

INSTANT NUTRITIONAL ASSESSMENT (INA) IN CHILDREN WITH PROTEIN ENERGY  
UNDERNUTRITION (PEU)

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**ABSTRACT**

**Objective:** PEM is a significant nutritional disorder in India. The aim of this study was to assess the severity of the disorder and make a quick nutritional assessment in the patients using serum albumin, total cholesterol and lymphocyte count as the laboratory parameters. The study also aimed at correlating these biochemical parameters with physical parameters.

**Materials and Methods:** 42 clinically undernourished children in the age group of 2-5yrs were enrolled for the study. Their age and body weight were noted and the subjects were accordingly grouped under Grade 1, 2 or 3 malnutrition as per Gomez' classification. Serum Albumin, total lymphocyte count and total cholesterol values of these cases were noted. Depending on the values obtained, the subjects were grouped into 3 categories – mild, moderate and severe malnutrition. Physical parameters were correlated with the biochemical parameters.

**Results:** Pearson's correlation test results showed a significant positive correlation between Grade I & mild malnutrition; Grade II & moderate malnutrition; and Grade III & severe malnutrition.

**Conclusion:** We conclude that serum albumin, cholesterol and total lymphocyte count correlate significantly with physical parameters. They are reliable parameters that can be used not only to assess severity of undernutrition but they also provide more information about the nutritional status such as protein and lipid reserves in the body and immune status of the individual.

**Key words:** Albumin, Cholesterol, Total Lymphocyte Count (TLC), PEM (Protein energy malnutrition), PEU (Protein energy under nutrition).

**INTRODUCTION**

The term malnutrition includes both undernutrition as well as overnutrition. In general, however, it is used to describe undernutrition. World Health Organization has defined malnutrition as the cellular imbalance between supply of nutrients & energy and body's demand to ensure growth, maintenance and specific function (Onis M et al, 1993).

Protein energy malnutrition (PEM), now preferably called Protein energy undernutrition (PEU) is an important nutritional deficiency disease, affecting children mainly under the age of 5 years. It constitutes a global public health problem in children. More than a 100 million children are underweight in the world today. The burden is obviously higher in developing countries, Asia contributing to be home for 80% of children affected by PEM. Closer home in India, more than 6000 children die every day because of malnutrition (Kotecha PV. 2008).

According to the UNICEF, one in every three malnourished children in the world lives in India, the prevalence highest being in MP and least in Kerala (UNICEF India). Children living in rural areas are noted to be having PEM in higher proportions when compared to their peers in urban areas. Also, prevalence of severe malnutrition is higher in young girls as compared to young boys. Also in India, malnutrition is higher during the peak harvesting period of April-May, and September-October. (Sunder Lal et al, 2013).

As per the Hungama report 2011, under-five children malnutrition is 42% and below 24 months of age, it is 50%. (Kishore J. 2014). National Family Health Survey and India Nutrition data indicate that nearly 50% of children below 5yrs of age in India have PEM of various grades.

PEM affects children mainly under the age of 5 years. The first few years are most vital for a child's physical/mental/emotional health, for which proper nutrition is of utmost importance. Knowing the enormity of PEM, it is very important to diagnose the condition and prevent its complications at the earliest so as to avoid growth retardation and sickness.

## ASSESSMENT OF NUTRITIONAL STATUS

The assessment of nutritional status in PEM can be done clinically, by anthropometric methods and by biochemical tests and accordingly classified. Some of the popular methods of classifications are as follows:

- I. ANTHROPOMETRIC METHODS: These are based on measurement of physical parameters such as weight, height,
  1. Gomez classification: PEM is classified into 3 grades depending on the percentage of expected weight for age (Table 1). Weight-for-age is an index of the adequacy of the child's nutrition to support growth. Standard weight-for-age is the 50th percentile of the weight-for-age curves of well-fed children.

**Table 1: Gomez classification of PEM (Gomez et al, 1956)**

Grade 1(first degree)	90-75% of weight-for-age
Grade 2(second degree)	75-60% of weight-for-age
Grade 3(third degree)	<60% of weight-for-age

2. Wellcome classification: takes into consideration weight for age as well as edema (table 2)

**Table 2: Wellcome classification of PEM (Wellcome, 1970).**

Weight for Age (Gomez)	With Edema	Without Edema
60-80%	kwashiorkor	undernutrition
< 60%	marasmic-kwashiorkor	marasmus

3. Waterlow classification: This is based on height for age and weight for height (Waterlow JC. 1972):
  - Percent weight for height = [(weight of patient) / (weight of a normal child of the same height)] \* 100
  - Percent height for age = [(height of patient) / (height of a normal child of the same age)] \* 100

Most of the currently available methods to assess nutritional status in PEM are anthropometric methods. Very few are based on biochemical tests, which are much better as they offer more information regarding nutritional and metabolic status of the body. Instant Nutritional Assessment (INA) has been available since many years, which is based on estimation of serum albumin and TLC (Seltzer MH et al 1979 & 1981). Very few studies have been done where nutritional status has been assessed taking serum cholesterol into consideration. In the present study we have taken serum albumin, TLC, serum total cholesterol as the parameters for assessing nutritional status. We also tried to find out if there was a correlation between them and the traditional anthropometric parameters.

