Iodine intake in Germany on the decline again - tips for a good iodine intake

Questions and answers on iodine intake and the prevention of iodine deficiency

BfR FAQ of 20 February 2020 (updated 09 February 2021)

Iodine is an essential trace element which the body needs for the production of thyroid hormones and thus for the control of a large number of metabolic processes. Iodine has to be taken up with food. Since the iodine levels in the soil are low, agricultural products contain very little iodine. Sea fish and shellfish, on the other hand, have high iodine contents, but do not contribute significantly to iodine supply due to the low consumption frequency. Overall, the natural iodine content of our food is not sufficient to ensure an adequate iodine intake for the German population. The iodine intake of the German population had been improved by the recommended measures from the mid-1980s to use iodised table salt in the food industry and manufacture of artisanal food products, and in private households. The use of iodine as a feed additive, which resulted in higher iodine content in milk and dairy products, had also contributed to the improvement of the situation. However, current data show that the iodine intake of the population is still not optimal and/or demonstrates a declining trend. In order to guarantee an adequate iodine supply for the German population, sustainable and continuous measures are necessary.

The German Federal Institute for Risk Assessment (BfR) has answered and summarised the most frequent questions on the subject of iodine supply and the prevention of iodine deficiency below.

What is iodine and why does the body need it?

Iodine is an essential trace element which is notably indispensable for the production of thyroid hormones, and which must be ingested with food. In the body, thyroid hormones have a central function in the control of a number of metabolic processes and are required, among other things, for normal growth, bone formation, the development of the brain, and energy metabolism. If iodine intake remains below the recommended daily allowance over extended periods of time, the thyroid gland will produce insufficient amounts of thyroid hormones, which can in turn lead to severe health problems.

How much iodine does the body need?

The iodine requirement varies from person to person and depends on various factors, such as age and health status. To meet the iodine requirement, the German Nutrition Society (DGE, 2015) e.V. recommends age-dependent iodine intakes of 40-80 micrograms (µg) per day for infants, 100-200 µg/day for children aged under 15, and 180-200 µg/day for adolescents and adults. A daily intake of 230 and 260 µg/day is recommended for pregnant and breastfeeding women, respectively. The European Food Safety Authority (EFSA, 2014) considers an intake of 70 µg/day to be adequate for infants (7-11 months old), 90-120 µg/day to be adequate for children aged 1-14 years, and 130-150 µg/day to be adequate for adolescents and adults. EFSA considers a daily intake of 200 µg to be appropriate for pregnant and breastfeeding women.

Intake recommended by the German Nutrition Society (DGE) e.V.		
Age group		Recommended iodine intake in µg/day
Infants	up to 4 months (estimate)	40
	4 months to 12 months	80
Children	1 to under 4 years	100
	4 to under 7 years	120
	7 to under 10 years	140
	10 to under 13 years	180
	13 to under 15 years	200
Adolescents and adults	15 to under 51 years	200
	51 years and older	180
Pregnant women		230
Breastfeeding women		260

What iodine intake levels should not be exceeded?
According to EFSA, a long-term intake of a maximum of 600 µg of iodine per day does not represent a health risk for adults. For children, correspondingly lower *tolerable upper intake levels* (ULs) were derived depending on their age: 200 µg/day for 1- to 3-year-olds, 250 µg/day for 4- to 6-year-olds, 300 µg/day for 7- to 10-year-olds, 450 µg/day for 11- to 14-year-olds and 500 µg/day for 15- to 17-year-olds.

Since Germany has experienced prolonged iodine deficiency, which lasted until the 1980s, functional autonomy of the thyroid gland is still to be expected in the elderly in particular. These people may display higher sensitivity to iodine and may develop an overfunction of the thyroid gland as a result of excessive iodine intake. A UL of 500 µg/day for adults has therefore been set in Germany.

