Towards maintaining an optimum iodine intake

Gezondheidsraad
Health Council of the Netherlands

To the Minister of Health, Welfare and Sport

Subject	:	Presentation of advisory report *Towards maintaining an optimum iodine intake*
Your reference	:	VGP/VV 2646726
Our reference	:	I-169/06/RW/db/822-I
Enclosure(s)	:	1
Date	:	September 30, 2008

Dear Minister,

On 28 January 2006 your predecessor asked the Health Council to reconsider the policy on micronutrients. I am pleased to present our advisory report on one of these micronutrients: iodine. An advisory report on vitamin D is also being published today, and earlier this year the Health Council submitted a report on folic acid. Advisory reports on vitamin A and the other micronutrients will be submitted later this year and in early 2009.

In order to advise the government on optimum iodine intake, a committee of experts has looked at the most recent research and assessed the implications for the policy, partly in the light of new European regulations. 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 concluded that iodine intake in the Netherlands is at optimum levels, and that it is important for this situation to continue. The current fortification level of baker's salt in the Netherlands should therefore continue to be permitted and should not be reduced as a result of European agreements. The committee also recommended that action be taken to compensate for any reduction in iodine levels as a result of lower salt consumption.

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This new advisory report on iodine reflects the latest scientific findings and the current situation abroad. It also contains the factors that need to be taken into account when drawing up policies. I fully support the committee's conclusions and recommendations.

Your sincerely,
(signed)
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Vice-President

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to:

the Minister of Health, Welfare and Sport

No. 2008/14E, The Hague, 30 September 2008

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...” (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, and Agriculture, Nature & Food Quality. 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.

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

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

ISBN: 978-90-5549-747-8

A brief outline of the advisory report

Iodine is a component of thyroid hormones that are important for normal growth and development and a balanced metabolism. Because Dutch food does not naturally contain enough iodine, it can be added to table salt. Iodised salt used for baking bread and other baked products contains more iodine (up to 65 milligrams per kilogram of salt) than iodised salt destined for other foods (up to 25 milligrams per kilogram of salt). Roughly 50% of iodine intake is from bread. This advisory report addresses the issues of whether Dutch people are obtaining enough iodine and what action can be taken to ensure that they continue to do so.

Iodine intake in the Netherlands is good, and it is important that this remains the case

The title of this advisory report already indicates that the amount of iodine consumed by the Dutch population is sufficient, and the report puts forward two recommendations aimed at ensuring that this does not change.

Ensure that the current Dutch level of fortification of baker's salt remains allowed at European level

At European level minimum and maximum permitted levels of voluntary iodine fortification will be set. The maximum permitted level may turn out to be below the current baker's salt fortification level. This would lead to a decline in the iodine intake of the Dutch population, which would lead to a greater risk of iodine deficiency and goitre. The recommendation is that action be taken to ensure that the Dutch level of fortification of baker's salt remains permitted at European level.

Compensate for a decline in iodine intake caused by a reduction in salt consumption

In a previous report, the Health Council stated that salt consumption in the Netherlands should be reduced. As the main source of iodine for the Dutch population is iodine-fortified salt, a lower salt intake would, if nothing is done, lead to a greater risk of iodine deficiency and goitre. The advisory report therefore calls for careful monitoring of the iodine intake of the Dutch population, and changes in the fortification policy if necessary.

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Executive summary

Background of this advisory report

Regulations and research undergo rapid development

European regulations, legislation and research in the field of vitamins, minerals and trace elements, so-called micro-nutrients, undergo rapid development. For this reason, the minister of Health, Welfare and Sport asked the Health Council of the Netherlands for advice on reconsidering its policy in this area.

The aim of the new 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 advisory report, the specially appointed Committee outlines the requirements for iodine.

Iodine is essential for the body

Iodine is an essential component of thyroid hormones. These hormones are necessary for normal growth and development and to keep metabolism balanced.

Because foods naturally contain little iodine, it may be added to salt

Iodine is a trace element that occurs naturally in food. Because the amount naturally present in the Netherlands is insufficient, iodine may be added to salt.

Baker's salt, used for baking bread and other baked products, contains more iodine (up to 65 milligrams per kilogram of salt) than iodised salt destined for other foods (up to 25 milligrams per kilogram of salt). Roughly 50% of iodine intake is from bread.

Iodine intake is sufficient

As the title of the advisory report already indicates, the amount of iodine consumed by the Dutch population is sufficient. However, there are a number of gaps in the numbers – there is insufficient data on people who only consume self-baked or organic bread, which may contain non-iodised salt or sea salt.

Developments that may lead to lower intake

The determination of maximum levels for voluntary fortification on a European level may lead to lower iodine intake

In the near future, minimum and maximum levels for voluntary fortification will be agreed upon at a European level. If the maximum level of fortification ends up lower than 65 milligrams per kilogram of salt, iodine intake in the Netherlands will decrease, and the risk of iodine deficiency and goitre will increase.

Efforts to decrease salt consumption lead to lower iodine intake

The current level of iodine intake will drop due to the decrease in salt intake. From a public health standpoint, decreasing salt intake is highly desirable. However, it will be associated with a larger risk of iodine deficiency and goitre if iodine intake is not compensated.

Efforts to address these developments

Ensure that the current Dutch level of fortification of baker’s salt remains allowed at a European level

In order to safeguard good iodine supply in the Netherlands, it is of vital importance to continue to allow the current level of iodine fortification for baker’s salt at a European level. Therefore, a maximum level for salt fortification with iodine of at least 65 milligrams per kilogram should be strived for.

Monitor iodine intake in the Netherlands

Given the efforts to lower salt consumption in the Netherlands, regularly determining iodine intake and status among the Dutch population is important. Fortification policies can be adjusted based on these data. Given the essential role iodine plays in human development, it is important that particular attention is paid to children during their first year of life and to pregnant or breast-feeding women.

Additional research

Investigate the iodine intake of people who only eat self-baked or organic bread

There are insufficient data to determine whether the iodine intake of people who eat self-baked or organic bread is sufficient. This should be examined separately.

Define dietary reference values for iodine

There are no official dietary reference values for iodine intake in the Netherlands. The Committee recommends defining them.

Chapter 1

Introduction

Iodine is an essential component of thyroid hormones. Thyroid hormones are necessary for normal growth and development and to keep metabolism balanced.

The Ministry of Health, Welfare and Sport wants to develop a new policy in the context of European regulations ensuring that the largest possible proportion of the population ingests sufficient iodine and other micronutrients. However, it wants to simultaneously minimise the risk of people consuming amounts in excess of the defined safe upper level of intake. The Ministry has asked the Health Council for advice in the context of reviewing its policy on the fortification of foodstuffs with micronutrients such as vitamins, minerals and trace elements (annex A).

This advisory report is the third in a series of five reports. The first report, on folic acid[1], has already been published, the report on vitamin D[2] is being published in tandem with this report, and the other reports will deal with vitamin A and other micronutrients respectively.

