

zinc

FACT SHEET



Importance for health

Immune system

Zinc plays an important role in cellular processes, such as the humoral and cell-mediated immune defence. The normal activity of special immune cells and biological activity in a series of lymphokines can only be maintained when zinc is present in effective concentrations.^{1,2} Some studies have demonstrated a relationship between zinc intake and reduction in the length and severity of a cold. For example, Prasad et al. showed that symptoms only lasted 4.5 days in a group of 48 persons taking about 24 mg zinc daily for a 12-day period compared to 8.1 days in the control group.³

Skin health

The process of wound healing consists of various stages of tissue reconstruction. During the inflammatory process, special immune cells remove bacteria from the wound and further cells are needed in the growth of new tissue. Zinc is thought to have a beneficial role in new cell formation.⁴

Bone health

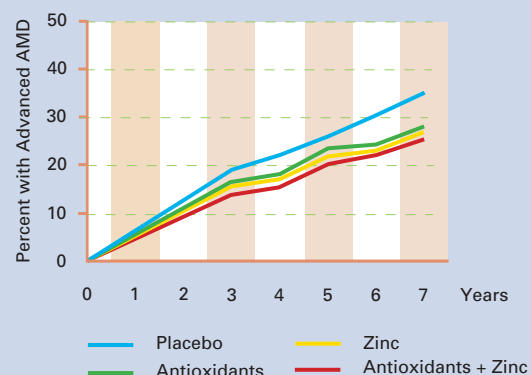
Zinc is contained in crystals forming bone matrix and is required to stimulate bone formation and inhibit bone decomposition. It is probable that zinc, in combination with calcium, has a positive influence on osteoporosis risk.⁵ This is particularly the case for growing children due to zinc's importance in "peak-bone-mass". For elderly women, particularly those affected by osteoporosis, who have lower serum zinc levels and higher urinary excretion rates, this relationship is also particularly important.¹ For example, a Swedish study has shown that low phosphorus and zinc intakes in middle-aged and elderly men showed increased fracture risk.⁶ Due to poorly balanced diets and worse absorption, the risk of deficiency increases in the elderly; in the USA 75% of people aged 60-90 years did not meet dietary zinc recommendations.⁵ In Europe about 414,000 hip and 1,400,000 vertebral (spinal) fractures are estimated to occur each year.⁷

Eye health

760 per 100,000 people in Europe suffer from visual impairment.⁷ The results of research into the role of zinc in AMD and dark adaptation have been inconclusive. It is known for certain, however, that the retina contains a high concentration of zinc compared to other human tissues, which assists the normal functioning of the retina. Furthermore, it seems likely zinc plays a role in the phototransduction process, so that deficiency may result in night-blindness and poor dark adaptation. The apparent positive influence of zinc on AMD may be explained by the lower zinc concentration in the retinal pigment epithelium in persons affected by AMD.⁸

In the AREDS report, the relation between high dose intake of antioxidants or zinc (80 mg) or a combination of both on AMD and visual acuity was examined in 3640 persons for 6.3 years. The positive effect of visual acuity was only statistically significant in the group treated with zinc and antioxidants. After treatment a risk reduction for AMD of 17% compared to placebo was noted for antioxidants, and 21% for those taking zinc. The greatest risk reduction, about 25% was associated with subjects taking antioxidants and zinc (see Figure 1). Therefore a combination of zinc and antioxidants might be an effective treatment in severe AMD.⁹

Figure 1: Risk of Developing Advanced AMD¹⁰



1 Biesalski HK et al. Vitamine, Spurenelemente und Mineralstoffe. (Thieme Verlag, Stuttgart, 2002) 151-160, 326-336, 486, 497-506.
2 Bogden JD, Klevay LM. Clinical nutrition of the essential trace elements and minerals: The guide for health professionals.) Humana Press, New Jersey 10, (2000) 107, 123, 186, 243, 289.

3 Prasad AS et al. Duration of symptoms and plasma cytokine levels in patients with the common cold treated with zinc acetate. Ann Intern Med. 133, 4 (2000) 245-252.

