



BLOCK 3
NUTRITIONAL ANTHROPOLOGY

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UNIT 7 ASSESSMENT OF NUTRITIONAL STATUS

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Learning Objectives

After reading this unit, you will:

- learn the different methods for assessing the nutritional status;
- determine the type and distribution of malnutrition in different geographical areas;
- follow to initiate nutritional intervention program to meet the community needs; and
- be able to measure the effectiveness or impact of nutritional programs on the overall health of the community.

7.0 INTRODUCTION

Nutritional status of an individual or a community is assessed by various methods and approaches to identify the nutritional problems going on with the children, with their mothers and other individuals (adults) living in your centre of population. Nutritional Status Assessment of a community is one of the first step in the formulation of public health strategy to combat malnutrition. By assessing the nutritional status, we can identify the “at risk” groups or populations and also determine the contributing factors.

Nutritional status is a powerful indicator of functional and survival process that is a systemic and planned collection process, and thus interprets the information derived from it in order to make informed decisions about the nutritional related health issues. This is a different approach from nutritional screening method that can be performed by any medical/health care practitioner and results to a nutritional assessment of an individual by a dietician.

As we have discussed above, assessing the nutritional status of an individual is the conclusion of various factors and parameters which are inter-related to each

other. It is subjective and influenced primarily by the quantity and quality of food intake and physical health. Thus, nutritional status can lead to both obesity and severe undernutrition.

7.1 METHODS OF NUTRITIONAL ASSESSMENT

There are numerous ways in which nutritional status can be assessed. Following are some of the methods used:

- 1) Anthropometric method
- 2) Biochemical method
- 3) Clinical method
- 4) Dietary intake method.

Let's study them in detail for better understanding.

7.1.1 Anthropometric Method

The term "Anthropometry" is derived from two Greek words which are *Anthropos* that means human and *metry* means measurement. This reflects changes in the morphological variation due to inadequate food intake or malnutrition. Anthropometric measurements can be used to determine the changes/growth in the composition of body of an individual. The compositions of the body is referred as the anatomical body design in relation to its bone, fat and water in muscles. By determining a single parameter you cannot get a full comprehensive overview of the individual's situation. There are different anthropometric measurements used to assess the growth and changes in the body composition.

Nutritional Status of Children

Malnutrition in childhood is a huge crisis that is caused by a number of factors such as insufficient intake of food, diseases and harmful practices in childhood, and improper care during illness. All these factors contributes to poor health and results in millions of deaths annually. It has also been reported that it also affects the changes related to growth and the mortality and morbidity in following years of life. The initial years of life are the most important ones because this is the time when the development of body takes place both mentally and physically and the body is susceptible to various diseases and illnesses. Indian children are majorly malnourished but then which are factors behind this fact? The factors contributing to this fact are increase in population i.e., overpopulation, environmental damage, poverty, gender inequality, improper education, and non-accessibility of medical care facilities. In India, the poverty incidence is a matter of concern whose major cause is malnutrition. The malnutrition restricts the availability of food amount to children, lack of minerals, vitamins and nutritional value that results in the body's low weight and stunting of the body. Different anthropometric measurements can be used to assess growth such as head circumference, mid upper-arm circumference, length/height, weight and chest circumference.

Using anthropometry, you can supervise child's health as it is a crucial component that can epidemiologically assess the nutritional status of a definite population of children. Anthropometric charts are used in hospitals related to public health,

feeding programs and nutritional surveys and community health in medical practitioner's offices to identify individuals with growth or nutritional abnormalities.

Length/height

As we all know, that the height of an individual is influenced both by genetic as well as the environmental factors. Though the maximum growth of an individual is determined by the hereditary factors, environmental factors always play a pivotal role in determining the extent of exploitation of the genetic potential. Proper nutrition and morbidity are the most important contributory factors of environment. Height of a child or children are affected only by long term nutritional deprivation.

In children below the age of two years who cannot stand properly, the length i.e. the crown-heel length can be measured with the help of an infantometer. In the older children or adults, height can be measured either with a stadiometer or a portable anthropometer.

Weight

Body weight is the most sensitive, widely used and simplest anthropometric tool for the evaluation of the nutritional status. Different types of scales are used for different age groups.

To measure the age of the children under two years old, you can use a weighting sling or spring balance, also known as the 'salter scale' to the nearest 0.1 kg. In children over two years and also in adults, beam balances are extensively used and the measurement is also taken to the nearest 0.1Kg. You need to calibrate the scales periodically for accuracy with known weights. The weight of the individual should be taken with minimum clothing and without shoes. You should always check the zero error of the weighing scale before taking the weights and it should be re-adjusted as and when required.

Mid- Upper Arm Circumference (MUAC)

Mid- Upper Arm Circumference is an accurate way to measure fat- free mass. This factor helps determine the development of muscles that is a good tool for screen and determining the risk of mortality in children. In order to assess the nutritional status, MUAC is quite easy to use, non-invasive and a simple technique for assessing large number of at community level for community- based intervention programme.

The MUAC is the upper arm circumference, that is the midpoint present between the shoulder tip i.e., the tip of the acromion of scapula to the elbow tip i.e., the tip of the olecranon of the fore arm of the left arm.

Head and Chest Circumference

The circumference of a head measured along with the forehead in the anterior position i.e., the supra orbital ridge and the optical prominence i.e., the major region of the head's back part in a posterior direction. The head circumference can be measured using a flexible and stretchable tape to the nearest millimetre. As we all know, the head size relates to the size of the brain. The size of the brain increases rapidly during infancy. Therefore, you can use head circumference as a useful tool to access chronic nutritional problem in children under two years.

On the contrary, the chest circumference in a normally nourished child grows even faster than head during the second and third year of life. Now, the chest circumference overtakes the head circumference by about one year age. But, in a protein energy malnourished child, the head circumference remains to be higher than chest circumference even at the age of 2.5 to 3 years due to poor growth of the chest. The circumference of chest is measured from the level of nipple, specifically in the mid inspiration.

Nutritional Indices in children

Nutritional indicators are an important aspect in this assessment of nutritional status. Majorly, there are three under-nutrition indicators used: i.e.

- ❖ stunting (low height for age),
- ❖ underweight (low weight for age) and
- ❖ Wasting (low height for weight)

to evaluate the nutritional status of the subjects.

An index is defined as the combination of two measurements and the combination of one measurement and the age of an individual. You have to understand the different indices which will be helpful to you to assess the growth of the child.

- ❖ Weight for age: Weight for age is an index used for assessing growth in the children. A child whose weight is less than the weight of the reference child of the same age is considered as underweight.

- o
$$\text{Weight-for-age} = \frac{\text{weight of the child}}{\text{weight of the reference child of the same age}} \times 100$$

- ❖ Height for age: Height for age is an index used for assessing low height for age (stunting) i.e. chronic malnutrition in children.

- o Stunting is a kind of impaired growth and development that children might experience from poor nutrition and this factor is defined as a child's low height when compared to the standard child having the same age.

- o
$$\text{Height for age} = \frac{\text{height of the child}}{\text{height of the reference child of the same age}} \times 100$$

- o Stunted children are found to have decreased mental and physical productivity. Stunting of children in a particular population reflect their poor socio-economic status and it also helps determine the children who have experienced from chronic malnutrition and has affected their growth linearly.

- ❖ Weight for height: This is an index parameter used for the assessment of accute malnutrition i.e., wasting among the children. Weight for height is an age independent index.

- o Wasting is defined as low weight for height of the child compared to the standard child of the same height.

- o
$$\text{Weight for height} = \frac{\text{child's weight}}{\text{weight of the reference child of the same age}} \times 100$$

- o Wasted children are found to be more susceptible to infection and face greater risks of mortality.
- Body mass index: Body Mass Index is the child's weight measured in kg divided by the child's height measured in metres squared. You can evaluate the growth of the child by accurately measuring the height and the weight and then calculate the body mass index of the child.

Table 7.1: Cut-off values based on percentiles used for the classification of nutritional status

Nutritional status based on BMI	BMI values Cut-off
Underweight	< 5 th Percentile
Healthy weight	≥ 5 th Percentile to < 85 th percentile
Overweight	≥ 85 th Percentile to < 95 th Percentile
Obese	≥ 95 th Percentile

Source: CDC, 2000

Now, if you wish to assess the nutritional status of a group of population by using anthropometry as a tool, you first need to record the anthropometric measurements and then compare it with the pre-determined specific cut-off values of the anthropometric indicators.

What do you see is an indicator?

An indicator is defined as an index having the specific cut-off values that helps to determine the nutritional status of a child i.e. whether underweight or malnourished. For example, weight for age or weight for height that we have discussed above.

