WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Vitamins

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ABSTRACT

Vitamins are wide group of organic compound that are required for normal body functions. Today there is increased interest in nutritionally rich food that are either natural or minimally processed. The use of emerging technologies aimed at improving the stability and bioaccessibility of vitamins in foods to maintain their functionality through their bioavailability, metabolism.

Keywords: Emerging technologies; physiology; bioavailability; health

Introduction

Vitamin, any of several organic substances that are necessary in small quantities for normal health and growth in higher forms of animal life. Vitamins are distinct in several ways from other biologically important compounds such as proteins, carbohydrates, and l ipids. Although these latter substances also are indispensable for proper bodily functions, almost all of them can be synthesized by animals in adequate quantities. Vitamins, on the other hand, generally cannot be synthesized in amounts sufficient to meet bodily needs and therefore must be obtained from the diet or from some synthetic source. For this reason, vitamins are called essential nutrients. Vitamins also differ from the other biological compounds in that relatively small quantities are needed to complete their functions. In general these functions are of a catalytic or regulatory nature, facilitating or controlling vital chemical reactions in the body's cells. If a vitamin is absent from the diet or is not properly absorbed by the body, a specific deficiency d isease may develop.

Vitamins are usually designated by selected letters of the alphabet, as in vitamin D or vitamin C, though they are also designated by chemical names, such as niacin and folic acid. Biochemists traditionally separate them into two groups, the water-soluble vitamins and the fat-soluble vitamins. The common and chemical names of vitamins of both groups, along with their main biological functions and deficiency symptoms

iological functions and deficiency symptoms, are listed in the table

CLASSIFICATION

Classification of vitamins with function and deficiency symptoms

Vitamin	alternative names/forms	biological function	symptoms of deficiency
Water-soluble			
thiamin	vitamin B_1	component of a coenzyme in carbohydrate metabolism; supports normal nerve function	impairment of the nerves and heart muscle wasting
riboflavin	vitamin B_2	component of coenzymes required for energy production and lipid, vitamin, mineral, and drug metabolism; antioxidant	inflammation of the skin, tongue, and lips; ocular disturbances; nervous symptoms
niacin	nicotinic acid, nicotinamide	component of coenzymes used broadly in cellular metabolism, oxidation of fuel molecules, and fatty acid and steroid synthesis	skin lesions, gastrointestinal disturbances, nervous symptoms

vitamin B_6	pyridoxine, pyridoxal, pyridoxamine	component of coenzymes in metabolism of amino acids and other nitrogen-containing compounds; synthesis of hemoglobin, neurotransmitters; regulation of blood glucose levels	dermatitis, mental depression, confusion, convulsions, anemia

Vitamin	alternative names/forms	biological function	symptoms of deficiency
Water-soluble			
folic acid	folate, folacin, pteroylglutamic acid	component of coenzymes in DNA synthesis, metabolism of amino acids; required for cell division, maturation of red blood cells	impaired formation of red blood cells, weakness, irritability, headache, palpitations, inflammation of mouth, neural tube defects in fetus
vitamin B_{12}	cobalamin, cyanocobalamin	cofactor for enzymes in metabolism of amino acids (including folic acid) and fatty acids; required for new cell synthesis, normal blood formation, and neurological function	smoothness of the tongue, gastrointestinal disturbances, nervous symptoms
pantothenic acid		as component of coenzyme A, essential for metabolism of carbohydrate, protein, and fat; cofactor for elongation of fatty acids	weakness, gastrointestinal disturbances, nervous symptoms, fatigue, sleep disturbances, restlessness, nausea
biotin		cofactor in carbohydrate, fatty acid, and amino acid metabolism	dermatitis, hair loss, conjunctivitis, neurological symptoms
vitamin C	ascorbic acid	antioxidant; synthesis of collagen, carnitine, amino acids, and hormones; immune function; enhances absorption of non-heme iron (from plant foods)	swollen and bleeding gums, soreness and stiffness of the joints and lower extremities, bleeding under the skin and in deep tissues, slow wound healing, anemia
Fat-soluble			
vitamin A	retinol, retinal, retinoic acid, beta-carotene (plant version)	normal vision, integrity of epithelial cells (mucous membranes and skin), reproduction, embryonic development, growth, immune response	ocular disturbances leading to blindness, growth retardation, dry skin, diarrhea, vulnerability to infection
	calciferol, calatriol (1,25-dihydroxy vitamin D_1 or vitamin D hormone),	maintenance of blood calcium and phosphorus levels, proper	

