

iron

FACT SHEET



Iron

Iron is a key mineral for human metabolism. The healthy human body contains between 2.5 g (40 mg/kg: menstruating woman) and 4.0 g (50 mg/kg: adult male) iron. About 60% is found in the haemoglobin of the red blood cells, and 15% in myoglobin (in muscles) and various enzymes. Haemoglobin and myoglobin are proteins specialised in the transport and storage of oxygen. About 25% of body iron is stored (as ferritin or haemosiderin) mainly in the liver, spleen and bone marrow. Iron turnover is normally small. In the absence of bleeding (including menstruation) or pregnancy, about 1 mg iron is lost daily. During menstruation and lactation, iron loss may be twice as high. Iron requirements are also increased during pregnancy (5-6 mg daily in the second and third trimesters) to meet the needs of the foetus and the increased blood volume.¹

Importance for health

Iron is required for a number of vital functions, including growth, reproduction, wound healing, and immune function. The main role of iron is to carry oxygen to the tissues where it is needed. Iron is also essential for the proper functioning of numerous enzymes involved in DNA synthesis², energy metabolism, and protection against microbes and free radicals.

Iron deficiency affects about 30% of the world population, and is one of the main deficiency disorders in Europe³ (see Table 1). People with iron deficiency may get short of breath and tire quickly; they have a lower resistance to infection, and may develop sores at the corner of the mouth, on the tongue and in the stomach. Severe iron deficiency results in anaemia associated with adverse pregnancy outcomes, and impaired mental and physical performance.

Table 1: Prevalence of iron deficiency (as % of population) in European countries⁴.

	Pregnant women		Adolescent girls	Children
	Depleted iron stores	Iron-deficiency anaemia	Depleted iron stores	Depleted iron stores
Denmark*	92%	18%	20%	2%
France	54 – 77%	9 – 30%	3 – 15%	14 – 38%
Italy	–	–	12%	7 – 25%
UK	25%	6%	21%	–

* Those not taking supplements. For those taking supplements the figures were 54% and 0% respectively.



Food sources

Iron occurs in foods in two different forms: haeme iron (mainly from haemoglobin and myoglobin in meat, poultry, and fish) and nonhaeme iron (from plants, dairy products, meat and iron salts used to fortify foods). While haeme iron accounts for only 10-15% of the iron in western diets, it may provide up to one third of total absorbed iron, because absorption is less influenced by other dietary factors than that of nonheme iron.

Absorption of nonhaeme iron is inhibited by phytates and polyphenols (in cereals, vegetables and legumes), tannins (in tea and coffee), calcium, and vegetable proteins (in soya and nuts), and is promoted by vitamin C (in fruit and vegetables), other organic acids and meat. It has been calculated that 1 g meat has the same enhancing effect on iron absorption as 1 mg ascorbic acid.⁵

Table 2: Food sources of iron⁶

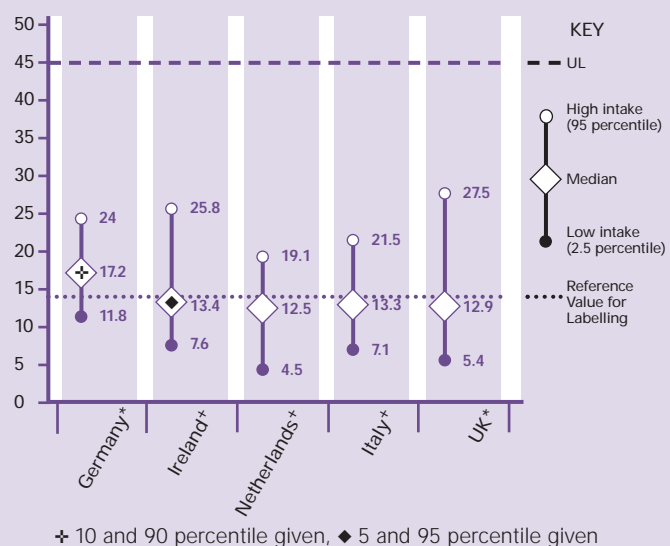
Food	Serving	Iron content (mg)
Beef	100 g	3
Chicken, dark meat	100 g	1.5
Oysters	6 medium	5
Shrimp	8 large, cooked	1
Tuna, light	100 g	1.5
Raisin bran cereal	1 cup, dry	5
Raisins, seedless	50 g	1
Potato, with skin	1 medium baked	2.8
Kidney beans	100 g	3
Lentils	100 g	3.5
Tofu, firm	100 g	11
Cashew nuts	50 g	3