You can use anthropometric indicators not only to assess the nutritional status but also

- ❖ To evaluate the effects of nutritional intervention programme.
- ❖ To initiate or admit children to the programme.
- ❖ To discharge children from the programme.
- ❖ To plan effective nutrition interventions.
- ❖ Helpful for policy makers and other public health programmes.

Three commonly used undernutrition indicators used to evaluate the nutritional status of children are:

- ❖ Stunting (ST)
- ❖ Underweight (UW)
- ❖ Wasting (WS)

The children are thus considered to be underweight, stunted and wasted respectively, when the z-scores pertaining to weight for age, height for age and weight for height were found to be less than -2 SD. This is based on the conventional international guidelines provided by World Health Organization (WHO, 2006) which is shown in the table below:

Table 7.2: Anthropometric indices and cut-off points for children to assess the severity of Malnutrition

Indicator	Meaning	Cut-off points	What it indicates
Underweight	Low weight-for-age(WAZ)	< -2SD	Moderate UW
		< -3SD	Severe UW
Stunting	Low height-for-age(HAZ)	< 2SD	Moderate malnutrition (MAM)
		<-3 SD	Severe Chronic Malnutrition (SAM)
Wasting	Low weight-for heightWHZ	< -2 SD	Moderate acute malnutrition
		< -3SD	Severe acute malnutrition

Source: WHO, 2006

Underweight, stunting and thinness are often diagnosed by comparing the weight, height and mid-arm circumference respectively of an individual with the anthropometric norms for the corresponding age in that community. Protein Energy Malnutrition (PEM) may be classified according to the severity, course and the relative contributions of energy or protein deficit. Assessment of children can be done by using anthropometric measurements (Srilakshmi, 2010).

Table 7.3: Anthropometric Measurements of Normal and PEM children

Measurement Rao index wt in kg/ (ht in cm) ² x 100 Skinfold thickness	Normal >0.15 >10 mm	PEM <0.15 <6 mm
Bangle test- 4.0cm in diameter	Does not pass	Passes above the elbow
Mid-arm circumference	16 cm	13.5cm – mild 12.5cm – Moderate <12.5cm –Severe
Kanawati index MUAC/Head Circumference	>0.32	0.28-0.32 – Mild 0.25-0.28 – Moderate <0.25 – Severe
Chest Circumference/ Head Circumference	>1.0	<1.0
Ponderal index*wt/ht ³	>2.5	2.0-2.5 – Borderline <2.0 – Severe

Source: Mukherji et al., 2009

Nutritional status of adults

You can assess both under and over nutrition and body composition (fat patterning) of an adult by using different anthropometric measurements like weight and height of the body, mid upper arm circumference, waist circumference, hip circumference and various skinfold measurements.

While assessing the composition of body i.e., the fat content, some of the parameters to be considered such as the body is made up of two compartments: the fat mass and the fat free mass. Consequently, the different anthropometric measurements can be used for the assessment of these two segments.

Nutritional indices in adults

- a) Measurements of fat mass: Body Mass Index: As you have already read earlier about BMI. Body Mass Index (BMI) is the person’s weight measured in kilograms divided by the height of a person that is metres squared. BMI is a measure to assess fat mass. The table below shows the cut-off values of BMI (WHO, 1995) for assessing adult nutritional status.

Table 7.4: Cut-off values of BMI for assessing adult nutritional status

BMI (Kg/m ²)	Nutritional status
>40.0	Very obese
30.0-40.0	Obese
25.0-29.9	Overweight
18.5-24.9	Normal
17.0-18.49	Mild Chronic Energy Deficiency
16.0-16.9	Moderate Chronic Energy Deficiency
<16.0	Severe Chronic Energy Deficiency

Source: WHO, 1995

An adult individual with BMI < 16.0 Kg/m² is likely to have poor energy stores which in turn will lead to poor physical activity or output. Moreover, those adults will be at the increased infection risk because of the impaired immunity. The risk associated with the morbidity and mortality escalates with the decrease in BMI. The risk of mortality and morbidity increases with decrease in BMI and also increase in BMI. Thus the relationship between BMI and the risk of morbidity and mortality is well established. Evidence shows that high BMI is associated with type 2 diabetes and high risk of cardiovascular morbidity and mortality.

Central/Abdominal obesity:

Waist Circumference: While measuring waist circumference, the subject is allowed to stand erect and in a straight position with relaxed abdominal masses, arms at the side and feet together you can measure the waist circumference at the level of the umbilical to the nearest 0.5 cm. The measurements have to be taken at the end of a normal expiration.

Table 7.5: Cut-off value of WC determines the individual’s risk

Male	Status	Female
<102 cm	Normal	< 88cm
≥102 cm	Risk	≥ 88cm

Source: WHO-2008

The individual at risk denotes obesity and requires weight management to reduce morbidity and mortality by minimizing the risk of Type 2 diabetes and CVD complications.

Hip Circumference: You can measure the hip circumference at the point of greatest circumference around hips and buttocks to the nearest 0.5 cm. Both the WC and HC should be taken with a flexible and non-stretchable tape.

The Waist- Hip ratio (WHR) is an index to assess the central or abdominal obesity. The WC measured in cm is divided by the HC also measured in cm to obtain the WHR index.

Table 7.6: Cut-off values of WHR

Male	Status	Female
<0.90	Normal	<0.85
≥ 0.90	Risk	≥ 0.85

Source: WHO-2008

A WHR determines the risk of the individual. The higher values indicate central obesity i.e., the fat deposition on the upper body part and is considered in case of high risk for diabetes and cardiovascular disease.

Skinfold measurements (regional fat mass):

- a) By using the skinfold calliper, you can measure the fat layer by picking the skinfold between the thumb and the fore finger. Based on the site of skinfold measurements, regional adiposity is determined. Some of the common skinfolds used quite often are the bicep skinfold, triceps skinfold, sub-scapular skinfold, abdominal skinfold, suprailiac skinfold, midcalf skinfold, etc.
- b) Measurement of fat free mass: You can accurately measure the fat free mass by measuring the mid upper arm circumference (MUAC). MUAC is a very simple, non - invasive and easy measure to screen a large number of people at community level. You have already studied the procedure to measure MUAC. MUAC is the only anthropometric measurement for assessing the nutritional status of the pregnant women. The cut-off values of the MUAC are given below.

Table 7.7: MUAC- Cut-off Values

Category	Range (cm.)	
	Male	Female
Normal	≥ 23	≥ 22
Undernourished	< 23	< 22

Source: Tang et al. 2017

1) What do you understand by nutritional assessment?

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7.1.2 Biochemical Method

Prior to clinical manifestation, any type of deficiency disease can be assessed by biochemical changes or by biochemical methods. The biochemical tests can be done on the easily accessible body fluids such as blood and urine which can help to diagnose disease at the sub-clinical stage. If the symptoms are non-specific during clinical diagnosis, the biochemical tests confirm the result or the deficiency disease.

Haemoglobin estimation is a most important bio-chemical test and a useful index to assess the entire nutritional status of an individual. Apart from anaemia, this approach also determines the protein and trace element nutrition. The stool examination of an individual identifies the presence of ova and/or intestinal parasites. The urine should be examined for albumin and sugar. The biochemical tests measure the nutritional concentration of an individual in body fluid such as vitamin D, serum retinol, serum iron. It can also can detect abnormal amount of metabolites in urine (e.g. urinary creatine, urinary iodine).

What are the advantages of using biochemical method of nutritional assessment?

- Biochemical method is very useful during the detection of initial changes in the metabolism of body and nutrition before it becomes too late or till the appearance of the clinical signs.
- It is an invasive method but very precise and accurate.

There are certain limitations also as:

- it time consuming
- it very expensive
- it cannot be applied on large scale
- biochemical assessment requires trained personnel & facilities

7.1.3 Clinical Method

At community level, clinical methods are the most simplest and practical approaches to ascertain the nutritional status. You will come across many people having problems related to nutritional deficiencies during a community health service programs. Clinical signs and symptoms can also be assessed that indicates the particular deficiency in nutritional status. If you find two or more clinical signs characteristics of a definite deficiency disease then their diagnostic chance is greatly enhanced.

An illness of a person might increase the malnutrition risk because increase in energy needs, reduction in the intake of energy and increase in the nutritional losses. Some of the examples of the diseases which might occurs in this state are,

- ❖ Heart stroke/failure
- ❖ Cancer
- ❖ Gastrointestinal diseases (GI)
- ❖ Surgeries, trauma and burns
- ❖ Mental disorders such as depression

Sometimes, few symptoms might also impact the nutritional status of an individual either by reducing the intake of nutritional supplements or by increasing the losses related to nutrition that includes:

- ❖ Lethargy
- ❖ Dysphagia
- ❖ Upper GI upset
- ❖ Diarrhoea and constipation

Since this is an essential feature of all nutritional survey, a good nutritional history is to be obtained. General clinical examination of the hair, mouth, gums, nails, skin, eyes, tongue, thyroid gland etc. has to be carried out carefully. Thus, relevant signs and symptoms will identify malnutrition and deficiency of vitamins and micro-nutrients.

