MARUDHAR KESARI JAIN COLLEGE FOR WOMEN, VANIYAMBADI

PG AND RESEARCH DEPARTMENT OF FOODS AND NUTRITION

CLASS : III.B.SC NUTRITION FSM & DIETETICS

SUBJECT CODE : CNU53

SUBJECT NAME : COMMUNITY NUTRITION

SYLLABUS

UNIT - III

Methods of assessment of Nutritional status - sampling techniques - identification of risk group. Direct methods- anthropometry, biochemical estimation, clinical, and diet survey. Indirect methods- Food balance sheet,Ecological parameter and vital statistics, use of growth chart.

UNIT 7 ASSESSMENT OF NUTRITIONAL STATUS IN COMMUNITY SETTINGS-I

Structure

7.1 Introduction

7.2 Nutritional Assessment – Goals and Objectives

7.3 Methods of Nutritional Assessment

7.4 Indirect Assessment of Nutritional Status
- 7.4.1 Age Specific Mortality Rates
- 7.4.2 Cause Specific Mortality Rates
- 7.4.3 Cause Specific Nutritionally - Relevant Morbidity Rate
- 7.4.4 Ecological Factors

7.5 Direct Assessment of Nutritional Status

7.6 Nutritional Anthropometry
- 7.6.1 Uses of Anthropometry
- 7.6.2 Common Measurements Used in Nutritional Anthropometry

7.7 Methods of Assessing Nutritional Status in Individuals
- 7.7.1 Determination of Nutritional Status using MUAC
- 7.7.2 Determination of Nutritional Status using Weight and Height

7.8 Methods of Assessment of Nutritional Status of Community

7.9 Let Us Sum Up

7.10 Glossary

7.11 Answers to Check Your Progress Exercises

7.1 INTRODUCTION

Earlier in Units 3 and 4, we have learnt about various nutritional problems prevalent in our community. It is important to know the extent and severity of these nutritional problems so that we can take appropriate steps towards eliminating these problems. The strategy to determine the extent and severity of nutritional problems is called *nutritional assessment* or *assessment of nutritional status*. In this unit and the next Unit 8, we are going to learn about different methods of nutritional assessment.

We have already learnt earlier that body weight is one of the most common indicators used to assess whether a particular individual is well nourished or not. Likewise, there are several other methods of measuring the nutritional status of the community. For example, in clinical practice, doctors identify children suffering from malnutrition by clinical examination. Some biochemical parameters like haemoglobin is estimated to assess the iron status among individuals. As a dietitian or nutritionist, you will be required to assess the dietary patterns of individuals or community groups as a means to assess nutritional status. Quite often, we also use certain vital health statistics like infant mortality rates, under 5 mortality rates to get a nutritional profile of our population. We shall learn about these methods i.e. anthropometrical, chemical, biochemical and diet survey in this unit and the next Unit 8. We shall start our study of nutritional assessment in this unit by focusing on nutritional anthropometry.

Objectives

After studying this unit, you will be able to:

- list goals and objectives of nutritional assessment,
- describe different methods of nutritional assessment,
- discuss indirect methods of nutritional assessment,
- explain the significance of nutritional anthropometry,
- discuss various methods of anthropometric classification, and
- carry out some of the nutritional anthropometric methods.

7.2 NUTRITIONAL ASSESSMENT–GOALS AND OBJECTIVES

We stated earlier that the strategy to determine the extent and severity of nutritional problems is called *nutritional assessment* or *assessment of nutritional status*. Before we discuss this further, let us first understand what we mean by the term nutritional status. *Nutritional status*, refers to the *state of health of an individual as it is affected by the intake and utilization of nutrients*. Thus, nutritional assessment is done to assess the severity and magnitude of nutritional problems prevalent in communities due to faulty intake or utilization of nutrients. The major objective of such an assessment is to determine the type (what?), magnitude (the numbers affected) and distribution of malnutrition in different geographic areas (where?), identify the at-risk groups (who?) and to determine the contributory factors (why?). In other words, the goal of the nutritional assessment of communities is to discover facts about nutritional situation and guide action to improve nutrition and health. Factual evidence of the exact magnitude of nutritional problems is essential to sensitize administrators and politicians to obtain allocation of material and human resources and plan appropriate intervention strategies. Also, in the formulation of a public health strategy to combat malnutrition, assessment of nutritional status of community is the first step. There are different methods of measuring nutritional status. Let us study what they are?

7.3 METHODS OF NUTRITIONAL ASSESSMENT

In our discussion so far we have studied as to why we do nutritional assessment. Next, let us get to know how we do nutritional assessment. There are certain methods which are used to conduct nutritional assessment. These methods can be categorized as *Direct Assessment* and *Indirect Assessment*. We would learn about both these methods in this section. Let us study about direct assessment first.

1. Direct Assessment

In direct assessment, we measure certain indicators on representative samples of community to determine nutritional status of community. In other words, we can directly take measurements like body weight or clinically examine or estimate haemoglobin levels on certain group of individuals. The representative samples of community can be taken with the help of nutrition survey. We will study about different methods of direct nutritional assessment a little later in this unit. Let us now look at Indirect assessment.

2. Indirect Assessment

Under the method of Indirect assessment, a variety of vital statistics are used to assess nutritional status. These are: 1) mortality rates among vulnerable groups of population

like infant mortality rate or maternal mortality rate, and 2) morbidity rates of conditions like diarrhoea and respiratory infections etc. to find out whether the community is adequately nourished or not.

We will begin our discussion on methods of nutritional assessment by first learning in detail about indirect assessment and review some specific health statistics data used under this method to assess nutritional status of community. We will then go over to study about direct assessment. So then, let us get started with indirect assessment.

7.4 INDIRECT ASSESSMENT OF NUTRITIONAL STATUS

Nutritional status, we have learnt above, can be assessed by indirect methods such as mortality rates (i.e infant, maternal and perinatal mortality rates), morbidity rates and other health statistics. Let us understand what we mean by mortality and morbidity rates. Mortality rate is defined as *the number of deaths in a group of people usually expressed as deaths per thousand* while morbidity rate *is defined as the number of people ill during a time period divided by the number of people in the total population*. You may recall learning about these statistics in the previous Unit 6 in section 6.5. Generally, in such cases, data already collected in connection with other national surveys is utilized for the purpose. The principle is that malnutrition influences several morbidity rates and mortality rates. In addition, morbidity rates also influence the nutritional status of vulnerable groups of population particularly young children.

It should be recognized that quite often collection of accurate data on these rates is often beset with a lot of problems. Only institutions having sufficient expertize should collect such data. In India, *sample registration scheme* collects information regularly using standardized procedures through trained investigators on statistically adequate samples. They publish annual reports, which could be used for the purpose. Collection of morbidity data requires prospective surveys on a statistically adequate sample using standardized definitions and procedures. Morbidity surveys involve collection of data on a longitudinal basis by visiting the selected households either weekly or at least fortnightly. The gap between two visits in a morbidity survey is called as *reference period*. It is recommended that this should never be more than a fortnight. Longer the gap, more will be the recall lapse by the persons providing information. Morbidities like diarrhoea, acute respiratory infections and measles are commonly associated with malnutrition. Higher incidence of these morbidities could be considered to lead to malnutrition. In addition, malnutrition could predispose to some of these morbidities, as the child's immunity (ability to fight infections) would have been affected during severe malnutrition. Some of the specific indirect indicators used to asses nutritional status of community are: age-specific mortality rates, cause specific mortality rates and cause specific morbidity rates. Many times, data is also collected on ecological factors which affect nutritional status of community. Let us study each of these indicators in detail. We shall start with the mortality indicators first.

7.4.1 Age Specific Mortality Rates

An age-specific mortality rate is a mortality rate limited to a particular age group. The numerator is the number of deaths in that age group, the denominator is the number of persons in that age group in the population. Age specific mortality rate is an important indicator of health status. In areas, where the prevalence of protein energy malnutrition is high, mortality among children between 1-4 years remains high. Though infant mortality rate (IMR) is considered as an indicator of health status, it is now recognized that the 1-4 year mortality rate is several fold higher in developing countries compared to developed countries due to high rates of protein energy malnutrition.

This is also evident by the fact that since independence there has been a considerable reduction in IMR (from about 160 to 60 per 1000 live births). The main reason for the high mortality among children 1-4 years is due to the combined effect of nutritional stress and high morbidity rates during this age period.

Now, where can we collect the data on age specific mortality rates?

We can collect this data by consulting birth and death records, wherever available. In India, *census data* collected regularly every decade can also provide such information. Special surveys could also be organized if necessary expertise is available on statistically adequate and random samples. However, such surveys are laborious and time consuming and may not provide any additional information over direct methods of assessment. Let us look at the second indicator now. i.e. cause specific mortality.

7.4.2 Cause Specific Mortality Rates

The cause-specific mortality rate is the mortality rate from a specified cause for a population. The numerator is the number of deaths attributed to a specific cause. The denominator is the at risk population size at the midpoint of the time period.

Data on cause-specific mortality would be extremely useful to determine the nutritional status of communities indirectly. However, in India, such data is not available in all the areas and most often is not accurate. Such data can be obtained from health centers and hospitals. Mortality due to clinically identifiable malnutrition, if records are available, could be of help to assess indirectly the nutritional status of communities. Hospital admissions of clinical cases of nutritional deficiencies, particularly of severe protein energy malnutrition and keratomalacia, also are often used as an indicator of nutritional status of communities.

We looked at the indicators related to mortality. Now let us look at the indicator on morbidity i.e. disease.

7.4.3 Cause Specific Nutritionally - Relevant Morbidity Rate

Information on the prevalence/incidence of nutritionally relevant diseases like measles, diarrhoeas and acute respiratory infections also are indirect indices of nutritional status at the community level. In clinical settings, most often children with severe forms of clinical malnutrition have a history of suffering from some of these morbidities before developing malnutrition. In fact, in the earlier days, epidemics of malnutrition followed epidemics of measles and diarrhoeas. There are other diseases which also contribute to malnutrition. Some of these are intestinal helminthiasis, malaria and tuberculosis. These could also influence the extent of malnutrition in a community. In the present circumstances, the occurrence of AIDS could be an important determinant of malnutrition.

