SALEM UNIVERSITY LOKOJA

COLLEGE OF NATURAL AND APPLIED SCIENCES

DEPARTMENT OF BIOSCIENCES

LECTURE NOTE

BCH 317 – NUTRITONAL BIOCHEMISTRY (2CU)

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Nutritional Biochemistry

The history of biochemistry actually started with nutrition. The first biochemists explored vitamins and how they worked, and what kind of deficiencies you'd see if someone lacked those particular nutrients. Basically, they observed certain disease states, like pellegra or rickets and were able to link to lack of certain foods. Chemists would then isolate various chemicals from the food to learn what the missing ingredient was. Think about the Limey sailors who discovered citrus fruits prevented scurvy. Only years later when technology evolved could biochemists discover that it was vitamin C in the limes that reversed the disease. Scientists felt that if we understood the chemistry of the body and what wasn't working, we could fix anything. In other words, it was better living through chemistry, just plug in the missing or 'broken' molecule and illnesses would be fixed.

In the 1960s, biochemistry was very much a reductionist discipline. Decades later, the whole person and family become part of the "biochemical equation", followed by stress, the mind and body.

Rather than seeing biochemistry as just another piece of academic information, we invite you to enjoy the visit into the deepest molecules of life, your life. Every physical part of us is chemical and by understanding just a bit of this vast wondrous molecular universe you may better appreciate how the vitality and health of your body depends on what its being fed.

Nutrition as defined by Robinson (1982) is " the science of foods and nutrients, their action, interaction and balance in relationship to health and disease, the processes by which the organism ingests, digests, absorbs, transports and utilizes nutrients and disposes of their end product".

Nutrients are the constituents in food that must be supplied to the body in adequate amounts. These include Carbohydrates, Proteins, Fats, Minerals and Vitamins; Water is included in current lists.

Nutritional status is the condition of health of the individual as influenced by the utilization of the nutrients.

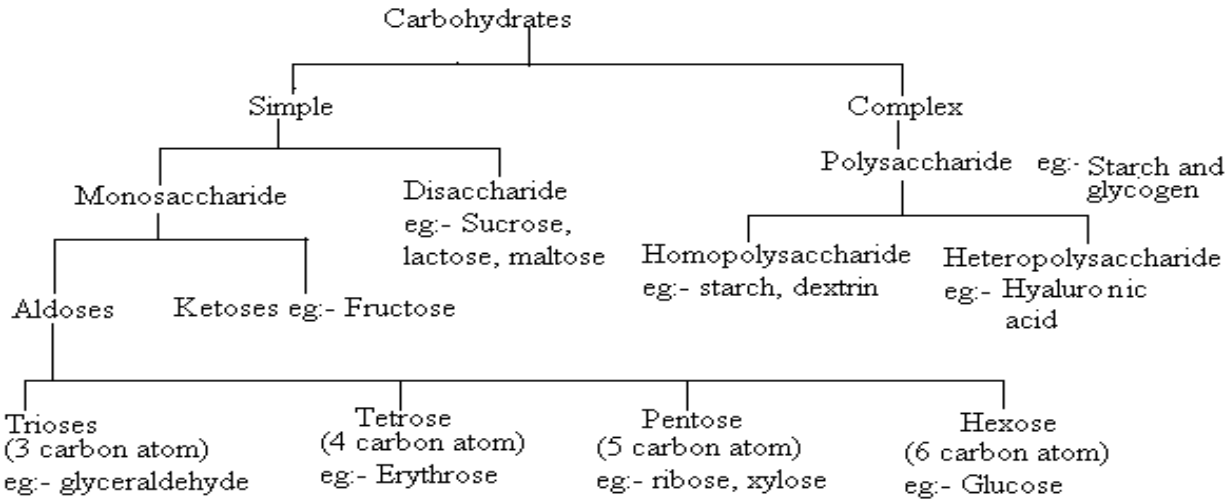
NUTRIENTS AND THEIR FUNCTIONS

Any chemical substance that can be used by an organism to sustain its metabolic activities is a nutrient. There are six basic types of nutrient.

1. **Carbohydrates**

Energy that is needed to move, perform work and live is chiefly consumed in the form of carbohydrates. Carbohydrates, primarily starches, are least expensive, easily obtained and readily digested form of fuel. Carbohydrates are organic compounds composed of carbon, hydrogen and oxygen, with the later elements in the ratio of 2:1. The general formula is CnH2nOn. They are viewed as hydrated carbon atoms.

Classification – simple and complex carbohydrates



Carbohydrates are classified, depending on the number of sugar units they contain, as simple carbohydrate and complex carbohydrates.

Monosaccharides and disaccharides make up simple carbohydrates, called simple sugars containing one and two sugar units respectively. Polysaccharides called complex carbohydrates are structurally larger and more complex than simple sugars. They include starch, dietary fibre and glycogen.

Functions of Carbohydrates

Carbohydrates perform the following functions.

1. Energy: The principle function of carbohydrates is to serve as a major source of energy for the body. Each gram of carbohydrate yields 4Kcal of energy regardless of its source. In Indian diets 60 – 80 % of energy is derived from carbohydrate.

2. Glucose: Glucose is indispensable for the maintenance of the functional integrity of the nervous tissue and is the sole source of energy for the proper functioning of the brain. Prolonged lack of glucose may cause irreversible damage to the brain.

3. Protein Sparing Action: Carbohydrates exert a protein sparing action. If sufficient amounts of carbohydrates are not available in the diet, the body will convert protein to glucose in order to supply energy. Hence to spare proteins for tissue building, carbohydrates must be supplied in optimum amounts in the diet. This is called the protein sparing action of carbohydrates.

4. Fat Metabolism: Carbohydrates are essential to maintain normal fat metabolism. An insufficient carbohydrate in the diet results in larger amounts of fat being used for energy than the body is equipped to handle. This leads to accumulation of acidic intermediate products called ketone bodies.

5. Synthesis of Body Substances: Carbohydrates aid in the synthesis of nonessential aminoacids, glycoproteins (which function as antibodies) and glycolipids (which form a part of cell membrane in body tissues especially brain and nervous system).

6. Precursors of Nucleic Acid: Carbohydrates and products derived from them, serve as precursors of compounds like nucleic acids, connective tissue matrix and galactosides of nervous tissue.

7. Detoxification Function: Glucuronic acid, a metabolite of glucose serves as a detoxifying agent. It combines with harmful substances containing alcohol or phenolic group converting them to harmless compounds which are later excreted.

8. Roughage of the Diet: Insoluble fibres known as composite carbohydrates can absorb water and give bulk to the intestinal contents which aids in the elimination of waste products by stimulating peristaltic movements of the gastrointestinal tract.

Food Sources of Carbohydrates

Cereal grains, roots and tubers are the major sources of starch. Fruits and vegetables contain varying amounts of monosaccharides and dissaccharides. Sugar is obtained from sugarcane.

Types and sources of Carbohydrates are given in the table below

S/No	**Carbohydrate**	**Food Source**
1	**Monosaccharides**	
	Glucose	Fruits, honey, corn-syrup.
	Fructose	Fruits, honey.
	Galactose, Maltose	These do not occur in free form in foods.
2	**Dissaccharides**	
	Sucrose	Cane and beet sugar.
	Lactose	Milk and milk products.
	Maltose	Malt and Cereal products
3	**Polysaccharides**	
	Digestible:	
	Starch & Dextin	Grains, vegetables especially roots& tubers and legumes
	Glycogen	Meat products and seafoods

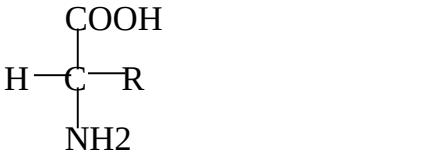
Indigestible:

Cellulose	Stalks and leaves of vegetables, outer coat of seeds
Pectins, Gums	Fruits, Plant secretions and seeds.

2. PROTEIN

One fifth of an adults total body weight is protein. Protein is found in every cell of our body. All the tissues in our body such as muscle, blood, bone, skin and hair are made up of proteins. Many hormones and enzymes are either protein or protein derivatives. The nucleic acids in the cell nucleus occur in combination with proteins as nucleoproteins. Protein is thus essential to maintain cellular integrity and function and for health and reproduction.

Protein is synthesized from basic units called amino acids. Protein molecules, which contain up to hundred amino acids are much larger than carbohydrates or lipid molecule. Chemically amino acids are composed of a carbon atom to which is attached a carboxyl (COOH) group, a hydrogen atom (H), an amino group (NH_2) and an amino acid radical (R) as shown below. They are distinguished from carbohydrates and fats by the presence of nitrogen. The carboxyl group, the amino group and the hydrogen atom are the same for all amino acids. The R group distinguishes one amino acid from another.



Structure of an Amino acid.

A protein is made upon of chains of amino acids joined to each other by a peptide linkage. The amino group of one amino acid is linked to the carboxyl group of another amino acid by removal of water. Proteins consist Polypeptides.

Nutritionally Essential and Non-Essential Amino Acids

An essential amino acid is one that cannot be synthesized by the body and hence should be supplied by the diet. The essential amino acids are histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan and valine. Non-essential amino acids are those that the body can synthesize. They are alanine, arginine, aspargine, aspartic acid, cysteine, glutamic acid, glutamine, glycine, proline, serine and tyrosine.

Biological Value of Protein: Biological value of protein is the percentage of a protein nitrogen that is absorbed and available for use by the body for growth and maintenance. Proteins are functionally divided into complete, partially complete and incomplete proteins. A complete protein contains all essential amino acids in relatively the same amounts as human beings require to promote and maintain normal growth. (eg) Protein derived from animal foods. A partially complete protein contains sufficient amounts of amino acids to maintain life but fail to promote growth. (eg) Gliadin in wheat. Incomplete proteins are incapable of replacing or building new tissue and cannot support life or growth. (eg) Protein in Wheat germ.

Food sources of dietry protein

	Food Stuff	Protein %
1	Meat, fish and liver	18 – 20
2	Eggs	14
3	Milk powder, full fat	26
4	Milk powder, skimmed	33
5	Cheese	18 – 20
6	Pulses	18 – 24
7	Nuts and oilseeds	18 – 26
8	Soyabean	35 – 40
9	Cereals and millets	6 – 12
10	Tender legumes, green peas, cow peas	7 – 8
11	Potato	2
12	Green leafy vegetables	2-6

Source : Swaminathan. M. 1986. Principles of Nutrition and Dietetics.