4 Scholl D, Langkamp-Henken B. Nutrient recommendations for wound healing. Journal of Intravenous Nursing, 24, 2 (2001) 124-132.

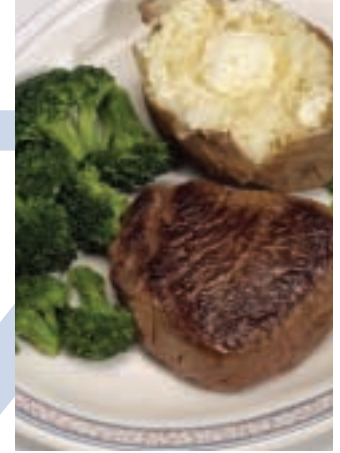
5 Lowe NM et al. Is there a potential therapeutic value of copper and zinc for osteoporosis? Proceedings of the Nutrition Society, 61, 2 (2002) 181-185.

6 Elmstahl S et al. Increased incidence of fractures in middle-aged and elderly men with low intakes of phosphorus and zinc. Osteoporos Int, 8 (1998) 333-340.

7 Godfrey D, Richardson D. Vitamins and minerals for health. British Food Journal, 104, 11 (2002) 913-933.

8 Ugarte M, Osborne NN. Zinc in the retina.

Progress in Neurobiology, 64 (2001) 219-249.



Bioavailability

The low absorption rate for zinc of about 15-40% is characteristic of all minerals. As intake increases, the rate of absorption decreases. Shellfish and wholemeal bread are particularly rich in zinc and, containing proteins to which zinc are easily bound, are especially conducive to absorption.¹ By contrast, vegetables contain both a smaller amount of zinc (with the exception of whole grain, nuts and leguminous plants) and higher levels of phytate which diminish absorption. For example, zinc absorption of phytate rich meals is about 15%.¹¹ Furthermore, some substances with low molecular weight such as amino acids, hydroxy acids and other organic acids stimulate absorption by increasing zinc solubility.^{11,12}

Some interactions with other micronutrients are well known. For instance, high iron intakes seem to reduce zinc absorption by competing with zinc for uptake into the body. This is of particular concern during pregnancy and lactation when higher intakes of iron are encouraged. High-dose zinc intake is also thought to cause copper deficiency.^{12,13}

Current intake

It is estimated that about 50% of the population in Europe do not have optimal nutrition in vitamins and minerals.⁷ Recent surveys in Austria¹⁸, Ireland¹⁴ and the UK¹⁵ provide an indication of current intake of zinc (see Figure 2). In the UK, 49% of men and 85% of women do not meet the recommended intake of 10 mg/day set by the SCF in 2003, although requirements for women are generally understood to be lower (see Table 2).

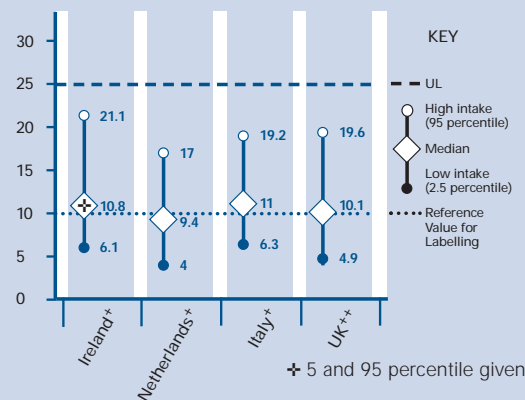


Figure 2: Average daily intake (mg) of zinc for adult men (intake from all sources including food supplements* or excluding food supplements[†])^{14,15,16,17}

Dietary sources

Although zinc is present in a wide variety of foods, there is considerable difference in zinc content between meat and vegetables. Red meat, beef, shellfish, whole wheat and unrefined cereals are an extremely good food source of zinc. During milling about 80% of protein rates in cereals and consequently zinc content is also lost. Vegetables, fruits, and milk are commonly low in zinc.^{1,12,13}

