REVIEW ARTICLE

Methods to Access Nutritional Status of Children and Adults

Mayank Agarwal*, H.L. Gupta**, Sonam Agarwal***, Shipra Singhal****, Pankaj Chaudhary*****

Abstract

Nutrition is of fundamental importance to life. Nutritional health is maintained by a state of equilibrium in which nutrient intake and requirements balance. Malnutrition occurs when net nutrient is less than requirements. Assessment of nutritional status based on body composition involves detecting the loss (or gain) of body components relative to previous measurements and relating the values in a given patient to normal standards. A number of techniques have been developed which can accurately measure the nutrition status the body. However, various methods developed till date have both, advantages as well as their limitations. In the present day clinical setting it is, therefore, difficult to say which method is the best i.e., the method (including equipment) which is inexpensive, easy to use, precise and gives accurate interpretation of body compartments and is easy to use.


Key words: malnutrition, nutritional, status

DIET and NUTRITION

Diet: Total oral intake of a substance that provides nourishment & supply. Nizel (1972)
Nutrition: Nutrition is the science of food and its relationship to health. It is concerned primarily with the part played by the nutrient in body growth, development & maintenance. (W.H.O.)

Protein- They are complex organic nitrogenous compounds. Composed of Carbon, Hydrogen, Oxygen, Nitrogen, Sulphur. They are made up of smaller units amino acids. Total 24 amino acids are required, 9 are essential.

Functions of proteins are body building, repair and maintenance, synthesis of certain substance and energy. The chief sources are milk, meat, eggs, cheese, pulses, cereals, beans, nuts etc. Protein requirement of the body is 1 gm protein/kg body weight for an adult.

Protein Deficiency

Protein energy malnutrition (PEM) has been identified as a major health and nutrition problem.
in India which occurs particularly in weak people and children in the first years of life. It is not only an important cause of childhood morbidity and mortality, but also leads to permanent impairment of physical and at times of mental growth in those who survive. The incidence of Protein energy malnutrition in India in preschool age children is 1-2 per cent. Nearly 80 per cent, are the "intermediate" ones, that is the mild and moderate cases which frequently go unrecognized. The current concept of Protein energy malnutrition is that its clinical forms - Kwashiorkor and Marasmus - are two different clinical pictures at opposite poles of a single continuum.

Classification of Protein Energy Malnutrition:\[1\]

Protein energy malnutrition is a spectrum of conditions ranging from growth failure to overt Marasmus or Kwashiorkor, hence classification has to be based on arbitrary cut-off-points.

Some of the classifications are as follows:

1) Gomez' classification

Gomez' classification is based on weight retardation. It locates the child on the basis of his or her weight in comparison with a normal child of the same age. In this system, the "normal" reference child is in the 50th centile of the Boston standards. This classification therefore, has a prognostic value for hospitalized children.

$$\text{Weight for age (\%)} = \frac{\text{weight of the child}}{\text{weight of a normal child of same age}} \times 100$$

- Between 110 and 115% : normal nutritional status
- Between 90 and 110% : 1st degree, mild malnutrition
- Between 75 and 90% : 2nd degree, moderate malnutrition
- Under 75% : 3rd degree, severe malnutrition

2) Waterlow's classification

When a child's age is known, measurement of weight enables instant monitoring of growth. Measurements of height assess the effect of nutritional status on long-term growth.

$$\text{Height/Weight} = \frac{\text{Height of the child}}{\text{Weight of a normal child at same height}} \times 100$$

- Normal
- Mildly impaired: 85 - 90
- Moderately impaired: 80 - 85
- Severely impaired: < 80

3) Arm Circumference (Jelliffe Classification)

Arm circumference yields a relatively reliable estimation of the body's muscle mass, the reduction of which is one of the most striking mechanisms by which the body adjusts to inadequate energy intakes.