Functions of Protein

Proteins form a major part of total body structures and they participate in many activities in our body. The major functions of protein in our body can be listed below

1. Build and repair body tissues: Proteins form integral parts of most body structure such as skin, tendon, membranes, muscles, organs and bones. They support the growth and repair of body tissues.

2. Enzymes: (eg) Lipase helps to breakdown fat and sucrase breaks down sugar.

3. Hormones: Regulate body process.

4. Antibodies: Inactivate foreign invaders thus protecting the body against disease.

5. Fluid & electrolyte balance: Proteins help to maintain the volume and composition of body fluids.

6. Acid-base balance: Proteins help maintain the acid-base balance of the body fluids by acting as buffers.

7. Energy: Proteins provide fuel for the body' s energy needs [4 KCal/gm].

8. Storage: Proteins help to store iron and copper.

9. Homeostasis: Proteins maintain normal osmotic balance among body fluids.

10. Transport: proteins (eg) Haemoglobin, lipoprotein These type of proteins carry nutrients to the tissues. eg lipoprotein carry lipids, haemoglobin transports oxygen.

11. Contribute to sensory & physical properties of food: Proteins impart colour , flavour, odour and texture to foods.

3. LIPIDS

Lipids more commonly known as fats and oil are integral part of our food. They are insoluble in water but soluble in organic solvents. They occur in both plant and animals. Lipids are a concentrated source of energy.

Classification

Lipids are classified into simple, compound and derived lipids which are further subdivided as follows

a. Simple lipids: Fats and Oils are included in this type. At room temperature, oils are liquids and fats are solids. Fats and oils contain esters of fatty acid and glycerol, a form in which lipids are present in food. Other simple lipids are waxes.

b. Compound lipids: They are esters of fatty acids containing phosphorous carbohydrate or protein. Phospholipids contain a phosphoric acid in addition to the alcohol and fatty acids. Glycolipids contain a fatty acid, carbohydrate and a nitrogenous base. Phospholipids and glycolipids form part of the cell membrane and the nervous system. Lipoproteins are macromolecular complex of lipids with proteins.

c. **Derived lipids:** These are substances liberated during hydrolysis of simple and compound lipids which still retain the properties of lipids. The important members of this group are sterols, fatty acids and alcohol.

Sterols: Sterols are solid alcohols and form esters with fatty acids. In nature they occur in the free state in the form of esters. Based on their origin sterols are classified as cholesterol (animal origin) and phytosterol (in plants). Cholesterol is a complex type of lipid that is regularly synthesised by and stored in the liver. It is present in all animal products.

Fatty acids: Fatty acids are the main building blocks of fat. They have a methyl group (CH_3) at one end and a carboxyl group (COOH) at the other end with a chain of carbon and hydrogen atom in the middle. They have a basic formula $CH_3 (CH_2)n$ COOH. Where 'n' denotes the number of carbon atoms which may vary from 2 to 2l.

Fatty acids can be classified either as Saturated Fatty Acids (SFA) or Unsaturated Fatty Acids (UFA).

Essential and Non – Essential fatty acid

Essential fatty acid (EFA) are those which cannot be synthesized by the body and need to be supplied through diet. E.g Linolenic acid, linoleic acid and arachidonic acid.

Non-essential fatty acids are those which can be synthesized by the body and which need not be supplied through the diet. E.g Palmitic acid, oleic acid and butyric acid.

Functions of Lipids

Lipids perform several important functions:

1) They are the concentrated fuel reserve of the body. When one gram of fat is oxidized it yields 9 kilocalories.

2) Lipids are the constituents of cell membrane structure and regulate the membrane permeability.

3) They are essential for the digestion, absorption and utilization of fat soluble vitamins like Vitamin A, D, E and K.

4) Lipids are important as cellular metabolic regulators (Steroid hormones and prostaglandin).

5) Lipids protect the internal organs serving as insulating materials.

6) As compounds of the mitochondria membranes, lipids (phospholipids) participate in electron transport chain.

7) Fat imparts palatability to the diet and slows stomach emptying time, thus giving a feeling of fullness. This delay of onset of hunger is called 'satiety value' of fats.

8) The calories in fat spare the proteins from being oxidized for energy.

9) Fat deposited in the adipose tissue serves as reserve source of energy during starvation. It acts as an insulator conserving the body heat. Essential fatty acids which are derived lipids perform important functions in our body.

Functions of essential fatty acids:

1) Maintenance of the function and integrity of cellular and subcellular membrane.

2) Regulation of cholesterol metabolism by transporting it between the blood and body tissues.

3) Acts as precursor of hormone like – prostaglandin which aid in regulating vascular function and help relieving pain and inflammation.

4) Delays blood clotting time.

Food Sources

Foods in general contain two types of fat namely "visible fats" and "invisible" or "hidden" fats.

Visible fats:

Visible fats are fats extracted from the following sources.

a. **Oil seeds :** coconut, corn, cornseed, groundnut, mustard, palm, rice bran, safflower, sesame, soyabean, sunflower and hydrogenated vegetable oils.

b. **Animal fats:** Butter and Ghee.

c. **Fish oils:** Shark and cod liver oils.

Invisible or hidden fats:

Invisible or hidden fats are those which form an integral part of foods and are therefore not visible. It includes the fats present in the cells and cell walls and cell membranes of both plant and animal tissues.

Almost everything we eat as listed below carries some invisible fats.

a) Plant food – Cereals, millets, vegetables, spices, nuts and oil seeds, coconut, avacado.

b) Animal food – Milk and milk products (curd, cream, cheese), flesh foods, (mutton, beef, pork, chicken) organ meats (brain, liver, kidney), fish, shrimp, prawn.

Sources of Saturated Fat:

Saturated fat is resistant to oxidation even at frying temperatures. Examples are

a) Plants – coconut oil. Hydrogenated vegetable oils. Palm kernel oil.

b) Animals – Butter, ghee, fats from flesh foods and organ meats.

Sources of Unsaturated Fat:

Unsaturated fats and oils include mono and poly unsaturated fatty acids (MUFA and PUFA) in various proportions:

a) Plant sources: All common vegetable oils with the exception of coconut oils are predominantly unsaturated. The invisible fats present in nuts and oilseeds, cereals, pulses and legumes, roots and tubers, vegetables, spices and fruits. In most plant foods and vegetable oils linoleic acid is the predominant PUFA, but mustard and soyabean oils, legumes/pulses. Fenugreek leaves, and green leafy vegetables are good sources of alpha linolenic acid.

b) Animal sources: The muscles (lean meat) of flesh foods, unlike the depot fat surrounding the tissues is mainly composed of cholesterol esters and phospholipids, both of which have a high proportion of long chain n-6 PUFA which are otherwise formed in the body from linolenic acid. Arachidonic acid is found in animal and human cells. Fish and fish oils provide long chain n–3 PUFA.

Cholesterol

Cholesterol is a constituent of animal foods but is absent in plants. Vegetable oils do not have cholesterol. In human diets, cholesterol is obtained from ghee, butter, cheese, milk, curd, egg, flesh foods, organ meats, fish and prawns. Most animal foods are good sources of both cholesterol and fatty acids.

Hydrogenation

Hydrogenation (addition of hydrogen at double bonds) converts liquid oils into semisolid or solid fats. During hydrogenation, linoleic and alpha linolenic acid present in the oils are converted to trans fatty acids and saturated fatty acids. Also, the monounsaturated fatty acids are converted to saturated fatty acids. Hydrogenated fats were designed to imitate ghee. It is used to prepare processed foods like biscuits and cakes.

MINERALS AND VITAMINS

Until the middle of the nineteenth century, the importance of minerals and vitamins was not known. It was observed that carbohydrate, fat, protein alone were incapable of promoting and sustaining growth. Hence scientists attempted to find out the "missing elements", namely minerals and vitamins which are essential for growth and maintenance.

4. MINERALS

Essential minerals which are inorganic substances are classified as macro and micronutrients based on the amount needed by humans per day.

Macrominerals are those which are vital to health and that are required in the diet by more than 100mg per day and those required in the diet less than 20mg per day are called microminerals or trace minerals. The essential macrominerals are Calcium, Phosphorous, Magnesium, Sulphur, Potassium and Chloride. Important microminerals of relevance in human nutrition are Iron, Zinc, Copper, Sodium, Cobalt, Fluoride, Manganese, Chromium, Iodine and Molybdenum.

Macrominerals- 2 examples

Calcium and Phosphorus

Calcium is an essential element required for several life processes. The requirements of Calcium and Phosphorous are considered together as their function and requirement are closely linked. Over 99% of the Calcium and Phosphorous is present in the bones and the remaining 1% in the body fluids.

The Calcium and Phosphorous are present in the ratio of 2:1 in our body. In the skeletal system Ca and P is present in the form of hydroxyapatite crystals. Hydroxyapatite is a compound made up of calcium and phosphate that is deposited into the bone matrix to give it strength and rigidity.

Functions:

1. Bone formation: The major mineral ions of the bone are Calcium, Phosphorous and Magnesium. For proper calcification of bones, (deposition of minerals on the bone matrix) which occurs during the growth, adequate supply of these minerals is essential.

2. Tooth formation: - C and P together are essential for dentin and enamel formation.

3. Physiological Process: -

a. C is essential for the clotting of blood as it is required for prothrombin activation.

b. C regulates the permeability of the capillary walls and ion transport across the cell membranes.

c. It is essential for the contraction of the heart and skeletal muscle.

d. Ca regulates the excitability of the nerve fibres.

e. Ca acts as an activator for enzymes such as rennin and pancreatic lipase.

4. Phosphorous is essential for the storage and release of ATP molecules.

5. Phosphates act as buffers to prevent changes in acidity of the body fluids.

6. Phoshpolipids are major components of cell membrane and intra cellular organelles.

7. In the DNA and RNA phosphate is an essential part of the nucleic acids.

Food sources

Cereals contains large amounts of calcium. Gingely seeds, cuminseeds, poppy seeds, drumstick leaves are good sources of calcium. Milk and milk products are good sources of calcium and phosphorous. Only 20 – 30 % of the calcium in the diet is absorbed, which is facilitated by Vitamin–D. All foods contain significant amounts of phosphorous.