1.1 The original policy on iodine

Prior to 1994 there were no statutory regulations in the Netherlands on the addition of iodine to dietary supplements. The first measure with respect to adding iodine to food stuffs was taken in 1928, and involved the addition of a small amount of iodine to table salt which was available on prescription. Iodine was first added to table salt for bread making and domestic use in 1942. Its addition

to table salt for bread making became mandatory in 1963. An organic baker successfully opposed this mandatory fortification in 1984, and since then the government has regulated the use of iodised salt for bread making by means of agreements with bakers.[3] The fortification of other foodstuffs with iodine was prohibited.

The Dutch government was forced to reconsider its policy in the early 1990s. The main reason was the pressure of free trade. This is because other European countries had long since approved the addition of vitamins and minerals to foodstuffs. Another reason for changing the policy was that it not all people had a habitual 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 which have a 'narrow margin', where the dietary reference value or the recommended dietary allowance and the safe upper level of intake are close to one another.

Commodities Act Regulation and Commodities Act Decree

The policy reviews in the 1990s led to the introduction of the Commodities Act Regulation on the Exemption of Vitamin Preparations in 1994[4] and the Commodities Act Decree on the Addition of Micronutrients in 1996.[5] The Commodities Act Regulation on the Exemption of Vitamin Preparations limits the amount of iodine that can be added to vitamin preparations.[4] The Commodities Act Decree on the Addition of Micronutrients enforces the permitted system of iodine fortification of table salt for bread making and domestic use, and authorises iodine restoration or substitution. The potassium iodine content of table salt for bread making, which until 1996 had been 55 to 65 milligrams per kilogram, was increased to 70 to 85 milligrams per kilogram, and the iodine content of table salt and table salt replacement products for domestic use was set at 30 to 40 milligrams per kilogram of salt.[5,6] The reason for the increase was that in 1993 the Nutrition Council had, having considered data on the occurrence of goitre in the Dutch population, concluded that iodine supply was too low.[7] In 1999 the number of products to which iodised salt for bread making could be added was expanded in line with changing dietary habits to include bread replacement products such as breakfast cereals, breakfast biscuits, crispbread, breadsticks and rusks. In addition, iodine could now also be added to pickling brine used in the production of meat products (20 to 30 milligrams of iodate per kilogram of salt).[8] This mea-

* Unless otherwise specified, the word 'diet' is used to cover intake from foodstuffs and supplements. See the end of the text for definitions.

sure is based not on nutritional status data but on scenario calculations of the effects of these measures on iodine intake.[9,10]

1.2 Developments that call for a review of iodine policy

At present (in 2008) new developments have made a revision of the policy on iodine necessary. Since 1996, the fortification of foodstuffs with vitamins A and D, folic acid, copper and selenium has only been permitted in the Netherlands where a nutritional 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. The Netherlands has therefore had to abandon its absolute ban on iodine fortification. Another change was the authorisation, introduced in 2005, to use table salt containing 15 to 25 milligrams of iodine per kilogram of salt in the production of bread and bread alternatives. This salt complies with German legislation and the Netherlands could not reject it on legal grounds in view of the aforementioned decision of the European Court of Justice.[11]

Revision of the Commodities Act Decree regarding the addition of iodine

The part of the Commodities Act Decree dealing with the addition of iodine was revised in 2008.[12] The Ministry of Health, Welfare and Sport decided this was necessary in the light of changing dietary habits and new European regulations in the field of voluntary fortification. The decree specified that iodised salt could be added not only to bread and bread replacement products but also to other bakery products. The advantage of this is that bakers now only needed to use one type of salt. Scenario calculations carried out by the applied science research institution TNO indicated that, in order to prevent this leading to a further increase in iodine intake, the iodine content of iodised baker's salt should be reduced to no more than 65 milligrams of iodine per kilogram of salt. The maximum iodate content of pickling brine salt for meat products and the iodine content of table salt for domestic use was also reduced to 25 milligrams of iodine per kilogram of salt. This salt can also be used in the commercial production of other foodstuffs and beverages. The Commodities Act Decree will remain in force until new European regulations are adopted.

European harmonisation

The policy on supplements and voluntary fortification of foodstuffs is due to be harmonised throughout the European Union between 2008 and 2012. The 2002 European Union directive on supplements and the 2006 European Union regulation on voluntary fortification of foodstuffs will be fleshed out around that time*.[15,16] However, in both cases the texts will take the form of framework legislation laying down the principles but not the details. The regulation and the directive have already specified that iodine may be added to supplements and foodstuffs in the form of sodium iodide, potassium iodide or potassium iodate.

At the time of drafting this advisory report it was not yet known what minimum and maximum amounts of iodine were to be permitted as additions to supplements and foodstuffs. The recommended daily amount to be indicated on the label had not yet been determined either. A regulation is to be adopted on this subject. It will also specify the minimum level at which the label may state that the foodstuff contains or is rich in iodine**. The regulation deals with voluntary fortification of specific foodstuffs, which by definition does not resolve the problem of possible deficiencies.[16] However, the regulation does give European Union member states the opportunity to enforce or introduce mandatory fortification of staple foodstuffs if this is necessary for public health.

1.3 Other measures with the same aim

The Ministry of Health, Welfare and Sport intends to develop a policy ensuring that the highest possible proportion of the population consumes sufficient micronutrients within safe margins. The highest priority is eating a healthy diet. If this should prove inadequate, four measures (alone or in combination) are available[17]: restoration, substitution, fortification, and supplementation.

- Restoration means replacing micronutrients to foodstuffs that are lost during the production process, storage and/or sale. The amount added to the food-

* The Dietary Supplements Directive and the Regulation on the Voluntary Fortification of Foodstuffs have already been incorporated into the Dietary Supplements (Commodities Act) Decree and the Dietary Supplements (Commodities Act) Regulation.[13,14]

** The new European Union health claims regulation states that a label may state that a foodstuff is a source of a micronutrient if it contains 15% of the recommended dietary allowance 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 claim that a foodstuff 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.

stuff restores the level of the micronutrient to the original concentration in the edible part of the foodstuff or the raw material from which it was made.
- Substitution means 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.
- Fortification means 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. The regulation draws a distinction between voluntary and mandatory fortification. In the case of voluntary fortification, 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. In the case of mandatory fortification, staple foodstuffs are fortified. Mandatory fortification is not legally feasible in the Netherlands. However, the government can make arrangements for mandatory fortification via an agreement with manufacturers. The Commodities Act specifies how much of a particular micronutrient can be added to which products.[18]
- Supplementation means using a supplement containing micronutrients as an addition to diet.

1.4 Issues

In its request for advice (see annex A), the Ministrer of Health, Welfare and Sport first asked the Health Council for an inventory of (1) essential micronutrients that were not provided in sufficiently high concentrations by a habitual 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, taking account of any health effects that may be associated with each option.

Consultations between the Health Council and the Ministry of Health, Welfare and Sport led to a decision to limit the request for advice to micronutrients which may not be supplied in sufficient quantities to the entire population from a habitual diet if they are not added to the habitual diet. This is the case for iodine, vitamins A and D and folic acid. Limited fortification is permitted for iodine. An active substitution policy is already in place for vitamins A and D.[7,17] Indications were found in the early 1990s that over half of all adults may have an inadequate nutritional status in respect of folic acid.[19] There are no clear indications that the intake of other micronutrients in the general population is too low.[20,21] The situa-

tion for specific population groups is different. The committee (annex B) will therefore look at what other micronutrients should be given priority in the last of its five advisory reports.