Therefore, during the field visits, information on these diseases could be obtained from hospitals and health centers. The cause specific nutritionally relevant morbidity rates, therefore, serve as an important indirect indicator to assess nutritional status. Let us now study about some ecological factors which could indirectly indicate the possible nutritional status of communities.

7.4.4 Ecological Factors

Human malnutrition is recognized to be an ecological problem in the sense that it is the end result of several overlapping and interacting factors in the community's physical, biological and cultural environment. Information on food consumption, particularly infant and child weaning practices, beliefs and cultural practices, medical and health services; educational services and socioeconomic conditions of the community will be of use in the assessment of nutritional status at the community level. We can collect the information through field visits to the areas. Let us study about some of these factors in a little detail to see how they could affect malnutrition.

- *Breastfeeding and Complementary feeding*

Breastfeeding practices like exclusive breast feeding up to 6 months of age, feeding of colostrums to newborn children and introduction of complementary food at six months of age to infants are the most important factors which could improve the nutritional status of communities. In India, where the prevalence of malnutrition continues to be high, colostrum is often discarded due to certain taboos (it is impure milk), complementary food is introduced only after the child completes the age of one year. In other words, the child is not getting adequate food even from a very young age.

- *Food Consumption Practices*

Similarly, qualitative information on food consumption could be an indirect evidence for malnutrition in that community. For example, the practice of consumption of foods like pulses, green leafy vegetables and milk particularly among young children can indicate the state of nutrition of the community. In addition, the practice of reducing food intakes and avoidance of foods during pregnancy, restriction of foods during certain diseases like during diarrhoea is indicator of poor dietary practices among the community.

- *Socioeconomic Factors*

Socioeconomic status determines nutritional status. Malnutrition is of higher magnitude among the poorer groups like scheduled caste and tribe communities people living in urban slums etc. Apart from poverty, the literacy - particularly female literacy - among these communities is very low leading to ignorance and food taboos. The living conditions of these groups is so poor that even if they spend all their incomes on foods, they still will not be able to meet the nutritional needs. The gender discrimination, particularly at the social level, could contribute to higher malnutrition among females.

- *Health Care Facilities and Practices*

The health care facilities as such in the rural areas are not satisfactory and even if they are available the community most often visits these facilities at a late stage. Most often, any visit to a health facility, which is situated at some distance means loss of wages for the household. In addition, the services are not satisfactory due to lack of accountability among the health functionaries. Assessment of environmental sanitation and hygiene practices also could indirectly indicate the possible nutritional status of communities. The information on these factors can be collected through rapid visits and collection of qualitative data.

From our above discussions, it is clear that factors such as feeding practices, food consumption patterns, socioeconomic factors and health care practices, can all influence nutritional status. Remember all these factors are indirect assessment methods.

Thus we saw that we could use health statistics data and also collect information on ecological factors to indirectly assess nutritional status of community. We will now study how we could directly assess the nutritional status of the community. But first let us recapitulate what we have learnt so far. Answer the check your progress exercise 1 given next.

Check Your Progress Exercise 1

1. Mention three main purpose of nutritional assessment.

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2. What are the different methods of nutritional assessment?

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3. List three health statistics data used for indirect nutritional assessment.

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4. List three ecological factors used for nutritional assessment.

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Now we move on the direct assessment of nutritional status.

7.5 DIRECT ASSESSMENT OF NUTRITIONAL STATUS

The last section focused on indirect assessment techniques of assessing nutritional status. We have also studied earlier that we can also directly assess nutritional status of community. We can directly reach out to the people and conduct nutritional assessment. How? We can do it in many ways. For example, we can ask people about their dietary intake, we can take their body measurement or conduct some biochemical tests. The commonly used methods are:

i. Nutritional anthropometry,

ii. Clinical examination for nutritional signs,

iii. Biochemical estimation, and

iv Dietary assessment.

In this unit, we will learn about the first commonly used method of assessment i.e. nutritional anthropometry in detail. About other methods, we will learn in the next unit i.e. Unit 8.

We stated in the beginning of this unit that we measure certain indicators on representative samples of community to assess the nutritional status of communities and these representative samples can be taken with the help of a nutrition survey. In the routine nutrition surveys, clinical examination and nutritional anthropometry form the most important components, since these are relatively simple in community situations and do not require any sophisticated equipment like biochemical estimations.

Before we discuss in detail about the different methods of direct assessment of nutritional status of community, let us learn as to how nutritional deficiency progresses, which would help us to decide the methods of assessment to be adopted to measure/ identify these changes.

Progression of Nutrition Deficiency Disorder

It is well recognized that the primary cause for nutritional deficiencies is inadequate dietary intakes for long periods. Such a dietary inadequacy, to start with, leads to changes in tissues and organs like muscles and liver progressing subsequently to biochemical changes. While the changes in tissues can be measured by examining the concerned tissues, examination of the blood and plasma or serum can identify biochemical changes. At this stage, the nutritional deficiencies are considered as *sub-clinical* as we cannot find any anatomical changes by naked eye examination. These sub clinical changes can be identified either by biochemical assessment or anthropometry. The anatomical changes in some of the organs of the body, like swelling in the body or changes in the eyes, can be diagnosed by clinical examination. Table 7.1 gives a flow chart indicating methods of assessment to be used as the nutrition deficiency progresses. It depicts that by conducting a dietary survey, we can assess dietary inadequacy and

as the deficiency progresses, different methods of assessment will indicate chang at different levels in the body.

Table 7.1: Progression of nutrition deficiency disorder

Progressive of Deficiency		Methods of Assessment
Dietary Inadequacy	→	Diet Survey
↓		↓
Tissue Changes	→	Examination of Tissues
↓		↓
Biochemical Changes	→	Biochemical
↓		↓
Sub clinical changes	→	Anthropometry
↓		↓
Anatomical Changes	→	Clinical Examination

It is important to recognize that the clinically diagnosable forms of nutritional deficiencies represent only the tip of the iceberg, the bulk of which is under water and is not visible. It is estimated that for every case of clinical form of protein energy malnutrition (kwashiorkor/marasmus), there are at least 5-6 cases of moderate to severe undernutrition. Thus, clinical examination measures only a small proportion of nutritional disorders and, therefore, other methods of assessment should be simultaneously used to determine the real magnitude of nutritional deficiencies. This is important not only to sensitize policy makers and administrators regarding the importance of malnutrition but also to plan the requirements for any intervention programmes.

With this basic understanding of the progression of nutritional disorders, let us now learn what is nutritional anthropometry? What are its uses and what are the common measurements used in nutritional anthropometry?

7.6 NUTRITIONAL ANTHROPOMETRY

One of the most important physical changes that occur in undernutrition is growth retardation. Nutritional anthropometry is the *tool which can assess even the early changes in growth failure.*

What is nutritional anthropometry? Nutritional anthropometry is *measurement of human body at various ages and levels of nutritional status.* It is based on the concept that an appropriate body measurement reflects any morphological variation occurring due to a significant fuhctional physiological change. It is an important component of any nutrition survey because it is simple, easily measurable by workers with limited educational qualifications and provides as much information on the nutritional status of individuals as biochemical parameters. What are the uses of anthropometry? Let us read and find out in the next sub-section.

7.6.1 Uses of Anthropometry

Nutritional anthropometry is a very useful tool. It helps in:

1. assessment of extent of undernutrition of vulnerable groups of population,
2. monitoring of individual children at regular intervals (monthly or quarterly) to find out faltering in growth (deterioration/no change of growth) to help in early detection and initiating prompt remedial measures,
3. identification of children who are at risk of undernutrition, to target and prioritize nutrition action programmes so as to control the extent of undernutrition,
4. mid-term appraisal or terminal evaluation to assess whether intervention programmes have achieved the objectives, and
5. assessing nutrition rehabilitation of malnourished children under treatment.

Having gone through the points above you would now realize how important nutritional anthropometry is. We will now study about various body measurements used in nutritional anthropometry and how they are used in determining the nutritional status.

7.6.2 Common Measurements Used in Nutritional Anthropometry

The methods of the body measurement, you must realize, should be simple and provide practical information on community. These should be quick to measure, and the easiest to reproduce, simultaneously providing maximum information concerning a number of nutritional problems. The most commonly used measurements in routine surveys are:

1) Body weight,
2) Standing height or Crown-heel length,
3) Mid-upper arm circumference, and
4) Body Fat.

Circumference of head and chest are also included in some surveys covering children less than five years of age. However, in view of their limited usefulness we will discuss only the four measurements mentioned above. You will now learn the relevance of the body measurements and the methods of their measurement. Let us start with the first measurement, that is, body weight.

1) Body Weight

Body weight is the most widely used and the simplest reproducible anthropometric measurement for the evaluation of nutritional status of individuals. Why ? Let's find out.

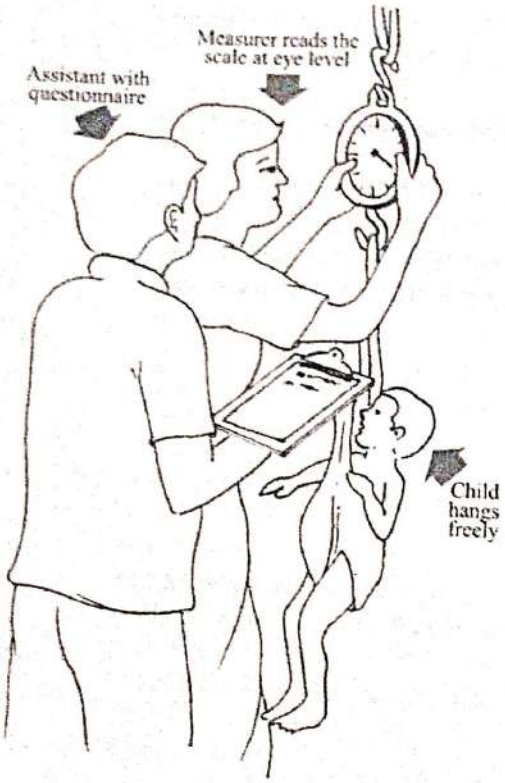
Why body weight?

