NUTRIENT REQUIREMENT , MALNUTRITION – An Overview

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NUTRIENT REQUIREMENTS FOR INFANTS

- Nutritional status of pregnant women and lactating mothers is of paramount importance for later development of their children,
- During pregnancy and lactation women in developing countries usually need extra macronutrients and micronutrients to obtain additional energy and protein to ensure normal development of the fetus and neonates,
- They must therefore consume the right kinds of foods,
- Breastfeeding perfectly combines the three fundamentals of sound nutrition for infants:
  - **Food,**
  - **Health**
  - **Care**

Why is breast milk the ideal diet for infants?

Human breast milk:

- Is the ideal diet required for normal growth and development of healthy infants,
- Contains adequate amount of Energy and all the Essential Nutrients in biologically available forms for the digestive tract of the infants,
- Contains antibodies and all that is required to protect the infants from early infections (Colostrum)
- Is clean, safe and always in the correct temperature,
- Tightens maternal and infant bonds thus ensuring proper care and security for the infant,
- Is cheap and readily available to the infant,
- It is important to encourage exclusive breastfeeding of the infant for the first 6 months of life,

Why should appropriate adequate complementary feeding be encouraged?

- It is important to encourage adequate **Complementary Feeding** for infants after the first 4 or 6 months of age because of several reasons:
  - After 4 months of age the nutrients in breast milk are usually not enough to meet all the energy needs for the infant,
  - Energy requirements of infants increase rapidly because they are growing quickly and are more active,
  - Healthy growing infants usually have high-energy requirement for their size,

How can the increase in energy intake be achieved?

- High-energy foods with good quality proteins eaten, as part of small and frequent meals, should be given to infants,
  - Infants do not have large enough stomachs to cope with big meals,
- Adequate amount of high quality protein is necessary,
- Adequate amount of Micronutrients (Vitamins and Minerals) is necessary,
- Adequate amount of Calcium with vitamin D are needed for healthy tooth and bone development ,
- Adequate amount of Iron rich foods must be given to children during the period of rapid growth,
  - Iron deficiency anemia is associated with frequent infections, poor weight gain and delay in development,
  - Trace elements such as, Iron, Zinc, Iodine and Selenium are very important for physical and cognitive development of children,

If vegetarian diets are excellent for adults, why are they not excellent for infants?

- Vegetarian diet keeps adults in good health,
  - BUT, not appropriate for infants and young children who are at the period of rapid growth and development when adequate quantities of energy and nutrients are needed;
- Diets that are low in energy and fat and high in bulk may pose a nutritional risk for children when stomach capacity is limited,
- Presence of milk, milk products or eggs in a child's vegetarian diet ensures that adequate amounts of Calcium, Vitamins B_{12}, D and Riboflavin are supplied,
- Children who are vegetarian must have alternative sources of Iron, such as dark green leafy vegetables, pulses (beans), nuts and fortified breakfast cereals,
  - Iron from plant sources is less well absorbed than iron from animal sources,

- Consuming Vitamin C rich foods or drinks with a meal increases Iron absorption from plant sources, (e.g. fresh orange juice);
- Vegetarian diets are not recommended for infants during the weaning period,
- However, for families who are Vegetarians:
  - Weaning should follow the same dietary principle as for non-Vegan babies,
  - At least a glass per day of infant Soya formula should be consumed when breast milk is no longer given,
  - Vegan children under five years of age should receive supplements of Vitamin drops containing Vitamins A, C and D,
  - Foods fortified with B_{12} should either be included in the diet or supplement given.,

MALNUTRITION
What is malnutrition?

- It is a pathological state, general or specific, resulting from a relative or absolute deficiency or excess in the diet of one or more Essential Nutrients,
- It may be clinically manifest or detectable only by Biochemical and Physiological tests,

What are the different forms of malnutrition?

- Starvation,
- Under-nutrition,
- Specific deficiency,
- Over-nutrition,
- Important to note:
  - Some authors do not consider over-nutrition and its resulting obesity as malnutrition,
  - In developing country malnutrition is synonymous with growth failure,
  - Malnourished children are shorter (stunted) and lighter than they should be for their age,

What parameters are used to determine malnutrition in children?

