ETIOLOGY AND BIOCHEMICAL PARAMETERS IN MALNOURISHED CHILDREN FROM 6 MONTHS TO 5 YEARS OF AGE

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ABSTRACT

BACKGROUND:

PEM is a very common problem in the developing regions of Asia, Africa, and Latin America. It is significantly associated with death among children especially below 5 years of age. There is considerable malnutrition among children in Nepal. Almost half of them are stunted and underweight. There are a number of biochemical changes in child with PEM which can be used to diagnose development of PEM early, assess its severity and manage it properly in a tertiary care setting.

OBJECTIVES:

To determine the etiology and clinical features of PEM in children under five years of age and to assess the serum levels of glucose, sodium, potassium, protein, albumin and calcium in malnourished children and compare them with children of normal nutritional status.

METHODS:

A cross sectional study was conducted at Nepalgunj Medical College Teaching Hospital, Kohalpur during the period of November 2013 to November 2014. The study was carried out to determine the etiology and clinical features of PEM in children and find the serum levels of glucose, sodium, potassium, protein, albumin and calcium and compare them with their normal counterparts.

RESULTS:

A total of 160 children (80 in PEM and 80 in control group) were enrolled in the present study. Among them 42 males and 38 females were in the PEM group (M:F=1.1:1) and 44 males and 36 females in the control group (M:F=1.2:1). In the study 21.25% had moderate stunting and 12.5% had severe stunting. Similarly 27.5% had moderate wasting and 28.5% had severe wasting. Only 10% of mother from the PEM group were literate and 20% of them were contributing economically to the family. The prevalence of low birth weight was high among PEM group (27.5%) as compared to the control group (10%). The children in the PEM group had less calorie (83.75%) and protein intake (92.5%). The common presentations of PEM children were wasting of muscles (58.75%), growth failure (43.75%) and hepatomegaly (35%). The level of blood glucose ranged from 48.2 mg/dl to 192.6 mg/dl (mean of 76.24±1.18 in PEM and 80±0.78 in control group). The incidence of hypoglycemia was significantly not different in both groups. The serum sodium level ranged from 129.8 mEq/L to 153.5 mEq/L (mean of 143±9.7 mEq/l in PEM and 144±3.4 in control group). and hyponatremia was also not significantly different in both PEM and control groups. The serum potassium level ranged from 2.8 mEq/L to 5.8 mEq/L (mean of 4±0.74

mEq/L in PEM and 4.3±0.63 mEq/l in control group). It was also statistically not significant in both groups. Serum protein and albumin level ranged from 5.6 mg/dl to 8.4 mg/dl (mean of 5.8±0.97 in PEM and 6.4±0.59 in control group) and 2.9 mg/dl to 4.2 mg/dl respectively. There was significantly higher levels of hypoproteinemia and hypoalbuminemia in the children of PEM group. The serum calcium level ranged from 7.2 mg/dl to 11.3 mg/dl (mean of 8.8±0.35 mg/dl in PEM and 10±0.22 mg/dl) and the incidence of hypocalcemia was significantly low in PEM group.

CONCLUSION:

In the present study, among the various etiological factors, maternal illiteracy, low socio-economic condition, low birth weight, low calorie intake were the most important causes for development of PEM in a child. Most of the children presented with wasting of muscles and growth failure. A significant proportion of children with PEM had low serum levels of glucose, protein, albumin and calcium as compared to their control counterparts. There was significantly higher incidence of hypoproteinemia, hypoalbuminemia and hypocalcemia in PEM children in comparison to normally nourished children. However, no significant difference in the serum levels of glucose, sodium and potassium was found in children with PEM in comparison to normally nourished children. Good correlation was found between PEM and the level of serum total protein, albumin and calcium. Hence biochemical parameters can be used as an early indicator for the assessment of PEM and to assess the prognosis.