## MATERIALS AND METHODS

This study was conducted over a period of 24 months (May 2012 to April 2014). During this period, PEM subjects were selected from those attending the following PHCs: Sarjapur, Mallasandra, Kannamangala Rural Health Centre, Bangalore. Diagnosis of PEM was made clinically and then graded as per Gomez' classification.

A total number of 42 children were included in the study, out of which 19 were males and 23 were females. The anthropometric measurements were recorded (weight, height, mid-arm circumference) and found that out of the 42 children included in the study, 13 had kwashiorkor, 21 had marasmus and 8 had marasmic kwashiorkor. This diagnosis was as per Wellcome classification (Wellcome 1970).

**Inclusion criteria:** Children with PEM in the age group of 1-5 years.

**Exclusion criteria:** Malnourishment due to non-nutritional causes was excluded. (Such as patients on drugs causing nausea/vomiting, patients with depression, patients having gastrointestinal diseases such as coeliac disease, Crohn's disease, surgical resection of the small or large intestines thereby increasing the demand for foodstuffs, increased nutritional losses seen in cases of malabsorption/diarrhea).

**Details of Laboratory assessment:**

Blood was collected from subjects in plain and EDTA bottles and sent to the laboratory for analysis. Serum from plain bottle was analyzed for albumin and cholesterol. Plasma obtained from samples in EDTA bottles was analyzed for lymphocyte count.

**Serum albumin:** Estimated by BCP (Bromocresol Purple) method

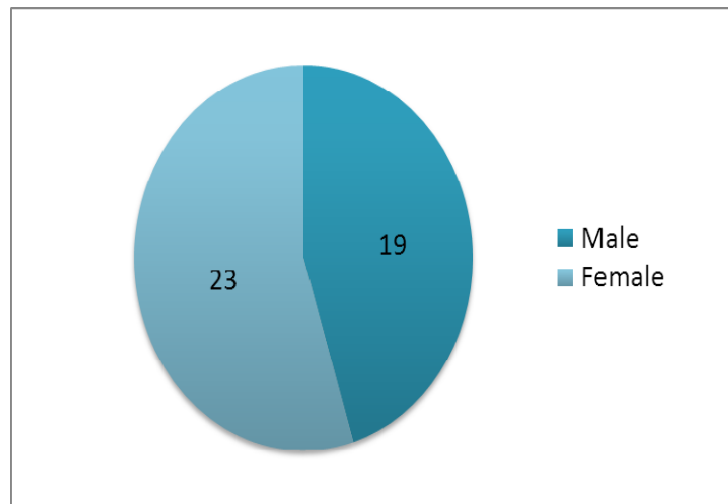
**Serum Cholesterol:** Estimated by enzymatic (cholesterol oxidase) method

**Lymphocyte count:** A blood cell counter was used for total lymphocyte measurement (TLC).

Results were tabulated in an Excel sheet for statistical analysis.

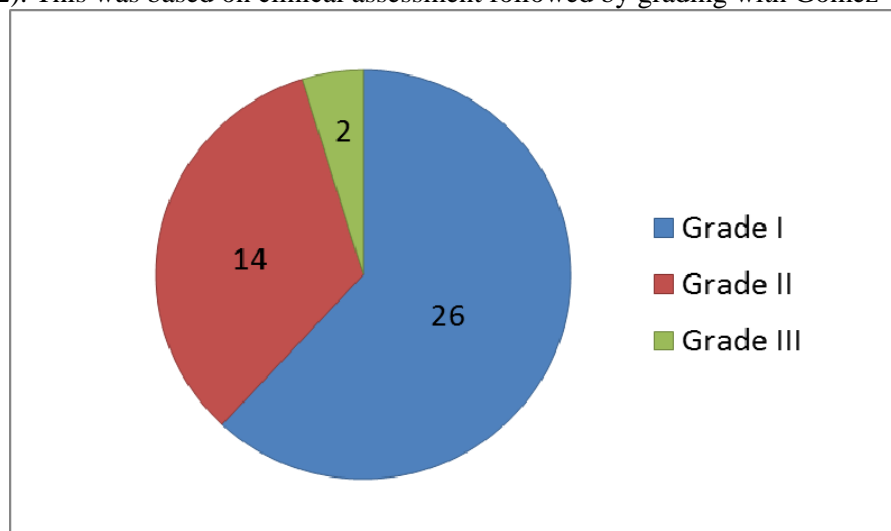
**RESULTS**

As described earlier in the study, 42 cases of PEM were chosen, Where female subjects outnumbered males, as shown in Fig 1.