The Clinical method of nutritional assessment is very advantageous than the other two methods because it is :

- ❖ fast and easy to perform
- ❖ not much expensive
- ❖ a non-invasive method

The clinical method of nutritional assessment has certain limitations too. The first and foremost is that it does not detect early cases.

7.1.4 Dietary Intake Method

Dietary intake method is the best indicator to assess the nutritional status of an individual or a community. An adequate or balanced diet is required to meet the overall nutritional need of an individual i.e., for growth, maintenance, repair, living processes and overall health. Inadequate diet or nutritional intake causes many adverse effects on the growth and health of the individuals. The dietary intake of an individual or a community is assessed by 24-hour recall method. According to NIN guidelines (National Institute of Nutrition, ICMR), Recommended Dietary Allowances (RDAs) are the levels of intake of essential nutrients required to meet the nutritional needs of all healthy individuals in a particular life stage and gender group.

2) Explain briefly the different methods of assessing the nutritional status.

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7.2 SUMMARY

Assessment of nutritional status of a community is an important screening tool for the formulation of any public health strategy in order to combat malnutrition. By assessing the nutritional status, we can identify the “at risk” groups or populations and also determine the contributing factors. So determining the individual’s nutritional status is sometimes the result of various inter-related parameters. They are influenced primarily by the quantity and quality of food intake and physical health.

Nutritional status can be assessed by four methods- Anthropometric methods, Biochemical methods, Clinical methods and Dietary methods. We have also discussed that in order to supervise child health and the epidemiological determination of the nutritional status of a set population, anthropometry is considered as an essential component. Therefore, there are various parameters available related to it that helps assist in the individual identification with growth or associated nutritional abnormalities. The parameters are: use of anthropometric charts in public health clinics, health and nutritional surveys and supplemental feeding programs. Three commonly used undernutrition indicators, i.e. stunting (low height for age), underweight (low weight for age) and wasting (low height for weight) were used to evaluate the nutritional status of the children. Both under and overnutrition and body composition (fat patterning) of an adult is assessed by using different anthropometric measurements like height, weight, mid upper arm circumference, waist circumference, hip circumference and various skin fold measurements. Prior to clinical manifestation, any type of deficiency disease can be assessed by biochemical changes or by biochemical methods. The biochemical tests can be done on the easily accessible body fluids such as blood and urine which can help to diagnose disease at the sub-clinical stage. If the symptoms are non-specific during clinical diagnosis, the biochemical tests confirm the result or the deficiency disease. This is the most flexible, simple and the practical method for determining the nutritional status at community level. If there are two or more clinical signs characteristics of a definite deficiency disease then their diagnostic chance is greatly enhanced. Since this is an essential feature of all nutritional survey, a good nutritional history is to be obtained. General clinical examination of the hair, mouth, gums, nails, skin, eyes, tongue, thyroid gland etc has to be carried out carefully. Thus, relevant signs and symptoms will identify malnutrition and deficiency of vitamins and micro-nutrients.

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7.4 ANSWERS TO CHECK YOUR PROGRESS

- 1) Nutritional status of an individual or a community is assessed by various methods and approaches to identify the nutritional problems going on with the children, with their mothers and other individuals (adults) living in your centre of population. Nutritional status assessment of a community is one of the first step in the formulation of public health strategy to combat malnutrition. By assessing the nutritional status, we can identify the “at risk” groups or populations and also determine the contributing factors.
- 2) There are numerous ways in which nutritional status can be assessed. Following are some of the methods used commonly: Anthropometric method; Biochemical method; Clinical method and Dietary intake method. Refer to section 7.2

UNIT 8 CONCEPT OF BALANCED DIET

Contents

- 8.0 Introduction
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- 8.2 Importance of Diet During Different Stages of Life
- 8.3 Healthy Lifestyle
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 - 8.5.2 What Do We Mean by Recommended Dietary Allowance (RDA)?
 - 8.5.3 RDA and its Implication at the Population Level
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 - 8.5.5 The General Principles of Deriving RDA (ICMR)
 - 8.5.6 Why do We Need Country-Specific RDA's?
- 8.6 Summary
- 8.7 References
- 8.8 Answers to Check Your Progress

Learning Objectives

Once you have gone through this unit, you will know:

- what is balanced diet and importance of diet during different stages of life;
- about healthy lifestyle;
- the benefits of a balanced diet according to WHO; and
- details about Recommended Dietary Allowance.

8.0 INTRODUCTION

According to the definition of WHO (1948) “Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity”. Health has been an important factor in the past and is now as well. A person may be physically healthy but if he/she does not have a sound mind, he/she cannot be termed as a healthy person. Here, we are trying to reinforce the well-known phrase “*Health is Wealth*”.

One of the most important yardsticks of good health is balanced diet. In every country the health system carries the herculean task to guarantee good quality and well-nourished food to the population in order to have a healthy population, this task needs to be quantified in terms of grade for measuring the impact and specification to fix the yardstick.

Recommended Dietary Allowances (RDAs) are one such important yardstick to be followed for health and wealth of the population. However, the Recommended

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Dietary Allowances (RDAs) are not widely circulated and they only serve as a standard at the aggregate level (Rao, 2010). Each population has different nutrient requirements of an individual and also different dietary allowances as well. We know that the nutrient requirements of an individual depend on age, gender, body weight and his/her physiological and metabolic status. At the individual level there are variations within the group which need to be considered for dietary allowances. The preparation of dietary allowances takes into consideration factors like the outcome of food processing, bio-resources availability of the nutrient from the diet and the quality of diet (ICMR, 2010).

Check Your Progress 1

- 1) What is health?

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8.1 DEFINITION OF BALANCED DIET

A balanced diet is a diet which has the following essential components, which are mainly:

- 1) Carbohydrate
- 2) Fats
- 3) Vitamins
- 4) Minerals
- 5) Water

Besides, Omega-3 fatty acids are essential for the proper functioning of the body.

Each specific nutrient has a role in decreasing the risk of chronic diseases. There are numerous evidences which support the utility of healthy dietary patterns that emphasize whole grain foods, legumes, vegetables and fruits. Also, consumption of limited refined starches, red meat, full fat dairy products and foods and beverages which is high in added sugar. Such diets have been associated with decreased risk of a variety of chronic diseases.

As recommended by World Health Organization (WHO) eating lots of fruits and vegetables, reducing fat, sugar and salt intake and exercising are important habits to lead a healthy lifestyle. There are many obesity markers like waist-hip ratio (WHR), waist-height ratio (WHtR), waist circumference, mid upper arm circumferences (MUAC), body mass index (BMI), etc. These are non-invasive and the most widely used markers to identify obesity. A person can check his/her body mass index (BMI), which is based on height and weight and see whether a person is underweight/normal/overweight/obese. The formula to compute BMI is weight in kilogram (kg) divided by height in meter square (m²). The unit for

BMI is kg/m² Besides these, the World Health Organization provides series of publications to encourage and support healthy lifestyle.

According to ICMR (2003), a balanced diet is food which provides all the required quantity of nutrients and in the right proportions to maintain good health which is devoid of diseases. A balanced diet can be easily achieved through a blend of four basic groups. These four basic groups are factors like age, gender, physical activity and physiological status and they serve as important features i.e. the quantities of foods needed by an individual entailed to meet the nutrient requirements for a healthy life. Balanced diet is established on a food composition which mainly aims to provide around 60-70% of the total calories from carbohydrate which is preferably starch, about 10-12 % from proteins and 20-25% from fat sources. In addition to these, there are requirements of other non-nutrients such as dietary fibre, antioxidants and phytochemicals which gives positive health benefits and should also be included in a balanced diet. Vitamin C, vitamin E, beta carotene, riboflavin and selenium are antioxidants which are essential for the proper growth and maintenance of the body. They also protect the human body from free radical damage. Besides, there are some spices such as turmeric, ginger, garlic, cumin and cloves which are rich in antioxidants and are also important in maintaining health and wellbeing.

