

Diet, Nutrition and Public Health

Diet is the indispensable part of life processes of an organism. Different food consumed by an organism / human in daily basis is considered as a diet. Proper dietary status is essential for growth and proper health functions. A diet is composed of several food groups which are required to provide nutrients in proper amounts.

The term '**Food**' can be considered as any edible substance which is essential for the nourishment of body or maintaining the physiological and anatomical functions of cells, tissues or organ and which directly reflected in system. The term **nutrition** can be defined as the process of taking and utilizing the food for proper physiological and anatomical functions of body.

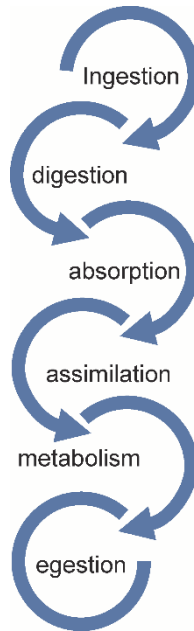
Plants are autotrophs as they can produce their own foods by Photosynthesis reactions whereas human and other animals are heterotrophs in respect to nutrition as they depend on plants or another animal.

Food and utilization of food i.e., nutrition can fulfill following functions in living multi-cellular living system:

- Growth and multiplication cells
- Energy production of cells
- Differentiation tissues and organ
- Adaptability to external environment
- Maintenance of Homoeostasis
- Synthesis of Biochemical for growth, development and communication with external environment

Importance of Diet in Nutrition and Health

Food includes **nutrients** or chemicals substances which are essential for maintaining the physiological and anatomical functions of body. **Diet** or different variety of food consumed by individual human being plays important role in human health and physiological and anatomical function. Human nutrition process involves the following stages:



- **Ingestion:** Act of food taking in.
- **Digestion:** Process of breaking down of complex food material into simpler with the help of enzymes.
- **Absorption:** Process of entering and diffusion of simpler components of food in blood stream and required part.
- **Assimilation** Incorporation of nonliving components of food in living protoplasm and utilization for energy production and other physiological purposes.
- **Metabolism:** Process of utilization of food for energy production.
- **Egestion:** Process of removal of residue left in process of nutrition.

As we discussed the role of nutrients or the components of food is essential for normal physiological and anatomical function of body, so a proper balanced diet is a fundamental requirements for every individual human life.

Living cell consists of mainly protein (or amino acids), carbohydrate and fat, so for the structure and function of cells all 3 components or nutrients are required in large quantity in human diet and known as **macronutrients**. Minerals and vitamins are required in less quantity for the functioning of cells so they are called **micronutrients**. Along with this sufficient quantity of water is required for the function of cells. Non starch Polysaccharide (NSP) or Dietary fibres are important part of human diet for roughage production should be present in Human diet.

According to National Institute of Nutrition (NIN) (2011), a **balanced diet** is one which provides all the nutrients in required amounts and proper proportions. However, quantity and proportion of ingredients in balanced diet is always variable depending upon following factors:

- Age
- Sex
- Physiological condition
- Climatic and geographical condition
- Socio cultural consideration

A balanced diet can be achieved by the combination of all basic food groups (NIN 2011) which include

- Millets, pulses and cereals
- Fruits and Vegetables
- Milk and dairy products, meat, fish and egg
- Fats and oils and nuts & oil-seeds

Along with these major 4 groups spices and condiments, sugar and jaggery, salts places a role in Indian diet.

Calorific Values of Various Foods

Calorific value: Calorific value [also known as energy value] of a foodstuff is defined as the quantity of heat liberated in calories by the complete combustion of a unit mass of the food stuff in excess air or oxygen under specified standard conditions. This is measured in BOM calorimeter and expressed in kilo calories and the standard mass taken is 100 g.

Calorie is the unit of heat. One calorie defines the amount of *heat required to rise the temperature of one gram of water by 1 °C* (i.e. from 15 °C to 16 °C).

The calorific value or energy value of foods can be expressed in terms of kilo calories (kcal) or megajoules (MJ). 1 kilo calorie is the quantity of heat required to raise the temperature of 1 kg of water through 1°. It is one thousand times the small calorie.

Calorific Values of Different Food Stuffs

Nutrients	Gross calorific value (kcal/gm)	Physiological energy value (kcal/gm)
Carbohydrate	4.1	4.0
Protein	5.65	4.0
Fat	9.0	9.0
Alcohol	7.1	7

The carbohydrates and fats are completely converted into CO₂ and H₂O through oxidation in the body; so that their energy or fuel values are determined in the bomb calorimeter or in the body, are almost the same. Unlike carbohydrate and fat, Proteins are not completely burnt in the body as they are converted in urea, creatinine and ammonia, and excreted from body. Due to this reason, protein's calorific value in the body is lesser than that obtained in a bomb calorimeter.

Calorific values of some Indian fruits, vegetable and foodstuffs as per NIN:

Food Item	Quantity	Calorific Value
Almond	10 numbers	85
Cashew nuts	10 numbers	95
Apple	1 medium	65
Banana	1 medium	90
Papaya	1 medium	80
Rice	1 cup	170
Chapati	1 cup	80
Poha	1 cup	270
Upma	1 cup	270
Dal	1 cup	100
Boiled egg	1 no.	90
Mutton curry	$\frac{3}{4}$ cup	260
Chicken curry	$\frac{3}{4}$ cup	240

Nutritional Requirement of Healthy Subject

For a healthy subject, healthy diet consumption is essential to prevent malnutrition and protect the body from different lifestyle mediated diseases. Proper nutritional requirement is essential for maintaining structure and function of human body. According to NIN, nutritional requirements are considered as the quantities of nutrients that a healthy individual must obtain. It can be expressed as recommended dietary allowances (RDAs) and which can be defined as 'estimated amount of nutrients to be consumed regularly to ensure the requirements of every individuals in a given population.'

Factors affecting RDA:

- Bioavailability (absorbed amount of nutrient which is utilized by the body) of nutrient present in given diet.
- Safety margin in respect to health (effect of food quality on health)
- Food tradition of a region (regional food habits and climatic condition)

(d) Age group (paediatric/ geriatric)

(e) Physiological condition (pregnancy, adolescence, lactating mother)

On the basis of the function food can be categorized in following way:

Energy Rich Foods	Body Building Foods	Protective Foods
Carbohydrates & Fats Whole grains, cereals, millets, ghee, butter, nuts and oilseed, sugars	Proteins Pulses, nut, oilseed, milk, milk products, meat, fish poultry	Vitamins and Minerals Green vegetable, fruits, milk, milk products, meat

For a healthy subject, healthy diet consumption is essential to prevent malnutrition and protect the body from different lifestyle mediated diseases; Macro and Micronutrients constituent of healthy diet are discussed as follows:

Macronutrients

Name of nutrient	Chemical nature	Dietary sources	Major role
Carbohydrate (energy value: 4Kcal/gm)	Polyhydroxy aldehyde/ ketone; Monosaccharide (Glucose, fructose), Disaccharide (Sucrose) Polysaccharide (Starch)	Fruits, vegetables and honey (Monosaccharide); sugar and jaggery (Disaccharide); cereals, millets, pulses and root vegetables(Polysaccharide)	<ul style="list-style-type: none"> • main source of energy • spare proteins for body building function • Ingredient of cell
Protein (energy value: 4Kcal/gm)	Complex polymer of amino acids	Animal generated foods includes milk and dairy products, meat, fish and eggs; plant foods such as legumes and pulses	<ul style="list-style-type: none"> • basic structural and functional components of cell, • maintenance repair and growth of tissues. • Essential for production and regulation of enzymes, hormones, haemoglobin, antibodies etc. • source of energy • source of Essential amino acids(not synthesized by human body) • essential for growing children, pregnant women and individuals during several infections and diseases or stress

Table Contd...

Name of nutrient	Chemical nature	Dietary sources	Major role
Fats and Lipids (energy value: 9 Kcal/gm)	Triglycerides of fatty acids; Compound phospholipids; Derived lipid (Cholesterol)	<ul style="list-style-type: none"> • Edible oils, ghee, butter • Oil-seeds, nuts • Meat, poultry, fish, eggs milk and unskimmed dairy items 	<ul style="list-style-type: none"> • concentrated source of energy • act as vehicle for fat-soluble vitamins [A, D, E and K], caroteneoids and helps in their absorption • sources of essential PUFA [polyunsaturated fatty acids] • regulates body temperature with the help of layer of fat under the skin in conservation of body heat • Reduce the use of proteins for energy • protects certain vital organs

Micronutrients

Minerals:

Micronutrient	Major food source	Functions
Zinc	Breast milk; meat; liver; egg yolk; seafood; whole-grain breads, cereals, and other zinc fortified grain products; legumes	Components of various enzyme system Helps in activity of enzymes Stimulate insulin activity Assist antioxidant enzymes Boost immunity
Sodium	Sodium chloride (table salt) abundant in most foods	Regulates acid-base equilibrium Maintains electrolyte balance Required for proper neuronal conduction and contraction of muscle
Calcium	Breast milk, yogurt, cheese, paneer fortified or enriched grain products, some green leafy vegetables (such as collards, kale, green mustard, and green turnip), tofu (made with calcium sulfate), fishes (sardines, cod, salmon)	Builds and maintains bones and teeth Essential in clotting of blood Influences transmission of ions across cell membranes Essential in nerve transmission
Iron	Breast milk; baby food; meat; animal liver; pulses and legumes ; whole-grain breads, cereals, or fortified or enriched grain products; and dark green vegetables	Essential for the formation of hemoglobin and oxygen transport; increases resistance to infection; functions as part of enzymes involved in tissue respiration

Table Contd...

