German Federal Institute for Risk Assessment

FAQ

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Cadmium in food: What is known about intake and health risks?

Cadmium is a component of the Earth's crust. It can be released into the environment naturally or through human activity, and then enters plants and animals, and thus also our food chain. For the non-smoking population, food is the main source of cadmium intake. Smokers are additionally exposed to cadmium through the inhalation of tobacco smoke.

Exposure to cadmium is associated with a wide range of health effects. In the context of dietary intake, the focus is on the long-term effects: The kidneys are particularly sensitive to cadmium, as cadmium accumulates there and can impair kidney function upon long-term exposure. Furthermore, cadmium can lead to bone demineralisation.

The European Food Safety Authority (EFSA) has derived a health-based guidance value (Tolerable Weekly Intake, TWI) for cadmium of 2.5 micrograms per kilogram of body weight.

For the majority of the population in Germany, dietary cadmium intake is below the health-based guidance value. However, cadmium intake may be higher in certain population groups. For example, depending on the foods consumed, exposure in children of certain age groups exceeds the health-based guidance value.

To reduce consumers' cadmium intake via food as much as possible, there are legal requirements such as Regulation (EU) 2023/915 of the European Commission on maximum levels for certain contaminants in food.

The German Federal Institute for Risk Assessment (BfR) has compiled the following selected questions and answers on the subject of cadmium.

What is cadmium and how does it enter the food chain?

Cadmium occurs naturally in the Earth's crust, but its occurrence is relatively rare there. It is usually found as a mineral alongside other elements such as lead, zinc and copper. Natural processes such as rock weathering and volcanic eruptions contribute to the release of cadmium into the environment.

Cadmium can also enter the environment through human activities. Cadmium is used in industry primarily in batteries, but also in pigments, coatings, stabilisers for plastics, non-ferrous alloys and photovoltaic equipment. It enters the air, soil and water via the smelting of other metals, the use of fossil fuels, waste incineration and the application of phosphate fertilisers and sewage sludge. Cadmium compounds in the air are stable and can be transported over very long distances, eventually reaching the Earth's surface.

In addition to soil and water, cadmium also enters the food and feed chain via forage crops. Food-producing animals take up cadmium via forage plants and soil particles adhering to them. Accumulation occurs particularly in offal such as liver and kidneys. Intake from plankton and water leads to the accumulation of cadmium in mussels and crustaceans and thus to its entry into aquatic food chains.

Cadmium is an environmental contaminant and is not intentionally added to food or feed.

What are the known routes of exposure to cadmium?

Cadmium can be taken up via the respiratory tract (inhalation), through the skin (dermal exposure), and via the mouth (oral exposure).

Cadmium can be taken up by inhalation, particularly through smoke from cigarettes, cigars or pipes (active and passive smoking), as well as through occupational exposure (for example, in metalworking), whilst absorption through the skin is negligible for the general population.

Cadmium intake in the non-smoking general population occurs mainly via the mouth (orally), primarily through food. However, cadmium can also be ingested via house dust or soil, particularly in young children who are crawling ('hand-to-mouth behaviour').

Which foods have particularly high cadmium concentrations, and which ones contribute considerably to cadmium intake?

The amount of cadmium that enters a food crop and thus certain foods depends primarily on regional conditions, such as how much cadmium is present in the soil in an agricultural region and how readily it can be taken up by the plants. The latter is linked, among other things, to soil conditions, such as the pH value.

In the BfR-MEAL study, porcini mushrooms, cocoa powder, sunflower seeds, linseeds and seaweed were among the plant-based foods with the highest concentrations. Cadmium can enter livestock via feed and then accumulate mainly in their offal, particularly in the liver and kidneys. In addition to plant-based foods, animal food products can therefore also have higher cadmium concentrations. In the BfR-MEAL study, alongside the offal mentioned above, squid and mussels were also among the animal food products with the highest cadmium concentrations.

