COURSE CODE: **BCH 306**

COURSE TITLE: **Nutritional Biochemistry**

NUMBER OF UNITS: 2 Units

COURSE DURATION: **Two hours per week**

COURSE DETAILS:

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COURSE CONTENT:

1. NUTRITION AND PUBLIC HEALTH
2. NUTRITION IN PREGNANCY
3. ELEMENT OF INTERNNATIONAL NUTRITION
4. NUTRITION IN CHILDHOOD
5. NUTRITION OF THE ELDERLY
6. NUTRITION DISEASES

COURSE REQUIREMENTS:

READING LIST:

LECTURE NOTES

NUTRITION AND PUBLIC HEALTH

Lavoisier a French scientist is the father of nutrition.

Nutrition as defined by Robinson (1966) at the congress of the American Medical Association is 'a branch of science which deals with food, the nutrients and other substances therein; their action , interaction and balance in relation to health and diseases; the processes by which an organism ingests, digests, absorbs, transports utilizes and excretes food substances'.

Note that nutrition is also concerned with the social, economic, cultural and psychological factors relating to food consumption, food production and distribution'.

In a simple form, Nutrition is defined as 'the science that interprets the relationship of food to the functioning living organism'.

Public health Nutrition is concerned with those problems of nutrition that affect large numbers of people and which can be solved most effectively through group action. The term **COMMUNITY HEALTH** can sometimes be used for Public Health e.g. students in a hostel, soldier in a barrack etc.

COMMUNITY NUTRITION on the other hand is that which tends to bring about a change in the eating habits of people living within a community with a view to bringing about the prevention and cure of nutritional diseases.

Food habits vary from individual to individual with age, culture and geographical environment.

The world's population increases by 180-200 million persons daily most of who engage in a struggle for food. Of the estimated 850 million children under 5 years of age in the world in 1983, 350 million of them were under nourished; 100 million were moderately or severely under nourished, 2/3 of them live in South Asia, $1/5^{th}$ in sub-Saharan Africa mainly in countries with very low average income. The % is however decreasing. These undernourished children have 20 times greater chance of dying than their normal peers while those that survive are physically and

mentally retarded, sometimes irreversibly. In the last few years the prevalence had decreased but Protein-Energy deficiency disease – Marasmus and Kwashiorkor tend to be on the increase in the urban slums of the poor countries.

FOOD GROUPS

The value of any food depends on its nutrient and non-nutrient constituents. They should be evaluated in terms of their total composition and not only for single nutrients for which they can be outstanding (e.g. beans- protein) therefore, one must consume all needed nutrients.

Grouping of foods is based on the functions they are supposed to perform. By grouping together foods with similar nutrient content, it is possible to choose from a wide variety of alternatives if certain food becomes scarce or money is in short supply. The groupings also reflect availability of food, food patterns and local nutritional problems.

The groups are (for tropical countries)

(1) Milk group

Made up of all dairy products – fresh, skim, condensed, powdered milk, local & foreign cheese butter, yogurt and ice cream. Good for infants. Lactose intolerance people could take cheese, yogurt etc.Contain high Ca, Mg, riboflavin, cobalamin and high quality protein but is low in iron and vitamin C.

(2) Meat group

Meat, poultry, eggs, fish, snails, shrimps, crabs and other sea food, termites, legumes, seeds and nuts – Although the nutritional contributions of each member of the group varies, they all provide valuable amounts of energy, proteins, iron and the B-complex vitamins. Since large amounts are consumed legumes are the most inportant source of protein in many African diets because they are cheap, palatable and keep fairly well. Usage of legumes, nuts, fish and poultry also reduce the intake of saturated fat that is abundant in meat.

(3) Cereal Group

This includes maize, guinea corn (sorghum) wheat, rice, barley, oats and teff. They contribute carbohydrates, B-complex vitamins, iron, magnesium and protein to the diets. They constitute the most important staple food for people all over the world.

(4) STARCHY FRUIT/TUBER GROUP

Examples are yams, coco-yams, cassava, potato, sweet potato, plantain and bread fruit. They are seasonal, contain large quality of starch but are perishable – cannot be stored for long periods of time. Can supply about 385 KCal per, 100g of dry matter but with very low amounts of other nutrients. They are inferior to cereals because they consist of about 2/3rd water and less proteins (about 2% compare to 8-10% in cereals) minerals and vitamins.

(5) FRUIT/-VEGETABLE GROUP

The term vegetable is used to include some fruits (tomatoes and pumpkins), leaves (spinach and cabbage), roots (carrots) stalks (celery) and flowers (cornflower). They provide water soluble vitamins, carotene (vitamin A) and minerals. Contribute to roughage in the diet in the form of cellulose. But have low protein content. Fruits-Mangoes, pawpaw, guava etc. Vegetables – bitter leaves, water leaves, okra, onions, mushrooms etc.

The cereal group and the fleshy fruit/tuber group constitute the largest portion of the typical African diet. They are often taken with soup (mixture of meat, fruit, vegetable oil etc which supply proteins, vitamins and minerals of high quality.

(6) EMPTY CALORIE FOOD

E.g. Alcohol, alcoholic beverages, carbonated drinks.

THE NUTRIENTS

These are the constituents of food which must be supplied to the body in suitable amount, they are – carbohydrates, fats & oils, proteins, vitamins, minerals and water. The first 3 are referred to as macro nutrients. All of them can be divided into 3 groups.

(a) Energy – giving nutrients – proteins, fats & oils, & carbohydrate
(b) Body-building nutrients – proteins, fats, carbohydrate, minerals & water

(c) Body processes regulatory substances

Under laboratory condition the essentiality of a nutrient can be established when

(1) A deficiency state occurs on a diet considered adequate in all respects except the nutrient under study
(2) The deficiency state correlation with sub-normal levels of the nutrient in the blood or certain tissues.
(3) There is significant growth response in growing animals in repeated demonstration after supplements of the nutrient under study.

When consumed in correct amount and proportion one is placed in the best position to maintain the highest level of health. A deficiency, an excess or an unbalance in the intake of these nutrients results in an aberration in health.

CARBOHYDRATES

They are classified into monosaccharide, disaccharides and polysaccharides.

Monosaccharide – simplest form of carbohydrate e.g. glucose fructose galactose etc.

Disaccharides – maltose, lactose sucrose.

Polysaccharides – the most complex therefore, must undergo digestion before they can be absorbed into the blood and utilized in the body e.g. starches, cellulose & glycogen.

FUNCTION:

1. Source of metabolic energy. If carbohydrate intake is sufficient in the diet proteins may not be used to produce energy.
2. They are the starting materials for the synthesis of several compounds in the body – mucopolysaccharide, glycoprotein, etc.
3. Cellulose, hemicelluloses & pectin provide bulk in the intestines and in the excretion of waste products.

Minimum daily carbohydrate for human adult is 100g obtain from yam, cassava, coco-yam, sweet and Irish potatoes honey, jams, vegetables wheat.

Clinical Application

Normally there are no specific disease caused by the deficiency or excess consumption of carbohydrate but there are some related to refined carbohydrate intakes which are:

- Dental caries – resulting for excessive consumption of sugar empty calories foods
- Colon cancer
- Obesity and/overweight problems
- Diabetes mellitus
- Elevated serum TGs – Cardiovascular diseases.

LIPIDS

Lipids or fats are water insoluble but soluble in ether or other fat solvents such as chloroform. Classified into simple lipid, compound and derived lipid.

SIMPLE LIPIDS

Also referred to as dietary lipid consist only of triglycerides – it is the most important in human nutrition.

Compound lipids – phospholipids, lipoproteins

Derived lipids – sterols,

Complex lipids -

TRIGLYCERIDES – Fatty acid of glycerol.

Fatty acids short chained < 6C, medium 6 – 12C, long 12 – 18C or extra long chained 20 or more. Long chained Fatty acid occurs in animal fats and most vegetable oils, the extra long chained are found in fishes. They can be saturated or unsaturated depending on their degree of H saturation. Unsaturated FA contain double bonds. FA containing 12C and those that are unsaturated are liquid at room temperature. While saturated FA containing 14C atoms are solid at room temperature e.g. Oleic, palmitic and stearic acid. Visible fats are those seen in butter or vegetable oils while invisible fats are those dispersed within food e.g. hidden fat in meat –

marbling. PUFA – Poly-unsaturated fatty acids that cannot be synthesised in the human body and must be supplied in the diet they are also called Essential fatty acids – linoleic, linolenic and arachidonic acid. Deficiency of them may cause eczematous dermatitia, sparse hair growth, poor wound healing.