Micronutrient	Major food source	Functions
Fluoride	Fluorinated drinking water	Helps protect teeth against tooth decay; helps in reducing bone loss
Chloride	Breast milk, sodium chloride (table salt)	Helps regulate acid-base equilibrium and osmotic pressure of body fluids; component of gastric juices
Selenium	Sea foods, Whole-grain breads, cereals, and selenium enriched grain products; onions; meats	Essential to tissue respiration; associated with fat metabolism and vitamin E; acts as an antioxidant
Chromium	Promote insulin function; Required for normal glucose metabolism	Meat; whole-grain breads, cereals, and other fortified or enriched grain products; brewer's yeast; corn oil
Potassium	Breast milk; infant formula; fruits including higher amount in orange, bananas, and dried fruits; milk products like yogurt; vegetables like potatoes, sweet potatoes; meat; fish; poultry; soy products	Regulate acid-base equilibrium and osmotic pressure of body fluids; influences muscle activity, especially cardiac muscle
Copper	Liver; kidney; poultry; shellfish; legumes and pulses; whole-grain breads, cereals	Catalyze the function of many enzymes and iron; may be an integral part of RNA, DNA molecules
Iodine	Breast milk, seafood, iodized salt	Regulate thyroid hormones; important in regulation of cellular oxidation and growth
Phosphorous	Breast milk; fishes; cheese; egg yolk; meat; poultry; fish; whole-grain breads, cereals, and other grain products; legumes	Constituents of bone and teeth; component of nucleic acids, phospholipids; as coenzyme functions in energy metabolism; buffers intracellular fluid
Magnesium	Breast milk; whole-grain breads, cereals; tofu; legumes; green vegetables	essential for many coenzyme oxidation-phosphorylation reactions, nerve impulse transmissions, and for muscle contraction
Manganese	Whole-grain breads, cereals, and other grain products; legumes; fruits; leafy vegetables	Essential part of several enzyme systems involved in protein and energy metabolism
Molybdenum	Meats; breads, cereals; dark green leafy vegetables; legumes	Part of the enzymes xanthine oxidase and aldehyde oxidase, possibly helps reduce incidence of dental caries

Vitamins:

Micronutrient	Major food source	Functions
<i>Fat soluble vitamins</i>		
Vitamin A	Milk, butter, egg, carrots, cod liver oil, tomatoes, pumpkin, green leafy vegetables	Preserves integrity of epithelial cells; formation of rhodopsin for vision in dimlight; necessary for wound healing, growth, and normal immune function

Table Contd...

Micronutrient	Major food source	Functions
Vitamin D	Cheese, butter, milk, green vegetables, fish liver oil, sunlight	Necessary for the formation of normal bone; promotes the absorption of calcium and phosphorus in the intestines
Vitamin E	Vegetable oils, spinach, lettuce, turnip leaves, butter, milk, whole grains, nuts, seeds, leafy vegetables	Act as an antioxidant in the tissues; may also acts as coenzyme; neuromuscular function
Vitamin K	Cabbage, cauliflower, spinach and other leafygreen vegetables, cereals, soyabeans	Catalyzes prothrombin synthesis; essential in the synthesis of other blood clotting factors; synthesis by intestinal bacteria
<i>Water soluble vitamins</i>		
Vitamin C	Fruit (especially citrus fruits like orange, lemon, blackcurrants, strawberries, papaya and kiwi), green vegetables, peppers and tomatoes	Essential in the collagen synthesis (hence, strengthens tissues and improves wound healing and immunity); iron absorption and transport; water-soluble antioxidant
<i>Vitamin B complex</i>		
Vitamin B1 (Thiamine)	Bread, fortified breakfast cereals, nuts and seeds, meat (especially pork), beans and peas	Combines with phosphorus to form thiamin pyrophosphate (TPP) necessary for metabolism of protein, carbohydrate, and fat; essential for growth, normal appetite, digestion, essential for nerve functions
Vitamin B2 (Riboflavin)	Milk and dairy products, eggs, fortified breakfast cereals, some oily fish (e.g. mackerel and sardines), mushrooms and almonds	Essential for growth; plays enzymatic role in tissue respiration and help as a transporter of hydrogenions; synthesis of FMN and FAD
Vitamin B3	Breast milk; meat; poultry; fish; whole-grain breads, cereals, and fortified or enriched grain products; egg yolk	Helps to maintain the normal balance of skin. Helps in the neuronal function normally and helps reduce tiredness
Vitamin B6 (Pyridoxne)	Meat, poultry, fish, fortified breakfast cereals, egg yolk, yeast extract, soya beans, sesame seeds, some fruit and vegetables (e.g. banana, avocado and green pepper)	Helps in formation of RBCs; in the synthesis and break-down of amino acids and unsaturated fatty acids from EFAs (Essential Fatty Acids); essential for conversion of tryptophan to niacin; essential for normal growth
Vitamin B12 (Cobalamin or Cyanocobalamin)	Breast milk, meat, fish, poultry, cheese, egg yolk, liver	Required for biosynthesis of nucleic acids and nucleoproteins; red blood cell maturation; involved with folate metabolism; stimulates immunity, reduces fatigue

Table Contd...

Micronutrient	Major food source	Functions
Folacin (Folate)	Leafy green vegetables, malted wheat, brown bread, peas and beans, oranges and other citrus fruits, berries and fortified breakfast cereals	Essential in the biosynthesis of nucleic acids; necessary for the normal maturation of red blood cells
Pantothenic acid	Breast milk; meat; fish; poultry; liver; egg yolk; yeast; whole-grain breads, cereals, pulses and legumes; vegetables	essential in the intermediary metabolism of carbohydrate, fat, and protein
Biotin	Breast milk, liver, meat, egg yolk, yeast, bananas, most vegetables, strawberries, grapefruit, watermelon	Essential component of enzymes; coenzyme carrier of carbon dioxide; plays an important role in the fatty acids- metabolism and amino acids

Recommended Dietary Allowances for Indians

Population	Body weight (kg)	Physiological condition	Requirement of net energy (kcal/day)	Protein (gm/day)	Visible fat (gm/day)
Man	60	Sedentary	2320	60	25
		Moderate	2730		30
		Heavy	3490		40
Woman	55	Sedentary	1900	55	20
		Moderate	2230		25
		Heavy	2850		30
Pregnant woman	55	Sedentary	1900+350	55+23	30
		Moderate	2230+350		
Lactating mother [0-6 months]	55	Sedentary	1900+600	55+19	30
		Moderate	2230+600		
		Heavy	2850+600		
Lactating mother [6-12 months]	55	Sedentary	1900+520	55+13	30
		Moderate	2230+520		
		Heavy	2850+520		
Infants [0-6 month]	5.4		92 kcal/kg/d	1.16 g/kg/d	-
Infants [6-12 month]	8.4		80 kcal/kg/d	1.69 g/kg/d	19
Children [1-3yrs]	12.9		1060	16.7	27

Maternal Nutrition

Special dietary requirements are required for pregnancy period due to alteration in physiological and anatomical state. This alteration begins after conception and continues till delivery to accommodate the developing foetus.

According to NIN, pregnant woman requires an additional 350 calories, 0.5 g of protein during first trimester and 6.9 g protein during second trimester and 22.7 g of protein during third trimester of pregnancy.

Nutrition should be fortified with additional micronutrients and folic acid to prevent congenital deformities and adequate erythropoiesis. For formation of osseous tissue and teeth of foetus sufficient calcium is required. Iron along with folic acid is required for haemoglobin formation and preventing anaemia of both mother and foetus. Iodine is also essential during this stage for proper mental health of foetus and newborn. Along with this, proper amount of Vitamin A, C are required for children during lactation.

The nutritional requirements of lactating mothers should meet the essential requirements for post pregnancy tissue repair, daily nutritional needs, nutritional requirements of the infant and for lactation. Nutritional needs are greater during lactation than during pregnancy. The body demands requirement of all the nutrients in right amounts during lactation. Fluid intake of 2-3 liters per day is essential to prevent dehydration during lactation.

An additional 550 kcal of energy, 25 g of protein, 25 g of fat and 600mg of calcium is required for lactating mothers than normal adult women. An additional 1 portion of cereals, 2 portions of pulses, 2 portions of fat/oil, 2 portions of milk, 1 portion of fruits and half portion of green leafy vegetables are required during lactation. Between 6-12 months of lactation, it is essential to bring the diet intake gradually back to the normal.

Nutrition in Childhood and Adolescent

Proper nutrition is essential for all the ages of life span for physical and mental growth as well as function of body. But the requirement is very crucial for childhood and adolescent. During these periods continuous development happened almost in geometric progression rate which include height, weight, development and maturation of various tissues.

