

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

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

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Iodine is a trace element which is necessary in the body for the production of thyroid hormones and thus for the control of a large number of metabolic processes. The iodine content of domestic agricultural products is not enough to guarantee a sufficient intake of iodine with food in Germany. The iodine supply of the German population was improved by the recommended measure from the mid-1980s to use iodised table salt in the food industry and artisanal food products, and in private homes. The increasing use of iodised animal feed, which resulted in higher iodine content in milk and dairy products, had also helped to improve the situation. However, current data show that the iodine intake of the population is still not optimal and/or demonstrates a declining trend. Continual long-term measures are therefore necessary to ensure that the German population has a sufficient iodine supply, and to prevent iodine deficiency.

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 requirement over an extended period of time, the thyroid gland will produce too little thyroid hormones, which can in turn lead to serious health consequences.

How much iodine does the body need?

The iodine requirement of a person varies from individual to individual, and also depends on different factors. These include age, environmental influences such as smoking, as well as high consumption of plant-based food which contain iodine-inhibiting substances (different types of cabbage, beans etc.). To meet the iodine requirement, the German Nutrition Society (DGE) e.V. recommends age-dependent iodine intakes of 40-80 µg per day for infants, 100-200 µg per day for children under 15, and 180-200 µg per day for adolescents and adults. A daily intake of 230 and 260 µg is recommended for pregnant women and breastfeeding mothers respectively. The European Food Safety Authority (EFSA) considers an intake of 70 µg per day to be adequate for infants (7-11 months old), 90-120 µg per day to be adequate for children aged 1-14 years, and 130-150 µg per day to be adequate for adolescents and adults. The EFSA considers a daily intake of 200 µg to be appropriate for pregnant women and breastfeeding mothers.

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

Which iodine intake amounts should not be exceeded?

According to the European Food Safety Authority (EFSA) a long-term intake of a maximum of 600 µg of iodine per day does not represent a health risk for adults. Lower tolerable upper intake levels (*ULs*) have been derived for children, taking their lower body weights into account: 200 µg per day for children aged 1-3, 250 µg per day for children aged 4-6, 300 µg per day for children aged 7-10, 450 µg per day for children aged 11-14, and 500 µg per day for children aged 15-17.

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

What pregnant women and breastfeeding mothers should consider?

Due to their particular metabolic condition, pregnant women and breastfeeding mothers have an increased iodine requirement. In order to avoid the risk of iodine deficiency and any 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-based foods, but the iodine content can vary considerably within a food category. It is influenced by geochemical conditions, as well as by the use of iodised table salt.

Sea fish is a good natural source of iodine, as are milk and dairy products, as long as the cows have been fed with iodised feed. Moreover, iodine is also mainly consumed via iodised table salt and foods made with it. If iodised salt is used in industrial foods, meat, sausages and bread are the main sources of iodine.

How high is iodine intake with and without the use of iodised salt in foods?

The average daily iodine intake *without* taking iodised table salt into consideration is around 100 µg for adolescents and adults in Germany. This is only equivalent to around half of the daily intake of 180-200 µg recommended by the German Nutrition Society (DGE) e.V. On average, the iodine intake recommendations of the DGE could only be achieved if around 50-80 percent of the foods consumed had been made with iodised salt. Meat, sausages and bread would then be the main sources of iodine. However, the proportion of foods made with iodised salt is actually much lower.

How can consumers ensure sufficient iodine intake through 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 iodized salt (pay attention to the labels!)

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 iodine deficiency. Vegetarians, vegans and persons who must keep to a special diet should therefore pay particular attention to a sufficient iodine supply. This also includes consumers who must avoid fish or dairy produce, due to an allergy to cow's milk or fish or because they suffer from lactose intolerance. Finally, pregnant women and breastfeeding mothers have a raised iodine requirement due to their particular metabolic situation, and should therefore ensure that they have a sufficient iodine intake and/or take 100-150 µg iodine per day in tablet form, after consultation with their gynaecologist.