**Fig1: Pie chart showing sex distribution in the study**

Among the 42 cases included in the study, 26 cases had Grade I PEM, 14 cases had Grade II PEM and 2 cases had Grade III PEM. (Fig 2). This was based on clinical assessment followed by grading with Gomez’ classification.



**Fig 2: Pie chart showing the data of severity of PEM cases included in the study**

Their blood samples were analyzed for albumin, cholesterol and total lymphocyte counts. The mean values are as shown in table 3.

**Table 3: Mean and Standard deviation (SD) values of the parameters analyzed.**

N=42	Serum Albumin in g/dl	Serum Cholesterol in mg/dl	Lymphocyte count in plasma in cells/ml
Mean $\pm$ SD	2.9 $\pm$ 0.35	142 $\pm$ 27.69	1226 $\pm$ 257.32
Reference Range	3.7 – 5.5	135 - 200	3000 – 9500

Following biochemical analysis, based on the levels of these laboratory parameters, the patients were categorized into light (mild), moderate and severe cases of PEM as shown in Table 4. (MadronoGA et al, 2011).

**Table 4: Classification of severity of PEM based on biochemical parameters (MadronoGA et al, 2011).**

	Light (mild)	Moderate	Severe
Serum Albumin in g/dl	3-3.49	2.5-2.9	< 2.5
Serum Cholesterol in mg/dl	140-180	100-139	< 100
Lymphocyte count in plasma in cells/ml	1,200-1,599	800-1,200	< 800

Next the physical parameters (body weight) of the subjects from each category (i.e, Grade I, II and III PEM) were correlated with the biochemical parameters for malnutrition (values of serum albumin, cholesterol and lymphocyte counts) from each category (mild, moderate and severe malnutrition) respectively. The results are as shown in Tables 5, 6 and 7. In mild (light) malnutrition, there was a significantly positive linear relationship between serum albumin, cholesterol, lymphocyte count and body weight (Table 5). This explains that as body weight increases, albumin, cholesterol levels and lymphocyte counts also increase in the body and vice versa.

Table 4 shows a positive correlation between serum albumin, cholesterol, lymphocyte count and body weight in moderate malnutrition, which was statistically significant.

Table 5 explains the results of correlation studies in severe malnutrition. A significantly positive linear relationship was noted between serum albumin, cholesterol, lymphocyte count and body weight. Any elevation in serum albumin, cholesterol or lymphocyte counts will see a corresponding increase in the body weight and vice versa.

**Table 5: Pearson's correlation between Mild PEM and Grade I (of Gomez classification) PEM**

Light(Mild) PEMparameters v/s Grade I malnutrition (Gomez)	Correlation= (r) Significance (p)
Serum Albumin v/s body wt	r + 0.96 p < 0.01
Serum Cholesterol v/s body wt	r + 0.97p < 0.01
Lymphocyte count v/s body wt	r + 0.96p < 0.01

P < 0.05: statistically significant

**Table 6: Pearson's correlation between Moderate PEM and Grade II (of Gomez classification) PEM**

ModeratePEM parameters v/s Grade II malnutrition (Gomez)	Correlation= (r) Significance (p)
Serum Albumin v/s body wt	r + 0.97 p < 0.01
Serum Cholesterol v/s body wt	r + 0.99p < 0.01
Lymphocyte count v/s body wt	r + 0.95p < 0.01

**Table 7: Pearson's correlation between Severe PEM and Grade III (of Gomez classification) PEM**

Severe PEM parameters v/s Grade III malnutrition (Gomez)	Correlation=(r) Significance (p)
Serum Albumin v/s body wt	r + 0.98 p < 0.01
Serum Cholesterol v/s body wt	r + 0.95p < 0.01
Lymphocyte count v/s body wt	r + 0.96p < 0.01

## DISCUSSION

Malnutrition, particularly protein energy malnutrition is a major public health problem in India. The present study was done to evaluate the severity of malnutrition in a patient through biochemical parameters such as serum albumin, cholesterol and also by total lymphocyte counts, rather than just by clinical assessment. Clinical assessment includes subjective evaluation of the status of the patient and includes anthropometry. Anthropometric assessment has its own drawbacks such as subjective errors in measurements, having problems with reference standards for the measurements, and most important aspect being limited nutritional information regarding the patient. Therefore it can be stated that biochemical parameters are better than anthropometric measurements for evaluating a patient with PEM.