FUNCTION:

1. To provide energy and heat. Contain 9 KCal/g compared to carbohydrate and protein which provide 4 KCal/g each.
2. For transport of the fat soluble vitamins.
3. Essential for the formation of nerve sheaths.
4. Act as lubricants in the intestine.
5. Add flavour to food.
6. Required for the production and secretion of bile.
7. Serve as packing materials in the body to prevent heat loss and to support the kidneys, eyes, and other internal organs.

Clinical Problems

Condition requiring fat metabolism or reductions are malabsorption syndromes, cystic fibrosis), fatty liver, diabetes mellitus, hyperlipidemia and obesity: such patients should select food low in fats. Those that require the addition of fat to the diet in e.g. underweight conditions. Dietary fat is a risk factor in coronary heart disease, colon and breast cancers.

PROTEIN:

The most abundant compounds in the body exceeded only by water is protein. About 18-20% of the body weights. 1/3 in the muscle, 1/5 in the bones and cartilage, 1/10th in the skin the remaining ones are in other tissues and body fluids except urine and bile.

During digestion, protein is broken down into 23 different amino acids - 8 essential for adults while in infants and children these + histidine are required. Valine, threonine, tryptophan, histidine, isoleucine, leucine, lysine, methionine and phenylalanine (VATT HILL MP). Animal foods contain greater amounts of essential amino acids than plant food.

The value or quality of a protein is determined by its amino acid composition. Biological value of a protein is an indication of the ability of that protein to support growth and repair of tissue cells in childhood and in later life. Proteins of animal origin have higher B.V. Plant foods contain insufficient amount of one or more of the following amino acids lysine, threonine, tryptophan and methionie. The correction of amino acid deficiencies in plant proteins is made through a process called Protein Complementarity. In this case two different protein of different essential amino acids which are low in one food are complemented in the other food eaten.

FUNCTIONS

1. For growth from birth till death for building and for maintenance of body tissues.
2. For synthesis of enzymes, hormones, anti bodies haemoglobin and anti-toxins
3. They contribute to blood osmotic pressure.
4. For the production of energy especially when insufficient energy is provided in the diet.

Individuals who consume no animal foods are known as vegans. Vegetarians who include eggs and dairy products are called lacto-ovo-vegetarians while those who include only dairy products are the lacto-vegetarians. Both groups are capable of maintaining perfect health. Children on such diet may have protein – energy deficiencies. They must therefor take Vitamin B_{12} as supplement to prevent pernicious anaemia.

Requirement: - Male = 56 g/day; Female = 46 g/day; Infants = 2.2 g/Kg body weight; 0 – 6 months and 2.0 g/Kg. Plant protiens provide more than 50% of human protien supply.

Soures: - meat, fish, eggs, milk, cheese, snail, beans, groundnut, melon, seeds, locust beans, cereals (wheat, rice etc).

Deficiency of proteins results in such diseases as kwashorkor, marasmus and the intermediate marasmus kwashorkor.

VITAMINS

They are organic compounds that are required in very small quantities to perform specific cellular functions and thus promote growth, reproduction and maintenance of life. They cannot be synthesized in sufficient amounts by the human body and has to rely on exogenous sources for its supply therefore essential but vitamin D, K and Niacin can be made within the human body. They are fat soluble vitamin A D E K and water soluble one B- Complex vitamin – thiamine, riboflavin, niacin, pyridoxine, biotin, pantothenic acid, folic acid, cyanocobalamin and ascorbic acid (vitamin C).

Primary deficiency is caused by consuming a diet that is inadequate in the vitamin concerned while in secondary deficiency the recommended allowance may be consumed but because of disease, medication or physiological state such as pregnancy, lactation and growth the actual requirement is increased. Insufficient intakes lead to deficiency symptom e.g. Vitamin A – night blindness, Xerophthalmia, Vitamin D – rickets Thamin – Beriberi, Niacin – Pellagia etc. Vitamin C – Scurvy.

MINERALS

They are inorganic crystalline and homogenous chemicals which perform unique roles in the body. They control water balance;

- Regulate acid base balance,
- Are cofactors of enzymes, homones etc,
- Structural components of body tissues e.g. Ca, P
- Are necessary for nerve cell and muscle function.

Classified based on their quantity in the body as macro – nutrients (Ca, Cl, K, P, Mg, Na) , micro nutrient – Co, Cu, Fl_2, I_2 , Fe etc.

Man requires 14 minerals for optimum growth.

WATER

Is found in every cell of the body and is the largest single component of the human body. Total body varies from 78% at birth to 60% in adult male 50% in adult female. It is distributed as ECF and ICF. ICF water **,** ECF – plasma, intersticial (lymph) and trans-cellular fluid

Water balance:-

Water intake from (water, food, drinks) metabolic H_20 from oxidation of carbohydrate, fats & proteins. H_2O loss through- faeces, urine, skin and breadth (expiration). Solid foods contribute about 25-50% of water needed by the body each day e.g. l g of proteins, carbohydrate, and fats provides 0.41g, 0. 61g, 1.07g of water and 1 kg of body fat = 1 L of water.

Water intake is determined by habit and customs, and environment e.g. hot temperature – more water is taken.

Clinical application: - Generally a 2% loss of body water due to dehydration produce thirst. Change in the volume of total body water can be as a result of failure of intake or abnormal loss. Dehydration is due to deficient of either water or electrolytes or both. If due to loss of electrolytes in excess of water, the result is hypotonic dehydration e.g. diarrhoea patients treated without including electrolytes.

Loss of water in excess of electrolytes leads to hypertonic dehydration. Loss of 4% of body water causes oliguria tachycardia (rapid heartbeat) and postural hypertension. Infants are more sensitive to electrolyte and fluid imbalance and prone to hypertonic dehydration because of greater evaporation losses and then immature kidney and inability to concentrate urine. If dehydration result from blood loss 3 – 4 times the volume of blood will be required to maintain cardiac output if replaced by electrolyte solution.

NB: Decreased thirst is a sign of improvement in an alert patient.

Function

As a solvent for for digestive processes, carries nutrient to the tissues and waste product away.

As a regulator controls body temperature.

- Facilitates conversion of food into tissue and energy
- Serves as lubricants in the GIT, joints, eyes etc.
- Structural component of the body, blood, lymph
- As an end product of fat, carbohydrate, protein catabolism(Kreb's cycle).

FOOD ENERGY

Food energy is the first nutritional priority of the human body system. It is required for all metabolic processes, contraction of the heart, and movement of diaphragm in breathing. Physical activities - daily work, exercise, maintenance of body temperature; biosynthesis, maintenance and repair of new and old tissues.

Energy is derived from carbohydrate, proteins, fat and oil - 4 KCal, 9 and 4 KCal/g. A typical human diet should provide

50-56% of its Energy from carbohydrate

30 – 35% of its energy from fats and oil

12 – 18% of its energy from proteins

Cellulose and water do not provide energy.

BASAL METABOLIC RATE:

It's the energy required for the basic maintenance of the cells of the body and body temperature. It is influenced by such factors as;

Age, Sex (women BMR lower than man) Weight (size and shape) Rate of growth, Endocrine activity -hyperthyoidism increases it while hypothyoidism decreases it. Sleep (it is 10% lower than waking). Body temperature: $1^{o}F$ rise in body temperature increases BMR by 7%

State of Nutrition

Physiological state e.g. last trimester of pregnancy it is increases by 15 - 25%. For an average individual ranges between 1300 – 1700 KCal/day.

FAO declaration: Individuals of the same size, living in the same environment and with the same mode of life have a similar energy requirement whatsoever the ethnic origin.

BIOCHEMICAL ASPECTS OF NUTRITION AND ENERGY REQUIREMENT

Nutrition is the science that deals with food requirements and utilization. It also deals with the elimination of waste products resulting from ingested foods.

Dietetics deals with the design of diets to suit different conditions. It involves the interpretation and application of the principles of nutrition in health and disease.

Food can be defined as anything solid or liquid possessing a chemical composition which enables it when swallowed to do one or more of the following:

(i) To provide the body with the materials from which it can produce work, heat and other forms of energy.
(ii) Provide materials for growth, maintenance repair and reproduction.
(iii) Supply substances which normally regulate the production of energy or process of growth repair and reproduction e.g. homones and enzymes.

This definition of food encompasses all recorganised foodstuffs from which the nutrients carbohydrates, fats, proteins, vitamins and minerals are derived as well as other groups of substances such as alcohols, and some plant production like organic acids and hemicelluloses compounds.