In this report, the committee has addressed the questions raised by the Minister as follows for iodine:

1 What is the intake and nutritional status of the Dutch population or sections of the population in terms of iodine?
2 If supply is inadequate, how much additional iodine can the various population groups safely consume (in addition to their habitual diet) in order to ensure a (lasting) adequate intake of iodine?
3 What is the best way of achieving this?

1.5 Working method

The committee assessed previous experience with fortification in the Netherlands and abroad when drawing up this advisory report. In addressing the issues, the committee described iodine supply, discussed effects of various policy measures, and formulated recommendations in the light of its conclusions.

1.6 Structure of the advisory report

Chapter 2 discusses the physiological role of iodine and the consequences of excessively low or high intake. Chapter 3 describes the dietary reference values for iodine. Chapter 4 describes the current iodine supply. This chapter therefore answers the first question to be addressed in the advisory report. Chapter 5 looks at new scientific developments, focusing mainly on policy measures in other countries and their effects. Chapter 6 discusses current Dutch policy. This chapter answers the second and third questions to be addressed in the advisory report. The committee presents its conclusions and recommendations in chapter 7.

Chapter 2

Function, effects and sources of iodine

This chapter examines the role of iodine in the body and the effects of too much and too little iodine. It also describes the various sources of iodine.

2.1 Nomenclature and function

Iodine is an essential component of the thyroid hormones thyroxine (T_4) and triiodothyronine (T_3). Thyroid hormones are needed for normal growth and development. They are also involved in energy production and oxygen consumption by cells, and therefore in maintaining a balanced metabolism.[22]

2.2 Consequences of deficiency and overdose

Iodine deficiency can lead to a large number of different conditions depending on the age at which the deficiency occurs. The most well-known and visible condition is an enlarged thyroid, referred to as goitre or struma. This can cause problems with swallowing and breathing. Severe iodine deficiency during pregnancy can lead to cretinism of the infant, a condition which features mental retardation among other effects.[22]

Iodine overdose causes the thyroid to malfunction. This can take the form of goitre, excessively low production of thyroid hormone with or without goitre, or excessively high production of thyroid hormone. The outcome depends on the individual's iodine status and how well his or her thyroid is working. Other reac-

tions to excessively high doses are hypersensitivity reactions and intoxication. Overdose during pregnancy can lead to goitre and excessively low production of thyroid hormone in the newborn child.[23]

2.3 Sources

Iodine is naturally found in salt-water fish, shellfish and seaweed. Milk and eggs also have a relatively high iodine content. The iodine content of plants and animals depends largely on the environment in which they are grown or raised. For example, plants grown in land with a low iodine content contain hardly any iodine.[22]

Iodine supply from natural sources is inadequate in the Netherlands. [10,24,25] That is why iodine is added to table salt and low-sodium salt for special diets in the Netherlands. It is also added to salt used to make bread and bread substitutes, meat products and other products. None of these additions are mandatory.[26]

Chapter 3

Dietary reference values

There are no dietary reference values for iodine in the Netherlands. For that reason, this chapter describes which dietary reference values and safe upper levels used in other countries will be applied in this advisory report.

3.1 Dietary reference values and their uses

The term 'dietary reference values' is a collective term for various reference values for energy and nutrients. The figures are intended for healthy individuals and aimed mainly at disease prevention. They are used to:

- programme food supply for healthy groups
- create dietary guidelines for healthy individuals
- assess intake data for healthy groups
- 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*.

The Dutch dietary reference values make a distinction between recommended daily allowance and adequate intake, which corresponds to American reference values.[27] The recommended amount of a nutrient is derived from figures relating to estimated average requirements of the nutrient in question. Where such figures are not available, only figures for adequate intake are set. Recommended daily allowance and adequate intake mean the same thing in practice: they both indicate

what level of intake is desirable for health reasons.[28] There are many variations on the terminology used and the definitions applied in various countries. Scandinavian and Belgian dietary reference values make no distinction between *recommended* and *adequate*, and this is also true of the dietary reference values established by the World Health Organisation.[29-31] The dietary reference values used in Germany, Switzerland and Austria do draw this distinction, but the definitions are not exactly the same as those used in the USA.[27,32]

3.2 Dietary reference values for iodine

There are no dietary reference values for iodine in the Netherlands. In 1981 the recommendation of the World Health Organisation was adopted in the context of efforts to prevent goitre. This recommendation set the minimum supply at 100 micrograms a day, with the optimum level being 150 to 300 micrograms a day.[33,34]

The United States dietary reference values are the only recent values to establish an average requirement for all age groups from the age of one year. The dietary reference values set an adequate intake for children less than a year old.[27] The American values are based on the composition of breast milk, balance studies and the accumulation and turnover of iodine in the thyroid.

Recommended daily allowances of iodine for adults in other countries range from 130 to 200 micrograms. [29-32]

In this advisory report the committee uses the dietary reference values applied in the United States (table 3.1).

3.3 Safe upper level for iodine

No safe upper level has been established for iodine in the Netherlands. The most recent safe upper level was set by the EU Scientific Committee on Food at 0.6 milligrams a day for adults aged 18 and over (table 3.1).[23]

The safe upper level is derived from dose-response studies into the effects of iodine on blood levels of thyroid-stimulating hormone (TSH) (lowest observed adverse effect level) and the sensitivity of TSH to stimulation by TSH-releasing hormone (TRH). At an estimated intake of 1.7 and 1.8 milligrams of iodine a day for two to four weeks, these effects are minimal and have no negative consequences. An uncertainty factor of three was applied when working out this safe level, as it is still not known whether chronic exposure to excessively high levels of these biochemical parameters could in fact have negative health consequences. [23]

The upper level of 0.6 milligrams per day set by the EU Scientific Committee on Food is much lower than the upper level of 1 milligram of iodine a day for adults set by the World Health Organisation and the 1.1 milligrams of iodine a day for adults set by the United States Institute of Medicine.[27,35] That is because these bodies used a smaller uncertainty factor. The reason given for this is that the aforementioned changes in biochemical parameters are small and reversible.

The UK Expert Group on Vitamins and Minerals considers that there is not enough data to establish a safe upper level for iodine. Instead of this, it proposes a guidance level of 0.5 milligrams of additional iodine a day from the habitual diet. The expert group assumes that the changes in the biochemical parameters TSH, T_3 and T_4 that are found at this level represent normal feedback processes. If it is also assumed that the 97.5 percentile of iodine intake from food is 0.43 milligrams a day, this works out at a safe upper level of total intake of 0.94 milligrams of iodine a day.[36] The safe upper levels do not apply to people with iodine deficiency, with conditions that are caused by iodine deficiency, or to people undergoing iodine treatment under medical supervision.[23]

In this advisory report the committee will use the safe upper levels set by the EU Scientific Committee on Food (table 3.1).

