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Original Research Article

Cross-sectional study of blood biochemical profile in malnourished children admitted in pediatrics indoor in a tertiary care hospital with respect to severity of malnutrition

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ABSTRACT

Background: Malnutrition encompasses both undernutrition and overnutrition. In India, undernutrition is widely prevalent among under-five children in resource limited rural and tribal dominated areas of Bankura district of West Bengal, where the study was conducted. In undernourished state, there is alteration in blood glucose, electrolytes, liver function tests, renal function tests, lipid profile etc. These metabolic and biochemical markers are very important for feeding and fluid management of malnourished children.
Methods: The present study will provide an overview of blood biochemical changes in malnourished children aged 6 months to 60 months and admitted in Paediatric indoor of Bankura Sammilani Medical College. This observational study included 105 children aged 6 months to 5 years, admitted with undernutrition and was categorized as per WHO classification according to its severity into moderate acute malnutrition (MAM) numbering 65 and severe acute malnutrition (SAM) numbering 40. Initial blood sugar, serum Na^+, K^+, liver function tests (ALT, AST, albumin, alkaline phosphatase), urea, creatinine, lipid profile were estimated as per standard protocol after taking consent from the parents of children included and were correlated with respect to severity of malnutrition.
Results: Significant difference in mean serum values of ALT, alkaline phosphatase, albumin, urea, sodium, potassium, cholesterol and triglyceride was observed between MAM and SAM groups. However, differences in mean values of blood glucose, AST, HDL and creatinine were not significant. Changes in blood biochemical parameters were also observed in phenotypic variants of malnutrition, namely marasmus and kwashiorkor.
Conclusions: Levels of blood biochemical parameters vary with severity of malnutrition.

Keywords: Malnutrition, Severe acute malnutrition, Moderate acute malnutrition, Blood biochemical profile

INTRODUCTION

Malnutrition is a broad term that can be used to describe any imbalance in nutrition namely undernutrition as observed in rural areas to overnutrition that is frequent in urban affluent families. Undernutrition, a problem of infants and toddlers usually results from varying proportion of protein and energy deficiency in diet. It is the most common nutritional disorder, the third most common disease entity and a complicating factor for other illnesses in developing countries.[1] About 45% of deaths among under-five children globally are attributed to malnutrition.[2,3] Reported under-five mortality in India in 2023 is 28 per 1000 live births as revealed in UNICEF Data. While irreversible physical and cognitive damage accompanies stunted growth even affecting next generation, a child with moderate or severe wasting has an increased risk of death, but treatment is possible.[4] Malnourished state is associated with changes in blood levels of glucose, electrolytes and various biochemical

parameters. Infections and diarrhoeal disorders consequent upon malnutrition further aggravate metabolic dysfunction. Assessment of blood biochemical markers along with clinical evaluation and nutritional screening tools help in identifying nutritional deficiencies, excesses, or imbalances, allowing for personalized interventions to improve health outcomes.[5]

METHODS

This cross-sectional study was conducted on children admitted in the Department of Pediatrics in Bankura Sammilani Medical College and hospital for one year after obtaining ethical clearance from Institutional Ethics Committee and necessary approval of The West Bengal University of Health Sciences.

Study design

It was a cross-sectional observational comparative study.

Study location

Study conducted at pediatrics ward of Bankura Sammilani Medical College and Hospital.

Study duration

Study conducted for one year, from June 2019 to May 2020.

Sample size

Calculated based on the formula

$n=Z^2pq/d^2$, where n=sample size, z=1.96 at 95% confidence limit (two tail)

p=prevalence of wasting among under-fives=21% according to NHFS 4 factsheet.[6]

q=(100-p), d=allowable error (absolute)=8.

Equals to 99.54 or 100. Keeping in mind possible drop out, 5% attrition rate was taken. So, total participants were 105.

Sample design

Sample was chosen by systematic random sampling method, technique fulfilling age and anthropometric criteria for malnutrition.

