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A REVIEW ON VITAMINS: IT'S BIOLOGICAL ROLE AND DEFICIENCIES IN HUMANS

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ABSTRACT

The study focused on the benefits of vitamins and the diseases and health issues that come with their shortage. Vitamin deficits pose major health risks because they are essential for human health, growth, development, reproduction, and maintenance. Thirteen vitamins are real vitamins that can be divided into two categories: water soluble and fat soluble. Vitamins A, E, K, and D are fat soluble, and vitamins B1, B2, B3, B5, B6, B7, B9, B12, and C are water soluble. Micronutrients are vital components that humans and other organisms require in variable amounts throughout their lives to coordinate a variety of physiological activities and maintain good health. Essential nutrients can't be generated in humans or can't be synthesised in significant levels, thus they have to be received from diet. These vitamins can be found in a variety of foods, including plant and animal sources. For good health and development, they must consume a balanced diet on a regular basis. Vitamin shortages are linked to major health issues, as well as delays in normal development and growth.

Keywords : Antioxidants, Deficiency, Vitamins.

INTRODUCTION

Vitamins are a diverse set of chemical molecules that are unable to be manufactured by the human body but are required for the body's basic processes to function properly. Essential nutrients, like several beneficial phytochemicals, cannot be generated or synthesised in the human body (organism), either entirely or in inadequate amounts, and must therefore be received through diet (Awuchi, 2019a). Under normal circumstances, we can receive the various vitamins via food and proper nutrition, but minimum nutritional requirements are frequently not satisfied, necessitating supplementation. Vitamins are necessary for metabolism, as well as for body growth and proper function. The body produces only vitamin D; all other vitamins must be received through food. The majority of vitamins are made up of vitamers, which are groups of linked molecules. Vitamin E, for example, is made up of four tocopherols and four tocotrienols.

Vitamins serve a variety of biochemical purposes. Vitamin A is a growth and differentiation regulator for cells and tissues. The B vitamins serve as cofactors for enzymes and coenzymes, or as precursors to these enzymes. Vitamins C and E are antioxidants that protect cells from oxidation by free radicals in the body (Bender, 2003). Vitamin D has hormone-like properties, controlling mineral metabolism in the bones and other body organs.

Vitamins are divided into two categories: fat-soluble and water-soluble. There are 13 vitamins in humans: four fat-soluble (A, D, E, and K) and nine water-soluble (vitamin C and eight B vitamins). Water soluble vitamins breakdown rapidly in water and are eliminated from the body quickly, to the point where urine output is a good predictor of vitamin consumption (Fukuwatari and Shibata, 2008). Because they can't be stored as easily, they need to be consumed more frequently. Lipids assist fat-soluble vitamins to be absorbed through the digestive system (fats). Vitamins A and D can build up in the body, leading to hazardous hypervitaminosis (excess vitamins).

Vitamin deficiency and excess intake can both cause clinically significant illness, however high watersoluble vitamin intake is unlikely to do so. In cystic fibrosis, fat-soluble vitamin insufficiency as a result of malabsorption is particularly important (Maqbool and Stallings 2008).

Scurvy (vitamin C) and beriberi (vitamin D) are two disorders linked to a shortage of a certain vitamin (Garc'a, 2009). In general, vitamin-related organic illnesses include:

• Hypervitaminosis: an overabundance of one or more vitamins, particularly those that are poorly soluble in water and so difficult to eliminate through urine.
• Hypovitaminosis: a vitamin deficiency.
• Avitaminosis is a condition in which one or more vitamins are completely deficient.