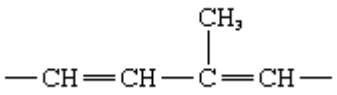
vitamin D	cholecalciferol (D_3; plant version), ergocalciferol (D_2; animal version)	mineralization of bones	defective bone growth in children, soft bones in adults
vitamin E	alpha-tocopherol, tocopherol, tocotrienol	antioxidant; interruption of free radical chain reactions; protection of polyunsaturated fatty acids, cell membranes	peripheral neuropathy, breakdown of red blood cells
vitamin K	phylloquinone, menaquinone, menadione, naphthoquinone	synthesis of proteins involved in blood coagulation and bone metabolism	impaired clotting of the blood and internal bleeding

The vitamins

THE *FAT-SOLUBL*E VITAMINS

The four fat-soluble vitamin groups are A, D, E, and K; they are related structurally in that all have as a basic structural unit of the molecule a five-carbon isoprene segment, which is

Each of the fat-soluble vitamin groups contains several related compounds that have biological activity. The active forms and the accepted n omenclature of individual vitamins in each vitamin group are given in the table. The potency of the active forms in each vitamin group varies, and not all of the active forms now known are available from dietary sources; i.e., some are produced synthetically. The characteristics of each fat-soluble vitamin group are discussed below.



Chemical properties

The chemical properties of fat-soluble vitamins determine their biological activities, functions, metabolism, and excretion. However, while the substances in each group of fat-soluble vitamins are related in structure, indicating that they share similar chemical properties, they do have important differences. These differences impart to the vitamins unique qualities, chemical and biological, that affect attributes ranging from the manner in which the vitamins are stored to the species in which they are active.

Vitamin A

Ten carotenes coloured molecules synthesized only in plants, show vitamin A activity; however, only the alpha- and beta-carotenes and cryptoxanthin are important to humans, and beta-carotene is the most active. Retinol (vitamin A alcohol) is considered the primary active form of the vitamin, although retinal, or vitamin A. Aldehyde is the form involved in the visual process in the retina of the eye.

Foods that are high in beta-carotene, a form of vitamin A, include squash, carrots, grapefruit, oranges and apricots.

Vitamin A is a fat-soluble vitamin that is good for healthy vision, skin, bones and other tissues in the body. Vitamin A often works as an antioxidant, fighting cell damage, but it also has many other uses.

"Through its role with cell growth and division, vitamin A has an important role in the normal formation and maintenance of the heart, lungs, kidneys and other vital organs," Dr. Sherry Ross, women's health expert at Providence Saint John's Health Center in Santa Monica, California, told Live Science.

Sources

There are two types of vitamin A. Preformed vitamin A, also called retinol, is found in animal products. Good sources are fortified milk, eggs, meat, cheese, liver, halibut fish oil, cream and kidneys. Pro-vitamin A is found in plant-based foods such as fruits and vegetables, The most common type of pro-vitamin A is beta-carotene, a carotenoid that produces dark pigments in plant foods. Beta-carotene can be found in these brightly colored foods:

- Cantaloupe
- Pink grapefruit
- Apricots
- Carrots
- Pumpkin
- Sweet potatoes
- Winter squash
- Dark green, leafy vegetables
- Broccoli

Benefits

Vitamin A has many varied functions. Retinol not only creates the pigments in the retina of the eye, according to NLM, but also is integral for good vision, especially night vision, and overall eye health. An age-related eye disease study by the National Eye Institute found that taking high levels of antioxidants, such as vitamin A, along with zinc, may reduce the risk of developing advanced age-related macular degeneration by about 25 percent. A ge-related macular degeneration is the most common cause of loss of vision in the older population, said Ross.

Vitamin A also helps skin grow and repair skin. "This being the case, it is the active ingredient in most Retin-A type products out today," said Dr. David Greuner, director and co-founder of NYC Surgical Associates. Retin-A is a brand name for tretonin, a prescription medication that treats acne and other skin conditions. "It works by signaling to the cells to grow at a faster rate, bringing fresher, more youthful skin to the surface more rapidly. Used in excess, it can be quite irritating, however."

Other functions of vitamin A include the formation and maintenance of teeth, bones, soft tissue, white blood cells, the immune system and mucus membranes. Beta-carotene also acts as an antioxidant, protecting cells from free radical damage. Though many antioxidants prevent cancer, there is no evidence that beta-carotene supplements are helpful in the prevention of cancer. On the other hand, all-natural beta-carotene that can be consumed through vegetables and fruits has been found to helpful in preventing cancer in many studies. Vitamin A deficiency due to maternal alcohol use is thought to be a factor in fetal alcohol syndrome treating mothers with vitamin A may help to prevent fetal alcohol syndrome.