For neonatal, colostrum followed by exclusive breast feeding is only nutrition up to six month. Then breast feeding with nutrient rich complementary food till 2 years is suggested. Adolescent is considered as transition period from childhood to adult [early adolescence (ages 10–14 years), late adolescence (ages 15–19 years), youth (ages 15–24 years), and young adulthood (ages 20–24 years).] Adolescent is characterized by speedy increase in height and weight, structural growth, hormonal changes, reproductive organ and sexual maturation and wide swings in emotion. Adolescent are periods of continuous growth and development.

High calcium rich diet is essential for growth of osseous tissue development. At the ages of 11-18 years, calcium requirement is the reference nutrient intake for boys is 1000 mg per day and for girls is 800 mg per day. Due to menstruation and hormonal changes, girls are at greater physiological stress than boys. Additional Iron and folic acid rich supplement diet required for them to prevent anaemia. According to British Nutrition Federation, reference nutrient intake for 11-18 years old girls is 14.8 mg of iron each day, while for boys of the same age the figure is 11.3 mg of iron daily. Iron rich food like liver, red meat, leafy vegetable is important source of iron.

Regular consumption of vitamin C helps absorption of non-haem iron from vegetable source. Sufficient intake of vitamin A, Zinc and iodine and dietary fibre are required for physical and mental health. Maintenance of correct body mass index important for this age group to reduce the risk of chronic diseases like cardio vascular disease, type 2 diabetes and osteoporosis.

Anorexia nervosa and bulimia nervosa are 2 common nutritional disorders in adolescent where people keep their body weight low by not taking proper amount of food. Overeating is an emerging problem in adolescent when a person eats excessive quantities of food in response to negative emotions (depressed or feeling anxious). Restriction of excessive salt, free sugars and trans-fat is the reason of adolescent obesity which leads to cardiac diseases, hypertension, diabetes and other chronic diseases.

Nutrition in Aging

Due to more sedentary life, and decreased activity, the energy requirement during old age is lesser than adults. However, proper functional dietary intervention is required for the maintenance of health and in reducing the onset of chronic diseases, contributes to quality of life in daily activity, to energy and mood and helps in regulating the functional independence.

Adequate protective foods are required during old age to prevent damage from free radicals and oxidative stress related degenerative diseases. Intake of foods that contain high fibers, like whole grains, legumes, leafy and fibrous vegetables and fruits is essential for proper bowel movement and function, 10-12% of total calories should be from protein and 50% from carbohydrates. The requirement for calcium is higher and is 1000 mg/day for postmenopausal women. Saturated fats should be limited in the diet. 20g of fiber everyday is essential to prevent bowel discomfort however rough bran, fiber and mature vegetables are not recommended. A daily intake of dietary fibre of an amount of 21 g for women and 30 g for men is essential.

Deficiency Conditions and Health Problem

Deficiency of macro and micronutrient can cause different physiological and psychological symptoms which are described as follows:

Carbohydrate Deficiency Diseases

Name of disease/ Symptoms	Cause(s)	Physiological impacts
Ketoacidosis	<ul style="list-style-type: none"> starvation or low carbohydrate intake; body produces ketone bodies out of fat, and using them for energy instead of carbohydrate. 	<ul style="list-style-type: none"> over production of ketoacids results in ketosis or ketoacidosis leads to decreasing of blood pH and irreversible damage of cells
Ketosis	during long starvation acetyl CoA in liver is used to form ketone bodies from fatty acid and deamination of amino acids leads to ketosis	<ul style="list-style-type: none"> headache, fatigue, nausea, cramp, irritability, bad breath
Hypoglycemia	non-availability of long-time carbohydrate	<ul style="list-style-type: none"> leads to fall of blood sugar(70mg/dl) giddiness, delirium, fatigue, shock.
Constipation	lacking of Non starch polysaccharide/dietary fiber	<ul style="list-style-type: none"> constipation and may be one of the causes of colorectal cancer

Protein Deficiency Disorders

Name of disease	Cause(s)	Physiological impacts
Protein Energy Malnutrition	common problem of children in underdeveloped countries which leads to high child mortality and permanent impairment of physical and mental growth of living children.	
Marasmus	insufficient calorie and protein intake disorder in children under one year	characterized by muscle wasting, loss of subcutaneous fat, and weakness but without oedema.
Kwashiorkor	low intake of protein in diet in children under 5 years of age	characterized by clinical symptoms like <ul style="list-style-type: none"> oedema pigmentation of hair and skin (red pigment) fatty liver retardation of growth in children diarrhea dermatosis reduced T-cell lymphocytes with secondary infections decreased plasma albumin concentration (<2g/dl)

Essential Fatty Acid (EFA) Deficiency Disorders

Name of disease	Cause(s)	Physiological impacts
Dermatitis, Eczema, reduced growth rate in infants, decreased resistance in infection	<ul style="list-style-type: none"> • lacking of adequate Essential fatty acids especially linoleic acid and linolenic acids • use of skim milk in children and fat less Total parenteral nutrition (TPN) in diet 	<ul style="list-style-type: none"> • endogenous synthesis of other fatty acid is retarded • affects membrane integrity of skin and cell membrane • affects prostaglandin and leukotriene synthesis

Vitamin Deficiency Disorders

Name of disease	Cause(s)	Physiological impacts
Night blindness (nyctalopia)	lacking of vitamin A or retinol; as retinol or vitamin A is the component of rhodopsin, so the absence of vitamin A inhibits the rhodopsin formation which is essential for vision in dim light	<ul style="list-style-type: none"> • night blindness followed by xerophthalmia
Xerophthalmia	lacking of vitamin A or retinol	<ul style="list-style-type: none"> • characterised by dryness of conjunctiva and cornea and further corneal destruction or kertamalacia • keratinization of the eyes
Skin disorder	inadequate dietary intake, impaired absorption of vitamin A, chronic alcoholism or hepatic problems	<ul style="list-style-type: none"> • keratinization of epithelial cells in skin • papillary hyperkeratosis of the skin
Others	lacking of vitamin A or retinol	<ul style="list-style-type: none"> • growth retardation • growth, impaired resistance to infection • degeneration of germinal epithelial (in male)
Ricket	deficiency of vitamin D in children	<ul style="list-style-type: none"> • soft bone, costochondral beading, epiphyseal enlargement, cranial bossing, bowed legs
Osteomalacia	deficiency of vitamin D in adult	<ul style="list-style-type: none"> • demineralization of bone, susceptibility to fracture
Renal osteodystrophy	less production of calcitriol in renal failure	<ul style="list-style-type: none"> • deformities of bone, joint pain, increased risk of fracture
Hemolytic anemia	deficiency of vitamin E	<ul style="list-style-type: none"> • destruction of premature erythrocytes
Hyporeflexia, spinocerebellar and retinal degeneration	deficiency of vitamin E	<ul style="list-style-type: none"> • impairment in reflex and vision • to prolonged bleeding and prothrombin time

Table Contd...

Name of disease	Cause(s)	Physiological impacts
Haemorrhagic manifestations	deficiency of vitamin K	<ul style="list-style-type: none"> to prolonged bleeding and prothrombin time
Scurvy	deficiency of vitamin C	<ul style="list-style-type: none"> spongy gums, loose teeth, anaemia, pinpoint peripheral haemorrhages, bleeding gums, osmotic diarrhoea
Beriberi	deficiency of vitamin B1 (Thiamine)	<ul style="list-style-type: none"> wet beri-beri, characterized with oedema and dry beri-beri, characterized by neuritis), neuritis, oedema, cardiac failure
Impaired carbohydrate metabolism	deficiency of vitamin B1 (Thiamine)	<ul style="list-style-type: none"> in absence of thiamine pyrophosphate, carbohydrate metabolism is impaired and accumulation of elevated pyruvate in tissue creates toxicity and alteration blood brain barrier resulting in polyneuritis; may lead to impairment in nerve impulse transmission
Photophobia	deficiencies of riboflavin (vitamin B2)	<ul style="list-style-type: none"> painful and irritation in bright light, dry eyes, migraine
cheilosis	deficiencies of riboflavin (vitamin B2)	<ul style="list-style-type: none"> Fissures and inflammation at the corner of mouth
glossitis	deficiencies of riboflavin (vitamin B2)	<ul style="list-style-type: none"> inflammation and swelling of the tongue change in color, and formation of a different appearance on the surface
others	deficiencies of riboflavin (vitamin B2)	<ul style="list-style-type: none"> corneal vascularization, poor growth
Pellagra	Deficiencies of niacin (mainly observed in people with staple diet maize or corn due to bound form of niacin in maize and low tryptophan)	<ul style="list-style-type: none"> Dermatitis Diarrhoea dementia
Microcytic anaemia	pyridoxin (vitamin B6) deficiency	<ul style="list-style-type: none"> reduction of haem production
Convulsions; irritability, depression	pyridoxin (vitamin B6) deficiency	<ul style="list-style-type: none"> neurological symptoms are due to less production of serotonin, epinephrine and norepinephrine and convulsion may happen due to excessive reduction of GABA
Neurological and digestive complication	deficiency of Biotin (Vitamin B7/H) prolonged use of antibiotic and high consumption of raw eggs may results biotin deficiency	<ul style="list-style-type: none"> loss of appetite dermatitis, nausea hallucination depression

Table Contd...

