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Vitamins: An Elixir of Life and Importance

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Abstract

Vitamins, very important known name need in very minute quantity and group of complex organic compounds present in natural food stuffs, play a key role in normal metabolism and lack of which in the diet causes deficiency several critical diseases. Vitamins are differentiated from the trace elements, also present in the diet in small quantities for health, growth, reproduction and other important metabolism. Vitamin are not formed in the body and need to take from natural source but some vitamin like A and K (Fat soluble vitamin) store in the body. Water soluble vitamin B complex and C (Water soluble vitamin) not store in the body and excess amount may easily pass out. In absent of single vitamin from the diet of a species that requires it will produce deficiency signs and symptoms. Deficiency and excesses of vitamin may cause harmful effect on the body and cause causes many symptoms.

Keywords: Vitamins; Fat soluble; Water soluble; Deficiency; Metabolism

Introduction

Vitamins are very essential nutrients that have directly contributed to a healthy life and in biochemical processes of several vital activities. Most of the vitamins we get from eaten food sources but if it is lacking in adequate amount in body then we take supplemental vitamins as part of our health regimen. The term "Vitamin" derives from the words "Vitalamine" because the first vitamins to be discovered contained an amino group (-NR2, where R is a hydrogen or some carbon-containing functional group) in their molecular structure. The vitamins can be mainly divided into fat-soluble (non-polar) and water-soluble (polar) molecules. The fat soluble vitamins include A, D, E, and K. The body stores them for a longer amount of time, so they are not needed every day. Water soluble vitamins dissolve easily in water and are readily excreted from the body to the degree that urinary output is a strong predictor of vitamin consumption [1]. Water soluble vitamins are not stored in the body so daily intake is very important [2]. Many types of water soluble vitamin are synthesized by bacteria [3].

Development of a vitamin intake strategy

It is very well known that human body need a very trace amount of vitamin intake and overdose in any form mainly fat soluble vitamin cause fatal effect on body so it is very important to make a strategy of vitamin intake. The 2005 Dietary Guidelines for Americans advises that nutrient needs be met primarily through consuming foods, with supplementation suggested for certain sensitive populations. These guidelines, published by the Department of Health and Human Services and the US Department of Agriculture (USDA), provide science-based advice to promote health and to reduce risk for chronic diseases through diet and physical activity. They form the basis for federal food, nutrition education, and information programs.

Special nutrient requirements

According to the Dietary Guidelines for Americans, people consuming more calories than they need without taking in recommended amounts of a number of nutrients. The Guidelines recommended that there are numerous nutrients including vitamins for which low dietary intake may be a cause of concern.

These nutrients are:

Adults: calcium, potassium, fiber, magnesium, and vitamins A (as carotenoids), C and E.

Children and adolescents: calcium, potassium, fiber, magnesium, and vitamin E.

Specific population groups: vitamin B-12, iron, folic acid, and vitamins E and D.

Risks associated with overdosing vitamins

Vitamins are needed in very trace amount for the normal cell functioning but overdose may cause fatal effects. Vitamins are not dangerous unless too much intake of them. More is not necessarily better with supplements, especially if you take fat-soluble vitamins. National Academy of Sciences has established upper limits of intake (ULs) of vitamins and minerals and recommends that intake should not be exceeded. Some side effects are given due to excess intake of vitamin doses.

Fat-soluble vitamins

Vitamin A (retinol, retinal, retinoic acid): Excess intake of it causes nausea, vomiting, headache, dizziness, blurred vision, clumsiness, birth defects, liver problems, possible risk of osteoporosis.

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These effects can be more fatal if person in taking excess of alcohol or have a chronic liver diseases (CLD) or high cholesterol levels or deficiency of protein in body.

Vitamin D (calciferol): Its excess intake causes nausea, vomiting, poor appetite, constipation, weakness, weight loss, confusion, heart rhythm problems, deposits of calcium and phosphate in soft tissues.

Water-soluble vitamins

Vitamin B-3 (niacin): Excess may induce flushing, redness of the skin, upset stomach.

Vitamin B-6 (pyridoxine, pyridoxal, and pyridoxamine): Vitamin B-6 overdose cause nerve damage to the limbs, which may cause numbness, trouble walking, and pain.