Deficiency and dosage

Vitamin A deficiency is rare in the United States, although it is common in many developing countries. "In fact, Vitamin A deficiency is the leading cause of childhood blindness in Southeast Asia," . Around 250,000 to 500,000 children around the world with vitamin A deficiency become blind every year. Half of those children die within 12 months of losing their sight, according to the World Health Organization. Symptoms of a severe deficiency are

- Night blindness
- Dry eyes
- Diarrhea
- Skin problems.

Vitamin A dosage is tricky. Too little can make a person more susceptible to disease and vision problems while too much can create many problems, as well. The recommended dietary intakes for vitamin A depend on age, gender and reproductive status. The Dietary Reference Intakes (DRI) for adult women is 700 micrograms (mcg) and for adult men it is 900 mcg per day. Doses over 25,000 international units (IU) per day should be avoided as they are likely to cause side effects, according to the NLM. One IU is the biological equivalent of 0.3 mcg retinol, or of 0.6 mcg beta-carotene, according to the National Institute of Health. For comparison, a baked sweet potato (half a cup) has 19,218 IU of vitamin A, according to the U.S. Department of Agriculture. A medium cantaloupe has 18,668 IU and a carrot (half a cup, chopped) has 10,692 IU.

"Overdose of Vitamin A is absolutely a plausible scenario given its fat soluble nature, and it has been associated with a diverse set of symptoms ranging from skin and hair loss to neurologic problems, to gastrointestinal complains. In addition, liver injury has been described in situations of long term excess,"

High doses long term can cause nausea, vomiting, fatigue, balance problems, liver problems, muscle pain, confusion, higher risk of osteoporosis and hip fractures.

Vitamin D

A human body produces vitamin D as a response to sun exposure. A person can also boost their vitamin D intake through certain foods or supplements.

Vitamin D is essential for several reasons, including maintaining healthy bones and teeth. It may also protect against a range of diseases and conditions, such as type1 diabetes.

Despite its name, vitamin D is not a vitamin, but a prohormone, or precursor of a hormone. Vitamins are nutrients that the body cannot create, and so a person must consume them in the diet. However, the body can produce vitamin D.

In this article, we look at the benefits of vitamin D, what happens to the body when people do not get enough, and how to boost vitamin D intake.

Benefits

Share on Pinterest During sun exposure, a person's body produces vitamin D. Vitamin D has multiple roles in the body. It assists in:

- promoting healthy bones and teeth
- supporting immune, brain, and nervous system health
- regulating insulin levels and supporting diabetes management
- supporting lung function and cardiovascular health
- influencing the expression of genes involved in cancer development

Sources of vitamin D

Getting sufficient sunlight is the best way to help the body produce enough vitamin D. Plentiful food sources of vitamin D include:

- fatty fish, such as salmon, mackerel, and tuna
- egg yolks
- cheese
- beef liver
- mushrooms
- fortified milk

fortified cereals and juices

Fig. sources of vitamin D

Here, learn how to get more vitamin D from the sun.