Is the consumption of products from seaweed and kelp suitable to ensure an iodine intake as required?

The iodine contents in dried seaweed and kelp products can be especially high, because iodine concentrates in seawater and is stored by some types of seaweeds. Depending on the type of seaweed, iodine contents fluctuate considerably and are between 5 and 11,000 µg/g of dry weight. Brown seaweeds are especially rich in iodine, especially the Arame, Kombu, Wakame and Hijiki species.

Even if only small amounts of 1-10 g of seaweeds are eaten, the maximum tolerable intake quantity of 500 µg per day (which applies to adults) can be significantly exceeded. Due to the iodine surplus, detrimental health effects may occur, depending on the dose and the sensitivity of the consumer. Given their non-standardised iodine content, therefore, focused consumption of seaweeds is not a good way of ensuring adequate iodine intake.

Which factors influence iodine absorption in the body?

Various environmental influences, food components and some medications can interfere with the absorption of iodine or the production of thyroid hormones, whereby negative effects of these factors on the iodine metabolism are only to be expected when iodine intake is far below the recommended intake. .

As regards environmental factors, smoking is especially relevant. However, iodine metabolism can also be influenced by other nutrient deficiencies, especially selenium, zinc and iron.

In addition, a high intake of certain foods - such as cabbage and radishes, or corn and millet - can lead to decreased iodine absorption in the thyroid. The cause of the reduced intake is the substance thiocyanate, which is contained in cabbage and radishes. Corn and millet contain cyanogenic glycosides, which can be converted into thiocyanate in the body.

What is the iodine supply like in Germany?

One way of determining the iodine supply status of the population is based on iodine urine excretion. As around 85 to 90 percent of the amount of iodine consumed with food is excreted via the urine (the remaining 10 to 15 percent constitutes iodine loss via sweat and faeces), the daily iodine intake can be estimated using the daily iodine excretion amount. Representative data for the German population on the iodine urine excretion has 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 period 2003-2006 and 2014-2017) and 'Studie zur Gesundheit Erwachsener in Deutschland (Study on the Health of Adults in Germany)' (DEGS, data collection period 2008-2011).

The data shows that around 30 percent of adults included, and around 44 percent of children and adolescents included, demonstrate an iodine intake below the estimated average requirement. This means that there is an increased risk of iodine deficiency for these people. The estimated daily iodine intake for children and adolescents has fallen by 13 percent since the base data were gathered (2003-2006).

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 to 12, during a longitudinal study of infants, toddlers and school age children carried out in Dortmund over several years (Dortmund Nutritional and Anthropometric Longitudinally Designed Study; DONALD Studie).

Is iodised salt prophylaxis still necessary in Germany?

With regard to the iodine content of the soil, Germany is an iodine deficiency region. This means that the natural iodine concentrations in food alone are not sufficient to achieve a sufficient iodine intake. For this reason, iodised salt prophylaxis continues to be necessary in order to ensure a sufficient iodine supply in the population.

The iodine intake in Germany has significantly improved thanks to the introduction of iodine deficiency prophylaxis in the mid-1980s, which recommended the use of iodised table salt in the food industry, artisanal food and private homes. The increasing use of iodised animal feed, which resulted in higher iodine content in milk and dairy products, also helped to improve the situation. However, current data from the Robert Koch Institute (DEGS and KiGGS) now show that the iodine intake of the German population is decreasing again.

The data from a recent market survey by the University of Gießen from 2019 also suggests that the use of iodised table salt in the food industry and artisanal food products is decreasing. Therefore, awareness of the health benefits of a sufficient iodine supply should be raised again and kept up an interest, as part of information and education campaigns aimed at consumers and food manufacturing businesses. However, consumer concerns and fears should also be addressed appropriately, and manufacturing businesses should be encouraged to accept the use of iodised salt.

How safe is iodised salt?