Foodstuff	Zinc content (mg/kg fresh weight)	Category
Oysters, wheat germs	>50	extremely high in zinc
Meat (beef, calf, pork, poultry), organs (liver, kidney, heart)	20-50	high in zinc
Egg, milk, cheese, fish, potatoes, whole-grain bread	5-20	moderate in zinc
Fruits, green vegetables, fats, white bread	<5	poor in zinc

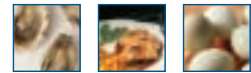
Table 1: Zinc content in food¹

9 AREDS Report No 8. A randomized, placebo-controlled, clinical trial of high-dose supplementation with vitamins C and E, beta-carotene, and zinc for age-related macular degeneration and vision loss. Arch Ophthalmol, 119 (2001) 1147-1436.

10 National Eye Institute, National Institutes of Health, see www.nei.nih.gov
11 Sandström B. Considerations in estimates of requirements and critical intake of zinc. Adaption, availability and interactions. Analyst, 120 (1995) 913-915.

12 Institute of Medicine Food and Nutrition Board Zinc. In: Dietary Reference Intakes for Vitamin A, Vitamin K, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium and Zinc. National Academy Press, Washington DC (2001) 442-501.

13 Shils M et al. Modern nutrition in health and disease. Williams & Wilkins, Baltimore, 9th edition 1998 223-239.



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Recommended intakes

In general recommended intakes for zinc range between 7 and 15 mg/day for adults (see Table 2) and between 2 and 10 mg/day in young children. Certain population groups are particularly at risk of zinc deficiency:

Elderly

As elderly people often take diuretics and thereby increase zinc excretion and their zinc absorption is often reduced, a higher intake is required in this population group. In the US, inadequate zinc intake was noted for about 45% of people above 60 years. This was improved through use of supplements to almost a quarter.^{13,19}

Vegetarians

Although zinc intake seems not to be different between vegetarians and people with mixed diets, vegetarians may have up to 50% higher dietary requirements due to impaired bioavailability.²⁰

Children

As zinc appears to be crucial to cell division and protein synthesis, the impairment of physical growth is one of the most relevant clinical features.^{2,21} In that zinc deficiency seems to affect linear growth and weight gain, sufficient zinc intake in children is essential.¹²

Pregnancy/Lactation

During pregnancy, zinc in the plasma is about 15-35% lower than in non-pregnant women. Several studies have examined the influence of maternal zinc status and birth weight: 54% found that zinc supplementation had an effect on birth weight.¹³

Sportsmen and women

In competitive and non-competitive sports and especially during rehabilitation, higher metabolic rates in micro and macronutrients are common. Sportsmen often also have elevated nutrient losses due to perspiration (higher for minerals than for vitamins), or lower dietary intake in order to achieve their weight class. In such cases elevated intakes are needed.^{1, 22}

Country/organisation	Adults	Pregnant women
Belgium, 2000	9.5	7
France, 2001	12	10
DACH*, 2000	10	7
Ireland, 1999	9.5	7
Netherlands, 2000	10	9
Nordic countries, 1996	9	7
Portugal, 1982	11	15
Spain, 1994-1998	15	15
UK, 1991	9.5	7
EU Reference Labelling Value, 2003	10	10

Table 2: Recommended Dietary Allowances (RDA) of zinc for adults and pregnant women in Europe²³

* Recommendations for Germany, Austria and Switzerland

14 Irish Universities Nutrition Alliance (IUNA). The North-South Ireland Food Consumption Survey (2001).

15 UK Office for National Statistics, The National Diet & Nutrition Survey (NDNS): adults aged 19 to 63 years (2003).

16 Turrini A, Saba A, Perrone D, Ciaffa E, & D'Amicis A, Food Consumption Patterns in Italy: the INN-CA Study 1994-96, European Journal of Clinical Nutrition, 55, 7(2001) 571-588.

17 Gezondheidsraad, Enkele belangrijke ontwikkelingen in de voedselconsumptie (2002).
18 Institut für Ernährungswissenschaften, Österreichischer Ernährungsbericht (1998).

