

vitamin D

FACT SHEET



Vitamin D is a fat-soluble micronutrient that is only “conditionally essential”, because it can be synthesised by UV light from 7-dehydrocholesterol, a derivative of cholesterol, in the skin. The main form in the diet (and the form mainly produced in the skin) is vitamin D₃ (cholecalciferol). Vitamin D is metabolised in the liver and kidneys to the active hormone calcitriol (1,25(OH)₂D). Vitamin D activity is measured in µg of cholecalciferol. 1 µg = 40 International Units (IU). Foods of plant origin (mainly yeast and fungi) contain ergosterol, which can be converted to vitamin D₂ (ergocalciferol) by UV light.

Sources

Sunlight

Vitamin D is produced from cholesterol when the skin is exposed to sunlight. During the summer months in Europe, about 15 minutes exposure on the face and arms may be enough. A regulation mechanism prevents overproduction from prolonged exposure. As melanin absorbs UV-B, dark-skinned people produce less vitamin D from sunlight. Use of a sunscreen (protection factor 8) reduces production of vitamin D by 95 %. Vitamin D synthesis is also decreased in old age.

Diet

Natural food sources of vitamin D are rare. Plant foods provide almost no vitamin D. The best sources are fatty fish and fish liver oils, and eggs from hens fed vitamin D (Table 1). Fish and fish products generally provide between 15 and 25% of vitamin D intake and meat provides between 22 and 35% of overall intake. Eggs are another important source providing between 11 and 13% of total vitamin D intake.^{1, 2}



Figure 1: The major metabolic pathways of vitamin D³

Table 1: Food sources of vitamin D⁴

Food	Portion	% of average daily dietary requirements provided by one portion
Salmon	100 g	235
Herring	100 g	470
Sardines	100 g	120
Margarine (fortified)	15 g	5-20
Egg yolk	1	10

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

2 UK Office for National Statistics, The National Diet & Nutrition Survey (NDNS): adults aged 19 to 64 years (2003).

3 Zittermann A (2003): Vitamin D in preventive medicine: are we ignoring the evidence? Br J Nutr 89: 552-557. (2003).

4 Linus Pauling Institute Micronutrient Information Center. (2003).

vitamin



Intakes and status

With sufficient exposure to sunlight, no dietary vitamin D is required. However, it becomes an important nutritional factor in the absence of sunlight and in the elderly. A substantial part of the European population does not get enough sunlight, especially during the winter months, to cover vitamin D requirement through endogenous production.

Recent surveys in Austria⁵, Ireland¹ the Netherlands⁶ and the UK² indicate that a substantial part of the European population has a vitamin D intake below the recommended dietary allowances (RDA). Table 2 provides recommended intakes for adults up to 65 years of age. Groups at the greatest risk of a poor vitamin D status are infants and elderly, as well as people with inadequate exposure of the skin to sunlight. This includes people living in urban areas with high levels of air pollution, dark-skinned individuals in northern European countries, and women who cover themselves when outdoors for cultural reasons.

Serum 25(OH)-vitamin D (25(OH)D), a precursor of calcitriol, is the best marker of vitamin D status and reflects dietary sources as well as vitamin D produced by UV light in the skin. Levels of 25(OH)D below 40-50 nmol/L are regarded as insufficient. Recent surveys from different European countries indicate that vitamin D deficiency is widely distributed, including pre-school children and the elderly. (see Table 3) Data from the SENECA study³ in 824 elderly people from 11 European countries reveal that 36% of males and 47% of females had 25(OH)D levels below 30 nmol/L. Interestingly, more than 80% of Greek and Italian women, compared to 18% of Norwegian women were below this level. This may be due to a higher consumption of cod liver oil and fortified products in Scandinavia.