The iodine quantity which may be added to salt is legally regulated and amounts to 15 to 25 mg/kg. This quantity is chosen in such a way that the salt does not pose health risks to

healthy individuals or those suffering from thyroid disorders. Compliance with legally prescribed concentrations is supervised by the food monitoring authorities.

How prevalent is the use of iodised salt in the food industry?

The data from a recent market survey by the University of Gießen from 2019 suggests that the use of iodised table salt in processed foods is decreasing. In recent years, the use of iodised salt in the butcher sector, and especially in the baking sector, has decreased greatly. Currently, iodised salt is only used in 10 percent of industrially produced breads and baked goods containing salt. Up to 47 percent iodised salt is used in industrially produced salted meats and meat products.

How much iodine is there in milk?

The iodine content of milk has risen in recent years, due to the use of iodised animal feed. Conventional milk contains around 120 µg iodine per litre (although the concentrations can fluctuate greatly). Conventional milk and dairy products can therefore be seen as good sources of iodine.

Do organic foods contain iodine?

The use of iodised salt is permitted by most organic farming associations. If iodised salt is used, it must be declared. Animal feed which contains iodine is also permitted by most organic farming associations. Certainly, iodised salt is only rarely used in organic food production and organic milk therefore only contains around two-thirds of the iodine quantity that conventionally produced milk contains. Anyone who regularly consumes organic milk and other organic products should meet their iodine requirement via other foods (consumption of sea fish, use of iodised salt at home and favouring foods made with iodised salt).

How can consumers determine whether or not food has been produced with iodised salt?

When purchasing packaged food, 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 they contain iodised salt.

What should consumers who want to or have to restrict their salt intake take into account?

Patients with high blood pressure who want to or have to restrict their salt intake should take the consumption of foods with higher iodine contents into account, such as sea fish (1 to 2 per week) or milk and dairy products. Iodised salt should be used if possible, even with a reduced salt intake. 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 iodine concentration in urine (see table).

WHO classification of iodine supply, based on excretion of iodine in urine		
Median iodine urine concentration [$\mu\text{g/l}$]	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 requirements	likely adequate intake for pregnant women and breastfeeding mothers, but may contain a slight risk of more than adequate intake in the general population
≥ 300	excessive	Risk of adverse consequences to health (iodine-induced hyperthyroidism, autoimmune thyroid disorders)
Pregnant women		
<150	insufficient	
150 - 249	adequate	
250 - 499	over the required amount	
≥ 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 breastmilk.

According to *World Health Organization (WHO, 2007)*, modified.

In adults, chronic iodine deficiency can result in the development of goitre either with or without nodules. Non-visible functional disorders of the thyroid are also common. Among those is hypothyroidism, which leads to reduced hormone production. Hypothyroidism can be associated with the following symptoms: Fatigue, weakness, reduced mental and physical ability, low metabolism with weight gain, slower heartbeat, dry and pale skin, brittle nails, apathy, concentration difficulties, loss of appetite, constipation and depressive moods.

In children and adolescents, iodine deficiency can lead to struma diffusa (goitre, enlargement of the thyroid) and the development of hypothyroidism. Other possible consequences of iodine deficiency include lowered mental capacity and delayed physical development. Studies have shown that treatment of mild to moderate iodine deficiency in children has led to improved cognitive performances.

Severe maternal iodine deficiency during pregnancy increases the risk of miscarriages and stillbirths, and deformity. In children it can lead to short stature, deaf-muteness and delayed mental development (symptoms of so called 'cretinism'). Such a marked iodine deficiency does not exist among the German population, due to improved iodine intake.

There is still less research on the consequences of mild to moderate iodine deficiency during pregnancy. However, several studies have shown an association between a mild iodine deficiency during pregnancy and reduced cognitive abilities in children.

What are the reasons for an iodine excess?

'Iodine excess' usually denotes an intake of more than 1000 µg of iodine per day. The reasons for excessive iodine intake can be the use of contrast agents and medications containing iodine or the consumption of seaweeds especially rich in iodine.