Vitamin C (ascorbic acid): It causes Upset stomach, kidney stones, increased iron absorption.

Folic acid (folate): Its overdose cause high levels may, especially in older adults, hide signs of B-12 deficiency, a condition that can cause nerve damage.

Vitamins Types, Sources and Related Diseases

Fat soluble vitamins

Vitamin A (Retinol): It is required for skin and body tissue repairs. It keys function in the body's defense system and other important functions. Most of fruits and vegetables not actually contain vitamin A, but rather contains β carotene which the body converts to vitamin A (Table 1). Different trials study has been performed on vitamin A and morbidity and vitamin A and young child mortality to determine the effectiveness of vitamin A supplementation on reducing mortality and morbidity in children from developing countries.

Mode of action: It functions at two levels in the body, first is in the visual cycle in the retina of the eye; the second is in all body tissues systemically to maintain growth and the soundness of cells. In the visual system, carrier-bound retinol transported to ocular tissue and to the retina by intracellular binding and transport proteins. Rhodopsin, the visual pigment critical to dim-light vision, is formed in rod cells after conversion of all trans retinol to retinaldehyde, isomerization to the 11-cis-form, and binding to opsin. Alteration of rhodopsin through a cascade of photochemical reactions results in ability to see objects in dim light [4].

The growth and differentiation of epithelial cells throughout the body are especially affected by vitamin A deficiency. Goblet cell numbers are reduced in epithelial tissues. The consequence is that mucous secretions with their antimicrobial components diminish. Both factors-the decline in mucous secretions and loss of cellular integrity-diminish resistance to invasion by potentially pathogenic organisms. The immune system is also compromised by direct interference with production of some types of protective secretions and cells [5].

Vitamin K: It is very important vitamin that helps in stop the flow of blood from a cut and helps the body hold onto calcium in bones. Lacking level of vitamin K causes impaired blood coagulation, uncontrolled bleeding occurs and also weaken bones and promote calcification of arteries and soft tissues. Dietary intake of vitamin K in tissues was hampered by the low specific radioactivity of the vitamin available (Table 1 and Figure 1).

Vitamin K is essential for the synthesis of proteins belonging to the Gla-protein family. Members of this family belong four blood coagulation factors, which all are exclusively formed in the liver. The importance of vitamin K for hemostasis is demonstrated from the fact that vitamin K-deficiency is an acute, life-threatening condition due to excessive bleeding. Other members of the Gla-protein family

Vitamin	Solubility	Deficiency	Sources	Dose (µg or mg)
Vitamin A (Retinol)	Fat	Night-blindness, Hyperkeratosis and Keratomalacia	Liver, orange, ripeyellow fruits, leafy vegetables, carrots, pumpkin, squash, spinach, fish, soymilk, milk	900 µg
Vitamin B1 (Thiamine)	Water	Beriberi, Wernicke-Korsakoff syndrome	Pork, oatmeal, brown rice, vegetables, potatoes, liver, eggs	1.2 mg
Vitamin B2 (Riboflavin)	Water	Ariboflavinosis, Glossitis, Angular stomatitis	Dairy products, bananas, popcorn, green beans, asparagus	1.3 mg
Vitamin B3 (Niacin, Niacin amide)	Water	Pellagra	Meat, fish, eggs, many vegetables, mushrooms, tree nuts	16 mg
Vitamin B5 (Pantothenic acid)	Water	Paresthesia	Meat, broccoli, avocados	5 mg
Vitamin B6 (Pyridoxine)	Water	Anemia, Peripheral neuropathy	Meat, vegetables, tree nuts	1.3-1.7 mg
Vitamin B7 (Biotin)	Water	Dermatitis, enteritis	Raw eggyolk, liver, peanuts, leafy green vegetables	30 µg
Vitamin B9 (Folic acid)	Water	Megaloblastic anemia and deficiency during pregnancy isassociated with birth defects, such as neural tube defects	Leafy vegetables, pasta, bread, cereal, liver	400 µg
Vitamin B12 (Cyanocobalamin)	Water	Megaloblastic Anemiaand other neurological disorder	Meat and other animal products	2.4 µg
Vitamin C (Ascorbic acid)	Water	Scurvy	Many fruits and vegetables, liver	90 µg
Vitamin D (Cholecalciferol (D3), Ergocalciferol-I (D2))	Fat	Rickets and Osteomalacia	Fish, eggs, liver, mushrooms	10 µg
Vitamin E (Tocopherols)	Fat	Deficiency is very rare; sterility in males and abortions in females, mild hemolytic anemia in new born infants	Many fruits and vegetables, nuts and seeds	15 mg
Vitamin K (Phylloquinone)	Fat	Bleedingdiathesis	Leafy greenvegetables such as spinach, egg yolks, liver	120 µg