Keyword : - *malnutrition, age, children*

1. INTRODUCTION

Protein energy malnutrition (PEM) is defined as a range of pathological conditions arising from co-incident lack of protein and calorie in varying proportions, occurring most frequently in infants and young children and usually associated with infection and micronutrient deficiencies.[1]

Malnutrition ranges in severity from mild to severe depending upon the degree of loss of weight. Various classification schemes have been proposed over the last few decades in order to assess and classify children with malnutrition. The most accepted are the classification of world health organization (WHO) and Indian Academy of Pediatrics (IAP) for determining the severity of malnutrition. WHO recommends the use of Z-scores or standard deviation scores (SDS) for evaluating the children with PEM.[2] IAP classification is based on 'weight-for-age'. Children weighing more than 80% of the 50^{th} percentile of WHO/NCHS standards are considered normal.[3]

WHO classification: Weight-for-height/length and height/length for age are nutrition index which are calculation of two measures- weight and height- into a single value so that children of different ages can be compared. There are several nutrition indices, weight-for-height specifically assesses wasting, a form of acute malnutrition and height for age assesses stunting a form of chronic malnutrition. The Z-score is used to describe how far a measurement is from the median, or average.

There is considerable malnutrition among children of Nepal. Forty-eight percent of children under age of 3 years are stunted, 11 percent are wasted and 47 percent are underweight. The Nepal Demographic and Health Survey (NDHS) 2006 showed that 49% of children aged less than five years were affected by chronic malnutrition (stunting), 39% were underweight(low weight for age), and 13 % were wasted(thin for age).[4] Variation by place of residence is marked with rural children, children living in the Mountains and in the Far-Western region of Nepal are more likely to be malnourished than other children. While stunting is very high nationally, it is even higher in mountain region. As many as five out of six children suffer from stunting in this region[5]. A study done by Gurung G in Nepal in 2010 found that malnutrition is still a serious threat to child development and survival in Nepal. Protein-energy malnutrition (PEM) and micronutrient deficiency (iodine, iron, and vitamin A) are the most common forms.[6]

The etiological factors for protein energy malnutrition are many including low energy intake, heavy physical workload, inadequate nutrition, and inadequate dietetic knowledge during pregnancy and lactation.[7]. There is inadequacy of breast feeding among the malnourished children. The complementary feeds are also inadequate and imbalanced. Mother's diet directly affects the child's nutritional status. Therefore, lack in mother's balanced diet is more likely to produce an under-nourished child. Various infections and systemic diseases also attribute to malnutrition. The family with low income suffers from food shortage and if the number of young

children is more in the family, they may not get adequate nutritious food as required. A high food price definitely affects a family of low income so that they are not able to consume the adequate nutritious food. Furthermore, if the mother of the young child is pregnant or ill, the child may not get adequate care.

Assessment of PEM has traditionally been clinical which is time consuming and skill dependent, with considerable inter-observer variability. Hence, biochemical markers like blood glucose, serum sodium, potassium, protein & albumin and calcium measurements may be used for the assessment of nutritional status. Along with clinical and anthropometric assessments, biochemical measurements are also carried out for the assessment of PEM in a hospital. These markers act as early and sensitive indicators of the development of PEM and also indicate the severity and prognosis. These can help in distinguishing between kwashiorkor and marasmus early. They can also provide information about underlying processes and for indirect assessment of food intake.

2.MATERIALS AND METHODS

2.1Place of study: This study was carried out at Department of Pediatrics, Nepalgunj Medical College, Kohalpur, Banke. Subjects were taken both from out-patient and in-patient department.

2.2Type of study: Case-control, cross sectional hospital based study.

2.3Time and duration: The study was conducted for a period of 12 months starting from April 2014 to April 2015.

2.4Total no. of subjects in PEM group (Z-score below -2) = 80

2.5Total no. of subjects in non-PEM group (Z-score more than-2) = 80

2.6Inclusion criteria:

1. Children from 6 months to 5 years of age with PEM as case group.

2. Children from 6 months to 5 years of age without PEM as control group.

3. Children whose parents gave consent for blood examination.

2.7Exclusion criteria:

1. Children above 5 years of age.

2. Children who were receiving intravenous fluids at the time of admission.

3.Children whose parents were not willing to give consent for blood examination

3.Ethical clearance: ethical approval was obtained from the institutional review committee of Nepalgunj Medical College, Kohalpur, Banke .

