

VITAMINS IN HUMAN NUTRITION: IMPORTANCE, DEFICIENCY AND PREVENTION

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Abstract

Vitamins are needed by the human body in small amounts, but they are important for many normal body functions. They help the body use nutrients, support growth, maintain immunity, form blood cells and keep organs and tissues working properly. There are 13 commonly recognized essential vitamins. They are divided into fat-soluble vitamins (A, D, E and K) and water-soluble vitamins (the B-group vitamins and vitamin C). A lack of vitamins can happen because of poor food choices, increased requirements, problems with absorption, some diseases, certain medicines or limited access to nutritious food. Different deficiencies can lead to problems such as night blindness, rickets, anemia, nerve problems and scurvy. The main way to prevent deficiency is to eat a varied diet. In some situations, fortified foods or supplements are also needed. At the same time, taking very large amounts of supplements is not always safe. This article explains the main vitamins, their sources, functions, deficiency disorders and simple ways of prevention.

1. Introduction

Good nutrition is necessary for the body to keep its normal structure and work properly. Nutrients can be broadly split into macronutrients and micronutrients. Macronutrients like carbohydrates, proteins and fats are needed in large amounts, while micronutrients are needed only in small amounts. Vitamins are one of the most important groups of micronutrients.

From daily meals to supplements, getting enough of the 13 essential vitamins is key to long-term health. Microscopic as these daily requirements might seem, they drive crucial internal processes—helping us convert food into energy, fight off infections, protect nerve health, and heal damaged tissues. [1,2].

Vitamins don't deliver calories directly, but we can't unlock energy from food without them. They act as essential helpers that allow enzymes to break down carbs, proteins, and fats. Beyond fueling metabolism, each vitamin has a specialized job.

2. Classification of Vitamins

Vitamins are classified based on what they dissolve in, so they are either fat soluble or water soluble.

2.1 Fat soluble vitamins

The fat soluble vitamins are:

- Vitamin A
- Vitamin D
- Vitamin E
- Vitamin K

These are absorbed along with the fat in our diet and get stored in the body, mainly in the liver and fat tissue. Since the body can store them, deficiency usually develops slowly. But if they are taken in excess, mostly through supplements, they can build up and become toxic [4].

2.2 Water soluble vitamins

The water soluble vitamins are:

- Vitamin B1 (Thiamine)
- Vitamin B2 (Riboflavin)
- Vitamin B3 (Niacin)
- Vitamin B5 (Pantothenic acid)
- Vitamin B6 (Pyridoxine)
- Vitamin B7 (Biotin)

- Vitamin B9 (Folate)
- Vitamin B12 (Cobalamin)
- Vitamin C (Ascorbic acid)

Most of these are not stored much in the body, so we need to get them regularly from food. Vitamin B12 is an exception because the body can keep good stores of it [4].

3. Functions and Importance of Vitamins

3.1 Role in metabolism

B-complex vitamins are the core drivers of human metabolism. Serving as essential coenzymes—or the building blocks that form them—they allow our cells to unlock energy from the proteins, carbohydrates, and fats in the food we eat.

Thiamine forms thiamine pyrophosphate, which is used in carbohydrate metabolism and oxidative decarboxylation. Riboflavin forms FAD and FMN, which are used in oxidation reduction reactions. Niacin is needed to make NAD and NADP, which are also used in many redox reactions. Pantothenic acid is a part of coenzyme A and helps in fatty acid and energy metabolism. Vitamin B6 helps in amino acid metabolism and in making neurotransmitters [2,4].

This shows that even though vitamins are needed in small amounts, not having enough of them can disturb important pathways inside cells.

3.2 Growth and development

Vitamins are needed for normal growth and development of tissues. Vitamin A controls cell differentiation and keeps epithelial tissues healthy. Vitamin D is needed for proper bone development and mineralization. Folate and vitamin B12 are needed for DNA synthesis and cell division, which is why they matter so much during periods of fast growth.

Getting enough folate before conceiving and through the first few weeks of pregnancy is essential for a baby's growing nervous system. When a mother's folate levels drop too low during this initial window, the risk of brain and spinal cord birth defects—such as spina bifida—increases significantly.

3.3 Blood formation (hematopoiesis)

Some vitamins help in forming blood. Folate and vitamin B12 are needed for DNA synthesis and for red blood cells to mature properly. Lack of either one can lead to megaloblastic anemia.

Proper hemoglobin synthesis and iron utilization rely heavily on supporting vitamins. Vitamin B6 acts as a vital cofactor in heme production, while vitamin C enhances the intestinal absorption of non-heme iron. Consequently, clinicians evaluating a patient for anemia should always consider underlying vitamin deficiencies alongside standard iron panels.

