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**Original Research Article**

# A study of plasma proteins (serum total protein, serum albumin), and thyroid function in children with protein-energy malnutrition

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## ABSTRACT

**Background:** The study's objective was to evaluate and compare total serum protein, serum albumin, and thyroid hormones in children with PEM (protein-energy malnutrition) and healthy controls.
**Methods:** In this cross-sectional study, 100 children with PEM served as cases, while an equal number of age and gender-matched healthy children served as controls. 4 ml of venous blood were taken (3 ml in a plain vial and 1 ml in an EDTA vial) and immediately submitted for further investigation. SPSS software (version 25) was used to analyze the data. A p value of ≤0.05 was considered statistically significant.
**Results:** PEM children have lower serum total protein, albumin level, total T3 (TT3), and total T4 (TT4) levels compared to healthy controls ($p<0.0001$). Mean TSH levels in cases and controls were nearly similar. There was no significant difference between serum TSH concentrations in PEM children and the controls. Grade I PEM had the highest mean total protein, serum albumin, T3, and T4 levels, followed by grades II, III, and IV. When mean total protein, serum albumin, T3, and T4 levels of each grade of PEM were compared to controls, mean total protein, serum albumin, T3, and T4 levels were substantially lower in each grade of PEM ($p<0.0001$).
**Conclusions:** PEM children have low serum total protein and albumin levels. This is probably due to decreased oral intake of proteins and reduced biosynthesis. Serum TT3 and TT4 levels are lower in children with PEM than in healthy controls, which is most likely due to reduction in circulating plasma proteins.

**Keywords:** Protein energy malnutrition, Serum total protein, Serum albumin, TSH, Serum total T3, Serum total T4

## INTRODUCTION

Malnutrition in children under five is a widespread public health problem with international consequences because good nutrition is an essential determinant of their well-being.[1] According to estimates, about 162 million children suffer from various PEM forms. It is estimated that PEM is the primary or an associated cause of nearly half of approximately 3 million deaths in children under the age of 5 years. Three-quarters of the world's stunted children live in South Asia and Sub-Saharan Africa; India is home to nearly one-third of the world's malnourished children.[3]

Prevention of PEM is becoming an important issue worldwide; almost any "summary index" of the child development indicators would place India at the bottom

of this list. As per NFHS-4 (2015-16), 35.7% of children below five years are underweight, 38.4% are stunted, and 21 % are wasted, and these children have a mortality rate ranging from 20% to 30%.[4]

PEM applies to related disorders, including Marasmus, kwashiorkor, and intermediate states of marasmic-kwashiorkor.[5] According to WHO, PEM refers to "an imbalance between the supply of protein and energy and the body's demand for them to ensure optimal growth and function".[6] It is a significant public health problem in India. It mainly affects preschool children (<5 years), with dire consequences ranging from physical to cognitive growth and susceptibility to infection.[7]

The thyroid hormone regulates lipid and carbohydrate metabolism and is required for normal development and maturation-thyroid hormone deficiency results in mental and physical slowness, mental retardation, and dwarfism.[8] Serum total protein and albumin levels are lower in severely malnourished wasted children, although elevated globulin levels are expected since malnutrition is frequently linked with infections.[8,9]

According to studies, there is a significant shift in the secretion and metabolism of thyroid hormones and the structure of the thyroid gland in PEM. These cause a decrease in thyroid gland activity and, as a result, in triiodothyronine (T3) and thyroxine levels (T4). Thyroid function is altered due to alterations in iodine metabolism and a reduction in circulating protein levels. These modifications are essential in the adaptation process of energy and protein metabolism in children with PEM because they assist in conserving energy when the energy-producing substrate is sparse and protect the child from dying prematurely owing to a low-calorie reserve.[10]

The present study aimed to know the concentration of serum total protein, serum albumin, and thyroid hormones in PEM in children and compare them with normal children.

## METHODS

The present cross-sectional, non-interventional, observational study consisted of children of age six months to 5 years selected from the Department of Pediatrics, Maharani Laxmi Bai Medical College, Jhansi, Uttar Pradesh, India. This study was conducted from October 2019 to October 2020. Ethical clearance was obtained from the institutional ethics committee before commencing the study.

The study included 100 children with PEM as cases (PEM group) and an equal number of age and sex-matched healthy children as controls. Children with protein-energy malnutrition as per IAP classification of PEM (which is based on weight for age), i.e., whose weight for age was less than 80% of expected for age constituted cases (PEM group) they were further subdivided into grade I-IV as per IAP classification of PEM.[11] Children over 80% of the expected weight formed the control group.

### *Inclusion criteria*

All children suffering from malnutrition (fulfilling the WHO and IAP criteria) admitted in the department of Paediatrics (NRC and ward); children between 6 months to 5 years of age; children whose parents provided written consent were included.