4. **STUDY DESIGN:**

Eighty children with PEM and same number of healthy children who met the inclusion criteria and whose parents gave consent for examination and collection of blood sample were included in the study. Control group of 80 children were well nourished and of same age and sex. Relevant history regarding the etiological factors was taken by interviewing face to face with the parents. Physical examination of the patient was done and recorded as per proforma attached.

Weight and height was measured for each patient and healthy child. Length of the child was measured by placing in supine position on an infantometer below 2 years and by stadiometer from 2 years to 5 years. Weight of child was recorded by using weighing scale. The assessment of nutritional status of the children was done according to WHO classification of malnutrition i.e. weight for height (length), height (length) for age and presence of edema. Standard deviation (Z–scores) was used for evaluating nutritional status. Z-score of -2 to -3 indicated moderate malnutrition and score of less than -3 indicated severe malnutrition.[18]

5. Statistical Analysis: The data was analyzed using SPSS 20.0 software. Microsoft Word and Excel were used to generate graphs and table

6.RESULTS

Out of 160 patients enrolled in the study, 80 were from PEM group with z-score for weight for height or height for age less than -2 SD of the reference and 80 were from non - PEM group with z-score for weight for height or height for age more than -2 SD. In both the groups male were more (52.5% in PEM and 55% in control group)

Table 1: Sex distribution of children

Sex	PEM Group(n=80)	Control group(n=80)
Male	42(52.5%)	44(55%)
Female	38(47.5%)	36(45%)
Total	80(100%)	80(100%)

Table 2: Weight of children

Wt (in kgs)	PEM group(n=80)		Control group(n=80)	
	Male	Female	Male	Female
5-10	9(21.42%)	11(28.94%)	12(27.27%)	9(25%)
10.1-15	12(28.57%)	10(26.31%)	10(22.73%)	7(19.44%)
15.1-20	16(38.09%)	12(31.57%)	12(27.27%)	12(33.33%)
20.1-25	5(11.92%)	5(13.18%)	10(22.73%)	8(22.22%)
Total	42(100%)	38(100%)	44(100%)	36(100%)

Table 3: Distribution of children according to age and weight.

Weight of children(in kgs)	Age of PEM group of children(in months)							Age of control group of children(in months)						
	6-12		13-36		37-60		Total	6-12		13-36		37-60		Total
	M	F	M	F	M	F		M	F	M	F	M	F	

5-10	3	5	4	4	2	2	20	4	6	3	6	1	1	21
10.1-15	9	3	2	6	1	1	22	6	2	3	9	1	2	17
15.1-20	0	0	4	9	12	3	28	0	0	2	7	11	4	24
20.1-25	0	0	2	3	3	2	10	0	0	2	2	8	6	18
Total	12	8	10	22	18	10	80	10	8	10	24	22	6	80

Table 4: Distribution of children according to weight and height

Height (in cms)	Weight in kgs (PEM group)								Weight in kgs (Control group)							
	5-10		10.1-15		15.1-20		20.1-25		5-10		10.1-15		15.1-20		20.1-25	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
60-70	2	3	2	1	4	3	1	2	3	1	2	3	2	3	2	1
71-80	3	2	3	1	3	2	1	1	3	1	3	1	4	2	3	1
81-90	1	2	2	3	2	2	0	0	2	2	1	1	1	3	1	2
91-100	1	2	2	2	1	1	0	0	1	2	2	2	2	3	2	2
101-110	2	1	3	2	2	3	2	2	2	3	1	0	1	1	1	2
111-120	1	1	0	1	4	1	1	0	1	0	1	0	2	0	1	0
Total	9	11	12	10	16	12	5	5	12	9	10	7	12	12	10	8

Out of 42 males 22(52.38%) had moderate PEM and 20(47.62%) had severe PEM. In 38 females 17(44.74%) had moderate PEM and 21(55.26%) had severe PEM.

Etiological factors

a. Maternal factors

1. Mother's Education:

Table 5: Distribution of mothers according to educational status.

Educational Status	PEM Group (n=80)	Control Group (n=80)
Illiterate	72 (90%)	30 (37.5%)
Literate:		
Grade1-5	4 (5%)	10 (12.5%)

Grade5-10	3 (3.75%)	21 (26.25%)
>10th grade	1 (1.25%)	19 (23.75%)
Total	80 (100%)	80 (100%)

In PEM group 80% were housewives and 20% were working as labourers whereas in control group 56.25% were housewives, 18.75% were in service and 25% worked as laborers.