Inclusion criteria

The study population included undernourished children aged between 6 months and up to 5 years satisfying WHO criteria for MAM and SAM.[7]

Exclusion criteria

Following were the exclusion criteria for the study: Malnourished children with pre-existing conditions. Liver disease, hyperlipidaemia, cardiovascular disease, nephrotic syndrome and end stage renal disease, chronic systemic disease and child taking drugs other than nutritional supplements.

Procedure

The study sample satisfying selection criteria was classified with the help of WHO growth chart and evaluated. Malnutrition was categorised by: WHO classification of undernutrition, which takes the reference values based on the data assembled by the United States National Centre for health statistics (NCHS). It takes account of a) low height for age to assess stunting b) low weight for height to assess wasting) c) low weight for age to assess underweight and d) micronutrient deficiencies.[2]

MAM

Weight-for-length/height or BMI-for-age ≤-2 SD and ≥-3 SD of the median, or mid-upper arm circumference ≥115 mm and <125 mm

SAM

Weight-for-length/height or BMI-for-age <-3 SD of the median or mid-upper arm circumference <115 mm, or bilateral pitting oedema.[7]

Wellcome trust classification

Takes into account weight for age and oedema protein energy malnutrition is categorised phenotypically into Kwashiorkor, undernutrition, Marasmic kwashiorkor and Marasmus.[8]

Table 1: Wellcome trust classification.

Malnutritions	Body weight of standard (50th centile of Harvard standard)	Edema
Underweight	60-80	(-)
Marasmus	<60	(-)
Kwashiorkor	60-80	(+)
Marasmic Kwashiorkor	<60	(+)

The socio-economic status was assessed by using modified Prasad's classification.[9]

Study technique

The study was conducted among admitted children fulfilling selection criteria with signed informed consent from the guardian/ parents and was recorded in predesigned proforma.

The cases were investigated for initial blood sugar, serum Na^+, K^+, liver function tests (SGOT, SGPT, serum albumin, alkaline phosphatase), urea, creatinine, lipid profile (cholesterol, HDL and triglyceride) as per standard protocol.

Venous blood was collected under aseptic precautions from each participant. The samples each measuring 2 ml, were allowed to clot and centrifuged to collect the serum.

Blood glucose was measured by glucose oxidase and peroxidase method. Serum SGOT and SGPT were measured by modified IFCC (International Federation of Clinical chemistry) method, serum alkaline phosphatase estimated by PNPP (p Nitrophenyl Phosphate) and DEA (Data envelopment analysis) method and serum albumin by bromocresol green (BCG) method. Serum Na^+ and K^+ were measured by ion selective electrode (ISE) in NOVA biolytic analyzer. Serum creatinine was measured with alkaline picrate method and serum urea with Berthelot method. Serum triglycerides were measured by glycerol phosphate oxidase-p-aminophenol (GPO-PAP) end point method. Serum cholesterol and HDL cholesterol were measured by cholesterol oxidase-peroxidase (CHOD-POD and phosphotungstate- Mg^{++} precipitation methods respectively.

Statistical analysis

All the necessary data were collected, tabulated and analyzed. The parametric data were analyzed using unpaired t test or Mann Whitney U test as applicable, while the non-parametric data were analysed by using chi-square test.

SPSS for windows trial version 22 was be used for statistical analysis and $p<0.05$ was considered statistically significant.

Graph pad prism software and Microsoft office were used for drawing the diagrams.