The biochemical parameters chosen for nutritional assessment were serum albumin, cholesterol and total lymphocyte counts.

Serum albumin has been used as a parameter for nutritional assessment since many decades. The reasons for popularity of albumin are aplenty. Most of the albumin present in the body is distributed between vascular and interstitial spaces. The vascular compartment (serum) albumin usually does not fluctuate much unless disturbed by any inflammation, drugs or hepatic dysfunction. Besides, the half- life of albumin is quite long (21 days) and therefore a good marker of chronic changes in nutritional status. Measurement of serum albumin is also quite easy, simple and cost effective.

Serum albumin is more of an indicator in kwashiorkor rather than marasmus. In kwashiorkor, the main source of energy is carbohydrates. The insulin that is produced prevents muscle protein breakdown. Thus hepatic protein synthesis suffers, resulting in hypoalbuminemia (Fuhrman MP. 2002). Serum albumin measurement also helps in the assessment of severity of PEM. A study done by Chowdhury et al in 2008 on 30 children with different grades of malnutrition showed decreasing levels of albumin with increasing severity of PEM. (Chowdhury MSI et al, 2008). The present study showed a significant decrease in total lymphocyte count correlating positively with decrease in body weight in malnourished children.

Many studies have reported similar results. Saka AO et al investigated the entire hematological profile in Nigerian children with PEM and found that children with PEM had significantly lower TLC when compared to controls (Saka AO et al, 2012). Najera O et al also showed that all types of lymphocytes are reduced in protein energy undernutrition (Najera O et al, 2004). The cause for the reduced lymphocytes has been said to be atrophy of the lymphoid organs – thymus and tonsils.

Lymphocytes normally originate in the central lymphoid organs such as bone marrow and thymus in children. But in children, an atrophy of the thymus is noticed. Nassar et al conducted a case-control study on 32 infants with PEM, in which they tried to correlate the peripheral lymphocyte count with the size of the thymus by ultrasound. They found that children with PEM had atrophy of thymus. (Nassar MF et al. 2007). This could be one of the reasons for decreased lymphocyte count in PEM. Apart from the thymus, even the tonsils are atrophied. The function of tonsils is to serve as first line of defense in the immune system. It traps the bacteria and viruses which try to gain entry into the body via the mouth.

McMurray et al evaluated 71 malnourished Colombian infants in a study and showed that these children had reduced tonsil size at the age of 2 years along with other features of reduced cell mediated immunity (Mc Murray et al, 1981). The reduction in tonsil size in undernourished children has been quoted by several other authors (Smythe PM. 1971, Schonland M. 1972). The atrophy of thymus / tonsils have been noted more so in cases of kwashiorkor rather than marasmus. The atrophy of these lymphoid tissues result in depletion of immune cells produced and thereby a deficiency of cell mediated immunity.

Therefore TLC can be used to find out the immune status of the child apart from the severity of malnutrition.

Serum Cholesterol indicates a measure of energy reserves in the body. Infact, it has been observed that serum cholesterol level drops in cases of undernutrition even before weight loss or any other anthropometric changes occur (Madrono GA et al, 2011). Serum cholesterol is frequently lowered in cases of PEU. A cross sectional study involving 60 malnourished Sudanese children in 2012 revealed that these children had significantly lowered serum albumin and cholesterol levels when compared to control group (Sana Fageer et al, 2013). Another study involving 115 children with PEM also revealed similar results: total cholesterol was significantly lowered in cases of PEM (Akuyam et al, 2008). The present study also showed lowered serum cholesterol levels which lowered correspondingly with increasing grade of malnutrition. This type of hypocholesterolemia is generally known to improve with good diet (PrietoMB and Cid JL. 2011).

The above points discussed suggest that estimating serum albumin, cholesterol and TLC are not only good indicators of nutritional status, but also provide comprehensive information regarding the protein and energy reserves in the body as well as immune status of the patient with PEU. Also, in the present study we have shown that these biochemical parameters correlate very well with the physical / anthropometric parametric parameters (body weight in this study) in each stage of malnutrition. The grades of severity of undernutrition based on these laboratory parameters are comparable to the grades of Gomez' classification. In addition, they are reliable, can be estimated easily and reasonably fast, and cost effective. Therefore, estimating these parameters will be of importance in the assessment of PEU patients.

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