3.4 Nervous system

Many vitamins are needed for the nervous system to work properly. Thiamine is needed for energy metabolism in neurons, and severe deficiency can cause peripheral neuropathy, heart problems or Wernicke encephalopathy.

Our nervous system relies heavily on B vitamins to run smoothly. Vitamin B12 protects the myelin sheath—the insulation around our nerves—so running low over time can trigger nerve damage, leading to numbness, loss of balance, and trouble coordinating movement. Vitamin B6 is just as crucial, working behind the scenes to produce chemical messengers like serotonin and dopamine that carry signals across the brain. [4].

3.5 Vision

Vitamin A is necessary for normal vision. Retinal, which comes from vitamin A, is part of rhodopsin, the pigment in the eye that helps us see in dim light.

Vitamin A also keeps epithelial tissues healthy. Severe deficiency first causes night blindness and can later lead to xerophthalmia, damage to the cornea and even blindness. This is a big problem in children in areas where diet is poor [1].

3.6 Bone health

Skeletal strength relies heavily on vitamin D to regulate calcium and phosphate levels. By enabling the body to absorb these nutrients through digestion, it supplies what bones need to harden properly. Long-term shortages compromise bone framework, leading to developmental bone softening in children and osteomalacia later in life.

Vitamin K also plays a supporting role here, helping produce key proteins needed to build and maintain healthy bone tissue.[4].

3.7 Immunity

Getting enough vitamins supports a healthy immune system. Vitamin A helps keep epithelial barriers intact and supports immune responses. Vitamins C and E work as antioxidants, and vitamin D has a regulating effect on immune cells.

Severe vitamin A deficiency makes children more likely to get serious infections and is still a public health issue in many populations [1].

4. Major Vitamins: Sources, Functions and Deficiency

Table 1. Summary of the major vitamins [4,6]

Vitamin	Food sources	Main role in body	Deficiency disease / signs
A	Liver, eggs, milk, carrots, green leafy veg	Vision, healthy skin and lining tissues, immunity	Night blindness, xerophthalmia
D	Sunlight, fatty fish, egg yolk, fortified foods	Calcium and phosphate absorption, bones	Rickets (children), osteomalacia (adults)
E	Vegetable oils, nuts, seeds	Antioxidant, protects cell membranes	Nerve problems, hemolysis
K	Green leafy vegetables, oils	Blood clotting	Bleeding tendency
B1 (Thiamine)	Whole grains, pulses, meat, nuts	Carbohydrate metabolism, nerves	Beriberi
B2 (Riboflavin)	Milk, eggs, meat, cereals	Redox reactions (FAD, FMN)	Cheilosis, glossitis
B3 (Niacin)	Meat, fish, poultry, legumes	Forms NAD and NADP	Pellagra
B5 (Pantothenic acid)	Meat, eggs, dairy, legumes	Part of coenzyme A	Deficiency is rare

B6 (Pyridoxine)	Meat, fish, cereals, legumes	Amino acid metabolism, heme synthesis	Neuropathy, anemia
B7 (Biotin)	Eggs, nuts, seeds, meat	Carboxylation reactions	Rare, dermatitis
B9 (Folate)	Leafy vegetables, legumes, fortified grains	DNA synthesis, cell division	Megaloblastic anemia, neural tube defects
B12 (Cobalamin)	Meat, fish, eggs, dairy	DNA synthesis, nerve function	Megaloblastic anemia, neuropathy
C (Ascorbic acid)	Citrus fruits, amla, guava, tomatoes	Collagen formation, iron absorption	Scurvy

5. Dietary Sources and Requirements

Eating a varied diet is the main way to get enough vitamins. Important food groups are vegetables, fruits, whole grains, pulses, legumes, nuts, seeds, milk products, eggs, fish and other animal foods for those who eat them.

How much of each vitamin a person needs depends on age, sex and physiological state. The need goes up during pregnancy, breastfeeding, childhood and illness. In India, the ICMR National Institute of Nutrition gives the recommended dietary allowances for Indians, so it is the most useful reference for us [7].

Dietary vitamin A comes in two forms: active preformed retinoids found in animal products like liver, eggs, and milk, and provitamin A carotenoids abundant in orange and dark leafy vegetables. Meanwhile, rich sources of vitamin C include a wide variety of fresh produce—most notably citrus fruits, amla, guava, bell peppers, and tomatoes.