What should pregnant women and breastfeeding mothers keep in mind?
Due to their particular metabolic conditions, pregnant women and breastfeeding mothers have increased iodine requirements. In order to avoid the risk of iodine deficiency and any adverse health effects resulting from it for mother and child, it is recommended that pregnant and breastfeeding women should, following consultation with their gynaecologist, take 100 to 150 µg of iodine per day in tablet form, in addition to a diet of foods rich in iodine and iodised salt.

Which foods are good sources of iodine?
Iodine is contained in plant and animal food products, but their iodine content can vary considerably within a food category. This is influenced by geochemical conditions, e.g. iodine contents in the soil, as well as the use of iodised salt. Sea fish is a good natural source of iodine, but so are milk and dairy products, since iodine is used as a feed additive in animal feed. Iodine is also consumed via iodised table salt and foods made with it. If iodised salt is used in processed foods, meat, sausages and bread are the main sources of iodine.

How much iodine is taken up with and without the use of iodised salt in foods?
The median daily iodine intake *without* taking into account the use of iodised salt in processed foods is around 75 µg for adults in Germany (calculated on the basis of the urinary iodine excretion). This corresponds to half of the daily intake recommended by EFSA of 150 µg and around 40 percent of the DGE reference value of 200 µg per day. At present, an adequate intake can only be achieved if around 40 percent of all foods were manufactured with iodised salt. However, the proportion of artisanal and industrially processed foods currently produced with iodised salt is only around 30 percent.

How much iodised salt would have to be used in foods in order to achieve an adequate iodine intake, taking account of a reduced salt consumption?
The intention of the national reduction and innovation strategy for sugar, fats and salt in processed foods (NRI) of the German federal government is to gradually achieve a reduction of the content of sugar, fat and salt in food products over the next few years. This aims to reduce the prevalence of overweight and obesity and associated diseases. However, the desirable reduction in salt consumption could at the same time lead to a reduced intake of iodine via iodised salt. With the current iodine content in salt averaging 20 milligrams per kilogram (mg/kg) salt and a 10 percent reduction in salt consumption, around 45 percent of all foods would have to be produced with iodised salt to ensure adequate iodine intake for the population.

What would the usage level of iodised salt need to be for an adequate iodine intake if the iodine content in salt is increased, taking into account a reduced salt consumption?
If salt consumption is reduced by 10 percent and the iodine content in salt increased by 5 mg/kg, around 36 percent of all foods would have to be manufactured with iodised salt in order to ensure an adequate iodine intake for the population.

What can consumers do to ensure an adequate iodine supply through their diet?
A sufficient iodine supply is possible if attention is paid to the consumption of iodine-containing food. This includes:

- daily consumption of milk and dairy products
- consumption of sea fish once or twice a week
- consistent use of iodised salt in the household and
- the preferential purchase of foods produced with iodised salt (pay attention to the labels!)

Pregnant women should avoid a high consumption of predatory fish species (e.g. tuna, swordfish), which are at the end of the maritime food chain and can contain higher levels of substances harmful to health.

Are there groups of persons who have to pay particular attention to a sufficient iodine supply?
Abstaining from food of animal origin (meat, fish, milk, eggs) results in an increased risk of insufficient iodine supply. People who follow a vegetarian or vegan diet or who have to follow a special diet should therefore pay particular attention to a sufficient iodine supply. This also includes consumers who have to avoid fish or dairy products due to an allergy to cow's milk or fish or because they suffer from lactose intolerance. Finally, pregnant and breastfeeding women have increased requirements for iodine due to their particular metabolic situation and should therefore ensure a sufficient iodine intake and, after consulting their gynaecologist, take iodine in a dose of 100 to 150 µg/day in tablet form.

Is the consumption of products from seaweed and kelp suitable to ensure adequate iodine intake?