Name of disease	Cause(s)	Physiological impacts
megaloblastic anaemia	Folic acid deficiency Folate deficiency is common in pregnant and adolescent girls. The cause of deficiency includes less dietary intake, poor absorption, increase demand in body (pregnancy), consumption of anticonvulsant drugs	<ul style="list-style-type: none"> • less number of larger RBC • due to impaired production of purine and subsequent DNA formation • delayed maturation of erythrocyte is leading to macrocytic anaemia with megaloblastic changes in bone marrow
Pernicious anaemia	deficiency of Vitamin B12 (cyanocobalamin)	<ul style="list-style-type: none"> • low haemoglobin formation • decreased number of erythrocytes due to autoimmune destruction of gastric parietal cells that secrete intrinsic factors which leads to malabsorption of cyanocobalamin • strict vegetarian diet also leads to this deficiency
Others	Deficiency of vitamin B12 (cyanocobalamin)	<ul style="list-style-type: none"> • neurologic deterioration

Mineral Deficiency Disorders

Name of disease	Cause(s)	Physiological impacts
Hypocalcemia causing tetany	deficiency of calcium	neuromuscular irritability, spasms convulsions
Rickets	deficiency of calcium	defective calcification of bones
Osteoporosis	deficiency of calcium in elder	weak and brittle bones
microcytic hypochromic anemia	deficiency of iron	low blood hemoglobin
Others	deficiency of iron	low serum protein-bound iron, poor tissue cytochromes leading to reduction in tissue respirations and metabolic processes, poor neutrophil myeloperoxidase activity and a decline in immunocompetence, irritability, anorexia, pallor, lethargy
Impaired growth	deficiency of zinc	poor growth low carbonic anhydrase activity of erythrocytes, dermatitis, alopecia, cutaneous hyperkeratosis decreased gustatory acuity, abnormal taste loss of appetite, delayed wound healing dementia spermatogenic defects, hypogonadism, dwarfism

Table Contd...

Name of disease	Cause(s)	Physiological impacts
Digestive and hormonal impairment	deficiency of chloride	vomiting diarrhea respiratory alkalosis Addison's disease
Dental carries	deficiency of fluorine(less than 0.5ppm)	breakdown of tooth enamel decay of teeth
Impaired glucose metabolism	deficiency of chromium(Cr3+)	to reduced sugar tolerance hyperglycemia and glucosuria rise in serum cholesterol
Others	deficiency of chromium(Cr3+)	<ul style="list-style-type: none"> • low sperm count and infertility • impaired growth • peripheral neuropathy • negative nitrogen balance • decreased respiratory quotient
Impaired bone and cardiovascular function	deficiency of copper	demineralization of neural tissue fragility of arteries, anemia myocardial fibrosis
Others	deficiency of copper	palor (hypopigmentation of skin) gray hair retardation of growth edema anorexia
Endemic goiter	deficiency of iodine	abnormal increase in thyroid gland depressed thyroid function
cretinism	deficiency of iodine	retardation of physical and mental growth due to lacking of secretion of thyroid in deficiency of iodine hormone in children
myxoedema	deficiency of iodine	Physical and mental growth retardation in adult
Neuromuscular abnormality	deficiency of magnesium	Vertigo Depression increased neuromuscular excitability (<i>hypomagnesemic tetany</i>) leading to tremors epileptiform convulsions carpedal spasm abnormal electromyography hyper or hyporeflexia
Impaired growth	deficiency of manganese	abnormalities in skeletal muscle and bones neonatal ataxia [lacking of muscle coordination]
Metabolism and excretory impairment	deficiency of molybdenum occurs in human when kept on parenteral nutrition	lowers uric acid excretion xanthine oxidase activity raises urinary xanthine
Ricket, renal ricket and osteomalacia	deficiency of phosphorus	decreased serum phosphate

Table Contd...

Name of disease	Cause(s)	Physiological impacts
Muscular and cardiovascular impairment	deficiency of potassium	Weakness of muscle, reduced intestinal tone and distension cardiac arrhythmias respiratory failure
Hyponatremia	deficiency of sodium; due to diarrhoea, vomiting, chronic renal diseases, adrenocortical insufficiency; edema (which occurs in cirrhosis or congestive heart failure)	reduced blood pressure and circulatory failure
Keshan syndrome	deficiency of selenium	dilated cardiomyopathy risk of congestive cardiac failure cardiomegaly, on occasion fulminant myocarditis
Muscular and cardiovascular impairment	deficiency of selenium	myalgia; tenderness of muscle cardiac myopathy increased fragility of RBC degeneration of pancreas
Neuronal and cardiac impairment	deficiency of sulfur	arthritis, brittle nails and hair, convulsions, depression. Sulfur deficiency in the body may lead to obesity, heart disease, Alzheimer's disease

Dietary Components in Prevention and/or Curing Diseases

According to Encyclopedia Britannica, Disease is considered as any harmful deviation from the normal structural or functional state of an organism, generally associated with certain signs and symptoms and differing in nature from physical injury. A diseased organism commonly exhibits signs or symptoms indicative of its abnormal state. As we discussed that absence or deficiency of nutritional components may lead to abnormal physiological changes in body and turns to disease state. So, nutritional intervention can prevent, manage or cure diseases/ physiological deviation.

In this section we will discuss the role of nutrition in preventing or managing diseases/physiological changes.

A. Obesity and overweight

According to WHO, Overweight and obesity are defined as abnormal or excessive fat accumulation that may impair health. This is further categorized by the Body Mass Index (BMI) scale [person's weight in kilograms divided by the square of his height in meters (kg/m^2)].

For adult individual overweight is considered as a BMI greater than or equal to 25; and obesity is a BMI greater than or equal to 30. For children less than of 5 years of age, overweight can be defined as weight-for-

height greater than 2 standard deviations above WHO Child Growth Standards median; and obesity is weight-for-height greater than 3 standard deviations above the WHO Child Growth Standards median. For children aged between 5–19 years overweight is defined as BMI-for-age greater than 1 standard deviation above the WHO Growth Reference median; and obesity is greater than 2 standard deviations above the WHO Growth Reference median.

In 2018, about 40 million children under the age of 5 years were overweight or obese. Previously it was considered as a high-income country problem, now it is a burden of low income and developing countries. Obesity is considered as reason of co morbidity of other diseases.

Cause of obesity

Imbalance of energy between consumed and expended calories lead to obesity and overweight. This imbalance is the contribution of following reasons:

- excess intake of high energy rich food comprising of excess sugar and lipids.
- lacking of physical activity
- sedentary work and lifestyle
- metabolic disorders
- high intake of alcohol
- neuro-endocrine causes which include hypothyroidism, growth hormone deficiency, Cushing's syndrome, hypogonadism, and polycystic ovary syndrome
- consumption of antidepressants, antidiabetic drugs, anticonvulsants, antipsychotic medication, beta-blockers, and steroid hormones.

Health implications of obesity and overweight

- leads to co morbidity of different diseases
- cardiovascular disease— like hypertension, coronary artery disease, stroke, venous stasis deep vein thrombosis
- gastrointestinal disease
- osteoarthritis
- gastroesophageal reflux disease (GERD)
- cholelithiasis
- non-alcoholic fatty liver disease (NAFLD)
- endometrial breast cancer, colorectal cancer
- diabetes

- Hyperlipidemia
- polycystic ovary syndrome
- obstructive sleep apnea (OSA)
- childhood obesity leads to difficulties in breathing, increased risk of bone fractures, hypertension, and initial markers of cardiovascular disease, insulin resistance and several psychological effects.
- reduction in life expectancy by 6 to 7 years on average

Nutritional intervention in obesity

WHO suggested remedy regarding the obesity at the individual level, people can:

- Reduction of energy intake from total fats and sugars.
- High consumption of fruit and vegetables, as well as legumes, whole grains.
- regular physical activity (60 minutes a day for children and 150 minutes spread through the week for adults).

As per NIH, the corner stone of dietary therapy for weight loss in overweight and obese patients is intake of low-calorie diet (LCD). This diet is different from a very low-calorie diet (VLCD) (less than 800 kcal/day). The recommended LCD in this guide includes the Step I Diet, also contains the nutrient composition that will decrease other risk factors such as high blood cholesterol and hypertension. Diets having 1,000 to 1,200 kcal/day should be selected for most women and a diet between 1,200 kcal/day and 1,600 kcal/day should be chosen for men to manage obesity as guided by NIH. VLCDs are not preferable routinely for weight loss therapy as which require special monitoring and supplementation.

LCDs are high in carbohydrate (55–60%), low in fat (less than 30% of energy intake), and high in fiber and have a low glycemic index excluding alcohol and high calorie snacks should be avoided. Several randomized trials LCD has been shown to reduce body weight by 8% during 3–12-month period.