The energy requirements of man are met by 3 classes of organic foodstuffs: carbohydrate, proteins and fats. The metabolism of carbohydrate supplies more than half of the energy required for the day. For example, a sedentary woman requires 2000 Kcal per day. Her carbohydrate intake must be designed to contribute more than half of this requirement, otherwise fat and proteins may be called upon to supply it.. This impairs other specifically attributed functions of proteins, viz: repair and growth.

The main conversion factor of the energy values of food may be summarized as follow

Protein	4.1
Carbohydrate	4.1
Fat	9.3

Energy expenditure may be classified as follows:

(a) Based metabolism:

When a subject is at complete rest and no physical work is being carried out, energy is required for the activity of the internal organs and to maintain body temperature. This is referred to as basal or resting metabolism and it is estimated by measuring the basal metabolic rate (BMR). It is fairly constant for a given individual and is influenced by age, sex, body sex, environmental temperature, barometric pressure and such physiological state as lactation and pregnancy.

(b) Specific Dynamic Action (SDA):

Some food terms usually generate heat when consumed i.e. they are calorigenic. The effect of such food substances is raising the metabolic rate above the basal rate is referred to as Specific Dynamic Action. It has been shown that metabolism might increase by as much as 30% during protein ingestion. The heat produced by the SDA of protein contributes to the maintenance of body temperature.

(c) Muscular Activity:

This is the most important variable under normal condition. It depends on the type of work the individual engages in e.g.

Energy requirement per day (in KCal)

Adult	Male	Female
Sedentary	2,400	2,000

Moderately Active	3,000	2,400
Strongly Active	4,500	3,000
During lactation		3,000
During Pregnancy		2,400
Children:	Male	Female
16-20 years	3,180	2,400
10-12 years	2,500	2,000
4-6years	1,600	1,600
Under 1 years	110	110

If energy provision is not sufficient to meet the demand, the body tissues will be called upon. In prolonged starvation, the adequate tissue is depleted and ketosis results. The body will become emanciated and this leads to a condition known as marasmus. When a child is overfed with carbohydrate, with little or no protein, the needed protein will be drawn for the blood. This results in a reduction in osmotic pressure and consequently oedema.

Proteins contribute between 10 and 15 percent of the total energy value of most balanced diets. They are very important because every cell in the body is partly composed of protein which as constantly being broken down and replaced. They also contain nitrogen and sulphur which are not found in other food compounds such as carbohydrates and lipids. Furthermore, while fats can be synthesized from dietary carbohydrate and carbohydrates from amino acids in proteins, the proteins required by the body are usually derived for dietary sources.

Therefore the function of dietary proteins can be summarized as follows:

(1) Supply of energy
(2) As constituents of tissue in the form of enzyme and hormones which require chemical processes with the cell.

(3) As blood proteins which aid in controlling the distribution of fluid in the body and in providing antibodies (i.e. plasma gamma globins). To combat infection as well as haemoglobin in erythrocyte which serve to transport oxygen from lungs to tissues.
(4) Growth and tissue repair

Quality of food protein:

Food proteins vary in the efficiency of their utilization for the synthesis of tissues protein. The efficiency of dietary protein is usually measured by any of the following:

(1) Protein Efficiency Ratio (PER)
(2) Biological Value (BV)
(3) Net Protein Utilization (NPU)

PER: is the amount of body weight gained per gram of protein consumed.

BV: of a protein is the amount of protein incorporated into the body tissue.

It is calculated as $\frac{\text{N Retained}}{\text{N Absorbed}} \times 100$

NPU: is the amount of dietary protein that has actually become part of the body.

Calculated as $\frac{\text{N Retained}}{\text{N intake}} \times 100$

BV makes no allowance for losses of N during digestion.

The most important single fact that influences the quality of a protein is the quantity of the essential amino acid in the protein. There are those that cannot be synthesised in adequate amount to meet body requirement. They have to be supplied in the diet for adult human. They are Valine, Isoleucine Leucine, Methionine, Phenylalanine, Tryptophan and Lycine. Histidine is added for infant. Histidine and Arginine are added for Rats.

Consequences of protein deficiency

(1) Retarded growth in children and low of body in adult
(2) Delayed wound healing in adults and children.
(3) Impaired haemoglobin synthesis resulting in anaemia
(4) In extreme cases, excess amount of fat may accumulate in the liver resulting fibrosis of the liver
(5) Inadequate synthesis of plasma protein leading to oedema
(6) Resistance to infection because of lower antibody production
(7) Certain hormones or enzymes may be absent or produced in little quantities leading to impaired function of the tissues.

2. ASSESSMENT OF NUTRITIONAL STATUS

Nutritional status is the physical health of a person as it results from consuption and utilization of food in the body. Defined by Christakis 1973 as health condition of an individual as influenced by his intake and utilization of nutrients determined by physical (anthropometric), biological, clinical and dietary studies

The effect of diet on health is measured by an assessment of nutritional status. Nutritional assessment procedures were used as early as in 1932 in survey designs to describe the nutritional status of population on a national basis. Nutritional assessment has become an essential component of nutritional care of hospitalized patient.

Nutritional assessment can be defined as the interpretation of information obtained from anthropometric, dietary, biochemical and chemical studies. The information obtained is needed to determine the health status or population groups as influenced by their intake and utilization of nutrients.

Nutritional assessment is done for survey, surveillance screening and monitoring.

Nutritional Survey:-

The nutritional status of a selected population may be assessed in cross sectional survey. The cross sectional data can be used for baseline nutritional data or can ascertain the overall nutritional status of a population. It can also identify the population at risk, so that there could be allocation of resource to the much needed population and also to form policies to improve the overall nutrition.

Nutritional surveillance:

Surveillance means continuous monitoring of nutritional status of a selected population group. Here the data is collected analysed and utilized for an extended period of time.Surveillance studies identify the possible causes of malnutrition and hence can be used to formulate and initiate intervention measures as population or sub population level.

Nutritional screening:-

The identification of malnourished individuals requiring intervention can be accomplished by nutritional screening. This involves a comparison of an individual's measurement with predetermined risk levels or cut off points. Screening can be carried out at the individual level or at a specific sub population considered to be at risk.

Nutritional Monitoring: -

This is required during the nutritional management of the patients. Base line parameters are compared during and after the nutritional intervention.

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 maybe 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 wieght for age, hieght for age, head circumference for age, or from combination of raw measurement such as wieght and hieght, 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.

Techniques

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 undernutrition
	AC < 12.5	severe underrutrition

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 thier 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.

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

Normal range = 18.5 – 25kg/m^2, below it = underweight, above it = overweight and obesity.

17 – 18.5	1st degree malnutrition
16 – 17	2nd degree malnutrition
Below 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 judgement 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 B_{12} 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. Longtitudinal differences in food consumption are not reflected for mean total consumption data of the whole population.

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 inadequaces if any. Assessment ranges from a qualitative type of inquiry to those of a more quatitative 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 generalised.

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 poor to the survey can be recalled often referred to as the 24hours recall method.

Individual intake (in volume) X Raw amount = Y

Total cooked quatity (in volume)

Standardised volumetric measures of the ingredient are recorded

Advantage

Useful method is 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 wieght 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.

Questionaire method: - It is identical to diet history. Questionaire are sent to the respondordance 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 represerntative samples and analysis for various nutrients.

2. NUTRITIONAL DISEASES

A nutritional disorder results from an inbalance between the body's requirement for nutrient and energy and the supply of those substrates of metabolism.

A nutritional deficiency whether primary or secondary begins with the inadequate availability of one or more nutrients to the body. An insufficient intake leads to decrease in

serum level of the nutrient – decrease in biochemical function for the nutrient - result in manifestation of a clinical deficiency disease. When there is an excessive intake - build of these nutrients in the body a nutritional disease referred to as the disease of affluence occurs.

The most widespread of these diseases especially in Nigeria are (1) low birth weight (2) P. E. M. (Kwashiorkor and marasmus) obesity, goitre, xerophthalmia / keratomalaca and iron deficiency anaemia, Rickets / Osteomalcia and pellagra. Note that nutrient deficiencies are generally associated with vitamin deficiencies because vitamin deficiencies underlie numerous diseases.

Low birth weight:- Low birth weights are not a genetic characteristic but are due to maternal malnutrition possibly associated with protein deficiency especially in the last trimester e.g. A study in South Africa showed that the differences food in the birth weights of Europeans, coloneds; Bantus and Indians were attributable to differences in economic status of the parents. Jelliffe also showed that symptomless maternal malaria in hyper endemic tropical areas is often associated with placental infection which has resulted in lowering of birth weights.

(1) 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

Obesity has been classified by the WHO as a disease of epidemic proportions for the poor countries. It is the most prevalent among the rich but in developed countries they look upon obesity as an undesirable development and a form of malnutrition.