As in case of mothers, fathers in the PEM group were significantly more illiterate ($p<0.05$) and with less higher education ($p<0.05$).

4. Fathers' Occupation

Table 6: Fathers' occupation

Occupation	PEM Group (n=80)	Control Group (n=80)
Farming	36 (45%)	22 (27.5%)
Service	12 (15%)	35 (43.75%)
Laborer	23 (28.75%)	17 (21.25%)
Business	9 (11.25%)	6 (7.5%)
Total	80 (100%)	80 (100%)

5. Socio-economic status:

Table 6: socio-economic status of family

Socio-economic status according to Kuppu-swamy scale(2014)	PEM group(n=80)	Control group(n=80)
Upper	0(0%)	4(5%)
Upper middle	3(3.75%)	8(10%)
Lower middle	5(6.25%)	18(22.5%)
Upper lower	35(43.75%)	28(35%)
Lower	37(46.25%)	22(27.5%)
Total	80(100%)	80(100%)

67.5% of children from PEM group were born at home whereas only 47.5% were born at home from the control group.

Table 7: Birth-weight of children

Birth-weight(in gms)	PEM Group (n=80)	Control group (n=80)
Low birth weight(below2500gm)	22 (27.5%)	8 (10%)
Normal (2500-4000g m)	53 (66.25%)	68 (85%)
Not known	5 (6.25%)	4 (5%)
Total	80 (100%)	80 (100%)

8. Feeding:

Colostrum feeding: Out of 80 in PEM group, one baby (1.25%) was not given colostrum because of medical reasons. All the babies (100%) in control group were given colostrum at the time of their birth.

Seventy-two(90%) children in the control group were exclusively breast fed whereas only 60 children (75%) were only exclusively breast fed for six months.

Table 8: Dietetic intake

Group	Calorie intake		Protein intake	
	Expected	Below expected	Expected	Below expected
PEM	13(16.25%)	67(83.75%)	6(7.5%)	74(92.5%)
Control	72(90%)	8(10%)	64(80%)	16(20%)

B. Etiological factors for PEM in children

Though almost half of children in both groups had acute diarrhoea in last two weeks there was no significant difference in its incidence ($p>0.05$). Children in the PEM group presented with significantly higher incidence of chronic diarrhea (25%) in comparison to non – PEM group ($p<0.05$). Though almost half of children of both groups had ARI in last two weeks, there was no any significant difference in its incidence ($p>0.05$).

Table 9: miscellaneous causes

Causes	PEM group (%)	Control group (%)
Good Sanitation practice	22	76
Pure drinking water	45	65
Hand washing	27	87
Domestic animals near home	74	23
Safe waste disposal	17	82

Chronic diseases	11	2

CLINICAL FEATURES OF PEM:

Most of the children with PEM presented with wasting of muscles (58.75%), growth failure (43.75%), hepatomegaly (35%), diarrhea (33.75%) and irritability (23.75%).

BIOCHEMICAL INDICATORS

1. Blood Glucose level: The level of blood glucose ranged from 48.2 mg/dl to 192.6 mg/dl. Mean blood glucose level in PEM group is 76.24 mg/dl (SD ±1.18) and that in control group is 80mg/dl(SD 0.78).

Table 19: Blood glucose level

Glucose level(mg/dl)	PEM group	Control group
<50	19(23.75%)	5(6.25%)
50-180	45(56.25%)	62(77.5%)
>180	16(20%)	13(16.25%)
Total	80(100%)	80(100%)

The incidence of hypoglycemia was significantly higher in PEM group as compared to non-PEM group. (P value<0.05). Sixteen (20%) children in the PEM group and 13 in control (16.25%) had hyperglycemia but the difference was insignificant (p>0.05).

2. Serum Sodium level

The serum sodium level ranged from 129.8 mEq/L to 153.5 mEq/L. Mean serum sodium in PEM and control groups are 143(SD ±9.7) and 144 (SD±3.4)mEq/l respectively. The mean sodium in both groups was not significantly different (p>0.05).

