

PROTEIN ENERGY MALNUTRITION

Q. What is Protein Energy Malnutrition (PEM)?

A. Protein Energy Malnutrition (PEM) is a deficiency disease caused in the infants due to 'Food Gap' between the intake and requirement. It affects children under 5 mostly belonging to the poor underprivileged communities. PEM is particularly serious during the post-weaning stage and is often associated with infection.

The term PEM covers a wide spectrum of clinical stages ranging from the severe forms like kwashiorkor and marasmus to the milder forms in which the main detectable manifestation is growth retardation.

Q. What is the aetiology of PEM?

A. There are many causes which contribute to PEM: -

Diet –

- A diet which is deficit in protein and energy or calories results in PEM.
- Through prolonged breastfeeding of children should be the rule, the amount of breast milk secreted in poor Indian mothers is lower.

Social and Economic factors –

- Poverty is one of the major causes of PEM, which leads to low food availability and unsanitary living condition which is the root cause infections and other diseases. Improper distribution of food among the family members.
- Improper child care, neglect etc may also lead to PEM. Misconceptions, food and fallacies, poor child rearing practices and lack of knowledge, lack of adequate feeding during illness may all lead to PEM.

Environmental Factors –

- Overcrowding of living space along with unsanitary living conditions lead to frequent infections like diarrhoea.
- Respiratory infection and diarrhoea are the common diseases that cause severe PEM and death.

Biological factors –

- Maternal malnutrition before and during pregnancy may already make the child vulnerable to under nutrition and proper care and nutrition if not provided post birth may cause PEM.
- Infectious diseases are major contributing cause of PEM. Diarrhoeal diseases, measles, respiratory and other infections decrease the body's immunity. Lack of adequate nutrition further hinders the nutritional status. As the needs of the child are not fulfilled and the child becomes deficit in Energy and protein primarily along with many other micronutrient deficiencies.

Role of free Radicals and Aflatoxins

- Free oxygen radicals potentially are toxic to all cell membranes and are produced in the body during infections. These free radicals are not combatted well when the diet of the child is deficit in micronutrients like Vitamin A, C and E. There is thus an accumulation of toxic free radicals and aflatoxins in the body which harm the liver cells and may cause kwashiorkor.

Age of the host

- Adequate food is the most important requisite for growth. While it is important throughout childhood, it is more crucial during the first 5 years of a child's life especially during the first 3 years when the growth is rapid.
- PEM in pregnant and lactating women can affect the growth of the baby.
- Elderly population may also suffer from PEM due to alteration in their gastrointestinal system as they age.

Q. How is PEM classified?

A. There are many methods that have been suggested to classify PEM. The choice of the classification is based on the purpose for which it is used:

- **New WHO Child Growth Standards**

Currently, the new Growth Standards are being used across the country for monitoring and promotion of young child growth and development within the National Rural Health Mission NRHM and the Integrated Child Development Services (ICDS).

Acute malnutrition Classification
Moderate Acute Malnutrition (MAM) is defined by WHO/UNICEF as:
Weight-for-Height Z-score <-2 but >-3
Severe Acute Malnutrition (SAM) is defined by WHO/UNICEF as:
MUAC<11.5cm
Weight-for-Height Z-score <-3
Bilateral pitting oedema
Marasmic-kwashiorkor (both wasting and oedema)

Diagnostic criteria for SAM in Children aged 6-60 months		
Indicator	Measure	Cut-off
Severe wasting (2)	Weight-for-height (1)	< -3 SD
Severe wasting (2)	MUAC	< 115 mm
Bilateral oedema (3)	Clinical sign	

1-based on WHO Standards (www.who.int/childgrowth/standards)

2, 3 independent indicators of SAM that require urgent action

Source: WHO Child Growth Standards, 2006

- **Indian Academy of Paediatrics**

The classification provided by the IAP (Indian Academy of Paediatrics), is also based on weight for age but the cut off level to separate the malnourished children is 80 % of the standard. Severely malnourished children are classified into grade III and grade IV malnutrition.

Malnutrition	Body Weight (% of standard)*
Grade I	71-80
Grade II	61-70
Grade III	50-60
Grade IV	<50

* 50th centile of Harvard standard

Source: Textbook of Human Nutrition , Bamji, Rao and Reddy

Q. What is Marasmus?

A. Repeated infections and inadequate food consumption leads to protein energy malnutrition. Marasmus is a form of PEM, where growth is severely retarded. Marasmus usually occurs in the first 2 years of life.