- Four Indicators or Indices of nutritional status are used to determine if a child is malnourished or well nourished: They are:
- **Weight-for-Length (W/L) or Weight-for-Height (W/H);**
- **Length-for-Age (L/A) or Height-for-Age (H/A);**
- **Weight-for-Age (W/A);**
- **Mid-Upper-Arm-Circumference (MUAC);**

- There are standard reference tables for each indicator that contain measurements done on healthy and well-nourished children;
- **Weight-for-Height or Weight-for-Length**:
  - Indicates wasting and the current nutritional status of the child, because weight is most sensitive to recent events;
  - If a child has been sick and has experienced a recent shortage of food, the weight will decrease but the height remains the same,

- In PNG the classification use for Weight-for-Height or Weight-for-Length is as follows:
- Percentage of Standard W/H (Classification):
  - Below 80% (Severe wasting)
  - **80 – 89%** (Moderate wasting)
  - 90 – 120% (Normal)
  - Above 120% (Obesity or Over-nutrition)

Example: James is a 4 years old boy. His Weight is 10.0kg and height is 80.0cm. If in the reference table the standard weight for an 80.0cm child is 12.0kg, **what is the nutritional status of James?**

- **Answer**:
  - In Weight-for-Height reference table the Standard weight for a child of Height 80.0cm is 12.0kg;
  - Weight of James is 10.0kg,
  - Therefore James will have a percentage of W/H as:
    - Weight of James divided by Standard Weight multiplied by 100;

    10.0/12.0 x 100% = 83.3% of standard W/H
  - In the Classification above the nutrition status of James is Moderate Wasting;

What is Z-score or Standard Deviation Unit (SD)?

- Z-score or Standard Deviation unit:
- Difference between the value for an Individual and the Median Value of the Reference Population for the same Age or Height, Divided by the Standard Deviation of the Reference Population:

$$\text{Z-score (SD-score)} = \frac{\text{(Observed value) – (Median Reference value)}}{\text{Standard Deviation of Reference Population}}$$

What is the WHO (Z-score) classification for malnutrition?

System	Cut-off	Malnutrition classification
WHO	< -1 to > - 2 Z-score (< - 1 SD to > - 2 SD	Mild
	<-2 to > - 3 Z-score (< - 2 to > - 3 SD)	Moderate
	<- 3 Z-score (< -3 SD)	Severe
Road-to-Health	> 80% of Median	Normal
	60% to < 80% of Median	Mild-to-Moderate
	<60% of Median	Severe

What is Protein-Energy Malnutrition (PEM)?

- Protein-Energy Malnutrition (PEM), or Protein-Calorie Malnutrition (PCM) is due to deficit in the diet of:
  - Macronutrients (Energy and Protein) and
  - Some Micronutrients,
- PEM represents the various levels of inadequate protein and/or energy intake between starvation (no food intake) and inadequate nourishment,
- Although PEM occurs more commonly in infants and children in some developing countries, it can occur in individuals of any age in any country;

What are the different forms and grades of PEM?

- Clinically, PEM has three forms, which depends on the balance of Non-protein (Carbohydrate and Fat) and Protein sources of energy:
  - Dry (thin, desiccated),
  - Wet (edematous, swollen),
  - A combined form between the two extremes,
- Each of the three forms can be graded as
  - Mild,
  - Moderate, or
  - Severe

What are the characteristics of the different forms of PEM?

Dry form (Marasmus):

- Is due to near starvation with deficiency of Protein and non-protein (Carbohydrates and Fats) nutrients;
- Marasmic child consumes very little food – often because the mother is unable to breastfeed – thus the child is very thin from loss of muscle and body fat;
- It is the predominant form of PEM in most developing countries;
- It is associated with early abandonment or failure of breastfeeding
- It is usually associated with infections, most notably those causing infantile gastroenteritis,
  - Infections usually result from improper hygiene and
  - Inadequate knowledge of infant rearing that is prevalent in the rapidly growing slums of developing countries,

Wet form (Kwashiorkor):

- Protein deficiency (intake of poor quality protein) is more marked than the Energy deficiency,
- Child consumes Carbohydrate rich food with very poor quality protein,
- Edema usually occur in such children,
- Children tend to be older than those with Marasmus and tend to develop the disease after they are weaned from breast milk,
- **Kwashiorkor** is less common; It usually manifested as Marasmic Kwashiorkor,

- Kwashiorkor is confined to developing countries where carbohydrate rich (Yam, Cassava, Sweet Potato, Green Banana) staples and weaning foods are fed to infants;
- These foods are excessively starchy and contain low quality protein;
- Combined form of PEM is **Marasmic Kwashiorkor**,
- Children with this form have some Edema and more body fat than those with Marasmus,

What are some of the metabolic changes in Marasmus?