Table 8.1: Three Different Types of Foods and its Nutrients

Type of Food	Major Nutrients	Other Nutrients
Energy Rich Foods	<p>Carbohydrates and fats Whole grain cereals, millets</p> <p>Vegetable oils, ghee, butter</p> <p>Nuts and oilseeds Sugar</p>	<p>Protein, fibre, minerals, calcium, iron vitamins like B-complex</p> <p>Fat-soluble vitamins, essential fatty acids</p> <p>Minerals, Proteins & Vitamins</p>
Body Building Foods	<p>Proteins Pulses, oilseeds and nuts</p> <p>Milk & milk products</p> <p>Meat, fish & poultry</p>	<p>B- complex vitamins, invisible fat, fibre</p> <p>Calcium, Riboflavin Vitamin A & Vitamin B₁₂</p> <p>B- complex vitamins, iron, iodine, fat</p>
Protective Foods	<p>Vitamins and minerals Leafy green vegetables</p> <p>Other vegetables & fruits</p> <p>Eggs, milk & milk products</p>	<p>Antioxidants, fibre and other carotenoids</p> <p>Fibre, sugar and antioxidants</p> <p>Protein and fat</p>

(Source: ICMR, 2003)

Check Your Progress 2

2) What is a balanced diet?

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3) What are the three different types of foods?

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4) What are the major nutrients for energy rich foods?

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5) What are the major nutrients for body building foods?

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6) What are the major nutrients for protective foods?

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8.2 IMPORTANCE OF DIET DURING DIFFERENT STAGES OF LIFE (ICMR, 2003)

- The diet for a person who is physically active and healthy should comprise of nutrient dense low fat foods.
- The diet to improve productivity and disease prevention related to diet and to support pregnancy and lactation: To improve health, a person actually requires a diet which is nutritionally adequate. During child bearing/rearing the mother should be loaded with extra food and nutrients.
- The diet for adolescent growth spurt, maturation and bone development: During this stage the body requires body building foods akin to protein and protective foods like vitamins and minerals.
- The diet for growth and development and to fight infections: Energy, body building and protective foods like milk, vegetables and fruits.
- The diet for growth and appropriate milestones: Breast milk, energy rich foods like fats and sugars.

8.3 HEALTHY LIFESTYLE

What do we mean by a healthy lifestyle and how do we lead a healthy lifestyle?

A healthy lifestyle is one which helps to keep and improve people's health and well-being (WHO, 2005).

Some of the ways to lead a healthy lifestyle are as follows:

- A person should eat a nutritious diet based on a variety of foods originating mainly from plants, rather than animals.
- A person should preferably eat bread, whole grains, pasta, rice or potatoes several times per day.
- A person should eat a variety of vegetables and fruits, preferably fresh and local, several times per day (at least 400g per day).
- A person should maintain body weight between the recommended limits (BMI of 18.5 kg/m^2 – 25 kg/m^2 as per International BMI standard and 18.5 kg/m^2 – 23 kg/m^2 as per Asian standard of BMI classification) by engaging in moderate to vigorous levels of physical activity which can be preferably daily. This is a reminder of a famous saying "*all work and no play makes Jack a dull boy*". Moreover, the increasing screen time among people of all ages have added to the increased number of obese persons.
- A person should control intake of fat (not more than 30% of daily energy) and replace most saturated fats with unsaturated fats. This is often hindered by the increased consumption of fast foods.
- A person should replace fatty meat and meat products with beans, legumes, lentils, fish, poultry or lean meat.
- A person should use milk and dairy products (kefir, sour milk, yoghurt and cheese) which are low in both fat and salt.
- A person should select foods that are low in sugar, and sparingly eat free sugars, limiting the frequency of sugary drinks and sweets.

- A person should choose a low-salt diet. The total salt intake should not be more than one teaspoon (5g) per day per person, including the salt in bread and processed curd and preserved foods. Preserved foods mostly contain more salt and so should be consumed in limited quantity.
- Evidence shows that the ideal solution for health is not to drink alcohol at all but World Health Organisation (WHO) does not set any particular limits for alcohol consumption but less is better.
- Food should be prepared in a safe and hygienic way. A person should consume foods which are preferably steamed, baked, boiled or microwave to help reduce the amount of added fat.
- For lactating mothers, WHO promotes exclusive breastfeeding upto 6 months, and the introduction of safe and adequate complementary foods from the age of about 6 months. Preferably, it is healthy to promote the continuation of breastfeeding during the first 2 years of life to increase the immunity of a child from diseases.

8.4 BENEFITS OF A BALANCED DIET ACCORDING TO WORLD HEALTH ORGANISATION

An important step towards a happy and healthy lifestyle is to opt for a balanced, adequate and varied diet. Vitamins and minerals play important role in the diet to boost immunity and lead to healthy development of the mind and the body. It has been found that healthy diet can protect a person against several types of diseases and to be specific it can protect from chronic non communicable diseases such as obesity, diabetes, cardiovascular diseases and even some types of cancer. It has also been found to improve mental health. It has been found that there are significant associations between mental disorders and several chronic diseases. These are diseases which are on the rise due to sedentary lifestyle and unhealthy diets. Healthy diets therefore can also contribute to attainment of an adequate body weight and maintenance of health and wellbeing. These days, experimenting with different foods from different cultures will help us to prepare healthy food in different ways. For example: These days boiled/ steamed foods are preferred over fried foods due to its health benefits. Healthy eating is also a good opportunity to enrich life. A balanced diet therefore is an important ingredient of variety and colour and adds to the benefits of eating a wide variety of foods.

8.5 DIETARY STANDARDS

There are specific dietary standards followed by each country:

In India, the Indian Council of Medical Research (ICMR) dietary standards are followed.

8.5.1 Background of ICMR Dietary Standards

The Indian Council of Medical Research (ICMR) which was earlier known as Indian Research Fund Association is the oldest apex body of Medical Research in the country. The ICMR Nutrition Advisory Committee for the first time in the year 1944 advised the nation on dietary requirements (IRFA, 1944). From then on, periodical revisions have been done by the ICMR Nutrition Advisory Committee. Recommended Dietary Allowances (RDAs) characterize the amount

of the nutrient requirements for most of the healthy individuals with moderate physical activity in a particular population which is to be consumed daily. The nutrition Advisory Committee of the then Indian Research Fund Association (now ICMR) in the year 1944 made the first attempt to recommend dietary allowances of energy, protein, iron, calcium, vitamin A, thiamine, ascorbic acid and vitamin D for the Indian population. This was done after following the recommendations of the League of Nations in 1937. This was done as it found that the then existing diets of Indians particularly of the poor were inadequate in several aspects and could be improved by the inclusion of certain protective foods. It has been a practice since ages that the Food and Agricultural Organization (FAO) gave recommendations of energy and protein requirements. Following this, ICMR in the year 1958 attempted to define protein and calorie requirements for Indians based on the available data.

In 1968, the requirements of all the nutrients except energy for the Indians were reviewed and recommendations on dietary requirements were prepared by ICMR constituted expert Committee. The combined data of the International data by the joint FAO/WHO Expert groups and those generated in India were made use of in the year 1978. Another Expert group of the ICMR again reviewed the Recommended Dietary Allowances (RDAs) and following this, RDAs for several nutrients were revised. Energy allowances for Indians recommended in 1958 have not been revised so far although the RDA's for proteins and other nutrients were revised in 1968 and 1978. On the basis of the newer data generated in India, an Expert Committee was constituted in 1988 by the ICMR to review the 1078 recommendations and update the RDA whenever necessary. Several additional nutrients or dietary factors like dietary fibre, electrolytes, phosphorus, vitamin E and vitamin K which were not considered by the earlier Committee were included in the newer data. In 1988, some nutrients for example: certain trace elements, electrolytes (sodium and potassium), magnesium and phosphorus, two other fat soluble vitamins i.e., vitamin E and vitamin K and dietary fibre were considered for the first time.

Table 8.2: Reference value of body weight (kg) of Indians employed for computing Recommended Dietary Allowances (RDAs), 2010

Group (unit)	Age	Reference value of body weight (kg)
Infants (months)	0-06	05.4
	07-12	08.4
Children (years)	01-03	12.9
	04-06	18.0
	07-09	25.1
Boys (years)	10-12	34.3
	13-15	47.6
	16-17	55.4
Girls (years)	10-12	35.0
	13-15	46.6
	16-17	52.1
Adult man (years)	18-29	60.0
Adult woman (NPNL) (years)	18-29	55.0

Source: ICMR, 2010

As has been mentioned in the Report (ICMR, 2010), the Committee has defined a reference of man and woman for the calculation of the requirements. The Committee considered adults of both sexes within the age group of 18-29 years with normal body mass indices for this purpose. This study, it has been envisioned that there is importance of apparent health of the individual and fixed routine with adequate rest. It was found that good health was in concordance with the moderately active reference man and woman but this finding was a major deviation from the findings of the previous Committee. The adult women considered in Table 2 were only non-pregnant and non-lactating (NPNL) women.

8.5.2 What Do We Mean by Recommended Dietary Allowance (RDA)?

For different age groups of a population a scientific data is required to prepare a Recommended Dietary Allowance (RDA), which is the estimated amount of a nutrient (or calories) per day considered necessary or recommended for the maintenance of good health.

Check Your Progress 3

7) What is Recommended Dietary Allowance (RDA)?