Table 20: Serum sodium level

Serum sodium level is not significantly associated with nutritional status. (P value >0.005 for both hyponatremia and hypernatremia.

Serum sodium level(mEq/L)	PEM group	Control group
<135	29(36.25%)	16(20%)
135-145	23(28.75%)	38(47.5%)
>145	28(35%)	26(32.5%)
Total	80(100%)	80(100%)

3. Serum Potassium level:

The average potassium level ranged from 2.8 mEq/L to 5.8 mEq/L. Mean serum potassium level in PEM and control groups are 4.0 (SD±0.74)and 4.3 (SD±0.63)mEq/L respectively. There was no significant difference in mean potassium in both groups (p>0.05).

Table 21: Serum potassium level

Serum potassium level is not significantly associated with nutritional status (p value for both hypokalemia and 0.10 hyperkalemia is >0.05).

Serum potassium level(mEq/L)	PEM group	Control group
<3.5	17(21.25%)	13(16.25%)
3.5-5.5	51(63.75%)	53(66.25%)
>5.5	12(15%)	14(17.5%)

4. Total Protein

The serum total protein value ranged from 5.6 mg/dl to 8.4 g/dl. Mean serum total protein are 5.8 (SD±0.97) and 6.4 g/dl (SD±0.59)in PEM and control groups respectively. There was significant decline in total protein in the PEM group (p<0.005).

Table 22: Serum total protein

Serum protein level(g/dL)	PEM group	Control group
<6.1	42(52.5%)	18(22.5%)
6.1-7.9	29(36.25%)	52(65%)
>7.9	9(11.25%)	10(12.5%)
Total	80(100%)	80(100%)

Table 23: Serum albumin level

Serum albumin level ranged from 2.9g/dl to 4.2 g/dl. There was significantly higher incidence of hypoalbuminemia in PEM group as compared to control group (p<0.05).

Serum albumin level(g/dL)	PEM group	Control group
<3.4	52(65%)	21(26.25%)
3.4-4.2	28(35%)	59(73.75%)
Total	80(100%)	80(100%)

5. Serum Calcium

Serum calcium level ranged from 7.2 mg/dl to 11.3 mg/dl.The mean serum calcium in PEM and control groups are 8.8 mg/dL(SD ±0.35) and 10 mg/dL (±0.22)respectively. The mean calcium in PEM group was significantly low in PEM group as compared to control group ($p<0.005$).

Table 24: Serum calcium level

Serum calcium level(mg/dL)	PEM group	Control group
<8.8	37(46.25%)	9(11.25%)
8.8-10.8	42(52.5%)	56(70%)
>10.8	1(1.25%)	15(18.75%)

7.DISCUSSION

This study was conducted at Nepalgunj Medical College, Kohalpur, Banke which comprised of two cohorts; PEM and control group. The study comprised of 80 subjects each on PEM and control group based on weight for height and height for age. The children in PEM group had weight for height/length or height/length for age below -2SD and the control group children had above -2 SD. All cases were taken from patients attending Nepalgunj medical college teaching hospital emergency ward and out-patient department. There were almost equal number of males and females in PEM group (M:F=1.1:1). The ratio of males and females in the control group was 1.2:1. The age group of study population was six months to five years. The mean age of the children in the PEM group and control group was 29.4±15.5 months and 30.3±15.2 months respectively

In the present study, out of 80 children, 21.25% (male-12.5% and female-8.75%) had moderate stunting and 12.5% (male-3.75% and female-8.75%) had severe stunting. Similarly 27.5% (male-15% and female 12.5%) had moderate wasting and 28.5% (male-21.25% and female-17.5%) had severe wasting. Sapkota VP and Gurung CK (2009) from Kathmandu, Nepal reported the the prevalence of underweight, stunting and wasting as 27%, 37% and 11% respectively[8]. Another study done by *Ruwali D from Chitwan, Nepal reported the* prevalence of underweight, stunting and wasting to be 22.7%, 37.3% and 25.7% respectively[9] which is almost in conformity to the present study.