Body weight is a composite of all body constituents like body water, minerals, fat, protein; bone etc and indicates the body mass. One of the advantages of body weight is that its utility is perceived not only by the health personnel, but also by the community, both the educated and illiterate alike. It is not uncommon to find several mothers approaching doctors either because their children weigh less (in their perception) or are losing weight. Thus, it is easier for the health professionals to provide education to women about the need for proper nutrition by comparing body weights *vis á vis* the normal weights. Serial measurements (repeated measurements at regular periods) of weight, as in growth monitoring, are more sensitive indicators of changes in nutritional status than a single measurement at a point of time. [illegible]

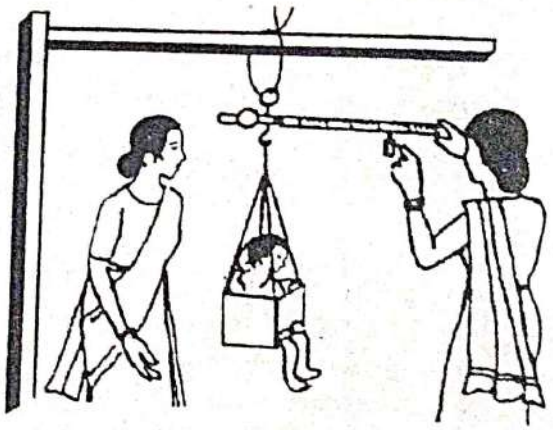
be aware, refers to the regular measurement of growth which enables mothers to visualize growth, or lack of it, and obtain specific relevant and practical guidance to ensure continued regular growth and health of children. Body weight is sensitive even to small changes in nutritional status, caused by short duration childhood morbidities like diarrhoea etc. Rapid loss of body weight in children should be considered an indicator of potential malnutrition. Weight is indicative of short-term malnutrition. On the other hand, weight may also be fairly quickly regained after appropriate intervention. Thus, body weight is also a good indicator of nutritional rehabilitation.

How do we measure body weight?

The choice of suitable weighing scales is very important to obtain accurate measurements of body weight. Two types of weighing instruments are available. These are 1) Salter Weighing scale, which is a spring balance, and 2) Beam or lever scales as shown in Figure 7.1 (a) and 7.1 (b), respectively. Salter weighing scale is light and portable and can be hung from a roof or a tree as shown in the Figure 7.1 (a). The child is placed in the sling and then the weight is recorded.



(a) Salter Scale



(b) Beam Scale

Figure 7.1 : Weighing scale

Beam or lever scales with an accuracy of 50 g or 100 g are preferable for taking body weight, as they are more accurate. In the case of birth weight the accuracy should be at 20 g. The commonly used 'bathroom type' weighing scales are spring balances. These are not recommended as the springs get stretched and inaccurate from frequent use. A comparative study of spring type and lever actuated weighing scales indicated considerable differences in weights. The errors in measurements using bathroom scales are quite high ranging between 0.5 to 1.5 kg in young children between 1-5 years of age. Beam balances are manufactured in India and have been found to be reliable and are currently in extensive use in ICDS projects. However, it should be recognized that all the weighing scales are tested for accuracy with known standard weights at regular intervals and put out of use as soon as the accuracy is lost. Let us get to know about the technique of taking weight.

Technique

Weights should be taken as far as possible with minimal clothing, without shoes and without holding any support (in case of children they will be holding the hands of one of their parents/relatives). In the case of infants and noncoperative children, the weights could be taken with an elder person carrying the infant/child (usually the mother/ caretaker)and subtracting the weight of the elder to get correct weight. In cold places, the subjects may be wearing heavy warm clothing as a protection against cold. In such situations, an average weight of the warm clothing can be obtained which can be subtracted from the weight of the individual.

Let us go over to the second method i.e. height.

2) Height

Length or height is a very reliable measure that reflects the total increase in size of the individual up to the moment it is determined. Let us find out why height is used as an important measure to assess nutritional status.

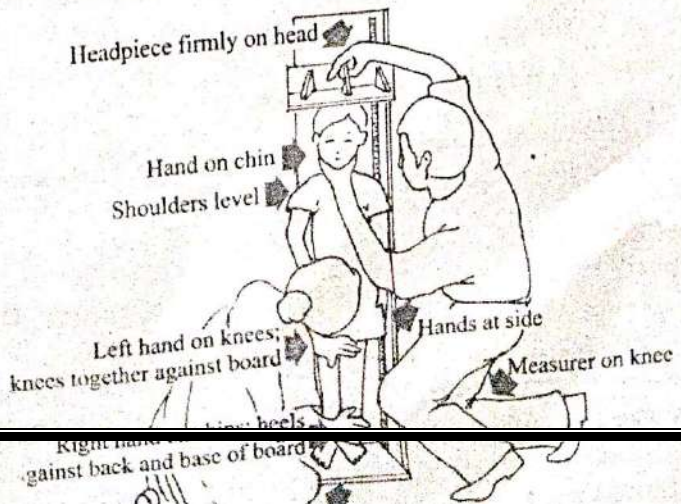
Why Height?

The height of an individual is influenced both by genetic (hereditary) and environmental factors. An individual's maximum growth potential is determined by hereditary factors (parent's height). The environmental factors, the most important being nutrition and morbidity, determine the extent of exploitation of that genetic potential. In other words, only when there is appropriate environment - optimal nutrition and good health care - an individual can achieve his/her maximum height. Inadequate dietary intake and/or infections reduce nutrient availability resulting in growth retardation. During periods of severe nutritional deprivation, growth of height slows down leading to stunting (short stature) in an individual. Thus, stunting is a consequence of chronic food deficiency. Since height is affected only by long-term nutritional deprivation, it is considered an indicator of chronic or long-duration malnutrition.

Next, let us learn about the techniques used for height measurement.

Technique

Standing height is measured by anthropometer rods, which are four-piece chromium plated portable metal rods with a headpiece with an accuracy of 0.1 cm. Some companies in Delhi and Hyderabad make such anthropometer rods. A vertical measuring rod or a wooden scale with accurate divisions could also be used. Figure 7.2 shows the instrument for taking standing height of children.



Height is taken without shoes with the subject standing [illegible] surface of the platform of the weighing scales, with the arms hanging naturally at the sides. The head should be held comfortably erect, with the lower border of the eye orbit in the same horizontal plane as the external auditory meatus (hole of the ear). The headpiece of the anthropometer rod should be held, without much pressure, in the sagittal plane (central part of head).

In the case of infants and young children who cannot stand or those who do not cooperate, the height is measured with an *infantomter*. This is referred to as *recumbent* or *crown-heel length*, which is taken on children below the age of 24 months. Figure 7.3 shows the *infantometer* for taking recumbent length of the children.

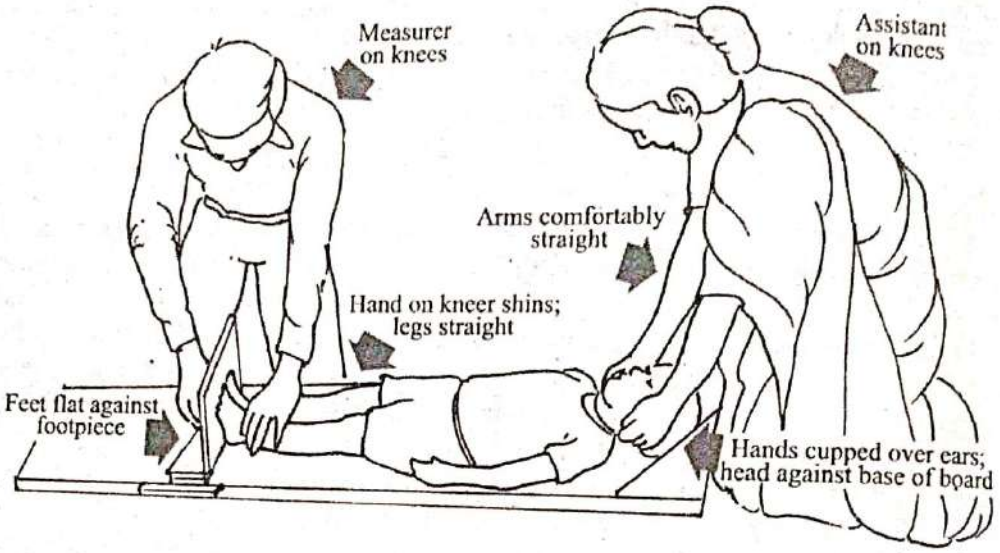


Figure 7.3: Child length measurement

The child should be laid on the infantometer board with his head touching the fixed headpiece. An assistant should hold the child's head in proper position. The investigator should ensure that the child's body is straight, and flat; should press the knees and ankles flat against the board and bring the movable piece of the board flat against the heels with optimum pressure. The measurement should be read while child is still in position. It is generally agreed that recumbent length measurements are greater than stature measurements.

Let us now go over to the third method i.e. mid-upper arm circumference as a measurement used in nutritional anthropometry.

3) Mid-Upper Arm Circumference (MUAC)

Mid upper arm circumference is a useful indicator of nutritional status of individuals and communities. How does this measure reflect the nutritional status? Let us find that out.

Why Mid-Upper Arm Circumference?

Poor musculature and wasting are cardinal features of moderate and severe protein energy malnutrition in early childhood. Circumferences of mid-upper arm (MUAC) and calf are recognized to indicate the status of muscle development in the body. The mid-upper arm is heavily muscled and approximately circular. The mid-upper arm circumference is considered more feasible as it is easily accessible in any age and sex, and so is simpler and practical to measure. The MUAC may be useful not only in identifying malnutrition but also in determining the mortality risk in children. The measurements of MUAC correlate well with weight, weight for height and [illegible]

CPEM. When measured along with fat fold at triceps, MUAC, in addition, can be used to calculate mid arm muscle circumference (fat free arm circumference). The assumption is that the cross-section of the mid upper arm circumference approximates a circle, and that the adipose tissue (fat) is evenly distributed around the area. Let us learn about the technique next.