It is characterised by an excess accumulation of body fat, when an individual energy intake consistently exceeds its expenditure, weight gain occurs and this results in obesity. Actually human survival depends on body fat accumulation and maximizing energy utilization but in modern times when the supply of energy is constant throughout the year and the energy demand of daily activities has greatly decreased the adaptation has become a handicap.

Garrow's method is used to classify obesity

(1) Body Mass Index (BMI) weight(Kg) / height(m^2) (weight with minimal clothing with no shoes)

BMI of between 25 and 29.9 = obesity grade 1

BMI of between 30 to 40 = obesity grade 2

BMI of over 40 = obesity grade 3

Normal adults have a BMI of 20 – 24.9.

Since being overweight is not synonymous with being obesity it has become necessary to adopt the term desirable or ideal weight which is the weight that conforms to the longest life span.

(2) Another method for measuring obesity is the triceps skinfold thickness. Since more than half of the fat in the body is deposited under the skin and its % increases with age Seltzer and Stare proposed the figure of 23 mm and 30 mm for male and female as the minimum for defining obesity.

In general, an adult obese person is one

(1) Who with the exception of the muscular athlete is 9kg or more above her desirable weight.

(2) Who weighs 15 – 20% or more above her desirable weight or weight attained at the age of 20 under normal nutritional considerations.

(3) Whose triceps skinfold thickness is 23 mm or more for men and 30mm or more for women at the age of 30 – 40

(4) Whose BMI exceeds 25.

Some studies have shown that there is increased mortality with increasing overweight with the higher mortality in men than in women. Also when obesity occurs at earlier ages 20-40years it has a greater influence on cardiovascular disease than later-onset obesity. Since many of these deaths arise from cardiovascular disease and diabetes it would appear there are no single value of weight or fatness that is optimal for all. Hypertension occurs more often among the obese than among the non obese and the mortality rate of those who are obese hypertensives is higher than for those who are only obese or only hypertensive. Extremely obese individual develop respiratory difficulties which produces lethargy and somnolence (so we see that obesity has a high association with coronary heart disease, hypertension and maturity onset diabetes)

CAUSES OF OBESITY

1. Genetic: There are lot of investigations showing a high incidence of obesity among the parents of the obese. Withers provided circumstantial evidence to show that if neither parent is obese the risk of obesity may be less than 10% but if one of them is obese, the risk of fatness is 40%, if both parents – 80%. The impact of family food and food consumption patterns which are taught by parents cannot also be overlooked. Newman and his co-workers discovered that theres a great difference between twins raised apart and twins raised together implicating environmental factor but identical twins however have tendency towards similar fatness or thinness implicating genetic component. Therefore, genetic factor is modified by environment and behavioural factor.
2. The shape of the body is also important because a long thin person will have much more body surface than a short plump person of the same weight and the greater the body surface, the greater the heat loss.
3. Body type or somatotypes: endomorphic (soft and roundish) has much fat storage capacity mesomorphic (bony and muscular) in between ectomorphic (lean, linear, fragile, thin or slender usually with long thin fingers) has low fat storage capacity

Physical activity:

The physical activity of an individual constitutes a measure of his lifestyle. Modern technology has ways of reducing this e.g. use of automobiles, television tap water etc. These conveniences have turned the population into a sedentary people. Where physical activity is not highly priced the genetic potential for obesity has greater opportunity to be expressed.

Physiological factors: The food intake regulation centre is located in the hypothalamus of the brain. A short term regulation of the glucose sensitive receptors found in the ventomedial nucleus of the hypothalamus. When blood glucose is high the lateral nucleus (feeding centre) is shut off and activated again when glucose levels are low. The obese compulsive person seems to have lost the normal control mechanism and his appetite is controlled by external influences and finds it difficult to stop eating. Man and animals eat in response to hunger and appetite, when they are satisfied the person stops eating but the obese react to external cues related to food differently from that of the non obese. An over activity of the adrenal glands is also a cause.

Psychological:-

Many obese persons eat to derive certain types of satisfaction or to compensate for certain personality deficiencies e. g. The overweight gay who is not socially acceptable may appease his ego by indulging in unwise eating or someone who lacks affection, recognition may turn to food for solace.

Sometimes this burdens on pathological state e.g. eating in the night syndrome with the patient suffering from insomnia and voracious appetite at night followed by a marked anorexia in the morning.

Women tends to gain excess weight following puberty after their first pregnancy and during menopause but men tend to gain weight gradually after the age of 25. Actually the older we get the less energy we required due to change in body chemistry and as well as reduced activity changes i.e. BMR changes with age.

Socio cultural influences:

There's a belief that associates hearty eating with a change in fortune or occupational success but this comes at an age when caloric expenditure is decreased because of the modern conveniences and less physical activities. Generally in Nigeria urban dwellers are fatter than their village dwellers.

Dietary factors

Overfeeding in infancy may be a factor in the incidence of obesity later in life. Formula fed babies are usually fatter than breast fed babies. Infants who gain excessive weight during the 1st six months of life have a greater likelihood of being obese later in childhood than do infants who gain normally. The lack of nutrition knowledge as relates especially to the caloric value, choice and amount of food is another cause of obesity. Cumulative effect of extra food eating beyond caloric needs e.g. a manager after eating tops it with beer and suya, or eating at so many engagements.

Obesity in childhood:

Fat cells adipocytes grow by increase in number and size and lose weight in the cell size not number. In infants growth occurs by increase in number and size, in adults it is increase in size. Obesity which results from an increase in fat cell number is called hyperplasic obesity. Obesity in early life is hyperplasic but in later life it is hypertrophic. Multiplication of adipocytes appears to take place during first 3years of life and adolescent period.

People who become obese as children have a higher number of fat cells then those who become obese as adult.

Prevention and treatment

The best and most effective treatment is its prevention. Losing weight and keeping off the weight is extremely difficult especially for those who are 25% or more overweight. A gain of 2kg above one's ideal weight should be a signal to start curtailing energy intake. The mode of treatment varies from one individual to another.

1st conduct investigation to show whether it is due to endocrine problem (hypothyrodism) if it is accompanied by diabetes or other health problems - diet and dietary advice, psychological counselling, exercise and drugs.

Dietary advice:

1. Each patient should receive specific guideline – must eat breakfast, avoid late dinners.
2. Increase the amount of water, fruit and vegetable intake with less amount of food energy consumed.
3. Lowering the total amount of fat especially animal fat will decrease the amount of energy and saturated fat consumed.Fish or chicken should be substituted for beef, decrease the amount of refined sugar and snacks. There is a liquid formula diet which can lead to a loss of weight within. 2-4 weeks but it is not sustainable they soon return to the conventional eating habit.

   Some proposed total fast especially type 11 obese but loose both fat and lean body mass which may not be easy to regain .In general a diet should permit the gradual loss of weight of no more than 0.9 kg/wk. The diet for a man should provide 1000 – 1500 KCal for man 1500 – 2000 KCal which supply the basal metabolism per day. Over eating in the evening which is more common in the obese should be avoided.
4. Psychotherapy (behaviour modification): The believe that eating habits are learned behaviour so the focus is to change eating habit especially emotional and environmental (actions that can lead to overeating).
5. Exercise: If energy expenditure can be increased by incremental physical activity and energy intake is kept constant weight will drop but a significant amount of physical effort is required to expend a significant number of calories.
6. Some drugs are given for weight control on a mixed theory of both appetite control and stimulation of the body to burn more fat.
7. Surgical treatment:
   a. A short bowel is created to produce malabsorption of ingested calories.
   b. A small stomach is created so that the reduced reservoir for feed will prevent much caloric intake at anytime.

c. Truncal vagotomy including suction lipectomy, jaws wiring can be done.

Conclusion – he must eat less than he would like to eat.

Other Nutritional disease.

Iron Deficiency Anaemia: - Anaemia is decrease in the total red cell mass due to fewer red blood cells or to smaller red blood cells which contain less hemoglobin.

Nutritional Anaemia depends on nutritional factors involved in the causation e.g. iron, folic acid and vitamin B_{12}.

Iron deficiencies anaemia, folic acid deficiencies anaemic and vitamin B_{12} Pernicious anaemia.

Iron deficiency anaemia: The most common, it is characterized by hypochromia and microcytosis of the red blood cells. It results from inadequate diet, impaired absorption, blood loss or repeated pregnancies.

The anaemia is prevalent in pregnancy because the requirement is so large and greater than dietary intake so must be supplemented. In the adult intestinal helmithiasis e.g. lookworm can cause anaemia also accident, surgery, menstruation or blood donation are the ways of losing blood and consequently iron deficiency (1ml of packed red cell = 1mg iron). Iron deficiency is also common among cereal (maize) eating population life. It is poor in iron.