Microminerals -1 example

Microminerals are also known as trace elements. However only the deficiency of few of these elements is observed in humans. Iron and Iodine deficiencies are wide spread while deficiencies of Cu, Zn, Cr and Se have been reported in recent years.

Iron

The total body iron is 4g in adults. Iron exists in a complex form in our body. Present as

a) Iron porphyrin compounds – hemoglobin in RBC, myoglobin in muscle.

b) Enzymes – (eg) peroxidases, succinase dehydrogenase and cytochrome oxidase.

c) Transport and storage forms: - (eg) transferrin and ferritin.

Functions

The chief functions of iron in the body are:

1. Iron forms a part of the protein – haemoglobin which carries oxygen to different parts of the body.

2. It forms a part of the myoglobin in muscles which makes oxygen available for muscle contraction.

3. Iron is necessary for the utilization of energy as part of the cells metabolic machinery.

4. As part of enzymes iron catalyzes many important reactions in the body. Examples are

a) Conversion of beta carotene to active form of Vitamin A

b) Synthesis of carnitine, purines, collagen and neuro transmiters.

c) Detoxification of drugs in the liver.

Food Sources

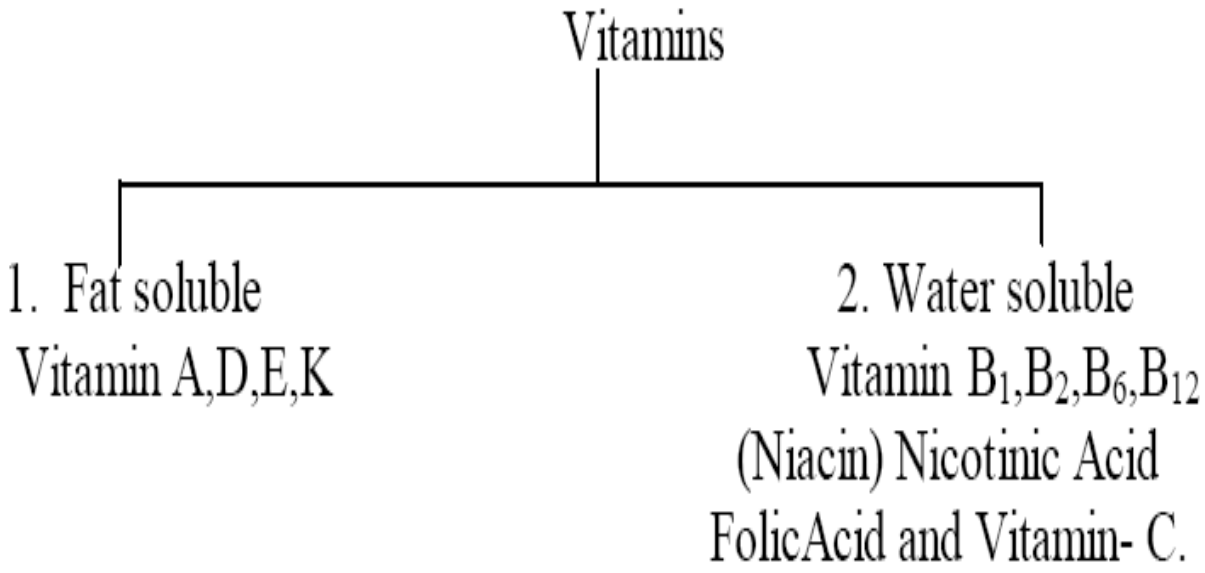
The iron present in food can be as haem and non-haem iron depending upon the source from which it is obtained. Haem iron – is obtained from animal tissues, non-heam iron – is obtained from plant foods.

Sources of non-haem iron are green leafy vegetables, dried fruits and jaggery. Liver, fish, poultry, meat, eggs dates are good sources of haem iron. Haem iron is absorbed and utilized better than the nonhaem iron. Iron absorption from Nigerian diets is only 3 percent as it is mainly cereal based diet.

5. VITAMINS

Vitamins are organic substances present in small amounts in food, they are required for carrying out vital functions of the body. They are involved in the utilization of the major nutrients like proteins, fats and carbohydrates.

Though needed in small amounts, they are essential for health and well being of the body. When these Vitamins were discovered on the basis of their function and before their chemical nature were elucidated, they were designated as A,B,C,D or in terms of their major functions like, antineuritic, antirichitic Vitamins. Vitamins are classified based on their solubility as fat soluble and water soluble vitamins.



Water soluble vitamins are not accumulated in the body, but are readily excreted while fat soluble vitamins are stored in the body. For this reason excessive intake of fat soluble vitamins, especially Vitamin A and D can prove toxic. Excessive intake leads to the condition called hypervitaminosis.

Functions, food sources, requirements and effects of deficiency

Fat soluble vitamins: 2 Examples

Vitamin A

Vitamin A was the first fat soluble vitamin to be recognized. Three forms of Vitamin A are active in the body, retinol, retinal and retinoic acid. They are collectively called as retinoids.

Beta carotene is the provitamin of Vitamin A. Provitamins are substances that are chemically related to a vitamin but must be changed by the body into the active form of the vitamin. Vitamin A in the diet comes in two forms. Retenoids (preformed Vitamin A) and carotenoids. Vitamin A is present in vegetable foods which contain yellow pigment called carotenes. It was isolated from carrots hence called carotenoids which are provitamins of Vitamin A.

Functions

1) A well understood function of retinol is in the visual process. The retina of the human eye contains two distinct photo receptors of which one is sensitive to light intensities. Vitamin A is essential for the formation of rhodopsin and normal functioning of the retina for clear vision in dim light. Lack of Vitamin A leads to impaired adaptation to darkness.

2) Participates in protein synthesis and cell differentiation and thereby maintaining the health of the epithelial tissues and skin.

3) Supports reproduction and growth

4) Vitamin A regulates the antibodies and cellular immune response. It is essential for maintaining the epithelial tissue which is the first line of defence against invading microorganism.

5) Beta carotene acts as an antioxidant capable of protecting the body against disease like cancer, cardiovascular diseases and cataract.

Sources

Vitamin A in the human diet exist as retinol or as retinal or beta carotene which has to be converted to Vitamin A. Foods of animal origin contain retinol. Plant sources are rich in Beta carotene. Only one third of the dietary beta Carotene is absorbed.

Beta Carotene from green leafy vegetables is well utilized than from carrots and papayas.

Good sources of Vitamin A are sheep liver, butter, ghee, egg, milk, curds, liver oils of shark and halibut. Good sources of beta carotene are green leafy vegetables, mango, papaya, carrot and jack fruit.

Vitamin D

Vitamin D can be synthesized in the body in adequate amounts by simple exposure to sunlight, even for 5 minutes per day is sufficient. It is essential for bone growth and calcium metabolism. It acts as a hormone in the body by facilitating calcium absorption and deposition in the bone.

Functions

1. Vitamin D helps in the absorption of calcium and phosphorous by increasing the synthesis of calcium binding protein.

2. Vitamin D helps to maintain the calcium and phosphorous levels in the body by stimulating,

a) Absorption in the gastro intestinal tract.

b) Retention by the kidney

3. Vitamin D helps in deposition of calcium in the bones. The bones grow denser and stronger.

Food Sources

The Vitamin D content of food sources from animals varies with the diet, breed and exposure to sunlight of the animal. The good sources of Vitamin D are cod liver oil, shrimp, liver, butter, yolk, cheese, milk, spinach and cabbage.

Requirements

Only in those cases where the Vitamin D requirement is not met due to inadequate exposure to sunlight 400 µg/day of Vitamin D is recommended.

Water soluble Vitamins: 2 Examples

Vitamin C (Ascorbic Acid)

The chemical name for Vitamin C is ascorbic acid. It was discovered in 1747 by the British physician Lind who showed that citrus fruit juices prevented and cured scurvy.

Functions :

1. Ascorbic Acid is essential for formation of cement substances and collagen which is found in blood vessels teeth and bones.

2. It helps in the biosynthesis of non-essential amino acids (eg) hydroxy proline, tyrosin.

3. It is required for absorption of iron as it reduces ferric to easily absorbed ferrous form.

4. Vitamin C is essential for the formation of collagen a major structural protein

5. It is required for wound healing because it helps in the formation of connective tissue.

6. Required for carnitine synthesis which aids in the transport of fatty acids in cells.

7. Vitamin C is essential for the synthesis of norepinephrine a neurotransmitter.

8. It activates hormones (eg) growth hormone, gastrin releasing peptide, calcitonin, gastrin oxytocin.

9. Drug detoxifying metabolic systems in the body require Vitamin C for its activity.

10. Vitamin C is an excellent anti-oxidant. It combines with free radicals oxidizing them to harmless substances that can be excreted.

Food Sources: guava, cashew fruit, cabbage, bitter gourd, oranges, tomatoes are good sources of ascorbic acid. Cereals and pulses are poor sources. Vitamin C content of pulses increases on germination.

Vitamin B1 (Thiamine)

Thiamine is known as Vitamin B1. **Functions**

1. Thiamine is converted to thiamine pyrophosphate (TPP), which is an important co enzyme in the carbohydrate metabolism.

2. It is involved in transmission of nerve impulses across the cells

3. Thiamine as TPP is an essential cofactor for the conversion of amino acid tryptophan to niacin.

Sources:

Yeast, whole wheat, millets, hand pounded rice, parboiled rice are good sources of thiamine. The bran contains most of the thiamine in the cereals. Gingelly seeds, groundnut, soyabean, cashewnuts, organ meats, pork, liver and eggs supply thiamine.

Requirements

Thiamine is involved in the carbohydrate metabolism. Its requirement is related to energy derived from carbohydrate. An allowance of 0.5 mg per 1000 Kcal for adults and for infants 0.3 mg/1000 Kcal is suggested.