RESULTS

The current study included a total of 105 undernourished subjects, comprising 65 children with MAM and 40 children with SAM. Age range of the sample was 6 months to 59 months with mean age 16.16 months and standard deviation (SD) of 10.42. Minimum weight of children studied was 5 kg and maximum weight was 17.6 kg. Mean weight was 7.11 kg±SD 2.08. Height of the sample studied varied from 60 cm to 110cm, the mean being 68.61±SD 11.27

Demographic, socioeconomic and clinical parameters

The undernourished children included in this research comprised of 47 infants, 42 children aged 13-24 months and 16 children aged 25-59 month (Table 2). Majority of the study subjects, i.e., 89 children out of 105 (84.76%) belonged to 6-24 months age group as shown in Table 3. This group comprised of 50 out of 65 MAM children and 39 out of 40 SAM children. There were significantly higher number of SAM cases as compared to MAM in this age category (p=0.003). Among MAM children, 43 (66%, n=65) were boys and 22 (34%, n=65) were girls. Among SAM children, 23 (57%, n=40) were boys and 17 (43%, n=40) were girls. There was no significant difference in gender distribution among MAM and SAM children included in the study.

Out of the total, 76 malnourished children (72%) belonged to tribal population. There were more tribal children with SAM (85%) as compared to MAM (64%) and the difference was statistically significant (p=0.023).

Majority (86%) of the study sample resided in rural areas, while only 14% came from urban localities. There was no significant difference in distribution of severity of malnutrition between children residing in urban and rural areas (p=0.68).

Comparison of malnourished children with respect to father's occupation showed that there was increased number of severely malnourished offsprings among unskilled labourers than skilled labourers and the differences was statistically significant (p=0.01). Families with higher monthly per capita income had lower proportion of severe acute malnourished children and the value was statistically significant ($p\leq0.05$). There was increased occurrence of severe malnutrition in families with more numbers of siblings and the data was statistically significant ($p<0.05$). However, maternal age at childbirth, maternal education and family type had no significant association with increasing severity of malnutrition (Table 4).

Only 36(34.28%) malnourished children were exclusively breastfed (EBF) up to 6 months of age (Table 5). There was significant difference between number of exclusively breastfed (EBF) children in MAM (n=27, 41.53%) as compared to that (n=9, 22.5%) in SAM (p=0.046).

Distribution of malnutrition in children with respect to appropriate complementary feeding (CF) started at 6 months of age revealed only 26 out of 105 (25%) children were fed with appropriate complementary food after 6 months of age. However, there was no significant statistical difference between the study groups of MAM and SAM children in this respect.

Oedema was present in 15 MAM and 12 SAM children. The difference was not statistically significant. Symmetrical oedema could be demonstrated in 25.71% of the malnourished children included in the study.

Among the 105 study subjects, the phenotypic categories included undernutrition, marasmus, kwashiorkor and marasmic kwashiorkor in decreasing order of proportions (Table 6).

Biochemical parameters

Table 7 showed mean blood sugar in SAM group was less than that in MAM, but difference was not statistically significant. Mean ALT, AST, ALP values different in SAM and MAM groups. There was significantly higher value of ALT and ALP in MAM than in SAM group of children. Also, mean values of serum albumin, serum urea, serum sodium and potassium were significantly lower in SAM children as compared to MAM, $p<0.05$.

Lipid profile analysis demonstrated that there was dyslipidaemia in form of decrease in HDL and triglyceride in both groups. S. cholesterol and triglyceride levels were significantly lower in SAM group.

Blood biochemical dysfunctions observed among study population included hypoglycemia (blood glucose ≤55 mg/dl), hyponatremia (<135 mEq /dl)), hypernatremia (>145 mEq /lit) and hypokalemia (<3.5 meq /lit). However, no significant difference was found between the two groups regarding their incidence (Table 8).

Biochemical parameters as assessed in different clinical categories of malnutrition showed that mean serum cholesterol and triglyceride values were lower in marasmic children as compared to kwashiorkor and marasmic kwashiorkor subjects. Whereas, mean serum albumin value was found to be low in kwashiorkor and marasmic kwashiorkor population as compared to marasmic children (Table 9).

Table 2: Age distribution of malnourished children.

Age (in months)	Malnutrition	
	MAM	SAM
6-12	34	13
13-24	16	26
25-59	15	1

Table 3: Demographic profile of undernourished children.