Current intakes

Recent surveys in Austria⁷, Ireland⁸, the Netherlands⁹ and the UK¹⁰ suggest that inadequate intake of iron is widespread among women. In the UK, 84% of women (93% in the age group 25-34 years) do not achieve the recommended intake, while 50% consume less than 10 mg/day. Only 15% of men consume less than the recommended intake (See Figure 1).

A similar pattern was found in the other countries. In the Netherlands, women aged 19-35 years consumed on average only 10.5 mg/day. In Austria, women's average intake of iron was 73% of the national recommendation, with women under 25 years most at risk of inadequate intake, and those over 56 years least at risk. Similarly, in Ireland, more than half of women surveyed did not meet the recommendations for intake with those aged 18-35 years recording the lowest intake.

Figure 1: Average daily intake (mg) of iron by adult men – (intake from all sources including food supplements* or excluding food supplements[†]).^{7, 8, 9, 10, 11}



5 Monsen ER, Hallberg L, Layrisse M, et al., Estimation of available dietary iron. *Am J Clin Nutr* 31 (1978) 134-41.
6 Linus Pauling Institute Micronutrient Information Center.

7 Institut für Ernährungswissenschaften, Österreichischer Ernährungsbericht (1998).
8 Irish Universities Nutrition Alliance (IUNA), The North-South Ireland Food Consumption Survey (2001).

9 Gezondheidsraad, Enkele belangrijke ontwikkelingen in de voedselconsumptie (2002).
10 UK Office for National Statistics, The National Diet & Nutrition Survey (NDNS) (2003).

11 Turrini A, Saba A, Perrone D, Cialfa 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.



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Recommended intakes

Recommended intakes range between 8-15 mg daily for men and postmenopausal women, and 15-20 mg daily for menstruating women (Table 3). Up to 30 mg daily is recommended for pregnant women (such amounts are difficult to achieve from food sources alone).

Requirements vary depending on the individual's iron status and the type of diet consumed. People with iron deficiency absorb a greater proportion of the iron consumed than those with adequate stores. Haeme iron (found in meat, poultry and fish) is well absorbed; nonhaeme iron (found in other foods as well as in meats) is poorly absorbed, and its absorption is strongly influenced by inhibitors and enhancers in the meal. A diet of low iron bioavailability (high intakes of cereals, legumes and tubers, and negligible amounts of meat, poultry, fish and fruits/vegetables rich in vitamin C, as common in developing countries) containing 15 mg iron daily will contribute less than 1 mg to the body stores. A diet of high iron bioavailability (generous quantities of meat, poultry, fish and vegetables/fruits rich in vitamin C) can contribute up to 2-3 mg. Vegetarian diets have an intermediate iron bioavailability.¹²

Table 3: Recommended Dietary Allowances (RDA) of iron (mg) in Europe¹³

Country/Organization	Male	Female
Belgium, 2000	9	20
France, 2001	6	16
DACH*	10	15
Ireland, 1999	10	14
Netherlands, 2000	9	15
Nordic countries, 1996	10	18
Portugal, 1982	15	15
Spain, 1994-98	10-15	18
UK, 1991	8.7	14.8
EU Reference Labelling Value, 2003	14	14

* Recommendations for Germany, Austria and Switzerland

Food fortification

In a number of Member States a range of foods are fortified with iron. Breakfast cereals in, for example, France, Ireland, Spain and the UK may be fortified with iron at between 15-25% RDA per serving. In the UK, Ireland and Germany such cereals provide around 5-20% of iron intake making a valuable contribution to iron intake, which is inadequate in certain groups of the population, including children and adolescents.^{14,15} White wheat flour in the UK has iron added in order to restore one of the minerals lost during processing to its natural level. The iron added to flour, including that used to make bread is especially important in the diets of older adults. Iron is sometimes added to other cereal-based foods such as biscuits and also to fortified beverages at low levels. There are a number of technical and taste problems associated

with adding iron to foods which means it cannot be added to all food categories. In accordance with EU legislation iron is also added as defined to specific foodstuffs for particular nutritional uses, for example, infant formulae milks, meal replacers and dietetic supplement drinks.