Table 1: List of Vitamins, Sources and Deficiency Disease.

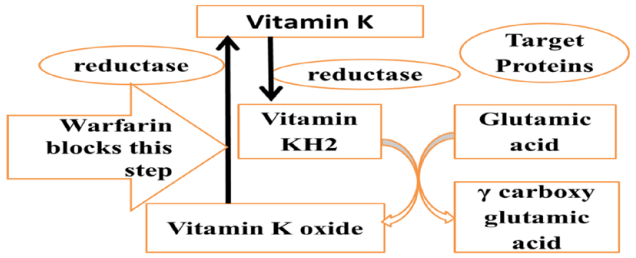

Figure 1: Vitamin K cycle.

are osteocalcin, matrix Gla-protein (MGP), and Gas6 that play key functions in maintaining bone strength, arterial calcification inhibition, and cell growth regulation [6].

Mode of action: The vitamin K-dependent proteins circulate as inactive forms of serine proteases until converted to their active forms. These conversions occur in stages where an active protease, a substrate, and a protein cofactor (triangles) form a Ca mediated associated with a phospholipid surface. The protein cofactors V and VII are activated by thrombin (IIa) to achieve full phase activity. The clotting system divided into two pathways: the extrinsic pathway, having involvement in tissue factor in addition to blood components on the other hand an intrinsic pathway, involves components present in the blood.

Vitamin D: It play very important role in bone formation and mainly in the presence of sunlight. Milk and margarine are both fortified with vitamin D. Its discovery was due to effort to find the dietary substance lacking in rickets [7]. Cod liver oil is has a high concentration and stored in the liver. Its low level can produce unhealthy weight loss, vomiting and calcium deposit in the lungs and kidneys (Figure 2).

Mode of action: In liver, cholecalciferol is converted to calcidiol, also known as calcifediol (INN). Ergocalciferol is converted in the liver to 25-hydroxyergocalciferol. These two specific vitamin D metabolites are measured in serum to determine a person's vitamin D status [8]. Part of the calcidiol is converted by the kidneys to INN, the biologically active form of vitamin D [9]. INN circulates as a hormone in the blood, regulating the concentration of calcium and phosphate in the bloodstream and promoting the healthy growth and remodeling of bone.

Vitamin E: It is necessary for the prevention of fetal death and reabsorption in rats fed a rancid lard diet [10]. It deficiency symptoms are liver necrosis in rats and pigs, erythrocyte hemolysis in rats and chicken, and white muscle disease in calves, sheep, mice, and mink [11]. However, due to the lack of a definite clinical syndrome attributable to vitamin E deficiency.

Mode of uptake: The mechanisms involved in the uptake of tocopherols by tissue are not very clear. Lipoprotein lipase bound to the surface of the endothelial lining of capillary walls catabolizes the triglycerides in the core of chylomicrons and forms chylomicron remnants [11,12]. Along with the free fatty acids, some vitamin E is also taken up by peripheral tissues during catabolism of lipoproteins by lipoprotein lipase. This includes lipoprotein receptor dependent and receptor-independent pathways, independent transport and co-transport of α-tocopherol and LDL, and uptake from a number of lipoproteins [13]. Most tissues, including liver, skeletal muscle, and adipose tissue, have the capacity to accumulate α-tocopherol [14-16]. The adrenal gland has the highest concentration of α-tocopherol, although lung and spleen also contain relatively high concentrations [17]. Approximately three-fourths of mitochondrial α-tocopherol is found in the outer membrane one-fourth is associated with inner membrane [18]. Also, essentially all tocopherol in the red cells is found in the membranes [19].