The iodine content in dried seaweed and kelp products can be particularly high because the iodine contained in seawater is absorbed by algae and highly enriched in some species. The iodine levels fluctuate considerably, depending on the species of algae and have ranged between 5 and 11,000 micrograms per gram (µg/g) dry weight in previous measurements. In the last monitoring carried out by the German federal and state governments (2018), maximum iodine levels of up to 5,500 µg/g dry weight were measured. Brown seaweeds are especially rich in iodine, especially the Arame, Kombu, Wakame and Hijiki species. Even by consumption of small amounts of 1 to 10 grams (g) of such iodine-rich algae, the tolerable upper iodine intake level (UL) of 500 µg/day (applies to adults) may be exceeded many times over. The excessive iodine intake may have negative health consequences, depending on the dose and the sensitivity of the person consuming it. Therefore, in order to avoid iodine intake by sea algae that is harmful to health, information is required for algae with an iodine content of more than 20 mg/kg dry matter that excessive iodine intake can lead to thyroid disorders. In addition, information on the iodine content and the maximum consumption should be given. When buying seaweed, care should be taken whether these instructions are listed on the label.

What factors affect iodine absorption in the body?

Various food components, environmental influences and some medications can inhibit the absorption of iodine or the formation of thyroid hormones, although negative effects of these factors on iodine metabolism are only to be expected if iodine intake is far below the recommended intake.

The iodine metabolism can be affected by nutrient deficiencies, especially of selenium, zinc and iron. Furthermore, a high intake of certain foods - such as cabbage, cress, radish, flax or millet - can lead to a reduced absorption of iodine in the thyroid gland. This is, among other things, caused by glucosinolates contained in cabbage, cress and radish (mustard oil glycosides) or their degradation products such as thiocyanates. Some foods, such as flaxseed or millet, contain cyanogenic glycosides that can be converted into thiocyanate in the body. Smoking is a particularly relevant environmental factor affecting iodine absorption, since thiocyanate is also formed in this case.

What about the iodine supply in the German population?

The iodine supply status of the population can be determined on the basis of iodine urine excretion. As around 85 to 90 percent of the iodine intake is excreted via urine (the remaining 10-15 percent constitutes iodine loss via sweat and faeces), the daily iodine intake can be estimated using excretion data. Representative iodine excretion data for the German population have been gathered as part of the national health surveys by the Robert Koch Institute (RKI): ‘Studie zur Gesundheit von Kindern und Jugendlichen in Deutschland (Study on the Health of Children and Adolescents in Germany)’ (KiGGS study, data collection periods: 2003 to 2006 and 2014 to 2017) and ‘Studie zur Gesundheit Erwachsener in Deutschland (Study on the Health of Adults in Germany)’ (DEGS, data collection period: 2008 to 2011).

The data show that around 30 percent of the adults and 44 percent of the children and adolescents included in these studies have an iodine intake below the estimated average requirement and are therefore subject to a health risk of inadequate iodine status. The estimated daily iodine intake has thus fallen in children and adolescents by 13% since the baseline data were gathered (2003 to 2006). A declining trend in iodine intake has also been observed in recent years in both children aged 3 to under 6 and children aged 6-12 years, as shown in a cross-sectional study of infants, young children and school age children carried

out in Dortmund over many years (Dortmund Nutritional and Anthropometric Longitudinally Designed Study; DONALD Studie).

Is iodised salt prophylaxis still necessary in Germany?
Since the iodine levels in the soils in Germany are low, many agricultural products contain very little iodine. While sea fish and shellfish may have high iodine contents, they do not contribute significantly to iodine supply due to the low consumption frequency. Overall, the natural iodine content of our food is not sufficient to ensure an adequate iodine intake for the German population. Continuous iodised salt prophylaxis is therefore necessary in order to ensure an adequate iodine supply for the population.