Parameters	MAM	SAM	Chi square value	Df	Significance (p value)
Age (in months)					
6-24	50	39	8.925	1	0.003
Above 24	15	1			
Gender					
Boys	43	23	0.794	1	0.373
Girls	22	17			
Race					
Tribal	42	34	5.147	1	0.023
Non-Tribal	23	6			
Residence					
Rural	55	35	0.168	1	0.68
Urban	10	5			

Table 4: Distribution of malnutrition according to socioeconomic status.

Parameters	MAM	SAM	Df	Significance (p value)	Chi square value
Mother's age at child's birth (in years)					
<20	45	30			
20-29	15	9	2	0.19	3.93
30-49	5	1			
Mothers' education					
Illiterate	30	20			
Middle school	23	17	2	0.089	4.98
High school and above	7	3			
Fathers' occupation					
Unskilled labour	26	25			
Skilled labour	32	8	2	0.01	8.97
Others	7	7			
Family type					
Nuclear	35	16	1	0.168	1.93
Joint	30	24			

Continued.

Parameters	MAM	SAM	Df	Significance (p value)	Chi square value
Monthly per capita income (Rs.)					
>399	14	4			
240-399	39	13	2	0.00	17.02
<240	12	23			
Numbers of siblings					
None	10	8			
1-2	40	12	2	0.005	10.66
≥3	15	20			

Table 5: Distribution of the sample according to feeding practices and oedema.

Variables	MAM	SAM	Chi squared value	Df	Significance
EBF					
Yes	27	9	3.984	1	0.046
No	38	31			
CF					
Yes	15	11	0.26	1	0.610
No	50	29			
Pedal edema					
Yes	15	12	3.19	1	0.074
No	50	28			

Table 6: Distribution of malnutrition according to Wellcome classification.

Malnutrition phenotype	N
Undernutrition	50 (47.6%)
Marasmus	28 (26.6%)
Kwashiorkor	15 (14.2%)
Marasmic Kwashiorkor	12 (11.4%)
Total	105

Table 7: Comparison of initial blood sugar, LFT and RFT. Serum electrolytes and lipid profile mean values between MAM and SAM children.

Parameters	MAM	SAM	T value	Significance
Blood sugar				
Mean	96.37	83.85	1.951	0.491
SD	31.61	32.48		
ALT				
Mean	63.09	39.98	8.261	0.016
SD	10.67	18.03		
AST				
Mean	69.42	40.90	11.32	0.668
SD	11.83	13.59		
Albumin				
Mean	3.29	2.93	4.532	<0.005
SD	0.384	0.432		
ALP				
Mean	238.72	205.45	6.05	<0.005
SD	24.24	31.80		
Urea	Urea			
Mean	31.42	22.98	5.99	<0.005
SD	7.82	5.42		
Creatinine				
Mean	0.309	0.322	-0.686	0.49
SD	0.096	0.087		

Continued.

Parameters	MAM	SAM	T value	Significance
Sodium				
Mean	139.22	130.60	6.22	0.04
SD	6.46	7.87		
Potassium				
Mean	3.96	3.05	7.44	0.03
SD	0.504	0.735		
HDL				
Mean	38.82	40.73	-1.423	0.157
SD	6.008	7.612		
Cholesterol				
Mean	175	140	10.82	<0.005
SD	15.69	17.42		
Triglyceride				
Mean	93.35	73.35	5.29	<0.005
SD	19.20	17.91		

Table 8: Distribution of blood sugar and electrolyte abnormalities among the study groups.

Biochemical abnormality	MAM	SAM	Chi square value	Df	Significance
Hypoglycemia					
Yes	04	06	2.249	1	0.134
No	61	34			
Hyponatremia					
Yes	10	09	0.86	1	0.25
No	55	31			
Hypernatremia					
Yes	08	06	0.155	1	0.454
No	57	34			
Hypokalemia					
Yes	06	09	3.56	1	0.56
No	59	31			

Table 9: Blood biochemical profile in kwashiorkor, marasmic kwashiorkor and marasmus.