Vitamin D is different from most other vitamins because our skin can make it when exposed to UVB rays from sunlight. Food sources such as fatty fish, egg yolk are good vitamin D sources. Vitamin D levels depend on age, skin colour, where a person lives, the type of clothes they wear and how much time they spend outdoors.

Animal foods are a good source of vitamin B12. So people who follow a strict vegan diet need to get B12 from fortified foods or supplements [6].

No single food has all the vitamins in enough amounts, which is why eating a variety of foods is important. The WHO also recommends a healthy diet with many different nutrient rich foods [8].

6. Causes and Risk Factors of Vitamin Deficiency

There are several reasons why a person may become deficient in vitamins.

6.1 Not eating enough

A diet with little variety, lack of access to food, or a diet mostly made of low nutrient foods can lead to low vitamin intake. Very strict diets can cause specific deficiencies.

6.2 Higher requirements

The body needs more vitamins during periods of fast growth. Pregnancy and breastfeeding are especially important since good nutrition of the mother is needed for her own health and for the growth of the baby.

6.3 Malabsorption

Diseases of the gut can reduce how well vitamins are absorbed. Celiac disease, Crohn disease, long term diarrhea, pancreatic disease and some surgeries can lead to deficiency.

Fat malabsorption is a big concern because vitamins A, D, E and K depend on normal fat digestion to be absorbed [4].

6.4 Chronic diseases and medicines

Chronic liver disease, alcohol use disorder and some gut diseases can affect how vitamins are stored or used.

6.5 Restrictive diets

People who follow very restrictive diets can develop specific deficiencies. Vitamin B12 is the main concern for people on strict vegan diets unless they use fortified foods or supplements.

7. Major Vitamin Deficiency Disorders

7.1 Vitamin A deficiency

This mainly affects the eyes and epithelial tissues. The first sign is usually difficulty seeing in the dark, or night blindness. As it gets worse it causes changes in the conjunctiva and cornea, called xerophthalmia.

Severe cases can lead to corneal ulcers, keratomalacia and permanent blindness. It weakens immunity and can increase the risk of serious infections in children [1].

7.2 Vitamin D deficiency

Lack of vitamin D leads to poor mineralization of bones.

In children, this is called rickets, which can cause poor growth and bone deformities. In adults, it causes osteomalacia, where newly formed bone does not mineralize properly, sometimes with bone pain and muscle weakness.

Risk factors are low intake, less exposure to sunlight, malabsorption and some chronic diseases [4].

7.3 Vitamin E deficiency

This is not common in healthy people but can happen in severe fat malabsorption or some genetic disorders. It can cause nerve problems and, in severe cases, hemolysis [4].

7.4 Vitamin K deficiency

Vitamin K is essential for generating hepatic coagulation proteins. Deficiencies directly compromise normal hemostasis, increasing hemorrhagic risk and prolonging bleeding times.

It is seen mainly in newborns, in patients with severe fat malabsorption and in people taking medicines that interfere with vitamin K.

7.5 Thiamine (B1) deficiency

Thiamine deficiency causes beriberi.

Dry beriberi mostly affects nerves and causes peripheral neuropathy, weakness and sensory problems. Wet beriberi affects the heart and can lead to heart failure.

Severe deficiency can also cause Wernicke encephalopathy, mostly in people with severe malnutrition or alcohol use disorder [4].

7.6 Riboflavin (B2) deficiency

This can cause angular stomatitis, cheilosis, glossitis and dermatitis. It usually occurs along with other nutritional deficiencies and is rarely seen alone.

7.7 Niacin (B3) deficiency

Severe niacin deficiency causes pellagra, which is known for the 3 Ds: dermatitis, diarrhea and dementia.

If not treated, severe pellagra can be fatal. It is mostly linked with severe malnutrition and conditions that affect niacin metabolism [4].

7.8 Vitamin B6 deficiency

This can cause dermatitis, anemia, peripheral neuropathy and in severe cases, seizures. It can happen due to low intake or because of some medicines that affect B6 metabolism.

7.9 Folate (B9) deficiency

Folate is needed for DNA synthesis and cell division. Lack of it affects red blood cell maturation and causes megaloblastic anemia.

It is very important in pregnancy because low folate in early development increases the risk of neural tube defects [5].

7.10 Vitamin B12 deficiency

B12 deficiency causes megaloblastic anemia and can also cause nerve problems.

The nerve symptoms include tingling (paresthesia), peripheral neuropathy, loss of vibration and position sense, ataxia and changes in memory and thinking. If the deficiency goes untreated for long, the nerve damage can become permanent.

It can be caused by low intake, poor absorption, autoimmune disease affecting intrinsic factor, or other gut disorders.