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8.5.3 RDA and its Implication at the Population Level

We are now clear that the Recommended Dietary Allowances (RDAs) is the foundation to discuss nutrients need for at least 90 percent or more of the healthy population to build healthier diets within energy (calorie) goals. At the aggregate level, RDAs are used to compare the nutritional value of foods and formulating dietary guidelines. They also play important role in proper policy planning and implementation. For example: For fixing the amount of rations, fixing minimum wages of workers and in monitoring how the food supply chain works to meet the nutritional needs of the population. It is also useful to study trends and evaluate the change in diets over time, planning for agriculture and food production and security, and import and export of food.

Here, one needs to be clear that RDAs do not form the basis for diet planning and diet assessment at the individual level. But these can be used to plan healthy meals for groups/ populations. Each country has a country specific nutrient requirements and Recommended Dietary Allowances. In India, RDAs have been providing policy directions and they have been used to guide the State Governments and public agencies to operationalize food assessment and nutritional assistance like the Public Distribution System (PDS), Integrated Child Development Services (ICDS), Midday Meal Scheme (MDM); it is also used for monitoring the food industry, the scientific and regulatory bodies which formulate standards and regulations based on scientific data for the safety of

marketed foods in the country. In the food marketing industry for food labelling and advertisements, RDAs have also been in use extensively. While considering the factors of bioavailability or habitual intake it has been found that RDAs also indicate if there is any requirement for food fortification with regard to fixing the level of food enrichment of the population (Nair & Augustine, 2016). Therefore, for nutritionist and health professionals RDA has been a useful guide and tool to educate, evaluate and monitor public health.

8.5.4 Nutritional Requirement and Recommended Dietary Allowances as per ICMR Guidelines

The Indian Council of Medical Research set and revised periodically the nutrient requirements and recommended dietary allowances (RDAs) of a population. We have already discussed that for a healthy population, the RDAs are used to guide the population and provide policy directions for the country regarding nutrient requirements. It is not an easy task as there are many; the Committee was faced with many challenges to contextualize RDA for the Indian scenario. This could be due to the country's diverse background and the double burden of undernutrition and overnutrition. Moreover, every region or ethnic groups have their own dietary habits where in some groups follow predominantly home-based cereal and vegetarian diet comprised of cereal and pulse which have low content of several nutrients and lesser utilization of fortified food packages. Therefore, owing to the diverse background of each country, globally, there is a call for country specific requirements and harmonization of methodologies associated to nutrient requirements and RDA. Periodical measures are taken for RDA revisions to ensure its sustainability and applicability.

Man needs a wide range of nutrients to lead a healthy, active and quality life; and these nutrients are derived through the diet he/she consumes daily. In order to provide all the nutrients a person needs in adequate amounts and in proper proportions the components of his/her diet must be chosen judiciously. The amount of each nutrient should contain enough for maintaining the prescribed and healthy body weight to ensure that the body functions properly. The maximum amount of nutrients is required during infancy and childhood which is not only for maintenance but also for growth and development. Indeed, infants and young children require relatively 2-3 times more nutrients per kilogram of body weight as compared to adults. Pregnancy and lactation is a stage when the women require additional nutrients to meet the extra demand for total growth of the foetus and maternal tissue expansion during the stage of pregnancy and later milk secretion for the period of lactation.

There are certain general principles for determining the dietary allowances of different groups/population. The general principle for deciding on the nutritional requirements of an individual and the dietary allowances for a group or a population are distinctly diverse. Determining the nutritional requirements of an individual depends upon the age, body weight, the physiological and metabolic status. However, determining the dietary allowances for a group or a population must also take into account individual variation within the group, the quality of the diet, the effect of cooking and processing and the bioavailability of the nutrients.

Check Your Progress 4

8) Which Committee advised the nation on dietary requirements for the first time in the country?

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8.5.5 The General Principles of Deriving RDA (ICMR)

A number of approaches have been used in arriving at the multinational requirements of an individual and the RDA for a population. The general principles are:-

- **Dietary Intakes:** This approach has been used to determine the energy requirements of children. For this purpose, the energy intakes of healthy children who are normally growing are considered.
- **Growth:** In early infancy stage the requirement of any particular nutrients or the breast milk intake, for satisfactory growth has been utilized for defining requirements.
- **Nutrient balance:** For arriving at the protein requirements nutrient balance in adults and nutrient retention which are consistent with satisfactory growth in children have widely been used. It is also important to maintain the minimum intake of nutrients for equilibrium (intake = output).
- **Obligatory loss of nutrients:** The negligible loss of any nutrient or of its metabolic waste (for eg: nitrogenous end products in the case of proteins) through the natural routes of elimination like urine, faeces and sweat is normally determined on a diet which is totally lacking of nutrient or very low in terms of nutrient contents (eg: a protein free diet). In the course of this process, we can determine the amount of daily nutrient to be consumed through the diet in order to substitute the same due to obligatory loss of nutrients. Infants and children require more nutrients as compared to adults; thus more growth requirements are added for the obligatory loss of nutrients.
- **Factorial approach:** In factorial approach, the requirements for different functions of the body are measured separately, it is then added up to arrive at the total daily requirements. This approach was widely employed earlier as a method for assessing the protein requirement but it is now less in use.
- **Nutrient turnover:** Requirements of vitamin A, vitamin C, iron and vitamin B₁₂ have been obtained from the data from turnover of nutrients in healthy persons by employing isotopically labelled nutrients. Currently compounds labelled with a stable isotope are increasingly being used to determine the nutrient turnover in the body while radio isotopic labelled compounds were utilized earlier. Among infants, children and in women during pregnancy and lactation stable isotopes are particularly useful as radioisotopes are contra indicated among this group.

- Depletion and Repletion studies: Requirements of water soluble vitamins are arrived at by employing depletion and repletion studies approach. In this approach, the levels of vitamins or its coenzyme in serum or tissue are used as a biochemical marker of the vitamin status. By employing this approach requirements of ascorbic acid, niacin, pyridoxine, riboflavin, and thiamine have been established. Response to feeding graded doses of the nutrient is determined by first engaging the subjects are on a diet very low in the nutrient under study till the biochemical parameters reach a low level. An indication of the requirement is obtained when the level at which response increases rapidly.

Table 8.3: Recommended Dietary Allowances for Indians (Macronutrients and Minerals)

Group	Particulars	Body Wt. (kg)	Net Energy Kcal/d	Protein gm/d	Fat gm/d	calcium mg/d	Iron mg/d
Man	Sedentary work	60	2425	60	20	400	28
	Moderate work		2875				
	Heavy work		3800				
Woman	Sedentary work	50	1875	50	20	400	30
	Moderate work		2225				
	Heavy work		2925				
	Pregnant woman Lactation 0-6 months	50	+300	+15	30	1000	38
			+550	+25	45	1000	30
	6-12 months	50	+400	+18			
Infants	0-6 months	5.4	108/kg	2.05/kg		500	
	6-12 months	8.6	98/kg	1.65/kg			
Children	1-3 years	12.2	1240	22	50	400	12
	4-6 years	19.0	1690	30			18
	7-9 years	26.9	1950	41			26
Boys	10-12 years	35.4	2190	54	22	600	3419
Girls	10-12 years	31.5	1970	57			
Boys	13-15 years	47.8	2450	70	22	600	4128
Girls	13-15 years	46.7	2060	65			
Boys	16-18 years	57.1	2640	78	22	500	5030
Girls	16-18 years	49.9	2060	63			

Source: ICMR, 2010

8.5.6 Why do We Need Country-Specific RDAs?

There is a need for each country to have its own specific RDA as each country have their own different food habits, different style and process of cooking and also varied availability of bio resources. Although, the task to unify the guidelines of nutrient requirements appears to be appealing, it is as well very important to comprehend why each country/region needs to contemplate and consciously put in effort to contextualize the Recommended Dietary Allowances (RDAs). That is, the estimates of the nutrient requirements which are presented as the quantity of the nutrient that must be there in the diet consumed daily. As a result, nutrient

Nutritional Anthropology **Table 8.4: Recommended Dietary Allowances for Indians (Vitamins)**

