Research Article

International Journal of Pharmaceutical Biological and Chemical Sciences

SERUM ELECTROLYTE PATTERN IN CHILDREN WITH PROTEIN ENERGY MALNUTRITION

SHAHEEN B[*1], ISMAIL M HAJI [2], PARVEEN D [3], SARFARAJ S[2]

[1]*Department of Biochemistry, Institute of Medical Sciences and Research, Mayani, Maharashtra, India.*

[2]*Department of Critical Care Medicine, St. John's Medical College, Bangalore, India.*

[3]*Department of Biochemistry, DM Wayanad Institute of Medical Science, Meppadi, Kerala, India.*

***Corresponding Author Email:** *drshaheenshaikh@gmail.com*

ABSTRACT:

Protein energy malnutrition (PEM), the most widespread nutritional deficiency disorder of mankind, is a group of related disorders, with a more complex and still incompletely understood etiologic basis than its name suggests. PEM in India is a very common problem in children under five years of age. There are number of biochemical parameters which become altered during protein energy malnutrition. Abnormal total body serum electrolytes concentration are common in protein energy malnutrition. The aim of this study was to estimate and compare the concentration of serum electrolytes in PEM patients and healthy controls. Serum electrolytes were measured in 30 protein energy malnourished children of different grades (I-IV). Serum sodium, potassium and chloride were estimated by ion selective electrode method using Bayers AVL Compact 3. The results were compared with 30 healthy, age and sex matched controls. There was a significant decrease in serum sodium, potassium and chloride levels in PEM patients, when compared to the control group with a statistically significant value of $p < 0.001$.

KEYWORDS:

Protein energy malnutrition, serum electrolytes, sodium, potassium, chloride.

INTRODUCTION

Protein-energy malnutrition (PEM) is a major public health problem in the tropical and subtropical regions of the world, often arises during protein and / or energy deficit due to nutritional inadequacy, infections, poor socio-economic and environmental conditions. Protein Energy Malnutrition (PEM) in India is a very common problem in children under five years of age. It is the most common nutritional disorder affecting children in developing countries and the third most common disease of childhood in such countries. PEM has a lasting effect on immune functions, growth and development of children, learning ability, social adjustment, work efficiency and productivity of labour [1]. The child may be marasmic or kwashiorkor. UNICEF reports that India has unfortunate distinction of having 75 million malnourished children below 5 years of age [2].

The National Child Nutritional Survey conducted in 2000 demonstrated that among the children of 6 to 71 months of age, almost 49% were found stunted, nearly 12% wasted and 52% were underweight. In 2000, a study done by UNICEF found that among the South Asian countries, prevalence of wasting was in India 18%, Bangladesh 11.6%, Pakistan 11%, Nepal 11%, Sri Lanka 14%, Bhutan 4%, Maldives 17% and South Asia 18% [3] .

PEM increases one's susceptibility to and severity of infections, and is the major component of illness and death from diseases. It is the direct cause of about 300,000 deaths per year and is indirectly responsible for about half of all deaths in young children [4, 5].

There are a number of biochemical parameters which become altered during protein energy malnutrition. In addition, abnormal total body and serum electrolyte concentration are common in PEM and appear to be related to the prognosis [6].Protein Energy Malnutrition in early childhood is the predisposing factor that leads much of the morbidity and mortality in children under five[7]. There are many ways to evaluate PEM; however biochemical parameters provide the valuable information for the over-all management and act as sensitive indicators especially in a tertiary health care centre. Clinical and anthropometric features of PEM are late to appear. Hence biochemical parameters will prove as early and sensitive indicators during the development of PEM. Biochemical value will trace the real nutritional status and also help in optimal specific and precise management of PEM in tertiary care centre [8]. With increasing severity there is increasing failure in the homeostatic mechanisms of the body and damages to the immune defences, which may result in infections and death [9]. It seems that many deaths from PEM occur as a result of outdated clinical practices and that improving these practices reduces the rate of morbidity and mortality [1] . With this view the aims and objectives of this study was to estimate the concentration of serum electrolyte levels in PEM patients and healthy controls.

MATERIALS AND METHODS

This is a prospective study carried out on 30 children with age range of 12-48 months. An equal number of age and sex matched healthy subjects formed the control group. The present study was conducted on diagnosed patients of PEM admitted in pediatric ward of J.S.S. Medical College and Hospital, Mysore.