Technique

The arm circumference is measured with flexible fibre glass tape up to 0.1 cm. It is taken on the left arm, while hanging freely by the side, at its mid point. The mid point of the left upper arm is measured by taking first the length of the upper arm - between acromion process of scapula and the tip of ulna - by flexing the forearm at right angles. The mid point is marked at half the length with a skin marking pencil/ball pen. The fiberglass tape is placed at the mid point gently but firmly without disturbing the contours of the arm in any way. Figure 7.4 gives arm circumference insertion tape and correct tape position for arm circumference.

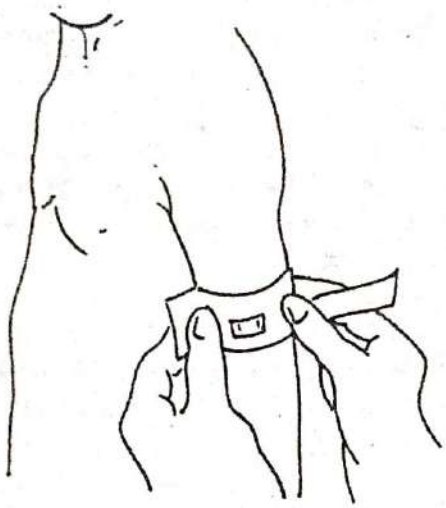


Figure 7.4: Measurement of mid upper arm circumference

Let us go to the fourth method of body measurement i.e. body fat

4) Body Fat

The adipose tissue is distributed over a large number of sites in the body. Subcutaneous fat constitutes the body's main store of energy (calorie) reserves. How does the measure of subcutaneous fat, then reflect the nutritional status. Let us find out next.

Why measure fat?

Close association has been observed between fatness and calorie reserves, and between muscularity and protein status. This relationship can be used as a tool for assessing the gross nutritional status of persons at specific stages of life. Usually, in field circumstances, measurement of fat fold thickness at different sites is more feasible than the sophisticated densitometry or underwater weighing etc. The thickness of fat at various sites of the body has good correlation with measures of body fat as determined by autopsy, densitometry and radiography. Fat distribution in and around the body varies with age, sex, physiological, nutritional and health status and ethnicity. Of all the measures of fatness, fat fold at triceps is considered to be the simplest and most feasible in community surveys. In addition, fat folds are measured at subscapular and supreiliac regions. Let us learn about the technique of fat measurement next.

Technique

Fat fold at triceps is taken at the same point where mid upper arm circumference is taken. Skinfold calipers like the one shown in Figure 7.5 is used to measure skinfold thickness

Figure 7.5: Measurement of fat fold using skinfold calipers

Various types of skin fold calipers (Harpenden/Lange skin fold calipers) are available in the market. These are mostly imported. One of the important factors to be considered while selecting the calipers is that the pinch area should be 20-40 mm^2 with an accuracy of 0.1 mm and should exert a constant pressure of about 10 g/ mm^2 The fat fold measured consists of a double layer of skin and fat. The measurement is made with the arm hanging loosely by the side. The fat fold parallel to the long axis is picked up between thumb and fore finger of the left hand without including any underlying muscle and the measurement taken with the calipers. An average of three measurements is recommended.

Now that we have learnt about how to take the correct body measurements, we should find out how we can assess nutritional status with these measurements. Before we move on to this topic, let us review what we have learnt so far, by answering the questions given in check your progress exercise 2.

Check Your Progress Exercise 2

1. Mention various methods of direct assessment of nutritional status.

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2. List four uses of anthropometry.

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3. What are the common measurements used in nutritional anthropometry?

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8.2 CLINICAL ASSESSMENT

Clinical examination is one of the common tools used to assess the extent of forms of undernutrition. In the following section, we will discuss about clinical exam and also know about the common clinical signs of various nutrition disorders in nutrition surveys. Before we go into details about clinical signs, we should kn training of the staff assessing clinical signs is very important. Let us find out i about the training and standardization procedures.

8.2.1 Training and Standardization

Trained workers only should carry out clinical examination and it should be d good light. All the investigators should undergo rigorous training so that there is co agreement in the diagnosis of signs between individuals and between two examin of a subject by the same investigator. We should record only the presence or a of a particular sign. Any grading of any clinical sign (like + or ++ etc) sho scrupulously avoided. We should look for the presence of all the signs of com occurring nutritional deficiency so that nothing is missed. For the purpose, a sch proforma should be prepared including all the clinical signs to ensure no defi sign is missed. You might recall that we studied about clinical signs of v nutritional disorders in Unit 3. Can you recall these signs and symptoms? List signs/symptoms in the proforma given herewith including all the clinical sign learnt in Unit 3.

Proforma for reporting nutritional deficiency disorders and signs and symp

Nutritional deficiency disorders	Signs and symptoms

Are you having trouble in recapitulating all the deficiency signs and symptoms? do not panic! Here, in the next section, you will once again find information on cl signs and symptoms. So review the section below and get back to the proforma

8.2.2 Clinical Signs of Nutritional Disorders

What do we mean by clinical signs? *Clinical signs are changes in the body are indicative of nutritional deficiency/excess.* In this section, we are briefly to recapitulate the clinical signs of the following nutritional disorders:

- Protein energy malnutrition
- Vitamin A deficiency
- Anaemia
- Goitre
- Fluorosis
- Vitamin C deficiency
- Rickets
- Essential fatty acid deficiency
- Vitamin B complex deficiency

Let us begin with protein energy malnutrition.

A. Protein Energy Malnutrition

You are aware that the clinical forms of protein energy malnutrition (PEM) are kwashiorkor, marasmus and marasmic-kwashiorkor. We will now review the clinical signs of these three forms of PEM? You may find this information repetitive, but it is important we recapitulate these clinical signs here. Let us begin with kwashiorkor.

a. *Kwashiorkor*

It is more common among children of 1-3 years of age. The most important sign without which a diagnosis of kwashiorkor should not be made is presence of *oedema* (swelling of the body). The swelling is present mostly in the extremities particularly the lower extremities (legs and feet). The investigator can confirm the presence of oedema by applying pressure with the thumb over the skin just above the ankle or feet for a few seconds. It would leave a depression, when thumb is removed, the depression will disappear. In a normal child who does not have any oedema, no such depression would occur.

Children with kwashiorkor are always apathetic and often irritable showing no interest in their surroundings. Their skin and hair (flag signs) may show changes. Kwashiorkor may be associated with other deficiencies and infections. Let us now discuss clinical signs of marasmus.

b. *Marasmus*

Marasmus is characterized by extreme wasting of muscle and subcutaneous fat. The child is very thin, with skin loosely hanging and appears to have nothing but skin and bones. The child has an old man's face and is extremely weak with little strength even to cry. The body weight could be as low as 50% of standard weight for age. Hair will be thin and sparse. The child may be associated with diarrhoea and other infections.

Let us now discuss clinical signs of marasmic kwashiorkor.

c. *Marasmic kwashiorkor*

Sometimes a child may suffer from clinical signs of both marasmus and kwashiorkor, this child may be having marasmic kwashiorkor. Marasmus with associated oedmea is called as marasmic kwashiorkor. The child therefore would be emaciated and will also have oedema.

Let us go to clinical signs of vitamin A deficiency.

B. Vitamin A deficiency

Deficiency of vitamin 'A' leads to changes in eyes (ocular signs). The ocular lesions - also known as *xerophthalmia* - can be of milder nature, such as night blindness, changes in the white of the eye like conjunctival xerosis or Bitot's spots. The severe lesions of eye affect the black of the eye (cornea). These are corneal xerosis, corneal ulcer or keratomalacia, which ultimately results in permanent loss of vision. Let us review these manifestations.

a. *Night Blindness*

Night blindness is the earliest symptom of vitamin 'A' deficiency in preschool children. The affected child cannot see properly at dusk. Often, an attentive mother can recognize the child's inability to see the plate of food or toys in ill-lit room.

b. *Conjunctival Xerosis*

Conjunctival Xerosis is recognized by dryness of the conjunctiva, which also becomes thick and wrinkled. It appears rough instead of being smooth and glistening. The dryness becomes more obvious when the conjunctiva is exposed to air for 10-15 seconds by keeping eyelids drawn back.

c. *Bitot's spots*

These are dirty white, foamy and raised spots on the surface of the conjunctiva, generally seen on the outer side of the cornea. Look up Figure 3.3(a) in Unit 3. Bitot's spot may appear as a single spot or as several small spots, which may later unite to form a large triangular patch with base towards cornea. Bitot's spots will be stained black when the children use 'Kajal'. The Bitot's spots may appear in only one eye or both the eyes.

d. *Corneal Xerosis*

This is a manifestation of severe Vitamin 'A' deficiency, in which the cornea loses its normal smooth and glistening appearance and becomes dry and rough. Due to inability to see bright light, the child tends to keep the eyes closed and, hence, the condition may be missed during the clinical examination, if not observant.

e. *Corneal ulcer*

Corneal xerosis, if not treated promptly, leads to ulceration of the cornea. Initially, the ulcer may be shallow, and if it becomes deep, it may lead to perforation resulting in prolapse of contents of the eyeball.

f. *Keratomalacia*

This is a condition of rapid necrosis and liquefaction of full thickness of cornea, leading to prolapse of iris, resulting in permanent blindness. Vitamin 'A' related corneal involvement (ulcer/keratomalacia) could be differentiated from other infective conditions of the eye, by the fact that it is painless and the conjunctiva will be muddy white. In infective conditions, the eye will be red and swollen.

g. *Corneal Scar*

The ulcer of the cornea, on healing, leaves a white scar, which may vary in size depending upon the size of the ulcer. When the scar is big or positioned centrally, normal vision is affected.

Let us now go over to clinical signs of anaemia.

