is known about each micronutrient and what subsequent action is needed.

2.1 Methods used to determine the supply of micronutrients

Three steps are involved in determining whether the supply of a particular micronutrient is adequate (Figure 1). The first is to ascertain whether the dietary reference values and tolerable upper levels of intake are recent, or whether they need to be revised in the light of new scientific findings.

Table 1 Summary of essential micronutrients, corresponding dietary reference values and tolerable upper levels of intake, stating whether these substances are included in the Dutch Food Composition Database (NEVO).

Essential micronutrients	Dutch dietary reference values (year of publication) [27-29]	European tolerable upper level of intake and EFSA's conclusions as to whether high intake could be harmful [a 30]	Included in NEVO[31]
Vitamins			
Vitamin A	1989	2006	Yes
Thiamin (vitamin B_1)	2000	Current levels of intake [a,b] do not represent a health risk	Yes
Riboflavin (vitamin B_2)	2000	Current levels of intake do not represent a health risk [a]	Yes
Niacin	2000	2006	Yes
Vitamin B_6	2003	2006	Yes
Folic acid	2003	2006	Yes
Vitamin B_{12}	2003	Current levels of intake do not represent a health risk [a]	Yes
Vitamin C	1989	Possibility of acute gastrointestinal effects if intake exceeds 1 gram per day [a]	Yes
Vitamin D	2000	2006	Yes
Vitamin E	1989	2006	Yes
Pantothenic acid	2000	Intake significantly higher than current levels of intake do not represent a health risk [a,c]	No
Biotin	2000	Current levels of intake do not represent a health risk [a]	No
Vitamin K	Not determined	Daily intake of up to 10 mg of phylloquinone from supplements for a short period has no adverse effects [a]	No
Minerals			
Calcium	2000	2006 [a,d]	Yes
Phosphorus	1989	Current levels of intake do not represent a health risk [a,e]	Yes
Potassium	Not determined	Current levels of intake from food do not represent a health risk for normal, healthy children and adults [a,f]	Yes
Magnesium	1989	2006 [a,g]	Yes
Sodium	Not determined	Current intake from food exceeds requirement and is associated with an elevated risk of increased blood pressure [a]	Yes
Chloride	Not determined	Current intake in the form of NaCl exceeds requirement and is associated with an elevated risk of increased blood pressure [a]	No
Trace elements			
Iron	1989	50-60 milligrams of non-haem iron from supplements can cause adverse gastrointestinal effects [a,h]	Yes
Iodine	Not determined	2006	No
Copper	1989	2006	Yes
Selenium	1989	2006	Yes
Zinc	1989	2006	Yes
Chromium	Not determined	Intake of up to 1 milligram per day from supplements causes no adverse effects [a,i]	No

Fluoride	Not determined	2006	No
Manganese	Not determined	Intake higher than the current intake from food could be neurotoxic [a]	No
Molybdenum	Not determined	2006	No

a This conclusion is adopted from the report drawn up by the European Food Safety Authority (EFSA)[30] and has not been assessed by the Committee on Micronutrients.

b Dietary intake refers both to foods and supplements.

c Doses of 10 to 20 grams of pantothenic acid a day have in some cases caused diarrhoea and water retention.

d A tolerable upper level of intake of calcium has only been derived for adults.

e Normal, healthy adults can tolerate a daily intake of phosphorus of up to 3,000 milligrams a day. In some cases, an intake of at least 750 milligrams a day of phosphorus from supplements can cause gastrointestinal complaints.

f In some cases, 5 to 7 grams of potassium a day from supplements has caused conduction disorders or compromised cardiac function in apparently healthy adults. Elderly people and individuals who experience significant dehydration as a result of strenuous activities, who have impaired kidney function or are on cardiovascular disease drug treatment are at greater risk.

g No tolerable upper intake level of magnesium has been derived for children aged between one and three.

h Especially when supplements are not taken in conjunction with food.

i This conclusion does not apply to chromium picolinate.

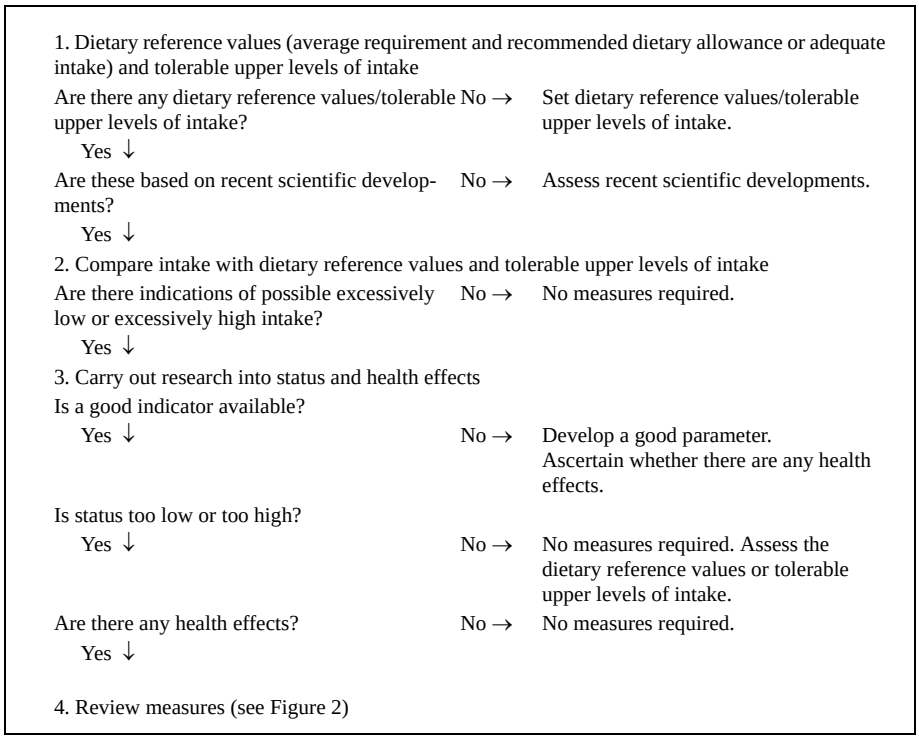

Figure 1 Multi-stage plan defining groups at risk in terms of: population group; percentage with an excessively low or high supply; extent to which thresholds are breached; existence of related health effects. In the light of the results, it can be assessed whether measures are needed to improve a low intake of micronutrients or reduce high intake.

2.1.1 Step 1: Dietary reference values and their uses

The term ‘dietary reference values’ is a collective term for various reference values for energy and nutrients. They are designed for healthy individuals. They are used to:

- programme food supply for healthy groups,
- create dietary guidelines for healthy individuals,
- assess intake data for groups of healthy individuals,
- assess the intake of individuals who have been shown by biochemical parameters to have a poor nutritional status,
- draft the so-called *Guidelines for a Healthy Diet*.

In the past, dietary reference values were always set by the Committee on Dietary reference values of the Food and Nutrition Council/Health Council. The recommended dietary allowance of a nutrient was derived from figures showing the average requirement of the substance and the variation in requirement. These figures are determined on the basis of data describing the relationship between intake, biochemical parameters and, where possible, health effects. Where the amount of data available was insufficient to determine an average requirement and recommended dietary allowance, as in the case of vitamin D, the committee simply set an adequate intake figure. Recommended dietary allowance and adequate intake mean the same thing in practice: they both indicate the level of intake which is desirable on health grounds.[27]

Tolerable upper levels of intake have been determined in addition to these dietary reference values. These indicate the highest level of long-term daily intake at which no harmful effects on health are to be expected.[30]

The first step in assessing supply is to ascertain whether new scientific developments have taken place since the dietary reference values and tolerable upper levels of intake were set which could affect advice on micronutrient intake. An assessment of new scientific developments is necessary for this purpose. These developments were systematically investigated in the previous advisory reports (Annex C); the conclusions have been graded on the basis of parameters such as levels of evidence, with reference to the research on which the grading is based. The grading system used is largely in line with the approach used when developing evidence-based guidelines.[32]

2.1.2 Step 2: Comparing intake data with dietary reference values

Intake data is compared with the dietary reference values* which have been established for the various age groups, sexes and physiological states such as pregnancy and breastfeeding. In order to ascertain whether intake is too high, the data is compared with the tolerable upper levels of intake. The (Dutch) dietary reference values need to be up to date. If they are not, then recent dietary reference values from other countries can be used instead. The comparison should indicate whether the micronutrient intake is correct, too low or too high and to what extent the thresholds are breached. It is important to take account of the quality of the data on which the comparison is based in order for the assessment to be accurate. Specifically, this means examining the quality of the estimate of food intake; the data in NEVO**; the dietary reference value; and the variation in requirements.[31]

Most of the intake data on which this advisory report is based has been obtained from food consumption surveys conducted among the general population (1987/1988, 1992 and 1997/1998) and among young adults (2003).[33,34] Until the year 2000, this intake data was collected on two consecutive days. Data of this kind is therefore not independent, but does give an insight into day-to-day variation. A correction can be applied to allow for this variation; the term 'observed intake' relates to the raw intake data, while the term 'habitual intake' relates to adjusted data. The average of the habitual intake is similar to the average of the observed intake, but the variation is smaller.[35] Data relating to habitual intake is the preferred measurement when determining the number of people whose intake is too low or too high.

A threshold method is used to estimate the percentage of people in a population who might be at risk of having an undesirable level of intake of micronutrients for which an average requirement and a recommended dietary allowance have been determined. The threshold method provides information as to the percentage of the population with an intake above or below the recommended dietary allowance or adequate intake, but does not take account of distribution of the requirement.

The only way in which intake data can be evaluated for micronutrients for which only an adequate intake level has been determined is by means of a global qualitative assessment. That is because the percentage of people with insufficient

* Ideally taking account of new scientific developments.
** NEVO: the Dutch Food Composition Database.[31]

intake cannot be estimated on the basis of an adequate intake figure, as the distribution of the requirement is not known. The percentage of individuals with a median intake below adequate intake is therefore of little meaning. It is not possible to determine the proportion of this group for which intake really is insufficient; however, if the median intake is higher than the adequate intake, the likelihood of excessively low intake is small.[28]

When assessing intake it is important to consider not only the percentage of people with excessively low or excessively high intake but also the extent to which the threshold is breached. The force of the evidence for a health impact being caused by excessively low or excessively high intake must be taken into account.

2.1.3 *Step 3: status research and investigation into the existence of health effects*

Step three involves investigating the nutritional status* of a specific group of individuals and any health effects which are regarded, in the light of strong indications, as likely to be associated with excessively low or excessively high intake of the micronutrient in question. This step should clarify the estimate arrived at in step two. If intake is too low or too high, but status is adequate, the advice is that dietary reference values or tolerable upper levels of intake should be reviewed.

However, good status parameters or a consensus as to the cut-off points of status parameters are not available for many micronutrients. In these cases the advice is based on intake data combined with any data available on health effects**. If there is no indication that an excessively low or high intake of a micronutrient causes health effects in the population, there is no scientific reason for considering measures other than recommending a varied diet. Indeed, this is also true of substances for which status is inadequate but where it is not clear whether increasing intake would be beneficial to health.

There is no reason to revise dietary reference values if excessively low or high intake and/or status are not associated with harmful effects on health. The basic principle followed by the committee is that measures should produce health benefits; in the case of dietary reference values and tolerable upper levels of intake, both health effects and biochemical effects*** were taken into account.

* Biochemical indicator of the supply of a particular micronutrient.
** The PASSCLAIM project has devised criteria for ascertaining whether a health effect has been demonstrated.[36]
*** Effects on blood parameters, for example.

2.2 Data used

2.2.1 *Dietary reference values*

The committee assessed intake on the basis of the Dutch dietary reference values (Table 1).[27-29] As the dietary reference values for vitamins C and E, phosphorus, magnesium, iron, copper, selenium and zinc were established in 1989,[29] when drawing up this advisory report the committee compared the average intake of these substances and potassium (for which no dietary reference values have been established in the Netherlands) with a set of reference values in use in the United States of America and another set in use in Australia and New Zealand; these were the two most recent sets of reference values at the time that this report was written.[20-22,24,25]

The committee drew up this report using the tolerable upper levels of intake that have been set at European level (Table 1).[30]

In contrast to the committee's four previous advisory reports, which reviewed new scientific developments in detail, this advisory report does not include material based on an assessment of new scientific developments for individual micronutrients. This was not considered to be part of the committee's remit.

2.2.2 *Research and population groups*

Most of the research that has been conducted into micronutrient intake, nutritional status and health effects has been conducted on populations of healthy individuals of Dutch origin. This research has been collated in a report compiled by the Netherlands Institute for Public Health and the Environment (RIVM)*.[37] Annex D contains a summary of intake data obtained from food consumption surveys in the RIVM report. The third food consumption survey (1997/1998) also looked into the micronutrient intake of fifty pregnant women. This data does not constitute strong evidence as the sample was so small, and it is therefore not included in Annex D.[38]

* The RIVM has investigated what micronutrient status research should be conducted as a matter of priority in the light of data from intake studies and a limited number of status studies. It decided that priority should be given to micronutrients for which there are indications that intake is too low or too high and to micronutrients whose intake cannot be determined and in respect of which there are concerns about excessively low or high intake. Low priority is given to micronutrients in respect of which there are no indications that its supply is causing problems.[37] The committee did not follow these priorities as they were set with a different objective than that being pursued by this report.

In addition to data from food consumption surveys, the RIVM has also used data on the intake of micronutrients and the nutritional status of elderly people (SENECA study)[39] and of eight-year-old children and their mothers of Dutch or non-Western origin.[40,41] Since this report was published, new research conducted in the Netherlands has been published on: the intake of fourteen micronutrients by children aged nine, twelve and eighteen months* [42,43] and by children aged between two and six years[44]; and specifically the intake of calcium and iron by children of asylum-seekers[45], by young adults of Turkish or Moroccan background[46] and by adults of Surinamese background.[47] New findings have also been released on: the vitamin B_{12} status of various population groups (Table 2); and the iron status of children aged between two and six years, pregnant women[48] and adult men and women of Dutch or non-Western background.[49] In addition, use has been made of data from other European countries on: women who are pregnant or breastfeeding; individuals of non-Western origin; elderly people; and people of low socio-economic status. This advisory report does not cover people with a medical condition.

2.2.3 *Intake data and comparison with dietary reference values*

The amount of information available about the content of particular micronutrients in food varies from one substance to another. In addition, the quality of intake data and the way in which intake is compared with dietary reference values also differs depending on the research.

The level of many essential micronutrients in foods is known (Table 1).[31] This is not the case for biotin, pantothenic acid, vitamin K, chloride, chromium, fluoride, manganese or molybdenum**. It is therefore impossible to calculate the intake of these substances from the daily diet. The committee is not aware of the existence of deficits of these substances, apart from neonates who need additional vitamin K to prevent cerebral haemorrhage.*** [50]

* This study was sponsored by Nutricia Nederland B.V. and conducted by TNO with the support of an independent advisory committee.