The present study showed that only 10% of the mother from PEM group were literate whereas 62.5% of mother from control group were literate. The educational status of parents of children with PEM was found to be low as compared to the control group which was statistically significant ($p<0.05$). In the study conducted by Arya A et.al. (1991) revealed that the children of literate mothers had better anthropometric measurements than children of illiterate mothers[10]. Gupta MC et al. (1991) from India reported a strong correlation between nutritional status of the children and educational level of their mothers ($p < 0.025$)[11]. A study done by Bisai S from west Bengal, India also showed that mothers of children with malnutrition were having lack of education and high number of children[12]. In a study in Ludhiana, Punjab by Anoop et al., (2003) a highly significant inverse relationship was observed. Higher maternal education was associated with lower prevalence of childhood malnutrition, which is similar to the present study[13]. Phengxay M et.al. (2007) from Laos also reported that low maternal education, poor nutrition knowledge of mothers and faulty feeding practices for sick children also affect children's health regarding stunting and underweight[14].

In the present study father's educational status was found to be unrelated to children's nutritional status ($p>0.05$). The findings are similar as reported by Anuradha R et al. (2014) from Tamilnadu, India[15]. In a study done by Prasot RM et al. (2014) from UP, India malnutrition was significantly more in a family with illiterate father[16]. Another similar study by Imran M et al (2012) from Bangalore, India reported that the proportion of underweight among children of illiterate fathers was significantly higher as compared to their control counterparts[17]which were contradictory to the present study.

In this study only 20% of the mother of PEM group were contributing economically to the family whereas 43.75% of mother from the control group were earning and contributing to the family. This study revealed that malnutrition was more common in the children whose mothers were not contributing economically to the family. Similarly, only 55% of fathers from PEM group were earning from occupation whereas 62.5% of fathers from the control group were earning from business, labor and unskilled works. A positive relationship was seen between the socio-economic status of the family with the nutritional status of children. Families with lower socio-economic status had more number of PEM (46.25%). Saito K et.al. (1997) from South India showed that socioeconomic factors were stronger risk factors for malnutrition and the father's occupation was a more accurate indicator which was similar to our study[18]. Sonkaria L et.al. (2014) from Rajasthan, India reported that nutritional status of children was associated with maternal age, maternal education and spacing between children whereas it was not associated with maternal occupation[19]. *Eze UIH et.al. (2005) from Nigeria* showed no significant difference between the nutritional status of children with the educational level and occupation of mothers[20] which was not in conformity to the present study.

The present study showed that 27.5% children in PEM group were born with low birth weight and only 10% from the control group had low birth weight. There was a significant relationship between the low birth weight of the babies and development of PEM subsequently. Alvear J et.al. (1986) from Spain also showed a correlation between protein energy malnutrition and birth weight of infants[21]. Kurup PJ and Khandekar R (2003) from Oman found that low birth weight were significant predictors of PEM[22]. Similarly Rajapaksa LC (2011) from Sri Lanka reported that the key factors associated with PEM among children under 5 years were low birth weight and the total number of children in the household[23].

In this study 83.75% of children from PEM group had calorie intake below expected for age and weight of the child and 92.5% had protein intake below expected. There was a positive relationship between the daily calorie and protein intake and development of PEM. The infant who received exclusive breast feeding for six months of life was less likely to suffer from PEM. Similar results were reported by Baranwal K, Gupta VM and Mishra RN (2012) from Varanasi, India[24]. The prevalence of PEM in their study was higher among children who were vegetarian by dietary habits, in children who were deprived of colostrum and exclusive breast feeding. All studied children, in general were consuming less calories than the recommended dietary allowances. However, PEM group of children had significantly lower intake as compared to non-PEM group of children. Muoki MA (2012) from Kenya reported that there was a positive relationship between dietary intake and nutritional status of children[25]. Kone MB, Traore S and Brou K (2015) from Ivory Coast showed a negative correlation between the increase in macronutrient intake and prevalence of protein-energy malnutrition[26].

In the present study the most common presentation of PEM in children were wasting of muscles (58.75%), growth failure (43.75%), hepatomegaly (35%), diarrhea (33.75%) and irritability (23.75%). Mushtaq A and Rehman S (2013) from Lahore, Pakistan found that fever (81.5%), diarrhea (66.2%) and vomiting (50.8%) were most common presenting symptoms of PEM[27].