C. Anaemia

Child with anaemia is less active than the normal child. The child may be pale and if the condition is severe, he/she will be breathless and will have swelling of face, body and limbs. The best way to detect anaemia is by examining the inner side of the eyelids, buccal mucosa (top of the roof of the mouth) and nail beds. They appear pale. Similar signs and symptoms also exist among adults, especially in pregnant and lactating women with anaemia. In severe condition, the nails of fingers and toes become papery thin and bend upwards to assume the shape of a spoon. This condition is known as "koilonychia". Haemoglobin estimation in blood is the best way for the diagnosis of anaemia.

Let us review clinical signs of goiter, which is the deficiency of iodine.

D. Goitre

Goitre, deficiency of iodine, manifests as enlarge[illegible] thyroid gland situated in front of the neck as you may recall seeing in Figure 3.4 earlier in Unit 3. In normal

subjects, thyroid gland is neither visible nor palpable. In iodine deficiency, as you may ecate seeing in Figure 3.4 earlier in Unit 3 it tends to enlarge in size. A thyroid gland hen enlarged to a size of greater than the terminal phalanx of the thumb will be onsidered as goitrous. Other ill effects of iodine deficiency disorders include cretinism physical and mental retardation), deaf mutism (deaf and dumb).

E. Vitamin B complex deficiency

Under this, we will review two most common types of vitamin B complex deficiencies riboflavin and niacin deficiency. Let us review the riboflavin deficiency first.

Riboflavin deficiency

Angular stomatitis, cheilosis, red or magenta tongue, atrophic papillae, and dyssebacea are signs of riboflavin deficiency. A review of there clinical symptoms follows:

a. *Angular Stomatitis*

Ulcers at the angles of the mouth, with fissures, are characteristic of this vitamin deficiency. The fissures may be shallow or deep confined to the angles of the mouth. They may extend into the oral cavity and also on to the skin outside. Milder lesions are identified easily with the mouth half-open.

b. *Glossitis*

The tongue appears bright red or magenta in colour with or without fissures as you may have observed in Figure 4.1(a) in Unit 4 earlier. The condition is often painful. The tongue may become completely bald in B complex deficiency.

c. *Cheilosis*

The lips become red and may develop painful fissures and may sometimes get even ulcerated. Let us now look at the niacin deficiency.

- Niacin deficiency (Pellagra)

Deficiency of niacin, leads to photo dermatitis (changes in the skin) on the parts of the skin exposed to sunlight, such as cheeks, neck, waist, hands and feet. In acute cases, the affected skin may appear red, slightly swollen and cracked, causing itching and burning sensation. In chronic cases, the skin becomes dry, rough and thick with brown pigmentation. Red and raw tongue with fissures and atrophic papillae are also seen in niacin deficiency.

Let us now review the clinical signs of vitamin C.

F. Vitamin C deficiency

Spongy bleeding gums

Gums are swollen (spongy) and bleed with even slightest touch. There may be associated petechial haemorrhages, ecchymosis and painful epiphyseal enlargement of bones.

We will now review the clinical signs of deficiency of vitamin D.

G. Active Rickets

It is due to vitamin D deficiency and is characterized by painless epiphyseal enlargement of growing ends of the long bones, beading of ribs, persistently open anterior fontanelle (after 18 months of age), craniotabes (parietal or occipital bones of skull become soft, and dent on pressure which spring back to normal shape when pressure is released (in children of <1 year), and muscular hypotonia. Healed rickets is characterized by the prominence of frontal and parietal bones of skull (referred to as frontal/parietal bossing), knock-knees (knees touching each other) /bow legs (legs becoming curved)

due to inward or outward lateral bending of lower limbs, as a result of weight bearing. Look up Figure 4.4 in Unit 4 earliar for viewing there clinical manifestations.

Let us move on to essential fatty acid deficiency.

H. Essential fatty acid deficiency

Phrynoderma: Phrynoderma is *a hyperkeratotic lesion of the skin.* Projections that resemble cones are formed surrounding the mouths of hair follicles. It is readily recognized by the spiky feeling it gives, when the palm is passed over the affected skin. It is generally seen on back of elbows, around knees and sides. They may sometimes be pigmented and the surrounding skin is dry.

Let us review the clinical signs of fluorosis - a condition caused by excess intake of fluorine.

I. Fluorosis

Earlier stages of fluorosis are characterized by changes in teeth known as *dental fluorosis.* Normal teeth are ivory white in appearance. In fluorosis, the teeth are mottled (with yellowish streaks) and appear chalky white (opaque) with brownish patches as you may recall seeing in Figure 4.5 eailier in Unit 4. Sometimes, pitting or chipping of enamel is seen, especially in the upper incisors. In areas of severe endemic fluorosis, many adolescents and young adults may also have skeletal deformities particularly in spine.

For your convenience, the various signs and symptoms of the nutrition deficiency disorders, we have discussed above are summarized in Table 8.1.

Table 8.1: Nutritional deficiency disorders and signs and symptoms

Nutritional deficiency disorders	Signs and symptoms
Kwashiorkor	• Oedema • Underweight (<80% of normal weight for age) • Apathy and irritability • Moon face • Hair and skin changes
Marasmus	• Extreme muscle wasting - "skin and bones" • Loose and hanging skin folds • Old man's or monkey face
Marasmic kwashiorkor	• Extreme muscle wasting - "skin and bones" • Loose and hanging skin folds • Old man's or monkey facies • Absolute weakness • Oedema
Vitamin A deficiency	Changes in the eye such as • Conjunctival xerosis:dryness of the transparent membrane that covers the cornea and lines inside of the eyelid

	• Xeropthalmia (including keratomalacia): cornea becomes soft and raw and easily infected • Bitot's spot dry foamy, triangular spots appearing on the temporal side of the eye • Night blindness: inability to see in dim light
ron deficiency anaemia	• Paleness of conjunctiva, • Paleness of tongue • Paleness of mucosa of soft palate • Low haemoglobin • Swelling of feet in severe anaemia • Spoon shaped nails
odine deficiency disorder	• Thyroid enlargement: gland visible and enlarged • Abortions, Congenital abnormalities, • Cretinism
iboflavin deficiency	• Angular stomatitis- lesions on both angles of the mouth • Glossitis - Tongue bright red or magenta • Cheilosis - Lips become red and develop cracks
iacin deficiency	• Dermatosis - Symmetrical skin lesions evident only on areas exposed to sunlight
itamin C deficiency	• Spongy bleeding gums
ickets	• Changes in skeletal system- such as beading of ribs, pigeon chest: protruding breast bone, knock-knees or bow legs
ssential fatty acid ficiency	• Lesions in the skin-generally seen on back of elbows, around knees and sides
uorosis	• Mottled teeth with chalky white and brownish areas with or without erosion of enamel

We discussed above that we can assess various nutritional problems by looking at the clinical signs in the person. We will now discuss the next method of direct nutritional assessment which is the biochemical assessment. But, first let us recapitulate what we have learnt so far.

Check Your Progress Exercise 1

1. What are the other three methods of direct assessment of nutritional status in addition to nutritional anthropometry?

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2. What do you mean by clinical assessment?

.....

3. List two clinical signs each of the following nutritional disorders.

Nutritional disorders	Clinical signs
Kwashiorkor	
Vitamin A deficiency	
Anaemia	
Iodine deficiency	
Riboflavin deficiency	
Niacin deficiency	
Vitamin C deficiency	
Rickets	
Fluorosis	

Now let us learn about the biochemical assessment.

8.3 BIOCHEMICAL ASSESSMENT

Biochemical assessment deals with *measuring the level of essential dietary constituents (nutrient concentration, metabolites) in the body fluids (normally blood and urine) which is helpful in evaluating the possibility of malnutrition.* We have learnt in the previous unit that in the development of nutritional deficiency disease, certain biochemical changes occur before clinical changes take place. These are also considered to indicate sub clinical nutritional status with reference to various nutrients. The range of biochemical tests that can be used is considerable. Before we go into details about various biochemical tests, we will give you an overview of biochemical tests. Let us begin with an overview of biochemical tests.

8.3.1 Biochemical Tests – An Overview

Before we conduct a biochemical test, there are some important points about which we should know. These are: what is an ideal biochemical test, what criteria do we use for selection of field test, what precautions do we use while performing a test, why do we need accuracy and what is the importance of standardization in these tests. Let us find out the answers to these questions next.

What is an ideal test?

An ideal biochemical test suitable for field survey should be *sensitive* (easily identify most positives), *specific* (easily identify normal subjects), *easy to carry out*, preferably non-invasive and *inexpensive*. It should reveal information on the extent of tissue unsaturation rather than the fluctuations that occur with variations in the diet. However, it is often difficult to have a biochemical test satisfying all these specified conditions. The choice of the test depends on the actual aim i.e. to make diagnosis of population surveys.

What is the criterion for selection of field tests?

In the field conditions, the selection of the tests will be limited by the need for single-specimen tests rather than tests required more than once, age groups (collection of blood samples in young children being difficult), the site of collection of blood samples (finger-prick vs. veni-puncture samples), availability of laboratory facilities and skilled manpower. Thus, for field surveys, finger-prick blood samples and random samples of

fasting samples of blood like for assessment of the extent of diabetes mellitus. The samples should be stable particularly during transport, not requiring refrigeration, as far as possible, and should not be affected by the recent meal or water consumption. In view of this, currently, tests involving dry *blood spot methods* are being developed. For example, such tests are already available for estimation of haemoglobin and serum vitamin A. It is often suggested, considering the logistic difficulties and the cost of the tests, that biochemical assessment be carried out in a sub sample of the study population.

What precautions do we take while performing a biochemical test?

Another important factor of consideration is use of disposable lancets for finger pricking and of disposable syringes for venipuncture specimens to avoid the danger of hepatitis and HIV infections. Even the investigators collecting the blood samples should wear disposable gloves as a precautionary measure against these.

The commonly included biochemical investigations in some routine field surveys are estimation of haemoglobin to assess the extent and distribution of anaemia and urinary iodine estimation to assess iodine status of the communities. In specific surveys for the assessment of sub clinical deficiency of vitamin A deficiency, estimation of serum vitamin A is also being attempted.

Next, let us get to know why there is a need for accuracy and standardization of procedures in biochemical assessment.

Why there is a need for accuracy?