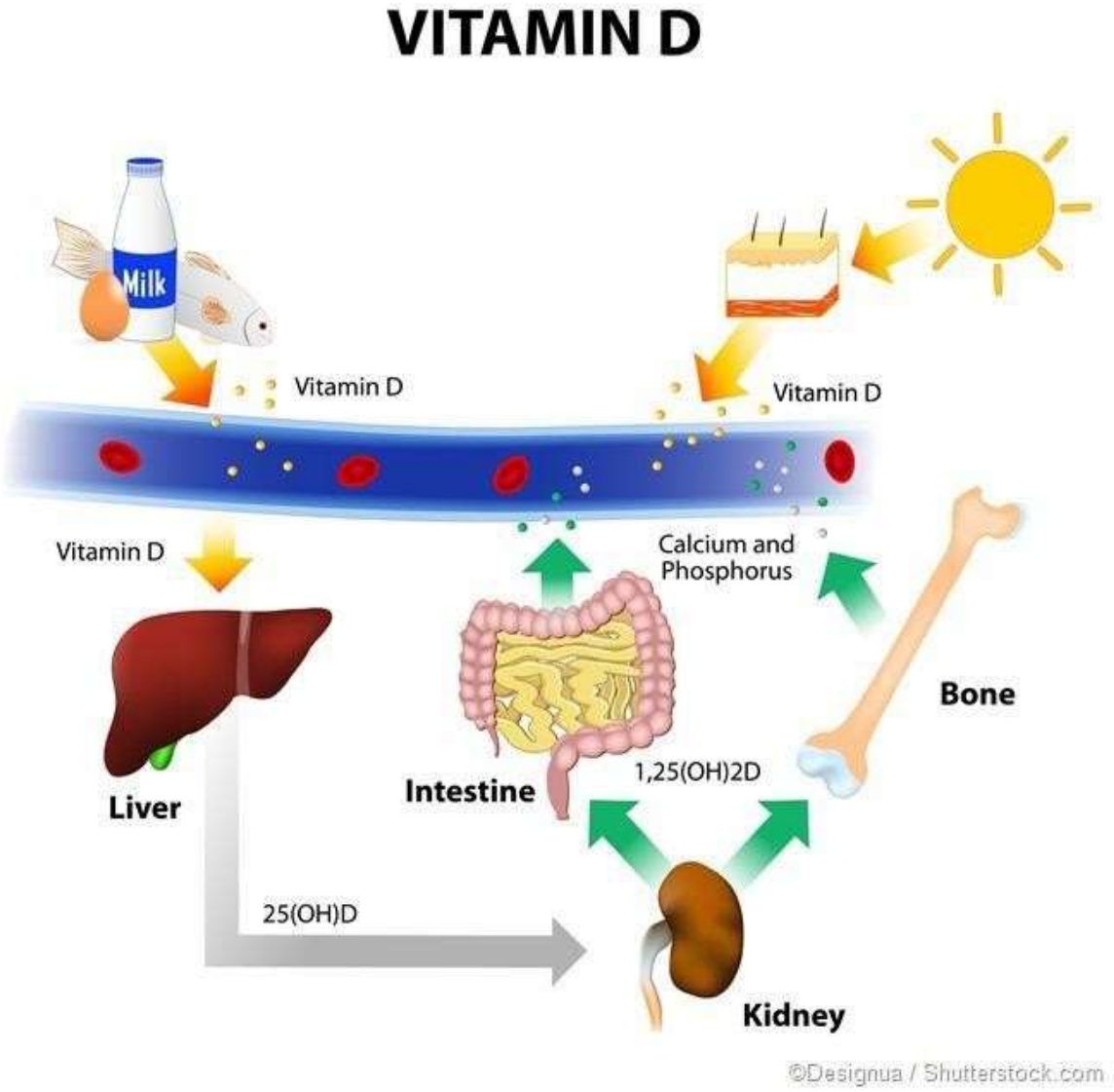


Fig. sources and absorption of vitamin D

Deficiency

Although the body can create vitamin D, a deficiency can occur for many reasons.

Causes

Skin type: Darker skin and sunscreen, reduce the body's ability to absorb the ultraviolet radiation B (UVB) rays from the sun. Absorbing sunlight is essential for the skin to produce vitamin D.

Sunscreen: A sunscreen with a sun protection factor (SPF) of 30 can reduce the body's ability to synthesize the vitamin by 95%. Covering the skin with clothing can inhibit vitamin D production also.

Geographical location: People who live in northern latitudes or areas of high pollution, work night shifts, or are homebound should aim to consume vitamin D from food sources whenever possible.

Breastfeeding: Infants who exclusively breastfeed need a vitamin D supplement, especially if they have dark skin or have minimal sun exposure. The American Academy of Pediatrics recommend that all breastfed infants receive Although people can take vitamin D supplements, it is best to obtain any vitamins or minerals through natural sources wherever possible.

Symptoms

Symptoms of vitamin D deficiency may include:

- Regular sickness or infection
- Fatigue
- Bone and back pain
- Low mood
- Impaired wound healing
- Hair loss
- Muscle pain

If Vitamin D deficiency continues for long periods, it may result in complications Trusted Source, such as:

- Cardiovascular conditions
- Autoimmune problems
- Neurological diseases
- Infections
- Pregnancy complications
- Certain cancers, especially breast, prostate, and colon.

Vitamin E

Vitamin E is a vital nutrient for good health, and it's found in a wide variety of foods and supplements. The best way to consume this vitamin is through a healthy diet. Deficiency is rare, and overdosing by using supplements is a concern. Those who have certain health conditions or take certain medicines should be cautious with supplements.