Cannot be used before the age of one year and between ages one and five years, it hardly varies

Arm circumference:
- exceeding 13.5 cm : satisfactory nutritional status,
- between 12.5 and 13.5 cm : mild-moderate malnutrition
- below 12.5 cm : severe malnutrition.

Fats - They are concentrated source of energy. They are of three types: simple lipids (triglycerides), compound lipids (phospholipids) and derived lipids (cholesterol)
The main sources of fats are ghee, butter, milk, cheese, eggs, meat, fish, groundnut, mustard, coconut etc.

Visible fat– it is separated from natural sources like ghee from milk and oil from nuts.

Invisible fat– not visible to naked eyes and is present in all food articles.

**Excess Intake**

Obesity– Abnormal growth of the adipose tissue due to enlargement of fat cell size (hypertrophic obesity) or an increase in fat cell number (hyperplastic obesity) or a combination of both—it has an increased risk of coronary heart disease.

**Assessment of Nutritional Status**

The nutritional status of an individual is often the result of many inter-related factors. It is influenced by food intake, quantity & quality & physical health. The spectrum of nutritional status spread from obesity to severe malnutrition.

The need to assess the nutritional status is to identify individuals or population groups at risk of becoming malnourished, identify individuals or population groups who are malnourished, to develop health care programs that meet the community needs which are defined by the assessment and to measure the effectiveness of the nutritional programs & intervention once initiated.

**Methods of Nutritional Assessment**

1. Clinical history and examination
2. Anthropometric methods
3. Biochemical, laboratory methods
4. Dietary evaluation methods
5. Functional assessment
6. Vital and health statistics
7. Ecological studies

**Clinical History and Examination**

Patient complaints:
- General weakness
- Chronic fatigue
- Loss of appetite
- Painful bleeding gums
- Loss of weight
- Sore lips, oral mucus membrane, tongue
- Irritability
- Loss of ability to concentrate.
- Loss of manual dexterity

**MEDICAL AND SOCIAL HISTORIES**

- Chronic debilitating diseases
- Alcoholism
- Digestive disturbances
- Ulcerative colitis
- Diarrhea

**EMOTIONAL PROBLEMS:**

- Excessive weight loss – anorexia nervosa
- Food fads
- Medically unsupervised quick weight reduction diets

**Clinical Assessment**

It is an essential features of all nutritional surveys. It is the simplest & most practical method of ascertaining the nutritional status. It utilizes a number of physical signs, (specific & non specific), that are known to be associated with malnutrition and deficiency of vitamins & micronutrients. General clinical examination is done, along with special attention to organs like hair, angles of the mouth, gums, nails, skin, eyes, tongue, muscles, bones, & thyroid gland. Detection of relevant signs helps in establishing the nutritional diagnosis.

**Clinical Signs Of Nutritional Deficiency**

**Hair**

<table>
<thead>
<tr>
<th>Description</th>
<th>Deficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spare &amp; thin</td>
<td>Protein, zinc, biotin deficiency</td>
</tr>
<tr>
<td>Easy to pull out</td>
<td>Protein deficiency</td>
</tr>
<tr>
<td>Corkscrew</td>
<td>Vitamin C &amp; Vitamin A deficiency</td>
</tr>
<tr>
<td>Coiled hair</td>
<td></td>
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</tbody>
</table>

**Face**

<table>
<thead>
<tr>
<th>Description</th>
<th>Deficiency</th>
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</thead>
<tbody>
<tr>
<td>Dark skin over cheeks and under eyes, scaling of skin around nostrils,</td>
<td>Vitamin B complex specially niacin, pyridoxin, riboflavin</td>
</tr>
<tr>
<td>Edematous (moon face)</td>
<td>Protein deficiency</td>
</tr>
<tr>
<td>Color loss (pallor)</td>
<td>Iron deficiency</td>
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</tbody>
</table>