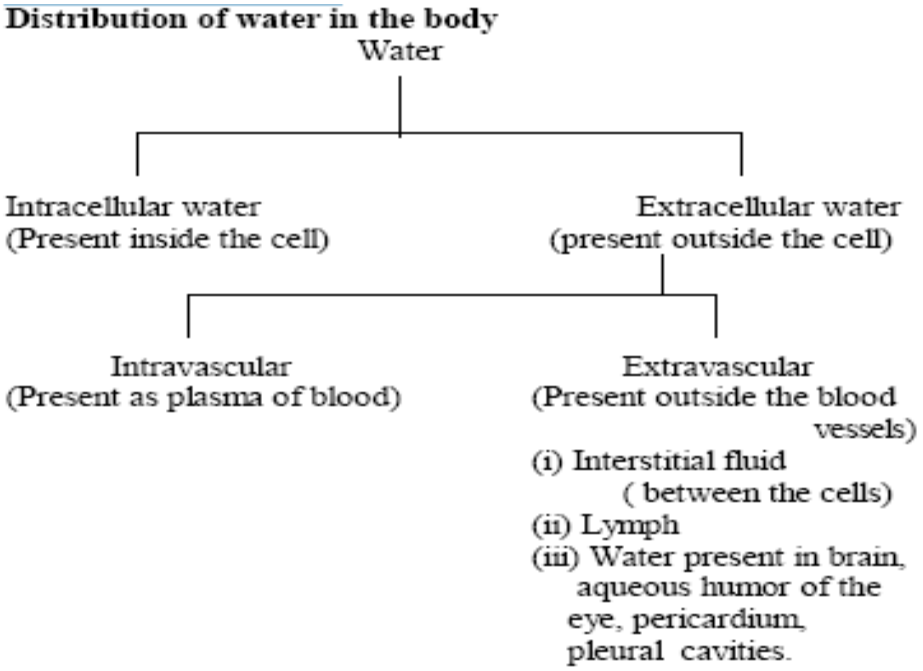
6. WATER

Water makes up about 70% of the weight of human. For each 100kcal of energy metabolized, animals can manufacture about 12g of water. Fresh and clean tap water is adequate as water source for humans although, municipal water supply do sometimes contain dissolved minerals, hydrocarbons, chlorine and fluorine. Water (moisture) is the predominant constituent in many foods.

Water is vital for human existence. We can live without food for extended periods of time, but without water will result in death. Water is colourless, calorie less compound of hydrogen Water is closer being a universal solvent than any other compound with a chemical formula of H_2O.

Water is the largest single compound of the body and it is distributed as follows.

Distribution of water in the body



Total body water content is mainly determined by total amount of salt in the body. Salt and water concentration in the body is controlled by the kidneys.

Functions of Water

1. It is an essential constituent of all the cells of the body and the internal environment.

2. Serves as a transport medium by which most of the nutrients pass into the cells and removes excretory products.

3. Water is a medium for most biochemical reactions within the body and sometimes a reactant.

4. It is a valuable solvent in which various substances such as electrolytes, non – electrolytes, hormones, enzymes, vitamins are carried from one place to another.

5. Plays a vital role in the maintenance of body temperature. Heat is produced when food is burnt for energy. Body temperature must be kept at 80º - 108º Fahrenheit for higher or lower body temperature will cause death. Body heat is lost through the skin, lungs, urine and faeces.

6. It forms a part of fluids in body tissues; (eg) the amniotic fluid surrounds and protects the foetus during pregnancy.

7. Saliva is about 99.5 percent water. In healthy individuals it makes swallowing easier by moistening the food.

8. Water helps in maintaining the form and texture of the tissues.

9. Water is essential for the maintenance of acid base and electrolyte balance. It should be noted that pure water consists of hydrogen ion (H+) and hydroxyl ion (OH-).

Substances dissolve in water as ions with positive and negative charge. They are called electrolytes. The common electrolytes in our body are sodium, potassium and chloride. Changes in electrolyte balance causes accumulation or depletion of water in intracellular and extra cellular fluid.

The balance between the positively and negatively charged ions is essential for water flow and maintain osmolarity between the cells. This is called electrolyte balance. Acid base balance is the dynamic state of equilibrium of hydrogen ion concentration. When pH falls below 7 it is termed acidity and when it increases above 7 it is termed alkalinity. Extremes of both cases results in death. The pH of the body should be maintained near neutrality. Enzymatic action depends on the pH. The digestion, absorption and utilization of nutrients are dependent on pH. Most body fluids are near neutral with the exception of gastric juice. The pH value of some solutions are given below:

Acid

0 – Hydrochloric acid

1

2 – Gastric juice

3 – Vinegar, orange juice

4 – Grapes

5 – Bread, coffee

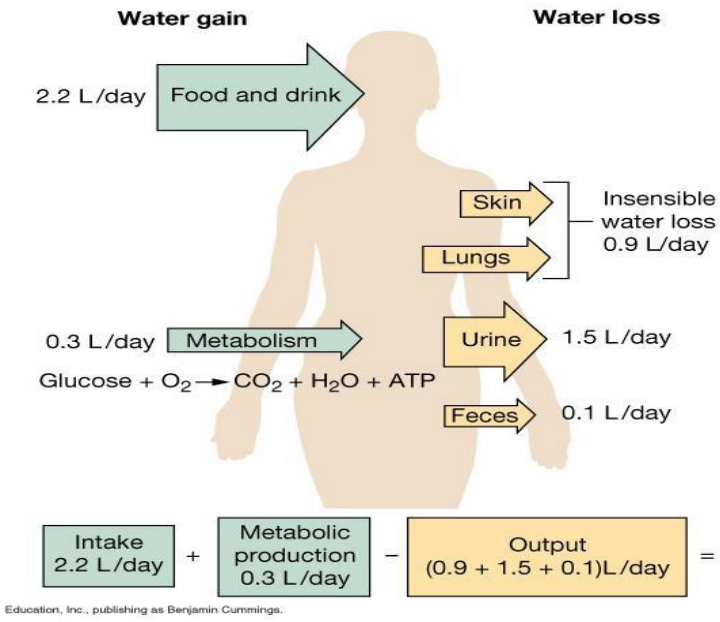
Neutral 6 – Urine

7 – Pure water, eggs, blood

8 – Sea water

14 – Sodium hydroxide

Alkali



10. Water forms good source of macro minerals like Calcium, Magnesium, Fluoride, Iron and Iodine.

Requirements

Requirements of water varies with climate, dietary constituents, activities and surface area of the body. As a rule a person should take enough water to excrete about 1200 –1500 ml of urine per day. In tropics because of greater water loss through perspiration increased water intake is required to maintain urine volume. Normal intake of water ranges between 8 – 10 glasses per day.

Daily Water Input

In tropical countries like Nigeria the daily water input amounts to 2400 – 3000 ml of water through food, as fluid drinks and as metabolic water.

1. As fluid drinks – water, tea, coffee, milk soups	1500 - 1750 ml
2. Water intake through solid food	600 - 900 ml
3. Oxidation of carbohydrate, fat, proteins (metabolic water)	300 - 350 ml
	Total 2400 - 3000 ml

Daily output of water

1. Urine	1200 – 1500 ml à (kidney)
2. Perspiration	700 – 900 ml à (Skin)
3. Respiration	400 ml à (lung)
4. Faeces	100 – 200 ml à (intestine)
	Total 2400 – 3000 ml

Therefore the water intake and output is fairly kept constant. This is called water balance. The water equilibrium is maintained by kidneys, lungs, intestine and pituitary gland. The water balance coordinates with both electrolyte and acid base balance.

Causes and Effects of Dehydration

Causes: When water is constantly lost from the body as in severe vomiting, diarrhoea, excessive sweating or excessive urine formation due to treatment with diuretics, the total water content of the body is reduced. Extra-cellular and intra-cellular fluid decreases leading to dehydration.

Effects of dehydration

1. Tongue is dry.

2. Pinch test is done by raising and releasing the skin. Slow return of skin to original position indicates decreased ECF.

3. Decrease in plasma volume reduces cardiac output and may lead to cardiac failure.

Prevention of Dehydration

Dehydration can be prevented by taking sufficient amounts of water as fluids. The correction of dehydration is called rehydration.

Oral rehydration therapy

It is the administration of fluid to prevent or correct dehydration.

Oral rehydration salt

WHO, UNICEF formula consist of the NaCl – 3.5 g, $NaHCO_3$ – 2.5 g, KCl – 1.5g and glucose - 20 g to be dissolved in one litre of potable drinking water.

The Glucose present aids in the absorption of sodium chloride and potassium chloride apart from giving energy. This mixture is administered through the oral route at frequent intervals until the normal state is attained.

Potable water is that water which is safe and wholesome. It should be:

a. free from pathogenic agents

b. free from harmful chemical substance

c. pleasant to taste; free from colour and odour

d. usable for domestic purpose.

HEALTHY NUTRITION

A healthy nutrition, help one get the right balance of vitamins, minerals, and other nutrients have plenty of energy and handle stress better, prevent and control health problems. There is also strong evidence that, as a rule, the closer to nature one eats, the fewer calories it will take for satiety, the reason is that processed foods often have low amounts of fiber and water, ''high ratio of calories to nutrients'', and a mixture of taste from added sugar, salt and flavorings that overly stimulate the appetite center in the hypothalamus. But that is not the case with clean foods, which has lots of fiber and fluid, a high ratio of nutrient to calories, and free of added flavors, all of which send signals of satiety to the brain before one consumes too many calories (Davids, 2010).

'**Nutrition and Health**

Health is defined by the World Health Organization (WHO) as the "State of complete physical, mental and social well being and not merely the absence of disease or infirmity". To maintain good health and nutritional status one must eat a balanced food, which contains, all the nutrients in the correct proportion.

The essential requisites of health would include the following:

1. Achievement of optimal growth and development, reflecting the full expression of one's genetic potential.

2. Maintenance of the structural integrity and functional efficiency of body tissues necessary for an active and productive use.

3. Mental well-being

4. Ability to withstand the inevitable process of aging with minimal disability and functional impairment.

5. Ability to combat diseases such as; resisting infections (immunocompetence), preventing the onset of degenerative diseases

EFFECTS OF HEALTHY NUTRITION

- **Fuel To Perform Daily Activities:** A proper nutrition containing in the right proportions, proteins, fats and carbohydrates contribute to the total energy pool of the body which also uses vitamins and minerals to conserve and use the energy. These nutrients are also required for the production and maintenance of body tissues, electrical conduction of nerve activity, mechanical work of muscle effort and heat production to maintain body temperature. Diets deficient in these essentials lead to serious health problems.
- **Nutrients for The Body Cells:** All systems e.g. cardiovascular, reproductive and respiratory systems can be broken down to cellular levels where hormones, enzymes and neurotransmitters are constantly interacting through complex processes to make the body function properly.
- **Growth and Repair of Tissues:** During childhood and pregnancy, healing and the maintenance and buildup of muscle mass.