19 Ervin RB, Kennedy-Stephenson J. Mineral intakes of elderly adult supplement and non-supplement users in the third National Health and Nutrition Examination Survey. J Nutr, 132 (2002) 3422-3427.

20 EC Scientific Committee on Food. Opinion of the Scientific Committee on Food on the tolerable upper intake level of zinc. (2003)

21 Hambidge M. Human zinc deficiency. J Nutr, 130 (2000) 1344-1349.

22 Maughan RJ. Nutrition in sport. Blackwell Science, Oxford, (2000) 339-341.

23 EU Scientific Committee on Food. Opinion of the Scientific Committee on Food on the revision of reference values for nutrition labelling (2003).

Fortified foods

In the US, fortification with zinc is a common practice, especially in breakfast cereals (usually at levels of around 25-100% of the RDA¹), flour, bakery products and macaroni.¹³ Fortification with zinc is not widespread in the EU, although some breakfast cereals are enriched and have been shown to currently provide around 6% of daily zinc intake.¹⁵ There are a number of organoleptic problems associated with the addition of zinc to foods, which requires careful selection of the mineral compound. In accordance with EU legislation zinc is added as defined to specific foodstuffs for particular nutritional uses, for example, formulae milks, meal replacers and dietetic supplement drinks.

Food supplements

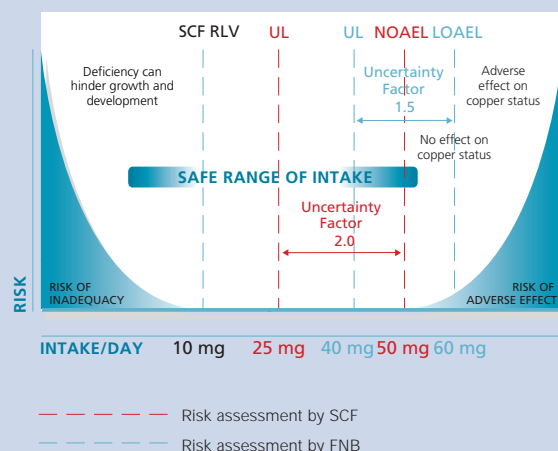
Multivitamin and mineral supplements containing zinc at a range of 2-20 mg as well as single zinc supplements at a range of 15-50 mg are currently available on the EU market.²⁰ Zinc supplements provide on average around 2-4% of total zinc intake.¹⁴ In Germany, where about 22% of women and 18% of men take supplements at least once a week, 8.8% of men and 12.5% of women take mineral supplements. Women aged 60-69 tend to be the greatest users of mineral supplements, whereas for men the intake is at its lowest in this age group.²⁴

Safety

In excess, zinc intake can have adverse effects such as loss of appetite, diarrhoea, headaches, nausea and abdominal cramps. At intakes higher than 45 mg, the immune system function can be negatively affected.²⁵ The Food and Nutrition Board and the Scientific Committee on Food have set different Tolerable Upper Intake Levels (UL) for zinc. Drawing on a study on supplemental intake of 50 mg/day, the FNB established a Lowest Observed Adverse Effect Level (LOAEL) of 60 mg. The UL was calculated by dividing the LOAEL by an uncertainty factor (UF) of 1.5 to take into account the potential different sensitivities between individuals, and to extrapolate a No Observed Adverse Effect Level (NOAEL) from a LOAEL. A higher UF was not justified given the rarity of the relevant adverse effect, namely reduced copper status in humans.¹²

The SCF determined a NOAEL of 50 mg/day at which adverse effects on copper status were not apparent. Because of the small number of study participants

involved in the study on which this NOAEL was based, an uncertainty factor of 2 was applied, resulting in an UL of 25 mg/day.²⁰



24 Mensink GBM, Ströbel A. Einnahme von Nahrungsergänzungspräparaten und Ernährungsverhalten. Gesundheitswesen, 61, 2 (1999) 132-137.

25 Reinhold D et al. Immunobiology of zinc and zinc therapy. Immunology today, 20, 2 (1999) 102.