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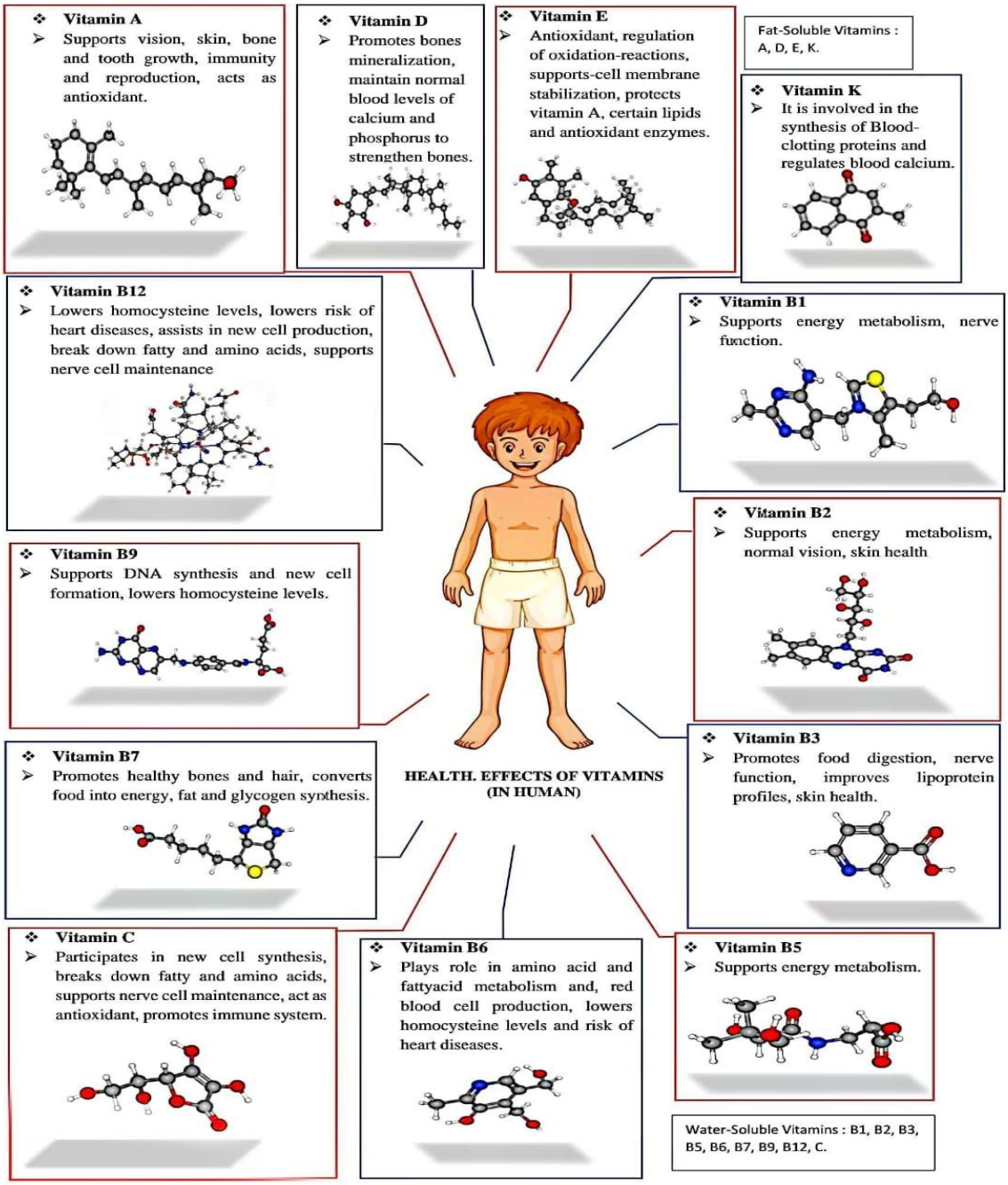

figure 1. Vitamins and their role in human body (Structure- https://pubchem.ncbi.nlm.nih.gov)

Vitamin B1 (Thiamine)

This vitamin is a component of the coenzyme thiamine pyrophosphate, which plays a role in cellular energy metabolism pathways like the pentose synthesis cycle and the tricarboxylic acid cycle. Thiamine is involved in alpha-keto acid oxidative decarboxylation, which includes the oxidative conversion of pyruvate to acetyl-CoA. Transketolase, the enzyme that catalyses the exchange processes of two carbon pieces in the oxidation of glucose via hexose monophosphate, uses it as a cofactor (Kochetov & Solovjeva, 2014)

Vitamin B1 deficiency is seen in cases of chronic drinking and malnutrition.A lack of this vitamin produces beriberi, a disorder that affects the heart and nervous system. Cyanosis, Peripheral neuropathy, tachycardia, peripheral paralysis of the lower extremities, and eventually death due to heart failure are some of the symptoms (Spinazzi, Angelini, & Patrini, 2010). Pyruvate cannot enter the tricarboxylic acid cycle without thiamine pyrophosphate, resulting in cardiac failure due to a lack of energy for the heart muscle.