### *Exclusion criteria*

Patients more than 6 years of age and below 6 months of age; nephrotic syndrome, nephritic syndrome and acute renal failure; patients with lead poisoning, thalassemia, HIV and congenital anomalies were excluded.

For serum total protein, serum albumin, and thyroid hormones, 4 ml of venous blood (3 ml in the plain vial and 1 ml in the EDTA vial) was collected and transported to the laboratory. Within 2 hours of the draw, the serum was extracted from the clot. Serum specimens are kept at 2-8 °C and analyzed the next day if testing is delayed for more than 24 hours.

All samples were immediately subjected to assay serum total protein, serum albumin, and thyroid hormones after thawing at 37 °C. Serum total protein and serum albumin were estimated by the biuret endpoint method by a fully automated biochemistry analyser of Selectra Company. Serum thyroid stimulating hormone (TSH), serum total triiodothyronine (TT3), serum total thyroxine (TT4), and level were estimated by hormone chemiluminescence analyzer (ABBOTT).

### *Statistical analysis*

The data obtained were entered into an MS Excel spreadsheet. The results were expressed in mean±standard deviation (SD) for continuous variables and as a percentage for categorical data. Observations were statistically analyzed using SPSS software version 23. An unpaired t test was used to determine the correlation between different variables. A p value of ≤0.05 was considered statistically significant.

## RESULTS

The present study was conducted in two groups of patients. Group 1 included 100 patients with PEM, while group 2 included 100 normal controls. Figure 1 showed demographic details of cases and controls.

The majority of cases in the present study belonged to grade II PEM (45%), followed by grade I (26%), grade 111 (23%), and grade 1V (6%) according to IAP classification in cases (weight for age%). The mean hemoglobin levels in cases (9.6±1.92) are significantly

lower as compared to controls (11.64±2,4) with p<0.0001.

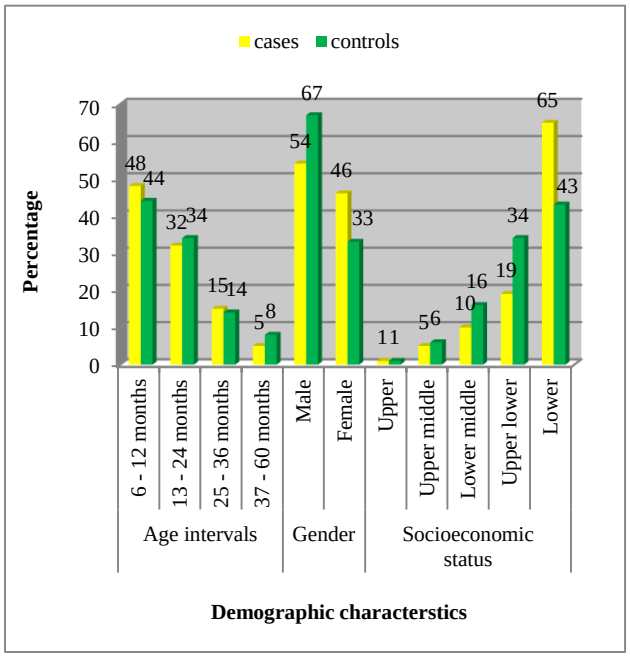


**Figure 1: Demographic data of the patients.**

Mean serum total protein, and serum albumin levels were lower in cases compared to controls, and the difference was statistically significant (p<0.0001). Mean TT3 and TT4 levels were lower in cases than in controls, and the difference was statistically significant (p<0.001).

Mean TSH levels in cases were nearly similar to controls, with no statistically significant difference between the mean values of cases and controls (p=0.33) (Table 1).

The mean total protein and serum albumin were highest in grade I PEM (5.78±2.09, 2.89±1.14 respectively) and lowest in grade IV PEM (4.73±0.30, 2.55±0.13 respectively). When the mean total protein and serum albumin values of each grade of PEM were compared to controls, it was observed that mean total protein and serum albumin levels were significantly lower in each grade of PEM as compared to controls (p<0.0001) (Table 2).

When the mean TSH levels of individual grades of PEM were compared to controls, it was discovered that the mean TSH values in grades I (2.12±1.04), II (2.30±1.09), III (2.30±0.67), and IV (2.15±0.7) were comparable to controls (2.126±0.823) and no statistical difference was observed (p>0.05) (Table 2).