Biochemical parameters	Kwashiorkor	Marasmic Kwashiorkor	Marasmus
HDL	40.46±5.73	38.71±6.60	42.11±7.20
Cholesterol	164.31±14.48	165.99±23.56	147.16±24.86
Triglyceride	77.92±19.94	90.04±21.24	74.53±15.69
Sodium	132.62±5.23	140.49±6.09	137.53±6.63
Potassium	3.80±0.74	3.91±0.53	4.14±0.68
Urea	22.62±5.40	29.20±8.20	25.43±6.79
Creatinine	0.33±0.12	0.30±0.08	0.32±0.09
SGOT	59.92±23.92	58±16.80	52.42±21.04
SGPT	54.62±25.18	57.70±16.36	44.79±15.22
ALP	223.62±26.69	229.89±38.33	212.64±26.34
Albumin	2.89±0.42	2.93±0.47	3.26±0.39

DISCUSSION

India is home to more than one-third of the world's under-nourished children. Malnutrition is a severe problem in under developed and developing countries. Children with poor socioeconomic and community status were at higher risk of malnutrition. Children from food insecure families were more likely to be malnourished.[10] Protein-energy malnutrition (PEM) has been identified as a major health and nutrition problem in India as well. It not only leads to childhood mortality and morbidity but also leads to permanent impairment of physical and possibly mental growth of those who survive.[11]

In this study, undernutrition was categorised into MAM and SAM as per WHO standard (weight for length/height), whereas the phenotypic nomenclature was assigned according to Wellcome classification.[7,8]

Demographic parameters: age, gender, residence and race

The mean age of malnourished children studied was 16.16±10.42 months. Earlier, Laxmi observed that the mean age of presentation of SAM children was 18.45±2.37 months. They commonly presented between 6 and 24 months as in our study. Interestingly, we found that SAM cases were most common (65%) in 13-24 months age group.[12]

We found that 62% of undernourished children were males and 38% of children were females. Similarly, Lakshmi et al and Gebre et al observed that malnutrition was more prevalent among males than females.[12,13]

In our study, majority, i.e., 90 out of 105 malnourished children resided in rural area, though there was no statistically significant difference between two group of malnutrition in relation to residence. According to National Family Health Survey-5 (NFHS-5) there is increased prevalence of wasting, stunting, underweight and SAM among children in rural as compared to urban areas.[14] Similar findings were seen in article of Prabhat et al.[15] In our study, 76 malnourished children (72%) were from tribal population. It was found there were more children with tribal origin in SAM (85%) compared to MAM (64%) and the difference was statistically significant ($p<0.02$). This could be due to poor economic background compounded by lack of access to available resources and health facility. Similar ethnic distribution of malnutrition was observed by Chatterjee et al and Das et al.[16,17]

Socio economic factors

Using Modified Prasad's classification with respect to fathers' occupation we found more malnourished children have father working as unskilled labourers and the differences were statistically significant among the groups ($p=0.01$).[9] The findings are corroborated by a study conducted in Jhansi.[18] We derived that families with higher monthly per capita income had significantly lower SAM, while severe malnutrition was significantly higher in families with greater numbers of offsprings. Benjamin and Zachariah observed poor family income as a risk factor for severe malnutrition and found an increasing prevalence of PEM with increasing number of siblings.[19]

The mother's age at the child's birth, maternal education and type of family did not appear to be a significant risk factor for severity of malnutrition here. Articles published by Chakraborty et al and Benjamin et al showed a highly significant inverse relationship between higher maternal education and childhood malnutrition.[18,19]