** Food content data on selenium and magnesium was approximately 75% and 50% complete respectively in 2003.[37] As magnesium levels in the principal sources are known, the committee is of the opinion that this data is sufficient for assessment of intake data. As the NEVO table has since been expanded to include selenium contents of other foods, the food consumption survey among young children has estimated selenium intake.[44] Information is also available on selenium intake from duplicate diet surveys.[37]

*** All neonates are given 1 milligram of vitamin K after birth to prevent cerebral haemorrhage. Infants who are breast-fed also need an extra 25 micrograms of vitamin K a day in the form of a supplement for the first three months of life. Infants who are entirely bottle-fed do not need this as infant formula contains enough vitamin K.[50]

As some supplements on the market contain high levels of these substances, this advisory report has also looked into them.

The studies included in the aforementioned RIVM report and other studies into intake from the daily diet [45-47] used data on observed intake. As indicated above, this produces an overestimate of the number of individuals whose intake is too low or too high. Only the study into micronutrient intake among two- to six-year-old children used figures for habitual intake.[44]

2.3 Micronutrient intake, status, and any health effects

The first part of this section deals with the micronutrients for which the amount provided by the daily diet is known. These are the substances included in the Dutch Food Composition Database (Table 1).[31] This is followed by a description of micronutrient intake from supplements. Finally, consideration is given to groups for which intake data is inadequate and groups at greater than normal risk of deficiencies in more than one micronutrient.

2.3.1 Vitamins

Thiamin, niacin, vitamin B_6 and vitamin C

There are no indications that intake of thiamin, niacin, vitamin B_6 or vitamin C in the Netherlands is too low or too high.[37]

Riboflavin

There are indications that women of non-Western origin may have an excessively low riboflavin intake.

One study found that all Turkish and Moroccan mothers had a riboflavin intake (average 0.95 milligrams per day) below the recommended dietary allowance of 1.1 milligrams per day.[40] However, food consumption surveys found average riboflavin intake to be well above the recommended dietary allowance (Annex D). No studies into the riboflavin status of these women are available. Furthermore, the committee is not aware of any reported health effects among these women caused by excessively low riboflavin intake.

Vitamin B_{12} (cobalamin)

There are indications that 12 to 25 per cent of elderly people have low vitamin B_{12} status. Indications that around 15 per cent of adults of Dutch or non-Western background may have an inadequate vitamin B_{12} status have not been verified. Vegans are at risk of excessively low vitamin B_{12} intake as their diet contains little or no animal products.

Vegans are at high risk of low vitamin B_{12} status due to excessively low vitamin B_{12} intake as their diet contains little or no animal products. Infants being breast-fed by mothers who are vegans and do not take vitamin B_{12} supplements are at very high risk of severe neurological disorders caused by vitamin B_{12} deficiency.[51] In elderly people, low vitamin B_{12} status is usually caused by impaired absorption rather than excessively low intake.

The advisory report *Towards an optimal use of folic acid* contains a summary of the vitamin B_{12} status of the Dutch population (Table 2).[2] This shows that around 12 to 25 per cent of elderly people may be suffering from vitamin B_{12} deficiency.

It also seems that adults of Dutch, Turkish or Moroccan background may have inadequate vitamin B_{12} status. Percentages range from 6 per cent of Moroccan men to 32 per cent of Turkish women. The reasons for this are still unclear.[52]

These figures may be either over-estimates or under-estimates of the actual number of people with low vitamin B_{12} status as the cut-off value for serum vitamin B_{12} levels is still a matter for debate. Additional measurements of methylmalonic acid and homocysteine levels produce a more specific diagnosis.[53]

Vitamin E (tocopherol)

There are indications that approximately 16 to 27 per cent of children may have an excessively low vitamin E intake.

The food consumption surveys found that average vitamin E was above the adequate intake level determined in 1989 (Annex D).[37] When intake is compared with more recent dietary reference values, we find that average intake by teenage girls (12 milligrams per day) and adult women (11 to 11.6 milligrams per day) is

Table 2 Summary of studies into vitamin B_{12} status.

Study	N, gender, age	Low vitamin B_{12} status Definition	%
General Health Monitor study, Amsterdam 2004[52]			
	210 Dutch men aged 18 or over	Serum cobalamin < 150 pmol/l	13
	189 Turkish men aged 18 or over		16
	181 Moroccan men aged 18 or over		6
	289 Dutch women aged 18 or over		10
	212 Turkish women aged 18 or over		32
	145 Moroccan women aged 18 or over		11
Van Asselt 1998[54]			
	105 men and women aged 74-80	Plasma cobalamin < 260 pmol/l & methylmalonic acid > 0.32 micromol/l	24
Van Asselt 2001[55]			
	189 men and women aged 64-89	Plasma cobalamin < 150 pmol/l	15
Dhonukshe-Rutten 2005[56]			
	615 men and women aged 70 or over[a]	Serum cobalamin 100-300 & methylmalonic acid $\geq$ 0.30 micromol/l	18
Eussen 2006[57]			
	896 men and women aged 70 or over	Serum cobalamin 100-200 or 200-300 & methylmalonic acid $\geq$ 0.32 micromol/l & creatinine $\leq$ 120 micromol/l	25
Manders 2006[58]			
	43 men and women aged 65 or over[a]	Serum cobalamin < 160 pmol/l	12
De Jong 2001[59]			
	130 men and women aged 70 or over[b]	Serum cobalamin < 221 pmol/l	44

a Institutionalised elderly.

b Frail elderly.

below the American recommended dietary allowances (15 milligrams per day) [21] but above the adequate intake figures set in Australia and New Zealand (8 milligrams per day for girls and 7 milligrams per day for adult women).[20]

More recent research based on the distribution of habitual intake has shown that 16 to 27 per cent of children aged between two and six years have a vitamin E intake below the (American) average requirement of 5 to 6 milligrams per day. The fifth percentile of vitamin E intake among children was 1 to 1.7 milligrams per day below this average requirement.[21,44] No research has been published into the vitamin E status of these children. Furthermore, the committee is not aware of any reported health effects in this group caused by excessively low vitamin E intake.

2.3.2 *Minerals*

Phosphorus and potassium

There are no indications that intake of phosphorus (Annex D) or potassium is too low or too high.[37]

Calcium

There are indications that individuals of non-Dutch origin may have an excessively low calcium intake.

The average calcium intake of children aged between seven and thirteen years, boys aged fourteen to nineteen, adult women aged nineteen to sixty-five and individuals aged over sixty-five (about 900 milligrams per day) is below the adequate intake level (1.0 to 1.2 grams per day depending on age and gender) (Annex D).[37] The average calcium intake of Turkish and Moroccan women and their eight-year-old children was considerably lower than that of individuals of Dutch origin (approximately 600 milligrams per day).[40,41] The same is true of young adult men (approximately 870 milligrams per day) and women (approximately 500 milligrams per day) of Turkish, Moroccan or Surinamese background.[46,47] In addition, the calcium intake of 42 per cent of children of asylum-seekers was below 80 per cent of the recommended dietary allowance.[45]

Dutch reference values for calcium are almost identical to the adequate intake figures set in America and the recommended dietary allowance set in Australia and New Zealand.[20,24] The Dutch figures aim to achieve maximum peak bone mass around the age of thirty and to minimise age-related loss of bone mass. In view of the relatively small difference between average calcium intake by people of Dutch origin and adequate intake level, the committee does not expect that current intake levels will cause harm to health. The question is, does the same apply to people of non-Dutch background? Research shows that the risk of fracture among people at greater than normal risk of osteoporosis increases when calcium intake falls below 400 milligrams a day.[60]

Magnesium

There are no indications that magnesium intake is too low or too high.

Food consumption surveys show that average magnesium intake is above the adequate intake levels set in 1989 (Annex D).[37] Comparing intake with more recent reference values indicates that average magnesium intake by children aged thirteen and over and by adults is up to 110 milligrams a day below the recommended dietary allowance (US: 310 to 420 milligrams a day, Australia and New Zealand: 320 to 420 milligrams a day). The difference between intake and the recommended dietary allowance was greatest among teenagers.[20,24,61] Magnesium intake is somewhat overestimated in the food consumption surveys because at that time the magnesium content was known for approximately three-quarters of the products in NEVO (in fact the most important products). Therefore, this data does not provide firm evidence of excessively low magnesium intake in the Netherlands. There are also no known reports of the existence of health problems caused by excessively low magnesium intake in the Netherlands.

2.3.3 *Trace elements*

Iron

There are indications of low iron status among almost 50 per cent of pregnant women, approximately 35 per cent of women of childbearing age, and 20 per cent of children of asylum-seekers. On the other hand, iron accumulation affects a small percentage of children, women aged over 50, and men.

Food consumption surveys have found average iron intake to be below adequate intake levels (7.0 to 16.0 micrograms per day depending on age and gender) among children aged one to three years, girls aged four to ten years, boys and girls aged ten to nineteen, women aged nineteen to fifty, and pregnant women (Annex D).[37,38] In the European SENECA study, 23 per cent of women in their seventies had an excessively low iron intake.[39] Iron intake among women varies according to ethnic origin: it was found to be lowest among women of Moroccan background (7.2 milligrams per day), highest among women of Dutch background (10.3 milligrams per day), with the value for women of Turkish background falling between these figures (8.8 milligrams per day).[40,41]

These findings also hold true when more recent reference values, established in the United States of America or Australia, are used.[20,22] The findings for young

children and women are also confirmed by more recent research into iron intake.[45-47,62,63] The food consumption survey found the average iron intake of children aged nine to twelve months to be above adequate intake levels, while that of children aged eighteen months was 0.5 milligrams a day below the American recommended dietary allowance of 7.0 milligrams a day.[42,43] In addition, the iron intake of about half of children of asylum-seekers was less than 80 per cent of the recommended dietary allowance.[45] Women of Surinamese origin also had a low iron intake, similar to that among Turkish women.[47]

One important point in relation to the findings of research into intake is that the iron requirements of women of childbearing age vary considerably. The requirements of individual women can be very different because of the variation in the amount of blood lost during menstruation. The average requirement has been set at 8 milligrams a day, while the recommended dietary allowance is 18 milligrams a day.[20,22] This means that average intake below the recommended dietary allowance does not necessarily mean that there is a problem.

The RIVM report concludes that the limited amount of status research available seems to confirm the findings (the use of different status parameters makes interpretation more difficult).[37,40,64,65] Haemoglobin measurement has low sensitivity and low specificity. In the absence of inflammation, one sensitive method of determining iron status is by combining determination of serum ferritin levels (as a measure of iron stores in the body) and determination of serum transferrin receptor levels (as a measure of iron deficiency in tissues).[66]

More recent status research (summarised in Table 3) does not confirm that iron intake among two-year-old children of Dutch background is too low.[48] The situation among children of asylum-seekers is different: detailed investigation found low iron status among 20 per cent of these children, and 20 per cent of this sub-group (4 per cent of the group as a whole) were suffering from anaemia as a result of iron deficiency.[67]

Additional status research provides further confirmation that iron intake may be too low among women of childbearing age and pregnant women.[48,49] This research applied the normal values for non-pregnant women to pregnant women. As the authors point out, the question is whether the low iron status among pregnant women is the consequence of an increase in blood volume (haemodilution) or whether it actually points to a functional deficiency.[48]

Iron deficiency is very rarely seen among women aged over fifty or men of any age. However, iron accumulation did occur among 8 per cent of these individuals of Dutch or other (apart from Turkish or Moroccan) origin. The corresponding figure for participants of Turkish or Moroccan background was less

than 2 per cent.[49] The KOALA Birth Cohort study found iron accumulation in one of the 553 two-year-old children examined.[48]

These studies have not investigated whether excessively low iron intake among eighteen-month-old children or low iron status among women of child-bearing age and pregnant women causes health problems.

2.3.4 Copper

There are no indications of excessively low or high copper intake among the Dutch population.

The third food consumption survey (1997/1998) found that average copper intake by girls aged ten to thirteen, teenagers aged thirteen to nineteen, and adults was below the adequate range of intake (Annex D), but the food consumption survey of young adults (2003) found it to be above this level. At the time that the RIVM report was written, the copper content of 62 per cent of the products in NEVO was known[37]. Actual intake is therefore probably higher. Comparing intake data with more recent dietary reference values shows average copper intake to be above the recommended dietary allowance set in the United States of America[22], but below the adequate intake level set in Australia and New Zealand, for all population groups.[61] The committee does not expect this latter factor to signify a public health problem as copper intake is underestimated, and because the process of setting an adequate intake figure is associated with a greater degree of uncertainty than that of setting a recommended dietary allowance.

Research published since then only contains indications of excessively high intake. 48 and 37 per cent of the two- and three-year-old boys and girls taking part in the food consumption survey among young children and six to eight per cent of children aged four to six have a copper intake from food and supplements in excess of the tolerable upper levels of intake laid down by the EU Scientific Committee on Food.[30,44] However, these findings are probably attributable to the very high copper content of some chocolate products in NEVO.[31] New chemical tests are being performed at the moment; once the findings are available, it may be possible to re-evaluate intake.

Table 3 Summary of research into iron status.

Study	N, gender, age	Low iron status Definition	%
General Health Monitor study, Amsterdam 2004[49]			
	210 Dutch men aged 18 or over	Ratio transferrin receptor / ferritin > 2.8	3
	189 Turkish men aged 18 or over		3
	181 Moroccan men aged 18 or over		8
	289 Dutch women aged 18 or over		14
	212 Turkish women aged 18 or over		30
	145 Moroccan women aged 18 or over		35
KOALA Birth Cohort study[48]			
	580 children aged two	Plasma ferritin < 12 micrograms per litre	3
	552 women, 34-36 weeks pregnant		48
Stellinga-Boelen 2007[68]			
	122 children, 2-12	Plasma ferritin < 15 micrograms per litre	20
		Haemoglobin < 6.8 mmol per litre among children under six and < 7.1 mmol per litre among children aged six to twelve	4

2.3.5 Selenium

There are indications that selenium intake among young children may be excessively low.

Only limited data is available on selenium intake in the Netherlands. Comparison with the dietary reference values established in 1989 indicates that selenium intake among men aged eighteen and young children is adequate.[29,44,69] But this is no longer the case for young children when more recent reference values are applied. Approximately 7 to 12 per cent of children aged two or three and 35 to 53 per cent of boys and girls aged four to six have a selenium intake from food* which is lower than their average requirement, as established by the American Institute of Medicine.[21,44] The fifth percentile of intake from food and supplements was 1 to 2 micrograms per day lower than the average requirement of 17 micrograms per day among two- and three-year-olds, and 6 to 7 milligrams per day lower than the average requirement of 23 micrograms per day among four- to six-year-olds**.[21] Duplicate diet studies among young children have con-

* The percentage of children with a selenium intake from foods and supplements below the average requirement was not reported.