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Vitamin B2 (Riboflavin)

Flavin adenine dinucleotide (FAD) and flavin adenine mononucleotide (FAM) are coenzymes that forms riboflavin (FMN). These are redox cofactors that operate as hydrogen acceptors and donors in redox processes in cells (Joosten & van Berkel, 2007). The flavin adenine dinucleotide accepts two hydrogens from FADH2 and transfers the hydrogens into the mitochondrial electron transport chain. The two hydrogens combine with oxygen to create water, which is then used to regenerate the FAD. In each transport cycle, two molecules of ATP are produced.

This vitamin deficiency is rare, and it usually occurs in conjunction with other B vitamin deficits. After months of vitamin deficiency, photophobia, tearing, soreness and burning on the lips, mouth, and tongue, as well as dermatitis, are some of the clinical indications that arise. It can also cause peripheral neuropathy.

Vitamin B3 (Niacin)

The nicotinamide adenine dinucleotide (NAD) and the phosphate nicotinamide adenine dinucleotide (PNAD) are two coenzymes that include niacin (NADP). Both coenzymes are essential for most enzymatic activities in cells, particularly glucose, lipid, and alcohol metabolism. Nicotinamide adenine dinucleotide transports hydrogens (and electrons) in metabolic reactions, including transport from the tricarboxylic acid cycle to the electron transport chain, in a similar way to the coenzyme FAD.

Anorexia, muscle weakness, dyspepsia, and a cutaneous rash are the initial signs of niacin insufficiency. Irritation and inflammation of the mouth and digestive tract mucous membranes are caused by digestive diseases. Pellagra, sometimes known as the sickness of the 3 Ds (diarrhoea, dermatitis, and dementia), is a severe deficiency that can sometimes lead to death. Pigmented and desquamative dermatitis are two types of dermatitis. Confusion, neuritis, and disorientation are symptoms of central nervous system illnesses (Prakash, Gandotra, Singh, Das, & Lakra, 2008).

Vitamin B5 (Pantothenic acid)

Pantothenic acid plays a role in the synthesis of lipids, haemoglobin, steroid hormones, and neurotransmitters in cells. Coenzyme A (CoA) and the acyl carrier protein are both components of acylation processes (ACP).

Pantothenic acid is a vitamin that is extensively available in meals, therefore lack is uncommon. It's only been seen in malnourished people or people who are on pantothenic acid antagonists. Fatigue, depression, exhaustion, weakness, and sleeplessness and paraesthesia in the fingers and soles of the feet are among symptoms of deficiency (Mataix & V arela Moreiras, 2009).

Vitamin B6 (Pyridoxine)

Pyridoxal phosphate, the active form of the vitamin, is a cofactor of several enzymes involved in the production of non-essential amino acids, as well as the metabolism of proteins and urea, due to its capacity to transfer amino groups. In the synthesis of heme group and nucleic acids, pyridoxal phosphate is involved in the conversion of the amino acid tryptophan to niacin or serotonin (Mataix & Sanchez de Medina, 2009). Vitamin B6 also has a role in the release of glucose from glycogen for the formation of myelin sphingolipids in nerve cells, as well as the modulation of steroid hormone receptors.

Vitamin B6 deficiency is uncommon because it is abundantly distributed in nature. It is kept in large amounts in muscle tissue, unlike other water-soluble vitamins. The interaction of some drugs with deficiency is frequently linked. Deficiency symptoms, like those of other B vitamins, include weakness, sleeplessness, irritability and peripheral neuropathies (Plecko & Stockler, 2009).

Vitamin B7 (Biotin)

As a coenzyme carrier of carbon dioxide, biotin plays a vital function in metabolism. It's important for the TCA cycle because it transfers a carboxyl group from pyruvate. It also plays an important role in fatty acid synthesis, gluconeogenesis, and fatty acid and amino acid catabolism.

Because it is extensively distributed and can be produced by the intestinal bacteria and absorbed in the colon, deficiencies are uncommon. Loss of appetite, seborrheic nausea, dermatitis, hallucinations, baldness, depression, and weariness are all symptoms of deficiency (Schellack, Harirari, & Schellack, 2015).

Vitamin B9 (Folic acid)

Folate has been the subject of intensive research over the last decade, with the conclusion that folates are vital for human health. Dihydrofolates, methyl folates, polyglutamyl folates, and monoglutamyl folates are some of the numerous types of folates found in foods (Crider et al., 2011). Folic acid is a methyl group donor that is involved in DNA synthesis, especially in cells that need to expand more. Tetrahydro folic acid is the active form.