Particulars	Vit. A µg/d		Thiamin mg/d	Riboflavin mg/d	Nicotinic acid mg/d	Pyridoxine mg/d	Ascorbic acid mg/d	Folic acid µg/d	Vit.B ₁₂ µg/d
	Retinol	β caroten-e							
Sedentary work Moderate work Heavy work	600	2400	1.2	1.4	16	2.0	40	100	1
			1.4	1.6	18				
			1.6	1.9	21				
Sedentary work Moderate work Heavy work	600	2400	0.9	1.1	12	2.0	40	100	1
			1.1	1.3	14				
			1.2	1.5	16				
Pregnant woman Lactation 0-6 months	600	2400	+0.2	+0.2	+2	2.5	40	400	1
6-12 months	950	3800	+0.3	+0.3	+4	2.5	80	150	1.5
0-6 months 6-12months	350	1200	55µg/kg	65µg/kg	710µg/kg	0.1	25	25	0.2
			50µg/kg	60µg/kg	650µg/kg	0.4			
1-3 years 4-6 years 7-9 years	400 400 600	1600 2400	0.6 0.9 1.0	0.7 1.0 1.2	8 11 13	0.9 1.6	40	30 40 60	0.2-1.0
10-12 years 10-12 years	600	2400	1.1	1.3	15	1.6	40	70	0.2-1.0
			1.0	1.2	13				
13-15 years 13-15 years	600	2400	1.2	1.5	16	2.0	40	100	0.2-1.0
			1.0	1.2	14				
16-18 years 16-18 years	600	2400	1.3	1.6	17	2.0	40	100	0.2-1.0
			1.0	1.2	14				

requirements are population specific because of their variations in the genetic, environment and socio- demographic characteristics of each population. It has been found that these estimates depend on the nature of the routine or customary diet and the dietary factors which affect the release and absorption of the nutrient. For consideration of nutrients, it is important to note the region- specific phenomena such as the food pattern (which are dietary diversification and culinary practices), the effects of food matrix relating to inhibitory/promoting effects taking into consideration bioavailability and bioconversion. The Indian Council of Medical Research (ICMR, 2010) have used scientific judgement based on several factors like ethnicity, environment/ climate, deficiency and lifestyle, prevalence of disease in the area, physical activity and growth pattern, regional reference body weight changes, etc. One classical example of this can be that a vast majority of the Indian population diet based on cereal- pulse and vegetarian which is largely considered to be low in protein quantity and quality. According to Nair & Iyengar (2009) the Indian diet consist of low bioavailability of iron, which derives >95 percent of iron consumed from the non-heme food sources. This leads to at least 50 percent lower bioavailability as compared to the Western countries i.e. >75 per cent of the food source is assumed to be from heme source (Nair & Augustine, 2018) which therefore translates to a higher RDA for the Indians and

a lower RDA for the Western countries. Even in the case of the requirement for zinc, vitamin B₁₂, vitamin D and provitamin A it is the same which are from food sources (Nair & Augustine, 2018).

8.6 SUMMARY

Health has been an important factor in the past as has been now. To be healthy, a person must consume a balanced diet which comprise of essential components like carbohydrate, fats, vitamins, minerals and water. Therefore, a balanced diet is food which provides all the required quantity of nutrients and in the right proportions to maintain good health which is devoid of diseases. As recommended by World Health Organization (WHO) eating lots of fruits and vegetables, reducing fat, sugar and salt intake and exercising are important habits to lead a healthy lifestyle. In every country the health system carries the herculean task to guarantee good quality and well nourished food to the population in order to be healthy, this task needs to be quantified in terms of grade for measuring the impact and specification to fix the yardstick. The Nutrition Advisory Committee of the then Indian Research Fund Association (now ICMR) in the year 1944 made the first attempt to recommend dietary allowances of energy, protein, iron, calcium, vitamin A, thiamine, ascorbic acid and vitamin D for the Indian population. This was followed by an attempt to define protein and calorie requirements for Indians by ICMR in the year 1958. So over a gap of a decade the Recommended Dietary Allowances have been reviewed according to the need of the population. The Recommended Dietary Allowances (RDAs) is the foundation to discuss the need of nutrients for atleast 90 percent or more of the healthy population to build healthier diets within energy (calorie) goals. RDAs are used to compare the nutritional value of foods and formulating dietary guidelines. They also play vital role in appropriate policy planning and aids in implementation of the policy. It is also useful to study trends and assess the change in diets over time, agricultural planning and food production and security, and import and export of food as well.

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8.8 ANSWERS TO CHECK YOUR PROGRESS

- 1) Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.
- 2) A balanced diet is a diet which has the following essential components are Carbohydrate, Fats, Vitamins, Minerals and Water. Besides, Omega- 3 fatty acids are essential for the proper functioning of the body.
- 3) Energy rich foods, body building foods and protective foods.
- 4) The major nutrients for energy rich foods are carbohydrates and fats viz.; whole grain cereals, millets, vegetable oils, ghee, butter, nuts and oilseeds, sugar.
- 5) The major nutrients for energy rich foods are proteins like pulses, oilseeds and nuts, milk and milk products, meat, fish and poultry.
- 6) The major nutrients for energy rich foods are vitamins and minerals like leafy green vegetables, other vegetables and fruits, eggs, milk and milk products.
- 7) Recommended Dietary Allowance (RDA) is the estimated amount of a nutrient (or calories) per day considered necessary or recommended for the maintenance of good health.
- 8) The ICMR Nutrition Advisory Committee for the first time in the year 1944 advised the nation on dietary requirements.

UNIT 9 IMPACT OF MALNUTRITION

Contents

- 9.0 Introduction
- 9.1 Overweight and Obesity
- 9.2 Impact of Obesity
 - 9.2.1 Metabolic consequences
 - 9.2.2 Cardiovascular consequences
 - 9.2.3 Mechanical consequences
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 - 9.3.1.1 Marasmus
 - 9.3.1.2 Impact of Marasmus
 - 9.3.1.3 Kwashiorkor
 - 9.3.1.4 Impact of Kwashiorkor
 - 9.3.1.5 Mild to moderate protein-energy malnutrition
- 9.4 Summary
- 9.5 References
- 9.6 Answers to Check Your Progress

Learning Objectives

Once you have gone through this unit, you will:

- understand the concept of malnutrition with respect to undernutrition and overconsumption of calories;
- comprehend the impact of obesity on health status; and
- analyze the consequences of protein energy malnutrition in children

9.0 INTRODUCTION

The fundamental cause of mortality and morbidity among children is malnutrition, if someone is not having enough food to eat or more than feeling hungry. In other words, insufficient intake of calories (a measure of energy the body needs), protein (necessary to build muscle and to keep the body healthy), iron (for appropriate blood cell function), and different types of nutrients can cause malnutrition (Saeed et al, 2020).

For proper body functioning, your body needs protein, calories and general vitamins and nutrients to function and the insufficient quantity of nutrition can make your bone brittle. What are calories? Calories are the smallest energy units that help your body to function as our body requires a large amount of protein. Because with the deficiency of proteins, you cannot heal wounds or injuries easily.

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When a person’s intake of energy as well as nutrient imbalances, excesses, or deficiencies, it is referred to as malnutrition. Two types of conditions are covered by the term malnutrition. One is ‘undernutrition which comprises underweight (low weight for age), wasting (low weight for height), as well as stunting (low height for age) and the other is overweight or obesity (Saeed et al, 2020).

The majority of the deaths among children under 5 years age group occurring in low- and middle-income countries are due to undernutrition. Paradoxically, in the same age group, there is a rise in obesity and overweight. There are various impacts of the global burden of the malnutrition on countries such as economic, medical, and social on individuals and their families, for societies, All these impacts are quite serious and long-lasting. As the realize there are several reasons because of which undernutrition can occur. Let’s know the symptoms associated with undernutrition

- Fatigue
- Body weakness
- Diarrhea
- Low body temperature
- Irritability
- Slower breathing
- Wounds and bruises
- Loss of hairs
- Dry skin

The economic, social, and medical impacts of the global burden of malnutrition are serious and lasting, for individuals and their families, for communities, and for countries (World Health Organisation, 2020)

Check Your Progress 1

- 1) Enlist the symptoms associated with undernutrition

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9.1 OVERWEIGHT ANS OBESITY

When an individual becomes too heavy for his/her height then he/she is overweight and obese. In case of excessive or abnormal accumulation of fat in the subcutaneous areas, it can lead to impaired health. Body Mass Index i.e., called BMI that is commonly used to categorize overweight and obesity. This is an index is used to measure the weight-for-height parameter (as shown in table 1). BMI is defined in terms of formula as a weight of a person in kilograms divided by the square of his/her height measured in metres i.e., kg/m². The overweight

factor in the case of adults has defined if the BMI of person is 25 kg/m² or above than this whereas obesity if BMI is 30 kg/m² or above.

Table 9.1: BMI cut offs according to World Health Organization

Classification	BMI (kg/m ²)	Risk of co-morbidities
Underweight	<18.5	Low (but the risk of other clinical problems increased)
Normal range	18.5–24.9	Average
Overweight	>25.0	
Pre-obese	25–29.9	Mildly increased
Obese	≥ 30.0	
Class I	30.0–34.9	Moderate
Class II	35.0–39.9	Severe
Class III	≥ 40.0	Very severe

Source: WHO, 2000

When your body weight increases, it leads to the overweight or obese condition. This condition is the result of an imbalance between the consumption of too much energy and the expansion of energy in a small amount. Nowadays, people are consuming foods and liquids that contain high content of sugar and fat worldwide and also are less involved in physical activity because of the sedentary lifestyle. Being obese or overweight is related to an increased risk of extensive diseases and health complications as well as premature mortality (Caterson, 2002).