Such a high intake is not possible purely through a normal diet. Calculations based on consumption studies have shown that the iodine intake is far below this value even at high consumption levels and even if 100% iodized table salt would be used in the food industry.

What health effects can iodine excess have?

Depending on the dose and the sensitivity of the person, iodine excess can lead to the following symptoms:

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

Single high doses under 1,000 µg per day are usually tolerated without any side effects by people who do not suffer from any thyroid disorders. The surplus of iodine is excreted via the urine.

Are there groups of persons who are especially sensitive to a surplus of iodine (> 500 µg per day)?

Elderly people who were raised in times of iodine shortages, and who have therefore developed functional autonomy, are seen as a risk group that is especially sensitive to a surplus of iodine. In order to protect sensitive consumers, the German Nutrition Society therefore recommends limiting the total iodine intake from food and supplements for adults to 500 micrograms per day.

Can iodine deficiency prophylaxis lead to hyperthyroidism?

In countries where iodine deficiency prophylaxis was introduced in a relatively short period of time, iodine-induced hyperthyroidism was increasingly observed, but mostly only temporarily. Affected persons are mainly the elderly who have been exposed to iodine shortages for long periods of time, and who have therefore developed autonomous nodules which react to slight increases of iodine intake with an increase in the production of thyroid hormones. Permanently exceeding the recommended maximum level of 500 micrograms of iodine per day could therefore be a problem for elderly people suffering from thyroid disorders. Calculations have shown, however, that this maximum value is not exceeded in Germany even in case of maximum use of iodised table salt.

The current average iodine intake does not pose a problem even for patients who are receiving treatment for hyperthyroidism due to Graves' disease (autoimmune hyperthyroidism).

What is Hashimoto's thyroiditis?

Hashimoto's thyroiditis denotes an inflammation of the thyroid which generally leads to hyperthyroidism in its early stages, and later to hypothyroidism due to scarring of the thyroid tissue. This disease is the consequence of an autoimmune reaction and is facilitated by genetic factors. Over the course of the disease, antibodies against the own thyroid tissue first cause an infiltration of the thyroid with defence cells and an inflammatory reaction, and then scarring with hypothyroidism.

Progression of this disease is very slow, meaning that hypothyroidism only occurs years or decades after the first detection of thyroid autoantibodies. 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 preserved for life.

Is a low-iodine diet required for patients suffering from Hashimoto's thyroiditis?

Medical societies do not recommend iodine renunciation or a diet low in iodine for patients suffering from Hashimoto's thyroiditis. There is also no need to avoid iodised table salt. However, additional iodine intake, e.g. through iodine-containing food supplements and vitamin preparations, should be avoided.

Can the iodine intake as part of iodine deficiency prophylaxis cause cardiovascular disease?

Normal iodine intake as part of iodine deficiency prophylaxis does not lead to cardiovascular diseases; on the contrary, it even increases performance capacity. However, an already existing thyroid disorder with a deficiency or excess 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; 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. There is therefore no such thing as an iodine allergy. However, patients may develop allergies to products containing iodine, such as x-ray contrast agents. But, 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 quantities of iodine in the milligram or gram range - and therefore far above the iodine intake based on iodine prophylaxis - are consumed. However, iodine intake in this quantity can occur, for example, when medications containing iodine are taken.

You can find further information on the BfR website: www.bfr.bund.de

A-Z index: Iodine, https://www.bfr.bund.de/de/a-z_index/jod-4600.html

Information sheet for doctors: Iodine, folate/folic acid and pregnancy, <https://www.bfr.bund.de/cm/350/jod-folat-folsaeure-und-schwangerschaft.pdf>

Topic page: Assessment of vitamins and minerals in foods,
https://www.bfr.bund.de/de/bewertung_von_vitaminen_und_mineralstoffen_in_lebensmitteln-54416.html

About the BfR

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