

NUTRITIONAL DISORDERS

Nutrients are chemicals in foods that are used by the body for growth, maintenance, and energy. Nutrients that cannot be synthesized by the body and must be derived from the diet are considered essential. They include vitamins, minerals, some amino acids, and some fatty acids.

Nutrients that the body can synthesize from other compounds, although they may also be derived from the diet, are considered **nonessential**.

Macronutrients are required by the body in relatively large amounts; **micronutrients** are needed in minute amounts.

Lack of nutrients can result in deficiency syndromes (eg, kwashiorkor, pellagra) or other disorders (Under nutrition). **Excess** intake of **macronutrients** can lead to obesity and the Metabolic Syndrome. **Excess** intake of **micronutrients** can be toxic. Also, the balance of various types of nutrients, such as how much unsaturated versus saturated fat is consumed is important e.g. atherosclerotic plaques

EXAMPLES OF NUTRITIONAL DISORDERS

- Protein-calorie disorders: In children: marasmus-kwashiorkor(growth & mental retardation); in adults: starvation- cachexia- immunodeficiency
- Eating disorders: Anorexia nervosa & bulimia nervosa
- Nutritional excesses: Obesity
- Antioxidants and minerals(trace elements & Fe) :
 1. Decreased levels of zinc is responsible for delayed wound healing
 2. Decreased levels of iodine is responsible for goiter
 3. Decreased levels of Fe is responsible for anemia
 4. lead or mercury toxicity is responsible for neuropathy
- Vitamin deficiency - Hypervitaminosis (mostly fat soluble vitamins)

VITAMIN DEFICIENCIES

- Vitamins are micronutrients (organic chemical compounds) found in a large variety of foods. They are essential for health because they serve as critical catalytic cofactors which speed up reactions without being consumed or prosthetic groups on enzymes involved in vital metabolic reaction
- The body usually cannot synthesize them by itself.

The **fat-soluble vitamins** A, D, E & K. Found mostly in fatty foods (dairy products and meat). These are storable, but do not get absorbed through the gut in biliary insufficiency and other forms of fat malabsorption

The **water-soluble vitamins** (B & C, and folic acid) are available in most food stuffs as fruits, vegetables & animal products (only B12 is found exclusively in meat). The body does not store them well.

Disorders responsible for Hypovitaminosis

1ry : Malnutrition decreased intake

2ry:

- Malabsorption
- Increased metabolism i.e. relative insufficiency e.g. folic acid in pregnancy
- Presence of an antagonist e.g. methotrexate is a folic acid antagonist
- Debilitating diseases & malignancy

Vitamin A

- Vitamin A, is derived from Retinol found in dairy products and meat whilst the previtamin B carotene is found in yellow fruit and leafy vegetables. The body stores it in the liver and shuttles it around on retinol-binding protein
- Obvious deficiencies are common in the poor nations. Between 100 and 140 million children are vitamin A deficient.

FUNCTIONS OF VITAMIN A:

Vitamin A is involved in **gene expression**, cell growth and differentiation and **its functions** include:

- 1-Maintenance of specialized epithelium especially the mucin secreting types.
- 2- Important for vital pigments in the retina.
- 3- Increases the immunity.
- 4- Antioxidant function.
- 5-Anticarcinogenic due to its regulatory effect on cell growth

Vitamin A deficiency:

1-The best known symptoms of deficiency are

The first complaint in vitamin A deficiency is diminished vision in the dark Xerophthalmia or dry eye results from inadequate function of the lacrimal glands which produce conjunctival dryness

Bitot's spots(keratin plaques) result in opacification of cornea

Keratomalacia : degeneration of cornea with dryness, softening and ulcerations

Blindness is the end result.

2- Other problems due to squamous metaplasia include kidney stones , obstruction of the sweat and sebaceous glands leading to acne and lung infections .

3- Immunodeficiency.

4- Increase susceptibility to cancer.

Vitamin D

- While some vitamin D is supplied by the diet (yolk of eggs, as well as in various oils particularly fish liver oil and fats), most of it is made in the body, by the action of ultraviolet light on 7-dehydrocholesterol in the skin. After 25-hydroxylation in the liver, it is completely activated by 1-hydroxylation in the kidney.
- Its function is to maintain adequate Ca and phosphorus levels for normal mineralization of bone.
- Vitamin D deficiency occurs due to lack of dietary sources, lack of exposure to sun, liver and kidney diseases, fat malabsorption or inborn errors of metabolism (vitamin D resistant rickets; type I lacks 1-hydroxylase in the kidney, type II probably lacks vitamin D receptors).
- Vitamin D deficiency blocks mineralization of the osteoid laid down in remodeling of bone leading to **osteomalacia** in adults and impaired mineralization of the epiphyseal cartilage leading to **rickets** in children.

Rickets:

The sequence of events:

1-The epiphyseal cartilage does not even calcify. Instead, it overgrows .

2-Deposition of osteoid among inadequately mineralized cartilaginous remnants.

3- Enlargement and lateral expansion of osteochondral junction

4- Loss of structural rigidity leading to deformities.

Pathological features of rickets:

I-The bone abnormalities of rickets, include

1. **Head:** a)delayed closure of fontanelles, b) craniotabes (a softening of the skull bones resulting in the bone popping in and out similar to pressing on a Ping-Pong ball), c) frontal bossing(unusually prominent forehead) , d) square head and delayed eruption of temporary teeth.
2. **Chest:** a) rachitic rosary(knobs on the costochondral junctions due to overgrowth of cartilage), b) pigeon breast (anterior protrusion of the sternum, pulled forward by the respiratory muscles), c) Harrison's groove: a horizontal line at the lower margin of the thorax where the diaphragm attaches to the ribs. It appears in rickets because the patients lack the mineralized calcium in their bones necessary to harden them; thus the diaphragm, which is always in tension, pulls the softened bone inward

3. **Vertebrae**: lumbar lordosis (excessive inward curve of the spine)
4. Bow **legs** and trifoil pelvic deformities.