For the individual who is being measured, various techniques are available for the measurement of total body fat and this is specifically used for research purposes. Two elaborative techniques are widely becoming available such as bioelectrical impedance (BIA) and Dual X-ray absorptiometry (DEXA). All these measures mentioned have their drawbacks as they are too expensive, time-consuming, and complicated at the same time, for epidemiological research and routine clinical use.

The weight of the body despite being the easiest and cost-effective measure is not sufficient alone to measure adiposity. Thus, BMI calculation helps in providing a reasonable approximation of adiposity and majorly it is used in both research and clinical practice. As per the reports, it is not found to be helpful in aged individuals, very active and muscular individual, and children. The World Health Organization (WHO) recommends the cut-off points for Body Mass Index for clinical use as well as research purpose where studies are done on population. All these studies are performed based on increased risks associated with being obese or overweight.

Another quite common method used to indirectly measure the adiposity level is obtained by following the skinfold thickness measurement from various sites. This measurement requires the skinfold calipers and the observer should be well trained to reduce error while taking measurement. There are some cases in some body areas where obesity has reached a maximum extent that it is not possible to raise or measure a skinfold.

To assess obesity in children, a new international standard has been obtained which involves the age charts for BMI having >95 percentile for obesity and >85 percentile are at major risk. The other measure is also used that is solely based on height and weight growth percentile charts. If a child's health has been followed regularly, then the increase in weight with a greater rate than the predicted one in terms of increase in height with age indicates the major cause of concern. For those children whose health is not being followed up over time, a greater weight level than the estimated from their charts of height (specifically if their height is more than the 95 percentile) represents a potential problem (Caterson, 2002).

9.2 IMPACT OF OBESITY

Undoubtedly, there are adverse health effects associated with obesity. Being overweight is related to a reticent increase in the risk factors and all these risks increase with the rate of obesity. The association of metabolic complications related to obesity with visceral fat is there and with the increase in this repository, the health risks are escalating even if the BMI is found to be in a desirable range. As we know smoking is a major risk for health problems and is an additive to obesity. Even though stopping smoking suddenly also results in weight gain but undoubtedly leaving a smoking habit is better for health rather than to keep continuing it for your weight to decrease. Whilst a decrease in weight is coupled with a decrease in the several risks as described below, yet there is little information and evidence is available, yet that life can be long lasting as research related to weight decrease and longevity have not been on those who have lost weight intentionally. On the other hand, stopping the habit of smoking does show a reduction in the mortality rate. (Caterson, 2002).

9.2.1 Metabolic Consequences

Among overweight or obese, abnormalities in plasma lipids known as dyslipidaemias are common especially in those with increased abdominal fat. This condition gave rise to high triglyceride and cholesterol levels along with HDL and VLDL levels. Sometimes, even a normal cholesterol level can cause vascular damage and atherosclerosis because of the changes in the particles of LDL. All these unfavorable and detrimental changes can be improved by weight loss. Cellular resistance to the action of insulin i.e., called insulin resistance occurs in the case of obesity. This factor is connected with a group of abnormalities such as increased triglycerides level, raised levels of serum insulin, low levels of HDL cholesterol, impaired glucose intolerance or type 2 diabetes mellitus, and changes in some of the factors related to coagulation. They are collectively defined as metabolic syndrome. For diabetes to occur, there must be a simultaneous abnormality in the secretion of insulin, the insulin resistance that is produced by the obesity accumulated in the abdominal region and probably by resist in underlies the concern.

Other metabolic syndromes are also there which are observed frequently, for example, the rise in the transaminases of the liver because of the fatty liver. With the increase in weight and age, the incidence of gallstones increases. In the case of obese individuals, fertility is impaired, and it's quite interesting that as per the reports most of the women in IVF i.e., *in-vitro* fertilization programs are obese or overweight. Thus, a weight reduction escalates the possibility of a successful fertility outcome substantially.

9.2.2 Cardiovascular Consequences

Obesity makes an individual prone to cardiovascular disease may be because of its association with blood pressures, dyslipidemia, and diabetes. But majorly in cases of those individuals who are younger than 50, obesity might also increase the risk of CHD i.e., Coronary Heart Disease by other processes. In these times, the occurrence of varicose veins and peripheral edema are more common and other abnormalities related to the heart may occur with coarse obesity.

9.2.3 Mechanical Consequences

In obesity, the most common risk factor is osteoarthritis of both the weight-bearing and non-weight-bearing joints i.e., in hands. Occurrence of spinal problems in the lower cervical and upper thoracic area sometimes causes chest pain. Obstructive or disruptive sleeping is quite common in the case of obesity. There are some other problems as well associated with obesity which are snoring, stoppages in breathing, and lack of attentiveness.

9.2.4 Social Consequences

Obese people, especially those who face problems in losing weight, often have low self-esteem. Obesity and/or its medical consequences may prevent individuals from doing many activities which they enjoy. Children see obesity as a disability. In some societies, there is a poor perception of obesity by the community at large and obese individuals may experience discrimination in various forms, including employment opportunities.

9.3 UNDERNUTRITION

The subforms of undernutrition include stunting, wasting, insufficient vitamins and minerals, and underweight. Children become more vulnerable to illnesses/diseases and death when they facing are undernutrition problems.

Wasting is the low weight-for-height that generally represents the current and severe reduction/loss in weight. This is because of not having sufficient food in your diet and/or due to the infectious disease such as diarrhoea that leads to weight loss. A young child who is wasted in a severe or a moderate condition has an increased death risk but the treatment of that particular disease is possible.

Now, stunting is the low height-for-age that is the result of recurring or chronic undernutrition. This problem of stunting is generally associated with poor socioeconomic status, poor maternal nutrition and improper health, recurrence of illness, and /or feeding children or young children inappropriately. Stunting stops children from regaining their cognitive and physical potential. Some children having low weight-for-age are called undernutrition and an underweight child might be stunted, wasted, or can be both.

Undernutrition can be mild, severe, or dangerous. The loss of weight is a manifestation of energy depletion. Essential nutrients, protein, and micronutrients are likely to be depleted at the same time, but some micro-nutrients have large stores in the body, and the requirements of some others are lower when energy intake is reduced. In children, who have higher protein requirements than adults, important depletion of protein is likely to accompany serious undernutrition.

There are several ways in which the body gets affected because of protein depletion. In case of depletion of somatic protein, the tissue loss is represented as the usual muscle wasting, which in combination contains the maximum amount of protein of the body. Whereas in depletion of visceral protein, the major effect of protein is on the gut, pancreas, and liver. This kind of protein malnutrition is the least common and nutritional scientists still did not found any evidence about its occurrence.

Check Your Progress 2

2) What is the formula for Body Mass Index?

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9.3.1 Protein-energy malnutrition (PEM) in young children

There are two forms of severe Protein-energy malnutrition (PEM):

- v marasmus and
- v kwashiorkor

9.3.1.1 Marasmus

Starvation in an infant or young child is referred to as Marasmus. This word has been derived from a Greek term called 'marasmus' that simply means wasting. In this condition, the child becomes very thin and the weight becomes <60% of the median reference weight-for-age and there is marked wasting (Fig.9.1). As per the reports, it does not show oedema.

9.3.1.2 Impact of Marasmus

There is loss of almost all the adipose tissue and wasting of the voluntary muscles but to a smaller extent. In this the growth stops and then it takes weeks of insufficient feeding for a child to become wasted. The major cause of these factors discussed above is taking a diet that is very less in energy, not taking sufficient foods and liquids. For e.g. because of ignorance or poverty, early weaning from the breast on to dilute food is observed. When your hygiene is not good or is poor then it results in various

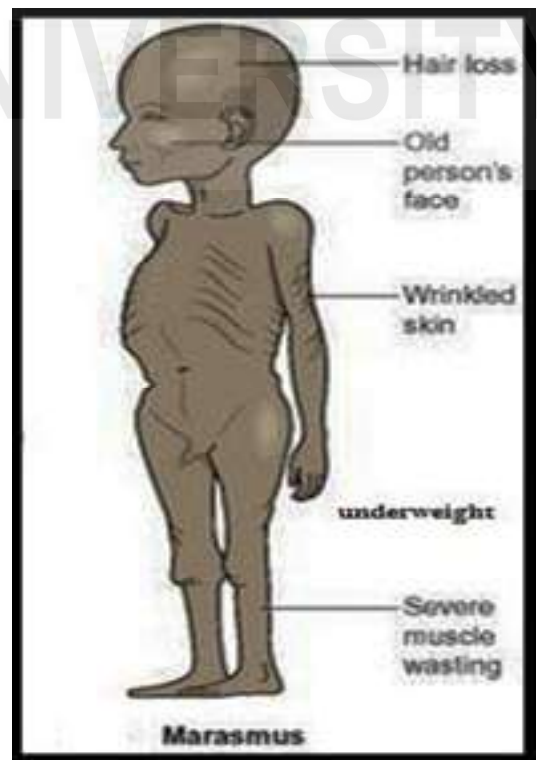


Fig. 9.1: Image showing impact of Marasmus

Source: www.medicoapps.org

diseases such as gastroenteritis, diarrhoea, and vomiting which might lead to poor appetite so that dilute foods are provided. If the depletion continues further then it results in intestinal atrophy and makes the body more vulnerable to illnesses. Not enough food implies not enough protein because most foods contain some protein. This is not true that if the child is not having proper/sufficient food, then he/she is having protein-rich diet food since food is costly. Fatty-free acids from the adipose tissue are the major catalyst or fuel that is used to maintain a healthy life.