BIOCHEMICAL MARKERS:

Biochemical markers act as early and sensitive indicators of the development of PEM and also indicate the severity and prognosis. These can help in distinguishing between kwashiorkor and marasmus early. They can also provide information about underlying processes and for indirect assessment of food intake. The parameters that were included in the present study were blood glucose, serum sodium, potassium, protein, albumin and calcium

The level of blood glucose ranged from 48.2 mg/dl to 192.6 mg/dl. Mean blood glucose level in PEM group was 76.24 mg/dl (SD ±1.18) and that in control group was 80mg/dl (SD 0.78). The mean glucose concentration in PEM and control group is not significantly different ($p>0.05$) but as the variance of serum glucose is significantly different in two groups, the incidence of hypoglycemia is significantly higher in PEM group ($p<0.05$) in comparison to the control group. In spite of frequent occurrence of hypoglycemia, the levels of glucose were not extremely low, the lowest value being 40 mg/dl (Reference value = 50-180 mg/dl). None of the cases with hypoglycemia presented with altered consciousness showing thereby the unique capability of body to cope with low glucose. Buchanan N et.al.found impaired glycogenolysis in severe kwashiorkor leading to hypoglycemia. Glyn-Jones R got a higher incidence of hypoglycemia, which was significantly associated with higher mortality rate. No correlation was found between blood sugar and serum sodium levels.

A number of children of both groups (20% in PEM group and 16.25% in control group) were found to have hyperglycemia but were found statistically insignificant ($p<0.05$). According to Gupta P et.al. (1997) from Delhi, India transient hyperglycemia occurs as a part of stress response in acute illnesses and is brought about by elevated levels of counter-regulatory hormones. They had found it in 4.7% of children with acute illness.[28]

In the present study the serum sodium level ranged from 129.8 mEq/L to 153.5 mEq/L. Mean serum sodium in PEM and control groups were 143(SD ±9.7) and 144 (SD±3.4) mEq/l respectively. There was no significant correlation of hyponatremia with nutritional status of the children ($p<0.05$). Mushtaq A and Rehman S (2013) from Lahore, Pakistan also reported the similar findings[27]. Mishra SK et al. (2010) from Kathmandu also found that there was no significant relation between serum sodium level and the nutritional status of children[29]. But Shaheen B et al. (2013) from Maharastra, India found that hyponatremia is more common with malnourished children as compared to the children from control group[30]. According to Mittal SK et.al. serum sodium level did not seem to affect the outcome in children with PEM[31]. This contrasts with the present study as well as the study conducted by Rao A et al in which no significant difference in serum sodium was found between children with PEM and normally nourished children[32]. Kalra K et al found no significant difference in serum sodium levels in children with or without edema[33].

The average potassium level ranged from 2.8 mEq/L to 5.8 mEq/L. Mean serum potassium level in PEM and control groups are 4.0 (SD±0.74) and 4.3 (SD±0.63) mEq/L respectively. In the present study, no significant difference in serum potassium level was noted in PEM and non-PEM groups. Mishra SK et al. (2010) from Kathmandu also found that there was no significant relation between serum potassium level and the nutritional status of children[29]. This contrasts with many other studies done in other countries. Wake VC et al found a significant decline in serum potassium level ($p < 0.001$) in PEM cases when compared to controls[34]. Similar results with low serum potassium were obtained from studies conducted by Rao A et.al. (1990)[32] and Kalra K et al (1975) in India[33]. Shaheen B et al. (2013) from Maharastra, India also found that hypokaalemia was more common with malnourished children as compared to the children from control group[30]. Occurrence of hypokalemia can be falsely decreased if samples taken are hemolyzed as a result of improper sampling technique. In the present study all the hemolyzed samples were excluded from the study.

