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NEURODEVELOPMENT AND NEUROBEHAVIOR PERFORMANCE OF CHILDREN WITH SEVERE ACUTE MALNUTRITION AT HOSPITAL DISCHARGE AT A TERTIARY CARE TEACHING HOSPITAL

Paediatric Medicine

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ABSTRACT

Background: Severe acute malnutrition (SAM) is a significant risk factor for impaired motor, cognitive, and socio-emotional development. The aim is to study the neurodevelopmental and neurobehavioral performance of SAM children in SAM children six months to 5 years of age at discharge from NRC and explore the role of various risk factors affecting neurodevelopment & neurobehavior. **Methods:** This Cross-Sectional Observational study was conducted over one year after enrolling 134 children meeting the inclusion criteria, admitted to the NRC, aged six months to 5 years, after taking written consent from their parents. Neurodevelopment and neurobehavioral performance were assessed using ASQ3 and ASQ SE scales before discharge from the hospital. **Results:** The present study observed that 76% of SAM children had poor performance in the gross motor domain, 74.6% in communication, 73.6% in personal social, 69.4% in fine motor, and 66.4% lagged behind the problem-solving domain. Out of 134 SAM children, 70.1% were found to have poor neuro-behavioural performance. Risk factors like maternal illiteracy, poor socio-economic status, low birth weight, poor complimentary diet, and recurrent hospitalisations due to diarrhoea and pneumonia were significantly associated with poor developmental performance in various domains. **Conclusion:** Severe acute malnutrition is a preventable and treatable cause of childhood morbidity and mortality. Along with Nutritional intervention, specific attention should also be given to neurodevelopment assessment, and necessary psychomotor stimulation should be instituted for overall and appropriate physical and mental growth.

KEYWORDS

Severe Acute Malnutrition, Neurodevelopment assessment, Neurobehavior assessment, ASQ 3, ASQ SE

INTRODUCTION

Severe acute malnutrition (SAM) is a significant risk factor for impaired motor, cognitive, and socio-emotional development. The development of the brain starts in utero, but the process of synaptogenesis and myelination continues throughout early childhood. Keeping this in the account, adequate nutrition, as well as psychomotor stimulation of the child, is extremely important.[1]

Survival of SAM children has improved with specific treatment in nutritional rehabilitation centres, which mainly focus on nutrition supplementation. Still, the neurodevelopmental and behavioural deficit is also prevalent in these children, which requires early psychomotor and sensory stimulation interventions. In addition, these SAM children require comprehensive early intervention to limit neurodevelopmental sequelae.

Delayed neurodevelopment and neurobehavior incidence among SAM children is 40-80% globally.[2]

It has been observed in various studies[3,4,5] that the neurodevelopmental performance of SAM children in all domains was poor, as were their cognition and neurobehavior. However, few available studies study the detailed neurodevelopment status of SAM children, and those available[3,4,5] have yet to document detailed data on various development domains, especially neurobehavior performance. Therefore, further research is necessary to identify the effect of malnutrition on neuro-cognitive development using universally acceptable and definitive neurodevelopmental scales in the context of early adversities experienced by children in resource-limited settings. Thus, the present study was conducted to study the developmental performance of children with SAM and to explore the effect of various risk factors on a child's behaviour and cognition.

Methods

The present Cross-Sectional Observational study was undertaken on 134 children aged six months to 5 years who were admitted to the NRC of a tertiary care teaching hospital of the Department of Pediatrics in central India over a period of 1 year. After taking prior approval from the institutional scientific and ethical committee, Children fulfilling the inclusion criteria of SAM after taking written consent from parents were enrolled in the study before discharge from NRC. Children having preexisting central nervous system disease or perinatal insults were excluded from the study. After taking detailed socio-demographic, anthropometric and clinical profiles in the predesigned pro forma, neurodevelopment and neurobehavioral assessment were done using the ASQ3 and ASQ SE scale, following the instructions per the scale manual. Performance in the various domains of neurodevelopment as Gross Motor (GM), Fine Motor(FM), Personal Social(PS), communication, and problem-solving, was assessed using ASO3, and children were categorised according to cut-off score. Children who scored below the cut-off score on the ASQ 3 scale were interpreted as having poor performance and needing further assessment. Above the cut-off score meant good performance, and development appears to be as expected. A grey zone close to the cut-off meant the child required regular monitoring and needed learning activities. Various risk factors were also studied, such as maternal illiteracy, poor socio-economic status, low birth weight, poor complimentary diet, and recurrent hospitalisations due to diarrhoea and pneumonia.

ASQ-3-The Ages & Stages Questionnaires®, Third Edition (ASQ®-3) is a developmental screening tool that identifies developmental progress in children between one month to 5 ½ years. Its success lies in its parent-centric approach and inherent ease of use, making it the most widely used developmental screener globally. ASQ-SE-Effectively screens seven vital social-emotional areas: self-regulation compliance, adaptive functioning, autonomy, affect, social-communication, and interaction with people.