In the selection of methods for field surveys, accuracy and precision should not be sacrificed for the sake of convenience. For example, in large scale national surveys in India 'haemocue' was used as it was simple and required a drop of blood for estimation of haemoglobin. Subsequent investigations have revealed that 'haemocue' gives higher values of haemoglobin in countries like India, where anaemia is widely prevalent leading to underestimation of the prevalence. Thus, in the selection of methods and equipments, appropriate care should be taken.

Why standardizing the procedures?

As discussed earlier, it is very important to standardize the procedures and the investigators for accurate measurements. All the equipment should be tested for their accuracy and necessary care should be taken to carry voltage stabililizers in rural areas where electricity fluctuations are very common. The training of the investigators should be such that the *between observer* and *within observer variations* should be within the allowable minimum ranges. It should be recognized that errors could lead to inaccuracy, if the procedures of collection of samples are not proper. Cold-storage of the biological specimens is most often required and adequate arrangements should be made for the purpose. If the samples are collected elsewhere and are transported to the laboratory, steps should be taken to provide for cold thermos flasks, which would keep cool for sufficient length of time.

Having learnt about the basic concepts of biochemical assessments, it is now the turn of biochemical tests i.e. let us review the different biochemical tests which can be used to assess nutritional status.

8.3.2 Biochemical Tests for Nutritional Deficiencies

We will now discuss the different biochemical tests used to assess nutritional status of community. It may be mentioned that the information on methodology for conducting the various tests is not provided in this section, since it is not within the purview of this unit. If you are interested to know about the methodology we suggest you look in the publications on laboratory methods of biochemical tests in any library or perhaps

find it on the internet. Here our focus will be to learn about the different tests that could be used to assess the sub clinical status of various nutritional deficiencies and about the interpretation of results. The nutritional deficiencies that we will discuss are:

A. Protein energy malnutrition,

B. Vitamin A deficiency,

C. Anaemia,

D. Iodine deficiency,

E. Vitamin D deficiency, and

F. Other nutrients like riboflavin, niacin, folic acid, vitamin B_{12} and zinc.

Let us start with protein energy malnutrition.

A. Protein Energy Malnutrition

In most situations, dietary protein deficiency is secondary to calorie deficiency, dietary protein deficiency may be a specific problem only in some clinical conditions. The principle is that in protein deficiency, proteins and its derivatives are lowered. A number of tests like *serum proteins*, *urea creatinine ratio* and *hydroxyproline index* have, therefore, been suggested to assess protein nutritional status. However, these are not sensitive indicators of early protein malnutrition and do not provide any additional information over anthropometry. However, in clinical practice and nutrition surveys, serum albumin is the preferred method. Serum albumin reflects the long-term changes in protein nutritional status. The guidelines for determining changes in protein nutritional status of children using serum albumin as an indicator are presented in Table 8.2.

Table 8.2: Serum albumin levels as an indicator to assess protein nutritional status in children < 5 years of age malnourished children

S.No.	Protein nutritional status	Serum albumin levels (g/100ml)
1.	Deficient (high risk)	< 2.8
2.	Low (medium risk)	2.8 - 3.4
3.	Acceptable (low risk)	> 3.5

Serum proteins, though are used in some cases, but can be raised during infections, which are very frequent in rural preschool children. Hence, we need to consider this aspect while using this measure. You can note from Table 8.2 that different serum albumin cut-off values are used to indicate deficiency (high risk), low or medium risk and acceptable cases.

Let us go to the vitamin A deficiency assessment tests next.

B. Vitamin A Deficiency

There are three methods to assess vitamin A deficiency. These include:

1) Serum retinol method,

2) Relative dose response method, and

3) Filter paper method.

Let us get to know them.

1) *Serum retinol method*

Serum retinol or serum vitamin A is generally the simplest and feasible method of assessment of vitamin A status in communities. It may be noted that this indicator does not indicate the true tissue status of vitamin A. The guidelines for determining the vitamin A status based on serum retinol is given in the Table 8.3.

Table 8.3: Vitamin A status based on serum Vitamin A levels

S.No.	Vitamin A status	Serum vitamin A levels	
		ug/dl	Umol/litre
1.	Deficient (high risk)	< 20	< 0.7
2.	Low (moderate risk)	20 - 30	0.7 - 1.05
3.	Acceptable	> 30	> 1.05

Vitamin A is regarded as public health problem in a community if serum vitamin A levels are <10 µg/dl or <0.37 µmol/litre in more than 5% of children under the age of six years. In other words, in such communities, there is a need for initiating nutrition intervention programmes like vitamin A supplementation.

Let us now learn about the second method which we can use to assess vitamin A status.

2) *Relative dose response method*

A new method known as *Relative dose response (RDR)* is considered to be a better indicator of vitamin A stores in the body. Increase (%) in serum vitamin A levels is measured after a small oral dose of 450-1000 µg of vitamin A. The post dose is inversely related to the vitamin A status of the individual. An increase >20% is indicative of vitamin A deficiency in an individual. The limitation of the test is that it requires taking blood samples twice, which may not be feasible in young children particularly in community surveys. This limitation could be got over in Modified Relative Dose Response (MRDR) test where only one blood sample after administration of a prescribed dose (100 µ g / kg body weight) of dehydroretinol (vitamin A_2) is taken. However, it is often difficult to procure vitamin A_2. A ratio > 0.06 of vitamin A_2/ vitamin A is suggestive of deficiency. The major limitation of serum retinol estimations is the requirement of sophisticated and expensive instruments like High Pressure Liquid Chromatography (HPLC). Finally let us learn about the filter paper method.

3) *Filter paper method*

In the filter paper method, a blood spot is collected on a special filter paper and dried and carried to a laboratory for estimating serum retinol levels. This method though is simple, requires HPLC and the samples should be kept in cold storage. These facilities may not be available in many areas.

Next, let us learn about the biochemical assessment methods for the presence of anaemia in individuals.

C. Anaemia

Nutritional anaemia, as you may already know, is the most widespread of all the nutritional deficiencies. It is largely due to iron deficiency though folate deficiency is also observed in poor communities. There are two main methods used to assess iron deficiency. These are: 1) measurement of haemoglobin, and 2) estimation of iron stores. Let us review these now.

Measurement of haemoglobin is the simplest method to assess nutritional anaemia communities. In fact in view of the subjective bias in identifying clinical anae haemoglobin estimation is adopted in large-scale surveys. It requires 20 µl of fin prick blood sample, collected in a haemoglobin pipette and is estimated cyanmethaemoglobin method by colorimetry. Inexpensive models of colorimeters available in India now. Earlier in sub-section 8.3.1, we studied about the Haemo method which is also used to assess haemoglobin levels. Because haemocue is e to use in a field situation, it is recommended for use. However, it has few limitati specific to accuracy, which needs to be considered.

The criteria for diagnosing anaemia as recommended by the World Health Organizat are given in Table 8.4.

Table 8.4: WHO guidelines for diagnosing anaemia

Group	Cut-off for Haemoglobin (g/100 ml)
Children < 6 years	11
Children > 6 years Adolescents	12
Non-pregnant and non-lactating adult women	12
Pregnant women	11
Lactating women	12
Adult males	13

Cases with values lower than the cut off suggested in Table 8.4 are considered anaemic.

Next let us learn about methods of estimating iron stores in the body.

2) *Estimation of Iron Stores*

Estimation of either *bone-marrow* iron or *serum ferritin*, both of which are lowered, indicates the earliest stage of iron deficiency. Other than serum ferritin, *transferrin saturation*, *erythrocyte protoporphyrin* and *serum transferrin receptors* are the other measures used to examine the prevalence of iron deficiency. Let us get to know about these measures.

Serum Ferritin (SF) test permits an evaluation of the storage iron level of a population. At all ages, serum ferritin levels <12 µg are strongly suggestive of iron deficiency. What we need to know here is that any inflammatory condition can also lead to increase in serum ferritin levels and, therefore, should be excluded. Serum iron is also estimated to assess iron deficiency. Serum iron levels < 40 µg/dl and transferring saturation of <15% are suggestive of iron deficiency. *Transferrin saturation* helps to determine whether the supply of iron is appropriate for the bone marrow, which is esponsible for the production of haemoglobin and red blood cells. This is a ratio (expressed as percentage) of serum iron and total iron binding capacity. The normal value is 33%. A low transferrin saturation and serum iron are characteristics of both iron deficiency, and recent or concurrent infection. *Erythrocyte Protoporphyrin*, like, transferrin saturation, helps to determine the supply of iron. Erythrocyte protoporphyrin is elevated in cases of iron deficiency (i.e. when there is insufficient supply of iron for heme synthesis). In children below the age of four, values > 80 µg/dl of red blood cells are indicative of iron deficiency. *Serum transferrin receptors*, is a new test for the evaluation of iron status. Measure[illegible] of circulating transferrin receptor, on cell surfaces and in plasma, provide a rel[illegible] iron deficiency anaemia. *Transferrin* become elevated whenever there is insufficient iron supply to cells or iron depletion.

The criteria generally used to diagnose iron deficiency is listed in Table 8.5.

Table 8.5: Diagnostic criteria for iron deficiency anaemia

Indicator	Cut-off point
Serum Iron (µg/dl)	< 60
Total iron binding capacity (µg/dl)	> 300
Transferrin saturation (%)	< 15
Erythrocyte protoporphyrin (µg/dl)	> 100
Serum ferritin (µg/l)	< 12

In view of the need for laboratory facilities and skilled man power these tests are carried out only on a limited scale.

Next, let us go over to tests related to iodine deficiency.

D. Iodine Deficiency

Urinary iodine levels reflect the iodine status in a community. On adequate dietary iodine intakes, the median urinary iodine is 100 µg/L and is considered as normal. In other words, in areas with adequate iodine intakes, in half of the population urinary iodine level will be >100 µg/L. Similarly, if in > 20% of the subjects, urinary iodine levels are < 50 µg/L, the population is considered to be iodine deficient. The cut-off points for defining the iodine status of a population according to the median urinary iodine concentration are given in Table 8.6.

