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STUDY TO DETERMINE THE PROTEIN ENERGY MALNUTRITION IN CHILDREN BY BIOCHEMICAL MARKERS: SERUM ALBUMIN, TOTAL PROTEINS AND ELECTROPHORESIS OF SERUM PROTEIN

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Abstract:

Introduction: *Protein energy malnutrition (PEM) is a global problem among children. Worldwide, 27% of children under five are malnourished. PEM is more common in Pakistan, where nearly half (47%) of children are underweight. Assessment of PEM has traditionally been clinical, which is time-consuming and skill-dependent, with high inter-observer variability. Accordingly, biochemical markers such as serum protein and albumin measurements can be used to assess the nutritional status. At the same time, there is controversy as to whether edema can be considered a reliable clinical marker of hypo-albuminemia. Readily available and reliable tests can often detect nutritional deficiencies before they adversely affect biological function, and certainly before deficiencies can be detected by physical examination.*

Aims and Objectives: *The study aimed to assess PEM in children using biochemical markers such as serum protein, albumin and protein electrophoresis, and to establish a correlation between edema and hypo-albuminemia.*

Materials and Methods: *This analytical clinical study was conducted at the Pediatric Unit-II of Nishtar Hospital Multan for one-year duration from November 2019 to November 2020. The study material included 50 cases of PEM and 20 normal, healthy children.*

Result: *In the PEM cases, total protein and serum albumin were found to be significantly lower compared to normal healthy controls. In this way, total protein and serum albumin can become useful indicators of the nutritional status of malnourished children and good markers of PEM. The albumin and beta fractions in serum protein electrophoresis were significantly lower, while the alpha1, alpha 2 and gamma globulin fractions were significantly higher in malnourished children compared to the control group.*

Key words: *PEM, biochemical markers, serum protein, hypoalbuminemia, electrophoresis, edema*

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INTRODUCTION:

Protein energy malnutrition (PEM) is a series of conditions resulting from the concomitant lack of different proportions of proteins and calories, most common in infants and young children and often associated with infection1. Malnutrition is a global problem that adversely affects the survival, health and development of population groups. Globally, 27% of children under 5 are underweight. Malnutrition is more common in Pakistan (47%) than in Sub-Saharan Africa (29%). One in three malnourished children in the world live in Pakistan. The National Family Health Survey (NHFS) shows that PEM is most common in preschool children aged 6 months to 2 years of age, with approximately 50-60% of children under 22 years of age being malnourished. PEM has been identified as a major health and nutritional problem in Pakistan, with an estimated 6,600 children under the age of 5 dying from malnutrition every day. PEM is responsible for death in 7% of cases and is the cause of death in 46% of child deaths below 5-years of age. The main cause of death is the worsening of infectious diseases caused by malnutrition. In Pakistan, 46% of all children under the age of three are too young for their age, 47% are overweight and 16% are malnourished. Only 2-5% of preschool children suffer from severe PEM, while most cases (60-70%) are mild to moderate and the features of PEM are difficult to recognize. Clinical parameters are subjective and time-consuming, and therefore some biochemical markers would aid in easy and objective identification of mild to moderate cases. Protein energy malnutrition is characterized by a low protein concentration in the plasma. Measurement of serum protein is widely used to assess the nutritional status. The circulating concentration of a transport protein, traditionally albumin, was used to determine protein deficiency. An interest in biochemical parameters as a means of assessing nutrition stems from the belief that biochemistry can provide the earliest possible clues to altering nutritional status. This is true because the sequence of nutritional pathogenesis is biochemical change, followed by cell or organ damage, and ultimately, overt clinical malnutrition. Readily available and reliable nutritional tests and measurements can often detect nutritional deficiencies before they adversely affect biological function, and certainly before deficiencies can be detected by physical examination. This study was designed to evaluate protein energy malnutrition in children using biochemical markers such as serum total protein, serum albumin, and serum protein electrophoresis, and to establish a correlation between edema and hypoalbuminemia.

MATERIALS AND METHODS:

Study design: This analytical clinical study was conducted at the Pediatric Unit-II of Nishtar Hospital Multan for one-year duration from November 2019 to November 2020. The study included 50 children suffering from PEM (cases) and 20 healthy children (control group). The study included all children who presented to the outpatient clinic or were admitted to the pediatric ward. Informed consent was obtained from the parents of the children.

Admission Criteria.

Cases: The study included all children under 5 years of age who presented to the outpatient clinic or were admitted to the pediatric ward.

Exclusion criteria

Children with changes such as lymphoma, tuberculosis, leukemia, dehydration, clinical signs of infection or sepsis, nephrosis, cirrhosis, heart failure and severe anemia or any other systemic disease leading to weight loss were excluded from the study.

METHODS:

A detailed history and thorough clinical examination, including auxologic measurements (height, weight, arm circumference) and appropriate laboratory tests, were performed in accordance with the proforma.