II- Somatic lesions:

1. lymph node and adenoid enlargement and splenomegaly due to hyperplasia.
2. Weak tendons and muscles.

III- General lesions:

1. Overweight due to limited movements.
2. Protuberant abdomen due to weak muscles (Potts belly), lordosis.
3. Lymph node enlargement , splenomegaly

Osteomalacia

- Occurs in adults, commonly in females as a result of repeated pregnancies with vitamin D deficiency.
- Osteomalacia means "soft bones", the osteoid does not mineralize properly, during bone remodeling and it accumulates. The bone density and cortical thickness are decreased, predisposing to fractures. Bones are soft, easily bent resulting in a trifoil pelvis (this deformity is responsible for obstruction of labour), bowing of legs & lumbar lordosis.
- In osteomalacia, the non-calcified bone looks pale on x-ray and has a tendency to break.

Vitamin K

- This is the cofactor for the synthesis of gamma-carboxy glutamic acid, which is required for the calcium-binding clotting factors II, VII, IX, and X, plus protein C, S, and Z .
- Although our intestinal flora makes a little vitamin K for us, it is inadequate and it is usually complemented from the diet. It is present in oils, green leafy vegetables and dairy products
- Vitamin K is hard to avoid in the diet, we store several weeks' supply.
- Deficiency is seen mostly in newborns and in those with lipid malabsorption or rarely due to wiping out the bacterial flora with antibiotics

Pathology of vitamin K Deficiency:

1. Hemorrhagic disease of the newly born
2. Petechia, ecchymosis and haematomas occur in any tissue following minor trauma.
3. Persistent bleeding follows wounds and surgical incision.

Vitamin C (ascorbic acid)

Humans, cannot synthesize it and its reserves are limited so the deficiency manifestations appear after 30-40 days. In the diet, it is present in citrus fruits and tomatoes

Vitamin C functions:

- 1- It is involved in developing and maintaining collagen, synthesizing chondroitin sulfate.
- 2- Antioxidant as it protects the body against oxidative stress, and is a cofactor in several vital enzymatic reactions and maintains Fe and Cu in various oxygenases in a reduced state.
- 3- Synthesis of neurotransmitters.
- 4- Important in immune functions.
- 5- Increases intestinal absorption of iron and folic acid.

The deficiency syndrome is "scurvy":

- Occurs in people who eat very poorly for several weeks. In the poor nations, scurvy occurs in children whose mothers feed them with un-supplemented formula.
- Scurvy is a distinctive clinical syndrome related to problems with osteoid synthesis and collagen support of the blood vessels.

Pathological features of scurvy:

- In children, the osteoblasts lay down scanty, poor-quality osteoid. The end result is deformities similar to rickets (enlargement of bony ends rosary bed, sternal depression, bowing of legs and defective teeth formation).
- In both children and adults, the capillaries weaken. Patients bruise easily, and bleeding gums, and petechiae around the hair follicles. Eventually, hemorrhages beneath the periosteum develop, making this the most painful of the deficiency diseases.
- Wounds heal poorly.
- A secondary functional folic acid deficiency develops, because vitamin C is responsible for maintaining folate in its reduced state leading to anemia.

Vitamin B1 (thiamine)

- This vitamin is important in carbohydrate metabolism, synthesis of ATP and it also maintains nerves
- Thiamine deficiency was seen classically in people subsisting on polished rice, and today in alcoholics, cancer victims who do not eat, women with extreme vomiting of pregnancy, and in children and adults who have been starved.

Thiamine deficiency

- A cardiomyopathy, with a flabby, failing heart ("wet beriberi"), plus generalized dilatation of arterioles requiring "high output"
- A peripheral neuropathy ("dry beriberi"), with numb fingers and toes, weak muscles, and lost reflexes. First the myelin, then the axons and even the motor and sensory neurons go.)

Vitamin B3 (niacin, nicotinic acid)

- It's formed from spare tryptophan.
- Niacin in maize ("corn") is poorly absorbed, maize is low in tryptophan.
- Pellagra ("dry skin") used to be endemic in southern "corn belt" (corn eating societies and in an alcoholics.

Niacin deficiency ("pellagra"):

Niacin deficiency produces the "three D's"

- **Dermatitis:** Red, thick, scaly, sharply demarcated, irregularly pigmented skin, especially sun-exposed regions; and "beefy red tongue";

Microscopically: acanthosis, confluent parakeratosis, hyperkeratosis and increased pigmentation. .

- **Diarrhea:** The mucosa of the colon is hyperemic and covered by pseudomembrane.

Microscopically : hyperaemia , areas of necrosis and mononuclear inflammatory cellular infiltration.

- **Dementia:** Mental illness and loss of neurons in frontal lobes; and demyelination of the lateral and posterior column (subacute combined degeneration). The fourth "D" is "death".

B12 (Cyanocobal-amine) & Folic acid

- Coenzyme for nucleic acid & RBC production. Folic acid is also an important for proper nerve function
- Present in vegetables & fruit (bananas & lemons)
- Responsible for megaloblastic anemia in addition to Neurological damage in cases of folic acid deficiency