7.11 Vitamin C deficiency

Severe vitamin C deficiency causes scurvy. Vitamin C is needed to make collagen and keep connective tissue healthy.

Signs include bleeding gums, easy bruising, petechiae, slow wound healing, tiredness and anemia. Scurvy is rare where fresh fruits and vegetables are easily available, but it can still happen with very restricted diets or lack of food [4].

8. Clinical Assessment and Diagnosis

To diagnose a vitamin deficiency, the doctor has to put together the clinical findings, diet history and suitable tests.

Lab tests

Tests should be chosen based on which deficiency is suspected. Some examples are:

- CBC and peripheral smear for nutritional anemia
- Serum vitamin B12, and methylmalonic acid or homocysteine if needed
- Folate levels
- Serum 25 hydroxy vitamin D
- PT/INR if significant vitamin K deficiency is suspected
- Other specific tests when needed

Lab results should always be read along with the clinical picture, because blood levels of a vitamin do not always show the total amount stored in the body or how well the tissues are working.

9. Prevention of Vitamin Deficiency

Prevention is a key part of both clinical nutrition and public health.

9.1 Dietary diversification

A varied, balanced diet is your best defense against deficiencies. The WHO advises filling your plate with diverse, wholesome foods, including produce, whole grains, legumes, nuts, seeds, and quality animal products. [8].

9.2 Food fortification

Food fortification means adding vitamins or minerals to foods that people commonly eat. It works well when a deficiency is common in a population and there is a food that most people eat regularly.

Examples are fortified wheat flour, rice, edible oil and other staple foods.

The WHO considers food fortification an important way of preventing and reducing micronutrient deficiencies [1,9].

9.3 Supplementation

Supplements are helpful when diet alone is not enough or when the body needs more due to some condition.

Supplements should be based on evidence and given in the right dose, not taken randomly.

9.4 Biofortification

Biofortification means increasing the vitamin and mineral content of crops through farming and breeding methods. It is useful for people who depend heavily on a few staple foods.

It can work together with a varied diet, regular food fortification and supplements [3].

10. Vulnerable Groups

Some groups of people need special attention when it comes to vitamins.

10.1 Infants and children

Fast growth means children need more nutrients. Poor variety in diet and improper complementary feeding can lead to deficiency.

10.2 Adolescents

Adolescence is a time of fast growth. Poor eating habits, dieting, and not eating enough nutritious food can increase the risk of deficiency.

10.3 Elderly people

Elderly people are at higher risk because they may eat less, have chronic diseases, take many medicines and absorb nutrients poorly. Vitamin B12 and vitamin D need special attention in them.

10.4 People with malabsorption

Patients with gut diseases or past gut surgery may need nutritional assessment and sometimes long term supplements.

11. Vitamin Toxicity

Deficiency is the bigger concern, but taking too much of some vitamins can also be harmful.

Fat soluble vitamins are more likely to build up and cause toxicity. Too much vitamin A can cause headache, nausea, liver damage and other problems. High doses of preformed vitamin A are especially risky in pregnancy as they can cause birth defects [4].

Too much vitamin D can cause hypercalcemia, which can affect the gut, kidneys and other organs. This usually happens from taking too many supplements and not from normal sun exposure [4].

High vitamin B6 doses for a long time can cause sensory neuropathy. So the idea that a bigger dose always means more benefit is wrong.

The aim should be to get enough vitamins, not as much as possible. Supplements should only be used when there is a real need and in the right dose.

12. Conclusion

Vitamins are essential micronutrients needed for growth, metabolism, nerve function, immunity, blood formation, vision, bone health and maintenance of tissues. Even though only small amounts are needed, not getting enough can lead to serious diseases like xerophthalmia, rickets, beriberi, pellagra, megaloblastic anemia and scurvy.

Deficiency can be caused by poor diet, higher body needs, malabsorption, chronic illness, restrictive diets and social and economic conditions. The groups at higher risk are pregnant women, infants, children, adolescents, the elderly and people with gut disorders or restricted diets.

The main way to prevent deficiency is a balanced and varied diet with many nutrient rich foods. Where diet is not enough, fortification, proper supplementation, biofortification and nutrition education are useful additional steps. Surveillance and targeted programmes are especially important for high risk populations.

At the same time, too many supplements should be avoided since some vitamins can be toxic in large doses. The goal is not maximum intake but adequate and balanced intake based on evidence.

For doctors, understanding vitamin nutrition is necessary to recognize nutritional diseases, prevent deficiency, counsel patients and contribute to public health. Adequate vitamin intake at every stage of life plays an important part in preventing disease and keeping the body healthy.

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