Zinc (Zn)

Food:

	mg/100g
Mussels boiled	2.20
Egg boiled	1.63
Cheese 30+	4.47
Cashew nuts	5.80
Green beans boiled	0.37
Beef steak prepared	5.53

(Dutch Food Composition Database, NEVO)

Main functions:

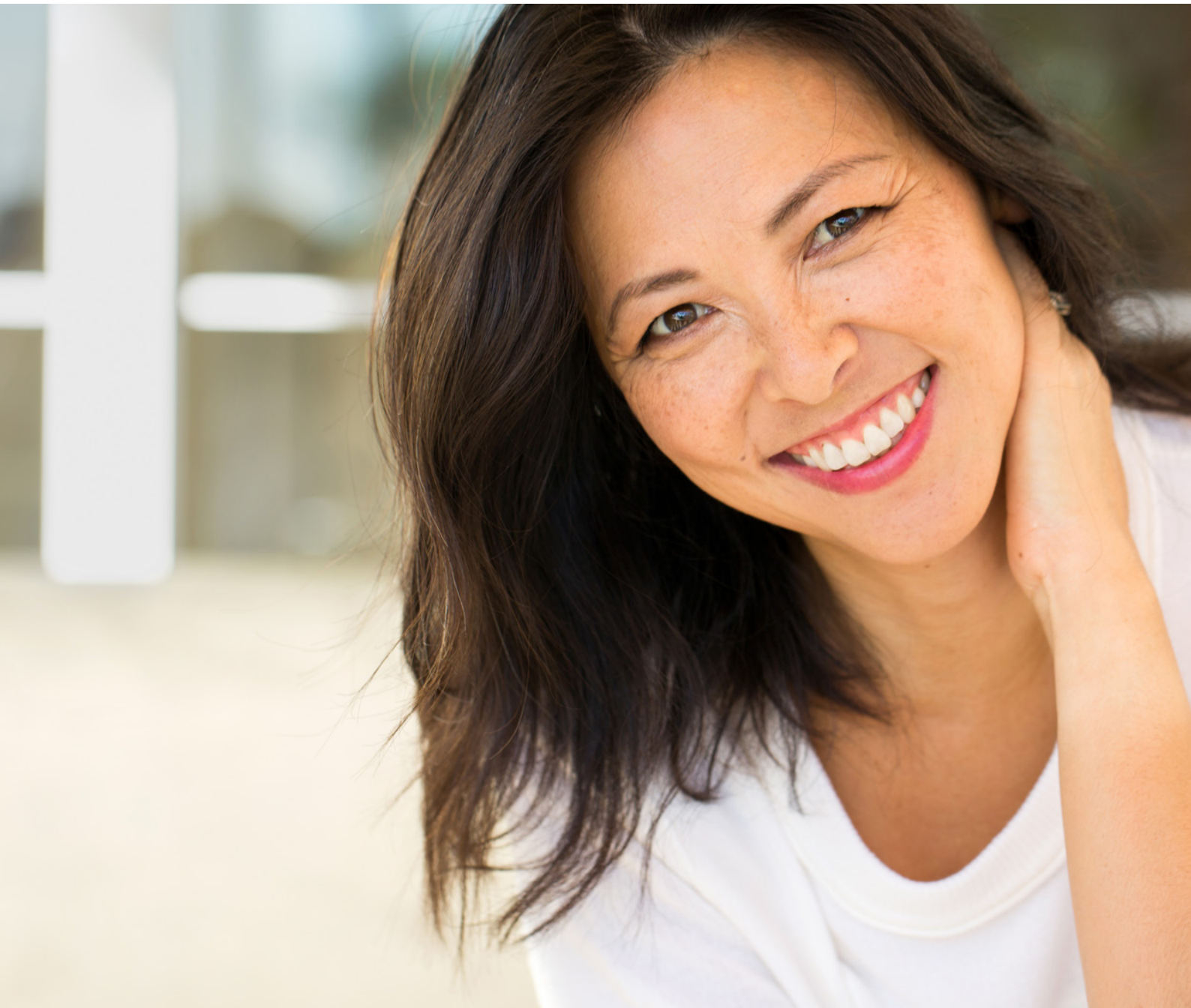
A sufficient dietary intake of zinc is important as it supports the body in:

- Immune function
- Protein synthesis
- Wound healing
- DNA synthesis
- Cell division
- Normal growth and development during pregnancy, childhood, and adolescence

For scientific sources, please contact **info.nutritionscience@dsm.com.**

Zinc (Zn)

Zinc is the second most common trace mineral in the body after iron and is present in every living cell. It is involved in many different functions including the immune system, fertility and reproduction, as well as the maintenance of normal bones, skin, vision, hair, and nails. Although severe zinc deficiency is rare, mild to moderate cases are quite common throughout the world – particularly in developing countries where zinc deficiency is regarded as a public health issue.