- **Reinforcing The Immune System:** Enables the body to fight diseases more effectively, thereby shortens the duration of illness and decrease the occurrence of illness.
- **Preventing Chronic Diseases Of Lifestyle:** As tool for combating chronic disease of life style e.g. obesity and overweight that can lead to chronic diseases like diabetes type 2, heart diseases, hypertension, osteoarthritis and some cancer. This can be achieved by cutting down saturated fats and added sugars, include more plant -based foods in the diet as they have lower fat content, rich in fiber and also excellent sources of phytochemicals which are particularly used in prevention of cancer and heart disease via its mechanism of neutralizing free radicals and thwarting enzymes that activate cancer causing agents in the body.
- **Maintaining Good Mental Health:** ''food is like a pharmaceutical compound that affects the brain'' says Fernando Gomez-Pinilla, an UCLA Professor of neuro-surgery and physiological science. The basic principle in preventing depression and mood swings, is to eat a balanced diet that contains foods from all different food groups- fruit and vegetables, unprocessed grains and cereals, lean meat, eggs, milk and dairy products, legumes and nuts, poly or monounsaturated margarine and oils, fatty fish e.g. tuna and salmon.
- **Ensuring Healthy Teeth And Bones:** A balanced calcium-rich diet especially during childhood, teen and early adulthood ensures adequate peak bone mass throughout life hence prevents osteoporosis in later life.(Kathleen et al, 2007)
- Improve digestion, sleep and concentration, regular bowl, weight loss, improve skin tone and texture.

UNHEALTHY NUTRITION

Gradually, but unfortunately, our eating habits have changed in a significant way from their usual, natural pattern. Each passing day, various hazardous agents enter our body through our diets, while neglecting the powerful foods and nutrients that can protect our body. Modern food industries use many preservatives, artificial colorants, additives and chemicals in order to enhance the appearance, flavor and shelf of food we eat. However, these compounds ultimately end up accumulating in our body only to show their deleterious effects in the form of diseases, cancers, and genetic malformations in the new-born

Unhealthy diet is a major risk factor for a number of chronic or western diseases including high blood pressure, diabetes, abnormal blood lipids, overweight or obesity, cardiovascular diseases and cancer (WHO, diet and physical activity). The WHO estimates that 2.7 million deaths are attributed to a diet low in fruit and vegetable every year (WHO, diet and physical activity). Globally, it is estimated to cause about 19% of gastrointestinal cancer, 31% ischaemic heart disease, and 11% strokes (WHO, promoting fruit and vegetable consumption around the world).

Malnutrition – Under Nutrition and Over Nutrition

Malnutrition as defined by World Health Organisation (WHO) is a pathological state resulting from a relative or absolute deficiency or excess of one or more essential nutrients, this state being clinically manifested or detected only by biochemical, anthropometric or physiological tests.

Four forms can be distinguished:

a. Undernutrition – the pathological state resulting from the consumption of an inadequate quantity of food over an extended period of time.

b. Marasmus is synonymous with severe undernutrition. Starvation implies total elimination of food and hence the rapid development of under nutrition and marasmus.

c. Specific deficiency – the pathological state resulting from a relative or absolute lack of an individual nutrient.

d. Over nutrition – the pathological state resulting from a disproportion of essential nutrients with or without the absolute deficiency of any nutrient as determined by the requirement of a balanced diet.

NEED FOR AND METHODS OF ASSESSING NUTRITIONAL STATUS

Nutritional status is the condition of health of the individual as influenced by the utilization of the nutrients. It can be determined by correlation of information obtained through medical and dietary history, thorough physical examination and laboratory investigation.

Nutritional assessment aids in identifying

a) Under Nutrition

b) Over Nutrition

c) Nutritional deficiencies

d) Individuals at the risk of developing malnutrition

e) Individuals at the risk of developing nutritional related diseases

f) The resources available to assist them to overcome nutritional problems.

METHODS USED IN NUTRITIONAL ASSESSMENT

Nutritional assessment systems utilize 4 types of methods which are used with alone or in combination. They are;

(1) Anthropometric assessment

(2) Biochemical assessment

(3) Clinical assessment

(4) Dietary methods

For the assessment of nutritional status in a community basically Dietary and Anthropometric measurements are used. The methods are simple, less time consuming and do not require sophisticated instruments.

ANTHROPOMETRIC ASSESSMENT

This involves physical measurements of body and dimensions. Body composition may be estimated from anthropometric measurements. The measurements vary with age and degree of nutrition and as a result are useful in assessing imbalances of protein and energy. They can be used to defect moderate as well as severe degree of malnutrition. The technique also provides information on past nutritional history which cannot be obtained in other assessment techniques.

Anthropometric measurements are of 2 types – growth and body composition measurement. Anthropometric indices are weight for age, height for age, head circumference for age, or from combination of raw measurement such as weight and height, skinfold thickness at various sites.

Advantage of Anthropology Assessment

(1) The procedure is simple, safe and non-invasive and can be used for large population

(2) Equipment required is inexpensive

(3) The methods are precise and accurate

(4) An unskilled person can also perform the measurement procedure

(5) Mild to moderate malnutrition can be detected

(6) Information on past long term nutritional history can be retained

(7) Changes in nutritional status over time or over generation changes can be absorbed.

Weight for age

The development of a child is determined by the increase in weight over a given time. This in turn is determined by weight measurements over regular intervals. Here the child weight is compared with reference weight value for his age. The most widely used method is that of Gomez and Co-workers (1956). The observed weight of a child is expressed as a % of expected weight of a child of that age using the 50th percentile (medium) of Havard Standards

Gomez Classification

% expected weight for age	Classification	Category of nutritional status
>90%	Normal	Normal
76-90%	Mild malnutrition	1st degree malnutrition
61-75%	Moderate malnutrition	2nd degree malnutrition
< 60%	Severe Malnutrition	3rd degree malnutrition

In 1972 nutrition sub-committee of Indian Academy of Paediatrics (IAP) proposed another classification.

% of expected water	classification
>80%	Normal
71 – 80%	Grade I
61 – 70%	Grade II
51 – 50%	Grade III severe malnutrition
< 50%	Grade I severe malnutrition

Disadvantage for the 2 classifications

(1) It takes no account of other measurements

(2) It assumes that children are of the same height

(3) Single measurement of weight does not indicate definite malnutrition when former weight measurement are not known

(4) Harvard references are not easily available

Advantages:

(1) It is very simple to measure.

(2) It is widely used.

Height for age

It is used as an indication of nutritional status of groups of population for estimating past and chronic malnutrition but not necessarily the present nutritional status. The disadvantage is that the deficiency in height takes some time to occur and it may not be manifested in malnourished infants. Also genetical differences are partly responsible for the variation in height in any group in any population.

Weight for height

This can be expressed as a % of the reference median weight for median height at any age. The advantage for using weight for height as an index of nutritional status is its apparent age independence, this allows its use in populations where ages are uncertain or unknown. Marked decrease in weight for height is a more reliable finding in the determination of PEM in all age groups.

Disadvantages: The difficulty in measuring body length in young infants which may make it difficult to obtain adequate data in this age group.

Mid Arm Circumference (MAC)

One of the most widely used indices for the assessment of nutritional status especially during childhood because the tape used is inexpensive and portable.

Advantage: measurement is easy and simple, takes less time to perform. It involves only a simple measurement, can be taught to lay people, equipment is inexpensive. MAC correlates well with weight and weight for height. It indicates state of muscle protein. MAC should be measured only when weighing scale, cannot be supplied.

Cut oft points:	AC > 14cm	normal nutritional state
	AC 14 – 12.5	mild/modest under-nutrition
	AC < 12.5	severe under-nutrition

ASSESSMENT OF DURATION OF MALNUTRITION

Children with poor linear growth but adequate weight for height may be classified as normal but the condition is not justifiable, but if height for age is also taken into consideration then it may be okay. Seone and Lytham 1971 further made their own classification.

Nutritional Status	Height for age	Weight for age	Weight for ht
Normal	Normal	Normal	Normal
Past Chronic Malnutrition (Nutritionally dwarf)	low	low	low
Current short duration Malnutrition	Normal	Low	Low
Current long duration Malnutrition	Low	Low	Low

Body Mass Index

In adults low weight for height may indicate inadequate nutrition whereas high weight for height may indicate overweight and obesity. In recent years BMI is used. It is the best simple and quantitative anthropometric indicator of body composition and thus nutritional status.

$$\text{BMI} = \frac{\text{Body weight (Kg)}}{\text{Height}^2\ (m^2)}$$

Normal range = 18.5 – 25 kg/m^2, (below it = underweight, above it = overweight & obesity)

17 – 18.5	1st degree malnutrition
16 – 17	2nd degree malnutrition
< 16	3rd degree malnutrition
18.5 – 25	Normal
> 25	Obese

Skinfold Thickness

The most direct measure of fatness in people is measurement of skinfold thickness using skinfold calliper. These springs loaded callipers exert a constant pressure on a fold of skin, the thickness of skin is indicated in a meter. The thickness depends in the amount of fat stored subcutaneously in the region of the skinfold. It is measured at several sites and it is still the representative of the total amount of body fat. Typically, it is determine at 4 sites (i) over the triceps muscle (ii) over the biceps (iii) in the subscapular region (iv) in the supra-iliac region.

The single triceps muscle is sometimes used in nutritional survey because it can be measured quickly.

BIOCHEMICAL ANALYSIS

The biochemical evaluation of nutritional status in when quantitative determination of nutrients or related metabolites in such tissues as blood and urine. Low blood levels of a nutrient may reflect a low dietary intake, defective absorption, or increased utilisation, destruction in excretion. The data serves to confirm findings from clinical observations and dietary studies or to identify subclinical deficiencies before clinical symptoms are evident. They can be used for some nutrients to assess the range for frank deficiency levels through adequate optimal and excessive levels of nutrition intake.

CLINICAL OBSERVATIONS

Clinical observations, the least sensitive approach lend themselves to use in nutritional surveys of population groups because they involve an assessment of the health of those part of the body that can be readily observed in a routine physical examination and do not involve obtaining blood, urine or tissue samples. The most commonly observed are eyes, skin, mucous membranes, hair, mouth teeth, tongue, thyroid gland, and lower extremities.