Diagnosis of PEM:

PEM was diagnosed by anthropometric measurements and physical examination.

Table 1: I A P Classification. This is based on weight for age values. [10]

Exclusion criteria: Patients with chronic infectious diseases like nephrotic syndrome, chronic glomerulonephritis, acute renal failure in which there is an excessive loss of proteins, patients with lead poisoning, thalassemia and with congenital anomalies were excluded from the study.

A semi–structured questionnaire (proforma) was used to obtain information from the subjects using interview method. Relevant information on the child's socio-demographic characteristics, nutritional indices and laboratory findings were documented. Study participants were grouped into upper, middle and lower socioeconomic classes based on the Oyedeji socio – economic classification scheme [11].

The study protocol was approved by the institutional ethical committee before the commencement of the study. Informed and written consent was obtained from the parents/caregivers of participants. Aseptically 5ml of venous blood was collected from patients and controls. As soon as the blood was collected from the patients, it was carried to the laboratory in an ice-container. The blood was allowed to clot and serum was separated by centrifugation at 5000 rpm for 5 minutes. It was used to estimate various parameters.

Analytical procedure: Serum sodium, potassium and chloride were estimated by ion selective electrode method using AVL Compact 3, Bayers. The quality control was done for all the tests performed.

STATISTICAL ANALYSIS

SPSS for windows Version-16 (2007) was employed for statistical analysis. The Independent-Sample's't' test procedure was used to compare the mean of the cases and controls. The One-Way ANOVA was used for one-way analysis of variance for a quantitative dependent variable by a single factor (independent) variable. The correlation between the parameters was worked out using Pearson's correlation. 'p' value < 0.05 was considered to be statistically significant.

RESULTS

This prospective study included 60 children, among them 30 were severely malnourished and 30 were well nourished (normal children). The characteristics of severely malnourished children are shown in **Table 2**. Among the PEM group, 65% were males and 35 % were females with a male to female ratio of 1.9:1. The mean age of the children with PEM was 2.86±1.02 years compared to 2.72±0.96 years for the controls. In PEM cases, the mean weight was 9.60 ± 1.64 (kgs) and height was 101.30 ± 2.95 (cms). In the control group, the mean weight was 13.70 ± 2.47 (kgs) and mean height was 102.86 ± 3.03 (cms). The difference was statistically insignificant. 42% of the children with PEM were in socio-economic class SEC IV, 28.8% in SEC III, 20% in SEC V and only 2.2% in SEC I. The subjects were of a lower socioeconomic class compared to the controls ($p=0.00001$) as shown in Table 2.

Of the 30 mothers interviewed, 32.2% had primary education, 27.8% had no form of education, while 23.3% and 16.7% had secondary and tertiary education respectively. The educational status of mothers of children with PEM were lower compared to that of controls ($p=0.0002$) as shown in **Table 2.** Occupations of parents whose children are in PEM group include mainly housewife and labourer. Larger proportion of children in our study was born at home and exact birth weights of children are not known.

Table 3 presents the values of mean ± SD of serum sodium (Na+), potassium (K+) and chloride (Cl-) in mEq/L respectively in both cases and controls**. Table 3** also represents student't' test values and 'p' values of the electrolytes in both the study groups. As represented in the **Table 3** there was a statistically significant decrease in the mean Na^+ values in patients when compared to the control group ($p<0.05$). Similarly, there was a significant decrease in the mean K^+ and Cl^- values in PEM patients when compared to the control group ($p<0.0001$).

This is also shown graphically as bar diagrams in figure 1 it shows that there is a significant decrease in the serum levels of Na^+, K^+ and Cl^- in PEM patients when compared to control group. There was significantly ($p<0.05$) higher incidence of hyponatremia, hypokalaemia and hypochloremia , in PEM group when compared to control group.

DISCUSSION

Protein energy malnutrition (PEM) continues to be a major public health problem throughout the developing world. Malnutrition increases one's susceptibility to and severity of infections, and is the major component of illness and death from diseases. The risk of death is directly correlated with the degree of malnutrition [12]. UNICEF reports that India has unfortunate distinction of having 75 million malnourished children below 5 years of age [2].

The educational status of parents of children with PEM was found to be significantly less as compared to their non-PEM counterparts.

The result showed higher rate of illiteracy among mothers in PEM group than control group ($p<0.05$). Illiterate mothers in PEM group were twice in number than mothers in control group.