Functions

An essential building block for life, zinc plays a vital role in growth and development, the immune response, neurological function, and reproduction. On a cellular level, zinc is involved in a diverse range of functions:

- Many different enzymes depend on zinc for their ability to increase the speed of vital chemical reactions in the body
- Many proteins contain zinc fingers (zinc finger proteins) in which zinc plays an important role contributing to the stability of the protein structure. Zinc fingers are abundant and present among proteins that perform a broad range of functions in various cellular processes.
- Zinc-stabilized proteins have been found to regulate gene expression by acting as 'transcription factors'; binding to DNA and influencing the expression of specific genes
- Zinc also plays a role in cell signaling and has been found to influence hormone release and nerve impulse transmission, such as tasting and smelling
- In addition, zinc has been found to play a role in programmed cell death (apoptosis), regulating cellular growth and development, as well as a number of chronic diseases

The **European Food Safety Authority (EFSA)**, which provides scientific advice to assist policy makers, has confirmed that clear health benefits have been established for the dietary intake of zinc in contributing to:

- The maintenance of normal vision
- The maintenance of normal bones
- The maintenance of normal serum testosterone concentration
- The maintenance of normal skin, normal hair, and normal nails
- Normal function of the immune system
- Normal cognitive function
- Normal fertility and reproduction
- Normal metabolism of fatty acids, normal carbohydrate metabolism, and normal macronutrient metabolism
- Normal acid-base metabolism
- Normal metabolism of vitamin A
- Normal protein synthesis
- Normal DNA synthesis and cell division
- The protection of cell constituents from oxidative damage

Dietary sources

An essential nutrient, zinc is found in a wide variety of animal and plant foods. The best dietary sources are oysters, red meats, poultry, cheese (e.g. ricotta, Swiss, Gouda), shrimp, crab, and other shellfish. Other good – though less easily absorbed – sources include legumes (especially beans, peas, soybeans, and peanuts), whole grains, tofu, brewer's yeast, cooked greens, mushrooms, green beans, pumpkin, and sunflower seeds.

Absorption and body stores

Bioavailability refers to the proportion of the intake that can be absorbed into the bloodstream and used by the body. Zinc bioavailability from a mixed or vegetarian diet is estimated to be 18–34%. Zinc from animal foods like red meat, fish, and poultry is more readily absorbed by the body than zinc from plant foods. This is due to the presence of certain amino acids (cysteine and methionine) that improve its absorption. Secondly, phytic acid, found in plant-based foods, plays a major role. Phytic acid strongly binds zinc in the intestines and thereby inhibits its absorption. Phytase is an enzyme that has been shown to increase absorption of zinc when added to plant-based foods. It also provides additional benefits regarding phosphorus, calcium, iron and amino acids. Phytase significantly decreased iron and zinc deficiency in children.

The human body contains approximately 3 g of zinc, the highest concentrations of which are located in the prostate gland and the eye.

Physiological interactions

- Minerals in plant-based foods are often bound to phytic acid. Phytase is an enzyme that has been shown to release the bound minerals from phytic acid to make them available for absorption. Therefore, phytase improves zinc absorption when added to plant-based foods.
- The bioavailability of dietary vitamin B9 (folate) is increased by the action of a zinc-dependent enzyme, suggesting a possible interaction between zinc and folic acid.
- Zinc is a component of a vitamin A (retinol)-binding protein, necessary for transporting vitamin A in the blood.
- Zinc is also required for the enzyme that converts retinol (the form of vitamin A in animal food sources) to retinal, which is necessary for the synthesis of a protein in the eye (rhodopsin) that absorbs light and thus is involved in dark adaptation.

Deficiency

Globally, 15-20% of the population is at risk for zinc deficiency due to dietary inadequacy. Zinc deficiency is characterized by a range of symptoms, depending on the severity. These include loss of appetite, poor growth, weight loss, lack of taste or smell, poor wound healing, skin problems (such as acne and psoriasis), hair loss, lack of menstrual periods, night blindness, white spots on the fingernails, and depression.

Individuals at increased risk include infants and children – particularly those living in developing countries – as well as pregnant and breast-feeding women. Low zinc levels are also sometimes seen in the elderly, alcoholics, people with anorexia or other form of malnourishment. A vegetarian or vegan diet may be of concern for a possible shortage of zinc intake as animal-derived foods are the richest and most bioavailable sources of this micronutrient.

Possible reduction of disease risk factors

Retarded growth

Marked growth retardation in children is a common feature of mild zinc deficiency and is particularly evident in developing countries. Reduced zinc intake by expectant mothers has been linked to decreased attention spans in newborn babies and poorer motor skills at six months. Better coordination in underweight babies and more energetic movement in very young children have been achieved through zinc supplementation. Adequate zinc supply is vital for normal development and growth throughout pregnancy, childhood, and adolescence.