**Mouth**

<table>
<thead>
<tr>
<th>Description</th>
<th>Deficiency</th>
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<tbody>
<tr>
<td>Glossitis</td>
<td>Riboflavin, Niacin, Folic acid, B12 , protein deficiency</td>
</tr>
<tr>
<td>Bleeding &amp; spongy gums</td>
<td>Vit. C, A, K, Folic acid &amp; Niacin</td>
</tr>
<tr>
<td>Angular stomatitis, cheilosis &amp; fissured tongue</td>
<td>B2, 6, &amp; Niacin</td>
</tr>
</tbody>
</table>
Leukoplakia | Vit. A, B-complex, Folic acid & Niacin
---|---
Sore mouth & tongue | Vit. B12, 6, C, Niacin, Folic acid & Iron

**Eyes**

<table>
<thead>
<tr>
<th>Night blindness, Bitot’s spot, conjunctival and corneal xerosis, soft cornea (keratomalacia)</th>
<th>Vitamin A deficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Photophobia, blurring, conjunctival inflammation</td>
<td>Vit B2 &amp; Vit A Deficiencies</td>
</tr>
<tr>
<td>Pale conjunctiva</td>
<td>Iron deficiency</td>
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</table>

**Nails**

<table>
<thead>
<tr>
<th>Spooning</th>
<th>Iron deficiency</th>
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<tbody>
<tr>
<td>Transverse lines</td>
<td>Protein deficiency</td>
</tr>
</tbody>
</table>

**Skin**

<table>
<thead>
<tr>
<th>Pallor</th>
<th>Folic acid, iron, B12</th>
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</thead>
<tbody>
<tr>
<td>Follicular hyperkeratosis</td>
<td>Vitamin B &amp; Vitamin C</td>
</tr>
<tr>
<td>Flaking dermatitis</td>
<td>PEM, Vit B2, Vitamin A, Zinc &amp; Niacin</td>
</tr>
<tr>
<td>Pigmentation, desquamation</td>
<td>Niacin &amp; PEM</td>
</tr>
<tr>
<td>Bruising, purpura</td>
<td>Vit K, Vit C &amp; folic acid</td>
</tr>
</tbody>
</table>

**Thyroid Gland** - Enlargement of thyroid gland is seen in mountainous areas and far from sea places. Goiter is a reliable sign of iodine deficiency.

**Joints & Bones** - Help detect signs of vitamin D deficiency (Rickets) & vitamin C deficiency (Scurvy)

**Anthropometric Methods** - Anthropometry is the measurement of body height, weight & proportions. It is an essential component of clinical examination of infants, children & pregnant women. It is used to evaluate both under & over nutrition. The measured values reflect the current nutritional status and do not differentiate between acute & chronic changes. They include height, weight, mid-arm circumference, skin fold thickness, head/chest ratio and hip/waist ratio.

**Measurements for Adults**

**Height**: The subject stands erect & bare footed on a stadiometer with a movable head piece. The head piece is leveled with skull vault & height is recorded to the nearest 0.5 cm.

**Weight Measurement**: Electronic or balanced-beam scale are mostly used. Spring scales are less reliable, weigh is taken in light clothes and without shoes and read to the nearest 100 gm (0.1kg)

**Age-weight chart for boys**

**Age-weight chart for girls**

**Body Mass Index (BMI)**  
The international standard for assessing body size in adults is the body mass index.  

BMI is computed using the following formula:  

\[ \text{BMI} = \frac{\text{Weight (kg)}}{\text{Height (m)}^2} \]

**BMI (WHO – Classification)**

- **BMI < 18.5**  = Under Weight  
- **BMI 18.5 - 24.5**  = Healthy weight range
BMI  25-30   = Overweight (grade 1 obesity)
BMI > 30-40        =  Obese (grade 2 obesity)
BMI >40   =  Very obese (morbid or grade 3 obesity)

Evidence shows that high BMI (obesity level) is associated with diabetes & high risk of cardiovascular morbidity & mortality