The iodine intake in Germany had significantly improved thanks to the introduction of iodine deficiency prophylaxis in the mid-1980s, which recommended the use of iodised salt in the food industry and in the manufacture of artisanal foods as well as the use of iodised table salt in private homes. The use of iodine as a feed additive, which resulted in higher iodine content in milk and dairy products, had also contributed to the improvement of the situation. However, current data from the RKI (DEGS: 2008 to 2011) and KiGGS: 2014 to 2017) show that the iodine intake of the German population is declining again. At the same time, results of a recent market survey by the University of Giessen indicate that less iodised salt has been used in the production of processed foods in recent years.

Therefore, awareness of the health benefits of a sufficient iodine intake should be raised again and kept alive, as part of information and education campaigns directed at consumers and food manufacturers. At the same time, however, the potential concerns and fears of consumers should be adequately addressed and acceptance of food manufacturing companies for the use of iodised salt be advocated for.

Does iodisation of salt pose a health hazard?
The amount of iodine that may be added to salt is regulated, and thus amounts up to 15 to 25 mg/kg may be used. This quantity is chosen in such a way that impairments of health are very unlikely for healthy people as well as for those with a thyroid disease. Compliance with these provisions is monitored by the food control authorities.

How prevalent is the use of iodised salt in the food industry?
Data from a recent market survey conducted in 2019 by the University of Giessen suggest that the use of iodised salt in processed foods is decreasing. In recent years, the use of iodised salt in the butchers´, and especially in the bakery sector, has decreased greatly. Currently, iodised salt is only used in 10 percent of industrially produced breads and baked goods containing salt. Iodised salt is used in 47 percent of industrially produced salted meat and meat products

How much iodine is contained in milk?
Due to the use of iodine as an animal feed additive, the iodine content in milk is about 100 to 150 micrograms per litre (µg/l) (although the levels can vary greatly due to the variation in the amount of iodine used in feed). Milk and dairy products are therefore considered to be a good source of iodine for humans.

How much iodine do organic foods contain?
The use of iodised salt for food processing is permitted by most organic associations, but the results of a market survey by the University of Giessen indicate that iodised salt is only used to a very limited extent in the production of organic foods, especially in bread. The use of iodine as a feed additive is also permitted on organic farms. However, individual studies show

that organic milk contains only 60 to 85 percent of the amount of iodine that is contained in conventional milk. These differences are probably due to variation in the iodine supply to animals, which is either seasonal (in the summer grazing season, additional feedstuff containing feed additives such as iodine is used to a small extent) or due to possibly generally reduced use of animal feed containing additives (including iodine) on organic farms.

How can consumers determine whether or not food has been produced with iodised salt?
When purchasing packaged foods, the consumer can glean from the list of ingredients on the label whether iodised or conventional salt was used in the production. When buying non-packaged goods from bakeries and butchers' shops, consumers must ask whether or not these products contain iodised salt.

What should consumers who want or have to limit their salt intake keep in mind?
People with high blood pressure who want or have to limit their salt intake should consider consuming foods high in iodine, such as sea fish (1-2 times per week) or milk and dairy products. Even with a reduced salt intake, iodised salt should be used whenever possible. If necessary, it should be discussed with a doctor whether it is advisable to take iodine tablets.

What health effects can iodine deficiency have?
The health effects of an insufficient iodine intake depend on the severity of the deficiency. The severity of iodine deficiency in the population can be classified on the basis of the median concentration of iodine in urine (see table).

WHO classification of iodine supply, based on excretion of iodine in urine		
Median urinary iodine excretion [micrograms/litre]	**Iodine intake**	**Iodine supply**
School aged children and adults		
< 20	insufficient	severe iodine deficiency
20-49	insufficient	moderate iodine deficiency
50-99	insufficient	mild iodine deficiency
100-199	adequate	adequate iodine supply
200-299	above requirement	likely adequate intake for pregnant women and breastfeeding mothers, but may contain a slight risk of an intake that is more than sufficient for the entire population
≥ 300	excessive	Risk of adverse health effects (iodine-induced hyperthyroidism, autoimmune thyroid disorders)
Pregnant women		
< 150	insufficient	
150 - 249	adequate	
250 - 499	above requirement	
≥ 500	excessive	excessive means far above the amount needed to prevent and inhibit iodine deficiency

Breastfeeding mothers*		
> 100	adequate	
Infants <2 years		
> 100	adequate	

*Although breastfeeding mothers have the same requirement as pregnant women, the average adequate urine concentration is lower, as iodine is also excreted via breast milk.
Modified in accordance with the *World Health Organization* (WHO, 2007).