Although clinical observation are of limited value in the early diagnosis of a deficiency state or in identifying marginal changes that prevail for that periods, they are widely used to confirm biochemical and dietary data. Because of the subjective nature of the judgment in a clinical evaluation, the method is quite unreliable even when used by highly skilled observers.

Observed symptoms

Eyes

Dryness of the cornea and conjunctiva – associated with lack of vitamin A.

Membranes

Colour of mucous membranes (underside of the eyelid) to observe the pigmentation of the blood – if pale = anaemia, if highly colored = adequate Hemoglobin level

Skin

Is often a reflection of nutritional state of an individual. Deficiency of some vitamin manifest in varying forms and degrees of dermatitis.

Mouth and teeth

Cracks at the corners of the mouth (angular stomatis) vertical cracks followed by redness, smelling ulcerations reflect lack of riboflavin. Loss of papillae on the tongue and flavin and scarlet and raw appearance of the tongue are associated with niacin deficiency. Soft spongy and bleeding gums in vitamin C deficiency. The presence of mottling in the tooth enamel results from a high intake of fluorine. The incidence of dental caries reflects deficient diets during the teeth forming years of life.

Other tissues

Enlargement of the thyroid gland – associated with iodine deficiency or intake of food **goitrogen** or iodine excess. Oedema of the lower extremities, depigmentation, lack of lustre.

Bowed and beading of ribs – vitamin D deficiency. Neurological abnormalities associated with thiamin and vitamin B12 deficiency (identified by testing reflexes in the lower extremities).

DIETARY ASSESSMENT METHODS

Two Methods

1st is a group method, 2nd is based on dietary intake of an individual. It is determined by record or recall of all foods consumed over a specified period of time. This is the most commonly used method for the field surveys.

Group Method

1. **Food Balance sheet**

On the basis of food availability food balance sheet from the entire population is prepared. The mean annual amount per person is obtained by dividing the total amount of different foods with the total population of the area. The mean intake of different nutrients is an essential part of food balance sheets.

Advantage

1 The food balance sheet gives view of the total food supplies of a community. It indicates whether food consumed by the population is inadequate, adequate or more than adequate.

2. It seems as a basis for planning of food programme and for emergency rationing of food

3. Valuable in inferring general food habits of the people

Disadvantage:

1. The reliability of such data depends on the statistics used for calculation and level of development of the country.

2. The data shows the total amount of food available and not the actual amounts consumed

3. Longitudinal differences in food consumption are not reflected for mean total consumption data of the whole population.

2. Food Accounts

This method of dietary assessment is commonly used for subjects living in institutions, families or groups. It involves detailed recording of the amount of food consumed over a period of time. This is compiled by an inventory of food supplies both at the start and end of the survey. The method provides accurate information on food consumption.

Advantage:

1. Larger samples can be obtained and food consumption data for longer period of time can be collected.

2. As seasonal variation are taken into account, the method provides excellent information on the annual mean food consumption

3. The method is cheap and does not alter the diet of the subjects to a great extent

Disadvantage

1. Families or household are not always representative of the whole population

2. It can be used only with the likely population

3. Precision may decrease after four days

4. Food distribution within the family is not known

5. The records may not always reveal how much food was actually consumed or thrown away due to spoilage or plate wastage

INDIVIDUAL DIETARY INTAKES

Dietary data on individuals is collected to obtain more precise measurement of average nutrient intake and to determine inadequacies if any. Assessment ranges from a qualitative type of inquiry to those of a more quantitative nature. It is one of the most accurate methods and is referred to as Precise and Weighed Individual inventory method. An inventory of the food supply both at the beginning and end of survey is made. As more food is acquired it is weighed and recorded. Weights and recording of food consumption at home and outside and food wastage are maintained. At the end, the amount of food wasted is added to the amount of food left over to obtain total wastage. Then divided the total food consumed by the no of adults given daily food with consumption per person. i.e. (initial inventory + issues or purchases) – (final inventory + waste)

Food consumed/person/day

Total weight of food item consumed / (days of survey X no of persons fed daily)

Advantage

1. The information can be collected by the subjects themselves and require minimal supervision

2. The amount consumed can be recorded accurately

Disadvantage

1. The sample size is not representative as **whinkein** are selected and the results cannot be generalized.

2. It is costly and requires trained personal

3. It changes the diet of the respondents so that it does not represent normal consumption pattern.

Interview method: - to collect food consumption data

(1) Diet recall (2) Diet history

Diet Recall: - Food consumption for a specified period of time prior to the survey can be recalled often referred to as the 24hours recall method.

$$\frac{\text{Individual intake (in volume)}}{\text{Total cooked quantity (in volume)}} \times \text{Raw amount} = Y$$

Standardized volumetric measures of the ingredient are recorded

Advantage

Useful method in recapitulation of one's habitual diet

It is helpful in revealing extreme daily variation in the diet

Disadvantage

A day intake may not represent usual intake.

Estimate becomes difficult when diet has a lot of variety.

Subjects reporting may not be sure about intake.

By weight of foods consumed by a single individual. All the food items mixed and blended for chemical analysis. At same time the weight of prepared food is obtained as it leaves the kitchen and the weight of leftover diet. The method is only for research purposes when facilitates from chemical analysis are available.

Diet History:-

Provide a more comprehensive assessment of diet and it permits investigation of lesser known or unidentified dietary factor that can be retained for future examination. The normal daily dietaries are 1st recorded along with the left over of each meal, the composition, snacking etc. Seasonal variations are also included.

Advantage

It is inexpensive and convenient

The representative and large sample size / events

Disadvantages:

It demands greater comportment**,** personal character of the investigator.

Does not give precise data on individual food consumption.

Diet histories are subject to problems of recall.

Nutrient uptakes tend to be overestimated especially from trace elements.

Food frequency method: - Intakes in terms of frequency with which various foods items are consumed is recorded.

Questionnaire method: - It is identical to diet history. Questionnaire are sent to the respondents to fill and return.

Advantage:

(1) It is possible to collect data in large samples in short period with a small budget.

(2) Random samples can be used.

Food composite analysis for laboratory estimate

This method involves sampling of each item during meals with subsequent blending of representative samples and analysis for various nutrients.

EATING DISORDERS

Eating disorders occur over a continuum of increasingly pathological behavior. Excessive self-evaluation and a preoccupation with weight, shape, and size characterize both Anorexia Nervosa (AN) and Bulimia Nervosa (BN). Other common characteristics include an intense fear of weight gain and a relationship with food that borders on obsessive. However, there are distinct differences between the two disorders (Christian, 2007).

Anorexia Nervosa

Although AN often starts with only small reductions in total food intake, patients eventually reduce their energy and fat intake to a point where they are consuming only a limited number or foods in a highly ritualistic fashion. Although patients often suggest that they cannot eat or that they are not hungry, an actual loss of appetite is quite rare. Individuals with AN refuse to maintain a minimally normal and healthy body weight, show an intense fear of gaining weight or becoming fat, exhibit a disturbance in their perception of their body weight or shape, and experience abnormal menses.

Implications

- The disorder is characterized by severe, voluntary starvation (300 - 600 kcal per day).
- Refusal to maintain body weight at or above 85% of expected for height and age (could include a BMI ≤ 17.5)
- Body image disturbances, which may include the denial or lack of appreciation for the seriousness of one's currently low weight,
- In females, primary or secondary amenorrhea

Bulimia Nervosa

Characterized by recurrent episodes of eating unusually large quantities of food at a meal, and eating until the food is gone or the person is uncomfortably or painfully full. Efforts to purge the excess food, typically between 1000 to 2000 kcal by some compensatory or purging behavior such as vomiting, laxative or diuretic abuse, excessive exercise, and restrictive dieting or fasting occur subsequent to the binge-eating episode. Some patients may binge and purge over an extended period of time, consuming close to 10,000 kcal. Amphetamine use may also occur in an attempt to restrict one's appetite. These behaviors are associated with a sense of loss of control and typically, shame, guilt, and embarrassment are associated with the binge-eating and purging process. Nevertheless, patients often report that the purging behaviors diminish the intensity of aversive emotions and provide them with a sense control. Similar to the diagnosis of AN, patients are further classified as either of two subtypes. Worthy of note is the fact that 25 to 30% of patients with BN have a prior history of AN (Christian, 2007).

Implications

- Recurrent episodes (a minimum average of twice per week for at least 3 months) of binge eating, defined as eating an abnormally large amount of food.
- Within a 2-h period, they are associated with a sense of lack of control over the eating process during the episode.
- Use of compensatory or purging behavior such as self-induced vomiting, laxative/enema or diuretic abuse, restrictive dieting, fasting, or excessive exercise.
- Self-evaluation largely determined by one's shape and weight.

Binge-Eating Disorder

This disorder is more nebulous, and is characterized by recurrent binge-eating episodes without a compensatory effort to eliminate caloric excess. It has only been widely recognized over the past 10 to 15 years. In fact, diagnostic criteria for BED is not yet an approved. Although persons diagnosed with BED are seen with a wide range of weights, most are obese. Although the age of onset is the same for BED, these patients typically do not present for treatment until they are much older and already overweight or obese (Christian, 2007).

Implications

- Eating much more rapidly than usual
- Eating until uncomfortably full
- Eating large amounts of food despite not feeling physically hungry
- Eating alone because of embarrassment over quantity of food consumed
- Feeling disgusted, depressed, guilty, or ashamed after the binge

SELECTED NUTRITIONAL RELATED CONDITIONS

PROTEIN ENERGY DEFICIENCY DISEASES (PEM)/PCM

This results when the body's needs for protein and food energy are not met by the diet. The manifestation depends on the intensity of protein or energy deficit, the severity and duration of the deficiencies, the age of the host and the associated nutritional or infection diseases kwashiorkor and marasmus.

Early symptoms- weight loss, fatigue (due to loss of energy) and irritability. At times symptoms of marasmus (wasting condition caused by insufficient food intake) and kwashiorkor exist in the same child.

Kwashiorkor: - A clinical syndrome caused by a deficiency of protein. Can occur when the intake of energy is adequate. Diarrhoea and infections are often the precipitating causes.

(1) The infections may divert the meagre amino acid pool to the production of globulins and acute phase reactant proteins instead of albumin and transport proteins.