Feeding

We found that exclusive breastfeeding up to 6 months was not possible in 65% and in 75% children complementary feeds were initiated either earlier or later than 6 months. Lakshmi et al showed lack of exclusive breast feeding in 67% of malnourished children and in 78% children complimentary feeds were initiated either earlier or later.[12] Khan et al showed similar findings.[20] Most common reason for not continuing exclusive breastfeeding was the mothers feeling that she did not have enough milk. In a country at risk of malnutrition, early introduction of complementary feeding initiated before 4th month, children receive little or no dietary food or other products with protein content.[12] A low protein, low energy diet coupled with frequent digestive and respiratory infection, favours the slow but progressive development of severe malnutrition. Late introduction of complementary feeding and inadequate intake also leads to increasing predisposition to undernutrition.[21]

Oedema

This study showed that out of 65 MAM subject 15 developed oedema and out of 40 SAM children, 12 developed oedema. Overall, symmetrical oedema developed in 25.71% of children. In previous literature, Kumar and Singh study documented development of bipedal oedema in 27% of SAM children.[22] Hypoalbuminemia is one of the major contributory factors for development of symmetrical oedema in kwashiorkor, compounded by oxygen free radical injury.[23]

In the present study, the overall distribution of children with protein energy malnutrition was in the form of marasmus 28 (26.6%), kwashiorkor 15 (14%), marasmic kwashiorkor 12 (11.4%) and underweight 50 (40.6%) depicted in Table 6. Verma et al found that overall children with protein energy malnutrition in the form of marasmus was 68 (62.9%), kwashiorkor was 22 (20.4%) and marasmic kwashiorkor was 18 (16.7%).[24]

Hypoglycaemia

In our study, 10 children were hypoglycemic at presentation and it was more common among SAM children. The liver produces glucose less readily, making the child more prone to hypoglycemia. Lakshmi et al also showed 15% hypoglycemia among 100 malnourished children studied.[12]

In accordance with WHO observations, all severely malnourished children are at risk of developing hypoglycaemia-or low blood sugar-which can rapidly lead to death if not treated. Hypoglycaemia may be caused by a serious systemic infection or can occur when a malnourished child has not been fed for 4-6 hours.[25]

Liver function tests and renal parameters

Our study revealed significant increase in ALT and ALP levels in MAM children as compared to SAM, although AST level did not differ significantly. Previous study by

Chowdhury et al found that mean value of serum ALT, AST were significantly higher in grade I PEM compared to grade II PEM, which was again higher than grade III PEM ($p<0.001$).[26]

The results of their study indicate that serum ALT and AST levels are increased in PEM which varies according to its severity. They suggested elevated value of serum ALT and AST in undernourished children occur due to tissue breakdown and hepato-billiary disorder. In order to metabolize the amino acids released from exaggerated tissue breakdown, the process of transmutation is enhanced leading to increase in activity of related enzymes.[26] We found that levels of ALP and ALT were elevated in MAM. As severity of malnutrition further increased, these levels came down in SAM children. Estimation of hepatic enzymes thus may help early identification of PEM on biochemical basis.

Mean value of serum albumin in MAM group was 3.29±0.38 and mean value in SAM group was 2.931±0.432, which was significantly lower ($p<0.05$). A low serum albumin concentration is a common finding in PEM; consequently, it is commonly employed as a measure of the child's nutritional status in absence of proteinuria. Our study established that serum albumin level decreases with increasing severity of malnutrition. Contributing factors can be "reductive adaptation", when protein is mobilized from muscle, skin and gastrointestinal tract to produce energy. Also, hepatic production of albumin and transferrin is reduced.[27]

The most consistently confirmed biochemical parameter in children with SAM has been a low serum albumin concentration. It is now established that changes in serum albumin concentration are sensitive to early malnutrition. It is often found convenient to classify children according to their albumin concentration and to relate other biochemical changes to this value. In Kwashiorkor, critical phase with "moon face" begins after serum-albumin concentration falls below 3·0 g/dl.[28]

Though serum urea level was significantly higher in MAM children ($p<0.005$), there was no significant difference in serum creatinine level among malnourished children categorised according to severity. Literature elaborating alteration of serum urea and creatinine levels among malnourished children is scarce. Hari in his work mentioned that serum creatinine levels are lower in malnourished children and lead to overestimation of glomerular filtration rate.[29]