**Midarm Muscle Area**

- Estimate of mid arm muscle area is an estimate of overall muscle mass.
- Assumptions are made that arm, muscle, bone are circular, Tricep skin fold is twice the thickness of fat and bone area is constant

\[
\text{ARM MUSCLE AREA-AMA} = ((\text{MAC} - (3.14 \times \text{TSF}))^2) / (4 \times 3.14)
\]

AMA = arm muscle area (cm²), MAC = mid-arm circumference (cm), TSF = tricep skin fold thickness (cm)

**Midarm Muscle Circumference**

- MAMC = AC - (3.14 x TSF)
MAMC = midarm muscle circumference in cm
AC = arm circumference in cm
TSF = tricep skinfold in mm

Change in arm muscle area is greater than the change in mid-arm circumference. Consequently, changes in upper-arm musculature are not as easily detected by measurement of mid-arm circumference as by arm muscle area. Therefore, arm muscle area is the preferred nutritional index.

**INTERPRETATION**

**Guidelines for Interpreting Percentile Values for Arm Muscle Area**

<table>
<thead>
<tr>
<th>Percentile</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;5th pct</td>
<td>Wasted</td>
</tr>
<tr>
<td>5th -12th pct</td>
<td>Below average</td>
</tr>
<tr>
<td>15th -85th pct</td>
<td>Average</td>
</tr>
<tr>
<td>85th-95th pct</td>
<td>Above average</td>
</tr>
<tr>
<td>&gt;95th pct</td>
<td>High muscle</td>
</tr>
</tbody>
</table>

**Head and Chest Circumference**

At birth – head circumference = 2 cms more than chest circumference. By 6 – 9 months – both measurements become equal. After 9 months – chest circumference overtakes head circumference.

**Waist/Hip Ratio**

Waist circumference is measured at the level of the umbilicus to the nearest 0.5 cm. The subject stands erect with relaxed abdominal muscles, arms at the side, and feet together. The measurement should be taken at the end of a normal expiration.

**Waist Circumference**

Waist circumference predicts mortality better than any other anthropometric measurement. It has been proposed that waist measurement alone can be used to assess obesity and two levels of risk have been identified

<table>
<thead>
<tr>
<th></th>
<th>Males</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 1</td>
<td>&gt;94 cm</td>
<td>&gt;80 cm</td>
</tr>
<tr>
<td>Level 2</td>
<td>&gt;102 cm</td>
<td>&gt;88 cm</td>
</tr>
</tbody>
</table>

**Waist Circumference**

Level 1 is the maximum acceptable waist circumference irrespective of the adult age and there should be no further weight gain. Level 2 denotes obesity and requires weight management to reduce the risk of diabetes & Cardiovascular complications.

**Hip Circumference**

Is measured at the point of greatest circumference around hips & buttocks to the nearest 0.5 cm. The subject should be standing and the measurer should stand beside him. Both measurement should be taken with a flexible, non-stretchable tape in close contact with the skin, but without indenting the soft tissue.

**Interpretation of Waist/Hip Ratio**

High risk Waist/Hip Ratio =  > 0.80 for females
                          > 0.95 for males

i.e. waist measurement >80% of hip measurement for women and >95% for men indicates central (upper body) obesity and is considered high risk for diabetes & Cardiovascular disorders. A Waist – hip ratio below these cut-off levels is considered low risk.

**Initial Laboratory Assessment: Hemoglobin Estimation**

It is the most important test and...
useful index of the overall state of nutrition. Beside anemia it also tells about protein & trace element nutrition. Stool examination can be done for the presence of intestinal parasites, urine dipstick & microscopy for presence of albumin, sugar and blood are also done.

**Biochemical Tests**

**Serum albumin level (3.5 gm/dl)** - Measures main protein in blood. Also determines protein status.

**Serum transferrin level (200 mg/dl)** - Indicates iron-carrying protein in blood
- Increase in Serum transferrin level indicates low iron stores
- Decrease in Serum transferrin level indicates body lacks protein

**Blood urea nitrogen (BUN) – 10-20 mg/dl** - May indicate renal failure, insufficient renal blood supply or blockage of the urinary tract.