Table 3.1 The dietary reference values used in this advisory report and the safe upper level of intake in micrograms per day.

Age	Estimated average requirement[27]	Recommended dietay allowance [a,27]	Safe upper limit[23]
0 to 5 months	-	110 [b]	-
6 to 11 months	-	130 [b]	-
1 to 3 years	65	90	200
4 to 8 years	65	90	250/300 [c]
9 to 13 years	73	120	300/450 [c]
14 to 18 years	95	150	450/500/600 [c]
19 to 50 years	95	150	600
Over 50 years	95	150	600
Pregnant women	160	220	600
Lactating women	209	290	600

[a] Unless otherwise stated.
[b] Adequate intake.
[c] Children aged 4 to 6: 250 micrograms per day; 7 to 10: 300 micrograms per day; 11 to 14: 450 micrograms per day; 15 to 17: 500 micrograms per day; adults aged 18 and over: 600 micrograms per day.[23]

3.4 Conclusion

This advisory report uses the dietary reference values laid down by the American Institute of Medicine and the safe upper levels set by the EU Scientific Committee on Food to assess the iodine intake of the Dutch population.

Chapter 4

Iodine intake in the Netherlands

This chapter deals with the amount of iodine that the Dutch population obtains from food (iodine supply). The committee first discusses how iodine supply is measured. It then goes on to assess the findings. It also describes the principal sources of iodine in the Dutch diet, looking separately at the use of iodine supplements. Finally it considers the extent to which excessively high iodine intake occurs in the Netherlands.

4.1 Methods used to measure supply

Three steps are involved in deciding whether iodine supply is adequate. The first of these is to collect intake data: what do people in the Netherlands eat and drink, and how much iodine do all these foodstuffs and supplements contain? The second step is to compare the findings with dietary reference values stating how much iodine people of varying genders, skin types and ages need for health. This data can be used to assess the iodine intake of various groups. The third and final step is carried out to give a definitive answer to the estimate produced in step two: investigating the iodine status of a specific group of individuals. It may also be necessary to investigate conditions which may be connected to excessively high or low intake.

4.1.1 Intake data

Most of the intake data on which this advisory report is based comes from food consumption surveys. In 1999 bread replacement products and meat products were added to the list of products to which iodine may be added. However, addition is not mandatory. This makes it impossible to get an accurate estimate of iodine intake by asking people about their food consumption. TNO used data from the third food consumption survey (1997/98), the food consumption survey of young adults (2003) and the nutrient intake survey of young children (2002) to estimate observed iodine intake. The findings are based on the statutory permitted iodine concentration in some of the products. TNO used a probability-based approach to take account of the large number of uncertain factors in estimating iodine intake. This approach reflected the various causes of variability and uncertainty, such as the use of table salt when cooking hot meals, the consumption of products fortified with iodine (market share), concentration distribution, and losses during preparation. The calculation did not take account of iodine intake from supplements. TNO did not convert observed intake into habitual intake, as it is impossible to do this while taking account of the distribution of iodine content in products and the market share of products containing iodised salt. This probably resulted in the number of people with excessively low or high intake being overestimated.[37]

4.1.2 Methods used to compare intake data with dietary reference values

The threshold method was used to estimate the percentage of people in a population at risk of an undesirable level of intake. The threshold method provides information about the percentage of the population whose intake is above or below a specific dietary reference value. As there is no dietary reference value for iodine in the Netherlands, TNO used the figures set by the Institute of Medicine to test intake.[27] It used the safe upper level set by the EU Scientific Committee on Food to determine the number of people with excessively high intake.[23]

As the figure derived for children aged under one year is an adequate intake figure, it is only possible to give an overall, qualitative assessment of intake data for this group. That is because the percentage of people with insufficient intake cannot be estimated on the basis of an adequate intake figure, as the distribution of iodine requirement is not known. The percentage of individuals with a median intake below adequate intake is therefore of little significance. If median intake is the same as adequate intake, then by definition half of all people will have an

intake below adequate intake. But it is not possible to determine the proportion of this group for whom intake is really inadequate. The risk of inadequate intake is small if median intake is higher than adequate intake.[38] Status investigations provide information about whether people really have iodine deficiency.

Intake data gives an indication of iodine supply, but the findings need to be confirmed by investigation of iodine status and any physiological problems.

4.2 Iodine supply

4.2.1 Intake data

Average iodine intake is estimated to range from 112 micrograms a day by children aged between 17 and 19 months to 322 micrograms a day by men aged between 19 and 30 years (table 4.1). The percentage of individuals with an average intake below the average requirement is highest among children aged between 17 and 19 months (3.0 per cent) and between 1 and 3 years (2.3 per cent).[37]

In a study into the iodine content of duplicate diets consumed by children between the ages of 2 and 6, median intake varied with age from 131 to 175 micrograms a day.[39] These children are not expected to be at risk of serious deficiency as the median intake is well above the recommended amount.

The percentage of pregnant women with iodine intake below the average requirement also appears to be relatively high (4.6 per cent) (table 4.2). However, too few pregnant women took part in the third food consumption survey (1997/98) to allow any definite conclusions to be drawn as to the number of women with excessively low intake. The figures given above are estimates of the observed intake, which means that in reality the percentage of individuals with excessively low intake is probably lower.[37]

In conclusion: intake data indicates that current iodine intake in the Netherlands is adequate.

4.2.2 Status data and effects on health

Three indicators are used to determine the iodine status of the Dutch population: the amount of iodine in urine, the size of the thyroid gland and the amount of TSH and free T_4 in blood.

Table 4.1 Average, standard deviation and percentile figures for estimated observed iodine intake in micrograms per day.[a,37]

	Average	Standard deviation	P5	P10	P50	P90	P95
Infants 17-19 months	112	31	66	75	109	153	168
Children 1-3 years	129	37	74	84	126	178	195
Children 4-6 years	168	45	102	113	162	226	249
Boys 7-10 years	227	56	140	157	223	303	327
Girls 7-10 years	198	48	124	138	194	262	287
Boys 11-14 years	275	73	165	186	271	367	397
Girls 11-14 years	225	58	137	154	222	303	328
Boys 15-17 years	312	80	193	217	305	413	447
Girls 15-17 years	241	62	138	165	239	318	343
Men 18+ years	299	92	165	189	290	420	461
Women 18+ years	250	67	152	170	244	336	367
Pregnant women	262	61	164	186	261	339	362
Men 19-30 years	322	89	189	215	315	440	479
Women 19-30 years	240	68	141	161	234	326	356

[a] The estimate is based on the statutory permitted iodine concentration in some of the products. The figures exclude iodine intake from supplements.