Sources of vitamin E

Vitamin E is a family of fat-soluble compounds. "It occurs naturally in eight different forms, including four tocopherols (alpha, beta, gamma and delta) and four tocotrienols. Alpha tocopherol is the most common and most potent form of the vitamin,"

Good dietary sources of vitamin E include nuts, such as almonds, peanuts and hazelnuts, and vegetable oils, such as sunflower, wheat germ, safflower, corn and soybean oils. Sunfloweand green, leafy vegetables such as spinach and broccoli also contain vitamin E.

Fig. sources of vitamin E

Benefits

Including sources of vitamin E in your diet brings many benefits.

As a fat-soluble nutrient, vitamin E functions mainly as an antioxidant, which means it helps protect cells from damage caused by unstable molecules called free radicals.

"It protects cells from damage, and it might aid in lowering [the risk of] a variety of health problems, from heart disease to cancer, and possibly even dementia," Somer told Live Science.

In addition to providing cell protection, vitamin E is vital to a functioning immune system. As a powerful antioxidant, it helps cells fight off infection.

This vitamin also helps protect eyesight. A study found that vitamin E intake and high serum-tocopherol levels were linked to a decreased risk of age-related cataracts.

Vitamin E plays an important role in the production of hormone-like substances called prostaglandins, which are responsible for regulating a variety of body processes, such as blood pressure and muscle contraction. vitamin E aids in muscle repair after exercise, said Somer.

People with Crohn's disease, cystic fibrosis or an inability to secrete bile from the liver into the digestive tract may need to take water-soluble, supplemental forms of vitamin E to avoid digestive problems

Vitamin E deficiency

A vitamin E deficiency is very rare, though some people are more prone to a vitamin E deficiency than others, according to NIH. Infants, people with fat malabsorption and abetalipoproteinemia (a condition that prevents the body from completely absorbing certain dietary fats) are more likely to have vitamin E deficiency. Anemia, skeletal myopathy, ataxia, peripheral neuropathy, retinopathy, impairment of the immune response and nerve damage are signs that there may be a deficiency.

Vitamin K

Vitamin K is a group of structurally similar, *fat-soluble vitamins* found in foods and in *dietary supplements*. The *human body* requires vitamin K for *complete synthesis* of certain *proteins* that are needed for *blood coagulation* for controlling *binding* of *calcium* in *bones* and other *tissues*. The vitamin K–related modification of the proteins allows them to bind *calcium* ions, which they cannot do otherwise. Without vitamin K, blood coagulation is seriously impaired, and uncontrolled bleeding occurs. Preliminary *clinical research* indicates that deficiency of vitamin K may weaken bones, potentially leading to *osteoporosis*, and may promote *calcification* of arteries and other soft tissues.

Chemically, the vitamin K family comprises 2-*methyl*-*1,4-naphthoquinone derivatives*. Vitamin K includes two natural *vitamers*: *vitamin K1* and *vitamin K2*. Vitamin K2, in turn, consists of a number of related chemical subtypes, with differing lengths of carbon side chains made of *isoprenoid* groups of atoms.

Vitamin K1, also known as *phylloquinone*, is made by plants, and is found in highest amounts in *green leafy vegetables* because it is directly involved in photosynthesis. It may be thought of as the plant form of vitamin K. It is active as a vitamin in animals and performs the classic functions of vitamin K, including its activity in the production of blood-clotting proteins. Animals may also convert it to vitamin K2.

Bacteria in the *gut flora* can also convert K1 into vitamin K2 (*menaquinone*). In addition, bacteria typically lengthen the isoprenoid side chain of vitamin K2 to produce a range of vitamin K2 forms, most notably the MK-7 to MK-11 homologues of vitamin K2. All forms of K2 other than MK-4 can only be produced by bacteria, which use these during *anaerobic respiration*. The MK-7 and other bacterially derived forms of vitamin K2 exhibit vitamin K activity in animals, but MK-7's extra utility over MK-4, if any, is unclear and is a matter of investigation.

Because a synthetic form of vitamin K, vitamin K3 *(menadione*), may be toxic by interfering with the function of *glutathione*, it is no longer used to treat vitamin K deficiency.

Vitamin K3 vitamin is synthetic,it is insoluble in fat but soluble in water

Sources

Vitamin K1 is found chiefly *in leafy green vegetables such as spinach*, *swiss chard*, *lettuce* and *Brassica* vegetables (such as *cabbage*, *kale*, *cauliflower*, *broccoli*, and *brussels sprouts*) and often the absorption is greater when accompanied by *fats* such as *butter* or *oils*. Some *fruits*, such as *avocados*, *kiwifruit* and *grapes*, also contain vitamin K. Some vegetable oils, notably *soybean oil*, contain vitamin K, but at levels that would require relatively large *calorie* consumption to meet the recommended amounts.