Impaired immune system function

Sufficient zinc supply is important for maintaining immune system function. Individuals exhibiting a zinc deficiency are often more prone to various infectious diseases, such as pneumonia, diarrhea, and (in children) malaria. Research suggests that zinc supplementation for children could be beneficial in reducing the severity, duration or occurrence of some of these conditions, although the results are largely inconclusive. Some studies also suggest that levels of immune cells among the elderly increase with zinc supplementation, although others have observed no effect. More research is needed before any recommendations can be made.

Pregnancy complications

Several pregnancy complications have been linked to poor zinc status among expectant mothers. These include pre-term birth, low birth weight, labor and delivery problems, and abnormalities in developing fetuses. There have been mixed results from trials where expectant mothers have been given zinc supplements. Some studies noted increased birth weight and reduced incidence of premature birth with supplementation of zinc, others showed no discernible effects. So further clarification through additional studies is required.

Age-related macular degeneration

The amount of zinc present in the retina (part of the eye that receives the image formed by the lens and converts into nervous signals which reach the brain) decreases with age. Zinc is therefore thought to be an important factor in the onset of age-related macular degeneration (AMD). This is where the part of the retina responsible for central vision begins to deteriorate. Zinc, vitamin C, vitamin E, beta-carotene, and copper were found to slow the development of AMD in a large-scale clinical trial. However, some studies have observed no effect with zinc supplementation. So, more research is needed to clarify the effects on AMD.

The common cold

Evidence is mixed, but many people believe that zinc lozenges or zinc nasal sprays can reduce the duration and severity of colds if used consistently from when they first notice symptoms. More high-quality research is required before conclusions can be drawn as to the effectiveness of zinc against certain strains of the common cold.

Diabetes

People who suffer from diabetes may often exhibit a moderate zinc deficiency. More studies are needed, however, before zinc supplementation can be prescribed for diabetics.

HIV infection / AIDS

People diagnosed with HIV are more likely to exhibit a deficiency of zinc, which is vital for maintaining normal immune responses. A more advanced stage of the illness as well as an increased mortality rate have been associated with low blood levels of zinc in HIV-positive people. Ascertaining optimal zinc supply levels for people with HIV will require studies.

Recommended Daily Intake (RDI)

European health authorities recommend zinc intakes for adults of 9.5 mg/day for males and 7 mg/day for females. In the U.S., the recommended intake for adults has been set at 11 mg/day for men and 8 mg/day for women. However, the requirements for dietary zinc may be as much as 50% greater for strict vegetarians whose major food staples are grains and legumes because high levels of phytic acid in these foods reduce absorption.

Recommended daily intakes (RDI)

Group	Life stage	Dose/day*
Infants	<6 months	2 mg**
Infants	7-12 months	3 mg
Children	1-3 years	3 mg
Children	4-8 years	5 mg
Children	9-13 years	8 mg
Males	14-18 years	11 mg
Females	14-18 years	9 mg
Males	>19 years	11 mg
Females	>19 years	8 mg
Pregnancy	<18 years	12 mg
Pregnancy	>19 years	11 mg
Breastfeeding	<18 years	13 mg
Breastfeeding	>19 years	12 mg

** Institute of Medicine (2001)*

*** Adequate intake (AI)*

If not otherwise specified, this table presents RDIs.

Safety

When consuming zinc from dietary sources or fortified foods, zinc overload is very rare. Isolated outbreaks of acute zinc overload have occurred as a result of the consumption of food or beverages contaminated with zinc released from galvanized containers. Recognized signs of acute zinc overload are abdominal pain, diarrhea, nausea, and vomiting, while milder gastrointestinal distress has been reported following high doses of supplemental zinc (50-150 mg/day).

European health authorities have defined safe upper intake levels of 25 mg/day for adults, as well as pregnant and breast-feeding women. In the U.S., the tolerable upper intake level for zinc has been set at 40 mg/day for adults. In all cases, any dietary or drug treatment with high-dosed micronutrients needs medical supervision.

Supplements and food fortification

The WHO/UNICEF recommends the use of zinc supplementation in combination with oral rehydration solution when treating children with diarrhoea. Studies have also suggested that zinc supplements may reduce the incidence of respiratory infections in children. A number of zinc supplements are available, including zinc acetate, zinc gluconate, zinc picolinate, and zinc sulfate. Zinc picolinate has been promoted as a more absorbable form of zinc, but there are few data to support this idea in humans. Due to the potential for interactions, however, dietary supplements should not be taken with medication without first talking to an experienced healthcare provider. In addition to supplementation, food fortification, dietary diversification and decreasing the consumption of absorption-inhibiting foods, like dietary fibre and phytates, are also examined as possible pathways to reduce zinc deficiency. So far, zinc fortification has been fairly limited. It is added to some infant formula milks, complementary foods, ready-to-eat breakfast cereals, and wheat noodles. There is also an increasing interest in fortifying cereal flours with zinc.