However, when estimating total intake, it is not only the concentration but also the quantity consumed that plays a role. Thus, even foods with lower cadmium concentrations but high long-term consumption volumes can contribute considerably to total intake. On average, 'grains and grain products' make the highest contribution to cadmium intake across all age groups, accounting for 40% to 50%. These are primarily wheat products, such as white bread or rolls, pasta, wholemeal and brown bread. However, potatoes are also among the top three foods contributing most to cadmium exposure in all age groups considered. The main group "potatoes and potato products" accounts for the second-highest proportion of exposure, at 13% to 15%. Although wheat and potato products do not have the highest concentrations of cadmium, cadmium intake results from the large amounts by which they are consumed by the general population.

Among children, those who eat spinach or creamed spinach take up the most cadmium. Spinach is among the ten foods with the highest concentrations according to the BfR-MEAL study. Creamed spinach has slightly lower concentrations due to the other ingredients, but is consumed much more frequently.

What are the potential health effects of cadmium exposure?

The non-smoking population mainly takes up cadmium through food. With regard to the potential health effects of this cadmium intake, the focus is on long-term effects.

Cadmium intake via the intestine is relatively low in humans (1–10% of the ingested amount). The cadmium absorbed in this way accumulates particularly in the kidneys and liver. Cadmium has a very long biological half-life of 10 to 30 years and is therefore excreted slowly.

Cadmium intake is associated with a wide range of health effects. The kidneys are particularly sensitive to cadmium; cadmium accumulates there and, upon long-term exposure, can impair kidney function. Furthermore, cadmium can lead to bone demineralisation.

The bioavailability and accumulation of cadmium, and consequently its toxicity, are influenced by various factors. For example, a deficiency in certain essential elements such as iron can promote the intake of cadmium in the body. It is therefore particularly important to ensure an adequate supply of iron.

Are there health-based guidance values for the assessment of cadmium exposure?

The BfR uses the TWI, derived by the European Food Safety Authority (EFSA) in 2009, for the health risk assessment of cadmium intake via food. The TWI is a health-based guidance value and represents the amount of a substance that can be consumed on a weekly basis over an entire lifetime without an appreciable health risk. Based on the cadmium-induced increase in a marker of kidney damage, EFSA derived a TWI for cadmium of 2.5 micrograms per kilogram of body weight per week (µg/kg body weight per week).

What is the level of exposure to cadmium among consumers via food?

The BfR has carried out an exposure assessment based on the National Total Diet Study (BfR-MEAL study) in order to assess the health risks associated with dietary cadmium intake among the population in Germany. For the majority of the population, cadmium intake is below the health-based guidance value of 2.5 µg/kg body weight per week. However, for certain population groups, the exposure to cadmium based on occurrence data from the MEAL data is higher. For example, depending on the foods consumed, exposure in children of certain age groups exceeds the TWI (Reference: MEAL opinion).

What is being done to reduce the concentration of cadmium in food?

Due to its presence in the environment, the entry of cadmium into food cannot be completely avoided and can only be reduced through long-term measures. To this end, extensive regulations have already been introduced by the Federal Government, the state authorities and at European level. These restrict the use of cadmium in industry and agriculture to protect consumers and the environment. In addition, EU-wide maximum levels for cadmium have been set for numerous foods. Different maximum levels apply depending on the foodstuff. For cadmium, for example, a maximum level of 0.050 mg per kg of fresh weight has been set for pork. For rice, quinoa, wheat bran and wheat gluten, a maximum level of 0.15 mg per kg of food applies. In Germany, compliance with these maximum levels is monitored in the individual federal states.

All maximum levels for specific contaminants in food, as laid down by the European Commission in Regulation (EU) 2023/915, can be found here.

Cadmium can also be introduced into agricultural soil via fertilisers and subsequently enter the crops grown on that land, as well as the food or feed produced from them. To reduce this contamination, the German Fertiliser Ordinance has set a limit value for cadmium in phosphate-containing artificial and natural fertilisers. This limit value is 50 milligrams (mg) of cadmium per kilogram (kg) of P_2O_5 (phosphorus pentoxide).