Mothers in control group were more literate than PEM group. The result showed that education was key factor in determining the nutritional status of

children especially under five. Similar types of results were obtained in two studies done in India by Aryan A et.al. [13] and Gupta MC et.al., [14]. In the study conducted by Arya A. and Devi R et.al. The impact of maternal literacy status on the nutritional status of pre-school children was studied. Two hundred children of both the sexes aged between 1-5 years were randomly selected for the study. Results revealed that the children of literate mothers had better anthropometric measurements than children of illiterate mothers. No mother in PEM group was a job holder where as one fourth of mothers in control group were working women. Mothers in PEM group were twice in labour work than in control group. Housewife mothers, if husband is a farmer or labourer, also help their husbands in their work so have little time to care their children. PEM children were more prevalent among children whose fathers were illiterate. The education of fathers above SSLC (equivalent to 10^{th} standard) in control group was more than twice as in PEM group. The major occupations in fathers of PEM group were farmer and labourer and that in control group were service-holder and farmer. So the result showed children of labourer are more prone to PEM. Also fathers of control group were more than three times in job than that of PEM group. In the study conducted by Gupta MC et. al [14] in India, 390 children aged 24-72 months participated. Out of these, 26 severely malnourished children weight for age 55.27 ±3.17 were identified in a colony of predominantly Muslim urban slum dwellers of low socio-economic status. An equal number (n=26) of normally nourished children match for age, sex and per capita income were identified, a strong correlation was found between nutritional status subjects and educational level of their mothers ($p<0.025$). Father's education was unrelated to children's nutritional status. The study showed no significant difference in the types of family structure in PEM in comparison to control group. Larger proportion of births took place at home in both groups, though more in case of PEM group. Larger proportion children were immunized in both groups, lower immunization in case of PEM group in comparison to control group. A large proportion of births occurred at home so mothers didn't know the exact birth weight of their children. Among known cases low birth baby was higher in PEM group than control group.

In the present study, we have found that the mean serum values of Na^+, K^+ and Cl^- were significantly decreased in cases when compared to control groups.The mean Na+ values in cases was 133.90 ± 3.31 meq/L and in control was 136.2 ±2.99 mEq/L ($p<0.05$). The mean K^+ values in cases was 3.25 ± 1.47 mEq/L and in control was 4.18±0.64 mEq/L ($p<0.0001$). The mean Cl^- values in cases was 98.8±5.89 mEq/l and in control was 103.1±2.71 mEq/L ($p<0.0001$) (Table 3).

These findings are supported by Mann M D et. al., where they have observed decreased levels of serum sodium, potassium and chloride levels in PEM patients when compared to controls [15]. The possible mechanism is due to chronic hypovolemia associated with severe malnutrition which leads to secondary hyperaldosternism which further complicates fluid and electrolyte balance [16].

This study showed strong association of hyponatremia and protein energy malnutrition. There was significant correlation of either hyponatremia or hypokalemia with nutritional status. 'P' value for hyponatremia and hypokalemia are <0.05 and 0.0001 respectively. Because of increase in intracellular water, the total sodium may be increased but the actual serum level may be relatively decreased as a result of excessive increase in water in comparison to increase in sodium. According to Garrow JS et.al., [17] hyponatremia was very bad prognosticfactor but according to Mittal SK et.al., [18] , serum sodium level did not seem to affect the outcome of patients.

There was significant difference in mean potassium concentration in both groups ($p<0.0001$). This showed strong association of hypokalemia and protein energy malnutrition. In the present study, significant difference in serum potassium concentration was noted in PEM and control groups. This result contrasted with many other studies done in other countries. Wakwe VC et.al., [19] found a significant decline in serum potassium level (p value <0.001) in PEM cases when compared to control group.

Similar results with low serum potassium were obtained from studies conducted by Rao A et.al., [20] and Kalra K et al [21] in India. Occurrence of hypokalaemia could be falsely be decreased if samples taken were haemolysed as a result of improper sampling technique. In the present study all the haemolysed samples were excluded from the study. The difference in mean sodium, potassium and chloride in PEM and control groups was significant in the present study. It showed that biochemical tests were particularly helpful as early indicator of malnutrition before the actual abnormalities in anthropometric measurements can be appreciated.