** The Australian and New Zealand average requirement for two- and three-year-olds is 20 micrograms a day, and 25 micrograms a day for three- to six-year-olds.[20]

firmed the possibility of low intake.[70] The low correlation between selenium intake and selenium levels in toenails and plasma means that it is not clear how far this intake data reflects actual selenium intake*.[71,72] The selenium intake of other groups in the population has not been investigated. The committee is not aware of any reports of medical problems due to low selenium intake in the Netherlands.

2.3.6 *Zinc*

There are no indications of excessively low zinc intake.

Intake data from 1997/98 shows that average zinc intake by adolescents is 0.3 to 0.9 milligrams per day below adequate intake level (9.0 to 11.0 milligrams per day depending on age and gender; see Annex D). Zinc intake was also investigated among a small group of pregnant women at the same time. Their average zinc intake, 9.5 milligrams per day, was lower than the adequate intake level of 12 (first trimester) to 15 (third trimester) milligrams per day.[37,38] Comparing intake with more recently established reference values (adequate intake 11 milligrams per day) narrows the gap.[22] Applying more recently established reference values shows that the average intake among men aged over sixty-five is 1 milligram below the American recommended dietary allowance of 11 milligrams per day**.[22] It should be pointed out that as the zinc content of 30 per cent of the products in the food composition table was not known at that time, intake was somewhat underestimated.[34] There are no known reports of health problems due to low zinc intake in this group.

Food consumption research released after the publication of the RIVM report[37] and based on habitual intake data estimates that around 28 to 43 per cent of children aged four to six have a zinc intake from food*** below their average requirement as based on the dietary reference values drawn up by the American Institute of Medicine.**** However, the difference between intake and requirement is small. The fifth percentile of zinc intake from food and supplements is 0.3 to 0.4 milligrams below the average requirement of 4 milligrams per day.[22,44] In addition, status research among children with symptoms that accompany zinc

* As there is no difference between plasma and serum selenium levels, this advisory report refers to plasma selenium levels throughout the text, even when the actual value measured was a serum level.

** The recommended dietary allowance is 14 milligrams a day in Australia and New Zealand.[20]

*** The percentage of children with a zinc intake from foods and supplements below the average requirement was not reported.

**** The Australian reference values for children aged two to six are almost identical to the American reference values.

deficiency (such as diarrhoea, repeated infection and growth retardation) has produced estimates that around 1 per cent of Dutch children with mild symptoms have zinc deficiency.[73] The committee therefore expects that although intake may be slightly too low, this is not likely to have any major impact on zinc status or on health.

Finally, approximately 12 per cent of children aged two or three have a zinc intake from food and supplements above the European tolerable upper levels of intake: the 9th percentile of zinc intake is 7.8 to 7.9 milligrams a day, compared to the tolerable upper level of intake of 7 milligrams a day. As the difference is small, the committee does not expect this to cause any health problems.[30,44]

2.4 Intake from supplements

Food consumption surveys have not so far extensively investigated the intake of micronutrients from supplements. However, this matter was addressed in the survey of intake among two- to six-year-olds discussed in section 2.3.

Limited data is available on the micronutrient content of supplements.[31,74,75] The amounts of micronutrients contained in supplements varies considerably, and in the case of some supplements is higher than the tolerable upper level of intake. The extent to which tolerable upper levels of intake are exceeded also varies considerably. In general, dietary supplements containing minerals pose more of a problem in this regard than those containing vitamins.[74,75]

Supplements can make a significant contribution to the total intake of micronutrients, as individuals who take them consume on average 0.5 to 2 supplements a day. However, little data is available that would allow intake to be quantified. The limited data available would appear to give little reason for concern as to excessively high intake of micronutrients from supplements for the general population. However, excessively high intake cannot be ruled out in the case of a small proportion of supplement users.[74] This latter conclusion is in line with scenario calculations produced by RIVM and published in the report *Measuring Dutch Meals**.[76]

2.5 Groups at risk for which intake and status data is insufficient

The committee finds that data on micronutrient intake and status is insufficient or incomplete in the case of women who are pregnant or breastfeeding and for indi-

* The full report is in Dutch and contains an English summary.

viduals of non-Western origin.* The same is true of people with a low energy intake, especially elderly people, and those with an unusual dietary pattern.

In addition to the third food consumption survey (1997/1998)[38], other research carried out in the Netherlands on pregnant women has concentrated mainly on deriving reference values for status parameters and on the impact of micronutrient intake or status on the outcome of pregnancy; almost all the women taking part in this research were of Dutch origin.[63,77,78] Research from other European countries confirms the picture of low calcium intake by pregnant women of non-Western background and low iron intake and status among pregnant women in general.[79-86] The possibility of low zinc intake does not appear to be confirmed by studies in other European countries. The situation with regard to other micronutrients is less clear. Some studies show that thiamin status[79] and riboflavin[83,86], vitamin E [86], potassium[84] and/or magnesium intake[84,86] by pregnant women may be too low.

People of non-Western background may be at risk of excessively low intake of certain micronutrients; two differences are relevant here: (1) the difference between their dietary pattern and a 'Dutch' dietary pattern; (2) the difference between the foods available in the Netherlands and those available in their country of origin. There is no single, clear picture as regards micronutrient intake by groups of different non-Western backgrounds. The limited amount of research available shows that the intake of many vitamins and minerals is lower among women and children of Turkish or Moroccan background compared with women and children of Western background; there is also a difference in intake between the Turkish group and the Moroccan group.[40,41] Other studies conducted in the Netherlands among these groups have looked only at a small number of micronutrients discussed earlier in this report and in other advisory reports produced by the Health Council.[45-47] In the United Kingdom, women of Asian or African background had a lower calcium and riboflavin intake than women of Western background. Men of Asian origin also had a lower calcium intake than men of Western origin. There were no clear differences between these groups in respect of the intake of other micronutrients.[87] Another smaller study found that people of Pakistani background had a lower calcium intake and people of Afro-Caribbean background had a lower iron intake than people of Western background.[88]

* There are some exceptions: the iron status of women of childbearing age and riboflavin, calcium and iron intake by people of non-Dutch background.

No studies have been conducted in the Netherlands into micronutrient intake by individuals of, for example, Eastern European or Indian origin, who have a low energy intake or an unusual dietary pattern*.

2.6 Groups at greater than normal risk of deficiencies of various micronutrients

Two groups thought to be at greater than normal risk of a low intake of various micronutrients are elderly people and individuals of low socio-economic status. Elderly people are at greater risk of a low micronutrient intake if their energy intake is low.[39,92] In fact, the European SENECA project found that 19 per cent of elderly men and 26 per cent of elderly women had an excessively low intake of one or more micronutrients even if their energy intake was over 1,500 calories a day.[39]

The effect of socio-economic status on micronutrient intake appears to be minor. The third food consumption survey (1997/1998) did find that the intake of calcium, iron, vitamin A and vitamin C was lower among individuals of low socio-economic status. However, the differences in intake between groups of different status were not particularly marked. It should be borne in mind that most of the participants in this study were of Dutch background.[93] These findings match those of studies carried out in other European countries[87,94], although some studies have found greater differences.[95-97] The UK Low Income Diet and Nutrition Survey found that the intake of micronutrients among low-income groups was similar to that of the British population as a whole, as well as with that of groups who are at greater risk of micronutrient intake below the recommended dietary allowance.[87] The study did find that people on low incomes were at greater risk of low haemoglobin levels than the general British population, and that women on low incomes were at greater risk of low serum transferrin levels.[98] The summary article produced by Darmon and colleagues concluded however that individuals of low socio-economic status consistently had a lower intake of vitamin C, beta-carotene, calcium and iron compared to individuals of high status. Status research, particularly that carried out on groups at risk such as elderly people and women who are pregnant or breastfeeding, appears to confirm this.[95]

* Apart from some research on micronutrient intake among children who are fed a macrobiotic diet.[89-91]

2.7 Summary and subsequent action

2.7.1 Summary

There are indications that the intake of thiamin, riboflavin, niacin, vitamins B_6 and C, phosphorus, potassium, magnesium, chloride, copper and zinc by most healthy children and adults is adequate. Certain groups at risk in the population may have an excessively low intake of vitamin B_{12}, iron, riboflavin, vitamin E, calcium and/or selenium. In the case of the first two of these substances, this is confirmed by low status values (Table 4). Two population groups are at risk of excessively low intake of various micronutrients simultaneously: elderly people (especially those with a low energy intake) and perhaps also individuals of low socio-economic status.

There is also a small group of the population who are at risk of having a micronutrient intake above the tolerable upper level of intake as a result of taking supplements.

Finally, the committee finds that insufficient data is available regarding micronutrient intake and status among children and adults of non-Western background, women who are pregnant or breastfeeding, and individuals with a low energy intake, particularly elderly people.

2.7.2 Subsequent action

Various forms of subsequent action are appropriate depending on the evidence available pointing to excessively low intake or status of various micronutrients (Table 4). This could entail investigations into status and/or health effects, or a revision of dietary reference values. The supplementation advice presented in table 4 is based on earlier advisory reports on micronutrients[1-4], apart from in the case of vitamin K.[50] A brief explanation of the subsequent action suggested for each micronutrient is given below.

Riboflavin

Riboflavin intake by women of Turkish or Moroccan background may be too low. It is not presently clear whether this excessively low intake is associated with low riboflavin status and a greater risk of associated health problems in these women, such as inflammation of the epidermis around the corners of the mouth.[28]

Vitamin B_{12}

There are clear indications that the vitamin B_{12} status of elderly people is too low. However, it is not clear whether this low status causes health problems in this group or whether vitamin B_{12} supplementation would in fact be beneficial to health.[99-102] Indications that about 15 per cent of adults of Dutch, Turkish or Moroccan background have low vitamin B_{12} status have not been verified; and should this in fact be the case, the causes are unknown.

Vitamin E

There are indications that vitamin E intake among young children may be too low. No studies have been carried out to ascertain whether low intake among this group is associated with low vitamin E status.

Calcium

Calcium intake by individuals of Turkish, Moroccan or Surinamese background may be too low. It is unknown whether this leads to lower bone density and greater risk of fractures among these groups.[28] Research shows that in countries where osteoporosis is common, individuals aged from 50 or 60 onwards who have a low calcium intake (400 milligrams a day) are at greater risk of bone fracture. Increasing calcium intake might reduce this risk.[60,103,104] Insufficient research has been carried out into the effects of calcium supplementation on bone density in children and young adults.[60]

Iron

The iron intake and iron status of young children of Dutch origin is adequate, but this is not the case for children of asylum-seekers. Low iron status in children is associated with poor psychomotor development.[105-107] A systematic summary article published in 2005 concluded that additional iron could improve mental development to some extent. This effect is particularly clear in intelligence tests conducted from the age of eight and in children with anaemia. There is no convincing evidence that additional iron improves the mental development of children under 27 months of age or that it improves motor development.[105]

The situation with regard to iron intake by children of non-Western background has not been investigated. Breastfeeding provides sufficient iron up to the age of six months. From that age onwards, infants need more iron than they can

obtain from breast milk. This means that supplementary feeding is required.[108] Children who are exclusively breast-fed for more than six months, something which is slightly more common among individuals of non-Western background than among people of Dutch origin, or who are given normal milk instead of follow-on milk in the first year of life, are at greater than normal risk of low iron intake and status.[108]

It is unclear whether excessively low iron intake and status among women of childbearing age and women who are pregnant causes harm to health. An excessively low iron intake usually causes no symptoms in the early stages. Symptoms such as fatigue and diminished endurance and physical capacity only arise when an individual's stores of iron have been too low for an extended period. Anaemia* occurs only when the lack of iron is severe.[29] Iron supplements can reduce an iron deficiency, but can also cause problems such as constipation.[110,111]

Selenium

Selenium intake by young children may be on the low side. This can be verified by research into selenium levels in toenails and plasma.[71,72] However, there is no consensus as to the cut-off values for low selenium status.[112,113] For that reason, further evaluation of supply is in theory dependent on the possible health impacts of low selenium intake. But the problem is that selenium deficiency alone rarely causes medical problems; it does however cause biochemical changes that may make an individual more susceptible to diseases caused by other factors such as infection.[21]

* Haemoglobin < 6 mmol per litre in women and < 6.5 mmol per litre in children and men, microcorpuscular volume < 80 fl, and ferritin < 15 micrograms per litre or microcorpuscular volume < 80 fl and 15 micrograms per litre < ferritin < 100 micrograms per litre and diminished serum iron and elevated transferrin.[109]

Table 4 Summary of possible problems in the supply of micronutrients among the Dutch population and subsequent action.

Micronutrient	Population (group)	Intake	% of group with excessively low or high status	Health effects	Subsequent action
Thiamin	Children and adults of Dutch or non-Western background	Adequate [a]			
Riboflavin	Women of non-Western background	Possibly too low [a]			Research into status and health effects
Niacin	Children and adults of Dutch background	Adequate			
Vitamin B_6	Children and adults of Dutch or non-Western background	Adequate			
Folic acid	Women of Dutch or non-Western background around the time of conception	Possibly too low	About 50% too low	Child with neural tube defect	Supplementation advice and possibly fortification of staple foods
Vitamin B_{12}	Elderly people	Adequate [a]	12-25% too low		Research into health effects
	Vegans	Possibly too low [a]	n.r. [b] % too low		Recommended dietary allowance of vitamin B_{12} to be obtained from a supplement or fortified foods
	Adults of Dutch or non-Western background	Adequate [a]	15% too low		Additional research into status and possible causes
Vitamin C	Children and adults of Dutch or non-Western background	Adequate [a]			
Vitamin D	Young children; children and adults of non-Western background or who do not spend enough time out-doors; Women who wear a veil; All women over 50; all men over 70	Possibly too low	5-85 % too low	Rickets, osteomalacia, osteoporosis	Supplementation advice and possibly fortification of staple foods
Vitamin E	Young children of Dutch background	Possibly too low			Investigate vitamin E status
Pantothenic acid		Unknown [a]			
Biotin		Unknown [a]			
Vitamin K	Breast-fed infants [c]	Possibly too low [a]		Cerebral haemorrhage	Supplementation advice
Calcium	People of non-Western background	Possibly too low			Research into health effects

Phosphorus	Children and adults of Dutch background	Adequate [a]			
Potassium	Children and adults of Dutch background	Adequate [a]			
Magnesium	Children and adults of Dutch background	Adequate			
Sodium	Children and adults of Dutch background	Too high [a]		High blood pressure	Advice on limiting salt intake
Iron	Young children of Dutch background	Possibly too low [a]	Adequate		Revise dietary reference values
	Children of asylum-seekers	Possibly too low [a]	20 % too low	Impaired psychomotor development	Treat the iron deficiency Investigate iron status of young children of non-Western background
	Pregnant women of Dutch or non-Western background	Possibly too low [a]	50 % too low		Investigate health effects
	Adult women of Dutch or non-Western background	Possibly too low [a]	35 % too low		Investigate health effects
	Children, men and adult women aged over 50 of Dutch or non-Western background	Adequate [a]	Less than 2 % to 8 % too high	Haemochromatosis	Medical treatment
Iodine	Children and adults of Dutch background	Adequate	Adequate		No additional measures required
Copper	Children and adults of Dutch background	Adequate			Check NEVO data
Selenium	Young children of Dutch background	Possibly too low			Check (cut-off values for) selenium status
Zinc	Children and adults of Dutch background	Adequate			
Chromium		Unknown [a]			
Fluoride		Unknown [a]			
Manganese		Unknown [a]			
Molybdenum		Unknown [a]			

a No tolerable upper levels of intake have been set for these substances. This means that very large amounts of these substances may be added to foods and supplements. The possibility that the use of such products may cause harm to health cannot be entirely ruled out.

b n.r. = not reported.

c All neonates are given 1 milligram of vitamin K after birth to prevent cerebral haemorrhage. Infants who are breast-fed also need an extra 25 micrograms of vitamin K a day in the form of a supplement for the first three months of life. Infants who are entirely bottle-fed do not need this as substitute milk contains enough vitamin K.