- **In Marasmus**:
  - Energy intake is insufficient for the body's requirements, thus it draws on its own stores;
  - Liver Glycogen is exhausted within a few hours,
  - Skeletal muscle protein is used via Gluconeogenesis to maintain adequate plasma glucose,
  - Triacylglycerols in fat depots are broken down into free fatty acids, which provide some energy for most tissues, but not for the nervous system,

- When near starvation is prolonged, fatty acids are incompletely oxidized to Ketone bodies, which can be used by the brain and other organs for energy,
- Severe energy deficiency of Marasmus adaptation is facilitated by high Cortisol and Growth Hormone levels and depression of Insulin and Thyroid hormone secretion,
- Amino acids are mobilized from muscle to provide the liver with substrate for protein synthesis,
- Plasma protein levels decrease less in Marasmus than in kwashiorkor,

What are some of the metabolic changes in Kwashiorkor?

In Kwashiorkor:

- Relatively increased Carbohydrate intake with decreased intake of protein and essential amino acids lead to decreased visceral protein synthesis,
- Resulting Hypoalbuminemia causes dependent edema,
- Impaired β-Lipoprotein synthesis causes fatty liver,
- Insulin secretion is initially stimulated but is reduced later
- Fat mobilization and amino acid release from muscle are reduced,
- Less amino acid substrate is available to the liver,

Some adaptations that occur in the body during protein deficiency

- Adaptive enzyme changes occur in the liver,
- Amino acid Synthetase increase,
- Urea formation diminishes, thus conserving nitrogen and reducing its loss in urine,
- Homeostatic mechanisms initially operate to maintain the level of plasma albumin and other transport proteins,
- Rates of albumin synthesis eventually decrease, and plasma levels fall, leading to reduced Oncotic pressure and Edema,
- Growth, immune response, repair of tissues, and production of some enzymes and hormones are impaired in severe protein deficiency,

What are some of the symptoms and signs that are typical of Marasmic?

- Some signs and symptoms in Marasmic children:
  - Hunger,
  - Gross weight loss,
  - Growth retardation,
  - Wasting of Subcutaneous Fat and Muscle;

What are some of the symptoms and signs that are typical of Kwashiorkor children?

- Some signs and symptoms in Kwashiorkor children:
  - Generalized edema,
  - “Flaky Paint”
  - Dermatosis,
  - Thinning,
  - De-coloration,
  - Reddening of the hair;
  - Enlarged fatty liver; and
  - Petulant apathy in addition to retarded growth.

What are some of the lab findings in children with PEM?

- **Mild or moderately severe PEM may cause**:
  - Slight depression of plasma albumin,
  - Decrease in urinary excretion of urea, due to decreased protein intake, and in Hydroxyproline, reflecting impaired growth,
  - Increased Urinary 3-Methylhistidine reflects muscle breakdown,

- **In Kwashiorkor**:
  - Plasma levels of albumin is low,
  - Transferrin is low,
  - Essential Amino Acids (branched-chain) are low,
  - β-Lipoprotein, and Glucose are low,
  - Plasma Cortisol and growth hormone levels are high,
  - Insulin secretion is depressed,
  - Insulin-like growth factor secretion is depressed,

- **In Marasmus and kwashiorkor**:
  - Percentage of body water and extracellular water is increased,
  - Electrolytes, especially Potassium and Magnesium, are depleted;
  - Levels of some enzymes and circulating lipids are low,
  - Blood Urea decreases,
  - Anemia due to Iron deficiency may occur,
  - Metabolic acidosis can occur,
  - Diarrhea is common and is sometimes aggravated by intestinal Disaccharidase deficiency, especially of Lactase,