Table 2: Recommended Dietary Allowances (RDA) of vitamin D (µg) for adults in Europe⁷

Country/organisation	µg
Belgium, 2000	2.5-10
France, 2001	5
DACH*, 2000	5
Ireland, 1999	0-10
Italy, 1996	0-10
Netherlands, 2000	2.5-5
Nordic countries, 1996	5
Spain, 1994-1998	2.5
EU Reference Labelling Value, 2003	5

* Recommendations for Germany, Austria and Switzerland

Age group and country	Latitude (°North)	Mean circulating 25 (OH)D level (nmol/l)	
		Summer	Winter
Children			
Germany	51	84	43
UK:white children	50-60	80	52
UK:dark-skinned children	50-60	-	36-42*
Spain	43.5	75	32
Adolescents			
Finland	60	63	34
France	49	71	21
Young adults			
Finland	60	-	46
Germany	51	70	30
Elderly subjects			
UK	50-60	35	23
Italy	42	-	28
Greece	35-38	-	24

Table 3: Vitamin D status in different European population groups during summer and winter (adapted from Zittermann³)

⁵ Institut für Ernährungswissenschaften, Österreichischer Ernährungsbericht (1998).

⁶ Gezondheidsraad, Enkele belangrijke ontwikkelingen in de voedselconsumptie (2002).

⁷ EC Scientific Committee on Food, Opinion of the Scientific Committee on Food on the revision of reference values for nutrition labelling. (2003).

⁸ van der Wielen RP, Lowik MR, van den Berg H, de Groot LC, Haller J, Moreiras O, van Staveren WA: Serum vitamin D concentrations among elderly people in Europe. Lancet 346: 207-210. (1995)

min

D



Importance for health

The principal function of vitamin D is to maintain intracellular and extracellular calcium concentrations within a normal range by regulating calcium and phosphorus metabolism in the intestine and bone. In this way, it is important for the proper functioning of the skeleton, muscles, nerves and blood clotting. The classical manifestation of vitamin D deficiency is loss of bone mineral (presenting as rickets in children and osteomalacia in adults). Vitamin D also plays an important role in the prevention of osteoporosis.

Receptors for vitamin D exist in many tissues, suggesting that it also has an important role in controlling cell growth and differentiation, as well as immune responses. Calcitriol has been used to treat psoriasis and autoimmune disorders such as diabetes, rheumatoid arthritis and multiple sclerosis. Various studies have shown an association between poor vitamin D intake/status and cancer of the breast, prostate and colon. Some studies indicate that vitamin D inhibits proliferation of colonic epithelial cells, and that lower levels may facilitate the growth of colorectal carcinoma.⁹

Bone health

In a French study, there were significantly fewer hip fractures (compared to placebo) in the 3'270 elderly women who took a supplement with 20 µg/day vitamin D and 1200 mg/day calcium for 3 years.¹⁰ On the other hand, there was no difference in fracture incidence after 3.5 years of supplementation with 10 µg/day vitamin D or placebo in a study of 1'916 women and 662 men.¹¹ Available evidence therefore suggests that daily supplementation with 10–20 µg vitamin D can help to reduce bone loss and fracture rates in the elderly and increase bone density in both men and women.¹² However, it must be accompanied by an adequate calcium intake (1000–1500 mg/day).

Food supplements

The oldest form of a vitamin D supplement is cod liver oil. Synthetic vitamin D₂, produced by irradiation of ergosterol, is still widely used in supplements, although it is now being increasingly replaced by vitamin D₃.

A survey of Irish dietary patterns found that supplements provide on average between 6.2% (men) and 11% (women) of total vitamin D intake.¹

The table below provides a review of the range of vitamin D 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 vitamin D content in food supplements on free sale (via health stores and supermarkets) in the major EU markets¹³

Country	Vitamin D (µg/day)
Germany	2.5-5
Denmark	2.5-10
Ireland	2.5-10
Netherlands	2.5-5
Portugal	PO*
UK	2.5-10

* Prescription only

⁹ Niv Y, Figer A, Igael D, Shani S, Sperber A, Fraser G, Schwartz B. Vitamin D serum levels in different Dukes' stages of colorectal cancer. *Cancer* 1999; 86:391-7.

¹¹ Lips P, Graafmans WC, Ooms ME, Bezemer PD, Bouter LM. Vitamin D supplementation and fracture incidence in elderly persons. A randomized, placebo-controlled clinical trial. *Ann Intern Med.* 1996;124(4):400-406.