Blood glucose that is required to only metabolize glucose i.e., brain and red blood cells is maintained by the gluconeogenesis of glucogenic amino acids (e.g. alanine). These amino acids are released from the proteins present in the body generally the muscles and viscera in some cases. In marasmus, the depletion of energy predominates and there is certainly inadequate intake of proteins and protein loss inside the body. The heart, kidneys, and brain are very less wasted inside the body but in advanced cases, the heart becomes wasted (called atrophied) and the weight of the brain decreases.

There is the increased mobilization of free fatty acids from adipose tissue, with ketosis (increased concentration of 3(OH) butyrate and acetoacetate) and the blood glucose may be subnormal. The metabolic rate at basal goes down, and as the basal metabolic rate goes down, and an increased proportion of triiodothyronine is in the inactive rT3 form. Plasma insulin is low.

Infections that are only a temporary nuisance in well-nourished children become life-threatening in children with severe PEM. Their bodies are not capable of producing the usual responses to common bacterial infections, pyrexia, and increased white blood cells (leucocytosis). Cell-mediated immunity, the main defense against viruses and tuberculosis, is impaired. Pathogenic bacteria in the intestines can more easily gain access to blood circulation (Stewart Truswell, 2002).

9.3.1.3 Kwashiorkor

Marasmus has been known for centuries; but there is another type of severe PEM i.e. kwashiorkor, which did not get recognized until the 1950s. Typically, a child with kwashiorkor (Fig. 9.2) develops oedema, which is generalized.



Fig. 9.2: Image showing impact of Kwashiorkor

Source: Slidetodoc.com

9.3.1.4 Impact of Kwashiorkor

The child suffering from this condition feels miserable, withdrawn, ill, and will not eat. There are areas of pigmentation on the skin which are symmetrical in distribution, specifically on the nappy regions. The skin afterward shows the cracks and the epithelial skin (superficial) peels off.

In this, the texture of hair becomes thin and discolored or sometimes becomes red or grey or blond. In case of diarrhoea, the physiological impact is that the liver gets enlarged and the cells of the parenchymal contains several fat droplets/particles. The concentration of protein present in the liver decreases and there are two main features of kwashiorkor that can be explained in detail by the liver failure to make two plasma proteins. Failure to synthesize albumin and the consequent very low plasma albumin may, because of low plasma osmotic pressure, at least partly explain edema. Failure to produce very-low-density lipoproteins, and the inefficiency to transport the fat out of the liver to the edges describe the fat accumulation in the liver. In plasma, there is an irregular and representative pattern of amino acids (Truswell, 2002).

In comparison to marasmus, kwashiorkor develops quickly. After the appearance of edema, the mother seeks medical help through skin and hair changes as they have been developing over a long period. It is not necessary that the child having kwashiorkor is underweight. Kwashiorkor simply means 'the deposed child' or you say 'first second'. In Accra, mothers thought that this was the disease that a child can get when a second baby follows and the first one got displaced from the breast. Kwashiorkor is followed by two schools of thought. The school of thought is confused by the question that why a severe protein depletion from the liver and the other viscera is there instead of the muscles in cases of PEM. Now, let's see what an original theory states: it says that the child who develops kwashiorkor has been fed on a diet moderately adequate in carbohydrate but very low in protein so that there is a relative deficiency of protein to energy (i.e. protein malnutrition), whereas the diet that leads to marasmus is low in both energy and protein (Truswell, 2002).

Few of the researchers were not in agreement with the proposed classical theory because as per their experience histories related to diet are not distinguishable between the children having kwashiorkor and children with marasmus. The dietary histories of an individual are not probably scientifically dependent on the child carer who has become acute malnourished. It is also reported that the children having kwashiorkor are not importantly underweight i.e., deficient in energy and their low urea urinary and blood levels represent the low intake of protein. Cure of kwashiorkor can be initiated with a diet consisting only of 18 pure amino acids plus only 30% energy from glucose. Kwashiorkor occurs in countries where the staple diets for weaned children have very low protein/energy ratios (e.g. cassava, plantains, sweet potato, or refined maize).

Kwashiorkor and marasmus are distinct diseases but in communities where both occur, cases of severe PEM often have some features of both (e.g. they are very underweight and have skin or hair changes). This is Marasmic kwashiorkor. PEM does not only affect protein and energy. Deficiencies of some micronutrients commonly occur in severe PEM, especially, vitamin A deficiency causing xerophthalmia, and potassium depletion from diarrhoea. There may also be evidence of zinc, folate and niacin, and calcium deficiency. Children with severe

PEM have diarrhoea. An infection may have brought on the severe illness, and these children stand open to infections. In such a situation help as soon as possible is important. As you know children suffering from Kwashiorkor may not be able to reach their full height and sometimes they also start developing physical and mental disorders. Various programs are running for the management and controlling the illnesses such as the intake of foods that are rich in absorbable micronutrients. In some areas where the supply of these types of foods is not available, some preventive measures are required to take. Health services provide supplementation of micro-nutrients that can be taken via the mouth or by injection. In the case where there is a specific deficiency, supplementation is important and the prioritized population is the pregnant women and children (Truswell, 2002).

9.3.1.5 Mild to Moderate Protein-energy Malnutrition

It is important to get recovery from these illnesses so seeking cases are getting increased, so with every acute case of marasmus or kwashiorkor, there are approximately 7-10 children in the population having mild to moderate PEM. Like an iceberg, there is more malnutrition below the surface and not easily recognized. Sometimes a mother is not able to understand that her child is malnourished because of the similarity in size and vitality to many of the same age in an impoverished neighborhood.

Most children with mild to moderate PEM can be detected, however, by their weight-for-age, which is less than 80% of the international standard. Such children are either wasted, with subnormal weight-for-height/length or stunted (nutritional dwarfism), with subnormal height-for-age (but not wasted), or both. Wasted children have used up body fat, and some muscle, to maintain their fuel supply. Stunted children have adapted differently, by stopping or slowing their growth.

Both illnesses often occur at different times of life such as Kwashiorkor occurs in the second year of life whereas marasmus in the first year. Kwashiorkor is more amenable to the medical model of education, for example, educating mothers regarding foods that contain protein for weaned children. Marasmus is a more intractable problem, bound up with poverty, the status and education of women, lack of contraceptive resources, and poor sanitation (Truswell, 2002).

Check Your Progress 3

- 3) Name the two forms of severe Protein-energy malnutrition (PEM).

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9.4 SUMMARY

Insufficient intake of calories, protein, iron and different types of nutrients can cause malnutrition resulting of an imbalance between the consumption of too much energy and the expansion of energy in a small amount. Overnutrition, we

are facing is due to consumption of foods and liquids that contain high content of sugar and fat and sedentary lifestyle. This results in being obese or overweight that is causative factor for an increased risk of extensive diseases and health complications as well as premature mortality. Another form of malnutrition is undernutrition that includes stunting, wasting, insufficient vitamins and minerals, and underweight. Children become more vulnerable to illnesses/diseases and death when they facing undernutrition problems. Undernutrition can be mild, severe, or dangerous and the loss of weight is a manifestation of energy depletion.

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9.6 ANSWERS TO CHECK YOUR PROGRESS

- 1) The symptoms associated with undernutrition
Fatigue, Body weakness, Diarrhea, Low body temperature, Irritability, Slower breathing, Wounds and bruises, Loss of hair and Dry skin.
- 2) BMI is defined in terms of formula as a weight of a person in kilograms divided by the square of his/her height measured in meters i.e., kg/m^2 .
- 3) There are two forms of severe Protein-energy malnutrition (PEM) are marasmus and kwashiorkor.