Statistical Analysis-

The data was coded and entered into Microsoft excel 2010 (Microsoft corp.) and analysed using excel 2010 and SPSS 20.0 for Windows (SPSS inc). Student T-test was used to compare quantitative data if data was found to be expected. The Chi-square test showed the association between qualitative data. A p-value less than 0.05 was considered significant.

RESULTS-

The present study enrolled 134 SAM children admitted to NRC, meeting the inclusion criteria of the study protocol. Parents were asked questions per the Ages and Stages Questionnaire ASQ3 and ASQ SE according to the child's age before NRC discharge. After completing the questionnaire, a performance score in each domain was calculated. Various risk factors were studied for their effect on the neuro development and behaviour of the child. It was observed that the age group most severely affected was the six months to 12 months, with

66% of children in this category (TABLE 1). All the domains of development are involved in SAM children; the most severely affected fields were gross motor(76%) and fine motor domain(73%) in the poor performance category (Figure 1)

Table 1 – Distribution On Basis Of Age Groups.

Age Group	Frequency	Percent
6-12 Months	89	66.4
13-24 Months	30	22.4
25-36 Months	4	3.0
37-48 Months	9	6.7
49-60 Months	2	1.5
Total	134	100.0

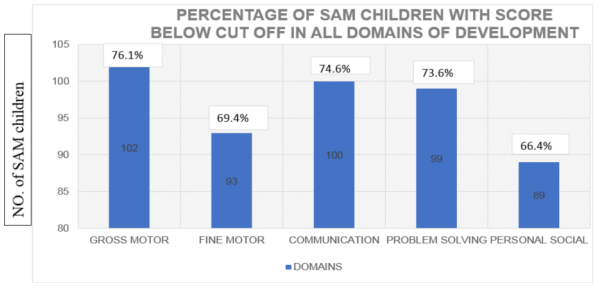

Figure 1 – Distribution of SAM Children With ASQ SE 3 scale Scores Below Cut-Off In All Domains Of Development

Table 2 - Percentage Of SAM Children In ASQ 3 And ASQ SE Scale And Their Distribution According To The Risk Factors.

Variable	Components	N`	GM	FM	Communication	Problem Solving	Personal social	ASQ SE
Gender	Male	60 (44.8%)	34 (45.3%)	40 (43%)	49 (49%)	39 (43.8%)	46 (46%)	46 (48.9%)
	Female	74 (55.2%)	41 (54.7%)	53 (57%)*	51 (51%)*	50 (56.2%)	53 (53%)	48 (51.1%)*
Maternal Education	Literate	21 (15.7%)	14 (18.7%)	14 (15.1%)	16 (16%)	13 (14.6%)	15 (15.2%)	16 (16.7%)
	Illeterate	113 (84.3%)	61 (81.3%)	79 (84.9%)	84 (84%)	76 (85%)*	84 (84.8%)	30 (83.3%)
EBF beyond 6 m/ failed weaning	Received	114 (85.1%)	15 (20%)	12 (12.9%)	13 (13%)	13 (14.6%)	14 (14%)	7 (19.4%)
	Not Received	20 (14.9%)	60 (80%)	81 (87%)	76 (85.4%)	76 (85.4%)*	85 (85.9%)	29 (80.6%)
Birth wt.	<2.5 kgs	93 (69.4%)	58 (77.3%)*	71 (76.3%)*	68 (68%)	63 (70.8%)	69 (69.7%)	25 (69.4%)*
	>2.5 kgs	41 (30.6%)	17 (22.7%)	22 (23.7%)	32 (32%)	26 (29.2%)	30 30.3%)	11 (30.6%)

Significant association between the risk factor and the domain affected.($p<0.05$)
BELOW CUT-OFF- POOR PERFORMANCE IN THAT DOMAIN IN ASQ 3 SCALE
ABOVE CUT-OFF- POOR PERFORMANCE IN THAT DOMAIN IN THE ASQ SE SCALE

Table 3 - Percentage Of SAM Children In ASQ 3 And ASQ SE Scale And Their Distribution According To The Risk Factors.