Water soluble vitamins

Vitamin C: It helps hold the cells together, heal wounds and build bones and teeth. It also acts as cofactor in at least eight enzymatic reactions and also acts as antioxidant and delay in cell apoptosis. These functions include the synthesis of collagen and neurotransmitters; the synthesis and catabolism of tyrosine; and the metabolism of microsome. Vitamin C has potent antioxidant properties. Importance of vitamin C may include protection against immune system deficiencies, cardiovascular disease, prenatal health problems, eye disease and sometime skin wrinkling. Several studies have been taken to effect on osteoporosis. Higher vitamin C intake levels were associated with a lower risk of osteoporosis in Korean adults aged over 50 with low levels of physical activity. However, no association was seen between vitamin C intake and osteoporosis risk in those with high physical activity levels.

Vitamin B complex: It is a class of water-soluble vitamins that play important roles in cell metabolism Although the yeast used to make beer results in beers being a source of B vitamins [20], their bioavailability ranges from poor to negative as drinking ethanol inhibits absorption of thiamine (B1) [15,21], riboflavin (B2) [22], niacin (B3) [23] biotin (B7) [24] and folic acid (B9).

Vitamin B1: It is the vitamin working with other B-group vitamins to help break down and release energy from food and to keep nerves and muscle tissue healthy. Person having dry beriberi suffers from a damaged nervous system may have nerve degeneration, nervous tingling throughout the body, poor arm and leg coordination and deep pain in the calf muscles. Wet beriberi relates to the cardiovascular system and includes an enlarged heart, heart failure and severe edema.

Vitamin B2: It is important vitamin to keep skin, eyes and the nervous system healthy and helping the body release energy from carbohydrate. People at risk include those who consume excessive amounts of alcohol and those who do not consume milk or milk products.

Vitamin B3: It is also important to produce energy from the foods and to keep the nervous and digestive systems healthy. Excessive intake large doses of niacin produce a drug-like effect on the nervous system and on blood fats. The symptoms of pellagra are commonly referred to

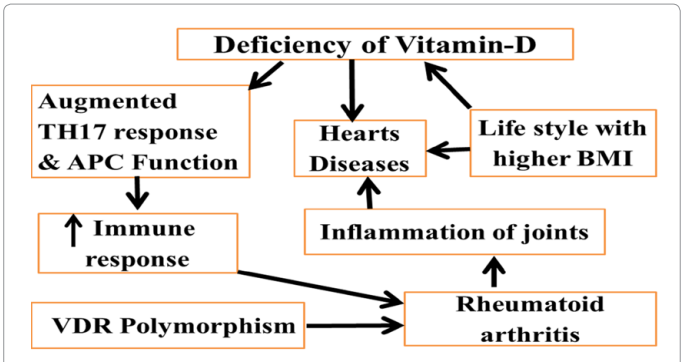

Figure 2: Vitamin D deficiency and its effects.

as the three Ds–"dementia, diarrhea and dermatitis".

Vitamin B5: It has several functions, such as helping release energy from the food we eat and also needed in needed to metabolize carbohydrates, proteins, fats. Symptoms include loss of appetite, fatigue and insomnia, constipation, vomiting and intestinal distress.

Vitamin B6: The active form pyridoxal 5'-phosphate serves as a cofactor in many enzyme reactions mainly in amino acid metabolism including biosynthesis of neurotransmitters. Symptoms are insomnia, depression, anemia, smooth tongue and cracked corners of the mouth, irritability, muscle twitching.

Vitamin B7: It is vitamin needed for energy metabolism, fat synthesis, amino acid metabolism and glycogen synthesis. Its deficiency is very rare because widely distributed in foods. Symptoms include pale or grey skin, cracked sore tongue, depression, hallucinations, abnormal heart actions, loss of appetite, nausea.

