

Impact of protein deficiency on performance and health

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Proteins

- Proteins are essential nutrients for the human body, one of the building blocks of body tissue
- Proteins are complex organic nitrogenous compounds, polymer chains made of amino acids
- Break down during digestion to form amino acids
- 3 categories: essential, non essential and conditional amino acid
- Essential amino acids cannot be synthesized in the body and has to be supplied by food.
- Essential and non essential amino acids are needed for synthesis of body protein
- Protein is needed by the human body for growth and maintenance
- It is the major structural component of all cells in the body, especially muscle, body organs, hair and skin. Proteins also are utilized in membranes, such as [glycoproteins](#), they are also used as precursors to [nucleic acid](#), co-enzymes, hormones, immune response, cellular repair and molecules essential for life, to form blood cells

Protein deficiency and immune function:

- **Protein deficiency reduces ability to synthesize some or all protein rich content of blood eg WBC that include neutrophils, eosinophils, basophils, monocytes, B cells and T cells. Neutrophils engulf invading bacteria, while eosinophils attack viruses and parasites, thus protein-containing leukocytes may be compromised, limiting ability to fight infection and recovery from injury.**
- **T cells secrete protein molecules called cytokines and chemokines which are critical in both stimulating immune cells, directing their activities and turning off immune and inflammatory reactions as necessary to avoid harming healthy cells. The vital regulatory role these proteins play may not be possible in absence of sufficient dietary protein.**

Repeated infections:

Inadequate protein consumption leads to diminished immune system response and frequent infections. Hence ability to recover from infections is also compromised when diet lacks sufficient protein

Delayed wound healing:

protein production in the area wound increases to replace the damaged tissue. In protein deficiency, this process may be markedly slowed.

Oedema:

Protein deficiency results in chemical balance in body resulting in leakage of fluid into tissues

Changes in hair:

Hair is composed of a specialized protein keratin. Protein malnutrition disrupts your hair growth. With a mild to moderate protein deficiency hair becomes brittle and breaks easily and there is thinning of hair

Reproductive health:

Irregular menstruation

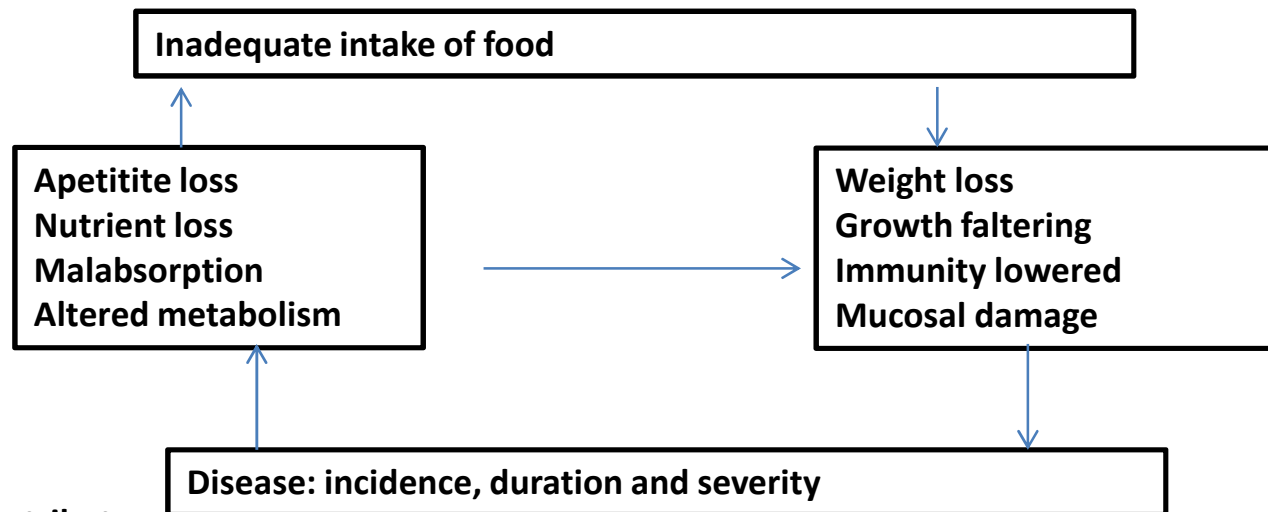
During pregnancy:

Increased complication of pregnancy

Protein deficiency and malnutrition can occur at any age due to illness or poor diet and may have devastating consequences on health.