Chapter 3

Measures for ensuring adequate intake

This chapter discusses measures (varied diet, restoration, substitution, fortification and supplementation) aimed at ensuring an adequate intake of micronutrients. It also looks back at earlier advisory reports on folic acid, vitamin D, iodine and vitamin A.

3.1 Methods used to select measures

When selecting measures aimed at countering the health effects of an excessively high or low intake of vitamins or minerals, a diet based on the *Guidelines for a Healthy Diet* is the starting point. Supplementation is an option for individuals who have an excessively low intake and do not adjust their diet. Restoration, substitution and fortification are options if diet adjustment does not suffice (Figure 2).

When considering measures, the committee always followed the principle that they must provide health benefits. This starting point is different from that adopted by the Committee on Dietary Reference Values, which sets dietary reference values on the basis of both health impact and biochemical parameters (blood values). An excessively low nutritional status is not necessarily associated with health problems: these often arise only once an individual is seriously deficient in a micronutrient.

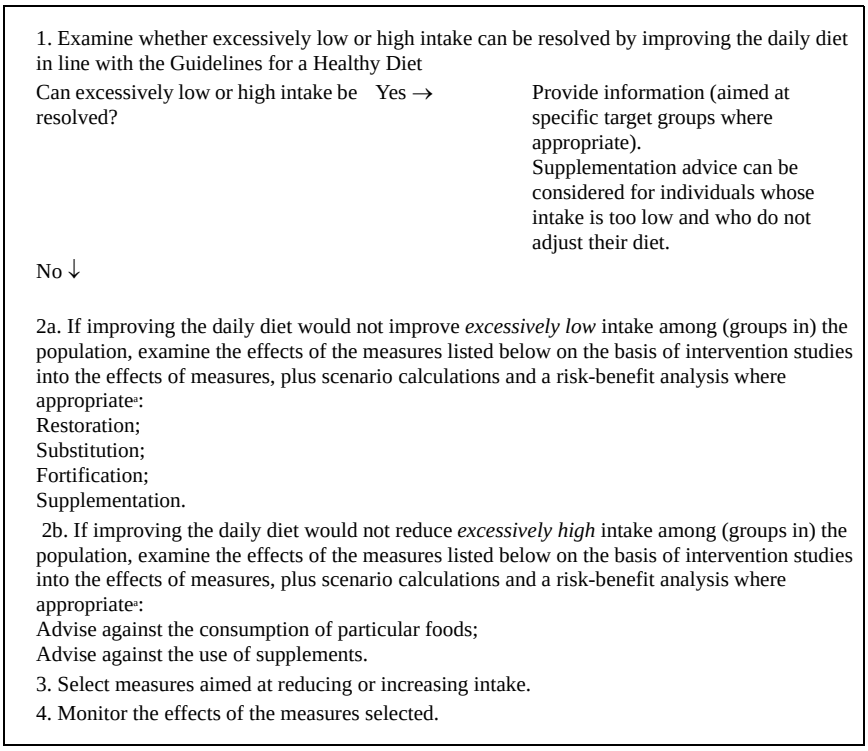

Figure 2 Multi-stage plan for selecting measures aimed at improving the intake of micronutrients (see figure 1 for determining whether measures are needed to ensure an adequate intake of a particular micronutrient).

3.2 A varied diet

Guidelines for a Healthy Diet

The *2006 Guidelines for a Healthy Diet* are, in combination with feasibility, used as a starting point for determining the Food-based Dietary Guidelines.[26,114] Calculations performed by the Netherlands Nutrition Centre indicate that certain groups in the population may not be receiving enough iron, zinc or selenium even if they follow a diet in accordance with the Guidelines for a Healthy Diet*. In the case of iron this is true of young children, teenagers and women of childbearing age; in the case of zinc and selenium the population groups have not

* Only the calculations for adults have been published.

been specified. The supply of the micronutrients thiamin, riboflavin, vitamins B_6, B_{12}, C and E, calcium, phosphorus, copper and magnesium is however adequate for the population as a whole.[114]

Five benchmark diets have been devised with a different composition of products placed in the 'preferred', 'neutral' and 'occasionally' categories. A number of comments need to be made on the calculations. For example, the calculations do not include non-staple foods, although these account for about a quarter of energy intake. As they can also contribute to micronutrient intake, it would appear that micronutrient intake is actually higher than shown in these calculations.[114]

The Food-based Dietary Guidelines are designed for nutritional information and meal planning, or for devising a healthy diet. They are aimed at ensuring that dietary reference values are met by means of a varied choice of foods.

In addition, the comparisons between the outcomes of the calculations and the dietary reference values were in the first instance carried out using the Dutch dietary reference values for iron, zinc and selenium.[29] But these are outdated; in its report, the Netherlands Nutrition Centre used the more recently established American values which take new scientific developments into account.[21,22] When considered in the light of these values, a healthy diet does contain enough zinc.

As stated in the previous chapter, it is unclear whether the calculated intake of iron and selenium is actually too low. For example, it is not known whether the calculated iron intake does cause harm to health. Furthermore, in the case of the estimate of selenium intake it is not clear how closely these figures reflect actual selenium intake in view of the low correlation between selenium intake and selenium levels in toenails or plasma*.[71,72] There is also no consensus on the cut-off values for low selenium status,[112,113] and selenium deficiency rarely causes medical problems.[21]

In the case of iron, zinc and selenium, the calculated intake from the benchmark diets is higher than the average intake from the daily diet consumed by participants in food consumption surveys.

In addition, advice aimed at increasing iron absorption from diet consists of recommending people to eat foods containing vitamin C.[114]

It is therefore not clear whether a diet in line with the Guidelines for a Healthy Diet provides enough iron and selenium. As a diet of this kind provides about three-quarters of energy requirement, iron and selenium are also obtained from other foods, but exactly how much is not known. Nevertheless, a diet in

* As there is no difference between plasma and serum selenium levels, this advisory report refers to plasma selenium levels throughout the text, even when the actual value measured was a serum level.

accordance with the Guidelines for a Healthy Diet does provide more iron and selenium than the normal daily diet.[114]

Supplementation advice for groups at risk

Some groups in the population need much more of certain micronutrients than they could obtain from a normal daily diet or even a diet in line with the Guidelines for a Healthy Diet. Examples include the vitamin D requirement of elderly people and the folic acid requirement of women around the time of conception.[2,3] Tables 5 and 6 contain a summary of the current recommendations for micronutrient intake in addition to the intake from the normal daily diet for children and adults respectively. Vegans are a special case in this respect: they do not consume any animal products and their vitamin B_{12} intake is too low as a result. Their requirement is not higher than that of the general population, but their intake from their daily diet is too low.

Specific recommendations have been produced for people with particular medical conditions. These are beyond the scope of this advisory report.

3.3 Investigation into the effects of measures

The *Healthy Nutrition from Start to Finish* policy document produced by the Ministry of Health, Welfare and Sport distinguishes between two ways of improving the health of the population, i.e. encouraging consumers to eat a healthy diet and encouraging businesses to offer healthy food.[116] Both are important to ensure an adequate intake of micronutrients by the general population.

The measures selected in addition to a varied diet will depend on what proportion of the population is receiving too little or too much of a particular micronutrient, the distribution of the requirement, and the risk of excessively high intake. The basic principle when selecting measures is that they must be beneficial to health (Figure 2). As long-term excessively high intake of some micronutrients can be harmful to health, it is not simply a case of more is better. The question is: what is the ideal level.

Before particular measures are chosen, an investigation should ideally be conducted to find out what effect they have, preferably by means of intervention studies. Another form of investigation that might be appropriate is scenario calculations into the effects of measures on intake; however, this form of investigation has less evidential strength than intervention studies. The positive and negative effects on health can be compared in a risk-benefit analysis. If the negative effects are serious and uncertain (such as the relationship between folic acid

and colon cancer), decisions can be justified on the basis of the precautionary principle.[117]

Table 5 Micronutrients that children need in addition to their daily diet.[2,3,27,115]

Population group	Micronutrient	Effect on health
Breast-fed neonates [a]	25 mcg vitamin K a day for the first three months	Prevents cerebral haemorrhage
All children up to 4 years	10 mcg vitamin D a day	Prevents muscle weakness and fragile, painful bones caused by vitamin D deficiency
Children aged four or over with dark skin or who do not spend enough time outdoors	10 mcg vitamin D a day	Prevents muscle weakness and fragile, painful bones caused by vitamin D deficiency
Vegans	Additional vitamin B_{12} according to the dietary reference value applying to the individual	Prevents anaemia caused by a vitamin B_{12} deficiency

a All neonates are given 1 milligram of vitamin K after birth to prevent cerebral haemorrhage. Infants who are entirely bottle-fed do not need this as infant formula contains enough vitamin K.

Table 6 Micronutrients that adults need in addition to their daily diet.[2,3,27,115]

Population group	Micronutrient	Effect on health
Pregnant women	400 mcg folic acid a day from at least four weeks before conception until eight weeks after conception	Reduces the risk of having a child with a neural tube defect
	10 mcg vitamin D a day	Prevents muscle weakness and fragile, painful bones caused by vitamin D deficiency
Breastfeeding women	10 mcg vitamin D a day	Prevents muscle weakness and fragile, painful bones caused by vitamin D deficiency
Women aged up to 50 and men aged up to 70 with dark skin or who do not spend enough time outdoors. Or women aged up to 50 who wear a veil	10 mcg vitamin D a day	Prevents muscle weakness and fragile, painful bones caused by vitamin D deficiency
Women aged over 50 and men aged over 70 with pale skin who do spend enough time outdoors	10 mcg vitamin D a day	Reduces the risk of falls or fracture.
Women aged over 50 and men aged over 70 with dark skin or who do not spend enough time outdoors. Or women aged over 50 who wear a veil	20 mcg vitamin D a day	Reduces the risk of falls or fracture.
Institutionalized elderly people or elderly people suffering from osteoporosis	20 mcg vitamin D a day	Reduces the risk of falls or fracture.
Vegans	Additional vitamin B_{12} according to the dietary reference value applying to the individual	Prevents anaemia caused by a vitamin B_{12} deficiency.

If large groups in the population have an excessively low intake, consideration can be given to adding the micronutrient to staple foods. This can be done by restoration, substitution or fortification. Substitution and restoration produce smaller changes to intake than fortification.

Fortification can, in theory, be ‘mandatory’ or voluntary. Mandatory fortification is not legally feasible in the Netherlands, since the mandatory addition of iodised salt to bread was successfully challenged in the mid-1980s by an organic baker. However, the government can make arrangements for fortification via an agreement with manufacturers. The Commodities Act specifies how much of a particular micronutrient can be added to individual products.[6] If fortification is regulated by agreements, it is very likely that most of the individuals in groups at risk will consume the fortified foods. This also applies to staple foods that undergo restoration or that are used as substitute products. This is unlikely in the case of voluntary fortification as the manufacturer decides whether or not to fortify a product, and so specific products are fortified. The government can encourage fortification in practice by consultation with manufacturers.

Adequate intake can be achieved by adding micronutrients to staple foods only if the requirements of various groups do not widely differ, as is the case with iodine. One example of this is salt which is fortified with iodine. Where requirements are very different, and there is a relatively small gap between recommended dietary allowance and the tolerable upper level of intake, then fortification cannot fully meet the requirements of groups at risk: this is because other groups would be at risk of an excessively high level of intake. In this situation the groups with the highest requirement will need to take a supplement. This applies to folic acid in the case of women around the time of conception and vitamin D for children, people with dark skin or who do not spend enough time outdoors, and elderly people.

3.4 Selection of measures

Measures that appear most likely to achieve an adequate intake of micronutrients should be selected on the basis of information as to their efficacy. However, this information alone is not sufficient to produce advice for the minister as to which measure is most suitable. It is also important to take European regulations and ethical considerations into account.

3.4.1 *European legislation and regulations*

Maximum levels for the addition of micronutrients to supplements and fortified foods have been set at European level in order to ensure that people who consume supplements and fortified foods do not exceed the tolerable upper levels of intake for these substances.

Prohibition of products that are voluntarily fortified

One of the consequences of European legislation and regulations is that the Netherlands cannot prohibit any foods that are voluntarily fortified unless it can be shown that these foods are dangerous to public health.[11] However, the prohibition of voluntarily fortified foods is a condition in the case of staple foods that are fortified with a substance that has a narrow margin, i.e. substances where the recommended dietary allowance and the tolerable upper level of intake are relatively close together. Otherwise some of the population would be at risk of excessively high intake. Under current European regulations, the Minister for Health, Welfare and Sport cannot follow up the advice given by the Health Council to fortify bread and bread replacement products with folic acid and thereby impose restrictions on voluntary fortification of foods with folic acid. The only option available to the Minister at the moment, in addition to permitting voluntary fortification, is to ensure that good information is provided about fortified foods and supplements. The problem here is that there is no comprehensive monitoring of fortified foods on the Dutch market.

The difficulty is that the concern among nutrition experts as to possible harmful effects does not meet the legal standard for firm evidence. The committee has, for example, used the tolerable upper intake levels for children when drawing up its advisory report on folic acid. There is no hard data indicating that a folic acid intake above these levels is harmful for children; this data would be needed in order to prohibit the addition of folic acid to foods in the Netherlands.

In the longer term it may be possible to prohibit voluntarily fortified products at European level. The European Commission wants, when setting minimum and maximum levels of fortification for micronutrients with a narrow margin, to restrict the number of product groups to which they can be added on a voluntary basis. At the time of writing this report it was not known exactly what they are and how much of each micronutrient can be added to these products. In its policy document *Healthy Nutrition from Start to Finish*, the Ministry of Health, Welfare and Sport stated that it would bring the advice given by the Health Council on

folic acid forward in this discussion.[116] The Dutch government may be able to use these regulations to encourage the fortification of certain products so that groups at risk benefit and at the same time the smallest possible number of individuals have excessively high intake.