Serum Sample: Approximately 5 mL of blood samples were collected from selected children under aseptic vein conditions. The sample was then transferred to normal test tubes to obtain serum. The samples were centrifuged and the thus obtained serum was either analyzed or stored at 2-8 ° C. Data analysis was performed using SPSS version 19.0. The variables tested were expressed as mean ± standard deviation (SD). A "p-value" <0.05 was considered significant and <0.001 was highly significant. In the study group, the relationship between 2 variables was assessed using the Pearson's correlation test with a "p-value" of less than 0.05 as a significant limit. The mean and standard deviation of all parameters were calculated.

RESULTS:

TABLE 1: Age and Weight Distribution

Parameter	Cases	Controls	t value	p value
Age (years)	3.34±2.66	3.4 ± 2.4	0.128	0.898
Weight (kg)	8.16±3.79	15.1 ± 5.5	6.110	0. 000

Table 1 shows the comparison of body weight by age between cases (children with PEM) and the control group. The age weight of the cases is significantly lower than that of the control group since the "p-value" is 0.000.

TABLE 2: Total Protein and Serum Albumin.

Parameters	Cases	Controls	t value	p value
Total protein(g/dl)	4.42±0.52	7.0 ± 0.9	14.673	0.000
Serum albumin (g/dl)	2.0551±0.38	4.1 ± 0.6	17.013	0.000

Table 2 shows the comparison of total protein and serum albumin between cases and controls. Both total protein and serum albumin were significantly lower in cases than in the control group. The "p-value" for both parameters is 0.000.

TABLE 3: Serum Protein Electrophoresis

Different Fractions Of Serum protein electrophoresis (%)	Cases	Controls	t value	P value
Albumin	46.3± 5.2	59.2 ± 3.1	10. 071	0.000
alpha 1 globulin	7.12± 2.44	3.3 ± 1.0	6.795	0.000
alpha 2 globulin	12.8 ± 3.89	9.9 ± 2.9	3.025	0.004
beta globulin	6.58 ± 1.64	9.7 ± 0.9	7.983	0.000
Gamma globulin	27.8 ± 5.31	17.9 ± 3.9	7.531	0.000

Table 3 compares the different fractions of serum protein electrophoresis between cases and controls. The mean value of the albumin and beta fractions in serum protein electrophoresis in malnourished children was 46.3 ± 5.2% and 6.58 ± 1.64%, respectively, while in the control group it was 59.2 ± 3.1% and 9.7%, respectively. ± 0.9%. Thus, the albumin and beta globulin fractions were significantly reduced in malnourished children compared to the control group, with the "p value" being 0.000 The mean value of the alpha 1, alpha 2 and gamma fractions in serum protein electrophoresis in malnourished children was 7.12 ± 2. 44%, 12.8 ± 3.89% and 27.8 ± 53.1%, respectively, while in the control group, respectively, 3.3 ± 1.0%, 9.9 ± 2.9% and 17.9 ± 3.9%. Thus, both the alpha 1, alpha 2 and gamma fractions were significantly increased in malnourished children compared to the control group, with the "p-value" being <0.05. Table 4 shows the correlation of edema with hypoalbuminemia in cases. Of the 28 children with edema, 22 children (79%) had hypo-albuminemia and 6 children (21%) did not have hypo-albuminemia. Therefore, there was no significant difference in the number of edema children with hypo-albuminemia and those without hypo-albuminemia. Of the 41 children with hypo-albuminemia, 19 (46%) had no edema. Likewise, there was no significant difference in the presence6 or absence of edema3 in the children without hypo-albuminemia.

TABLE 4: Edema in relation with Hypoalbuminemia in PEM cases

Parameter	Hypoalbuminemia Present	Hypoalbuminemia Absent	Total Number of cases
Edema			
Present	22	6	28
Absent	19	3	2

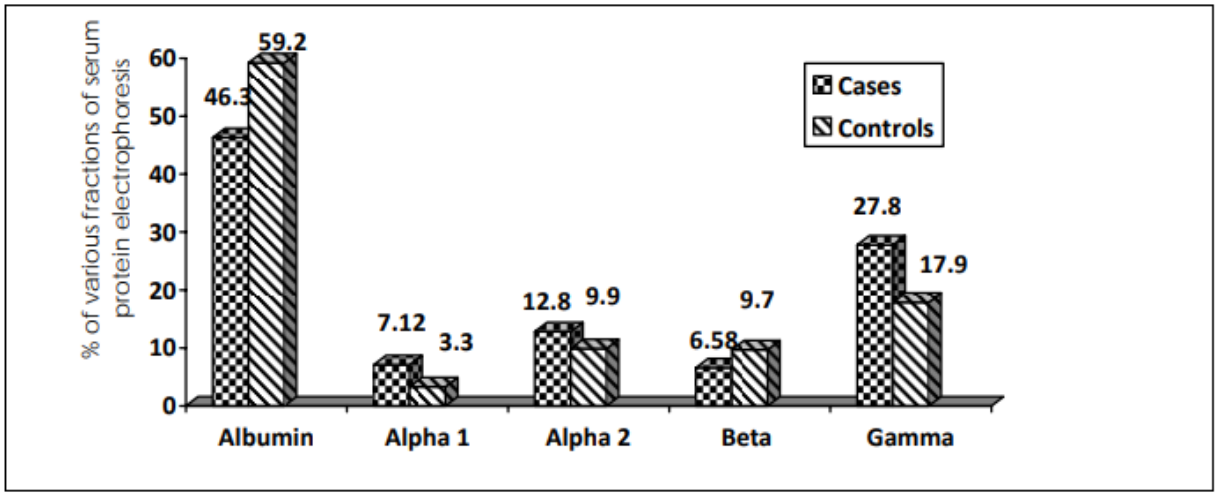

Fig 1: Comparison of various fractions of Serum Protein electrophoresis

DISCUSSION:

Comparison of total protein and serum albumin between cases and controls showed significantly lower values for cases than controls. The mean total protein value for the cases is 4.42 ± 0.52 g / dL and for the controls 7.0 ± 0.9 g / dL. (Table 2). Thus, there is a very significant "p-value" difference of 0.000. The mean value of serum albumin for the cases is 2.0551 ± 0.38 g / dL, and for the controls 4.1 ± 0.6 g / dL. So, the difference is very significant, the "p-value" is 0.000. Thus, in this study, it was observed that total protein and serum albumin are significantly lower in malnourished children compared to healthy children. Ibrahim, Elton, et al. Observed that total plasma proteins and albumin were significantly lower in the malnourished cases compared to the control group. Low serum albumin is a common symptom in PEM; as a result, it is commonly used as a measure of a child's nutritional status. The practical importance of serum albumin analyzes in assessing nutritional status has been reassessed in the area where malnutrition is a major problem. Low serum albumin concentration is the most consistently confirmed biochemical parameter in children with severe energy malnutrition. It has now been established that changes in serum albumin concentration are sensitive to early malnutrition. It is often convenient to classify babies based on their albumin concentration and to relate other biochemical changes to this value. This study is consistent with observations observed in other studies that have proposed low levels of total protein and serum albumin in severely malnourished children. This study contradicts the observation from the study that proposed that total protein and serum albumin are not sensitive markers of protein energy malnutrition. This point of view is based on the logic that since serum albumin has a long half-life of 20 days and a large storage pool, and because 60% of the total body albumin is extravascular, the response to protein deficiency is slow, limiting its usefulness as a marker PEM.

The results of this study suggest that albumin and the beta fraction of serum protein electrophoresis are significantly reduced in malnourished children compared with healthy children, while the alpha 1, alpha 2, and gamma globulin fractions are significantly higher in malnourished children compared to normal healthy children. The results of this study are consistent with the results of other studies that suggest that protein energy malnutrition may be responsible for low levels of albumin and beta-globulin and high levels of alpha-globulin relative to other serum proteins and normal or increased gamma globulin fraction.

Edema and its correlation with hypo-albuminemia:

An attempt has been made to investigate the correlation of edema with hypo-albuminemia in cases. In this study, 28 children had swelling and 22 had no swelling. The results of this study contrast with other studies that propose hypoalbuminemia to be an indicator of the susceptibility of a malnourished child to edema8. Regarding the cost of these biochemical tests, the material cost of the Serum Protein Electrophoresis Kit (Paragon, manufactured by Beckman Coulter Pakistan Pvt Ltd, costs PKR 20 per package and Serum Total Protein and Albumin (manufactured by Siemens Pakistan Ltd) costs approximately PKR Rs 8 per case; hence the total material cost was 28 PKR Rs. Assume the total cost is around PKR Rs 150 per case, which is quite cheap considering its objectivity, early PEM detection and physician time value.

SUMMARY AND CONCLUSIONS:

The material for the study included 50 children admitted to the Pediatric Ward and diagnosed as PEM and 20 normally healthy children. Inclusion criteria included all children up to 5 years old weighing less than 80% of the expected age. PEM showed a significantly lower concentration of total protein and serum albumin in malnourished children compared to the normal control group. Thus, total protein and serum albumin can be considered useful indicators of the nutritional status of malnourished children and are therefore proposed as good indicators of protein energy malnutrition. In the case of EMR, various fractions of serum protein electrophoresis also turned out to be useful for the assessment of malnutrition due to the significant changes observed in their values. The albumin and beta fractions were significantly decreased, while the alpha 1, alpha 2 and gamma globulin fractions were significantly increased in malnourished children compared to the control group. Thus, the study of different fractions of serum protein electrophoresis is also a good marker of protein energy malnutrition. In this EMF study, edema in malnourished children was not significantly associated with hypo-albuminemia. It has been observed that although hypoalbuminemia is one of the most important factors responsible for the pathogenesis of edema, it is not the only factor responsible for edema formation. Other factors may also contribute to the edema, as swelling has been found even in the absence of hypo-albuminemia, and in addition, all malnourished children with hypo-albuminemia did not necessarily have swelling. Thus, in the PEM study, it was observed that the correlation of edema with hypo-albuminemia is not very significant, as other factors may also play a role in the pathogenesis of edema. It is worth mentioning here that the cost of these biochemical markers (serum total protein, serum albumin and serum protein electrophoresis) was 150 PKR Rs per case. Hence, it is also cost effective. All these findings justify the use of biochemical markers as sensitive and objective factors causing protein energy malnutrition in children.

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