Oedema is caused by a reduction in osmotic pressure of the plasma leading to an outflow of fluid from the capillaries into the interstitial space.

(2) The increase of acute phase reactant protein which are protein which may impair muscle protein breakdown.

(3) An impaired production and utilization of ketone bodies for energy during infection might lead to the use of more amino acids for gluconeogenesis.

Protein catabolism and nitrogen losses are enhanced by viral and febrile infection. Protein loses can amount to as much as 2% of muscle protein/day.

Kwashiorkor occurs among children between 6 months – 3 years with the 2nd year being most vulnerable. It also coincides with weaning period when the diet is low in energy and protein.

Symptoms: Painless, pitting oedema, lack of growth, muscle wasting with the retention of some subcutaneous fat and psychomotor changes.

The patients are apathetic and irritable. They may easily have an expression of misery and sadness. Biochemically the increased hepatic fatty acid synthesis from excess carbohydrate impair lipolysis but increases as fatty infiltration of the liver and consequent hepatomegaly.

Oedema could be caused by reduction in renal blood flow and glomerular filtration rate due to decreased plasma volume decreased cardiac output as consequences of hypoalbuminemia.

This results in sodium retention and production of rennin and aldosterone which will increase tubular reabsorption of sodium and water leading to oedema.

Patient with severe energy deficiency are usually unable to maintain the supply and a serious decompensation occurs causing hypoglycaemia, hypothermia and impaired circulatory and renal function which results in acidosis, coma and death.

MARASMUS

It is an extreme form of undernutrition due to lack of calories and proteins. It is characterised by generalized muscle wasting, absence of subcutaneous fat which gives the 'skin and bones' appearance. The children have marked retardation in longitudinal growth, a lack of physical well being, abnormal behaviour and poor mental development. The hair is sparse, thin and without the normal sheen, the cheeks are sunken, because the disappearance of the bichat fat pads giving it the appearance of a monkey's or little old man's face.

Marasmic condition develops slowly to allow better adaptation to energy inadequacy. A decreased energy intake is followed by a decreased energy expenditure which accounts for shorter periods of play and physical activity in children, and for longer rest periods and less physical work in adults. When the decrease in energy expenditure cannot compensate for inadequate intake body fat is mobilized at a faster rate than body mass resulting in weight loss.

Where dietary proteins are of poor quality body proteins will not be synthesized, but body protein loses arise from skeletal muscle breakdown. Some visceral proteins are lost but this soon stabilizes until the non essential tissue proteins are depleted. The loss of visceral proteins now accelerates and death may occur.

75% of the free acids entering the body from dietary and tissue proteins are re utilized for protein synthesis, the remainder are broken down for other metabolic purposes. When dietary intake is decreased it causes a shift of albumin from extra vascular to the intra vascular pool, which leads to decrease in intra vascular oncotic pressure and outflow of water into the extra vascular space. This contributes to the development of oedema seen in kwashiorkor patient.

Decreased fluid intake decrease insulin secretion and increase glucagon, epinephrine release and conticosteriod secretion.

Severely underweight individuals are more likely to be ill and the recovery from illness is apt to take longer than with normal person. Nevertheless there is need for a gradual adjustment to normalcy as a premature introduction of a high calorie diet may be fatal to a severely marasmic patient.

Diarrhoea which is the primary cause of death for under 5 children in the less developed countries occurs much more frequently among the marasmic children than among the well feed.

Obesity

The role of nutrient intake in promoting obesity is quantitative, qualitative, and temporal. The increasing availability of food, often in excessive serving sizes, promotes hyperphagia. Hedonic factors such as food texture, temperature, color, appearance, and variety may also lead to overconsumption. Visual cues also influence intake; subjects eating from covertly self-refilling bowls consumed 73% more than subjects eating from normal bowls. Carbohydrates with a high glycemic response may promote obesity by altering fuel partitioning, that is, promoting postprandial carbohydrate oxidation and sparing fat oxidation. A dramatic increase in high-

fructose corn syrup temporally correlates with the development of the obesity epidemic. Compared to glucose, differences in the metabolism of fructose may promote adiposity.

The intake of dietary fat is significantly related to adiposity. Dietary fat is converted to body fat with approximately 25% greater efficiency than carbohydrate. Dietary fat may be less satiating than protein and complex carbohydrates, although foods with a high glycemic index (i.e., rapidly converted to glucose) may stimulate hunger and lead to more frequent eating. The long-chain fatty acid composition of dietary fat influences energy utilization; low ratios of polyunsaturated to saturated fat are associated with lower respiratory quotients (RQ; moles of carbon dioxide produced per mole of oxygen consumed). The pattern of food intake may play a role in the development of obesity. Widely spaced meals are used less efficiently because of the energy cost of storage. Compared to immediate oxidation, the energy cost of converting glucose into glycogen is 5%, and into fat is 28%.

Body Mass Index

The BMI is highly correlated with fatness, and minimizes the effect of height. It is calculated as:

BMI = wt (in kg)/ht2 (in meters) or BMI = wt (in lb) × 703/ht2 (in inches)

As an index of mass, it does not distinguish between fat and fat-free mass. Consequently, it is possible to be overweight without having excess adiposity (very muscular individuals) as well as obese without being overweight (sarcopenic individuals).

classification for BMI.

BMI Weight Classification

18.5–24.9 Normal weight

25.0–29.9 Overweight

30.0–34.9 Class 1 obesity

35.0–39.9 Class 2 obesity

>40 Class 3 obesity

Hypertension

Dietary sodium plays an important role in the determination of blood pressure, and reductions in sodium intake by 1.8 g/day have been associated with reductions in systolic and diastolic blood pressure of approximately 4 and 2 mmHg, respectively. The Dietary Approaches to Stop Hypertension (DASH) diet, a carbohydrate-rich diet that emphasized fruits, vegetables, and low-fat dairy products and reduced saturated fat, total fat, and dietary cholesterol, showed significant effects on reducing hypertension at all levels of salt intake. More recently, in the follow-up study entitled the OMNI-HEART study, replacement of carbohydrate with protein or unsaturated fat led to even greater decreases in blood pressure in prehypertensive and stage 1 hypertensive

participants. A reduction in LDL and HDL cholesterol was seen when carbohydrate was replaced with protein but not with unsaturated fat.

In the CARDIA study, 4304 young adults were followed for over 15 years in a multicenter, population-based, prospective study of CVD risk evolution. Diets rich in whole grains, refined grains, fruits, vegetables, nuts, or legumes were found to be inversely related to blood pressure, while positive effects of red and processed meat intake on blood pressure were observed.

In an epidemiologic study of approximately 1700 persons, those consuming 14 or more servings of fruit or vegetables per day were likely to have less of an increase in blood pressure than persons consuming less than 14 servings per day of fruits and vegetables after a 7-year follow-up.

Hyperinsulinism

Insulin is the hormone - produced by the pancreas - that allows glucose into cells where it can be utilized as fuel. Through bad luck (heredity) and lifestyle (too much dietary carbohydrate chiefly) your cells can become resistant to insulin. The mechanism of this resistance is still being studied but we know that the insulin receptors that sit on every cell's surface lose their ability to function. This causes the pancreas to secrete more insulin than is normal to get glucose inside the cell. Though insulin is absolutely essential to life, chronic and acute elevation of insulin wreaks havoc in the human body. This process is known as "insulin resistance" and the resultant condition is "hyperinsulinemia".

The amount of research being published suggesting a causal link between hyperinsulinism and disease is one of the more productive and exciting arenas in modern medicine. There is mounting evidence linking hyperinsulinemia to: Hypercholseterolemia, Hypertriglyceridemia, Obesity, Hypertension, Immune disorders, Thrombosis and platelet aggregation, Cellular proliferation, Diabetes, Heart disease, Mood dysfunction, Brain dysfunction, Arthritis, Hyper inflammatory states, Alzheimer's disease, Stroke, Osteoporosis, Metastasis, Angiogenesis and Cancer.

Goitre

This disease is more common in women than men and is often noticed at the onset of puberty, during pregnancy or at menopause. It is an iodine deficiency disorder. Iodine found in nature resides in the sea and ocean, hence its deficiency is more common in elevated regions. In Nigeria in hilly region food supplies comes from crops grown in iodine-deficient land. The thyroid gland contains about 70 or 80% of total body iodine used for synthesising thyroid hormones. It has to trap about 60 mcg of iodine/day to maintain an adequate supply of thyroxine.

Where cassava is poorly processed, goitrogens such as thiocyanate may make iodine unavailable, where there is a congenital defect in the biosynthesis of MIT and DIT it may result in a congenital form of goitre and hypothyroidism. Congenital goitre does not occur in iodine deficient goitre. Where goitre is due to iodine deficiency, the term iodine deficiency disorder is used especially when 8-14 years olds have goitre.

Food and Nutrition board recommends - 0 – 6 months (40 mcg), 6 month – 1 year

(50mcg), 1 – 10 years (70 – 120 mcg), > 11years (120 -150 mcg), pregnancy (175 – 200mcg).

They are supplied by increased amount of sea foods, use of iodized salt and of cause injectable

iodized oil.

Xerophthalma / Keratomalacia

This is a deficiency disease of Vitamin A. Under normal circumstance the reception cells or cones of the retina required constant replenishment of the small amounts of vitamin A lost in the visual cycle during which a heme impulse is transmitted to the optical nerve and rhodopsin is regenerated. When there is a deficiency of vitamin A. It expresses itself in a progressive manner. First the vitamin A deficient person experiences a history of night blindness (nyctalopia which results from reduced concentration of rhodopsin in (low serum vitamin A) in the rod outer segment of the eye, followed by a sequence of abnormalities of increasing security in the conjunctiva and cornea termed xerophthalmia in which the protective secretion of the eye is lost with consequent keratinisation of the epithelial cells. The eye becomes dry, the cornea also becomes dry and loses its sensitivity. Severe irreversible change in the cornea which perforates with loss of aqueous humour is called keratomalacia. PEM and zinc deficiency may also lower the rhodopsin content of the eye also viral infection such as measles may also do so under the condition.

Vitamin A deficiency also produces skin, changes of extra occular manifestations including perifollicular hyperkeratosis.

Good sources are liver, whole eggs carrots, green leaf vegetable and palm oil.