Non heme iron is the major source therefore enhancing its absorption will combat the deficiency. This is found in cereals and vegetables, meat, vitamin C improve its absorption. Iron pots also contribute to the supply.

Iron excretion is limited since it depends on absorption, its being used and revised. It is stored in the lower spleen and bone marrow and used for erythropoiesis.

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 synthesised 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.

Energy values of foods and energy expenditure by mammals

Food eaten is used as fuel. End products of food oxidation are CO_2, H_2O and heat. CO_2 and H_20 are eliminated in perspiration, heat is used to maintain body temperature. Part of the energy in food is used in muscular activity while the rest is stored as fat.

Energy is obtained from carbohydrate, protein, fat and oil. Minerals and vitamin are necessary in the biochemical reaction involved in food oxidation.

Unit: Calorie (C) unit of measurement is the amount of heat necessary to raise 1 kg of water through 1^oC.

The custom of expressing food values and food requirement in terms of calories is the usual practice.

Method of Experimentation:

5 types of calorimeters are used for direct measurement of heat production.

(1) Latent type e.g ice calorimeter of Lavoiser and Laplace

(2) Bath calorimeter (fixed amount of water type)

(3) The type that employs circulating air or water to remove heat e.g. respiration calorimeter

(4) Emission type calorimeter (heat recording type)

(5) Gradient or heat flow calorimeter.

Most direct calorimeter remove the heat eliminated in a radiation and conduction by means of measured stream of cold water flowing through tubing in the chamber. The heat expended in evaporation of water by the skin and lungs of the subject (about 25% of the total) is determined by passing the air from the chamber through H_2SO_4 absorbers and then measuing the and amount of H_20 from this source. Normally the chamber is equiped with adiabatic devices which present the flow of heat through the walls in either direction. Some calorimeter are used without such regulation and are calibrated for heat loss by introducing a known amount of heat into the chamber and noting the amount recovered in the standard operating temperature of the chamber and room.

Direct calorimetry is expensive in both time and apparatus except the gadient type. Direct calorimetry measures only and does not measure the energy (derived from the body) which appear in some other form.

Calculation:

Volume of H_2O through absorbers	=	1860 Li
Average rise in temperature	=	0.515oC
Water vapour produced	=	1016gm
Heat of vaporisation of water (18^oC)	=	0.586 Cal/gm
Heat production	=	(1860 x 0.515) + (1016 x 0.586)
	=	1553 Cal

(b) Indirect calorimetry

- Respiratory exchange. It is prefered to direct method
- Better limited to short time observations.

Two types of respiration chamber

(1.) An airtight compartment large enough to allow freedom of movement of the subject and is supplied with either a closed or open circuit type of ventilation.

(2.) Frequently employed method especially with human subjects is to connect respiratory passage with some sort of mask or breathing tube directly to the measuring appliances.

These type of respiration chambers depend on whether the ventilation was to be of closed or open circuit type.

Closed circuits: Consist of a glass bell jar, of sufficient size to accommodate a dog with tubes connecting it to an air sampling device, a manometer CO_2 absorbers and flask of O_2. O_2 was admitted as regard to maintain atmospheric pressure as shown by the manometers the CO_2 being removed by KOH absorbers.

Another method uses the spirometer, which is filled with a mixture of air and O_2 of unknown composition which falls gradually as the O_2 is consumed while the amount and rate are recorded on a kymograph. The exhaled air passes through a soda lime chamber which removes the CO_2 and excess moisture. Volume of O_2 used times 4.80 gives the calories produced. They are used to determine basal metabolisim.

(2.) Haldane procedure: Determination of oxygen absorption as developed by haldane in 1892. Its convenient for small animals.

(3.) Nitrogen – C balance method

The only analyses involved are N_2, C and energy (determined with the bomb calorimeter). Feed intake and excreta over a period of time are used.

(4.) Body balance method: It is limited to the determination of heat production over a long period of time and with small animals. It is accurate and better than other methods, no measurement of respiration.

Terminologies in Nutritive evaluation

Gross energy: Is the total heat produced when the food is burned in a bomb calorimeter. It is more and never lower than the energy available to the human body. Fat and carbohydrate are completely oxidized but protein only 78%.

Digestible Energy: Is the energy of the food minus that of the feces called apparent digestibility. It is not a perfect measure of nutritive value since it includes UE, SDA and in case of ruminants methane.

Metabolizable Energy: Is the energy of food minus urine + faeces (and methane for ruminants).

Net Energy: Is the net remainder after the expenses of utilization have been deducted from the feed energy (i.e. feces, urine, SDA, methane). Its an expression of the actual usefulness of a food for the purpose to be served. Factors affecting it includes – capacity of the animal to eat. Only the amount of food eaten above the maintenance requirement is available for production. Net

energy is a measure of what the food contains but of what it may accomplish e.g. milk (dairy cows) body tissue (stears).

Total Digestible nutrients: A feed minus feces evaluation. The content between DE and TDN is one of the experimental determinations.

To convert TDN to DE, multiply the weight of TDN in pounds by the factor 2000 to obtain its equivalent in calories.

Basal metabolism: Is the heat production of a person in a postabsorptive state, lying awake and relaxed.

SDA: The increase in heat production after the ingestion of food. SDA is about 6% of energy intake, attains a peak at about the third hour. Ingestion of protein produces a greater effect than carbohydrate or fat.

Conclusion: The largest energy expenditure is the basal metabolism.

Measurement of nutritive values

The measurement of nutritive values of diets or of components of diets may be achieved in a variety of ways. The criterion of result may be gain in live weight, apparent digestibility, metabolizable energy or net energy of the feed, body gain in energy, body retention of specific nutrients effects on general health reproduction lactation length of life etc.

The criterion to be used depends on condition to be met. Also the combination to be used must be determined by the investigation.

Increase in body live weight is a common criterion.

(a.) **Group feeding:** Consist of the amount of different food necessary to produce amount of useful product (gain in weight, milk, eggs etc). The method is used to project the overall food consumption of large groups as barracks.

(b.) **Paired feeding:** Two subjects that are alike are chosen. Each is fed one of the 2 rations to be compared, but one of them is fed ad libitum. Where good food intake occurs a nutritive different between the rations will become apparent in the superior growth of one subject of the pair it will be evident whether the poorer ration is unpalatable or an essential nutrient is lacking

Ad libitum feeding

If two rations of equal nutritive value but of unequal palatability are compared by feeding ad libitum, the results of the test are obvious, but the comparison will be obtained at a high level of intake with one ration and a low intake with the other.

Length of experimental periods

Short intervals of observation may contain errors of measurement. Longer periods are advised.

Formulation of diets

It is highly desirable to compare diets or ration of predetermined composition with respect to certain components.

Basal metabolic Rate

Fraction of the total energy metabolism that is needed to maintain the vital life processes of the body at rest.

CALORIC REQUIREMENTS

1. **Energy expenditures of physical activity and work.**

   It is the largest caloric expenditure, it is about 1/4th of the total energy expenditure of a moderately active person.

   Depends on the specific physical activity, the energy cost of the activity, the time spent on the activity and the body size of the individual.

2. **Work efficiency**

   Defined as the ratio of the work done to the energy required to accomplish it, calculated by dividing the amount of work done by the amount of extra heat produced in doing the work.

3. **Energy requirement**

   The total energy of an individual represents the sum of the energy expenditures for the basal metabolism, for physical activities or work and for the specific dynamic effect of food. One can use accepted standards or tables of recommended energy allowances.

4. **Calorie undernutrition and over nutrition**

   Western countries: food plentiful have problem of overweight but developing countries undernutrition.

NUTRITION IN CHILDHOOLD

At birth a baby has sufficient store of brown fat and glycogen which can be metabolized to produce heat for the maintenance of body temperature. The food given within the first few hours of life is to maintain a safe blood glucose level and to initiate milk flow. By the end of the 1st week, the rate of growth and weight gain of the infant is faster than at any other postnatal time when the baby gains between 180 and 210 g/wk. To achieve this, 1.5g per kg/day of proteins are required with sufficient calories from carbohydrates in the milk. At this time 1/3 of the total caloric uptake is expended for growth.

Human milk contains appropriate amount of all necessary nutrient, including the essential fatty acids, arachidonic and linoleic acids needed for optimal brain development. The amount of food required by each baby depends on the rate of metabolism, how active the baby is and on the need to keep him warm.

