ERNA

vitamin A
FACT SHEET

Vitamin A is an essential fat-soluble micronutrient. The term vitamin A describes a group of compounds related to retinol. Preformed vitamin A is found in foods of animal origin and food supplements only. Some carotenoids found in foods of plant origin (α-carotene, β-carotene, β-cryptoxanthine) can be converted to vitamin A by an enzymatic process. Conversion is regulated by the body's vitamin A status. Foods can be fortified with preformed vitamin A or provitamin-A carotenoids.

Vitamin A activity is measured in Retinol Equivalents (RE). 1 mg RE = 1 mg retinol (3.33 IU vitamin A, 6 mg β-carotene, 12 mg other provitamin-A carotenoids). Newer data indicate that, to produce 1 mg retinol from fruits and vegetables, more than twice this amount of carotenoids may be needed.

Importance for health[1,2]

Vitamin A is essential for vision, growth and development, and immune function.

Vision

Receptor cells in the retina of the eye contain a light-sensitive pigment called visual purple (rhodopsin). When exposed to light, the pigment disintegrates into its components (a protein called opsin and a vitamin A metabolite called retinal) and releases electrical stimuli to the brain to form the picture that we see. To maintain vision, new rhodopsin must be continuously formed using vitamin A. One of the earliest signs of a poor vitamin A status is 'night blindness' (difficulty to see in dim light).

Another form of vitamin A (retinoic acid) is needed to maintain the proper functioning of the cornea (the transparent fibrous front layer of the eyeball) and the conjunctiva (the mucous membrane that nurtures and protects the front of the eye).

Growth and development

Vitamin A is important for the proper functioning of most organs in the body, because it is involved in the genetic regulation of cell formation and differentiation, and in intercellular communication. It is needed for reproduction and for the proper development of the baby in the womb. Both too little and too much vitamin A can result in malformation of the skeleton, nervous system, heart, eyes and ears. The integrity of epithelial cells throughout the body (skin, gut, heart, lungs, bladder, eyes, etc.) is dependent on an adequate supply of vitamin A. When it is lacking, epithelial cells stop producing mucous, and "dry out".

Immune function

Vitamin A helps to protect against infections in a number of ways. It ensures the effectiveness of the mechanical barriers (skin and mucous membranes), and increases the production and efficacy of protective cells, such as phagocytes (that engulf "foreign" particles), killer cells and lymphocytes (that produce antibodies and other molecules to fight against intruders).

1 Sommer A, West KP jr. Vitamin A Deficiency. Oxford Press (1996).

2 Institute of Medicine, Food and Nutrition Board, Vitamin A. In: Dietary Reference Intakes for Vitamin A, Vitamin K, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium, and Zinc (2002).

Food sources

The richest food source of preformed vitamin A is liver; less than 5 g covers the daily requirement, putting people who regularly consume liver at a high risk of overdosage. Appreciable quantities of preformed vitamin A are found in whole milk, butter, eggs and cheese. Carrots, spinach and broccoli are good sources of provitamin-A carotenoids when appropriately processed and cooked.

Table 1: Food sources of vitamin A[4]

	Portion size	% of average daily dietary requirements provided by one portion
Liver (beef)	100 g	950
Egg	1 (50 g)	10
Milk (whole)	250 ml	4
Butter	15 g	12
Cheese (Cheddar)	50 g	18
Salmon	100 g	5
Carrots (cooked)	100 g	100
Spinach (cooked)	100 g	65
Broccoli (cooked)	100 g	14
Melon (cantaloupe)	100 g	20

Vitamin A is sensitive to light and heat, especially in the presence of oxygen, and in an alkaline environment. During storage and cooking, appreciable amounts can be lost. Approximately, 21-29% of vitamin A intake is provided by vegetables, 14-16% from milk and around 10% from meats (excluding liver).[3]

Food supplements

Food supplements sold in Europe generally contain a daily dosage of between 400 and 3000 µg. The forms of vitamin A most commonly used in vitamin supplements are retinyl acetate, retinyl palmitate and retinal. In some Member States, supplements containing vitamin A may not be sold.