At present, supplementation appears to be the best way of achieving sufficient folic acid intake by women around the time of conception.

Risk of high intake

The new European regulations mean that people who consume fortified foods and supplements may have an intake which is in some cases well above the recommended dietary allowance. This is because the exemptions will be decided on the basis of the tolerable upper levels of intake rather than on the recommended dietary allowance. It is true that it is unlikely that many manufacturers would add the maximum amount of micronutrient permitted to their products. Less fortification is required for a nutritional claim to be made on the label, i.e. the product must contain 15 per cent or 30 per cent of the recommended dietary allowance. Nevertheless, it is likely that consumers could receive considerably more than the recommended dietary allowance. There are no indications that intake at these levels is more beneficial to health than the recommended dietary allowance.[118-124]

Another question is how substances for which no tolerable upper level of intake has been set should be handled at European level. It may be that minimum and maximum levels of fortification and supplementation will be set for micronutrients for which there are indications that a certain level of intake could be harmful. These are vitamin C, beta-carotene, phosphorus, potassium, iron and manganese. The same approach might not be taken for micronutrients for which there is no known risk (or a low risk) of harm caused by high intake: these are vitamins B_1, B_2, B_{12} and K, biotin, pantothenic acid and chromium. However, in a few cases the fact that no tolerable upper level of intake has been determined is due not to strong evidence that these levels are safe but to the absence of sufficient systematic research into the health effects of such high doses. This means that it is not always possible to entirely rule out toxicity caused by supplements containing very high levels of these micronutrients.

3.4.2 Ethical aspects

Ethical aspects also play a part in addition to the question of whether introducing fortification of staple foods is legally possible. Fortification of staple foods such as milk, bread and oil restricts personal freedom. This is not the case (or less so)

if unfortified products are still available in addition to those which have been fortified. The question is: do the benefits, such as preventing excessively high intake, justify this breech of liberty. Consideration must also be given to whether alternative measures could also have a sufficient impact.

Another question is whether it is acceptable to expose the population as a whole if only a small, vulnerable group would benefit and if it is uncertain whether the rest of the population would not suffer harm to health. In the case of uncertain effects that could be serious, the final decision could be taken using a precautionary strategy.[117] This would mean taking account of a worst-case scenario when formulating policy, even if the evidence for the risk is not very strong.

3.5 Monitoring

The final step is to ascertain whether the measures selected have achieved a sufficient micronutrient intake. Investigations should be conducted into intake, status, and possibly also the effects on health. In order for an accurate estimate of intake to be produced it is very important that the composition of fortified foods in the Netherlands is monitored, as is already the case for supplements. It will be difficult to demonstrate the effects of measures on health, as many other factors may be involved. Nevertheless, this process (which should ideally be based on existing records) can give an impression of changes in the existence of health effects over time.

3.6 Summary

The primary measure among those aimed at resolving excessively low or high intake of micronutrients is adjustment to the daily diet. If people do not adjust their daily diet, supplementation advice can be considered in the case of excessively low intake. Some population groups have a very high requirement for certain micronutrients, or a very low intake as a result of their particular diet, and therefore need additional supply in the form of supplements or fortified foods (see Tables 5 and 6).

The basic principle when selecting measures to achieve adequate intake alongside a varied diet is that the measures should provide health benefits. This should ideally be ascertained by means of intervention studies, and possibly also scenario calculations and a risk-benefit analysis.

European regulations on voluntary fortification also have a part to play in considering measures. These regulations mean that it is not possible at present to

prohibit foods that have been fortified on a voluntary basis from the market. In the case of micronutrients with a narrow margin between the recommended dietary allowance and the tolerable upper level of intake, the combination of fortified staple foods and products fortified on a voluntary basis increases the risk of the tolerable upper level of intake being exceeded.

European regulations are to be drawn up on minimum and maximum levels for fortification and supplementation. As exemptions will be decided on the basis of the tolerable upper levels of intake rather than on the recommended dietary allowance, it is possible that some individuals may have an intake well above the recommended dietary allowance. Intake at this level is no more beneficial to health than intake at the level of the recommended dietary allowance. It is not yet clear how European regulations will deal with micronutrients for which no tolerable upper level of intake has been set.

Ethical aspects such as philanthropy, respect for autonomy, and refraining from harm need to be taken into consideration when devising policy, alongside European regulations.

Finally, the effects of the measures selected on intake and health need to be monitored, preferably on the basis of existing records.

Chapter 4

Conclusions and recommendations

This advisory report addresses the question of how an adequate intake of micronutrients by the general, healthy population can be achieved. Hereto, the following questions are addressed: (1) which micronutrients are obtained in insufficient quantities, or in excess, from the daily diet; (2) what needs to be taken into account when measures aimed at ensuring an adequate intake of micronutrients are taken; and (3) what measures should be given priority in this respect. The first two questions are discussed in the conclusions and the final question is addressed in the recommendations.

4.1 Conclusions

Micronutrients for which intake may be too low or too high

The daily diet of most children and adults of Dutch origin supplies enough thiamin, riboflavin, vitamins B_6 and C, phosphorus, potassium, magnesium, copper and zinc

There are indications that the intake of thiamin, riboflavin, niacin, vitamins B_6 and C, phosphorus, potassium, magnesium, chloride, copper and zinc by most children and adults of Dutch origin is adequate. Extensive data on micronutrient intake is available for these groups. Much less is known about the intake of these substances by women who are pregnant or breastfeeding, people of non-Western

origin, individuals with a low energy intake, especially elderly, or with an unusual dietary pattern.

The daily diet may not supply enough riboflavin, vitamin B_{12}, vitamin E, calcium, iron or selenium for some groups

People of Turkish, Moroccan or Surinamese background may not be consuming enough riboflavin or calcium. The vitamin B_{12} status of 12 to 25 per cent of elderly people is too low. The iron status of 20 per cent of children of asylum-seekers, approximately 35 per cent of women of childbearing age and almost 50 per cent of pregnant women is too low. Finally, the vitamin E and selenium intake of young children may be too low.

It is often unclear whether excessively low intake or status are associated with adverse effects on health

No studies have been carried out to ascertain whether excessively low intake of riboflavin and calcium by individuals of Turkish, Moroccan or Surinamese background and the low intake of vitamin E and selenium by young children is associated with low status or adverse health effects.

It is unclear whether low vitamin B_{12} status among adults and low iron status among women of childbearing age causes adverse health effects and whether supplementation with vitamin B_{12} or iron respectively would actually provide health benefit. Low status is not the same as a serious deficiency in vitamin B_{12} or iron; deficiencies need to be treated.

Factors that play a part in devising policy measures

A varied diet is the basis for good micronutrient intake

A diet in line with the Guidelines for a Healthy Diet provides enough micronutrients for the general population. However, there are some exceptions to this (see Tables 5 and 6). In addition, elderly people are at greater risk of deficiency of various micronutrients simultaneously, and the same may also be true of individuals of low socio-economic status.

There is no standard approach. A multi-stage plan can be used to determine how micronutrient intake can be guaranteed

The committee's four previous advisory reports show that it is impossible to devise one standard approach to select the right measure for a micronutrient. Each of the micronutrients examined is unique in respect of excessively low or high intake and the associated risks for the various population groups. A multi-stage plan can be followed when considering measures (Figures 1 and 2). A key principle of this multi-stage plan is that measures such as supplementation and fortification must provide health benefits; when considering measures relating to vitamin B_{12} or iron, for example, it is important to ascertain whether people with a low status would actual benefit from extra vitamin B_{12} or iron.

If large groups in the population have excessively low intake and requirements do not vary to any great degree, then consideration can be given to fortifying staple foods. If only a small number of groups in the population have excessively low intake, or if the requirements of different groups vary considerably, then supplementation advice, possibly combined with fortification, should be considered.

Micronutrient intake above the recommended dietary allowance does not provide any health benefits

The new European regulations mean that people who consume fortified foods and supplements may have an intake which is in some cases well above the recommended dietary allowance. This is because exemptions are decided on the basis of the tolerable upper levels of intake, not on the recommended dietary allowance; there are no indications that intake at this level is more beneficial to health than intake at the recommended level.

Another question is how substances for which no tolerable upper level of intake has been set should be handled at European level.

The current European regulations on voluntary fortification may be a limiting factor with regard to the fortification of staple foods

The advisory reports on folic acid and vitamin D recommended that the Minister consider fortification of only a limited number of staple foods. The European regulations on voluntary fortification may be a limiting factor with regard to the fortification of staple foods with these and other micronutrients where the recommended dietary allowance and the tolerable upper level of intake are relatively

close together: vitamin A, iodine, selenium, copper and zinc. It is not possible at present to prohibit foods that have been fortified on a voluntary basis from the market. In the case of micronutrients with a narrow margin, the combination of fortified staple foods with products that are fortified on a voluntary basis increases the risk of exceeding the tolerable upper level of intake.

4.2 Recommendations

Advice on ensuring an adequate supply of micronutrients

Information material should state that only certain groups of the population need extra vitamins and minerals in addition to a varied diet

A diet in line with the Guidelines for a Healthy Diet is the prime factor in ensuring an adequate supply of micronutrients. Additional measures such as supplementation advice and fortification are only desirable if they provide health benefits; this is why only certain groups at risk need extra micronutrients in addition to a varied diet. The groups in question are: neonates (vitamin K); women wishing to conceive (folic acid); children aged up to four, individuals with dark skin or who do not spend enough time outdoors, women who wear a veil, women who are pregnant or breastfeeding, women aged over 50 and men aged over 70 (vitamin D); and finally vegans (vitamin B_{12}).

Prevent excessively high intake from fortified foods and supplements

The committee recommends that people who want to consume fortified foods or take supplements should be advised that their intake from these sources should not exceed the level of the recommended dietary allowance per day of the micronutrient(s) in question in addition to the micronutrients they obtain from food. From a nutritional point of view there is no need to consume more of a micronutrient than is recommended. It does not confer any additional health benefit. In fact, long-term intake above the tolerable upper level of intake may actually be harmful to health.

Restrict at European level the number of products to which micronutrients with a narrow margin may be added

The committee takes the view that limits should be set on the number of product groups to which micronutrients with a narrow margin between the recommended

dietary allowance and the tolerable upper levels of intake (vitamins A and D, folic acid, iodine, selenium, copper and zinc) may be added. This can reduce the risk of excessively high intake.

Monitoring

Clarify further the micronutrient intake and status among children and adults of non-Western background

The committee recommends that high priority be given to obtaining more information about the micronutrient intake and nutritional status of children and adults of Turkish, Moroccan or Surinamese background. The aim of this is to identify and, if necessary, resolve any deficiency or excessively high intake among these groups. Particular attention should be paid to the iron intake and iron status of young children of non-Western background. In addition, the committee thinks it desirable that more data be obtained on micronutrient intake and status by women who are pregnant or breastfeeding and by individuals with a low energy intake, especially elderly people, or those with an unusual dietary pattern.

Over the next few years the RIVM will conduct food consumption surveys on some of the aforementioned groups. One of the questions that will be addressed in this additional research is how far their diet deviates from the Guidelines for a Healthy Diet, and whether this deviation causes excessively low or high intake. This information will be used to determine whether dietary advice can prevent excessively low or high intake, or whether certain groups of people need extra supplies of some micronutrients.*

Continue monitoring micronutrient intake and the composition of fortified foods

The committee recommends that the intake of micronutrients should be monitored continuously. This is particularly important in the case of micronutrients where the margin between recommended dietary allowance and the tolerable upper level of intake is narrow; the committee thinks it desirable that the contribution of fortified products to micronutrient intake be established. It is important

* It is expected that this issue will eventually be covered in a series of future advisory reports looking at the diet and nutritional condition of children, elderly people and people of non-Western origin or low socio-economic status based on data to be collected by the RIVM.

for intake from supplements to be taken into account as well. The committee also recommends that monitoring take account of new developments in science and regulations.

Further investigations

Investigation of the effects on health of low iron status among teenage girls and women of childbearing age

The committee recommends giving high priority to investigating whether low iron status among teenage girls and women of childbearing age, pregnant or not, is associated with health problems. It also recommends investigating whether low iron status among children and low vitamin B_{12} status among adults and the elderly is also associated with health problems.

Ascertain whether the intake of riboflavin, vitamin E, calcium and selenium among groups at risk may be too low

The committee advises that indications of excessively low micronutrient intake be verified by means of status research, if available, and where necessary by investigations into any health effects: riboflavin and calcium in the case of individuals of Turkish, Moroccan or Surinamese background, and vitamin E and selenium among young children in general.

Add information on vitamin K content to the Dutch Food Composition database

The committee recommends that the vitamin K content of foods be added to NEVO as vitamin K plays a role in blood clotting and bone building. Attention should also be paid to verifying the quality of data in NEVO.

Conduct additional research to verify the tolerable upper levels of intake for children

In the case of many micronutrients, little or no research has been carried out on children to ascertain the effects of intake above the tolerable upper levels of intake. Most of the values set for children are derived from the tolerable upper levels of intake in adults. There is therefore no evidence as to whether or not (excessively) high intake is damaging. For that reason, tolerable upper levels of

intake are not legally tenable in most cases and, for example, fortified foods must be permitted.

The committee is of the opinion that observational studies must in future be carried out, supplemented by cell research and animal experimentation where necessary, in order to rule out the possibility that some micronutrients have harmful effects on health in children at doses at or above the tolerable upper level of intake.

Evaluate dietary reference values

The committee recommends that the Dutch dietary reference values for micronutrients be assessed or determined by comparing the current values with those that have been set in the United States of America, Australia and New Zealand and with new dietary reference values that may be established in Scandinavia and Europe towards that time. This advisory report has made a move in this direction by using more recent American, Australian and New Zealand reference values for micronutrients whose dietary reference values in the Netherlands were set in 1989. The report also uses the European tolerable upper levels of intake.

References

1 Health Council of the Netherlands. Towards maintaining an optimum iodine intake. The Hague: Health Council of the Netherlands; 2008: publication no. 2008/14.

2 Health Council of the Netherlands. Towards an optimal use of folic acid. The Hague: Health Council; 2008: publicatie no. 2008/02.

3 Health Council of the Netherlands. Towards an adequate intake of vitamin D. The Hague: Health Council; 2008: publication no. 2008/15.

4 Gezondheidsraad. Naar een optimale inname van vitamine A. Den Haag: Gezondheidsraad; 2008: publicatie nr. 2008/26.

5 Voedingsraad. Advies inzake het toevoegen van essentiële microvoedingsstoffen aan voedingsmiddelen. Den Haag: Voorlichtingsbureau voor de Voeding; 1993.