Protein Energy Malnutrition

- Protein energy malnutrition(PEM) has been identified as a major health and nutrition problem in India
- PEM seen most commonly seen in under 5 children (peak 6 months to 3 years)
- PEM is primarily due to inadequate intake of food(food gap)



Contributory factors:

- Poor maternal health
- Poor environmental condition
- Large family size
- Early weaning, failure of lactation
- Adverse cultural practices

Signs and symptoms of deficiency

- **Depends on:**
 - severity and duration of nutritional deprivation
 - Age
 - Presence / absence of infection

May manifest in 3 principal clinical forms:

Marasmus: (usually associated with early weaning;

Usually seen in 0-2 yrs

characterized by chronic wasting condition and a gross underweight status, loss of subcutaneous fat, conscious but apathetic, in extreme cases listless, no interest in surrounding

Anaemia

May be associated with vit deficiencies, infections and infestations, electrolyte imbalance due to diarrhoea

Kwashiorkor: develops from protein deficiency

- **characterized by moderate growth retardation, changes to hair and skin color, edema, moon facies, and hepatosplenomegaly; diarrhoea, respiratory infections and vitamin deficiencies**

Marasmic kwashiorkor: characterized by severe wasting and presence of edema.

- **Marasmus appears by caloric and protein insufficiency, whereas kwashiorkor develops from protein deficiency**
- **There is invariably associated infection in children with PEM**
- **Biochemical markers:**
- **Low serum albumin**

Signs and symptoms of deficiency

Biochemical markers:

- Low serum albumin
- Low urinary creatinine
- Low hydroxyproline
- Low serum essential amino acid index
- Anaemia in case of kwashiorkor
- Fatty changes in liver biopsy in kwashiorkor

Effect on cognitive development

Malnutrition is associated with

structural and functional pathology of the brain

A wide range of cognitive deficits has been reported in malnourished children

Effect of chronic protein energy malnutrition (PEM) not only causes stunting and wasting in children but could also affect the ongoing development of higher cognitive processes during childhood (>5 years of age).

Effect on cognitive development:

- **In a study carried out at NIMHANS effect of stunting on the rate of development of cognitive processes using neuropsychological measures(Behav Brain Function 2008)**
 - Malnourished children performed poor on tests of attention, working memory, learning and memory and visuospatial ability except on the test of motor speed and coordination.
 - Age related improvement was not observed on tests of design fluency, working memory, visual construction, learning and memory in malnourished children. However, age related improvement was observed on tests of attention, visual perception, and verbal comprehension in malnourished children even though the performance was deficient as compared to the performance level of adequately nourished children.
- **In another study a rural cohort of 625 children registered from 1981 to 1983 in 10 villages in Varanasi, 196 children were assessed for physical growth, development, intelligence and concept development between 1 and 3 years of age. Home environment was also assessed using Caldwell Home inventory.**
 - These rural children remained below 3rd centile of NCHS standard for weight, height, skull and mid-arm circumferences throughout the study.
 - Malnourished children scored poorly in all the areas of development, i.e., motor, adaptive, language and personal social, 9% in Grade I and 16.6% children in Grade II + III had IQ less than 79 (inferior). Concept for color shape and size was poorly developed in malnourished children.
 - Maternal involvement and stimulation was strongly associated with better behavior development and intelligence. Multiple regression analysis showed that the effect of home environment on development and intelligence was of a higher magnitude as compared to status and family variables and nutritional status during 1-3 years of age(Indian Paediatrics 1992)