¹² Dawson-Hughes et al. *N. Eng. J. Med.* (1997). 337:10:670-676.

¹³ Market survey undertaken by the European Responsible Nutrition Alliance in 2001-2003.

¹⁰ Chapuy MC, Arlot ME, Delmas PD, Meunier PJ. Effect of calcium and cholecalciferol treatment for three years on hip fractures in elderly women. *BMJ.* 1994;308(6936):1081-1082.

Food fortification

Law in the northern countries of Europe frequently requires the addition of vitamin D to margarine. It is also added to some low or reduced fat spreads and reduced fat dairy products. A number of countries have recently allowed vitamin D to be added to specific foods due to the acknowledgement that foods with added (restored) vitamin D play an important role in maintaining the vitamin D status of certain population groups for example, older adults and strict vegetarians. The fortification of foodstuffs with vitamin D is not generally permitted in Europe unless specifically provided for in the legislation or by authorisation from the responsible authority.

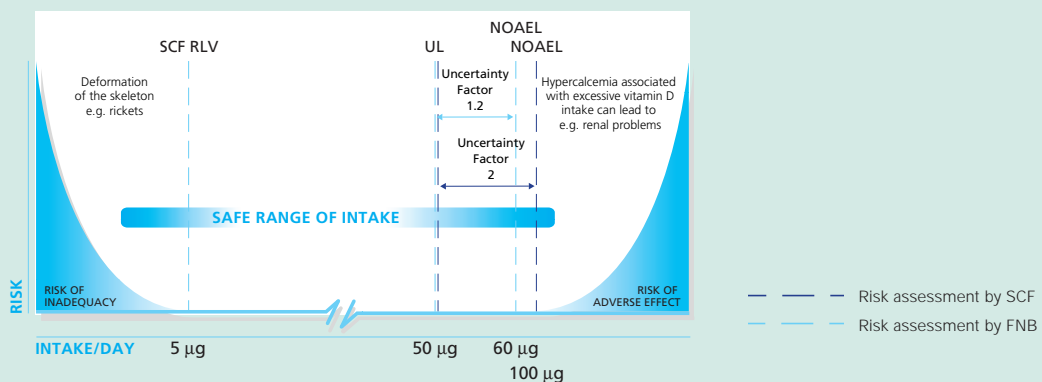
Dietetic foods

In accordance with EU legislation vitamin D is added as defined to specific foodstuffs for particular nutritional uses, for example, formulae milks, meal replacers and dietetic supplement drinks. Human milk provides only a marginal amount of total vitamin D activity, even when the mother has an adequate vitamin D status. Breast-fed infants, as well as infants fed non-fortified formula, should therefore be supplemented with vitamin D (400–500 IU/10–12.5 µg daily). In Germany, infant formula must be fortified with 10 µg/L vitamin D₃.

Safety

Excessive intakes of vitamin D can lead to hypercalcaemia (plasma calcium levels greater than 2.75 mmol/L or 11 mg/dL), and possibly to hypercalciuria (increased calcium excretion in urine). Prolonged hypercalcaemia can cause kidney stones, and calcification of soft tissues, including kidney, blood vessels, heart and lungs. Other symptoms of hypervitaminosis D include loss of appetite, loss of weight, weakness, fatigue, thirst, disorientation, vomiting and constipation. Growth retardation may occur

in children. While single intramuscular doses of up to 10'000 µg vitamin D have been administered to elderly subjects without any toxic effect, hypercalcaemia has been observed after chronic oral intakes of 95 µg/day. Both the Scientific Committee on Food (SCF)¹⁴ and the Food and Nutrition Board (FNB)¹⁵ have set the Tolerable Upper Intake Level (UL) at 50 µg/day for adolescents and adults. The SCF has set a UL of 25 µg/day for infants and children.



14 EC Scientific Committee on Food, Opinion on the Tolerable Upper Intake Level of Vitamin D (2002).

15 Institute of Medicine Food and Nutrition Board. Vitamin D. In: Dietary Reference Intakes for Calcium, Phosphorus, Magnesium, Vitamin D, and Fluoride (2001).