Table 4.2 Percentage of people with an estimated observed iodine intake below the average requirement or above the safe upper level.[37]

		% < average requirement	% > safe upper level
FCS-1997/1998			
	Children 1-3 jaar	2.3	3.9
	Children 4-6 jaar	0.1	4.8
	Boys 7-10 jaar	0	10.8
	Girls 7-10 jaar	0	3.1
	Boys 11-14 jaar	0	1.5
	Girls 11-14 jaar	0	0
	Boys 15-17 jaar	0.2	1.8
	Girls 15-17 jaar	0.9	0
	Men 18+ jaar	0.2	0.5
	Women 18+ jaar	0.3	0
	Pregnant women	4.6	0
FCS-2003			
	Men 19-30 jaar	0	0.3
	Women 19-30 jaar	0.5	0.1

Iodine levels in urine are a good indicator of recent changes in iodine intake. Iodine deficiency is regarded as a public health problem if the median iodine content of urine is less than 100 micrograms per litre, and if more than 20 per cent of the population have a median level below 50 micrograms per litre. A median urine iodine concentration of between 100 and 200 micrograms per litre is regarded as ideal. These cut-off figures have been calculated on the basis of a 24-hour urine production figure of 1.5 litres, which equates to secretion of 150 micrograms of iodine a day. Urine production in countries such as the Netherlands is higher than 1.5 litres, which means that iodine concentration per litre is underestimated by 30 to 35 per cent. It is therefore important to not only look at iodine concentration, but also at secretion over 24 hours.[40-42]

A second indicator, thyroid size, provides information about long-term exposure to iodine and is therefore mainly of use in determining the severity of baseline iodine deficiency. The third indicator, TSH and free T_4 levels, can be used to ascertain whether an individual is producing too much or too little thyroid hormone.[40]

Various investigations into iodine status have been carried out since 1996, the year in which the iodine content of iodised salt was increased.

A survey of 937 Dutch schoolchildren aged between 6 and 18 from the areas around Doetinchem and Amsterdam in 1995 and 1996 found indications of adequate iodine supply. Median iodine secretion in urine samples collected at two different times of the same day was 154 micrograms per litre. This is well above the threshold value of 100 micrograms per litre which would point to iodine deficiency. Other indicators of adequate iodine supply, using the World Health Organisation criteria, are the low incidence of goitre and the low 97.5 percentile of thyroid size (table 4.3).[43] In addition, no evidence was found that the iodine status of schoolchildren in the east of the country was worse than that of children in the west, which used to be the case.

Investigations carried out after 1999, when the list of products to which iodised salt could be added was extended to include bread replacement products, also lead to the conclusion that iodine supply is adequate.

The median urine iodine level of 309 adults from Doetinchem who took part in a study of salt intake in 2006 was 109 micrograms per litre. This study required participants to collect their urine for 24 hours. As explained above, median iodine concentration underestimates iodine secretion over 24 hours. In fact, this figure indicates that intake is well above the adequate intake level: 24-hour iodine secretion was 241 microgram (table 4.4).[41] An adequate iodine intake of 150 micrograms per day should give a secretion level of over 135 micro-

grams a day. This is because more than 90 per cent of iodine consumed is secreted in urine.[44]

Another study conducted in 2002 and 2003 on 6,434 adults from the Nijmegen region looked at the relationship between the percentage of people with excessively high and excessively low production of thyroid hormone, and also concluded that current iodine intake is adequate. Excessively high thyroid hormone production was observed in 0.4 per cent of the participants, and excessive but subclinically high production in 0.8 per cent. Excessively low production of thyroid hormone was observed in 0.4 per cent of the participants (subclinically: 4.0 per cent).[*,45] The authors conclude that the ratio of the number of cases of excessively high production to the number of cases of excessively low production of thyroid hormone indicates that iodine supply is (just) adequate. The fact that TSH levels are lower and free T_4 levels are higher among older participants than among younger participants indicates that this has not always been the case.[45,46]

Finally, the heel-prick screening test of newborn babies indicates that iodine supply during pregnancy is adequate. Infants who are found to have a low blood T_4 level in this test (about 20 per cent of all newborn babies) also undergo a blood TSH test. This group is not entirely representative for all newborn babies, as children with thyroid conditions are over-represented. On the other hand, the group is large enough to allow the results to be used to reach conclusions as to iodine supply during pregnancy.[**]

In conclusion: the iodine status of the Dutch population is adequate.

Table 4.3 Iodine status of Dutch schoolchildren aged between 6 and 18 in the Doetinchem and Amsterdam regions in 1995 and 1996.[43]

	Doetinchem	Amsterdam
N	390	547
Iodine concentration in urine (micrograms per litre)	157	153
Prevalence of goitre (%)	0.8	2.6

* Excessively high thyroid hormone production is defined as TSH $\leq$ 0.1 mIU/ l and free T_4 > 22 pmol/l, sub-clinically too high as TSH $\leq$ 0.1 mIU/ l and free $T_4 \leq$ 22 pmol/l, too low as TSH > 0.4 mIU/ l and free T_4 < 0.8 pmol/l and subclinically too low as TSH > 0.4 mIU/ l and free $T_4 \geq$ 0.8 pmol/l.

** Personal communication by Dr. J.G. Loeber 16-06-2008.

Table 4.4 Iodine status of Dutch adults from Doetinchem in 2007.[41]

	N	Average	P25	P50	P75
Iodine concentration in urine (micrograms per litre)	309	128	76	109	165
Iodine secretion (micrograms per day)	309	265	171	241	315

4.2.3 *Dietary sources of iodine*

Bread is the main source of iodine in the Dutch diet.[25,37,43] Estimates based on food consumption surveys indicate that bread accounts for 50 per cent of iodine intake. Products that naturally contain iodine (such as milk) account for 30 per cent, and table salt used in cooking for 16 per cent.[37] About 70 per cent of the 309 adults from Doetinchem who took part in a salt intake survey in 2006 used iodised salt. People who use iodised salt had a median iodine secretion level of 250 micrograms per day, compared to 227 micrograms per day for people who used table salt without extra iodine.[41]

4.2.4 *Iodine intake from supplements*

21 per cent of the 309 adults from Doetinchem who took part in a salt intake study in 2007 took iodine supplements.[41] Both seaweed supplements and some multivitamin/mineral supplements and mineral supplements contain iodine. Users of these supplements secreted 268 micrograms of iodine a day, compared to 236 micrograms a day among people who did not take supplements.

The average intake of iodine from supplements was 93 micrograms a day among men taking part in the food consumption survey of young adults (2003) who took supplements containing iodine (5 per cent). The 95th percentile of intake was 300 micrograms a day. Among female participants who took supplements containing iodine (9 per cent), the average intake of iodine from supplements was 88 micrograms. The 95th percentile of intake was 150 micrograms a day.[47,48] Almost all of the supplements providing iodine were multivitamin/mineral supplements.