In Ireland, food supplements provide between 5 and 8% of total intake of vitamin A.[5] In the UK, dietary supplements containing vitamin A increased mean daily intake by 12% for men and 19% for women. Supplements made the greatest contribution to total intake in women aged 19 to 24 years with a 26% increase over intake from food sources. The highest average daily intake of vitamin A from food supplements was 656 µg RE in women aged between 35 and 49 years (at the 97.5 percentile).[5]

Food fortification

In many countries in Europe law requires the addition of vitamin A to margarine, and in some cases it is routinely added to other low or reduced yellow fat spreads. It is widely viewed that the addition of vitamin A to 'butter replacers' is important for maintaining the vitamin A status of certain groups of the population, for example, the elderly. The addition or restoration of foods with vitamin A is limited in most countries to foods where the fat and hence the vitamin A has been removed. For example, low fat dairy products; such products contribute important vitamin A intake of 'dieters'. Vitamin A is added as beta-carotene (provitamin A) to a range of foods primarily to juice based drinks. In accordance with EU legislation vitamin A is added as defined to specific foodstuffs for particular nutritional uses, for example, formulae milks, meal replacers and dietetic supplement drinks.

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

4 USDA National Nutrient Database for Standard Reference, Release 16.

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

Recommended intakes

Recommended intakes for adults vary between 500 and 1000 µg RE/day (Table 2). Women need higher intakes during pregnancy and lactation (an extra 100 µg RE daily during pregnancy, up to an extra 700 µg RE daily during lactation). Preformed vitamin A is readily absorbed in the upper part of the small intestine. Absorption of provitamin-A carotenoids from natural sources varies widely, and depends on numerous factors, such as dietary fat and fibre. Absorption of carotenoids in fortified foods and supplements is better than from fruits and vegetables.

Groups at the greatest risk of a poor vitamin A status are infants, young children and elderly. Vitamin A stores in infants are small, and depend on the mother's intake during pregnancy and lactation (if the baby is breastfed). Women of childbearing age are discouraged from eating liver and are therefore also at risk of deficiency. Febrile infections during childhood can rapidly deplete vitamin A stores by increasing requirements as well as losses. Low intakes are common in elderly people who do not eat a balanced diet. Vitamin A status can also be impaired as a result of intestinal and liver disorders.

Table 2: Recommended daily intakes of vitamin A (µg retinol equivalents) for men/women[6]

Country/organisation	Male	Female
Belgium, 2000	700	600
France, 2001	800	600
DACH*, 2000	1000	800
Ireland, 1999	700	600
Italy, 1996	700	600
Netherlands, 2000	1000	800
Nordic countries, 1996	900	800
Spain, 1994-1998	750	750
UK, 1991	700	600
EU Reference Labelling Value, 2003	800	800

* Recommendations for Germany, Austria and Switzerland

Current intakes

Surveys undertaken in Austria[7], Ireland[3], the Netherlands[8] and the UK[5] suggest that intake patterns vary considerably across Europe. In Austria, average male intakes were between 105 and 125% of the RDA for all age groups. Female intakes ranged between 125% to 160% of the RDA (women aged above 56 years). In the Netherlands, male average intake exceeded Dutch recommendations for 1000 µg RE/day in adults, while for women average intake was 5% below the EU recommended 800 µg/day. Average intake was shown to be lower in Ireland and the UK.

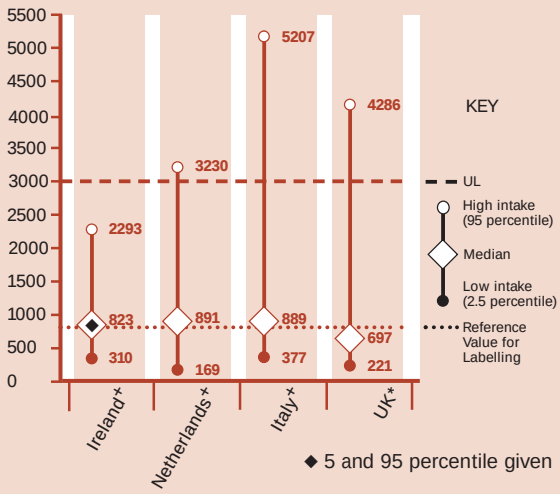


Figure 1: Average daily intake (µg) of vitamin A for adult men (intake from all sources including food supplements* or excluding food supplements†).[3, 5, 8, 10]

6 EC Scientific Committee on Food, Opinion of the Scientific Committee on Food on the revision of reference values for nutrition labelling (2003).
7 Institut für Ernährungswissenschaften, Osterreichischer Ernährungsbericht (1998).
8 Gezondheidsraad, Enkele belangrijke ontwikkelingen in de voedselconsumptie (2002).
9 Flynn A. et al (2003), Vitamins and Minerals: A model for the safe addition to foods, Eur J Nutr 42:118-130.
10 Turrini A, Saba A, Perrone D, Cialfa E, & D'Amicis A (2001): Food Consumption Patterns in Italy: the INN-CA Study 1994-96, European Journal of Clinical Nutrition, Vol. 55, 7, pp. 571-588.