Q. What are the symptoms of Marasmus?

A. The symptoms of Marasmus include the following -

- The child has very less subcutaneous fat and muscle however there is no oedema.
- The head of the child seems larger than the body, and has very little hair.
- The child is below 60% of her weight for age, and the height of the baby is also affected.
- The skin has some pigmentation or peeling skin lesions.
- The ribs of the child are visible because of the absence of tissue under the skin and the rib cage is prominent which gives the appearance of rickety rosary a symptom of calcium deficiency.
- The abdomen of the child appears extended and protruding due to the weakness of abdominal walls and wasting.
- The child suffers and is more prone to infections.
- The child is irritable and whines a lot.
- The child loses interest in her/his environment and is inactive.
- The fat on the face is last to go, post which the child gives the appearance of an old man. The child has shrivelled body, wrinkled skin and bony prominences.
- Moderate degree of anemia and other deficiencies are also there in the child.
- The appetite of the child lowers considerably and when adequate food is given catch up growth is seen.

Q. What is Kwashiorkor?

A. Kwashiorkor is another form of PEM, is it uncommon in the children under one year of age.

Q. What are the symptoms of Kwashiorkor?

The symptoms of kwashiorkor include the following -

- The three essential features of kwashiorkor are growth failure, oedema and mental changes.
- The weight of the child depends upon the extent of oedema in the body and it is usually less than 60% of the expected weight for age of the child.
- The height of the child is affected more and the retardation is more pronounced than marasmus.
- Pitting oedema appears first on the feet and legs and later spreads to the whole body.
- The face looks puffy with sagging cheeks and swollen eye lids.
- Abdomen is distended but ascites is rare.
- The liver is enlarged due to fatty infiltration.

- The symptoms include apathy (laziness), a moon face appearance due to oedema, un-lustrous and less hair.
- Loss of hair results in patchy alopecia. The texture of the hair is dull and can be pulled out easily.
- There are some changes seen in the skin as well, like pigmented or depigmented patches, peeling leading to crazy pavement dermatosis and even ulcers.
- Anorexia is common.
- Diarrhoea may occur due to defective digestion and absorption as a result of secondary infection.
- Associated iron and folate deficiencies may lead to anaemia.

Q. What is Marasmic Kwashiorkor?

A. Marasmic Kwashiorkor is the third form of PEM, where the child displays the symptoms of both marasmus and kwashiorkor. A child who does not have oedema first may develop it later down the years. Since lack of adequate energy is common to both the conditions, the term PEM is more apt than marasmus or Kwashiorkor.

Q. What are the symptoms of Marasmic Kwashiorkor?

A. The symptoms of Marasmic Kwashiorkor include signs of both conditions.

- There is varying degree of muscle wasting, oedema along with hair and skin changes.
- There is the presence of moderate anemia, and along with it more than one vitamin deficiencies are also found.
- Vitamin A deficiency is associated with severe malnutrition and may cause blindness.

Q. What are the biochemical and Metabolic changes during PEM?

A. The following changes occur during PEM –

- Alteration in hormone levels can also lead to fluid retention.
- Plasma levels of aldosterone are elevated in kwashiorkor but not in marasmus.
- Increased levels of ADH are seen in kwashiorkor.
- There are raised levels of plasma cortisol in PEM. The levels are higher in marasmus than kwashiorkor.
- Somatomedin activity is also reduced on kwashiorkor but not in marasmus.
- Plasma growth hormone levels are raised in kwashiorkor.

Q. How does PEM affect Protein Metabolism?

A. The following changes occur during PEM –

- Serum Concentration of total proteins is decreased

- Infections may lead to increased concentration of globulins altering the A/G (Albumin/ Globulins) ratio.
- Total serum amino acid is reduced particularly the branched chain amino acid.
- Non-essential amino acids are normal or raised.
- Serum concentration of many enzymes are reduced which reflects the low rate of protein synthesis.
- Urinary output of nitrogen is low in malnourished children due to reduction in urea excretion.
- There is a reduction in muscle mass.