Approximately 15 per cent of children aged between two and six took supplements containing iodine. On average, the supplements provided around 30 micrograms of iodine a day. The 95th percentile varied with age and sex, ranging from 50 to 100 micrograms a day.[48]

4.2.5 *Excessively high iodine intake*

The percentage of children aged one to ten whose intake was observed to be higher than the safe upper level was estimated at 3 to 11 per cent on the basis of the third food consumption survey (1997/1998). For 5 per cent of the boys aged seven to ten, the limit was exceeded by at least 27 micrograms of iodine a day. Among older boys and men, the percentage ranged from 0.5 to 1.8 per cent (tables 4.1 and 4.2).[37]

These findings are confirmed by a study into the iodine content of duplicate diets consumed by children aged two to six. This study found that 10 per cent of children had an intake above the safe upper level*. Approximately 7 per cent of the children had a daily iodine intake of between 210 and 240 micrograms; 3 of the children had an intake of 240 to 270 micrograms a day and 2 per cent had a higher intake.[39]

These figures are estimates of the observed intake. The percentages corresponding to a habitual intake would probably be lower. Furthermore, studies into iodine status and thyroid function provide no evidence that (excessively) high intake has harmful effects.[41,43,45]

In conclusion: intake data shows that some children and men might be consuming too much iodine, but data on iodine status and thyroid function does not indicate that this is any cause for concern.

4.3 Conclusion

The iodine status of the Dutch population is adequate.

* The safe upper level of daily iodine intake for children aged one to three is 200 micrograms, and for children aged four to six it is 250 micrograms.

Chapter 5

New scientific developments and policies in other countries

In this chapter the committee assesses new scientific developments and the effects of various policies in Western countries. It also describes policy proposals under consideration in Australia and New Zealand, as they are very similar to current Dutch policies.

5.1 New scientific developments

There are indications from observational studies that a marginal deficiency in the first trimester of pregnancy is associated with having a child that is less well developed from a neurological point of view. A severe maternal iodine deficiency during pregnancy can cause serious developmental disorders in the child (cretinism and mental retardation), and mild to moderate iodine deficiency is also associated with developmental disorders in the child.[49] Research indicates that a low iodine status in the first trimester of pregnancy is associated with having a child with neurological development delay between the ages of three weeks and two years[50-52] and a lower IQ between the ages of seven and nine years.[53,54] The actual significance of this link is still unclear. For example, we do not know how much T_4 is transferred from the mother to the child at the various stages of pregnancy. And no studies have yet been carried out to ascertain whether administering additional T_4 during pregnancy can improve the neurological development of the child. Marginal iodine deficiency later in pregnancy is not associated with the neurological development of the child.[50-52] This may also apply to women whose

status improves as their pregnancy progresses. [52] And children who do not produce enough thyroid hormone as a result of a congenital abnormality should be able to achieve practically normal IQ levels if they are given post-natal treatment in good time.[55]

5.2 Policies recommended by health organisations

In 1990 the World Health Assembly decided that universal iodisation of table salt would be an effective way of combating conditions caused by iodine deficiency. Assuming an average table salt intake of 10 grams a day, the amount of iodine that should be added to one kilogram of table salt is 20 to 40 milligrams.[56]

Few Western countries have followed this recommendation. Instead, policies in these countries permit the addition of iodine to table salt for domestic use, industrial food production and/or bakery salt (in some cases this is mandatory). In principle iodised salt can be used instead of non-iodised salt in most products. However, only a small number of products have undergone studies to determine the effect of production methods on their iodine content and the effect of iodised salt on food quality.[57]

5.3 Countries with no policies on iodine

The United Kingdom has no policy on iodine supplementation or the fortification of table salt with iodine. Iodine is added to cattle feed, making milk an important source of iodine.[58] There are suggestions that this may not be sufficient to meet the needs of the entire population. A pilot study conducted on 227 pregnant women found that 3.5 per cent had iodine deficiency and 40 per cent had a marginal iodine status.[59]

5.4 Countries which give advice on supplementation

A summary article[160] found that 13 to 50 per cent of pregnant women in Europe took a supplement containing iodine, while at the same time around two-thirds of the population of Western and Central Europe had iodine deficiency (as the previous chapter concluded, this is not the case for the Netherlands). The authors concluded that pregnant women living in regions where iodised salt is not available would benefit from taking supplements containing iodine. They should ideally start taking them before conception in order to avoid the negative effects on maternal and infant thyroid function and the mental development of the child. Kelp and seaweed supplements are not an option as the iodine content of these

supplements varies considerably. In half of the supplements investigated in the UK, the dose recommended on the label would give a daily iodine intake of 1,000 micrograms, which is 1.6 times as high as the safe upper level of intake set by the EU Scientific Committee on Food.[23,61]

5.5 Countries with voluntary fortification

Many European countries permit the voluntary addition of iodised salt to specific foodstuffs (table 5.1). The iodine content of this salt varies from 10 to 25 milligrams per kilogram.[30,37] A report by the World Health Organisation in 2004 found that iodine supply in these countries ranged from inadequate in Belgium and France to adequate in Germany and Switzerland , like in the Netherlands.[62] More recent research supports the findings of this report. In Belgium, figures on the iodine content of breast milk indicate that iodine supply for breastfeeding women is inadequate. Examination of the amount of iodine secreted in urine indicates that supply for newborn babies in Belgium is also inadequate. This may also be true for pregnant women in Belgium.[63]

In Switzerland the iodine content of table salt was increased from 15 to 20 milligrams per kilogram in 1998. It is estimated that 95 per cent of salt for domestic use and 70 per cent of salt for commercial food production is fortified with iodine. This increase led to an improvement in the iodine status of children and pregnant women from marginal in 1999 to more than adequate in 2004.[32,64]

5.6 Countries in which fortification of table salt is mandatory

Some neighbouring countries require by law that table salt be fortified with iodine. Food Standards Australia New Zealand has produced a summary report looking into the effects of mandatory fortification of table salt.[66] It concluded that introducing iodine-fortified table salt could cause both excessively low and excessively high production of thyroid hormone, and that both effects were usually temporary.

Table 5.1 Summary of policies in neighbouring countries.[a]

Country	Content (milligrams of iodine per kilogram of salt)	Foodstuffs
Voluntary fortification		
Belgium[30]	10-15	Table salt for domestic use and food production
Germany[32]	15-25	Table salt for domestic use and food production
France[37]	10-15	Table salt for domestic use and food production
Switzerland[32]	20-25	Table salt for domestic use and food production
Mandatory fortification		
Denmark[65]	13	Table salt
Austria[32]	20	Table salt

[a] The United Kingdom has no policy on the fortification of table salt with iodine.

Excessively low or high production of thyroid hormone

Excessively low production of thyroid hormone, either in isolation or combined with goitre, can be caused by excessively high iodine intake over an extended period or by suddenly shifting from excessively low iodine intake to excessively high intake. Excessively low production of thyroid hormone is often sub-clinical and temporary; if it is not temporary it can easily be treated by reducing iodine intake or administering thyroid hormone. In global terms, excessively low thyroid hormone production tends to be caused by excessively low rather than excessively high iodine intake.