Serum electrolytes

Our study documented significantly lower value of both serum sodium and potassium in SAM children in compared to MAM group. Among MAM children, hyponatremia was seen in 15% and hypernatremia seen in 12%. Among SAM hyponatremia was seen in 22% and hypernatremia was seen in 15%. The observed values of hypokalemia in MAM and SAM children were 9% and 22% respectively and the difference was statistically significant implying hypokalemia being more evident in SAM than MAM. Tarik et al in similar study found hypokalemia in 9.5%, hypernatremia in 8.2% cases of SAM.[30]

The possible mechanism is chronic hypovolemia associated with SAM leading to secondary hyperaldosterinism, which further complicates fluid and electrolyte balance. Because of increase in intracellular water, the total sodium may be increased but the actual serum level may be relatively low as a result of excessive increase in water in comparison to increase in sodium.

While some researchers observed hyponatremia to be a very bad prognostic factor, Mittal et al found that serum sodium level did not affect outcome.[31]

Lipid profile

Lipid profile analysis in this study demonstrated that there is dyslipidaemia in the form of decreased in high density lipoprotein (HDL) and triglyceride. Total cholesterol and triglyceride levels were significantly lower in SAM group as compared to MAM. Interestingly, serum HDL level was higher in SAM group, though the difference was not statistically significant.

Serum lipid levels may vary in malnutrition and is inversely proportion to the extent of fatty liver. Defatting stage may show higher values. Lipogenesis make the levels gradually normal. However low serum total lipid values have been observed as probable predictors of mortality.[32] The high prevalence of dyslipidaemia in children in the present study demonstrated that malnutrition in early life leads to change in lipid metabolism. Low HDL is caused by acceleration in catabolism and not by a decrease in synthesis of these particles. In order to explain the relationship between hypertriglyceridemia and low HDL, two main hypothesis have been put forward, namely: (i) the reduced activity of lipoprotein lipase may hamper the maturation of HDL particles, and (ii) the increased activity of the protein that promotes the transfer of cholesteryl esters from HDL to triglyceride-rich lipoproteins may reduce the levels of HDL particles.[33]

In the current study, serum cholesterol and triglyceride levels were lower in marasmic children in compared with kwashiorkor, and marasmic kwashiorkor children. Serum albumin was lowered in kwashiorkor and marasmic kwashiorkor in compared to marasmic children.

Verma et al observed earlier that total cholesterol, triglyceride and HDL levels were lower in PEM children while LDL and VLDL levels were higher in malnourished children group. They noted that kwashiorkor and marasmic kwashiorkor are severe forms of malnutrition, as lipid profile is maximally disturbed.

Marasmus is the compensated form of malnutrition, where lipid profile is minimally disturbed. Marasmic-Kwashiorkor is a group showing a mixed pattern of changes in the lipid profile, but pattern is more nearer to the kwashiorkor group at the severe stage as well as during the recovery stage.[24] Our findings were consistent with findings of Gabriela and Verma et al.[24,33]

CONCLUSION

The current study reveals that SAM was significantly more common among 6 months to 24 months age group and among tribal children as compared to MAM (p=0.003 and 0.023 respectively). Also, significantly higher proportion of SAM cases were seen among families with father working as unskilled labourer, per capita income <Rs. 240/month and increasing family size with 3 or more siblings.

While lack of exclusive breastfeeding upto 6 months was more commonly associated with SAM children as compared to MAM, no such difference was observed regarding appropriate complimentary feeding. Hepatic enzyme ALT, ALP and blood urea were significantly higher in MAM group. Serum albumin was significantly lower in SAM subjects. The mean values of both serum sodium and potassium were lower in SAM in compared to MAM. Mean values of serum cholesterol and triglyceride were also significantly lower in SAM population studied.

Levels blood biochemical parameters vary according to severity of malnutrition and therefore, may help formulating as well as monitoring therapy.

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