ERNA 50 Rue de l'Association B-1000 Brussels Belgium
Tel: + 32 2 209 11 50 Fax: + 32 2 223 30 64 email: secretariat@erna.be web: www.erna.org

Current intakes continued

In the UK, 50% of men and 49% of women did not meet current UK national recommendations for vitamin A. Likewise in Ireland, daily average intakes for men (598 µg RE/day) and women (529 µg RE/day) were considerably below national recommendations. However, at the higher end of intake (97.5th percentile), intake in the UK and Germany appears to be considerably higher than in other countries. In men, the highest (97.5th percentile) average daily consumption of vitamin A was 4286 µg RE/day in the UK and 4480 µg RE/day in Germany compared to 3200 µg RE/day in Netherlands and 2887 µg RE/day in Ireland.[3,5,9]

This is generally ascribed to the high liver intake in these countries which provides between 21 and 26% of total vitamin A intake.[3,5]

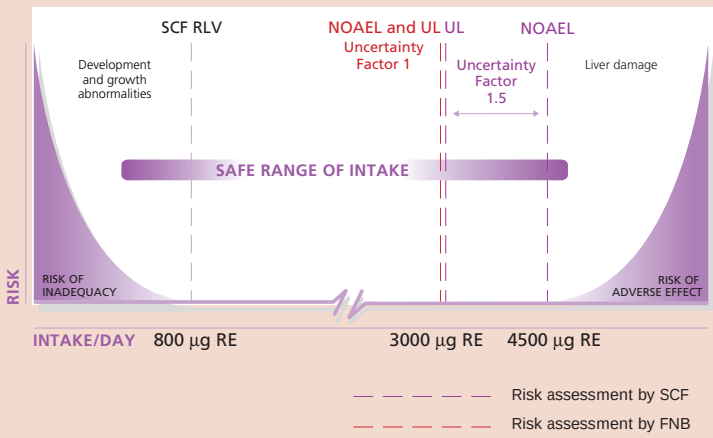
Comparative data available suggests considerable decreases in vitamin A intake over the last decade. Average vitamin A intake in the Netherlands dropped by 22% in men and 27% in women between 1987 and 1997.[8] Similarly in the UK, average vitamin A intake decreased by 39% in men and 46% in women between 1987 and 2001.[5]

Safety

Reports of acute hypervitaminosis A over the past 60 years are mainly anecdotal, and usually concern ingestion of large amounts of shark or polar-bear liver. Symptoms experienced included headaches, bone and joint pain, nausea and dry skin. A bulging fontanelle is frequently reported in infants under 6 months of age treated for vitamin A deficiency with single large doses of vitamin A. It is always rapidly reversible, and is not associated with any permanent adverse effects. The severest problem associated with hypervitaminosis A is teratogenicity (malformations in the newborn).

Cases of liver toxicity in adults have been linked to the intake of high doses of vitamin A over long periods. The cause is thought to be an overloading of the liver's vitamin A storage capacity. The symptoms are usually reversible after the intake is stopped. Recent reports suggest that excessive vitamin A intakes may increase bone resorption and decrease bone formation[11] as well as increasing blood fat and cholesterol concentrations.[12]

The EC Scientific Committee on Food has set the Tolerable Upper Intake Level (UL) for preformed vitamin A from diet and supplements at 3000 µg RE/day for adults with appropriately lower levels for children. Given that a large number of studies demonstrated a NOAEL of 3000 µg RE/day, there was considered no need to apply an uncertainty factor.[13] The Food and Nutrition Board also established a UL for vitamin A of 3000 µg RE/day /day. This UL was derived from a NOAEL of 4500 µg RE/day and an uncertainty factor of 1.5. Women of childbearing age who are likely to become pregnant should not eat liver.[2]



11 Binkley N, Krueger D (2000) Hypervitaminosis A and bone. Nutr Rev 58: 138-144.

12 Cartmel B, Moon TE, Levine N (1999). Effects of long-term intake of retinol on selected clinical and laboratory indexes. Am J Clin Nutr 69: 937-943.

13 Scientific Committee on Food, Opinion of the Scientific Committee on Food on the Tolerable Upper Intake Level of Preformed Vitamin A (retinol and retinyl esters) (2002).