**Table 1: Comparison of serum total protein, serum albumin, and serum TSH, serum TT3, serum TT4 in cases and controls.**

| Parameters | Biological reference interval | Group 1 (PEM) | Group 2 (control) |
|---|---|---|---|
| | | Mean±SD | Mean±SD |
| **Serum total protein (g/dl)** | 6-8 | 5.42±1.33 | 7.084±0.374 |
| **Serum albumin (g/dl)** | 3.7-5.3 | 2.78±0.73 | 4.082±0.566 |
| **Serum TSH (µIU/ml)** | 0.4-4 | 2.24±0.9 | 2.126±0.823 |
| **Serum TT3 (ng/ml)** | 0.56-1.88 | 118.98±32.52 | 157.13±27.54 |
| **Serum TT4 (mmol/l)** | 59-153 | 7.88±1.6 | 9.72±1.45 |

**Table 2: Comparison of serum total protein, serum albumin, and serum TSH, serum TT3, serum TT4 in various grades of PEM and control.**

| Variables | Total protein | | Sr. albumin | | TSH | | T3 | | T4 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Mean±SD | P value (compared with control) | Mean±SD | P value (compared with control) | Mean±SD | P value (compared with control) | Mean±SD | P value (compared with control) | Mean±SD | P value (compared with control) |
| **I (n=26)** | 5.78±2.09 | <0.0001 | 2.89±1.14 | <0.0001 | 2.12±1.04 | 1.0(NS) | 130.45±41.3 | <0.001 | 8.04±1.8 | <0.0001 |
| **II (n=45)** | 5.47±0.90 | <0.0001 | 2.80±0.51 | <0.0001 | 2.30±1.09 | 0.2(NS) | 118.97±27.29 | <0.0001 | 8.11±1.39 | <0.0001 |
| **III (n=23)** | 5.09±0.91 | <0.0001 | 2.69±0.53 | <0.0001 | 2.30±0.67 | 0.3(NS) | 113.28±25.4 | <0.0001 | 7.6±1.8 | <0.0001 |
| **IV (n=6)** | 4.73±0.30 | <0.0001 | 2.55±0.13 | <0.0001 | 2.15±0.7 | 0.9(NS) | 91.23±26.4 | <0.0001 | 6.5±1.0 | <0.0001 |
| **Control (n=100)** | 7.084±0.374 | | 4.082±0.566 | | 2.126±0.823 | | 157.13±27.54 | | 9.7283±1.4560 | |

The mean T3 and T4 were highest in grade I PEM (130.45±41.32, 8.04±1.8 respectively) and lowest in grade IV PEM (91.23±26.46, 6.57±1.00 respectively). When the mean T3 and T4 values of each grade of PEM were compared to controls, it was discovered that the mean T3 and T4 levels were considerably lower in each grade of PEM than in controls, p<0.0001 (Table 2).

## DISCUSSION

The present study was undertaken to know the status of serum total protein, serum albumin, serum TSH, serum TT3, and TT4 levels in children with PEM.

The mean hemoglobin level in cases (PEM group) was lower than in controls, which is consistent with findings from other studies, such as Adegbusi et al (2011), Sah et al (2017), and Raval et al, who found that the mean hemoglobin level in the under-nourished group was significantly lower than that of well-nourished children.[14,15,18] Lower hemoglobin in PEM children is due to iron, vitamins, trace elements, and protein deficiencies, which are often found in children suffering from PEM.

In the present study, mean serum total protein and albumin levels were significantly lower in cases compared to controls with a p value of <0.0001. It may be due to decreased protein intake and reduced biosynthesis. Adegbusi et al (2011), Mishra et al (2009), Rahman et al (2007), and Chowdhury et al (2008) obtained the same results.[14,16-18]

In the present study, mean TSH levels in cases and controls were nearly similar. There was no significant difference between serum TSH concentrations in our children with PEM and the controls (p=0.33). Studies performed by Sah et al (2017), Sandeep et al (2016), and Gupta et al (2019) also find the same results.[15,20,21] Meah et al found significantly reduced TSH levels in malnourished children compared to controls.[22]

In the present study, mean T3 and T4 levels were significantly lower in cases compared to controls (p<0.001). The results of the present study correlate with investigations conducted by Abrol et al and Turkey et al.[2,12] In contrast to our research, Das et al found no significant difference in mean T4 levels of cases and controls, they concluded that normal T4 levels in PEM children were secondary to an adaptive process.[13] Low T4 levels in children with PEM can be due to a fall in thyroid secretion rate, depletion of reserves, and failure of the adaptive mechanism.

### *Limitations of the study*

The sample size of the study was small, so further study was required with more sample size and also better techniques were needed.

## CONCLUSION

PEM children have lower serum total protein and albumin levels than healthy controls (p<0.001); this is probably due to decreased intake of proteins and reduced bio-synthesis. Serum TT3 and TT4 levels are lower in children with PEM than in healthy controls, and the difference is statistically significant (p<0.001). The cause for decreased TT3 and TT4 in a malnourished child is probably due to a reduction in circulating plasma proteins. The altered thyroid hormone status in children with PEM is a defense mechanism against excessive metabolic stimulation and energy consumption. It protects the malnourished child with a low-calorie reserve from early death.

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