¹² Cook JD, Finch CA, SA, Smith NJ. Evaluation of the iron metabolism in man. Oxford, UK: Blackwell Scientific Publications (1979).

¹³ EC Scientific Committee on Food, Opinion of the Scientific Committee on Food on the revision of reference values for nutrition labelling. (2003).

¹⁴ Serra-Majem L. Vitamin and mineral intake in European children: is food fortification needed? Public Health Nutr 4 (2001).

¹⁵ Sichert-Hellert et al. Ten-year trends in vitamin and mineral intake from fortified food in German children and adolescents. Eur J Clin Nutr 54 (2000).

Food supplements

Iron is sold in multivitamin and mineral supplements, in single iron supplements or in combination with vitamins and minerals such as vitamin D or magnesium. A German survey of nutritional supplement users showed that of the 36% of consumers using supplements, under 11% took iron supplements compared to 30% using magnesium supplements and 24% taking calcium supplements.¹⁶

A survey of Irish dietary patterns found that iron supplements provide on average between 2.7% (men) and 6.1% (women) of total iron intake.⁸ The greatest recorded daily intake of iron from supplements was 11.4 mg/day in women in the UK aged 35-49 with the highest level of intake (upper 2.5 percentile).¹⁰

Table 4 provides a review of the range of iron content in products currently sold freely in the EU, i.e. those that the consumer can find on the shelves of supermarkets and health stores (including products that in some countries may be registered as medicines). Food supplements sold in pharmacies and subject to specific controls are not included.

Table 4: Range of iron content in food supplements on free sale (via health stores and supermarkets) in the major EU markets¹⁷

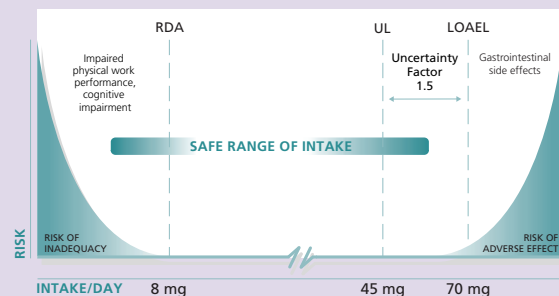
Country	Iron (mg/day)
Germany	2-100*
Denmark	2-66*
Ireland	2-15
Netherlands	2-20
Portugal	2-30
UK	2-15

*Food supplements in Germany and Denmark are generally sold at levels up to 20 mg/day, but individual products containing higher levels can be found on free sale.

Safety

High doses of supplemental iron have been associated with gastrointestinal side effects, especially when taken on an empty stomach. This risk was used by the Institute of Medicine's Food and Nutrition Board (FNB) to establish a Tolerable Upper Intake Level (UL) of 45 mg/day for iron.¹⁸ Interference with zinc absorption is also possible when high doses are taken on an empty stomach (but not when taken with a meal). Iron overload may occur as a result of iron injections, blood transfusions or certain blood disorders, such as the hereditary disease known as haemochromatosis. This may be a risk factor for organ damage, cardiovascular disease and some cancers. The FNB therefore recommends that men and postmenopausal women avoid iron supplements or foods highly fortified with iron.

The EC Scientific Committee on Food has not yet (August, 2003) completed a risk assessment of iron.



¹⁶ Wolters M and Hahn A, Nährstoffsupplemente aus Sicht des Konsumenten, Ernährungs-Umschau 48 (2001).

¹⁷ Market survey undertaken by the European Responsible Nutrition Alliance in 2001-2003.

¹⁸ Institute of Medicine, Food and Nutrition Board, Iron In: Dietary Reference Intakes for Vitamin A, Vitamin K, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium, and Zinc (2001).