Megaloblastosis of intestinal cells and macrocytic anaemia are symptoms of folic acid insufficiency. Folate deficiency is linked to hiperhomocysteinemia, or excess homocysteine, which is linked to an increased risk of coronary vascular disease and stroke Lack of this vitamin in pregnant women can cause neural tube problems in babies, such as spine bifida and anencephaly. High plasma levels of homocysteine (Hcy) have been associated to Alzheimer's disease (Ellinson, Thomas, & Patterson, 2004). Plasma Hcy levels are reduced when these patients are given large doses of vitamins B6 and B12, as well as folate (Aisen et al., 2008).

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Vitamin B12 (Cyanocobalamin)

The methylation cycle and vitamin B12 activity are inextricably linked. Folates help vitamin B12 become active by donating a methyl group. Folates and vitamin B12 are required for the regeneration of the amino acid methionine for the production of S-adenosylmethionine (SAM) and DNA synthesis (Mataix & V arela Moreiras, 2009).

Vitamin B12 deficiency affects cell division, particularly in bone marrow cells and the mucosa of the intestine. Erythrocyte mitosis is disrupted, resulting in abnormally large cells, immature erythrocytes, and a distinct anaemia known as megaloblastic anaemia. Progressive neuropathy with neural demyelination is another clinical condition. Burning feet, numbness, stiffness, tingling and general weakness are some of the symptoms.

Vitamin C (Ascorbic acid)

Vitamin C is required for L-carnitine synthesis, collagen production and the conversion of dopamine to noradrenaline. Collagen is the primary protein that keeps bone matrix, connective tissue, skin, cartilage, tendons, and dentin in good shape. Collagen synthesis is particularly critical in the creation of artery walls, which must expand and contract in response to blood flow. Because it serves as an electron donor, vitamin C is a crucial antioxidant for the body. It combines with free radicals produced during an oxygen burst and loses its electrons quickly as a reducing agent, eliminating reactive oxygen species from cells and biological fluids.

Scurvy is caused by a severe deficiency of vitamin C. The main symptom of vitamin C insufficiency is a decline in blood vessel integrity. The gums of the teeth bleed quickly, and capillaries beneath the epidermis are prone to breaking, resulting in microscopic punctate haemorrhages (petechiae).

Vitamin A (Retinoic acid)

Vitamin A is required for reproduction, eyesight, bone growth, cell division, and epithelial tissue differentiation, as well as immune system control (Hernandez, 2010). Ingesting provitamin A carotenoids from plants, as well as retynil esters, retinol, or retinal, can all be converted into the active form's retinol, retinal, and retinoic acid, ensuring these functionalities (Ochoa & Mataix, 2009).

Vitamin A insufficiency is caused by a lack of vitamin A stored in the liver. When a healthy adult quits eating vitamin A-rich foods, deficiency symptoms may not occur until the deposits have been depleted, which can take up to two years. During the growing phase, however, this period is relatively limited in children. Vitamin insufficiency is one of the most serious concerns in developing countries. More than 100 million children worldwide show signs of deficiency, making them more susceptible to infections, night or complete blindness (xerophthalmia), and keratinization, all of which can lead to mortality (Rao & Rao, 2007).

Vitamin D (Calciferol)

Because its biologically active form, 1,25-(OH)2colecalciferol or vitamin D3, is a hormone that may be produced in the body from cholesterol, vitamin D is not a required nutrient if enough UV radiation is received. Vitamin D is necessary for maintaining calcium and phosphorus balance as well as cell differentiation. The active form of vitamin D is found in the small intestine, which increases calcium ion active transport. It enhances calcium and phosphate ion reabsorption in the kidney tubules. Vitamin D has physiological functions in non-skeletal tissues as well.

Adults can develop osteocalcin, a bone deformity similar to rickets. It is more common in women who do not get enough calcium, do not get enough sunlight, and have had multiple pregnancies with breastfeeding. It involves the loss of bone density, which may typically be avoided by eating enough vitamin D, calcium, and phosphorus. The symptoms of vitamin D shortage (50 nmol/L) are similar to those of calcium deficiency because vitamin D deficiency prevents calcium from being absorbed, even if there is enough calcium in the diet. Rickets is a disease of vitamin D insufficiency in children. It's marked by structural anomalies in the bones, which become overly flexible and mushy. As a result, they are unable to endure stress, resulting in bone abnormalities such as bent legs. This disease continues to impact children in South Asia and the Middle East.