The tight binding of vitamin *K1 to thylakoid* membranes in *chloroplasts* makes it less *bioavailable*. For example, cooked spinach has a 5% bioavailability of phylloquinone, however, fat added to it increases bioavailability to 13% due to the increased *solubility* of vitamin in fat

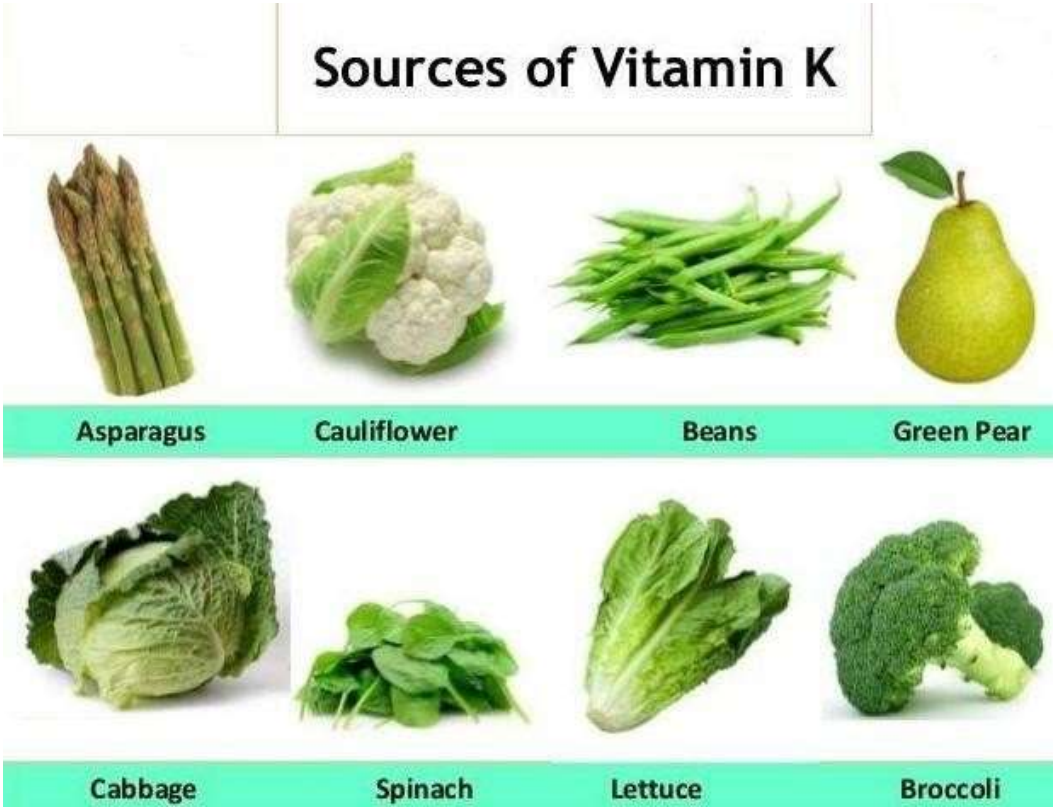


Fig. sources of vitamin k

Deficiency

Average diets are usually not lacking in vitamin K, and primary deficiency is rare in healthy adults. Newborn infants are at an increased risk of deficiency. Other populations with an increased prevalence of vitamin K deficiency include those who suffer *from liver damage or disease* (e.g. *alcoholics*), *cystic fibrosis*, or *inflammatory bowel diseases*, or have recently had abdominal surgeries. Secondary vitamin K deficiency can occur in people with *bulimia*, those on stringent diets, and those taking anticoagulants. Other drugs associated with vitamin K deficiency include *salicylates*, *barbiturates*, and *cefamandole*, although the mechanisms are still unknown. Vitamin K deficiency has been defined as a vitamin K-responsive hypoprothrombinemia which increase prothrombin time and thus can result in *coagulopathy*, a bleeding disorder.*[59]* Symptoms of K1 deficiency include *anemia*, *bruising*, *nosebleeds* and bleeding of the gums in both sexes, and heavy *menstrual bleeding* in women.

Osteoporosis and *coronary heart disease* are strongly associated with lower levels of K2 (menaquinone). Vitamin K2 (as menaquinones MK-4 through MK-10) intake level is inversely related to severe *aortic calcification* and all-cause mortality.

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