Gastric motility is poorly coordinated in the fruit few weeks of life, leading to poor natural mixing and therefore less digestion of solid foods. By the 12th weeks of age, intestinal peristalsis of a type seen in older children and adults develops but it is slower.

Intestinal mucosa permeability is greatest during the neonatal period and many large molecules including protein tend to be absorbed intact. The intestinal mucosa α-glucosidases (sucrase, maltase, isomaltase) are well developed by 32 weeks of gestation and are present at near adult level at term. For premature infants (27-32 weeks gestation) formulas with less than 60% of total carbohydrate calories as lactose are best tolerated.

See table in textbook on RDA for normal infants and Yg children for selected nutrients.

FEEDING THE PRE-TERM (LOW BIRTH WEIGHT) BABY

The most generally accepted goal for nutritional management of the pre-term (LBW) infant is to provide sufficient amounts of all nutrients to support continuation of the intrauterine growth rates. The initial practice of feeding pre-term infants with milk was abandoned fifty years ago following the demonstration that protein intakes higher than those provided by human milk resulted in a greater rate of weight gain.

Also breast milk cannot supply the infant with as much calcium and phosphorus and sodium, iron, copper as it would have obtained from its mother circulation. The smaller the infant (pre-term) the more marked is its inability to withstand starvation while the term baby has sufficient resume to survive a total starvation condition for a month. Once feeding has become

established in a baby weighing 1kg or less it should be given sufficient food to enable it to grow at the same rate as it would have done had it not been born.

INFANT FEEDING

Breast feeding is universal in the rural areas of Africa but its importance is diminished in the cities. It is the best means of delivering nutrients to the new born. A mother must be encouraged to feed adequately, exercise, rest and have freedom from anxiety in order to fulfill this function. Because of its ready availability, its safety and the promotion of enhanced resistance to infection and bonding between the mother and infant, human milk is the perfect food. But in cases where the mother dies after child birth or she has to return to work immediately artificial feeding is used.

The period of neonatal life and early infancy is characterized by rapid growth but the human infant grows less rapidly than the young of other mammals e.g. calf doubles its weight tin 1month but in man, 4-5 months.

COMPOSITION OF COLOSTRUM, HUMAN MILK AND COW'S MILK

See table in texbook.

The belief that human milk has a constant composition is false. The effect of very poor nutrition on a lactating mother is to reduce the quantity, and the quality of the breast milk e.g. if a mother's diet is deficient in thiamine, it produces less of it in her milk. Infant can also grow well on cow's milk or formular but breast milk is cheaper and safe microbiologically.

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BREAST FEEDING VS BOTTLE FEEDING

Breast milk remains the preferred food for human infants. Although science and industry have combined their skills to produce cow milk products which contain nutrients in qualities that are similar to those in breast milk statistical advantages of breast feeding persists. Mother who choose to feed their infants with formula should not be made to feel guilty if they can afford to do it properly.

Advantages

1. Breastfeeding gives a safe and protected feeding to the infant and a sense of satisfaction to the mother. It fosters good mother child relationship. Prolongation of breast feeding may cheat the infant of needed nutrition.

2. There is a reduced likelihood of diarrhea. Stools of infants fed breast milk has lower pH (5.4) than those fed cow milk (6.9) which promotes greater growth of pathogenic bacteria in the GlT of those fed cow milk.
3. It confers immunity on the child because of the presence of immunoglobulins and other constituents of breast milk. Also the reduced IgA in the breast milk promotes microorganisms in the infants intestine that is antagonistic to certain pathogen.
4. Human colostrums contain lactoferrin, which by building iron makes it unavailable to *E. coli* in the intestine, thus inhibiting their growth. Other binder protein which bind zinc, vitamin B12 and folate are also present.
5. It is available and convenient, and at right temperature no preparation is necessary.
6. It confers an economic benefit on the family
7. It has contraceptive effect and can delay the return of ovulation by 5-8 months.
8. The human milk contains an enzyme which aids protein digestions. Taurine an amino acid is present only in human not cow's milk. Lactose also aids the absorption of Ca, Mg and amino acids whereas some commercial formulas substitute syrup or sucrose for lactose since neither of these yield galactose on hydrolysis a deficiency of galactose may affect the development of the neonate.

These facts show that no other food is equal to that of the human milk for child nutrition provided that the mother has maintained adequate nutrition herself. Epidemiological observations show that following the feeding of such artificial milk products:

1. There were widespread outbreaks of rickets in the early part of the century.
2. There were cases of neonatal tetany in the early 50's

3. There were reported cases of pyridoxine deficiency also in the late 50s Epidemiological observations show that following the feeding of such artificial milk products:

1. There were widespread outbreaks of rickets in the early part of the century.
2. There were cases of neonatal tetany in the early 50's

and 60s.

4. Hemolysis due to vitamin E deficiency were also recorded Epidemiological observations show that following the feeding of such artificial milk products:

1. There were widespread outbreaks of rickets in the early part of the century.

2. There were cases of neonatal tetany in the early 50's

5. Risks of high plasma sodium (hypernatremia) have also been noted in recent years.
6. Variation or the quality of constituted milk in affluent homes over concentration can lead to infant obesity or other dilution may lead to marasmus.
7. It is costly, the mother may not be able to sustain it.
8. The gut flora of the artificially fed infant is made up largely of *E. coli*, and *Streptococcus fecalis* in contrast to the breast fed infant in whom the lactobacillus predominates but the breast milk protects against this.
9. The poor environmental sanitation in such places

FACTORS MILITATING AGAINST BREAST FEEDING

1. The mother's milk production may be less than half of the infant needs.
2. The mother may suffer from some chronic illnesses such as cardial diseases, tuberculosis, severe anemia, nephritis epilepsy, insanity, chronic fever and AIDS.
3. Another pregnancy occurs, although this may not stop breast milk flow.
4. The mother has to return to work outside the home
5. The infant is weak or unable to nurse because of cleft palate or half-lip or the mother has acute infection.

NUTRITIONAL ASPECTS OF GROWTH AND DEVELOPMENT

Growth is the increase in size from embryo to adulthood. The metabolic rates of infants and children are greater and the turnover of nutrients are more rapid than in the adult. Therefore, the nutritional needs for growth and development are superimposed upon maintenance requirements that are higher than in adults.

Each infants growth and development are determined by (a) the characteristics acquired from parents (b) the quality of nutrition of the mother during pregnancy (c) the adequacy of breastfeeding or formula feeding and the supplements offered throughout infancy.

Height and weight are compared to charts that depict a normal population. The best assessment of normal growth should be – measurement of body size (anthropometric) body composition and body cells.

It is the physiological age of a child that determines its nutrient needs. Physiological age is matched by the chemical index of growth, marked by urinary excretion of hydroxyproline (component of skin, tendons etc). Its rapid synthesis takes place during growth and reflected in an increased rate of its excretion.

Several criteria are used to determine whether an infant is well nourished or not

- a steady gain in height and weight
- sleeps well, is happy, is vigorous.
- has firm muscles and a moderate amount of subcutaneous fat, teeth begin to appear 5-6months, normally eliminates fecal waste after feeding.

Infants grow and develop more rapidly during the 1st year than at any other time. Birth weight is doubled in about 5 months, tripled by one year and quadrupled by 2 to 3 yrs. This growth is reflected in the Ponderal Index (P.I.) = weight / Height^3 x 100. The relation of bone weight to body weight is constant during life. The growth of a child tapers off after the 1st year. An infant's body contains a much higher percentage of water than that of older children and adults. Their muscles are poorly developed and the amount of subcutaneous fat is limited.

The 1st request of a new born is O_2 for its lungs to expand and circulation to be re-routed next is warmth, followed by feed and water and the digestive organs have to come into operation. It is able to digest proteins, emulsified fats and single sugars. Starches and most fats are poorly digested because of pancrease . The kidneys reach their full functional capacity by the end of the first year.

The Hb level at birth is about 17-20 g/100ml the level becomes lower as the infant grows and the body circulation expands. The level remains satisfactory until the 3rd month when iron rich foods are introduced.

The brain develops rapidly such that it completes its growth earlier than the rest of the body. 60% at birth, 4years 80%, complete 10 years. Severe malnutrition at any of these times leads to a reduction in the number of brain cells.

Growth processes are controlled by factors such as genetic and environmental factors amongst which is nutrition.

NUTRITIONAL REQUIREMENTS DURING INFANCY

After birth, a normal full term healthy baby should be put to the breast, (not later than 4 hours). If no breast milk is forthcoming the baby may be put to 10% dextrose or 5% sucrose or plain water. Eating at the time involves 3 mechanisms (1) rooting (searching for the nipple), sucking (continuously or intermittently) and swallowing well coordinated with breathing allowing milk to go to the eosophagus instead of the lungs.