Excessively high production of thyroid hormone can occur if chronic low intake has led to changes in the thyroid that, combined with an increased iodine intake, make an individual liable to produce too much thyroid hormone. This effect is particularly common among elderly people. Young people with an auto-immune condition (Graves' disease) can also produce excessive amounts of thyroid hormone, a phenomenon which was originally masked by low iodine intake. Both effects have been seen in some but not all fortification programmes. Where they have been observed, excessively high production of thyroid hormone among elderly people was temporary, but the auto-immune condition was permanent.[66-68]

Austria

Austria introduced mandatory iodine fortification of table salt in 1963. The level at that time was 10 milligrams of iodine per kilogram of table salt, but this was increased to 20 milligrams in 1990. Research in 1994 showed that this increase had led to adequate iodine supply among schoolchildren.[67,69] In 2000 another study among adults confirmed the conclusion that iodine supply is adequate. The number of cases of goitre fell sharply among people under 40 compared to the situation in 1963. The same is not true of older people who had been exposed to low iodine intake for a relatively long period.[67,70] The number of cases of individuals with excessively high thyroid hormone production or an auto-immune condition of the thyroid (Graves' disease) had increased. Another finding was that there had been a shift in the histological types of thyroid cancer, with the types more amenable to treatment making up a greater proportion of cases. There was no change in the total number of cases of thyroid cancer.[67]

Denmark

Mandatory fortification has more recently been introduced in Denmark. Voluntary fortification at a rate of 8 milligrams of iodine per kilogram of table salt was introduced in June 1998, and the level was increased to 13 milligrams when mandatory fortification came into force in 2000. It is estimated that iodine intake rose by 50 milligrams a day as a result of the mandatory fortification policy.

The *DanThyr* project is studying the consequences of this policy. The introduction of mandatory fortification brought the median iodine intake up to the recommended daily allowance. Only adults aged between 18 and 21 and women aged between 40 and 45 fail to reach the recommended levels for median iodine intake. The authors state that milk consumption is important in achieving adequate iodine intake.[71] The introduction of mandatory fortification has also led to a decline in thyroid volume in all population groups. The decline was most pronounced in regions where moderate iodine deficiency had been observed prior to 1999. As thyroid volume after fortification was just as large in regions where moderate iodine deficiency had previously been observed as in regions where it had been mild, the investigators concluded that the new fortification policy had led to iodine supply being almost at optimum levels.[65] The number of cases of people with excessively low thyroid hormone production had however increased from 38.3 per 100,000 per year before fortification became mandatory to 47.2 per 100,000 per year thereafter. This increase occurred only among young or middle-aged people who had previously lived in regions with moderate iodine

deficiency. There was no change in the number of cases of excessively low production of thyroid hormone among other age groups or in regions where mild iodine deficiency had previously been observed.[72] In addition, the number of cases of excessively high production of thyroid hormone increased from 102.8 per 100,000 per year to 138.7 per 100,000 per year after the introduction of mandatory fortification. The increase among young adults (160 per cent up on the baseline figure) was higher than in other groups, perhaps as a result of an autoimmune response.[68] Some of the rises in the number of cases of excessively low and excessively high thyroid hormone production may be due to the fact that doctors became more alert to thyroid conditions after the introduction of mandatory iodine fortification.

Eastern Europe and the former Soviet Union

Abandoning the use of iodised salt eventually leads to an increased risk of goitre. Targeted distribution of iodine tablets to high-risk groups meant that iodine deficiency was unknown in Eastern European countries between 1930 and 1960. This policy was less stringently applied in the 1970s and 1980s, and was dropped completely with the break-up of the Soviet Union. Iodine deficiency then reappeared, as could be seen in an increased number of cases of goitre and cretinism. The incidence of these conditions declined again when iodine use was reintroduced some years later.[73-75]

5.7 Countries considering the introduction of mandatory fortification

Voluntary fortification of table salt with 25 to 65 milligrams of iodine per kilogram of salt is currently permitted in Australia and New Zealand. Iodisation of table salt for bread making (except organic and unleavened bread) will be made mandatory in September 2009 on the advice of Food Standards Australia New Zealand. The iodine content of this salt will have to be between 35 and 55 milligrams per kilogram. Iodisation of table salt for domestic use will still be permitted, at levels of 25 to 65 milligrams per kilogram. Manufacturers will also be allowed to add this iodised salt to other products on a voluntary basis. Mandatory fortification has been chosen as it appears to be the best way of guaranteeing iodine supply for populations.[57,66,76]

5.8 Conclusion

There are indications from observational studies that women with a marginal deficiency in the early stages of pregnancy are likely to have a child that is less well developed from a neurological point of view. In some nearby countries, voluntary iodine fortification of table salt has led to adequate iodine supply, but this has not been the case in all countries. Mandatory iodine fortification of table salt in two nearby countries has resulted in adequate iodine supply, but has also been associated with an increase in the number of cases of excessively high thyroid hormone production and, in regions where iodine supply was originally moderate, with an increase in the number of cases of excessively low production of thyroid hormone. Past experience with iodine fortification in other countries leads the committee to conclude that these increases are temporary in nature. The iodine status of the Dutch population is adequate.

Chapter 6

Policies in the Netherlands

This chapter looks at scenario calculations for alternative fortification levels and the advice to cut salt consumption. The benefits and drawbacks of various policies are weighed up.

6.1 Supplementation

The Netherlands does not have a policy of advising specific target groups to take iodine supplements. People are advised not to take kelp tablets and other seaweed extracts because of their variable, sometimes very high, iodine content.[26]

6.2 Scenario calculations

6.2.1 Commodities Act Decree on the addition of iodine

The Commodities Act Decree on the addition of iodine was revised in 2008. This was based on scenario calculations produced by TNO.[12,37] The scenario calculations examine how the Dutch population can be offered optimum iodine supply. The scenario calculations were prompted by:

- the decision to allow table salt for bread making with a lower iodine content onto the Dutch market;
- the fact that bakers wanted to use just one type of table salt for all their products;

- new European legislation and regulations on voluntary fortification;
- the establishment of a new, lower safe upper level of intake for iodine.

Simulations were performed using data from the third food consumption survey (1997/98), the food consumption survey of young adults (2003) and the nutrient intake survey of young children (2002), which also included individuals on a sodium-restricted diet. People on a sodium-restricted diet are often advised to eat 'normal' bread and to cook food without adding salt. The iodine intake of people on a sodium-restricted diet may, depending on their actual behaviour, also be much lower. Intake of iodine from supplements was not taken into account.

In the simulations the range of types of products to which iodised salt is added, the different iodisation levels and the applied corrections for the market share of iodised salt varied. The simulation in which iodised salt at a concentration of 50 to 65 milligrams of iodine per kilogram of salt may be added to bread and other bakery products and breakfast cereals, and table salt with a concentration of 15 to 25 milligrams of iodine per kilogram of salt may be used in meat products and industrial products and for domestic use, resulted in an intake that is closest to current iodine intake. The average intake is estimated at one per cent lower than current intake, but the percentage of people with an intake lower than the average requirement is lower than the current percentage. The percentage of people with an intake higher than the safe upper level was slightly lower among the younger age groups and up to 1.5 per cent higher among the older age groups. The advantage of this scenario is that bakers only need to use one type of table salt (maximum iodine content of 65 milligrams per kilogram of salt), and that voluntary fortification of specific products with up to 25 milligrams of iodine per kilogram complies with European legislation.

6.2.2 *European regulations on voluntary fortification*

Under the revised Commodities Act Decree on adding iodine, the iodine content of baker's salt (where iodine is added) in the Netherlands is still higher than in neighbouring countries such as Germany, Belgium and France.[12] It may also be higher than the iodisation exemption level in Europe, which has yet to be determined.