Vitamin E (Tocopherol)

Vitamin E is the body's primary fat-soluble antioxidant. It is found in biological membranes, where it shields membrane phospholipids' polyunsaturated fatty acids (PUFA) from oxidative destruction by free radicals (Brigelius-Flohe & Traber, 1999). It works in tandem with other cell-defence mechanisms (such as the enzymes glutathione reductase, glutathione peroxidase, and superoxide dismutase) and is influenced by the nutritional status of other minerals like selenium. In comparison to other antioxidants like vitamin C and -carotene, a meta-analysis found that higher vitamin E intake can reduce Alzheimer's disease risk in older populations (Li, Shen, & Ji, 2011). Vitamin E's antioxidant action helps with ageing, arthritis, cancer, cardiovascular disease, cataracts, diabetes, and infections by reducing oxidative stress in cells. The most major protective effect is that of vitamin E. Vitamin E "contributes to the protection of cells from oxidative stress," according to the EFSA (EFSA, 2009).

Vitamin E deficiency is uncommon, however it is linked to diseases of fat malabsorption, such as cystic fibrosis. Long-term vitamin E deficiency can lead to neuromuscular dysfunction, which damages the spinal cord and retina (Doerflinger et al., 1995). A sustained deficiency might produce erythrocyte haemolysis due to PUFA oxidation, which can be seen in preterm new-borns.

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Vitamin K (Menaquinone)

Vitamin K is required for the activation of numerous proteins involved in the blood clotting process. This vitamin is also important in the manufacture of bone proteins, which allow minerals to link together to create bones (Bugel, 2003).

The deficit is uncommon and is caused primarily by poor absorption. Bleeding is the most common symptom of vitamin K deficiency, which can lead to fatal anaemia. Some drugs (coumarinsacenocumarol, Sintroms, anticoagulants, blood thinners, salicylates, and antibiotics) counteract vitamin K's effect by reducing the gut bacteria required to manufacture the bioactive form.

Table:1. Recommended Dietary Allowances (RDA) for Vitamins (http://whfoods.org/.)

Vitamins	Males Daily Value	Female Daily Value	Pregnant Daily Value	Breastfeeding Daily Value
Vitamin A	1000 µg/d	800 µg/d	800 µg/d	1300 µg/d
Vitamin B1	1.5 mg/d	1.1 mg/d	1.5 mg/d	1.6 mg/d
Vitamin B2	1.7 mg/d	1.3 mg/d	1.6 mg/d	1.8 mg/d
Vitamin B3	19 mg/d	15 mg/d	17 mg/d	20 mg/d
Vitamin B5	10 mg/d	9.0 mg/d	10 mg/d	12 mg/d
Vitamin B6	2.0 µg/d	1.6 µg/d	2.2 µg/d	2.1 µg/d
Vitamin B7	30 µg/d	30 µg/d	40 µg/d	60 µg/d
Vitamin B9	400 µg/d	400 µg/d	400 µg/d	600 µg/d
Vitamin B12	2.0 mg/d	2.0 mg/d	2.2 mg/d	2.6 mg/d
Vitamin C	60 mg/d	60 mg/d	70 mg/d	95 mg/d
Vitamin D	5.0 µg/d	5.0 µg/d	10 µg/d	10 µg/d
Vitamin E	10 mg/d	8.0 mg/d	10 mg/d	12 mg/d
Vitamin K	70 µg/d	60 µg/d	65 µg/d	65 µg/d

CONCLUSION

To conclude, there are two types of vitamins that are vital to the human body: water-soluble vitamins and fat-soluble vitamins; both play an important role in the human body. Nobody can deny the importance of these vitamins to the body at all ages, and a lack of them can cause significant damage to specific regions of the body depending on the vitamin, age, and health state of each individual. Vitamins can do a more work in a small quantity. As a result, their overall daily requirement is generally also very low. Vitamin deficiency is the absence of a vitamin for an extended period of time. Primary deficiency is defined as a lack of vitamin intake, whereas secondary deficiency is defined as a lack of vitamin intake due to an underlying health condition such as malabsorption. Hypervitaminosis, on the other side, is the accumulation of fat-soluble vitamins in bodily tissues as a result of excessive vitamin intake.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interests.

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