Variable	Components	N`	GM	FM	Communication	Problem Solving	Personal social	ASQ SE
SES	Normal	34 (24.6%)	20 (26.7%)	20 (21.5%)	23 (23%)	17 (19.1%)	21 (21.2%)	12 (33.3%)
	Low	100 (74.6%)	55 (73.3%)	73 (78.5%)	77 (77%)	72 (80.9%)*	78 (78.8%)	24 (66.6%)*
Diarrhoeal Illness Requiring Hosp.	Present	74 (55.2%)	36 (48%)	42 (45.2%)*	48 (48%)*	36 (40.4%)	48 (48.5%)	16 (44.4%)
	Absent	60 (44.8%)	39 (52%)	51 (54.2%)	52 (52%)	53 (59.6%)	51 (51.5%)	20 (55.6%)
Pneumonia Like Illness Req Hosp	Present	62 (46.3%)	37 (49.3%)	49 (52.7%)	51 (51%)	50 (56%)	48 (48.5%)	16 (44.4%)
	Absent	72 (53.7%)	38 (50.7%)	44 (47.3%)	49 (49%)	39 (43.8%)	51 (51.5%)	20 (55.6%)
Severe Anemia	Present	126 (94%)	7 (9.3%)	7 (7.5%)	6 (6%)	6 (6.7%)	6 (6.1%)	3 (8.3%)
	Absent	8 (6%)	68 (90.7%)	86 (92.5%)	94 (94%)	83 (93.3%	93 (93.9%)	33 (91.7%)

Significant association between the risk factor and the domain affected.($p<0.05$)
BELOW CUT-OFF- POOR PERFORMANCE IN THAT DOMAIN IN ASQ 3 SCALE
ABOVE CUT-OFF- POOR PERFORMANCE IN THAT DOMAIN IN THE ASQ SE SCALE

It was observed that females were slightly more affected than males, but statistical significance was not noted. As assessed by the ASQ SE scale, the neurobehavior of these children was also grossly affected in 70.1% of SAM children. The present study observed that various sociodemographic risk factors such as maternal illiteracy, poor socio-economic status, low birth weight and poor complimentary diet, and recurrent hospitalisations due to diarrhoea and pneumonia were significantly associated with poorer neurodevelopmental and neurobehavior performance(Table 2,3).

DISCUSSION:

A statistically significant association was seen between the Age Group and all five domains for assessing neurodevelopment, i.e., Gross Motor (P=0.003), Communication (P=0.010), fine motor (P=0.001), personal social (P=0.003) and problem solving (P=0.032); with the highest proportion of SAM children in 6-12 months age group. As suggested by a similar study[3,] they also noticed a significant difference in motor and mental DQ of SAM children compared to age-matched controls, which shows the impact of malnutrition on child development, as also demonstrated by other studies[4,5,6] in literature. In the present study, SAM was most common in children aged 6-12 months, i.e., 89 (66.4%). In a similar study, SAM was more common in children aged six months to 1 year[3,11]. Other literature[12] also reported prevalence of SAM increases up to 12 to 24 months and then decreases, and the mean age was said to be 13.1+6 months for Sam children in their study. The reason behind this is that this age group is very crucial for the child's brain development as critical processes like synaptogenesis and myelination happens during this age and lack of positive stimulation with presence of negative factors like malnutrition affects the child's brain so much so to delay the development and alter the behaviour of child as apathetic[1]. We also found a statistically significant association between the ASQ SE Questionnaire scale and Age group (P=0.009), with a maximum percentage of SAM children with poor behavioural outcomes belonging to the age group 6-12 months and the minor percentage to age group 49-60 months suggestive that ASQ SE can be used as a diagnostic tool for assessing and detecting developmental delays. This was in concurrence with another study[5] which evaluated ASQ for detecting developmental delay in Indian children.

In our study, SAM prevalence is higher in females than males. Male: female ratio was 1: 1.2. However, in another study conducted[11,] there was no variation in sex. In the present study, a statistically significant association was seen between gender and Communication (P=0.004), fine motor (P=0.020), Personal social (P=0.003) and problem-solving (P=0.032).

In our study, most children with malnutrition belonged to a low Socioeconomic Class, i.e., 100 (74.6%). In a similar study[12,13,] malnutrition is associated with low Socio-Economic Class. Amongst the subjects, the highest proportion of SAM children, i.e.,80.9% in the Lower middle class and lower status and 19.1% in the upper middle class and above socioeconomic status. A statistically significant association was seen between Social Economic Status and Problem Solving (P=0.043). Also, a significant association was found between poor neurobehavioral outcome and Socioeconomic status (P=0.021). Children with poor socio-economic status suffer from poor nutrition due to restricted financial resources and environmental conditions like poor sanitation, poor hygiene practices and limited/no parental awareness of the playful stimulation of a child.

A statistically significant association was seen between Birth Weight and Gross Motor (P=0.048), Fine Motor (P=0.024), with a higher proportion of SAM children below cut-off status having birth weight less than 2.5 kg. In our study Low Birth Weight is a significant association with malnutrition, i.e., 93 SAM patients had a birth weight of less than 2.5kg. Other prominent literature[14] also reported that Low Birth Weight is associated with malnutrition. Numerous studies have

established broad associations between small size at birth and suboptimal neurodevelopment[19]. The reason behind it is that the nutritional requirements of these babies to gain and maintain age-appropriate weight are more than those with average birth weight.