Low-fat diets reduce the daily intake of fat to 20–25% of total energy intake. When a person on a 1500-calorie diet, this translates to 30–37 g of fat and this is one of the effective interventions of obesity management. Clinical trial meta-analysis suggested that Low fat diet for 2-12 months not only help in weight loss but also reduction of chance of cardiac diseases.

Low-carbohydrate (60–150 g of carbohydrate/day) and very low-carbohydrate diet (0 to <60 g) are another way of dietary intervention for many years. Glycogen utilization happens when carbohydrate intake is

restricted. When the carbohydrate intake is less than 50 g/day, ketosis will develop due to glycogenolysis, resulting in fluid loss. Some current low-carbohydrate diets like Atkin's diet limit carbohydrate intake to 20 g/day however allow unrestricted amounts of fat and protein.

Nutritional intervention in individual level is not only solution of managing global burden, food industry and other stake holders have a great role in this section. WHO suggested following roles of food industry:

- reducing the sugar, fat and salt content of processed foods.
- ensuring that healthy and nutritious choices are available and affordable to all consumers.
- restricting marketing of foods which contain high sugars, salt and fats, especially those foods targeted at children and teenagers.
- Ensuring the availability of healthy food choices.
- Enhanced promotion of regular physical activity practice in the workplace.
- Measurement of Trans- fat in packaged food.

Food restrictions for obesity/ food

Following dietary intervention are essential to prevent the obesity:

- regular intake of variety of low-calorie fresh fruits instead of fruit juice is quite beneficial to reduce the obesity
- intake of less than 10% of calories from saturated fatty acids
- intake of green vegetables, like broccoli, cabbage, and other dark leafy greens; orange vegetables, such as carrots, sweet potatoes, pumpkin, and tomatoes
- intake of minimum amount of processed, whole foods-whole grains, vegetables, fruits, nuts, healthful sources of protein (fish, poultry, beans), and vegetable oils
- limiting salt intake is another major step to be adopted by obese people and should use less than 2 g of salt per day
- avoid of consumption of ready to eat and junk foods like French fries, potatoes and potato chips, sugary drinks, and refined grains, Red meat (beef, pork, lamb) and processed meats (salami, ham, bacon, sausage)
- intake of at least 30 grams of fibre in the form of whole-grain cereals, unpolished rice or millets like *ragi* every day

B. Diabetes mellitus (DM)

Diabetes mellitus is a chronic heterogeneous metabolic disorder that occurs either when the pancreas is not able to produce enough insulin or when the body cannot effectively utilize the insulin it produces. Major

pathological symptoms include elevation of blood sugar than normal (hyperglycaemia). Diabetes is broadly classified in 2 categories:

Type 1 diabetes also known as insulin-dependent, juvenile or childhood-onset which is characterized by impaired insulin production by pancreatic beta cells due different heterogeneous unknown causes. Major symptoms like intemperate excretion of urine (polyuria), thirst (polydipsia), frequent hunger, weight loss, altered vision, and fatigue observed in this case.

Type 2 diabetes also known as non-insulin-dependent, or adult-onset results from the body's ineffective use of insulin. Mainly Type 2 diabetes comprises the majority of people with diabetes around the world, and is mainly due to excess body weight and physical inactivity.

Gestational diabetes

Gestational diabetes is characterized with hyperglycaemia with blood glucose level above normal but below those diagnostics of diabetes, observed during pregnancy. Women with gestational diabetes are at an high level risk of complications during pregnancy and at delivery and chances of their children with high risk of type 2 diabetes in the future. It is mainly diagnosed through prenatal screening. Diabetes is a metabolic disorder which can damage different organs like heart, blood vessels, eyes, kidneys, and nervous system. Diabetes can enhance the risk of heart attacks and strokes along with reduced blood flow, neuropathy (nerve damage) in the feet leads to high the chance of foot ulcers, infection and eventual need for limb amputation. Diabetic nephropathy and retinopathy are the one of major cause of renal failure and blindness globally.

Apart from pharmacotherapy using insulin and oral hypoglycemic drugs, physical exercise along with dietary and nutritional intervention are only option of management of diabetes.

Nutritional intervention in diabetes:

Major purposes of Nutritional intervention in diabetes management are:

- maintaining blood glucose level within normal range or near to the normal
- to reduce lipid or lipoprotein profile and maintain blood pressure level within normal range to reduce cardiac problems
- to prevent or slowdown diabetes related complications.
- to reduce obesity related complication in diabetes (if any)

Several clinical studies shown reduced calorie intake (using reduced dietary fat) particularly saturated fat, may decrease the risk for diabetes by producing an energy-independent improvement in resistance of insulin

and helping weight loss. However clinical data are not available for low carbohydrate diet in preventing diabetes. It has been observed that whole grain-containing foods have been associated with improved insulin sensitivity and improved insulin secretion ability which is adequate to overcome insulin resistance.

Carbohydrate obtained from vegetables, Fruits, whole grains, legumes, and low-fat milk is beneficial for management of Diabetes. However, carbohydrate intake and consumption monitoring are considered as essential tool for dietary management of diabetes. Intake of nonnutritive sweeteners and sugar alcohols are safe when consumed within the daily intake levels.

Clinical trials suggesting that consuming a high-fiber diet (~50 g fiber/day) decreases the glycemia in subjects with type 1 diabetes and glycemia, hyperinsulinemia, and lipemia in type 2 diabetes patient. Several evidences from clinical studies have shown that dietary sucrose does not enhance glycemia more than isocaloric amounts of starch. However sucrose can be substituted for other carbohydrate sources in the meal plan or, if added to the meal, adequately maintained with insulin or another glucose-lowering medication.

Foods containing resistant starch (starch physically enclosed within intact cell structures as in some legumes,) or foods with high amylose content, such as specially formulated cornstarch, may alter postprandial glycemic response, prevent hypoglycemia, and decrease hyperglycemia.

Restricted saturated fat diet has important role in diabetes management and consequences related to cardiovascular diseases. (Limit saturated fat below 7% of total calories; Intake of *trans* fat should be minimized; limit dietary cholesterol below 200 mg/day). High polyunsaturated fatty acids (PUFA) diets appear to have similar effects to monounsaturated fatty acids on plasma lipid concentrations.

Some evidence based study shown food containing long-chain omega-3 fatty acids (Eicosapentaenoic acid or EPA and Docosahexaenoic acid or DHA, from fatty fish) and omega-3 linolenic acid (ALA) in diet additionally helps in lipoproteins, prevention of cardiac disease, and associations with positive health outcomes in diabetes patient.

Consumption of plant stanols or sterols fortified foods is recommended for Individuals with diabetes and dyslipidemia as they reduce total and LDL cholesterol.

Food for diabetes

In diabetes management, the intake of following groups of foods is important:

- Vegetables include broccoli, carrots, greens, peppers, and tomatoes, corn, and green peas
- Fruits include oranges, melon, berries, apples, bananas, and grapes
- grains (mainly whole grains) include wheat, rice, oats, cornmeal, barley, and quinoa
- protein include lean meat like chicken or turkey without the skin, fish, eggs, nuts and peanuts, dried beans and certain peas, such as chickpeas and split peas, meat substitutes, such as tofu
- dairy—non-fat or low fat include milk or lactose-free milk if you have lactose intolerance, yogurt, cheese, oils that are liquid at room temperature, such as canola and olive oil, nuts and seeds, heart-healthy fish such as salmon, tuna, mackerel, and avocado

Restriction of following foods is needed:

- partially hydrogenated or deep-fried foods which contains trans fat
- white bread, sugary processed cereals, refined pasta or rice
- Processed meat and red meat
- Low fat products that have replaced fat with added sugar such as fat like free yogurt
- packaged and fast foods, which contains high sugar, salt, baked food, sweets, chips,
- desserts

C. Osteoarthritis (OA)

Osteoarthritis (OA) is one of the most prevalent and disabling chronic diseases mainly affects above 40 years of age. It is a metabolically active, dynamic process which associated with all joint tissues (cartilage, bone, synovium/capsule, ligaments and muscle) and characterized by the progressive destruction of articular cartilage leads to impaired joint motion, severe pain, and finally lead to disability. Its high prevalence moderate-to-severe impact on quality of life and create significant public health problem.

Osteoarthritic condition developed when, the amount of depletion of proteoglycan is observed gradually, leading to a loss of shock absorption and compressibility. When cartilage cushion begins to break down, the joint space becomes narrowed and which associated with high stress to underlying bone along with hypertrophic repair. Entire change results

sclerosis of subchondral bone (eburnation), formation of cyst, and osteophyte formation in an effort to distribute the load through the joint. Several factors which lead to this disorder include:

- Genetics
- Prior injury
- Age (55-64)
- Sex (women are more affected)
- Obesity
- Profession (sports person, athletes, teachers, rickshaw pooler)
- Extended life span
- Non judicial exercise

Treatment strategies for osteoarthritis management are including pharmacological, non pharmacological and surgery. Non pharmacological managements include weight loss, education programs, exercise, mechanical supports and pharmacological intervention include non steroidal anti-inflammatory drugs and nutraceuticals. Several nutraceutical intervention trials has been carried out for management of osteoarthritis. Some of the nutraceutical's role have already well established in clinical management for this disease. Some important nutraceuticals are discussed as follows:

Glucosamine: This is an amino monosaccharide sugar and a precursor of glycosaminoglycans synthesis, which form proteoglycans and hyaluronic acid in articular cartilage. Glucosamine is an essential component of mucopolysaccharide such as glycosaminoglycan. Glucosamine stimulates the synthesis and inhibits the degradation of proteoglycans which was observed in vitro, and ultimately stimulates the regeneration of cartilage in vivo. It also stimulates the production of chondrocyte aggrecan mRNA and protein, also inhibits the production and activity of enzymes responsible for matrix degrading in vitro. Glucosamine also prevents the synthesis of pro-inflammatory mediators which induce the synthesis of the degrading enzymes as well as inhibiting chondrocyte proliferation. Glucosamine sulphate is prescribed in 1500 mg daily doses.