During the early period the infant needs between 6-8 feedings/day, as the stomach capacity increases 4-6 times at 5 months. After first week supplement of vitamin A, C and D should be offered. Some breast fed infants develop physiologic jaundice possibly due to functional immaturity of the liver, this will clean off within a few days with normal breast milk.

ENERGY NEEDS

The energy allowance recommended for infants is based on energy consumption of normal children. A new born full term baby increases his daily energy intake per unit of body weight until he is about 6 months when he is causing about 117 to 120KCal/kg, this drops to about 108KCal/kg between 6-12 months. These allowances cover the estimated energy needs.

Activity	0-6 months (KCal/kg)	6-12 months (KCal/kg)
Basal metals	60	55
Growth	15	35
Normal activity	35	10-25
Specific dynamic action	5	5
Fecal losses	5	5

The energy consumption of formula fed infants depends on the concentration of the formula needs but that of mammalians milk is constant at about 75 KCal/100ml.

CARBOHYDRATE REQUIREMENTS

As a rule roughly half of an infant's caloric requirement should be supplied as carbohydrate since infants consuming carbohydrate free diets develop ketosis. Lactose is the carbohydrate and its quality in cow's milk is 70% of that in man providing 29% and 38% of the

milk energy. Most milk formula provides 40-50% of the energy as carbohydrate. Whenever it is greater the 50%, some of it is not hydrolyzed and absorbed, it exert an osmotic effect causing water to enter the intestine resulting in diarrhea or may be insufficient lactase leading to accumulation of lactose which when acted upon by bacteria causes diarrhea.

PROTEIN REQUIREMENTS

Breast milk powder only 2-25g/kg body weight but the quality constancy of composition and regularity of breast milk makes it adequate. Cow and human milk both contain casein and lactalbumin, casein is more predominant in cow while lactalbumin in man. The higher protein content of cow's milk does not give it a nutritional advantage because its utilization is lower. Recommended allowance = 1.9g/100 KCal in the first 12 months of 2.2g/kg body weight first 6 months and 2g for the last 6 months.

FAT REQUIREMENTS

The dietary requirement is for essential fatty acids especially linoleic acid. About 3% of the total caloric intake should be linoleic acid so as to maintain the integrity of the skin and normal growth. Human milk 4.5g/100ml cow 3.7g/100ml but cow's contain more saturated but less cholesterol and polyunsaturated fatty acids than human milk.

MINERALS

Breast fed infants are adequately provided with minerals except iron. The iron content of cow's milk is the same as that of human milk but that of breast milk is better absorbed therefore formula fed infants must be supplemented with iron-usually 1mg/kg/day to a total of 15mg has been recommended. This should be initiated before 4 months since the iron stores acquired for the baby will be rearing exhaustion at 3 months. Premature infants don't have this privilege because the acquisition of 1 month for the other takes place during the last wk of pregnancy.

The RDA (recommended dietary allowance) for infants is usually based on the dietary iron needed to maintain optimum Hb level which is between 7-10mg/day up to 1year of age.

A breast fed baby recourses about 60mg of calcium per kg body weight each day compared with 170mg for the cow milk formula fed baby. The deficiency of iodide in a mother

could lead to cretinism in the infant and goiter later in life. While the deficiency of fluoride predisposes a child to dental carries, its excessive intake leads to fluorosis which is the discoloration and nothing with increased brittleness of the dental enamel.

WATER REQUIREMENT

The amount required depends on how much is lost in regulating the body temperature and how much is needed by the kidneys for its disposal. It is also required for growth and fecal excretion. Water loss for the skin is due to greater surface area in relation to the body weight. A more concentrated urine is not good for an infant because the excretory capacity of his kidneys is not as efficient as that of the adults, therefore they must take in a large volume of water. Infant's require 150ml of water per kg/day per 100KCal. The requirement is usually met by the breast milk (86% water) but may be supplemented with strained fruit juices.

NUTRITION IN THE ELDERLY

The maximum age for man is 110 years even though very few attain this age. After retirement, very few people look forward to old age because they see it as a time when with failing faculties they will no longer be able to live useful independent lives.

The degenerative changes which accompany aging include:

- Loss of sensations of smell and taste
- Deafness, failing sight, osteoarthritis, osteoporosis, arterial diseases, reduction of glucose tolerance and declare in muscle bulk and strength.

At this time, cardiac, renal and pulmonary functions decrease with aging, also changes in GIT functions occur – poor dentition and gastric emptying gastric acid production.

Good nutrition however improves the quality of life of older people and as medical treatment improves the population lives longer.

The nutritional requirements for most nutrients for older people are the same as those of the younger population. The only exception are a fall in energy requirement with age and an increased requirement for vitamin D in the house bound since they are less active and use less

energy. It can be difficult for older people to have a diet that is nutritionally adequate when their appetite is poor, or when in pain or have a disability.

ENERGY REQUIREMENT

Reduction in energy requirement occurs because

(1) Activity declares in the aged, so less energy is expanded.

(2) Changes in body composition and function lead to a reduction in basal metabolic rate.

e.g. for men 15-35years 3000 KCal (moderate activity)
35-65years 2900 KCal (moderate activity)
65-75years 2350 KCal (sedentary life)
75 years 2100 KCal (sedentary life)

For women it drops from 2200 KCal at age 18 to 1810 KCal at the age of 75years.

This reduction means that the diet has to be of a high nutritional quality to ensure that the requirements for all other nutrients are met while the energy intake is reduced.

Requirement is about 400 KCal/day, 30-50% can be provided as fat. Condition where more fat is used includes diabetes mellitus and stress induced glucose tolerance. Providing too many calories is very dangerous because it can lead to electrolyte imbalances, hypokalcemia, cardiac dysfunction and even death.

Protein:

There is a slight increase in protein requirement with age. 1g protein /kg/day. In stress it is increased to 2g protein intake is restricted in renal and hepatic insufficiency.

Fluid and Electrolyte

Diminished fluid intake and an altered response to thirst are common in the elderly. Some may voluntarily decrease their fluid intake due to problems with incontinence or decrease going to toilet. Medications may increase urine output.

Vitamin and trace elements

Decreased gastric acid secretion which is common in the elderly results in the absorption of several vitamins e.g. B_{12} and folate and trace elements – Fe, Zn. Medication can also affect absorption of micronutrients e.g. fibre supplements. Additional Ca is needed for the prevention and treatment of osteoporosis. Some micronutrients have beneficial effect on immune functions (Vitamin. A, C, D, E, B_6, folate, Zn) for wound healing (Vitamin A, C, B_2, Zn, Se) and antioxidant functions (Vitamin C, E and Se).

Malnutrition in older people can be divided into:

1. Generalized malnutrition: The diet count inadequate supplies of several nutrients which can be due to self neglect, illness, disability depression and bereavement.
2. Deficiency of a particular nutrient: Occurs when a particular food or group of foods is excluded from the diet e.g. (a) Iron deficiency in those with poor teeth who avoid meat because of chewing, or due to its cost. (b) Low vitamin intake in those who have little fruits and vegetable in the diet may be due to difficulty in shopping etc. (c) Folic acid: also from vegetable and yeast extracts.
3. Subclinical malnutrition: The diet is not so poor that they show clinical features of malnutrition but the body stores of nutrients are depleted. If exposed to any stress they become clinically malnourished.

Causes of malnutrition in older people

Malnutrition is normally precipitated by other social, physical or medical problem.

1. **Age:** The increasing frailty of extreme old age increases the risk of malnutrition.
2. **Social isolation and loneliness**: Most elderly people live alone. They cannot be bothered to cook for themselves; they cannot buy meat because they buy only small quantity. Widower's disease – applied to vitamin C deficiency is very common.
3. **Loss of appetite:** Enjoyment of food depends on usual appearance, taste and smell of it. Reduction of the activity of these sense organs leads to decrease in appetite. The perception of salt and sweetness also decrease greatly while bitterness remains unchanged. Salivary secretion also in older people contributes to loss of taste and makes chewing and swallowing more difficult.

Remedy: they need encouragement to take interest in food and their appetite needs to be stimulated to help overcome the reduction in taste and smell.

4. **Teeth:** The daily energy intake of older people with ill fitting dentition is 200 to 300 KCal less than for those with adequate dentition because eating is uncomfortable and they adopt a soft bland diet.
5. **Dysphagia:** Is a condition in which swallowing is either difficult or painful – may be due to multiple sclerosis, cerebrovascular attack, surgery, confusion, radiotherapy etc.

   Remedy: physiotherapy, dietitician, intravenous fluids, supplementary feeding etc.