Long term effect

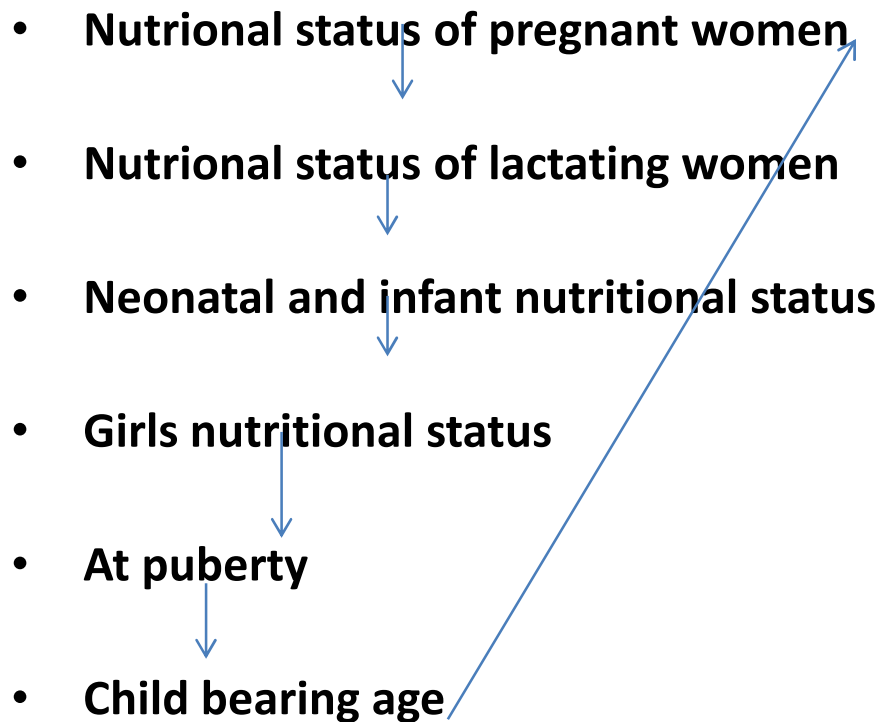
Attention problems were assessed by the Conners Adult ADHD Rating Scales (CAARS) and the Conners Continuous Performance Test (CPT) in 145 Barbadian adults (aged 37-43 y) who had been followed longitudinally since childhood. Teacher-reported attention problems in childhood predicted attention problems in adulthood(J Nutr 2012)

Effect on socioeconomic status:

- **Gap in weekly household income was also observed in a cohort of Barbadian adults followed up at 40 yrs as compared to controls (Paediatrics 2012 July 131(1))**

Protein deficiency during pregnancy and lactation

- Nutritional status of pregnant women has influence on nutritional status of children forming a vicious cycle



Protein deficiency in elderly

- **Major cause of concern**
- **the symptoms of protein deficiency in elderly resemble symptoms of ageing:**
- **decreased energy**
- **muscle loss**
- **increased susceptibility to disease**
- **mental confusion**
- **digestive disturbances**
- **weight loss – it remained unreported for some time**
- **elderly individuals who consumed low levels of protein had a significant loss of bone density especially in the hip and spine areas**
- **lack of sufficient protein poses many health risks to seniors, reversing the condition is relatively straightforward if caught early.**

Research

- **Understanding of biology of deficiency**
- **Clinical symptoms of deficiency in relation to level of deficiency**
- **Better understanding of modifiable risk factors in causation of deficiency and**
- **Improving coverage / availability of foods existing nutrition / food supplements to combat deficiency**
- **Strategies to improve coverage of evidence based nutrition**
- **Creating awareness at household , family and community level regarding appropriate infant and young child feeding practices, early detection of children with malnutrition**
- **Long term follow up studies**
- **developing a cognitive rehabilitation program for malnourished children.**
- **Studies on immune markers in malnutrition**



THANK YOU

Signs and symptoms of deficiency

- Different classifications for assessing grades of malnutrition:
- Gomez classification(based on weight)
- Jelli's (weight for age)
- Waterlow's Classification(weight and height)
- Based on NCHS standards
- IAP classification