6 Signalering ethiek en gezondheid 2005. Den Haag: Gezondheidsraad; 2005: publicatie nr. 2005/07.

7 Warenwetbesluit Bereiding en behandeling van levensmiddelen artikel 10. Staatsblad 1992; 678.

8 Warenwetregeling Vrijstelling vitaminepreparaten. Staatscourant 1994; 70.

9 Warenwetbesluit Toevoeging microvoedingsstoffen aan levensmiddelen. Staatsblad 1996; 311: 1-18.

10 Severs A. Voedingsmiddelen met extra vitamines: Hoe zijn ze wettelijk geregeld? Ned Tijdschr Diëtisten 1996; 51(7/8): 131-133.

11 Hof van justitie van de Europese gemeenschappen. Arrest van het Hof (derde kamer) van 2 december 2004, in zaak C-41/02, betreffende het beroep wegens niet-nakoming artikelen 30 en 36 EG-verdrag. http://eur-lex.europa.eu/ consulted: 16-1-2006.

12 Kloosterman J, Fransen HP, Rompelberg CJ. Advies risicobeoordeling verrijkte voedingsmiddelen: maximale dosis vitamine D per 100 kilocalorieën. Bilthoven: RIVM; 2006.

13 Kloosterman J, Fransen HP, Pronk M, Rompelberg CJ. Rekenmodel voor veilige toevoeging van vitamines en mineralen aan voedingsmiddelen: een model toegespitst op de Nederlandse situatie. Bilthoven: RIVM; 2005.
14 Kloosterman J, Fransen HP, Rompelberg CJ. Advies risicobeoordeling verrijkte voedingsmiddelen: maximale dosis vitamine A per 100 kilocalorieën. Bilthoven: RIVM; 2006.
15 Wijziging Warenwetregeling Vrijstelling vitaminepreparaten. Staatscourant 2005; 67.
16 Warenwetbesluit voedingssupplementen. Staatscourant 2003; 125.
17 Warenwetregeling voedingssupplementen. Staatscourant 2003; 66.
18 Richtlijn 2002/46/EG van het Europees Parlement en de Raad van 10 juni 2002 betreffende de onderlinge aanpassing van de wetgevingen der lidstaten inzake voedingssupplementen. 2002.
19 Verordening (EG) nr. 1925/2006 van het Europees Parlement en de Raad van 20 december 2006 betreffende de toevoeging van vitaminen en mineralen en bepaalde andere stoffen aan levensmiddelen. 2006.
20 Australian Government and Ministry of Health. Nutrient Reference Values for Australia and New Zealand. Canberra: The National Health and Medical Research Council; 2005.
21 Institute of Medicine. Dietary reference intakes for vitamin C, vitamin E, selenium and carotenoids. Washington, D.C.: National Academy Press; 2000.
22 Institute of Medicine. Dietary reference intakes for vitamin A, vitamin K, arsenic, boron, chromium, copper, iodine, iron, manganese, molybdenum, nickel, silicon, vanadium and zinc: a report of the Panel on Micronutrients. Washington, D.C.: National Academy Press; 2002.
23 Institute of Medicine. Dietary reference intakes for thiamin, riboflavin, niacin, vitamin B_6, folate, vitamin B_{12}, pantothenic acid, biotin and choline. Washington, D.C.: National Academy Press; 2000.
24 Institute of Medicine. Dietary reference intakes for calcium, phosphorus, magnesium, vitamin D and fluoride. Washington, D.C.: National Academy Press; 1997.
25 Institute of Medicine. Dietary reference intakes for water, potassium, sodium, chloride and sulfate. Washington, D.C.: National Academy Press; 2004.
26 Health Council of the Netherlands. Guidelines for a healthy diet 2006. The Hague: Health Council of the Netherlands; 2006: publication no. 2006/21.
27 Health Council of the Netherlands. Dietary reference values: vitamin B_6, folic acid and vitamin B_{12}. The Hague: Health Council of the Netherlands; 2003: publication no. 2003/04.
28 Health Council of the Netherlands. Dietary reference values: calcium, vitamin D, thiamin, riboflavin, niacin, pantothenic acid and biotin. The Hague: Health Council of the Netherlands; 2000: publication no. 2000/12.
29 Voedingsraad. Nederlandse voedingsnormen 1989. Den Haag: Voorlichtingsbureau voor de Voeding; 1989.
30 Tolerable upper intake levels for vitamins and minerals. Parma: European Food Safety Authority; 2006.
31 NEVO-tabel, Nederlands voedingsstoffenbestand. Den Haag: Voedingscentum; 2006.

32 Evidence-based richtlijnontwikkeling. Handleiding voor werkgroepleden. Kwaliteitsinstituut voor de Gezondheidszorg CBO 2007. http://www.cbo.nl/product/richtlijnen/handleiding_ebro/default_view consulted: 4-3-2009.

33 Voedselconsumptiepeilingen in Nederland. VCP-3 1997/1998, VCP-2 1992, VCP-1 1987/1988. Zeist: TNO Voeding; 1998: cd-rom.

34 Hulshof KFAM, Ocké MC, van Rossum CTM, Buurma-Rethans EJM, Brants HAM, Drijvers JJMM e.a. Resultaten van de voedselconsumtiepeiling 2003. Bilthoven: RIVM; 2004: RIVM rapport 350030002/2004.

35 Jansen M, Hulshof KF, Konings E, Brussaard JH. Foliumzuur in Nederland: wat is de gebruikelijke inneming? Voeding Nu 2002; Oktober(10): 25-28.

36 Aggett PJ, Antoine JM, Asp NG, Bellisle F, Contor L, Cummings JH e.a. PASSCLAIM: consensus on criteria. Eur J Nutr 2005; 44 Suppl 1: i5-30.

37 Fransen HP, Waijers PMCM, Jansen EHJM, Ocké MC. Voedingsstatusonderzoek binnen het nieuwe Nederlandse voedingspeilingsysteem. Bilthoven: RIVM; 2005: RIVM rapport 350050002/2005.

38 Berg H van den, Steegers-Theunissen RPM. De micronutriëntenvoorziening van vrouwen vóór en tijdens de zwangerschap: is specifieke suppletie gewenst? Ned Tijdschr Obstet Gynaecol 2007;(juni): 26-30.

39 Groot CP de, van den BT, van SW. Energy intake and micronutrient intake in elderly Europeans: seeking the minimum requirement in the SENECA study. Age Ageing 1999; 28(5): 469-474.

40 Brussaard JH, Brants HAM, van Erp-Baart AMJ, Hulshof KFAM, Kistemaker C. De voeding bij allochtone bevolkingsgroepen. Deel 3: Voedselconsumptie en voedingstoestand bij Marokkaanse, Turkse en Nederlandse 8-jarigen en hun moeders. Zeist: TNO; 1999: V99.993.

41 Brussaard JH, Brants HAM, van Erp-Baart AMJ, Hulshof KFAM, Kistemaker C. Bijlage bij rapport V99.855 De voeding bij allochtone bevolkingsgroepen. Deel 3: Voedselconsumptie en voedingstoestand bij Marokkaanse, Turkse en Nederlandse 8-jarigen en hun moeders. Zeist: TNO Voeding; 1999: TNO-rapport V99.993.

42 Boer EJ de, Hulshof KFAM, ter Doest D. Voedselconsumptie van jonge peuters. Zeist: TNO; 2006: V6269.

43 Voedingscentrum. Zo eten jonge peuters in Nederland. Resultaten van het Voedingsstoffen Inname Onderzoek 2002. Den Haag: Voedingscentrum; 2006.

44 Ocké MC, van Rossum CTM, Fransen HP, Buurma EJM, de Boer EJ, Brants HAM e.a. Dutch National Food Consumption Survey - Young Children 2005/2006. Bilthoven: RIVM; 2008: Rapport nr. 350070001/2008.

45 Stellinga-Boelen AA, Wiegersma PA, Bijleveld CM. Dietary intake in asylum seeker children in The Netherlands, strongly related to age and origin. Eur J Clin Nutr 2007; 61(1): 104-110.

46 Palsma AH, Nicolau M, van Dam RM, Stronks K. De voeding van Turkse en Marokkaanse Nederlanders in de leeftijd van 18 - 30 jaar. Prioriteiten voor voedingsinterventies. Tijdchr Sociale Geneesk 2006; 84: 415-421.

47 Dam RM van, Nicolau M, Stronks K. Voedingspatroon van Surinaamse Amsterdammers in kaart gebracht. Ned Tijdschr Diëtisten 2005; 60(4): 98-102.
48 Jansen E, Thijs C. IJzerstatus van 2-jarige kinderen en hun moeders. Resultaten van de KOALA studie. Bilthoven: RIVM; 2008.
49 Jansen EHJM, Ujcic-Voortman JK, Uitenbroek D, Ocké MC. IJzerstatus van de bevolking van Amsterdam. Resultaten van de AGM studie. Bilthoven: RIVM; 2007.
50 Nederlands Huisartsen Genootschap. NHG-Standaard zwangerschap en kraamperiode. http://nhg.artsennet.nl/upload/104/standaarden/M32/start.htm consulted: 20-9-2007.
51 Dror DK, Allen LH. Effect of vitamin B_{12} deficiency on neurodevelopment in infants: current knowledge and possible mechanisms. Nutr Rev 2008; 66(5): 250-255.
52 Jansen EHJM, Ujcic-Voortman JK, Uitenbroek DG, Ocké MC. Foliumzuur-, vitamine B_{12}- en homocysteïnestatus van de bevolking van Amsterdam. Bilthoven: RIVM; 2007.
53 Wiersinga WJ, de Rooij SE, Huijmans JG, Fischer C, Hoekstra JB. De diagnostiek van vitamine B_{12}-deficiëntie herzien. Ned Tijdschr Geneesk 2005; 149(50): 2789-2794.
54 Asselt DZ van, de Groot LC, van Staveren WA, Blom HJ, Wevers RA, Biemond I e.a. Role of cobalamin intake and atrophic gastritis in mild cobalamin deficiency in older Dutch subjects. Am J Clin Nutr 1998; 68(2): 328-334.
55 Asselt DZ van, Pasman JW, van Lier HJ, Vingerhoets DM, Poels PJ, Kuin Y e.a. Cobalamin supplementation improves cognitive and cerebral function in older, cobalamin-deficient persons. J Gerontol A Biol Sci Med Sci 2001; 56(12): M775-M779.
56 Dhonukshe-Rutten RA, van Zutphen M, de Groot LC, Eussen SJ, Blom HJ, van Staveren WA. Effect of supplementation with cobalamin carried either by a milk product or a capsule in mildly cobalamin-deficient elderly Dutch persons. Am J Clin Nutr 2005; 82(3): 568-574.
57 Eussen SJ, de Groot LC, Joosten LW, Bloo RJ, Clarke R, Ueland PM e.a. Effect of oral vitamin B-12 with or without folic acid on cognitive function in older people with mild vitamin B-12 deficiency: a randomized, placebo-controlled trial. Am J Clin Nutr 2006; 84(2): 361-370.
58 Manders M. Nutritional care in old age, the effect of supplementation on nutritional status and performance [Proefschrift]. Wageningen: Wageningen University; 2006.
59 Jong N de, Chin A Paw M, de Groot LC, Rutten RA, Swinkels DW, Kok FJ e.a. Nutrient-dense foods and exercise in frail elderly: effects on B vitamins, homocysteine, methylmalonic acid, and neuropsychological functioning. Am J Clin Nutr 2001; 73(2): 338-346.
60 Prentice A. Diet, nutrition and the prevention of osteoporosis. Public Health Nutr 2004; 7(1A): 227-243.
61 Department of Health. Dietary reference values for food energy and nutrients for the United Kingdom. Report of the panel on dietary reference values of the committee on medical aspectst of food policy. London: HMSO; 1991.
62 Jansen EHJM, Ocké MC. Dagelijkse inname van ijzer van jonge kinderen in Nederland. Resultaten van een duplicaat voedingsstudie. Bilthoven: RIVM; 2007.

63 Krapels IP, van R, I, Ocké MC, West CE, van der Horst CM, Steegers-Theunissen RP. Maternal nutritional status and the risk for orofacial cleft offspring in humans. J Nutr 2004; 134(11): 3106-3113.
64 Brussaard JH, Brants HA, Bouman M, Löwik MR. Iron intake and iron status among adults in the Netherlands. Eur J Clin Nutr 1997; 51 Suppl 3: S51-S58.
65 Poppel G van, Schneijder P, Löwik MR, Schrijver J, Kok FJ. Nutritional status and food consumption in 10-11 year old Dutch boys (Dutch Nutrition Surveillance System). Br J Nutr 1991; 66(2): 161-169.
66 Zimmermann MB. Methods to assess iron and iodine status. Br J Nutr 2008; 99 Suppl 3: S2-S9.
67 Stellinga-Boelen AA, Storm H, Wiegersma PA, Bijleveld CM, Verkade HJ. Iron deficiency among children of asylum seekers in the Netherlands. J Pediatr Gastroenterol Nutr 2007; 45(5): 591-595.
68 Stellinga-Boelen AA, Wiegersma PA, Storm H, Bijleveld CM, Verkade HJ. Vitamin D levels in children of asylum seekers in The Netherlands in relation to season and dietary intake. Eur J Pediatr 2007; 166(3): 201-206.
69 Dokkum W van, de Vos RH, Muys T, Wesstra JA. Minerals and trace elements in total diets in The Netherlands. Br J Nutr 1989; 61(1): 7-15.
70 Jansen EHJM, Ocké MC. Dagelijkse inname van selenium van jonge kinderen in Nederland. Resultaten van een duplicaatvoedingsstudie. Bilthoven: RIVM; 2007.
71 Brandt PA van den, Goldbohm RA, van ’t Veer P, Bode P, Hermus RJ, Sturmans F. Predictors of toenail selenium levels in men and women. Cancer Epidemiol Biomarkers Prev 1993; 2(2): 107-112.
72 Satia JA, King IB, Morris JS, Stratton K, White E. Toenail and plasma levels as biomarkers of selenium exposure. Ann Epidemiol 2006; 16(1): 53-58.
73 Wouwe JP van. Clinical and laboratory assessment of zinc deficiency in Dutch children. A review. Biol Trace Elem Res 1995; 49(2-3): 211-225.
74 Ocké MC, Buurma-Rethans EJM, Fransen HP. Dietary supplement use in the Netherlands. Current data and recommendations for future assessment. Bilthoven: RIVM; 2005: Report 350100001/2005.
75 Consumentenbond. Gezondgids. Den Haag: Consumentenbond; 2002.
76 Rijksinstituut voor Volksgezondheid en Milieu. Ons eten gemeten. Gezonde voeding en veilig voedsel in Nederland. Bilthoven: RIVM; 2004: RIVM-rapportnummer 270555007.
77 Weerd S de, Steegers-Theunissen RP, de Boo TM, Thomas CM, Steegers EA. Maternal periconceptional biochemical and hematological parameters, vitamin profiles and pregnancy outcome. Eur J Clin Nutr 2003; 57(9): 1128-1134.
78 Cikot RJ, Steegers-Theunissen RP, Thomas CM, de Boo TM, Merkus HM, Steegers EA. Longitudinal vitamin and homocysteine levels in normal pregnancy. Br J Nutr 2001; 85(1): 49-58.
79 Rees G, Brooke Z, Doyle W, Costeloe K. The nutritional status of women in the first trimester of pregnancy attending an inner-city antenatal department in the UK. J R Soc Health 2005; 125(5): 232-238.
80 Rees GA, Doyle W, Srivastava A, Brooke ZM, Crawford MA, Costeloe KL. The nutrient intakes of mothers of low birth weight babies - a comparison of ethnic groups in East London, UK. Matern Child Nutr 2005; 1(2): 91-99.