Q. How does PEM affect Lipid Metabolism?

A. The following changes occur during PEM –

- Varying degree of fat mal-absorption is seen in children with kwashiorkor.
- There is a reduction in the activity of pancreatic enzyme, lipase.
- In kwashiorkor, plasma levels of free fatty acids are raised while the levels of triglycerides, phospholipids and cholesterol are reduced.
- There is a decrease in the concentration of conjugated bile acids.
- The concentration of beta lipoprotein is decreased while that of the alpha lipoprotein is variable.
- There is a reduction in the level of carnitine and there is impaired transport of fatty acids across the mitochondrial membrane for oxidation.
- In marasmus, the plasma levels of lipoproteins, triglycerides and free fatty acids are normal.

Q. How does PEM affect Carbohydrate Metabolism?

A. The following changes occur during PEM –

- Fasting blood sugar levels are lower.
- Severe hypoglycaemia is seen.
- The glycogen stores are depleted which leads to fluctuation in the blood sugar levels.
- Rate of gluconeogenesis is altered.

Q. How does PEM affect Electrolyte and Water balance in the body?

A. The following changes occur during PEM –

- In kwashiorkor there is retention of fluid in the body in the extracellular compartments due to the inability of kidney to excrete sodium. This may occur due to altered renal function during PEM.
- Hypoalbuminaemia is one of the important factors contributing to oedema.

- Serum concentration of sodium is low, there is an excess of total sodium concentration in the body.
- Potassium concentration of serum is reduced in kwashiorkor.

Q. What are the haematological changes during PEM?

A. The following changes occur during PEM –

- There is moderate anaemia, which is a common feature.
- Protein deficiency leads to a reduction in haemoglobin synthesis and total red cell mass.
- Associated iron deficiency leads to microcytic anaemia.
- Serum Vitamin B 12 levels are actually increased in PEM.
- The red cell life is shortened in PEM along with various abnormalities of the red cell membrane, cell metabolism and composition.
- The neutrophil leucocyte response to infection is often impaired.
- Purpura and bleeding manifestations are seen in PEM.

Q. What are the pathological changes that occur in PEM?

A. PEM affects the body and changes that occur during PEM may be as following -

- Abnormalities in the organs may be seen in children suffering from PEM.
- The gastro-intestinal tract is affected; there is atrophy of mucosa particularly in the jejunum.
- There is marked cellular infiltration, of the lymphocytes and the plasma cells.
- There is poor digestion and absorption due to mucosal changes associated with decreased enzyme activity in the body.
- In kwashiorkor, liver is infiltrated with fat and hepatomegaly is common.
- There is marked atrophy in severe PEM. Acinar cells shrink and the nuclei become pyknotic.
- There is varying degree of duct proliferation.
- Muscle wasting is a characteristic feature with severe reduction in individual fibers and increase in interstitial connective tissue. There is muscle wasting in other organs like intestines and heart.
- The myocardial changes may lead to reduced cardiac output and electrocardiographic changes.
- There is a reduction in brain size, a decrease in the number of cells in the cerebellum and brain stem.
- The thymus is greatly reduced in size in children with PEM.

Q. How can dehydration be treated in PEM?

A. Due to diarrhoea, dehydration may often be fatal if not treated on time. Assessment of hydration status is difficult in malnourished children. Skin elasticity is poor in children with marasmus and their eyes are normally sunken. In kwashiorkor, the altered skin elasticity may be masked by oedema. Dryness of the mouth and skin, scanty urine and depressed fontanelle are more reliable signs in such cases.

Children with mild to moderate dehydration can be treated by oral or nasogastric administration of fluids. Severely malnourished children are deficient in potassium and have abnormally high levels of sodium. WHO has recommended a modified solution for severely malnourished children (ReSoMal).

Q. How is ReSoMal prepared?

ReSoMal can be prepared by diluting the standard WHO ORS solution in 2 litres of water instead of 1 litre and adding 50g of sugar. Between 70 and 100 ml of ReSoMal/Kg body weight is usually enough to restore normal hydration. This should be given in small quantities at frequent intervals in the first 12 hours.

For children with severe dehydration, intravenous fluid therapy is required to improve the circulation and expand plasma volume rapidly. By providing 15 ml/kg/hr I.V. drip of Ringer's lactate solution with 5% glucose.