What can consumers do to reduce their cadmium exposure through food?

Legislation is intended to ensure that the presence of undesirable substances in food is minimised. As cadmium is released through natural processes and also through human activities and enters the food chain, its occurrence in food cannot be completely avoided. Consumers have few options for actively reducing their cadmium intake themselves. Following the recommendations below can help to keep the intake of undesirable substances, such as cadmium, as low as possible:

- Consume offal from wild animals only occasionally (for example no more than every two to three weeks.), with the exception of wild boar liver: avoid consuming wild boar liver, as it may contain comparatively high concentrations of other undesirable substances, in particular per- and polyfluoroalkyl substances (PFAS)
- Consume wild mushrooms only occasionally or, if consumed regularly, in smaller amounts (200–250 g per week). Children should eat less depending on their body weight

- A diverse, varied and colourful selection of foods helps to limit exposure and also ensures a balanced nutrient intake.

You can also find this consumer tips on health and food safety on the website of the Federal Ministry for the Environment, Climate Action, Nature Conservation and Nuclear Safety (BMUKN).

Can cadmium leach from ceramic tableware and migrate into food?

Glazes and decorations on ceramic tableware – such as earthenware or porcelain – may contain heavy metals such as lead, cadmium and cobalt. These substances can leach out of the ceramic, a process known as element leaching.

The amount of heavy metals that migrate into food depends on various factors: the quality of the glaze (for example, the purity of the raw materials, the thickness of the glaze, and the temperature at which the ceramic was fired), the method of applying the decoration, the type of food, and the conditions of contact (for example, the temperature and duration of contact). The limit values for the release of cadmium are regulated by the European (Ceramics) Directive (84/500/EEC).

In 2020, the BfR carried out a health risk assessment of data from regional authorities on cadmium leaching from heavily decorated ceramic plates. In doing so, the BfR derived tolerable surface-area-based leaching limits for various elements (including cadmium). The results showed that more than two-thirds of the samples had cadmium release levels below the tolerable area-based release limits. However, some plates released too much cadmium. Further information on the assessment results for cadmium from ceramic tableware can be found here.

Is there a health risk posed by cadmium in baby and toddler food?

In 2015, the BfR conducted an assessment of the concentrations of lead and cadmium in infant and children's food based on occurrence data from the 2015 Federal Control Plan (BÜp) and the 2015 Monitoring.

The BfR concluded that, in the case of the products tested in the categories 'baby formula in powder form' and 'ready-to-eat baby formula', as well as 'processed cereal-based foods in powder form' and 'ready-to-eat processed cereal-based foods' no health impairment through cadmium is likely. This applies to children in the 0.5 to under 3 years age group, both for average and high consumption.

Further information on cadmium

Opinion on the BfR MEAL study on cadmium in food
https://www.bfr.bund.de/en/opinions/bfr-meal-study-on-cadmium-in-food/

Ceramic crockery: BfR recommends lower release of lead and cadmium

https://www.bfr.bund.de/cm/349/ceramic-crockery-bfr-recommends-lower-release-of-lead-and-cadmium.pdf

EU maximum levels for cadmium in food for infants and young children sufficient
https://www.bfr.bund.de/cm/349/eu-maximum-levels-for-cadmium-in-food-for-infants-and-young-children-sufficient.pdf

About the BfR

The German Federal Institute for Risk Assessment (BfR) is a scientifically independent institution within the portfolio of the German Federal Ministry of Agriculture, Food and Regional Identity (BMLEH). It protects people's health preventively in the fields of public health and veterinary public health. The BfR provides advice to the Federal Government as well as the Federal States ('Laender') on questions related to food, feed, chemical and product safety. The BfR conducts its own research on topics closely related to its assessment tasks.

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