CONCLUSION

A significant proportion of children with protein energy malnutrition had altered biochemical parameters which were related to food intake and biochemical metabolism mandatory during growth and development of children less than five years of age. There was significantly higher proportion of hyponatremia, ,hypokalemia and hypochloremia in children with PEM when compared to normally nourished children. Hence the evaluation of biochemical indicators in PEM at tertiary care centre and nutritional assessment centre will be helpful for treatment and nutritional status improvement after nutritious food supplementation.

REFERENCES

1. Akuyam SA., 2007. A review of some metabolic changes in protein-energy malnutrition. Niger Postgrad Med J ., 14(2):155-62.
2. Pankaj A, Ashok V, Hooda HS.,2001 .Thyroid hormone status in protein energy malnutrition in Indian children. Indian Journal of Clinical Biochemistry.,16(2):221-223.

3. Rahman MA, Mannan MA, Rahman MH.,2007. Serum iron and total iron binding capacity in severely malnourished children. Bangladesh Journal Pharmcol ., 2 :61-65.
4. Food and Agriculture Organization of the United Nations. Undernourishment around the world. *In*: The state of food insecurity in the world. Rome: The organization 2004.
5. Black RE, Morris SS, Bryce J.,2003. Where and why are 10 million children dying every year? Lancet., 361:2226-34.
6. Michaelsen KF, Clausen T 1987. Inadequate supplies of potassium and magnesium in relief food: implications and counter measures.Lancet .,1:1421-23.
7. Ministry of Health and Population. Nepal Demographic & Health Survey 2006. Kathmandu: New ERA, Macro International Inc.2007 173-98.
8. UNICEF. Situation analysis on children and women in Nepal. Kathmandu: UNICEF.1996.
9. Mishra SK, Bastola SP, Jha B., 2009. Biochemical nutritional indicators in children with protein energy malnutrition attending Kanti Children Hospital, Kathmandu, Nepal. Kathmandu University Medical Journal,7(26):129-134.
10. Heird WC. Food insecurity, Hunger and undernutrition. *In*: Kliegman, Behrman, Jenson, Stanton, editors. Nelson Textbook of Pediatrics. 18th edition: Elsevier: Saunders; 2008:227-232.
11. Meffat MEK, Longstaffe S, Besant J, Dureski C. Prevention of iron deficiency and psychomotor decline in high risk infants through use of iron fortified infant formula. A randomized clinical trial. J Pediatr 1994;125: 527-34.
12. Fernandex ID, Himes JH, De Oris M. Prevalence of nutritional wasting in populations: building explanatory models using secondary data. Bull World Health Organ 2002;80:282-91.
13. Aryan A, Devi R., 1991.Influence of maternal Literacy on the nutritional status of pre-school children.Indian Journal of paediatrics ., 58: 265-8.
14. Gupta MC, Mehrotra M, Arora S, Saran M.,1991. Relation with childhood Malnutrition to parental education and mother's nutritional related KAP. Indian Journal of Paediatrics., 58: 269- 74.
15. Mann MD, Bowie MD, Hansen JD.,1975. Total body potassium and serum electrolytes concentrations in protein energy malnutrition. S A Medical Journal .,76-78.
16. Manary MJ, Brewster DR.,1997. Potassium supplementation in Kwashiorkar. Journal Pediatr Gastroenterol Nutr ., 24:194-201.
17. Garrow JS.,1962. The treatment and prognosis of infantile malnutrition in Jamaican Children.West Indian Medical Journal., 11:217-27.
18. Mittal SK, Saxena S, Mundkur N, Srivastava G, Gupta S.,1980. Acute diarrhoea in malnourished children: Clinical, biochemical and bacteriological profile. Indian Journal paediatrics., 9(3); 247-53.
19. Wake VC, Okon KO.,1995. Plasma electrolyte pattern of children with protein energy malnutrition and children with prolonged diarrhoea. Journal of tropical paediatrics., 41(1): 59-60.
20. Rao A, cherian A., 1990. Renal tubular function in PEM. Indian journal of paediatrics., 57; 405-9.
21. Kalra K, Mital VP, pal R, Goyal RK, Dayal RS., 1975. Serum electrolyte studies in malnutrition. Indian paediatrics., 9(2):1135-9.