Physical disability

10% of elderly people are housebond because of physical disabilities due to hemiplegia, arthritis, Parkinson's disease, injuries from accidents etc.

Remedy: convenience foods can help a lot in this case.

Mental disturbances

Service dementia affects 5% of the post retirement population. So they forget to prepare or eat meals. Some are depressed they may forget to go to the market to buy food stuffs.

Remedy: treatment for depression.

Therapeutic diets

1. Keeping to a strict weight reduction diet long after the ideal target weight has been reached.
2. Self improved exclusion of carbohydrate in a well intentioned attempt to control diabetes.

Remedy: see dietitian

Dealing with problems affecting nutrition in the elderly

1. Loss of teeth: cut food into small pieces, crush.

   Add gravy or other liquid to food – make chewing easy, e.g. thick soup, porridge, milk drinks, fruit juice and mashed potato.

Loss of appetite

- Prepare colorful and tasty meals based on balanced diet
- Serve nourishing meals in pleasant surroundings and eat slowly

Poor digestion and constipation

Serve fresh fruits and vegetables, cooked vegetables and stewed fruits.

Lack of money

Buy low cost locally produced foods, keep a home garden.

Loneliness

Family and friends should spend time with them especially at meal times. Give them roles in the family maybe taking care of the young ones.

If the older person is sick – get a doctor and a dietitian or nutritionist to help.

Nutritional assessment of the elderly

1. Height and weight measurement and calculation of the body mass index. If it is impossible to obtain an accurate weight measurement especially for a disabled or confused patient, then measuring the demispan may be easier (web of the outstretched finger to the sternal notch and is related to height.

History: Discuss clients current weight – steady loss or gained

Discuss appetite, meals, any diarrhea, sore month etc.

Physical appearance – look fat/thin, clothes loose or not loose dentures.

Serum albumin, transferin and haemoglobin are all important biochemical parameters for assessing nutritional status.

Health education programs – aimed at older people including those who work with them should be encouraged.

(3) Pre-retirement course – not only in business but also include session in which nutrition is discussed.

NUTRITION IN PREGNANCY

Pregnancy is a normal physiological function and not a pathological one. Once conception has taken place; nutrition is the dominating environmental influence that determines the outcome of pregnancy or prenatal growth. A restricted diet during this period may lead to inadequate weight gain, inter-uterine malnutrition resulting in inter-uterine growth retardation or a shorter gestational period. These may also result in congenital malformations, low birth weight infants, neonatal deaths and still births. If iodine is deficient, may result in cretinism later in life.

During the course of pregnancy the maternal tissue undergoes a remarkable series of physiological adjustments in order to provide for fetal growth and development and at the same time preserve maternal homeostasis.

Women who enter pregnancy in good health with sound fully developed reproductive physiology and who have not suffered ill health or nutritional deprivations in childhood will have bigger and healthier infants than those who do not have such advantages. Inadequate nutrition during pregnancy results in greater harm to the fetus than to the mother. E.g. a mother deficient in vitamin A will give birth to blind child or have xerophthalmia. Also spontaneous abortion (miscarriages) and still births are more common in women who are poorly nourished. Most of them have eclampsia or develop toxemia of pregnancy. Underweight women produce smaller babies. In some cases e.g. if the woman is not consuming adequate calcium she will lose her body's store to the benefit of the fetus.

Nutrition needs

The growth of fetal tissues and bodily changes in the mother necessitates additional requirements for all the nutrients whose daily allowances are known more especially proteins, vitamin C and A, calcium, iron and folic acid. These allowances are based on the suggested allowances for non-pregnant women with superimposed additional requirements for pregnancy.

Energy requirements

This varies according to age, stage of pregnancy weight, height, activity and ambient temperature. The requirements are greatest during the 2^{nd} and 3^{rd} trimesters because of the accelerated fetal growth. Additional 46 KCal/kg energy is needed during this period to provide for the growth of the fetus, the development of the placenta, to support a higher metabolic rate and additional body mass of the woman.

Next to water, fat is the biggest component of the body tissue of a developing fetus. It rises from 2% at 6 months gestation to 15% at term. Healthy pregnant women may have very limited need for additional energy which is about 300 KCal/day which can support a steady weight gain of 0.25-0.35 kg/wk to a total of 10-12 kg for the pregnancy period weight gain is greater in young woman than in older ones and greater in primigravidas than others. An

inadequate weight gain may precipitate health problems as well as an excess both for the mother and the baby. She does not need to eat for two.

PROTEIN REQUIREMENTS

Pregnant women need more protein than non pregnant or adult male. Protein requirement is influenced by the quality of proteins, total energy intake and protein status of the woman as she enters pregnancy. Of the essential amino acid leucine is required in greatest quantities by the fetal body. The recommended increase in proteins is from 46g for the adult female to 75g during pregnancy at the rate of 1.01kg/kg body weight. Generally an amount of 1.7g/kg body weight may be required by the pregnant adolescent.

2/3rd of this intake must be of a high B.V. coming from such food items as milk, fish, eggs, meats, cheese and legumes. Since good quality proteins generally come with fat, an increase in protein density is often accompanied by an increase in fat density so they are advised to take plant proteins that are low in fat. A low protein intake leads to nutritional edema. Adequate calorie intake spares proteins and ensures that they are not used for energy.

VITAMIN REQUIREMENTS

This needs to be fed during pregnancy although this fed requirement may not be met by a regular Nigerians diet. Actually deficiencies of vitamins are rare if protein intake is adequate.

Vitamin A is increased from 4000 I.U. for adult non pregnant to 5000 I.U. for the pregnant woman. Excess intake of it leads to nausea, headache, dizziness and hair loss. Where vitamin D, E and K are jointly administered with Vitamin A, care should be taken because excess vitamin E and K could increase blood clotting time, excess vitamin D could produce hypecalcaemia, weight loss calcification of bones and soft tissues excess vitamin K could lead to hemolysis and hemolytic aneamia.

Ascorbic acid should be increased from 45 to 60 mg/dl during pregnancy because it is essential for collagen formation which is uptake in rapid growth process. Vitamin C aids absorption of iron in the GIT.

Folic acid is increased from 400mcg to 800mcg in order to prevent macrocytic and megaloblastic anemia. It has a growth promoting factor besides being a hematopoietic factor.

Its role in nucleic acid formation which is essential for the rapid cell multiplication in the fetus. Folacin deficiency is not as common as iron deficiency during pregnancy. Folacin is obtained from vegetables but over cooked vegetables have little content.

Prenatal administration of vitamin K is recommended as a prophylaxis against hemorrhagic disease of the new born.

MINERAL REQUIREMENT

Minerals must be increased in the diet especially during the 2nd and 3rd trimester

IRON REQUIREMENT

Iron deficiency is one of the most common nutritional deficiencies often considered with folacin since both of them are involved with maternal blood forming system. That notwithstanding the normal full term infant has sufficient stores of iron at birth to meet its requirements for the first 4-6 months.

The total amount of iron needed for the entire pregnancy period is 480-680mg. A pregnancy woman consuming 2400 KCal/day would ingest 12-15 mg/day. The recommended level of supplementation is 30-60mg ferrous iron/day. The unabsorbed iron forms a black colour on the stool, it could also precipitate either constipation or diarrhea. Uptake vitamin C increases iron absorption.

Most of the calcium is utilized in late pregnancy when calcification of the fetal skeleton occurs. The RDA for calcium is 1200mg/day. When protein and calcium requirements are met, it is likely that phosphorus requirement (1200mg/day) will also be met. However, the vitamin D requirement must be met for this to occur. Therefore the vitamin D requirement of 400I.U per day must be met by ingesting vitamin D fortified foods or its supplement.

Nacl Requirements

The common salt should be taken *ad libitum* throughout pregnancy. Excess sodium is not recommended since it is a contributory factor to toxemia of pregnancy. In recent years the concept of limiting Na intake in order to decrease the incidence of pre-eclampsia and hypertension in later life has increased popularity. Edema is one of the signs of pre-eclampsia.

Iodine requirement

It is required in microgram qualities but it is essential for successful reproduction because of its role in the formation of thyroxine which is responsible for the increased BMR. The RDA for iodine is 125mcg/d and can be met by consuming good food sources including sea foods and iodized salt. A high incidence of goiters has been noted in Sokoto, Ondo, Ekiti, Borno, Ogoja, Oyo, Borgu and old Kebbai province of Nigeria where the soil is iodine deficient.

CONCLUSION

The diet of a pregnant woman must be planned carefully to include foods of high nutrient digestives. The increased need for nutrients is proportionally greater than the increase in calories which must supply them.