Re assessment of the child every hour and switching to ReSoMal as soon as the child's condition's improves is advisable. When the urine flow is established, potassium supplements can be given orally (1-2 g/kg/day). It is recommended to start the feeding as early as possible.

Q. How can you treat infections in PEM?

A. Infections may be fatal if not treated during PEM. It is difficult to detect infections clinically as symptoms of PEM may mask the symptoms of fever and rapid pulse rate. Antibiotic therapy can be administered after the infectious agent is detected.

Q. How can hypoglycaemia be treated during PEM?

A. In children with mild hypoglycaemia, giving milk feed or glucose mixed in water may suffice. If the child develops convulsions or is unconscious, glucose should be given intravenously. 1 mg/kg of 50% dextrose solution can be given to the child.

Q. How can hypothermia be treated during PEM?

A. Children who are suffering from PEM have low body temperature due to the scanty subcutaneous fat. The child should be well covered with a blanket or warm clothes if the surroundings are cold. Thermal shock should be treated with intravenous injection of glucose saline or blood transfusion.

Q. How can anaemia be treated during PEM?

A. Severe anaemia may be fatal if not corrected. The haemoglobin should not fall below 5 g/dl, blood transfusion should be provided in such a case. A diet rich in iron sources like jaggery, rice flakes, spinach, raw banana, kamal kadhadi (lotus stem), liver etc should be provided to the child. Inclusion of vitamin C food sources like citrus fruits, Amla (Indian gooseberry) etc with iron rich foods should be given to increase the absorption of iron in the body.

Q. How to treat congestive heart failure during PEM?

A. Congestive heart failure can occur as a result of severe anaemia or as a complication of the IV fluid therapy. Symptoms include rapid pulse and respiratory distress, cold extremities and cyanosis (appearance of a blue or purple coloration of the skin or mucous membranes due to the tissues near the skin surface being low on oxygen).

Q. How can PEM be treated with dietary management?

A. severe malnutrition or PEM require intensive care and should be referred to a hospital for initial treatment. Nutrition intervention is the primary consideration. The child should be given a diet providing sufficient quantities of calories and proteins, with an increase in amounts gradually without provoking vomiting or diarrhoea. 170 – 200 kcal per kg of body weight and 3-4 g/ kg of body weight should be provided to the child.

It is suitable to initiate the feeding with a liquid formula gradually changing the consistency. The child may refuse the feed due to lack of appetite. Both proteins and calories are needed in large quantities. Sugar and vegetable oil should be added to increase the energy content.

Milk intolerance may be seen in severely malnourished children. In such cases, formulation should change to include buttermilk or dal based formulas. A mixed cereal based diet can be given with added oil to increase the energy.

Vitamin and mineral supplementation should be done to meet the increased requirements. These can be added to the diet or can be provided separately to the child. Vitamin A deficiency is quite common in children with severe PEM, hence a dose of 2 lakh IU of vitamin A should be provided to the child. Daily supplement of 60 mg/day of iron and 100 microgram/day of folic acid should be introduced in the diet.

Q. How can PEM be prevented?

A. Malnutrition is a multifaceted problem and a variety of measures should be taken to prevent it.

- Since the effects of under nutrition are cumulative, entry point into the life cycle should be adolescents who will be future mothers and should be given adequate attention. Their nutrition should be ensured and the family should be educated against the false practices.
- Special intervention measures like supplementary feeding and nutrition education programmes can help in alleviating the problem. Preschool children are being provided supplementary nutrition at the anganwadi centres. Several nutritious recipes have been developed by Food and Nutrition Board, National Institute of Nutrition and other home science colleges. Amylase rich food prepared from wheat or maize can also be used to reduce the bulk of the cereal mixture.
- Government of India has prepared National Plan of Action, to bring down the prevalence of moderate and severe malnutrition. The essential components of any control programme are supplementary feeding, immunization, control of minor infections, promoting food security, nutrition communication , poverty alleviation and empowerment of women,

Q. How can nutrition education help?

A. Nutrition education can help strengthen the various strategies formulated by the government for the eradication of PEM. These include –

- Laying stress on breast feeding and especially exclusive breastfeeding for 6 months.
- Mothers should be advised to give supplementary foods post 6 months based on the household foods like cereal and pulses. Oil or ghee can be added to increase the energy density of the food.

Bibliography

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