Chondroitin: Chondroitin, a glycosaminoglycan present in the proteoglycans that form the aggrecan of articular cartilage. At 1200 mg daily dose, chondroitin increases the synthesis of proteoglycan in articular cartilage. It is effective in contributing to cartilage matrix deposition, inhibition of proteolytic enzymes, and stimulation of glycosaminoglycan and collagen synthesis. In synergistic action, with glucosamine it helps in the synthesis of chondrocytes.

S-Adenosylmethionine: S-Adenosylmethionine is a sulfur-containing compound synthesized from the amino acid L-methionine and adenosine triphosphate. It enhances the synthesis of proteoglycans in cultures of chondrocytes obtained from the articular cartilage of osteoarthritis patients. It has also anti-inflammatory and analgesic properties. Clinically, 800 mg per day for 2 weeks, followed by a maintenance dosage of 400 mg per day is prescribed.

Collagen hydrolysate: Collagen hydrolysate is manufactured by the hydrolysis of pharmaceutical-grade gelatine. It may induce chondrocytes to synthesize collagen matrix and provide symptomatic improvement in osteoarthritis. It contains a large quantity of amino acids which helps in the synthesis of collagen. 10mg dose is preferable.

Diacerein: Metabolite of diacerein is rhein which inhibits the activity of interleukin-1. It reduces collagenase production in articular cartilage and prevents chemotactic and phagocytic activities of neutrophils and macrophages.

Avocado-soybean unsaponifiables: Unsaponifiable fractions of one-third avocado oil and two-thirds soybean oil is used in management of osteoarthritis. In vitro it inhibits the harmful effects of different mediators on joint structures. This combination blocks the activation of COX2 transcripts and secretions of PGE2 and TNF- α , IL-1 β by which it reduces NSAIDs use along with significant improvement in function.

***Boswellia serrata*:** Dried gum resin extracted from *Boswellia serrata* has been alleviate the severity of pain and swelling, as well as improve the function and range of movement. Ingestion of *Boswellia* reduces polymorphonuclear leukocyte chemotaxis and primary antibody synthesis.

Synergy of cocktail of nutraceuticals: Glucosamine/chondroitin arthritis intervention trials(GAIT) describe the synergy. Similarly, glucosamine/chondroitin/ASU show effective anti-inflammatory effects. Two cocktails of vitamins with added selenium also show promising effects.

Nutraceuticals intervention in osteoarthritis management enhance better patient acceptance/compliance, reduces joint replacement / arthroscopy, decreases in NSAIDs use and improve Quality of Life of patient.

D. Alzheimer's disease (AD)

Alzheimer's disease is a type of dementia associated with memory, thinking and behavior. It is a slow progressive degenerative disorder characterized by accumulation of abnormal protein deposits (known as

amyloid plaques) and tangles of fibers (known as neurofibrillary tangles) cause nerve cells in the brain to work less efficiently. This disease affects several cognitive, behavioral, and vital body functions. At present, this disease is not curable, however several nutritional or nutraceutical intervention has been carried out for the management and prevention of the disease.

Essential fatty acids (EFAs): Long-chain omega-3 polyunsaturated fatty acids, eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) is beneficial in Alzheimer's as they reduce inflammation, improve blood flow, and reduce abnormal clumping of the protein β -amyloid. Lower dietary intake may lead to enhanced risk of developing dementia or Alzheimer's disease.

Choline: Lecithin is the source choline may increase the amount of acetylcholine which actually reduced in Alzheimer's disease.

Minerals: high levels of unbound copper have been observed in Alzheimer's patients which may lead to metal accumulation in sensitive areas of the brain, oxidative stress, plaque formation, and destruction of nervous tissue. Studies suggest that a diet contains high in both copper and saturated fat may enhance cognitive decline in elderly subjects. Excessive iron accumulation with associated oxidative stress in the brain may contribute to the development of a number of neurodegenerative diseases like Alzheimer's disease. Some studies suggest that men and postmenopausal women should avoid excess iron containing dietary supplement to avoid the incidence of Alzheimer's disease.

Vitamins: Folic acid deficiency may lead to Alzheimer's disease by reduced synthesis of methionine and the accumulation of homocysteine. Deficiency of Thiamin enhances β -amyloid production and plaque formation leads to Alzheimer's disease, which are subsequently reversed following thiamin supplementation. Some studies suggest that vitamin B₁₂ supplementation decreases the rate of atrophy in part of the brain affected by Alzheimer's disease. Vitamin C administration in Alzheimer's disease could delay amyloid plaque formation and it also prevents the oxidative stress induced neurodegenerative disorder.

Others:

- The acetyl and carnitine components of acetyl-L-carnitine have been effective in energy metabolism, protein stability and clumping, and neuronal transmission in the brain.
- Dietary curcumin can reduce the oxidative stress, inflammation, clumping of β -amyloid, and memory loss.

E. Cardiovascular Disorders (CVDs)

(a) Hypertension

As per WHO, Hypertension is diagnosed if, when it is measured on two different days, the systolic blood pressure readings on both days is ≥ 140 mmHg and/or the diastolic blood pressure readings on both days is ≥ 90 mmHg. WHO considered that, Hypertension is one of the serious medical condition and can increase the risk of the diseases of heart, brain, kidney and other diseases. It is associated with several premature death worldwide. Nutrition has a significant impact on prevention and management of Hypertension.

Role of minerals:

Calcium: Calcium may influence the constriction and dilation of the blood vessel. Higher dietary intake of calcium is associated with lower systolic and diastolic blood pressure. Restricted intake of calcium [1,000-1,200 milligrams/day] may be beneficial in preventing and treating moderate hypertension.

Sodium: Sodium is the prime cause of extracellular (outside of cells) fluid volume and ultimate blood volume. High intake of sodium chloride than recommended daily intake can cause water retention, expansion of blood volume, edema (the accumulation of excess fluid in the body), and high blood pressure. WHO prescribed reducing salt intake (to less than 5g daily) can prevent and manage hypertension.

Magnesium: Magnesium may stimulate vascular smooth muscle cell relaxation, alter the inflammatory mediator's level, and decreases angiotensin-induced aldosterone synthesis, all of which can lower blood pressure. So, studies suggest that high intake of magnesium is associated with a reduced risk of developing hypertension.

Potassium: Increased potassium intake is associated to increased excretion of sodium in the urine resulting reduced water retention, blood volume, and blood pressure. RCT suggest that high potassium intake, mostly in the form of potassium chloride supplementation, has a modest blood pressure lowering effect in individual with normal or high blood pressure.

Vitamins: Riboflavin deficiency leads to decreased homocysteine conversion to methionine, and high homocysteine in the blood is related with an increased risk of hypertension.

The antioxidant activities of vitamin C may help in the protection of the blood vessels lining from damage associated with oxidative

stress. Deficiency of vitamin D may lead to increased activity of the renin-angiotensin system and an increased risk of hypertension.

Coenzyme Q10: coenzyme Q₁₀ may help reduce oxidative stress due to its antioxidant properties, also stimulates increasing the availability of nitric oxide which is needed for vasodilation.

Garlic: Garlic's phytochemicals stimulates the antioxidant enzymes, enhances the production of hydrogen sulphide and nitric oxide, other gaseous signalling molecules responsible for relaxation of blood vessels and inhibit enzymes responsible for vasoconstriction.

(b) *Atherosclerosis*

Atherosclerosis is a disease state characterized by plaque formation inside arterial walls which is considered as early event in the development of coronary heart disease (CHD). Nutritional intervention can prevent this condition.

Coenzyme Q₁₀ : C_{Q10} may beneficial to reduce **oxidative stress**, protect cell membranes in arterial walls, and prevent the oxidation of **lipoproteins** and reduces plaque formation.

Lipoic acid (LA): The antioxidant and metal-binding activities of LA may beneficial for atherosclerosis. LA can also inhibit the movement of a protein (called NFκB) that is essential in inflammation and the development of atherosclerosis.

Resveratrol: In vitro studies suggest that high concentrations of resveratrol inhibit platelet aggregation, increase the production of nitric oxide (relaxes arterial walls), and inhibit several inflammatory enzymes.

Minerals and vitamins: Both excessive and deficiency of copper have been associated with the development of atherosclerosis. As free copper enhances the oxidation of low-density lipoprotein (LDL) and make more atherogenic condition whereas copper deficiency may impair the activity of several antioxidant enzyme which contains copper. Less dietary intake of vitamin K associated with risk of **arterial calcification**.