Table 8.6: Criteria for defining the iodine status of a populataion based on median urinary concentration

Iodine status	Median urinary iodine concentration (µg/dl)
Severe iodine deficicieny	< 20
Moderate iodine deficiency	20 - 49
Mild iodine deficiency	50 - 99
Ideal iodine intake	100 - 200
More than adequate iodine intake (may increase the risk of iodine induced hyperthyroidism)	201 - 299
Excessive iodine intake	> 300

Let us now discuss the biochemical tests for vitamin D deficiency.

E. Vitamin D Deficiency

Clinical forms of vitamin D deficiency are rare in community surveys and cases of rickets are seen only in hospital practice. Serum levels of *25-hydroxy cholecalciferol* or *25 HCC* (which you may recall reading in the Nutritional Biochemistry Course, Unit 3, is a metabolite of vitamin D) are the accepted indicators of vitamin D deficiency. Levels >10 ng/ml (25 nmoles/l) are considered acceptable while 5-10 ng/ml as low and < 5 ng/ml as high risk.

Let us go over to the biochemical tests for deficiency of other nutrients.

F. Other Nutrients

Biochemical tests related to the deficiency of other nutrients i.e. riboflavin, niacin, folic acid, vitamin B_{12} and zinc can also be considered, for assessing biochemical status of community. These are indicated in Table 8.7. These are carried out in specific surveys.

Table 8.7: Biochemical tests and criteria for nutritional deficiencies

Nutritional deficiency	Test	Deficiency Criterion
Riboflavin	1. Urinary Riboflavin 2. Erythrocyte Glutathione Reductase (EGR) test	< 80 µg/g of Creatinine >1.7 (high risk)
Niacin	Ratio of N'- methyl -2-pyridone-5 carboxylamide and NI-methylnicotinamide	< 1
Folic acid	Serum Folate	< 3ng/ml
	RBC Folate	140 ng/ml
Vitamin B_{12}	Serum B_{12}	80 pg/ml
Zinc	Plasma Zinc	< 84µg/dl

Interpretation of biochemical parameters is often complicated. It is not frequent to observe florid cases of clinical nutritional deficiencies with normal biochemical values at the community level. Other factors like dietary intakes and bioavailability of nutrients should be considered for proper interpretation of the biochemical values. A common example is total goiter rate (TGR) and urinary iodine levels, despite the TGR being in the endemic range, the median urinary iodine values are normal. In such cases, the distribution of biochemical values would be better.

We hope having gone through the discussion above, you would now be in a good position to identify the biochemical tests which you would use while conducting nutritional assessment of population groups. Let us take a break here and then answer the questions given in check your progress exercise 2.

Check Your Progress Exercise 2

1. What do you understand by biochemical assessment? What are the characteristics of an ideal biochemical test?

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   .....

2. Match the following biochemical tests in column A with the nutritional deficiencies in column B.

Column A	Column B
1. Serum albumin	a. Goitre
2. Serum retinol	b. Anaemia
3. Haemoglobin	c. PEM
4. Urinary iodine	d. Vitamin A
5. Serum folate	e. Riboflavin
6. erythrocyte glutathione reductase	f. Folic acid

3. What are the methods to assess:

a) Vitamin A deficiency

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b) Iodine deficiency

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We have learnt about the clinical assessment and biochemical assessment as methods of direct nutritional assessment. Let us now study about the last method i.e. dietary assessment of nutritional status.

8.4 DIETARY ASSESSMENT

Dietary assessment is conducted with the help of diet surveys. When a *systematic inquiry into the food supplies and food consumption of individuals and population groups is made, we call it a diet survey.* Diet surveys, most often are a part and parcel of routine nutrition surveys. Accurate information on dietary patterns of communities would help in assessing the nutritional status of people but also for determining the relationship between nutrient intakes and deficiency diseases. These would help in understanding the dietary status of the community vis-á-vis other indicators of nutritional status like anthropometry, clinical signs of deficiency or biochemical parameters. Sometimes, dietary assessment of subjects in an institution like hostels or prisons also may be required to assess the adequacy of diet for any modifications. An appraisal of the dietary adequacy for populations would be required for planning programmes to overcome diet related disorders and to promote nutrition in general. Quantitative data on dietary intakes of populations are taken into consideration for fixing minimum wages and rations for households. In the recent past, assessment of the extent of poverty is based on dietary energy consumption pattern.

The dietary intakes can be assessed quantitatively either at the family or individual level. Sometimes institutional diet surveys are also important to find out the dietary intakes of individuals in large institutions. We would now study about common methods to assess dietary intakes at various levels.

The commonly used methods are:

- Family/Household Diet Survey
  - a. Weighment method
  - b. Consumption Expenditure Survey
- Assessment of dietary intakes of individuals
  - a. Individual Oral Questionnaire (24 hour recall method),
  - b. Food Record or Diary and
  - c. Diet History.

- Qualitative Survey
- Institutional Diet Survey
- Food Balance Sheets

Let us begin with dietary surveys for the family.

8.4.1 Family Diet Surveys

Family diet surveys collect information on diet at the household level. The results a expressed as per capita or per consumption unit. In these surveys, it is not possible find out the intakes of particular age groups or physiological groups. Since these a simpler than 24-hour recall individual diet surveys about which he will study later in th unit, routine nutrition surveys adopt these methods. These methods include: weighme method and consumption expenditure surveys.

Let us learn about these methods in details. Let us begin with weighment method firs

A. Weighment Method

Weighment method of diet survey involves actual weighing of raw foods on a give day. The investigator visits the households before the food is cooked and weighs wit the help of a grocer's balance or on a electronic balance all the foodstuffs (edibl portions) that will be cooked for the day.

Earlier, weighment of foods was being carried out on seven consecutive days and th method was known as *seven-day weighment method.* Seven day surveys were logistically more difficult and time consuming. They also required complete cooperation of the households selected for the purpose. In the nineteen sixties, considering the monotony of the rural Indian diets with hardly any variation in the diet, after comparing the results of seven day and one day methods, it was decided to adopt one-day weighment diet surveys for assessing family dietary status in villages. Even now, in the urban areas, 3-day weighment is adopted, since there is more variation in these diets. Under weighment method, all the raw food items (edible) are weighed according to meal pattern(i.e. breakfast, lunch, evening tea and dinner) for the day of survey using grocer's balance and local measures. Information on all the family members who will be consuming the meal on that day is collected according to age and physiological status. In the case of young children, information on breast-feeding and complementary feeding practices is also collected. The respondent (house wife) is requested to bring all the raw foodstuffs she will be using for that day's menu. Each food item is weighed carefully and the weights are recorded in a proforma. The team is expected to visit the house as many times as the food is cooked and weigh all the foods that will go into the meal. However, in practical terms, often this may not be possible as the family may have foods just adequate for one meal and for the evening meal foods may be purchased only after the day's wages are collected. Therefore, information about what the quantities of foods would be, is collected from the respondent. It is also important to collect information about foods eaten outside home, supplementary food given to young children and food that is left over at the end of the day. In certain areas, even the cattle are fed either chapatis (roties) or rice. This information should be collected lest there will be overestimation of the intakes. As far as possible, the survey should not be carried out either on feasts or fasting days. Similarly, on occasions when special guests are present, the diet may not represent the actual intakes in the family. In the urban areas, the data is collected in the same way for three consecutive days.

The dietary consumption is usually expressed *per consumption unit* (CU), which represents the intake of a sedentary adult male. These consumption units are calculated based on the calorie coefficients suggested based on the calorie requirements for different age, sex and physiological groups. The calorie requirements for one consumption unit are 2400 kcals. The Indian Council of Medical Research (ICMR) recommends the following calorie coefficients [illegible] in Table 8.8, considering the value for a sedentary adult male as 1.

Table 8.8: Calorie coefficient expressed in relation to consumption units (CU) for age/sex/activity levels

Age/ sex/physiological group	CU
Adult Male – sedentary	1
Adult Male – moderate activity	1.2
Adult Male – Heavy Activity	1.6
Adult Female – sedentary	0.8
Adult Female – moderate activity	0.9
Adult Female – Heavy Activity	1.2
Adolescents (12-21 years)	1.0
Children – 9-12 years	0.8
Children – 7-9 years	0.7
Children – 5-7 years	0.6
Children – 3-5 years	0.5
Children – 1-3 years	0.4

The total number of consumption units in each family is first calculated based on the information on age, sex, activity, and physiological status of all the individuals in the family. The number of consumption units will be less than the total number of members in the family. We can calculate intake of each food per consumption unit as follows.

$$\text{Intake of each food/CU per day} = \frac{\text{Raw amounts of each food}}{\text{No. of consumption units}}$$

We can explain this with the help of an example. Suppose we have a family of four consisting of two adults and two children in a household, we can calculate the total consumption units as shown in Table 8.9.

Table 8.9: Calculation of total consumption units by a family of four people

Characteristics	Adult male	Adult female	Child (3yrs)	Child (7 yrs)
Family composition	1	1	1	1
Type of activity	Moderate	Moderate	-	-
Physiological status	-	(Non pregnant, non lactating)	-	-
Equivalent consumption unit(C.U.)	1.2	0.9	0.4	0.6

We can note from the Table 8.9 that total CUs for this family are 3.1. We can now take the example of rice being consumed by the family and can calculate the intake of rice/CU per day as follows. Suppose during the survey of this family, if the total intake of rice is found to be 400 g/day, then intake of rice/CU/day = Total intake of rice/total CU= 400/3.1 = 129 g. In this way, we can determine the intake of each food/ CU/day for each food consumed by the family.

The raw foods are converted into nutrients using the food composition tables (Nutritive Value of Indian Foods, National Institute of Nutrition, 2004), which provide nutrient content of commonly consumed Indian foods. These are then compared with the recommended dietary intakes suggested by Indian Council of Medical Research (ICMR) for different nutrients for sedentary adult male to find out the adequacy or otherwise of the diets in the family. The data obtained on all the families is then summed up to calculate the average intakes of the community surveyed. The major limitation in the method is that consumption units are computed on the assumption that calorie coefficients hold good for all the nutrients. Sometimes, the data are also expressed per capita (per head) by dividing the total consumption of foods by the total number of members (every member is treated as equal irrespective of age/sex/physiological status who have partaken in the meal.