81 Alevizos AG, Stamatiou KN, Lacroix RE, Natzar MA, Mihas CC, Bovis KD e.a. Dietary intake in immigrant Arabian pregnant women. Saudi Med J 2006; 27(7): 1019-1021.
82 Petrakos G, Panagopoulos P, Koutras I, Kazis A, Panagiotakos D, Economou A e.a. A comparison of the dietary and total intake of micronutrients in a group of pregnant Greek women with the Dietary Reference Intakes. Eur J Obstet Gynecol Reprod Biol 2006; 127(2): 166-171.
83 Mouratidou T, Ford F, Prountzou F, Fraser R. Dietary assessment of a population of pregnant women in Sheffield, UK. Br J Nutr 2006; 96(5): 929-935.
84 Rogers I, Emmett P. Diet during pregnancy in a population of pregnant women in South West England. ALSPAC Study Team. Avon Longitudinal Study of Pregnancy and Childhood. Eur J Clin Nutr 1998; 52(4): 246-250.
85 Moran VH. Nutritional status in pregnant adolescents: a systematic review of biochemical markers. Matern Child Nutr 2007; 3(2): 74-93.
86 Moran VH. A systematic review of dietary assessments of pregnant adolescents in industrialised countries. Br J Nutr 2007; 97(3): 411-425.
87 Nelson M, Erens B, Bates B, Chruch S, Boshier T. Low income diet and nutrition survey. Volume 2. Food consumption and nutrient intake. London: The Stationery Office; 2007.
88 Vyas A, Greenhalgh A, Cade J, Sanghera B, Riste L, Sharma S e.a. Nutrient intakes of an adult Pakistani, European and African-Caribbean community in inner city Britain. J Hum Nutr Diet 2003; 16(5): 327-337.
89 Dagnelie PC, van Staveren WA. Macrobiotic nutrition and child health: results of a population-based, mixed-longitudinal cohort study in The Netherlands. Am J Clin Nutr 1994; 59(5 Suppl): 1187S-1196S.
90 Dagnelie PC, van Staveren WA, Verschuren SA, Hautvast JG. Nutritional status of infants aged 4 to 18 months on macrobiotic diets and matched omnivorous control infants: a population-based mixed-longitudinal study. I. Weaning pattern, energy and nutrient intake. Eur J Clin Nutr 1989; 43(5): 311-323.
91 Dagnelie PC, van Staveren WA, Hautvast JG. Stunting and nutrient deficiencies in children on alternative diets. Acta Paediatr Scand Suppl 1991; 374: 111-118.
92 Amorim Cruz JA, Moreiras O, Brzozowska A. Longitudinal changes in the intake of vitamins and minerals of elderly Europeans. SENECA Investigators. Eur J Clin Nutr 1996; 50 Suppl 2: S77-S85.
93 Hulshof KF, Brussaard JH, Kruizinga AG, Telman J, Löwik MR. Socio-economic status, dietary intake and 10 y trends: the Dutch National Food Consumption Survey. Eur J Clin Nutr 2003; 57(1): 128-137.
94 Tedstone A. The Low Income Diet and Nutrition Survey. Findings: nutritional science. Proc Nutr Soc 2008; 67(OCE): E91.
95 Darmon N, Drewnowski A. Does social class predict diet quality? Am J Clin Nutr 2008; 87(5): 1107-1117.
96 Andrieu E, Darmon N, Drewnowski A. Low-cost diets: more energy, fewer nutrients. Eur J Clin Nutr 2006; 60(3): 434-436.

97 James WP, Nelson M, Ralph A, Leather S. Socioeconomic determinants of health. The contribution of nutrition to inequalities in health. BMJ 1997; 314(7093): 1545-1549.

98 Nelson M, Erens B, Bates B, Chruch S, Boshier T. Low income diet and nutrition survey. Volume 3. Nutritional status, physical acitivity, economic, social and other factors. London: The Stationery Office; 2007.

99 Balk EM, Raman G, Tatsioni A, Chung M, Lau J, Rosenberg IH. Vitamin B_6, B_{12}, and folic acid supplementation and cognitive function: a systematic review of randomized trials. Arch Intern Med 2007; 167(1): 21-30.

100 Kang JH, Cook N, Manson J, Buring JE, Albert CM, Grodstein F. A trial of B vitamins and cognitive function among women at high risk of cardiovascular disease. Am J Clin Nutr 2008; 88(6): 1602-1610.

101 Aisen PS, Schneider LS, Sano M, az-Arrastia R, van Dyck CH, Weiner MF e.a. High-dose B vitamin supplementation and cognitive decline in Alzheimer disease: a randomized controlled trial. JAMA 2008; 300(15): 1774-1783.

102 Smith AD, Refsum H. Vitamin B-12 and cognition in the elderly. Am J Clin Nutr 2009; 89(2): 707S-711S.

103 Xu L, McElduff P, D'Este C, Attia J. Does dietary calcium have a protective effect on bone fractures in women? A meta-analysis of observational studies. Br J Nutr 2004; 91(4): 625-634.

104 Bischoff-Ferrari HA, Dawson-Hughes B, Baron JA, Burckhardt P, Li R, Spiegelman D e.a. Calcium intake and hip fracture risk in men and women: a meta-analysis of prospective cohort studies and randomized controlled trials. Am J Clin Nutr 2007; 86(6): 1780-1790.

105 Sachdev H, Gera T, Nestel P. Effect of iron supplementation on mental and motor development in children: systematic review of randomised controlled trials. Public Health Nutr 2005; 8(2): 117-132.

106 Shafir T, Angulo-Barroso R, Jing Y, Angelilli ML, Jacobson SW, Lozoff B. Iron deficiency and infant motor development. Early Hum Dev 2008; 84(7): 479-485.

107 Gunnarsson BS, Thorsdottir I, Palsson G, Gretarsson SJ. Iron status at 1 and 6 years versus developmental scores at 6 years in a well-nourished affluent population. Acta Paediatr 2007; 96(3): 391-395.

108 Booth IW, Aukett MA. Iron deficiency anaemia in infancy and early childhood. Arch Dis Child 1997; 76(6): 549-553.

109 Wijk MAM van, Mel M, Muller PA, Silvertand WGJ, Kolnaar BGM. NHG-Standaard Anemie. Huisarts Wet 2003; 46(1): 21-29.

110 Pena-Rosas JP, Viteri FE. Effects of routine oral iron supplementation with or without folic acid for women during pregnancy. Cochrane Database Syst Rev 2006; 3: CD004736.

111 Reveiz L, Gyte GM, Cuervo LG. Treatments for iron-deficiency anaemia in pregnancy. Cochrane Database Syst Rev 2007;(2): CD003094.

112 Thomson CD. Assessment of requirements for selenium and adequacy of selenium status: a review. Eur J Clin Nutr 2004; 58(3): 391-402.

113 Sunde RA, Paterson E, Evenson JK, Barnes KM, Lovegrove JA, Gordon MH. Longitudinal selenium status in healthy British adults: assessment using biochemical and molecular biomarkers. Br J Nutr 2008; 99 Suppl 3: S37-S47.
114 Voedingscentrum. Richtlijnen Voedselkeuze. http://www.voedingscentrum.nl/Voedingscentrum/Nieuws/Richtlijnen+Voedselkeuze.htm consulted: 4-3-2009.
115 Oldenziel JH, Flikweert S, Daemers DOA, Groenendijk B, Lo Fo Wong SH, Wiersma Tj. NHG-Standaard Zwangerschap en kraamperiode (eerste herziening). Huisarts Wet 2003; 46(7): 369-387.
116 Gezonde voeding, van begin tot eind. Nota voeding en gezondheid. Den Haag: Ministerie van Volksgezondheid, Welzijn en Sport en Ministerie van Landbouw, Natuur en Voedselkwaliteit; 2008.
117 Health Council of the Netherlands. Prudent precaution. The Hague: Health Council of the Netherlands; 2008: publication no. 2008/18.
118 Vivekananthan DP, Penn MS, Sapp SK, Hsu A, Topol EJ. Use of antioxidant vitamins for the prevention of cardiovascular disease: meta-analysis of randomised trials. Lancet 2003; 361(9374): 2017-2023.
119 Lee IM, Cook NR, Gaziano JM, Gordon D, Ridker PM, Manson JE e.a. Vitamin E in the primary prevention of cardiovascular disease and cancer: the Women's Health Study: a randomized controlled trial. JAMA 2005; 294(1): 56-65.
120 Sesso HD, Buring JE, Christen WG, Kurth T, Belanger C, MacFadyen J e.a. Vitamins E and C in the prevention of cardiovascular disease in men: the Physicians' Health Study II randomized controlled trial. JAMA 2008; 300(18): 2123-2133.
121 Gaziano JM, Glynn RJ, Christen WG, Kurth T, Belanger C, MacFadyen J e.a. Vitamins E and C in the prevention of prostate and total cancer in men: the Physicians' Health Study II randomized controlled trial. JAMA 2009; 301(1): 52-62.
122 World Cancer Research Fund / American Institute for Cancer Research. Food, nutrition, physical activity, and the prevention of cancer: a global perspective. Washington D.C.: AICR; 2007.
123 Huang HY, Caballero B, Chang S, Alberg AJ, Semba RD, Schneyer C e.a. Multivitamin/Mineral supplements and prevention of chronic disease. Evid Rep Technol Assess (Full Rep) 2006; May(139): 1-117.
124 Neuhouser ML, Wassertheil-Smoller S, Thomson C, Aragaki A, Anderson GL, Manson JE e.a. Multivitamin use and risk of cancer and cardiovascular disease in the Women's Health Initiative cohorts. Arch Intern Med 2009; 169(3): 294-304.
125 SIGN 50: A guideline developers' handbook. Scottish Intercollegiate Guidelines Netwerk. http://www.sign.ac.uk/guidelines/fulltext/50/index.html consulted: 4-5-2007.

A Request for advice

B The committee

C Assessment of the methodological quality and level of evidence

D Intake data from food consumption surveys

E Definitions

Annexes

Annex **A**

Request for advice

Date of request: 26 January 2006

Letter reference: VGP/VV 2646726

It is important for public health that the population has an adequate supply of essential micronutrients. We know that a habitual diet does not contain enough of some of these essential micronutrients to meet the needs of (certain groups of) the population. The Ministry of Health, Welfare and Sport therefore follows an active policy with regard to these essential micronutrients. This policy covers both the use of supplements (vitamin D for young children, folic acid for pregnant women and women who want to have a baby) and fortification of foodstuffs. The addition of vitamins A and D to margarine, butter, and oil is permitted and encouraged under the Agreement on the vitamin fortification of spreadable fats. The addition of iodine to table salt (and alternative products), bread and bread substitutes (via salt used in breadmaking) and meat products (via nitrite pickle) is also permitted.

On the other hand it is important to ensure that people do not consume too much of certain essential micronutrients, as this could be harmful to health. That is why foodstuffs cannot in principle be fortified with essential micronutrients that have a ‘narrow margin’. The micronutrients in question are vitamin A, vitamin D, folic acid, selenium, copper and zinc. A ‘narrow margin’ in this context means that the recommended dietary allowance (RDA) and the safe upper level of intake are relatively close to one another, which means that people can easily run the risk of consuming too much of a certain vitamin, mineral or trace element. The addition of iodine to foodstuffs is prohibited for the same reason. There are however exceptions to these rules: iodine can be added to salt (used in breadmaking

and preparing meat products) and vitamins A and D can be added to spreadable fats. Controlled additions seek to ensure that consumers do not ingest too much or too little. As far as the other essential micronutrients that do not have a narrow margin are concerned, fortification of foodstuffs is permitted up to 100% of the recommended dietary allowance per daily intake.

Three developments are taking place at the moment leading to a need to review micronutrient policy. They are set out below.

Following the judgement of the Court (2 December 2004, EC Commission v. Netherlands, C-41 102), the Netherlands has had to give up its absolute ban on fortification with substances such as folic acid. Requests for exemption from the ban on adding micronutrients can only be rejected if it can be demonstrated that placing the specific product on the market would endanger public health. According to the Court's judgement, the absence of a nutritional need for the fortification of foodstuffs, which has in the past been an important argument used by the Netherlands in rejecting requests for exemption, no longer constitutes adequate grounds. The EU regulation on voluntary fortification of foodstuffs with vitamins, minerals and some other substances will take effect in the course of the next year or two. Policy on the fortification of foodstuffs with micronutrients will then be harmonised throughout the EU. This regulation will set minimum and maximum amounts of vitamins and minerals that can be added. The same procedure will be carried out for dietary supplements in order to minimise the risk of overdoses of micronutrients by people consuming fortified foodstuffs and taking dietary supplements. It is true that the regulation deals with voluntary fortification and therefore by definition does not resolve the problem of possible deficits in the supply of essential micronutrients. But the regulation does allow EU member states to continue or introduce mandatory fortification of foodstuffs if this is necessary on public health grounds. The question is whether the Netherlands should maintain its current system of voluntary fortification of spreadable fats with vitamins A and D and the fortification of table salt, salt used in breadmaking and nitrite pickle with iodine or whether it should move to a system of mandatory fortification. Another point is that science is producing new findings. Increasingly, researchers are discovering that the health benefits of a supply of certain micronutrients at levels (far) above the current dietary reference values. As this might also lead to a risk of excessive intake, which needs to be considered in the light of the other effects, the Ministry’s policy could be based on a risk-benefit analysis. Risk-benefit analysis models are being devised. One example is the role that folic acid is thought to play in preventing cardiovascular diseases. The United States has examined the advantages and disadvantages of extra folic acid supply and has decided to introduce mandatory fortification of flour (for use in bread making and other applications). Ireland and the United Kingdom are currently considering whether to follow suit.

The challenge facing me is to devise a policy, within the context of the new European regulation, under which the largest possible proportion of the population will receive sufficient essential

micronutrients while the smallest possible proportion of the population will run the risk of consuming more than the safe upper level of intake.

In the light of this, I am asking the Health Council to address the questions set out below.