Long-term insufficient supply of iodine can lead to an enlargement of the thyroid gland (goitre). This represents a physiological adaptation of the body in order to compensate for the chronic iodine deficiency with more hormone-producing tissue. Uniform enlargement is known as “diffuse goitre”, while growth with nodule formation is known as “nodular goitre”. In the so-called “cold nodules” the cells have given up their function and no longer produce thyroid hormones. The vast majority of cold nodules are benign, but in a very few cases they can also be malignant. Within so-called “hot” nodules, active or overactive cells produce too much hormone regardless of need (functional autonomy). “Hot” nodules are usually benign, but can cause a thyroid hyperfunction. This usually develops slowly and can be recognised by a drop in thyroid-stimulating hormone (TSH). A sudden, very high intake of iodine (well above the tolerable upper intake level of 500 µg/day) can lead to acutely triggered hyperthyroidism in individuals with existing functional autonomy, some of which may be undiagnosed. Functional autonomy particularly affects older people who were exposed to more severe iodine deficiency before the start of iodised salt prophylaxis.

Furthermore, chronic iodine deficiency can lead to an underactive thyroid gland with a reduced production of thyroid hormones in both adults and children (hypothyroidism). Slightly elevated TSH levels can be the first sign of this. Hypothyroidism can be accompanied by symptoms such as fatigue, weakness, reduced mental and physical performance, reduced basal metabolic rate with weight gain, slow heartbeat, dry and pale skin, brittle nails, apathy, concentration disorders, loss of appetite, constipation and depressive moods.

In children and adolescents, an underactive thyroid can result in delayed development in addition to reduced mental and physical performance. Studies have shown that treatment of mild to moderate iodine deficiency in children led to improved cognitive performances. Severe iodine deficiency during pregnancy increases the risk of miscarriages and stillbirths, and deformity. In children, it can result in dwarfism, deaf-muteness and delayed mental development (symptoms of so-called ‘cretinism’).

There is still insufficient research on the consequences of mild to moderate iodine deficiency during pregnancy. However, several studies show an association between mild iodine deficiency during pregnancy and decreased cognitive abilities in children.

What are the reasons for an excessive iodine intake?
“Iodine excess” usually denotes an intake of more than 1,000 µg of iodine per day. The reasons for an excessive iodine intake are often the use of contrast agents and drugs containing iodine, or the consumption of seaweeds especially rich in iodine.
Such a high intake is not possible only through the normal diet. Calculations based on consumption studies have shown that the dietary iodine intake is far below this value, even at high consumption levels and even if 100 percent of iodised table salt would be used in the food industry.

What health effects can excessive iodine intake have?
Depending on the dose and the sensitivity of the person, iodine excess can lead to the following health consequences:

- Hyperthyroidism in the presence of functional autonomy
- Hyperthyroidism in the presence of Graves' disease (autoimmune disease)
- Hyperthyroidism or Hypothyroidism in the presence of Hashimoto's thyroiditis (autoimmune thyroiditis)
- Acute blockade of iodine uptake in the thyroid gland (Wolff-Chaikoff effect) with or without hypothyroidism
- Rare oversensitivity reactions (for example, in patients with a very rare skin disease, Dermatitis herpetiformis Duhring).

Single high doses below 1,000 µg/day are usually tolerated by people with a healthy thyroid gland without side effects. The surplus of iodine is excreted via the urine.