Table 1: I A P classification of malnutrition

Grade of malnutrition	Weight for age of the standard (median) (%)
Normal	> 80
Grade I	71-80 (mild malnutrition)
Grade II	61-70 (moderate malnutrition)
Grade III	51-60 (severe malnutrition)
Grade IV	< 50 (very severe malnutrition)

Table 2: The socio-demographic characteristics of the cases and controls

Variable	PEM (n=30)	Controls (n=30)
Age (years)		
Mean± S.D	2.86 ± 1.02	2.72 ± 0.96
Gender		
Male	17	17
Female	13 1	13
Weight(kgs)	9.60 ± 1.64	13.70 ± 2.47
Height(cms)	101.30 ± 2.95	102.86 ± 3.03
Social Economic Class		
I	2.2%	4.4%
II	6.8%	30.0%
III	28.8%	38.9%
IV	42.2%	17.8%
V	20.0%	8.9%
Maternal Educational Status		
None	27.8%	10%
Primary	32.2%	22.2%
Secondary	23.3%	25. 6%
Post secondary	16.7%	42.2%
		\

SD = Standard Deviation

Table 3: Showing the mean ± SD of serum Na^+, K^+ and Cl^- and their significant differences between the study groups.

Electrolytes	Cases (n = 30)	Controls (n= 30)	t value	p value
Na^+	133.90 ± 3.31	136.2 ± 2.99	-2.814	<0.05
K^+	3.25 ± 1.47	4.18 ± 0.64	-6.264	<0.0001 (HS)
Cl^-	98.8 ± 5.89	103.1 ± 2.71	-3.541	<0.0001 (HS)

SD = Standard Deviation
HS = Highly Significant
'p' value < 0.05 → Statistically significant
p value = level of significance
t value = test of significance
NS → Not significant

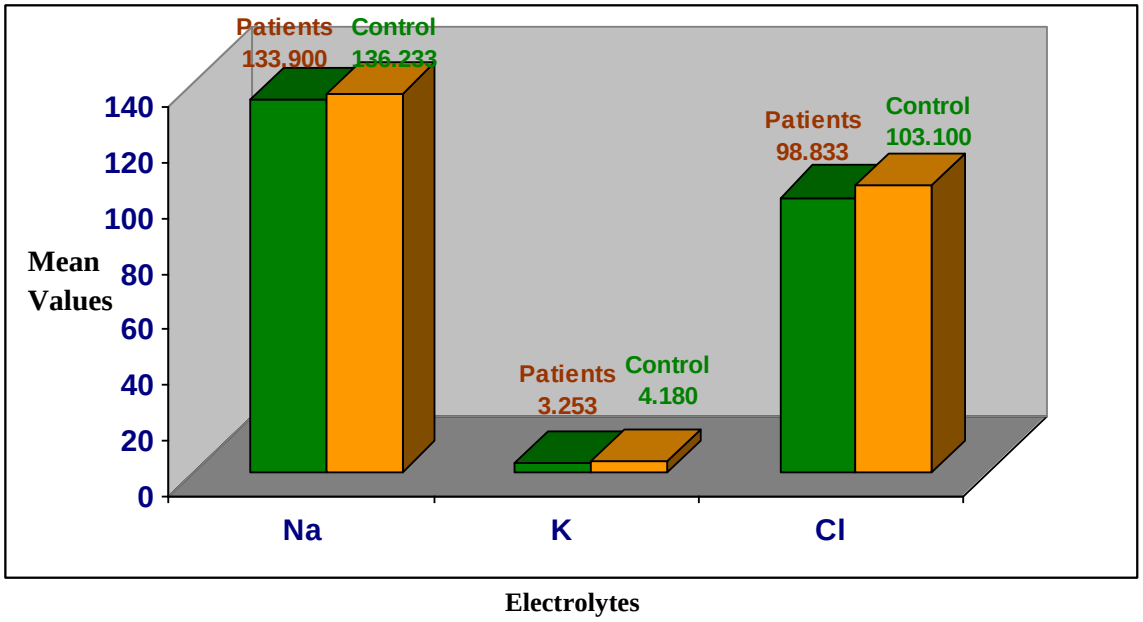

Fig 1: Bar diagram showing the mean values of serum Na^+, K^+ and Cl^- in the study groups

*Corresponding author address:
DR SHAHEEN BANU
MD BIOCHEMISTRY
ASSISTANT PROFESSOR
INSTITUTE OF MEDICAL SCIENCES AND RESEARCH.
VITA ROAD, VIDYAGIRI
MAYANI
SATARA- 415102
MAHARASHTRA.
INDIA.