Rickets/Osteomalacia

The biochemical and physiological consequences of inadequate vitamin D intake results in rickets in growing children and osteomalacia in adults. Rickets occurs when newly synthesized organic matrix osteoid fail to **mineralize** resulting in soft bones. Since the vitamin is essential for Calcium absorption it may also function in the prevention of osteoporosis later in life.

Sources – sun's irradiation of the skin, liver. Daily required of 200 – 400 1.U.

Alcoholism

Alcoholic beverages have been consumed by humans since the dawn of history. They have been used to ease anxiety, to promote social interaction, and as a vehicle to dominate others. Ethanol, a two-carbon alcohol in beverages such as beer, wine, whiskey, gin, and other liquors, is the quantitative end product of yeast glycolysis. Small amounts can be synthesized in mammalian cells. Ethanol has an energy value of 7.1 kcal/g. Thus, ethanol is a psychoactive drug, an energy-rich dietary ingredient, and a metabolite.

It has been estimated that upward of 90 million Americans consume alcoholic beverages every day and that about 18 million people are addicted to its consumption.

Alcoholism is more prevalent in certain cultural groups than in others. For example, alcoholism is quite prevalent in Native American population groups. Alcoholism has profound effects on nutrient need as well as nutritional status. Chronic alcohol use of greater than 80 g/day for more

than 10 years increases the risk of hepatocellular carcinoma approximately five fold.1 Excess alcohol consumption is associated with cirrhosis and also with an increase in risk for hepatitis C.2–6 People who are addicted to its consumption are at nutritional risk as well. The mechanisms by which these conditions develop are incompletely understood but may include damage to plasma membranes, damage to nuclear DNA, oxidative stress, destruction of retinoic acid, and altered DNA methylation.

Metabolism

Ethanol, once consumed, is rapidly absorbed by simple diffusion. The diffusion is affected by the amount of alcohol consumed, the regional blood flow, the surface area, and the presence of other foods. The different segments of the gastrointestinal tract absorb ethanol at different rates. Absorption is fastest in the duodenum and jejunum, slower in the stomach, ileum, and colon, and slowest in the mouth and esophagus. The rate of absorption by the duodenum depends on gastric emptying time, which, in turn, depends on the kinds and amounts of foods consumed with the ethanol. Certain drugs may also influence gastric emptying time and thus influence absorption. Complete absorption may vary from 2 to 6 h. The type of beverage can influence ethanol absorption. Ethanol from beer is absorbed slower than that found in whisky, which is slower than gin, and red wine. Pure ethanol is absorbed the fastest of all.

Once absorbed, ethanol is rapidly distributed between the intra- and extracellular compartments. This is because ethanol is completely miscible in water and thus freely travels any place water travels. The uptake of ethanol by the fat depots is minimal Ethanol crosses the plasma membranes but, in so doing, changes them. When ethanol is in contact with a protein, it denatures it. Thus, large and frequent ethanol exposures results in damage to proteins both within and around the cells. The most damaged tissue is the liver, as ethanol, absorbed by the gastrointestinal cells, is carried directly to this tissue via the portal blood. Alcohol consumption can have profound effects on gastrointestinal function. While gut cells are damaged by the alcohol that passes through them, these cells have such a rapid turnover time (less than 7 days) that damage due to intermittent ethanol consumption is not as long lasting as the damage that happens in the liver. Liver cells, in contrast, have a longer half-life and, once damaged, do not repair as readily. Alcoholic liver disease is a major cause of death among those who drink heavily and are addicted.

One mole of ethanol requires 16 moles of ATP for its conversion to CO_2 and H_2O.

While ethanol is distributed throughout the body, the liver is the chief site for its oxidation. As mentioned, the first rate limiting reaction is catalyzed by alcohol dehydrogenase and converts ethanol to acetaldehyde. Alcohol dehydrogenase has broad substrate specificity. It catalyzes the dehydrogenation of not only ethanol but also some steroids, shunt pathway alcohols and β-oxidation of fatty acids. Alcohol dehydrogenase is a zinc-containing enzyme, and it follows that excess alcohol consumption will have effects on zinc nutritional status. Acetaldehyde, the metabolite of ethanol, is quite damaging to cellular proteins and part of the hepatic injury found in alcoholics is due to this metabolite. It binds covalently to protein, impairs the microtubular assembly and the mitochondrial.

Deficiency OF Calcium

Calcium related health problems occur due to inadequate intake, improper absorption or utilization of calcium.

Osteoporosis: Osteoporosis is a condition found primarily among middle aged and elderly woman, where the bone mass of the skeleton is diminished.

It is a condition of multiple origin. It results due to the following reasons:

(i) Prolonged dietary inadequacy

(ii) Poor absorption and utilization of calcium

(iii) Immobility

(iv) Decreased levels of oestrogen in post menopausal women.

(v) Hyper parathyroidism

(vi) Vitamin – D deficiency

Osteomalacia – is a condition in which the quality but not the quantity of bone is reduced. This condition results from deficiency of Vitamin–D.

Tetany - Tetany occurs when Calcium in the blood drops below the critical level. There is a change in the stimulation of nerve cells resulting in increased excitability of the nerve and uncontrolled contraction of the muscle tissue. Hence Calcium and Phosphorous ratio in the diet should be maintained at 1:1 for proper utilization of Calcium in the body.

Deficiency of Iron

Dietary iron deficiency leads to nutritional anaemia. Nutritional anaemia is defined as the condition that results from the inability of the erythropoetic tissue to maintain a normal

haemoglobin concentration. Anaemia occurs when the haemoglobin level falls below 12 gm /dl in adult man and woman. During pregnancy haemoglobin level below 11 gm /dl is termed anaemia. This is the common form of anaemia affecting women in reproductive years, infants and children which is mainly due to poor intake and absorption. Iron deficiency anaemia is wide spread in our country.

Nutritional anemia is manifested as

1. Reduced Haemoglobin level. (less than 12 g /dl)

2. Defects in the structure, function of the epithelial tissues

3. Paleness of skin and the inside of the lower eyelid is pale pink

4. Finger nails becoming thin and flat and eventually (spoon shaped nails) koilonychia develops.

5. Progressive untreated anaemia results in cardiovascular and respiratory changes leading to cardiac failure. The general symptoms include lassitude, fatigue, breathlessness on exertion, palpitations, dizziness, sleeplessness, dimmness of vision, and increased susceptibility to infection.

Effects of Deficiency of Vitamin A

Deficiency of Vitamin A is Nutritional blindness is an important public health problem among young children. Night blindness is an early symptom of Vitamin A deficiency. The individual cannot see in dim light. This can be corrected with adequate supply of Vitamin A. In the absence of adequate Vitamin A intake the outer lining of the eye ball loses its usual moist, white appearance and becomes dry and wrinkled called xerosis.

This condition is followed by raised muddy dry triangular patches on the conjunctiva called the bitots spots. Redness and inflammation of the eye and gradual loss of vision may follow. The central portion of the eye loses its transparency and becomes opaque and soft if not treated and leads to total blindness termed Xeropthalmia. Xeropthalmia encompasses all ocular manifestations of Vitamin A deficiency.

Increased susceptibility to infection occurs because the mucous membrane lining becomes dry and rough which is easily invaded by the micro – organism.

Hypervitaminosis

Intake of large amount of Vitamin A for prolonged periods can lead to toxic symptoms which include irritability, headache, nausea and vomiting.

Deficiency

Deficiency of Vitamin D leads to decreased absorption of calcium which is manifested as muscular tetany, rickets in children and osteomalacia in adults.

Due to faulty calcification of bones the following derfomities is manifested in children which is called rickets. It is a disease in which there is weakness and abnormalities in bone formation. Rickets primarily affects children.

Manifestations

a) faulty deposition of calcium on the bones.

b) Bowing of legs

c) Enlargement of ends of long bones

d) Deformities of ribs – beading of ribs

e) Delayed closing of frontanel

f) Slow erruption of teeth.

g) Malformed, decay – prone teeth

Osteomalacia in Adults

Osteomalacia is a condition where the quality of the bone is reduced. It occurs in women who are not exposed to sunshine and who have depleted mineral reserves resulting from successive pregnancies and prolonged lactation.

Osteomalacia is associated with low phosphorous level but low blood calcium level is the most frequent cause.

The following symptoms occur

1. softening of the bones

2. deformities of the limbs, spine, thorax and pelvis

3. demineralization of the bones

4. pain in pelvis, lower back and legs

5. frequent bone fractures.

Hypervitaminosis

As in the case of Vitamin A intake of excessive amounts of Vitamin D leads to toxic symptoms which include irritability, nausea , vomiting and constipation.

Effects of Deficiency of Vitamin C: Prolonged deficiency of ascorbic acid produces a disease condition called as 'scurvy' in both infants and adults.

Infantile scurvy:

There is loss of appetite, failure to gain weight, irritability, palor, defective growth of bones. Haemorrhage occurs under the skin. There is defective formation of teeth and gums are swollen. The ends of the ribs become prominent resulting in beaded appearance called scorbutic rosary.

Adult Scurvy:

1. General manifestations are fever, susceptibility to infection, and delayed wound healing.

2. Anaemia: Microcytic hypochromic anaemia develops due to failure of absorption of iron.

3. Gums become spongy and bleed easily. Gums become swollen and ulcerated.

4. The blood vessels become fragile and porous due to defective formation of collagen. Joints become swollen and tender.

5. Clinical symptoms appear when total body pool of ascorbic acid decreases. Skin becomes rough and dry. There are small petechial hemorrhages around hair follicles.

Effects of Deficiency of B1

Deficiency of thiamine is associated with low calorie intake. Severe deficiency of thiamine produces a disease known as beri – beri.

It is manifested as

a. Dry beri – beri

b. Wet beri – beri

c. Infantile beri – beri

a. Dry beri – beri

There is loss of appetite, tingling numbness and burning sensation in hands and feet. Calf muscles are tender. Knee and ankle jerks are sluggish.

In later stages complete loss of sensation in hands and legs occur. It is characterized by foot and waist drop. Mental depression and confusion occurs.

b. Wet beri – beri

In this case there is enlargement of heart and the cardiac output is high. Oedema or accumulation of fluid in legs, face and trunk is observed. palpitations are marked.

c. Infantile beri – beri

It occurs in first few months of life if the diet of the mother is deficient in thiamine. Symptoms are restlessness, sleeplessness, constipation, enlargement of the heart and breathlessness.