For what essential micronutrients for which dietary reference values have been established in the Netherlands and in what situation does the habitual diet not offer sufficient guarantees that the population, or groups of the population, will have an adequate supply? Please use food consumption data, nutritional status data and other relevant scientific information when addressing this issue. What is the best way of ensuring an adequate supply of essential micronutrients in these situations? The Council is requested to look at all available policy instruments for each essential nutrient in its deliberations. What might the health benefits of an active fortification policy (whether with mandatory fortification or not) be for (groups of) our population in the light of a risk-benefit analysis for essential micronutrients such as folic acid and vitamin D (and any other relevant vitamins and/or minerals)?

I would very much appreciate receiving your advisory report around the middle of 2007.
(signed)
The Minister for Health, Welfare and Sport

H. Hoogervorst

Annex **B**

The committee

- Professor G. Schaafsma, *chairman*
  Emeritus Professor of Food and Nutrition, Wageningen University / Former director food and health, TNO Quality of Life, Zeist
- Dr. H. van den Berg
  Nutritional expert, Nutrition Centre, The Hague
- E.N. Blok, *advisor*
  Ministry of Health, Welfare and Sport, The Hague
- Dr. H.J. Blom
  Clinical biochemic geneticist, Free University Medical Centre, Amsterdam
- Professor C.P.G.M. de Groot
  Professor of Nutritional Physiology, with a particular focus on the ageing process and elderly people, Wageningen University
- Dr. M. den Heijer
  Endocrinologist, St. Radboud University Medical Centre, Nijmegen
- Dr. K.F.A.M. Hulshof
  Nutritional expert, formerly with TNO Quality of Life, Zeist
- Professor P.T.A.M. Lips
  Professor of Endocrinology, Free University Medical Centre, Amsterdam
- Professor I.M.C.M. Rietjens
  Professor of Toxicology, Wageningen University
- Professor P.J.J. Sauer
  Professor of Paediatric Medicine, University of Groningen

- Professor P. van ’t Veer
  Professor of Nutrition and Epidemiology, Wageningen University
- Dr. T. Vulsma
  Paediatrician and endocrinologist, Amsterdam University Medical Centre
- Dr. R.M. Weggemans, *scientific secretary*
  Health Council, The Hague

The Health Council and interests

Members of Health Council Committees are appointed in a personal capacity because of their special expertise in the matters to be addressed. Nonetheless, it is precisely because of this expertise that they may also have interests. This in itself does not necessarily present an obstacle for membership of a Health Council Committee. Transparency regarding possible conflicts of interest is nonetheless important, both for the President and members of a Committee and for the President of the Health Council. On being invited to join a Committee, members are asked to submit a form detailing the functions they hold and any other material and immaterial interests which could be relevant for the Committee’s work. It is the responsibility of the President of the Health Council to assess whether the interests indicated constitute grounds for non-appointment. An advisorship will then sometimes make it possible to exploit the expertise of the specialist involved. During the establishment meeting the declarations issued are discussed, so that all members of the Committee are aware of each other’s possible interests.

Annex **C**

Assessment of the methodological quality and level of evidence

Publications were assessed on the basis of the approach used when drawing up the Guidelines for a Healthy Diet 2006.[26] However, the approach is presented more clearly in the advisory reports on micronutrients as it incorporates tables in which the conclusions are classified according to their level of evidence, with a reference to the studies on which the classification is based.[1-4] This is largely in line with the approach used when developing evidence-based guidelines.[32] Another feature of the approach taken in this advisory report is that it uses the SIGN grading system, granting the highest level of evidence (A1) only to systematic review articles of good quality.[125]

The aim of the assessment system used is to determine relationships between factors. It is not, or only to a very limited extent, to assess data on the micronutrient supply of the Dutch population or the effects of current Dutch policy, and therefore was not applied to those subjects.

Table 7 Grades of methodological quality used to classify individual studies into interventions with folic acid or the relationship between folate intake or status and the risk of various conditions.[32,125]

Grade	Type of study
A1	Systematic review articles of good quality relating to at least two grade A2 studies conducted independently of one another.
A2	Randomised, double-blind, comparative intervention study of good quality and sufficient size.
B1	Systematic review articles of good quality relating to at least two grade B2 studies conducted independently of one another.
B2	Comparative studies, but without all the features referred to under A2 or goodquality cohort studies or patient case studies.
C	Non-comparitive studies.
D	Opinion of the committee.

Table 8 Level of evidence of conclusions.[26,32]

Level	
1: Convincing	Based on 1 systematic review article (grade A1) or at least 2 grade A2 studies carried out independently of one another.
2: Probable	Based on 1 review article (grade B1) or at least 2 grade B2 studies carried out independently of one another.
3: Insufficient	Based on 1 grade A2 or B2 study or on grade C research.
4: Insufficient	Based on the committee's opinion (grade D).

Annex **D**

Intake data from food consumption surveys

Table 9 Mean observed intake of micronutrients among participants of the third food consumption survey (1997/1998) and recommended dietary allowance (RDA) or adequate intake (AI) by age and sex.[37]

		1-4 year	4-7 year	7-10 year	10-13 year	13-16 year	16-19 year	19-22 year	22-50 year	50-65 year	> 65 year
Vitamin A (RE/day)											
Men	RDA/AI	400	500	700	1000	1000	1000	1000	1000	1000	1000
	intake	652	671	683	634	778	972	1000	1081	1198	1113
Women	RDA/AI	400	500	700	800	800	800	800	800	800	800
	intake	534	582	686	660	724	754	741	803	870	797
Thiamin (mg/day)											
Men	RDA/AI	0,3	0,5	0,8	0,8	1,1	1,1	1,1	1,1	1,1	1,1
	intake	0,68	0,73	0,89	1,16	1,25	1,26	1,40	1,47	1,42	1,37
Women	RDA/AI	0,3	0,5	0,8	0,8	1,1	1,1	1,1	1,1	1,1	1,1
	intake	0,67	0,72	0,87	0,97	1,04	1,15	1,14	1,22	1,30	1,13
Riboflavin (mg/day)											
Men	RDA/AI	0,5	0,7	1,0	1,0	1,5	1,5	1,5	1,5	1,5	1,5
	intake	1,31	1,37	1,43	1,57	1,58	1,64	1,78	1,72	1,75	1,64
Women	RDA/AI	0,5	0,7	1,0	1,0	1,1	1,1	1,1	1,1	1,1	1,1
	intake	1,21	1,34	1,42	1,42	1,36	1,35	1,34	1,45	1,50	1,45
Vitamin B_6 (mg/day)											
Men	RDA/AI	0,4	0,7	1,1	1,1	1,5	1,5	1,5	1,5	1,8	1,8
	intake	0,94	1,05	1,31	1,42	1,64	1,82	2,09	1,94	1,92	1,75
Women	RDA/AI	0,4	0,7	1,1	1,1	1,5	1,5	1,5	1,5	1,5	1,5
	intake	0,87	1,01	1,15	1,28	1,34	1,41	1,46	1,49	1,51	1,43

Table 9 continued.

		1-4 year	4-7 year	7-10 year	10-13 year	13-16 year	16-19 year	19-22 year	22-50 year	50-65 year	> 65 year
Vitamin C (mg/day)											
Men	RDA/AI	40	45	50	55	65	70	70	70	70	70
	intake	56	52	63	72	79	71	78	76	86	88
Women	RDA/AI	40	45	50	55	65	65	70	70	70	70
	intake	53	57	57	75	81	81	77	81	94	95
Vitamin D (mcg/day)											
Men	RDA/AI	5-10	2,5-5	2,5-5	2,5-5	2,5-5	2,5-5	2,5-5	2,5-5	5-10	12,5-15
	intake	2,0	2,3	2,9	3,6	3,9	4,6	4,7	4,4	4,9	4,8
Women	RDA/AI	5-10	2,5-5	2,5-5	2,5-5	2,5-5	2,5-5	2,5-5	2,5-5	5-10	12,5-15
	intake	2,2	2,2	2,8	3,1	3,4	3,2	2,8	3,2	3,3	3,6
Vitamin E (mg/day)											
Men	RDA/AI	5,7	7,8	9,1	10,1	11,8	13,3	13	11,8	10,7	9,4
	intake	7,6	9,1	11,2	12,4	15,4	16,4	15,6	14,8	14,6	13,7
Women	RDA/AI	5,5	7,1	8,3	9,5	10,6	11,0	9,9	9,3	8,7	8,3
	intake	6,8	8,4	10,4	11,7	12,1	11,8	11,0	11,6	11,2	11,6
Calcium (mg/day)											
Men	RDA/AI	500	700	1200	1200	1200	1200	1000	1000	1100	1100-1200
	intake	846	872	914	1006	1045	1095	1114	1068	1112	1024
Women	RDA/AI	500	700	1100	1100	1100	1100	1000	1000	1100	1100-1200
	intake	790	858	901	912	904	908	865	963	995	959
Phosphorus (mg/day)											
Men	RDA/AI	400-800	400-800	600-1200	900-1800	900-1800	800-1600	700-1400	700-1400	700-1150	700-1150
	intake	1005	1116	1273	1433	1572	1723	1847	1751	1740	1576
Women	RDA/AI	400-800	400-800	600-1200	700-1400	700-1400	700-1400	700-1400	700-1400	700-1150	700-1150
	intake	932	1073	1185	1289	1326	1359	1315	1387	1386	1338
Iron (mg/day)											
Men	RDA/AI	7,0	7,0	8,0	10,0	15,0	15,0	11,0	9,0	9,0	9,0
	intake	6,1	7,0	8,4	9,9	10,9	11,5	12,2	13,0	12,9	11,4
Women	RDA/AI	7,0	7,0	8,0	11,0	12,0	14,0	16,0	15,0	8,0	8,0
	intake	5,8	6,6	7,8	9,1	9,0	9,9	9,5	10,7	10,7	10,1
Copper (mcg/day)											
Men	RDA/AI	0,3-0,7	0,5-1,0	0,6-1,4	1,0-2,5	1,5-3,0	1,5-3,5	1,5-3,5	1,5-3,5	1,5-3,5	1,5-3,5
	intake	0,62	0,74	0,91	1,04	1,17	1,24	1,28	1,27	1,25	1,12
Women	RDA/AI	0,3-0,7	0,5-1,0	0,6-1,4	1,0-2,5	1,5-3,0	1,5-3,5	1,5-3,5	1,5-3,5	1,5-3,5	1,5-3,5
	intake	0,57	0,69	0,79	0,93	0,95	1,01	1,00	1,05	1,03	0,95
Magnesium (mg/day)											
Men	RDA/AI	60-70	90-100	120-140	150-175	220-255	275-325	300-350	300-350	300-350	300-350
	intake	192	210	247	276	301	336	365	381	379	332
Women	RDA/AI	60-70	90-100	120-140	155-185	210-250	225-275	250-300	250-300	250-300	250-300
	intake	177	202	220	243	251	261	264	302	306	284

Table 9 continued.

		1-4 year	4-7 year	7-10 year	10-13 year	13-16 year	16-19 year	19-22 year	22-50 year	50-65 year	> 65 year
Selenium (mcg/day)											
Men	RDA/AI	10-30	15-45	20-60	30-80	40-110	45-140	50-150	50-150	50-150	50-150
	intake	26	27	34	37	42	45	50	51	53	48
Women	RDA/AI	10-30	15-45	20-60	30-85	40-110	45-110	50-150	50-150	50-150	50-150
	intake	22	27	30	34	35	36	36	41	42	39
Zinc (mg/day)											
Men	RDA/AI	4,0	5,0	6,0	7,0	10,0	11,0	10,0	10,0	10,0	10,0
	intake	5,8	6,5	7,5	8,9	9,7	10,5	11,4	11,2	11,4	10,0
Women	RDA/AI	4,0	5,0	6,0	7,0	10,0	9,0	9,0	9,0	9,0	9,0
	intake	5,5	6,1	7,0	7,5	8,1	8,5	8,3	9,0	9,3	8,9

Table 10 Mean and standard deviation of the observed intake of micronutrients among participants (19-30 year) of the food consumption survey among young adults and recommended dietary allowance (RDA) or adequate intake (AI) by sex.[37]

	RDA/AI	Mean intake ± standard deviation
Vitamin A (RE/day)[1]		
Men	1000	1176 ± 1092
Women	800	856 ± 714
Thiamin (mg/day)[2]		
Men	1,1	1,5 ± 0,6
Women	1,1	1,1 ± 0,6
Riboflavin (mg/day)[2]		
Men	1,5	1,8 ± 0,8
Women	1,1	1,4 ± 0,7
Vitamin B_6 (mg/day)[3]		
Men	1,5	2,1 ± 0,9
Women	1,5	1,6 ± 0,8
Folate (B_{11}) (mcg/day)[3]		
Men	300	220 ± 108
Women	300	153 ± 56
Vitamin B_{12} (mcg/day)[3]		
Men	2,8	4,8 ± 5,3
Women	2,8	3,3 ± 2,0
Vitamin C (mg/day)[1]		
Men	70	99 ± 66
Women	70	93 ± 57
Vitamin D (mcg/day)[2]		
Men	2,5	3,8 ± 2,2
Women	2,5	2,7 ± 2,0
Vitamin E (mg/day)[1]		
Men	12,4	13,6 ± 6,9
Women	9,6	10,0 ± 5,4
Calcium (mg/day)[2]		
Men	1000	1135 ± 493
Women	1000	935 ± 411
Iron (mg/day)[1]		
Men	10	12,2 ± 3,6
Women	15,5	9,4 ± 3,7

Annex **E**

Definitions

Adequate intake

The lowest level of intake that seems to be adequate for practically the entire population. An adequate intake level is estimated if research data is insufficient to allow an average requirement and recommended allowance to be determined.[28]

Average requirement

The intake that meets the needs of half the population for a particular nutrient. The recommended dietary allowance is derived from the average requirement, assuming normal distribution of the requirement.[28]

Diet

Unless otherwise specified, 'diet' refers to foods and supplements.

Fortification

Adding one or more micronutrients to a foodstuff, resulting in a concentration higher than that which naturally occurs in the foodstuff or the raw material from which it was made in order to prevent or correct a proven deficit in one or more micronutrients in (parts of) the population.[5]

Recommended dietary allowance

The intake that meets the needs of 97.5 per cent of the population for a particular nutrient. It is assumed that this need is distributed normally.[28]

Restoration

Adding micronutrients that are lost during the production process, storage and/or sale to foodstuffs. The amount added to the foodstuff restores the level of the micronutrient to the previous concentration in the edible part of the foodstuff or the raw material from which it was made.[5]

Tolerable upper level

Highest level of intake at which no harmful effects are observed or to be expected.[28]

Substitution

Replacing a foodstuff with a different foodstuff that is as close as possible to it in terms of appearance, consistency, taste, colour and odour or that serves the same purpose for the consumer.[5]

Supplementation

Using a supplement containing micronutrients as an addition to diet.

Threshold method

The threshold method estimates the percentage of people in a population with an intake above or below a particular dietary reference value.