The serum total protein value ranged from 5.6 mg/dl to 8.4 g/dl. Mean serum total protein were 5.8 (SD±0.97) and 6.4 g/dl (SD±0.59) in PEM and control groups respectively. Serum albumin level ranged from 2.9g/dl to 4.2 g/dl. The total serum protein and serum albumin were significantly low in PEM group in comparison to non-PEM group, p value for total protein and albumin being less than 0.05. Williams C has attributed the deficiency of protein as the main cause of PEM especially kwashiorkor[35]. There is higher degree of correlation with albumin in comparison to total protein. It may be because of the fact that plasma proteins are reduced in PEM and the greatest reduction is in the albumin fraction especially in kwashiorkor. In a study conducted by Whitehead RG et.al., the serum albumin was found to be a significant marker of nutritional status[36]. A study was conducted by Dramaix M et al. to analyze the prognostic value of clinical, anthropometric and biological indicators of PEM in hospitalized children and serum albumin was found to be the best predictor of prognosis[37]. The low serum protein and albumin in PEM has also been found in studies conducted by Kumar V et al (1975)[38] and Kalra K. et al (1975)[33]from India which are in conformity to the findings in the present study.

Serum calcium level ranged from 7.2 mg/dl to 11.3 mg/dl. The mean serum calcium in PEM and control groups were 8.8 mg/dL (SD ±0.35) and 10 mg/dL (±0.22) respectively. The mean serum calcium concentration in PEM group was significantly low in comparison to non-PEM group ($p<0.05$). There was significantly higher incidence of hypocalcaemia in PEM group in comparison to controls ($p<0.05$) because serum calcium level is directly influenced by the serum protein level.

In the present study, the total protein and albumin are significantly low in PEM group as compared to controls so the level of calcium might have been apparently low in parallel with total protein and albumin levels. According to Adejuwon CA et.al.the level of calcium in PEM (with hypoalbuminemia) gets automatically corrected as hypoalbuminemia is corrected[39]. He concluded that the observed hypocalcaemia in kwashiorkor is merely apparent and is because of hypoalbuminemia; the level of free or ionized Ca^{++} being normal.

In the present study, the incidence of hypercalcemia is found to be higher in non-PEM group (18.75%) in comparison to PEM group (1.25%) ($p <0.05$) signifying thereby the tendency of PEM cases to be either normo-calcemic or hypo-calcemic.

Low serum calcium in PEM cases has also been found in study done by Kalra K. et.al.in India[33]. In contrast to present study and that conducted by Kalra K. et al serum calcium (albumin adjusted) showed no significant change in study conducted by Rao A. and Cherian A. (1990).[40]

8.**CONCLUSIONS**

This study was conducted from November 2013 to November 2014 in Nepalgunj Medical college which consisted 80 children in PEM group and 80 in control group.

- Forty two males and 38 females were in the PEM group (M:F=1.1:1) and 44 males and 36 females in the control group (M:F=1.2:1).
- In the study 21.25% had moderate stunting and 12.5% had severe stunting. Similarly 27.5% had moderate wasting and 28.5% had severe wasting.
- Only 10% of mother from the PEM group were literate and 20% of them were contributing economically to the family.
- The prevalence of low birth weight was high among PEM group (27.5%) as compared to the control group (10%).
- The children in the PEM group had less calorie (83.75%) and protein intake (92.5%).
- The common presentations of PEM children were wasting of muscles (58.75%), growth failure (43.75%) and hepatomegaly (35%).
- The level of blood glucose ranged from 48.2 mg/dl to 192.6 mg/dl (mean of 76.24±1.18 in PEM and 80±0.78 in control group). The incidence of hypoglycemia was significantly not different in both groups.
- The serum sodium level ranged from 129.8 mEq/L to 153.5 mEq/L (mean of 143±9.7 mEq/l in PEM and 144±3.4 in control group). and hyponatremia was also not significantly different in both PEM and control groups.
- The serum potassium level ranged from 2.8 mEq/L to 5.8 mEq/L (mean of 4±0.74 mEq/L in PEM and 4.3±0.63 mEq/l in control group). It was also statistically not significant in both groups.

Serum protein and albumin level ranged from 5.6 mg/dl to 8.4 mg/dl (mean of 5.8±0.97 in PEM and 6.4±0.59 in control group) and 2.9 mg/dl to 4.2 mg/dl respectively. There was significantly higher levels of hypoproteinemia and hypoalbuminemia in the children of PEM group.

- The serum calcium level ranged from 7.2 mg/dl to 11.3 mg/dl (mean of 8.8±0.35 mg/dl in PEM and 10±0.22 mg/dl) and the incidence of hypocalcemia was significantly low in PEM group

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