Scenario calculations show that lowering the iodine content of baker's salt to 15 to 25 milligrams per kilogram of salt would reduce iodine intake by at least a third of the current intake level*, and that as a result the proportion of children

* This scenario assumes that iodine-fortified bread has a market share of 85 to 95 per cent.

aged one to three receiving less than the average requirement would increase to over 15 per cent.[37] A 30% cut in iodine intake would increase the risk of iodine deficiency, which is associated with a greater risk of goitre.

TNO has not worked out the effect of adding table salt with a lower iodine content (15 to 25 milligrams of iodine per kilogram of salt) to all products. One argument against it is that it would very probably lead to a lower iodine intake in the Netherlands. Scenario calculations performed by Food Standards Australia New Zealand indicate that using table salt with an iodine content of 15 milligrams per kilogram in all processed food products containing table salt could meet iodine requirements just as effectively as adding table salt with an iodine content of 35 to 55 milligrams per kilogram of salt to bread. But this level is lower than the iodine content of baker's salt used in the Netherlands*.[57,66]

Another argument against adding table salt with a lower iodine content to all products is the uncertainty as to whether this is technically feasible. This is because for many products no research has been carried out to find whether production processes affect iodine content and whether iodised salt has a negative impact on product quality.[57,66]

6.3 Reducing salt consumption

In its *2006 Guidelines for a Healthy Diet* the Health Council concluded that reducing salt consumption from 10 to 6 grams a day was a reasonable aim. It based this figure on the findings of foreign expert committees, but did point out that this level should be regarded as a feasible target for the amount of salt in food rather than an optimum or acceptable level. A further reduction in the use of table salt would produce greater health benefits.[20]

The Ministry of Health, Welfare and Sport wishes to achieve this target mainly by encouraging producers of foodstuffs to gradually reduce the salt content of their products. This will allow consumers to gradually get used to a less salty taste. But cutting salt intake by 40% also reduces iodine intake.**

This would increase the risk of iodine deficiency and goitre. This explains why an expert meeting of the World Health Organisation recommended monitoring iodine intake. The fall in iodine intake caused by a decline in salt intake should be offset by adding more iodine per kilogram of salt.[77]

* Provisional scenario calculations produced by the RIVM appear to confirm this.[48]

** A summary report by the RIVM containing calculations of the effect of lower salt intake on iodine intake will appear later this year.[48]

6.4 Weighing up measures

The committee believes that current iodine supply is sufficient, and expects that this will continue to be the case under the amended Commodities Act Decree on adding iodine.

If the iodine content of baker's salt is reduced to 15 to 25 milligrams of iodine per kilogram of salt, the risk of iodine deficiency and goitre will increase. This is also true if salt intake drops by 40%. Requiring iodisation of all table salt is not an option as the effects of iodised salt on product quality is unclear.

Nevertheless, there are groups in the population who are at risk of iodine deficiency. For example people who eat bread that may have been made with uniodised salt or sea salt, such as home-baked and organic bread, and who also do not use iodised salt for domestic use.

The introduction of the revised Commodities Act Decree and the proposals for cutting salt intake mean that iodine intake must be carefully monitored. This could prevent the iodine intake of the Dutch population rising too high because of an increase in the number of specific products containing iodised salt, or declining because of reduced salt intake.

6.5 Conclusion

The current policy ensures optimum iodine supply. Careful monitoring of iodine intake in the Netherlands is certainly desirable in conjunction with the increase in the number of products to which iodised salt can be added and the expected decline in salt consumption. If necessary, iodisation policy can be adjusted in the light of this so as to ensure that iodine intake in the Netherlands remains adequate.

Chapter 7

Conclusions and recommendations

7.1 Conclusions

The iodine intake of the Dutch population is adequate

Data on iodine intake and on biochemical and physiological indicators indicate that current supply is adequate. Roughly 50% of iodine intake is from bread.

Iodising table salt for staple foodstuffs is the best way of guaranteeing optimum iodine intake

Iodine supply is adequate in European countries where the iodisation of table salt is mandatory. In countries where iodised salt can be added to specific foodstuffs on a voluntary basis, supply ranges from inadequate to adequate, while it appears to be inadequate in countries such as the United Kingdom where there is no policy on table salt iodisation.

A marginal iodine deficiency in the first trimester of pregnancy may be associated with poorer infant neurological development

Serious maternal iodine deficiency during pregnancy can cause developmental disorders in the child (cretinism and mental retardation). Mild to moderate iodine deficiency is also associated with (less severe) developmental disorders in the

child. New observational research indicates that marginal iodine deficiency in the first trimester of pregnancy is also associated with poorer infant neurological development. No research has been conducted to determine whether this can be prevented by treating the mother with the thyroid hormone T_4. In contrast, a marginal iodine deficiency later in pregnancy does not appear to have any effect on the child's neurological development.

Iodine intake in the Netherlands could fall as a result of European regulations on voluntary fortification and lower salt intake

If the permitted level of voluntary fortification in Europe is set at less than 65 milligrams of iodine per kilogram of table salt, it will no longer be possible to add table salt iodised at this level to bread and other bakery products. This will lead to a reduction in iodine intake. The same consequence would follow a decline in salt intake by the Dutch population. Both trends would increase the risk of iodine deficiency and goitre.

7.2 Recommendations

Ensure that the current Dutch level of fortification of baker's salt is still permitted at European level

The committee considers that it is very important to ensure that the current level of iodine fortification of baker's salt remains permitted at European level in order to guarantee good iodine supply in the Netherlands.

Monitor the iodine intake of the Dutch population and adjust policies where necessary

The committee is of the opinion that any changes in iodine intake and status as a consequence of lower salt intake must be monitored. The iodisation policy could if necessary be adjusted in the light of the data obtained through monitoring in order to ensure adequate iodine supply and prevent iodine deficiency and goitre. As iodine plays a key role in development, monitoring should focus particularly on children in the first year of life and women who are pregnant or breastfeeding.

Investigate iodine supply for people who eat home-baked or organic bread

The committee thinks that the iodine intake of people who eat home-baked or organic bread should be investigated. These products may be made with non-iodised salt or sea salt. Individuals who consume them are at risk of excessively low iodine intake, especially if they also use non-iodised salt at home. The importance of iodised salt can if necessary be pointed out.

Set dietary reference values for iodine

The committee recommends that official dietary reference values be set for iodine. In this advisory report the committee used the dietary reference values laid down by the American Institute of Medicine and the safe upper levels established by the EU Scientific Committee on Food. New insights from studies into iodine status should also be taken into account when setting the reference values.

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A Request for advice

B The committee

C 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**

Definitions

Adequate intake

The lowest level of intake that seems to be adequate for practically the entire population. An adequate intake is estimated if research data is insufficient to allow an average requirement and recommended allowance to be determined.[38]

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.[38]

Diet

Unless otherwise specified, 'diet' refers to foodstuffs 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.[17]

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.[38]

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.[17]

Safe upper level

Highest level of intake at which no harmful effects are observed or to be expected.[38]

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.[17]

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.