**Serum creatinine (0.5-1.5 mg/dl)** - Indicates amount of creatinine in blood and is used to evaluate renal function

**Creatinine excretion** - Indicates amount of creatinine excreted in urine over a 24-hour period. It is used in estimating body muscle mass. In case of muscle mass depletion as in malnutrition; creatinine level will be low.

**Vital And Health Statistics** include morbidity, mortality, infant mortality rate, rate of low birth-weight babies and life expectancy. These factors help in identifying high risk group. These are influenced by nutritional data and may thus be indices of nutritional status

**Mortality Rates**

Crude Death Rate – Number of death from all causes per 1000 estimated midyear population in one year in a given place.

Specific Death Rate can be, age specific death rates, sex specific or specific to income

Proportional Mortality Rate

Number of deaths due to a particular cause per 100 or 1000 total deaths

Rate of Low Birth-Weight Babies - Babies born with birth weight of less than 2.5 kg (up to and 2499 gm), measured within the first hour of life. It is a major problem in developing countries. Maternal malnutrition and anaemia are mainly responsible for this.

**Assessment of Ecological Factors**

In any nutrition survey it is necessary to collect ecological information of the given community in order to make the nutrition assessment complete.

It comprises of:

a) **Food Balance Sheet:** This is an indirect method of assessing food consumption, in which supplies are related to census population to derive levels of food consumption in terms of per capita supply availability.

Disadvantages: The estimate refers to the country as a whole and so conceals differences which may exist between regions and among economic, age and sex groups.

Advantage: Cheaper and probably simpler than any method of direct assessment.

Used intelligently, this method does give an indication of the general pattern of food consumption in the country.

b) **Socio-Economic Factors:** Food consumption patterns are likely to vary among various socioeconomic groups. Family size, occupation, income, education, customs, cultural patterns in relation to feeding practices of children and mothers, all influence food consumption patterns

c) **Health And Educational Services:** Primary health care services, feeding and immunization programmes should also be taken into consideration

d) **Conditioning Influences:** These include parasitic, bacterial and viral infections which precipitate malnutrition.

It is necessary to make an "ecological diagnosis" of the various factors influencing nutrition in the community before it is possible to
put into effect measures for the prevention and control of malnutrition. Study done by Mehta et al in 1998 where all neonates weight was recorded on an electronic weighing scale at birth. Length, mid arm and head circumferences were recorded between 24-48 hours of birth. Quantification of growth of children in terms of per cent deficit from standard measurement was done by using methods suggested by Gomez and Waterlow by D. Hanumantha Rao et al in 1994. BMI estimation technique was used for nutritional assessment Body weight (kg) and height (meters) by V. Chaer Borges in 2011.

**Dietary Assessment** Direct assessment of food consumption involves dietary surveys which may be household inquiries or individual food consumption surveys.

Diet survey includes:

*Weighment of Raw Foods*- It is widely employed in India and is fairly accurate. Here the survey team visits household, weighs all food that is going to be cooked and eaten, and that which is wasted or discarded. The survey usually varies from 1 – 21 days but mostly 7 days are taken, called as One dietary cycle

*Weighment of Cooked Food*- Food is weighed in way in which it is normally consumed. This method is normally not acceptable to people.

*Oral Questionnaire Method*- This method is useful for a large number of people, takes less time. Here retrospective inquiries are made about the nature and quality of food eaten during previous 24 – 48 hours.

**Conclusion**

Growth and development of tissues and organ are affected by nutritional environment. Excess or deficiency of nutrition does have effect depending upon time and duration of excess or deficiency of nutrition and phase of growth. Planned and careful examination can help prevent and treat the nutritional disorder. Clinician can act as counselor and educator, thus helping in diet planning and treating the disorder. Co-operation of government and social bodies can help to overcome nutritional crisis.

**References**