Having gone through the discussion above, you must have understood the weighment method and per consumption unit concept. Next, we move on to the consumption expenditure survey.

B. Consumption Expenditure Survey

In the consumption expenditure survey, the money spent on all the food and non food items for a fixed period in the immediate past (usually one month) is found out by administering a specially designed proforma. This is considered to be comparable to the results of weighment diet survey. The *National Sample Survey Organization* collects such information every five years. In fact, the extent of poverty in the country is calculated based on the results of food consumption surveys. The results provide information on foods bought by the family, which need not always mean actual consumption.

Having studied about the family diet surveys, next, we move on to the assessment of dietary intakes for individuals.

8.4.2 Assessment of Dietary Intakes of Individuals

Dietary status of individual "at risk" groups is often required to plan specific programmes for that group. For example, information of actual intakes of preschool children or pregnant women who are considered more vulnerable is essential to assess the actual deficit in the diets and to decide the quantities of supplements to be provided in the intervention programmes. We will discuss three types of methods used to collect information on dietary intakes of individuals. These are:

a. Individual Oral Questionnaire (24-hour recall method),

b. Food Record or Diary, and

c. Diet History.

Out of these, the *24-hour recall method* is probably the mostly widely used method of dietary assessment. We will now discuss these methods in details. Let us begin with the 24-hour recall method.

a. Individual Oral Questionnaire (24-hour Recall Diet Survey)

The 24 hour recall method is used in large nutritional surveys to collect dietary intake data of individuals. In this method, the individual is asked to recall in as much detail as possible the food intake for the past 24-hours by interview or by completing a questionnaire. The respondent recalls *what was eaten, how much food was eaten, how was the food prepared, when was it eaten and other details related to food intake*. However, while conducting the survey, both the respondent and the housewife (or the person who cooks the food for the whole family) is contacted. The dietary intakes are assessed in terms of cooked food with the help of standardized cups measures appropriate for the local conditions. These cups are used to help the

accurate, are a very poor descriptor of an individual's usual nutrient intake because of day-to-day or intra individual variability. However, a sufficiently large number of 24 hour recalls may provide a reasonable estimate of the mean nutrient intake of a group.

Let us now move on to the next method of assessing individual dietary intake i.e. Food Record or Diary.

b. Food Record or Diary

Food record or diary method provides food consumption data of individuals. Under this method, the subject records, at the time of consumption, the type and amounts of all foods and drinks consumed for a period of time usually ranging from 1 to 7 days. Portion sizes are estimated using food models and standard measuring instruments or food items are actually weighed. The strengths of the food record method are that it does not depend much on memory because the subject records food and drink consumption at the time of eating. In addition, it can provide detailed food intake data and important information about eating habits (for example, when, where, and with whom meals are eaten). However, the main limitation of this method is that recording food intake requires a literate and cooperative subject who is willing to spend the time and effort. Individuals having the time, interest and ability to complete several days of food records without assistance may not be representative of the general population.

Let us now move on to the third method of assessing dietary intake of individuals i.e. diet history.

c. Diet History

Diet history yields a retrospective estimate of food and nutrient intake of an individual over a period of time. The period covered may range from a month to one year at the most. Traditionally, the diet history approach has been associated with the method of assessing usual diet developed by a scientist, *B.S. Burke*. Burke's original method involves four steps; 1) collect general information about the subject's health habits 2) conduct 24-hour recall to get information on the subject's usual pattern of eating, 3) perform a cross check on the data given in step 2, and 4) have the subject complete a 3 day record.

Let us review these steps briefly.

1) Collect general information about the subject's health habits: Information is collected from the individual about the number of meals eaten per day, appetite, food dislikes, the presence or absence of nausea and vomiting, use of nutritional supplements, habits related to sleep, rest and work etc. This allows the interviewer to become acquainted with the subject in ways that may be helpful in obtaining further information.

   Next, collect 24-hour recall to get information on the subjects usual pattern of eating. Let us see how.

2) Conduct 24-hour recall to get information on the subject's usual pattern of eating: A 24-hour recall is conducted with the subject using the technique as discussed earlier. The information is thus collected on subject's usual pattern of eating during and between the meals including types of food eaten, serving sizes, frequency and timings. Next perform a cross check on this data as explained next.

3) Perform a cross check on the data given in step 2 above: Once the information on 24 hour recall is collected, the data is then cross checked by asking specific questions about the subjects' dietary preferences and habits. For example, the subject may have said that he or she drinks 200 ml of milk every morning. The interviewer should then inquire about a subject's milk drinking habits to clarify and verify the information given about the subject's milk intake.

4) Have the subject complete a 3 day record: Finally the subject is asked to complete a 3-day record, which serves as an additional means of checking the usual intake.

As we said earlier, this is an approach suggested by *B.S. Burke*, but several investigators have modified it to suit their needs. The strengths of the diet history approach are that it assesses the subject's usual dietary intake, including the seasonal variations, and therefore, data on all nutrients can be obtained. The main limitation of this method is that it requires 1-2 hours to conduct the interview. Highly trained interviewers are needed and nutrient intakes tend to be overestimated.

Thus, the three methods discussed above provide information on nutrient intakes of individuals. We can choose any method depending upon the objectives of our study, time and resources at hand although the 24-hour recall method remains a method of choice for large scale nutritional surveys.

The methods discussed above provide quantitative information about the diet. Sometimes we may want to collect only qualitative information about the diet. Let us get to know about qualitative diet surveys.

8.4.3 Qualitative Diet Surveys

In certain instances, quantitative information on dietary intakes may not be required. Under such circumstances, qualitative data is compiled by carrying out surveys either at family or individual level. In such surveys, information is compiled on the kinds of foods eaten, the frequency of their consumption, perceptions of the community about foods, attitudes towards different types of foods and the special foods consumed during particular conditions like pregnancy or lactation. An attempt is also made to collect data on the foods avoided during health and disease and foods restricted during morbidities. This data is useful for planning and evaluation of nutrition education programmes. Such data is collected through specially designed proforma.

We can study about one of such method in detail. This is known as food frequency method.

Food Frequency Method: Food frequency method consists of asking individuals (by interview or checklist) how often (daily, monthly, weekly) specific foods are eaten. This is then used as an index of diet pattern of population groups. The underlying principle of food frequency method is that average long term diet, for example, intake over weeks, months or years, is the conceptually important exposure rather than intake on a few specific days. Therefore, it may be advantageous to sacrifice precise intake measurements obtainable on one or a few days in exchange for more crude information relating to an extended period of time. In fact, food frequency methods has become the primary method for measuring dietary intake in epidemiological studies as they are easy for subjects to complete, often as self-administered form. A food frequency questionnaire or checklist consists of two components: *a food list* and *a frequency response section* for subjects to report how often each food was eaten. Refer to *Annexure 2* given at the end of this course. A food frequency questionnaire is given for you reference in this annexure. The questionnaire consist of a list of approximately 100 or fewer individual foods or food groups that are important contributors to the population's intake of energy and nutrients. Usually, the foods are grouped into categories (based on similarity of nutritive value, functions in the diet etc.). The strengths of food frequency questionnaire are that they are relatively inexpensive and quick to administer in large scale surveys. They are also considered one of the methods of choice for research on diet-disease relationships on both the macronutrient and micronutrient levels. The key limitation of food frequency questionnaire is that since the food list is limited to 100 or fewer foods and food groups, these must be representative of the most common foods consumed by individuals in a sample.

Sometimes we would like to know the dietary intake of large groups of people consuming food in an institution. For this, we use an institutional diet survey. Let us get to know about them.

8.4.4 Institutional Diet Survey

Institutional diet survey is used *to find out the dietary pattern of people residing in hostels, orphanages, prisons, army barracks and homes for the aged, homogenous groups of people take their food from a common kitchen.* The method of diet survey also is referred to as *inventory method.* The amounts of foods issued everyday as per the records are collected along with information on the number of individuals partaking in the meal. It is recommended that the inventory should be obtained for a period of at least one week. The average intake per person per day can be calculated as follows:

Average intake/person/day =

$$\frac{\text{Stocks at the beginning of the week} - \text{Stocks at the end of the week}}{\text{Total number of inmates} \times \text{Number of days of survey}} \quad (7)$$

The major limitations of this method are that the validity of the data depends on the accuracy of the records and any lapses in recording the issues could vitiate the results. The selection of the reference period should be random so as to avoid any manipulation of the records by the wardens. On a regular basis, we require information on dietary consumption of people at a country/regional level. For this, we use *food balance sheet.* Let us review what it is, next.

8.4.5 Food Balance Sheets (FBS)

The food balance sheet *is a method of indirectly estimating the amounts of food consumed by a country's population at a certain time.* It provides data on food availability or disappearance rather than actual consumption. Food and Agriculture Organization (FAO) of the United Nations compiles food balance sheets for different countries. These are prepared based on the assessment of the quantities of total food produced in the region/country, imports (if any), foods allocated for seed and industrial purpose, animal foods and wastage of foods (if any). The amounts are divided by the mid year population of the region/country and 365 to derive average per capita consumption per day. Food balance sheets generally provide information as to the foods available at the country level. The strength of this method is that it can give a total view of the food supplies of a country and can be used in drawing conclusions about food habits and dietary trends within a country. Food Balance Sheets are valuable for planning international nutrition policy and formulating food programmes. They are also useful for the administrators to monitor food position in the country. Food balance sheets also have some limitations. The accuracy of data is dependent upon available statistics, the quality of which can vary greatly depending upon a country's level of development. The data only represents the total amount of food reportedly available for consumption, not what was actually consumed, nor does it show how food was distributed among individuals or groups. Hence, they are of little use at the community level.

Thus you saw that there are different methods of assessment of dietary intake at various levels. The selection of the method of diet surveys depends upon the purpose, the group to be studied and the resources available.

With this, we end our study on dietary assessment. In the next unit, we will study about nutrition monitoring and surveillance.

Check Your Progress Exercise 3

1. Enumerate the common methods used to assess dietary intakes.

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