A statistically significant association between diarrheal illness requiring hospitalisation and communication was seen. (P=0.014), Fine Motor (P= 0.011) with the highest proportion, 52.0%, was for having Diarrheal disease requiring recurrent hospitalisation and the lowest value, 48.0%, was for not having Diarrheal illness requiring recurrent hospitalization[15,16]. In our study, we observed that 74 (55.2%) SAM children had recurrent hospitalisation due to Diarrhea because malnutrition exposes them to compromised immunity, making them prone to various infections. So they enter into a vicious cycle of recurrent infections and further malnutrition.

Pneumonia requiring recurrent hospitalisation Further, A statistically significant association was seen between Pneumonia requiring recurrent hospitalisation and communication (P= 0.003), Fine Motor (P=0.011) and Personal Social (P=0.035). However, anaemia requiring recurrent hospitalisation was insignificantly related to all five domains (P>0.05) of assessing neurodevelopment and the ASQ Questionnaire scale.

In maternal education-In our study, malnutrition was most common in children whose mothers were illiterates, i.e..,113 (84.3%) and less common in children of mothers who were graduates/post-graduates and working. Another similar study[12] reported that maternal education is the most crucial step towards eliminating malnutrition such that education and awareness of mothers will help them not only in optimising the child's diet to prevent malnutrition but also make the mother competent enough to recognise the red flags in the growth and development of her child.

The overall sensitivity of ASQ in detecting developmental delay was 83.3%, and specificity was 75.4%, with a negative predictive value of 84.6%. In the present study, Most SAM children lacked in all five domains of neurodevelopment (GM, FM, PS, communicating and problem solving) and neurobehavior as per ASQ3 and ASQ SE scale. When assessed, showed below cut-off values, i.e., 102(76%) had less gross motor skills,100 (74.6%) had poor communication, 93 (69.45&) lacked fine motor skills, 99(73.9%) had poor social personal social, and lastly 89 (66.4%) lacked in problem-solving. Further, 94 (70.1%) SAM children had poor neurobehavioral performance, 3 % had borderline performance requiring further monitoring, and 26.9 % had a good performance. The results of our study were comparable to Dwivedi et al.12[1], who, in a hospital-based cross-sectional study of 102 children with SAM assessed by DASII, all children with SAM had low Motor and Mental DQ. The malnourished children were markedly behind the controls, as stated by another study [6]. A review of earlier literature[7,8] also indicated that all developmental levels are deficient in the acute stage and generally improve during recovery. Our study is consistent with earlier studies which showed that SAM negatively affects motor skills. Earlier studies, however, did not specify the areas of development worst or least affected.

The present study reveals that the motor skills in general, and the gross motor in particular, are more seriously affected than the language and the personal social skills of SAM children. Moreover, more severe effects on motor skills (gross) are expected since severe acute malnutrition reduces muscle mass. However, studies have yet to concurrently address and compare various developmental dimensions among SAM children of different ages, particularly during its critical stage. Consequently, much is not known about how the different dimensions of child development are impaired during the acute phase of SAM in children under five. The limitations of this study were that the development performance of the study population needed to be done using more sophisticated and more specific scales due to the restriction of the availability of child psychologists. Moreover, our hospital mostly received referred patients with more severe malnutrition, so our result can only be generalised to some of the population. The strength of our study was that ASQ SE and ASQ 3 scales are easy to translate and interpret, and no equipment is needed, and a detailed analysis of 5 domains and the behavioural outcome was done in SAM children.

CONCLUSION-

The study reveals that the developmental performance of SAM children is seriously affected during the acute stage. This effect is multidimensional and age-dependent. Hence rehabilitation of SAM children should be multi-dimensional, age specific and focus on strengthening motor skills during the early period. In addition, nutritional education has to be imparted to people regarding consuming a cost-effective nutritious diet. The determinants of SAM include illiteracy, low SEC, malnourished mothers, LBW, faulty feeding practices, improper weaning, ignorance about the nutritional needs of infants and young children, repeated infections, etc. The importance of growth monitoring should be emphasised to every mother and health worker.

In every visit to a health care facility or ICDS, the child's height and weight should be recorded in a growth chart. In children deviating from the expected growth standards, the cause of malnutrition should be identified. These children should be triaged for the presence of danger signs. Children without danger signs can be treated in the community and should be followed up regularly. Children with danger signs will need a referral. Although malnutrition can manifest in multiple ways, the paths to prevention are virtually identical: adequate maternal nutrition before and during pregnancy and lactation; optimal breastfeeding in the first two years of life; nutritious, diverse, and safe foods in early childhood; a healthy environment, including access to essential health, water, hygiene, and sanitation services; and opportunities for safe physical activity. These key ingredients can deliver a world where children are free from all forms of malnutrition.

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