Are there any groups of people who are particularly sensitive to a surplus of iodine (> 500 µg/day)?
Elderly people who were raised in times of iodine shortages, and who have therefore developed a functional autonomy, are considered as a risk group that is especially sensitive to a surplus of iodine. In order to protect sensitive consumers, the German Nutrition Society recommends limiting the total iodine intake from food and supplements for adults to 500 µg/day.

Can iodine deficiency prophylaxis lead to hyperthyroidism?
In countries where iodine deficiency prophylaxis was introduced in a relatively short period of time, increased but mostly temporary iodine-induced hyperthyroidism has been observed. This mainly affects older people who have been exposed to iodine deficiency for long periods of time and have therefore developed autonomous nodules in the thyroid gland that can produce thyroid hormones regardless of need. These so-called “hot” nodules may respond to increases in iodine intake with increased thyroid hormone production. Permanently exceeding the recommended maximum iodine value of 500 µg/day could therefore pose a health problem for older people with thyroid disease. Model calculations by the Max Rubner Institute (MRI) with the currently permitted maximum content of iodine in table salt (25 mg/kg) showed, however, that even with 100 percent use of iodised salt, more than 90 percent of the population (14 to 80 years of age) would not exceed the UL of 500 µg/day via food consumption.

The current iodine intake does also not pose a health problem to patients treated for hyperthyroidism due to Graves’ disease (autoimmune hyperthyroidism).

What is Hashimoto’s thyroiditis?
Hashimoto’s thyroiditis denotes an inflammation of the thyroid gland, which in its early stages leads to hyperthyroidism, but usually leads to hypothyroidism in the further course due to scarring and mostly regression of the thyroid tissue. This disease is the consequence of an autoimmune reaction and is facilitated by genetic factors. In the course of the disease, antibodies are formed against the own thyroid tissue and immune cells infiltrate the thyroid, leading to chronic inflammation of the thyroid. The constantly inflamed thyroid causes scarring with hypothyroidism.

Progression of this disease is very slow, so that hypothyroidism does not occur until years or decades after thyroid autoantibodies are first detected. However, a positive autoantibody titre

does not always lead to Hashimoto's disease and hypothyroidism, as it is equally possible that the function of the thyroid is maintained throughout life.

Is a low-iodine diet required for patients suffering from Hashimoto's thyroiditis?
Medical Societies neither recommend that patients suffering from Hashimoto's thyroiditis avoid consuming any iodine, nor that they follow a low-iodine diet. There is also no need to avoid iodised table salt. However, additional iodine intake, e.g. through iodine-containing food supplements, should be avoided.

Can iodine intake as part of iodine deficiency prophylaxis cause cardiovascular diseases?
Normal iodine intake as part of iodine deficiency prophylaxis does not lead to cardiovascular diseases; on the contrary, it even increases cardiovascular capacity. However, an already existing thyroid disorder with a deficiency or surplus of thyroid hormones can have negative effects on the cardiovascular system. In case of a hormone deficiency caused by hypothyroidism, amongst other things, the heart rate is slowed down and the diastolic blood pressure is increased; in contrast, hyperthyroidism with increased thyroid hormone levels can lead to cardiac dysrhythmia (increased heartbeat, tachycardia) and an increase in systolic blood pressure.

Can iodised salt trigger allergies?
An allergy is an oversensitivity reaction, which is based on stimulation of the immune system by an allergen. The iodine compounds used in iodised salt are molecules that are too small to act as allergens. Allergies can occur to other products containing iodine such as X-ray contrast media. However, in that case, it is the carrier to which the iodine is attached that acts as an allergen.

Can iodised salt cause 'iodine acne'?
'Iodine acne' is an intolerance reaction associated with skin changes, which only occurs when daily amounts of iodine in the milligram or gram range, i.e. far above the iodine intake based on iodine deficiency prophylaxis, are consumed. Such high iodine intakes can occur, for example, when medications containing iodine are taken.

This text version is a translation of the original German text which is the only legally binding version.