Vitamin B9: It helps in red blood cells formation, which carry oxygen around the body and helps in development of the foetal nervous system. Folic acid is the synthetic form of folate and is used extensively in dietary supplements and food fortification. It also acts as a co-enzyme in the form of tetrahydrofolate. Main sources include green leafy vegetables, legumes, seeds, liver, poultry, eggs, cereals and citrus. Deficiency symptoms include weight loss, tiredness, fatigue and weakness and increased risk of neural tube defects such as spina bifida for the baby (Figure 3).

Vitamin B12: It is important vitamin of it segment helps to produce and maintain the myelin surrounding nerve cells, mental ability, red blood cell formation. It is involved in the cellular metabolism of carbohydrates, proteins and lipids. It is essential in production of blood cells in bone marrow, and for nerve sheaths and proteins. It functions as a co-enzyme in intermediary metabolism for the methionine synthase reaction with methylcobalamin, and the methylmalonyl CoA mutase reaction with adenosylcobalamin. Symptoms include tiredness and fatigue, lack of appetite and weight loss, apathy and depression, smooth tongue and degeneration of peripheral nerves progressing to paralysis. B12 include liver, meat, milk, cheese and eggs almost anything of animal origin. The neurologic manifestations of cobalamin deficiency result from demyelination with subsequent axonal disruption. Hyperhomocysteinemia (HCY) and elevated methylmalonic acid (MMA) may be involved in the process of demyelination. Different rat models has been used to document the pathophysiology of vitamin B12 deficiency by nitrous oxide exposure [25] and different oxidative stress, neurophysiology and other clinical parameters changes that produced by its deficiency [26].

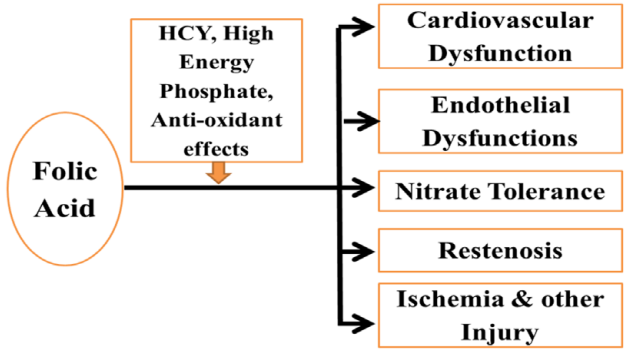

Figure 3: Folic acid and its deficiency diseases.

Vitamin B12 absorption and Vitamin B12 homeostasis: The vitamin after ingestion is absorbed via a complex mechanism. The acidic PH of the stomach cleaves cobalamin from other dietary protein. The free cobalamin then binds to the salivary R binder and the complex then travels to the upper small intestine. In the duodenum and upper jejunum, pancreatic enzymes lyse the R-protein-cobalamin complex. The IF-cobalamin complex is then absorbed through endocytosis in the terminal ileum. Once cyanocobalamin is internalized into the ileum, IF is removed from the complex and the vitamin gets bound to transport proteins namely transcobalamin I, II and III and is transported via the portal blood stream to the liver and other body tissues. Though transcobalamin II is the most important cobalamin transporter, about 70% of the serum cobalamin is bound by haptocorrins [27].

Neuropsychiatric Symptoms Associated with Vitamin B12 Deficiency

Dementia and cognitive impairment

Syndrome of acquired intellectual deterioration severe enough to interfere significantly with personal or social functioning. Defects in orientation, recent memory, learning, attention, deficits in abstraction, judgment, comprehension, language and calculation.

Bipolar disorder and attention deficit disorder

Psychiatric disorder characterized by increased periods of activity or mania and depression and inability to concentrate for prolonged periods of time.

Neurologic Manifestations of Vitamin B12 Deficiency

Spinal cord manifestations

Myelopathy (sub-acute combined degeneration of spinal cord).

PNS manifestations

Neuropathy, Motor-sensory polyneuropathy (parasthesias, numbness and weakness), Mononeuropathy (optic or olfactory), Autonomic neuropathy (impotence, urinary or fecal incontinence), and Myeloneuropathy (combined myelopathy and neuropathy).

CNS manifestations

Dementia, depression, acute psychosis, reversiblemanic/ scizophreniform states.

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