(c) *Myocardial infarction*

Myocardial infarction/ heart attack is associated with blocked blood flow to the heart muscle; when an atherosclerotic plaque in a coronary artery ruptures and obstructs the supply of blood to the heart muscle, results injury or damage to the heart. Dietary intervention can reduce or prevent the chances of heart attack.

- **Fibres:** Fibres are beneficial for cardiovascular health as they act by reducing serum cholesterol. Fibres regulate blood glucose and the insulin response, and lowers blood pressure. Fibre diet also

provides magnesium and potassium which can reduce the blood pressure. High intakes of fiber-rich foods are associated with significant reductions in heart attack.

- **Selenium:** Selenium-containing antioxidant enzymes protect LDL particles from oxidative stress induced damage. Lacking of dietary selenium could alter antioxidant enzyme activity and enhance the oxidation of LDL particles. Intake of selenium contain foods like sunflower seeds, see fishes are beneficial to decrease the chances of myocardial infarction.
- **Vitamin E:** It is an essential antioxidant nutrient in cell membranes, helps to protect heart tissue and LDL particles from damage associated with oxidative stress. High intake of Vitamin E containing foods (almond, avocado, sunflower oil) is associated with decreased heart attack risk or mortality from coronary heart disease in both genders.
- **L-carnitine:** It may be beneficial in cardiac and skeletal muscle function in ischemia and also reduces heart muscle injury due to inadequate blood flow.
- **Nuts:** Daily consumption of nuts is associated with a reduced risk of developing coronary heart disease. Nut contains soluble fibers and phytosterols inhibit intestinal absorption of dietary cholesterol and helps in reductions in serum total and LDL cholesterol.
- **Black tea:** Catechin present in black tea has been shown an enhanced endothelial function and promote relaxation of arterial walls.

(d) Angina pectoris

Angina pectoris is a chest pain or discomfort caused due to insufficient blood supply in the heart muscle (ischaemia). Dietary management is also effective in angina pectoris.

L-carnitine: Supplemental L-carnitine may improve cardiac and skeletal muscle function during ischemia.

Coenzyme Q10: dietary Coenzyme Q10 has been shown to improve exercise tolerance and reduce symptoms of ischemia in patients with chronic, stable angina.

(e) Congestive heart failure (CHF)

Congestive heart failure is a progressive condition in which a weakened heart cannot fulfill the body's demand. Heart makes up this by enlarging, developing more muscle, pumping faster, narrowing blood vessels, and diverting blood to vital organs. Dietary

intervention may be beneficial in the management of congestive heart failure.

Thiamin: deficiency of thiamin can associated with impaired cardiac function and finally congestive heart failure (CHF). Thiamin supplementation may improve left ventricular ejection fraction.

Vitamin D: Vitamin D can reduce the pro-inflammatory condition associated with initiation of heart failure and also reduce the blood pressure which may benefit individuals with CHF.

Coenzyme Q₁₀: It may reduce oxidative stress due to antioxidant property which is characteristic of heart failure and also help in increasing heart muscle cell contractility and maintain ATP (cellular energy) production.

F. Cancer

Cancer is a broad range of disease characterized by abnormal cells growth in almost all organs uncontrollably, go beyond their usual boundaries to invade adjoining parts of the body and/or spread to other organs. The latter process is known as metastasizing and is the main cause of death from cancer. According to WHO, it is the second leading cause of death globally, accounting for an estimated 9.6 million deaths, or one in six deaths, in 2018. Major cancers are Lung, prostate, colorectal, stomach and liver cancer (mostly in men); breast, colorectal, lung, cervical and thyroid cancer (most common among women). According to American Cancer Society, cancer can be prevented by physical exercise and dietary intervention. Intervention of healthy diet and exercise practices at any time from childhood to old age can promote health and reduce the risk of cancer.

According to American Cancer Society, following guidelines on diet and nutrition are quite recommended for reducing the chances of cancer.

- Selection of the most of the foods from plant sources:
 - Consumption of five or more servings of fruits and vegetables daily
 - Intake of other foods from plant sources, such as breads, cereals, grain products, rice, or beans several times daily
- Limit or restriction of intake of high-fat foods, particularly from animal sources:
 - Replacing of fat-rich foods with fruits, vegetables, grains, and beans
 - Consumption of smaller portions of high-fat foods
 - Selection of baked and broiled foods instead of fried foods
 - Selection of non-fat and low-fat milk and dairy products

- Limit consumption of meats, especially high-fat meats(lean meat is preferable)
- Physical activity to achieve and maintain a healthy weight
- Limit or restrict of consumption of alcoholic beverages

Several studies suggested that consumption of fresh fruits and vegetables reducing the chances of cancers of the gastrointestinal and respiratory tracts. However, this is not evident for those cancers related with hormonal association, such as breast and prostate cancer. Several studies have shown that eating fruits and vegetables (green, orange, red and dark yellow vegetables and those in the cabbage family, soy products, and legumes) protects against colon cancer. Different studies shown that high-fat diets may enhance the risk of cancers of the colon and rectum, prostate and endometrium.

Dietary intervention of cancer

Breast cancer: breast cancer is mainly regulated with circulating hormone levels throughout life. Several studies show that high or moderate level of alcohol consumption is one of the leading causes of breast cancers. Limiting of intake of alcoholic beverages, and consumption of diet rich in fruits and vegetables can reduce the risk of breast cancer.

Endometrial cancer: Overweight is one of predominant risk of endometrial cancer as high level of oestrogen is observed in post-menopausal woman. Maintenance of body weight using healthy choice of food is one of the important interventions to reduce the chance of endometrium cancer. High lycopene and carotenoid containing food reduces the chances of this cancer.

Lung cancer: Lung cancer is one of leading cause of cancer related death in population; mainly caused due to tobacco smoking and chewing tobacco. Avoiding of smoking and chewing tobacco is the best way to prevent this cancer. It has been observed in different studies that β -cryptoxanthin and lycopene can reduce the chances of lung cancers.

Prostate cancer: prostate cancer is associated to testosterone, however the exact mechanism is still unknown. Intake of red meats, animal fat and dairy products containing saturated fat has been found to be related to high risk of prostate cancer. Lycopene-rich diets are beneficial for reductions in the risk of prostate cancer, particularly in more severe forms. Regular oral soy isoflavone (60 mg/day) consumption resulted in a significant decrease in prostate cancer incidence in participants aged 65 years and older.

Colorectal cancer: Colorectal cancer is one of the common gastrointestinal cancers that starts in the colon or the rectum. Diets play

an important role in this disease condition. Intake of high amounts of red and processed meats is associated with the high risk of colorectal cancer while high consumption of fruit and vegetables, dairy products, fish, and fiber may prevent colorectal cancer.

Dietary fatty acids: Omega-3 fatty acids and their derivatives reduced the risk of cancer by triggering mechanisms against inflammation, **oxidative stress**, and abnormal cell proliferation.

Dietary fibres: Fiber consumption may be beneficial for the digestive tract by reducing exposure of the mucosa to carcinogens along with the fermentation of certain fibers in the large intestine releases short-chain fatty acids that have anticancer activities.

Tea: Tea is associated with a reduced risk of developing colorectal cancer as catechins (flavan-3-ol monomers) present in tea, a subclass of flavonoids with antioxidant properties which protects the epithelium of the digestive tract against oxidative stress, block the activation of carcinogen.

G. Infectious diseases

Infectious diseases are the diseases caused by microorganism like bacteria, fungi, viruses or parasites. Some of the Infectious diseases may be transmitted from person to person. Infectious diseases may be ranging from diarrhea to respiratory tract infections. Individual immunity may be beneficial in these types of diseases prevention. Dietary supplement plays an important role in individual's immunity development as well as prevention of infectious diseases.

Omega 3 fatty acids: Long chain omega-3 and omega-6 PUFAs, influence the immune response. Long chain omega 3 fatty acids [like eicosatetraenoic acid eicosapentanoic (EPA) and docosahexaenoic acid (DHA)] a variety of eicosanoids and bioactive lipid mediators and chemical messengers which regulate inflammation and immune cell action. These are quite beneficial in preventing infectious diseases.

Copper: copper protects the immune cells from oxidative stress. Copper in diet is beneficial to help cells of the innate immune response to kill bacteria.

Folate: Folate is essential for the proliferation of immune cells and helps in expression of immune response against pathogens.

Iron: Dietary iron is essential for several metabolic and antioxidant enzymes that are critical for normal immune function. Iron containing diet is beneficial for production of T lymphocytes and the generation of reactive oxygen species that kill pathogens.

Retinol or vitamin A: Vitamin A is essential for providing barriers against disease-causing organisms by maintaining the integrity of the skin, eye, respiratory, gastrointestinal, and genitourinary tracts. It is also essential for proper function of immune cells that generate antibodies.

Zinc: Zinc is essential for antibody development and immune cell response. Zinc deficiency is associated with an increased susceptibility to infection in elder and children

Vitamin E: Vitamin E enhances the functional activity of immune cells (T lymphocytes) by protecting their cell membranes and reducing the immunosuppressive factors production. Vitamin E supplementation is able to enhance resistance to respiratory tract infection.

Vitamin D: Vitamin D is required for the expression of antimicrobial protein and low level of serum 25-hydroxyvitamin D₃ is associated to a higher risk of upper respiratory tract infections. It has observed in some clinical trials that Vitamin D deficiency is related to a high incidence and severity of the COVID-19.

Vitamin C: As an essential antioxidant, it protects the immune and associated cells from damage by Immune cells generated reactive oxygen species [ROS] , which is used to destroy invading organisms

H. Stress

Stress is a particular condition in body in which physical and neuronal changes are observed abruptly. This may cause sudden change in shape, size and function of different organs and affects the physical and mental health of an individual. Like other diseases, nutrition can play important in role in stress management.

When we encounter with different stressors, nervous system and adrenal glands generates and transmit signals to the rest of the body to prepare it for a physical response. During the stress our body can produce a visible or invisible stress. Effect of stress may be as follows:

- Swing of mood
- becoming withdrawn
- irritability
- agitation
- anxious, discrete or racing thoughts
- loss of concentration and focus
- feeling tearful
- altered muscle tension
- nausea/dizziness
- increased heart rate/palpitations
- disturbed sleep/insomnia

- increased blood pressure
- appetite fluctuations

Long term stress may lead to chronic disease depression, diabetes, cardiovascular problems and digestive problems.

Some food have detrimental effects on stress like:

Caffeine: caffeine is a CNS stimulant, also causing the adrenal glands to release more hormones like cortisol (which are already high during stress). Increased levels of caffeine causes nervousness and insomnia, which are intrinsically connected to stress. Caffeine is associated with depletion of magnesium level of body, magnesium is essential for energy production.

High fat and sugar diet: During stress, cravings for processed and high sugar and salty foods may be heightened which is detrimental to the health. Sugar initially creates a short explosion of energy and temporary relief from stressful feelings. However, this lead to increased food cravings, irritability which can put a strain on the body. High consumption of processed fats can increase the risk of depression; the processed food fat block the production of essential fats needed to protect the cell membrane and nerve health.

Alcohol: alcohol consumption during stress is quite detrimental for health. Alcohol can create sleep problems, nervousness and skin irritations; alcohol makes the body release high amounts of adrenaline and affects blood sugar levels.

Stress-relieving foods

Fruit and vegetables: Consumption of fresh fruit and vegetables will ensure a plenty of nutrients and minerals, which is essential to combat against stress.

B vitamins: present in bananas, leafy greens, nuts, seeds, meat, fish and dairy products, these provide the body with energy after an incident of stress.

Vitamin C: The largest store of vitamin C lies in the adrenal glands, which are responsible for the production of stress hormones. Keep these healthy by eating plenty of vitamin C rich foods such as oranges, tomatoes, peppers, leafy greens and broccoli.

Magnesium: This mineral can help to relax muscles and reduce anxiety, while also playing an essential role in hormone and energy production. Nuts - particularly Brazil nuts - are high in magnesium, as are beans and lentils, whole grains and leafy greens.

Ashwagandha (*Withania somnifera* root): Ashwagandha root has adaptogenic effect; several trial shows that Ashwagandha root extract improves an individual's resistance towards stress.

Ginseng: *Panax ginseng* root is also an adaptogenic and helps in combating the stress.

Complex carbohydrates: Consumption of whole, unprocessed carbohydrates such as wholegrain bread, cereals, oats and brown rice will help to enhance levels of serotonin and creates a relaxing mood and combat against stress.

Essential fatty acids (EFAs): Essential fatty acids (Omega 3 and 6) reduce the release of glucocorticoids from the adrenal gland under stressful conditions and help to reduce the effects of psychological and physical stress.

Calcium-rich foods: Calcium-rich foods in diet (low-fat milk, yoghurt, sesame seeds, kelp, cheese, leafy greens and broccoli) may be able to help reduce certain symptoms, like muscle tension and anxiety.

Nutrition and Public Health: Education and Awareness

According to WHO, health can be defined as “A state of complete physical, mental and social well-being and not merely the absence of disease or infirmity”. Public health is actually a societal approach on health which includes an individual along with community.

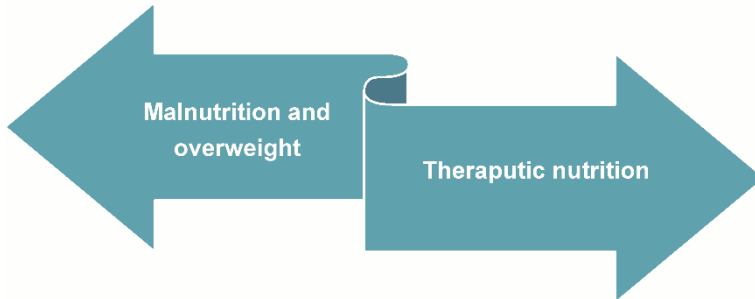
WHO defined public health as “the art and science of preventing disease, prolonging life and promoting health through the organized efforts of society” (Acheson, 1988; WHO)”.

The main aim of public health to help and an individual and entire community in maintain of health, prevention of different diseases and all-round development of wellbeing. Public health focuses on awareness of health, prevention of diseases, personal services to individual persons, such as vaccinations, behavioral counseling, or health advice.

Nutrition is the integral part of public health. Better nutritional status in community ensures improved child and maternal health, increased immune systems, safer pregnancy and childbirth, reduced risk of non-communicable diseases (such as diabetes and cardiovascular disease), quality of life and longevity.

Public health nutrition can be defined as a field of study that is concerned with promotion of good health through prevention of nutrition-related illnesses / problems in the population, and influence the government policies and programmes to solve these problems.

Public health nutrition is multidimensional approach which can be executed by a combined effort of dietician, clinical nutritionist, doctors, nurses, pharmacists, statistician, economist, social and behavioral scientist, policy makers. The major 2 concerns of public health are as follows



Malnutrition and overnutrition: Malnutrition is the major threat of global health. Along with under-developed countries, developing countries like India are facing a double burden of malnutrition i.e. coexistence of both under nutrition and overweight.

Deficiencies, excesses, or imbalances in individual's intake of energy and/or nutrients are considered as malnutrition. According to WHO, around 45% of deaths among children under 5 years of age are linked to under nutrition.

Malnutrition is broadly categorized in following 3 categories:

- undernutrition [wasting (low weight-for-height), stunting (low height-for-age) and underweight (low weight-for-age)]
- micronutrient-related malnutrition, which includes micronutrient deficiencies (deficiency of important vitamins and minerals) or micronutrient excess
- overweight, obesity and diet-related non-communicable diseases (such as heart disease, stroke, diabetes and some cancers)

The basic reasons of under nutrition are:

- poverty and low economic status
- inadequate education
- lack of public health nutrition awareness
- poor maternal and child health care and nutrition
- gender biasness, discrimination against women and girl child
- poor health, hygiene and sanitation
- environmental pollution, food adulteration, insufficient access to healthy food and drinking water

Overweight and associated diseases are now become a major problem of India and other developing countries. Like developed countries Indian population (irrespective of ages) are become habituated with intake of processed, fast and high calorie (high fat and sugar) food. These lead to different chronic diseases like obesity, atherosclerosis, diabetes, liver disorders, and cancers. The basic reasons of overweight are:

- Lack of physical exercise
- Sedentary lifestyle
- intake of processed, fast and high calorie (high fat and sugar) food
- less intake of f whole grains, pulses, vegetables and fruits

Therapeutic nutrition: therapeutic or clinical nutrition is nutritional intervention to prevent or manage a disease/illness along with maintenance of health. Several therapeutic interventions include:

- formulation of diet to manage the pathophysiological condition of patient and controlling of disease state
- incorporation of nutraceuticals, medical foods [products that are specially manufactured for persons with specific needs. Such foods are regulated and can be used only with a doctor's prescription for the specific dietary management of a disease or condition] and Phytochemicals/Bioactive compounds[non-nutrient constituents present in foods that have physiological or biological activity and influence health.] in diet to prevent a disease and increasing immunity and adaptability
- correction of nutritional deficiency
- guidance of dietary management in chronic disease

To execute the public health nutrition programs, community based nutrition education is required and which include:

- organizing community camp in school, *panchayet*, block, district and municipality level
- counselling and diagnosis of mother, child and elder at individual level on basis of anthropometric measurement and nutritional status
- midday meal program in school
- introduction of dietary diversion in diet

In India, Government has taken different public health nutritional programs as follows:

- Janani Shishu Suraksha Karyakaram (JSSK)
- Rashtriya Kishor Swasthya Karyakram(RKSK)
- Rashtriya Bal Swasthya Karyakram (RBSK)

- National Iodine Deficiency Disorders Control Programme
- MAA (Mothers' Absolute Affection) Programme for Infant and Young Child Feeding
- National Programme for Prevention and Control of Fluorosis (NPPCF)
- National Iron Plus Initiative for Anaemia Control
- National Vitamin A Prophylaxis Programme
- Integrated Child Development Services (ICDS)
- Mid-Day Meal Programme