

Original Article

Neurodevelopmental status of Severe Acute Malnutrition children of 6 months to 59 months and its follow-up at 6 months using Trivandrum Developmental Screening Chart (TDSC)

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ABSTRACT

Background: Malnutrition has a significant impact on the neurodevelopment of Children. Toddlers, especially those below 24 months, are more prone to malnutrition and neurodevelopmental delay. Once neurodevelopmental delay develops, there will not be much improvement even after treatment or rehabilitation. The nutritional status of severe acute malnutrition (SAM) children can be reverted to normal by proper management, rehabilitation, following advice, and with regular follow-up. This study was done to assess the neuro-developmental delay in SAM children at the time of diagnosis and their follow-up after six months to assess the level of recovery, if any, after the treatment using the Trivandrum Developmental Screening Chart (TDSC). **Materials and Methods:** A total of 103 children were assessed for any delay in development using TDSC at the time of diagnosis and after 6 months from the diagnosis, post-rehabilitation and treatment. The chronological and developmental ages were measured and marked at both intervals, which, on analysis, gave the developmental delay for that corresponding age if present. **Results:** Of 103 children, 47 (45.6%) identified as having developmental delay using the TDS chart. The highest number of children with neurodevelopmental delay (38 out of 47, i.e., 80.9%) was observed in the 6-24-month age group, which decreased to 32 (82.1%) at the 6-month follow-up. Among children aged > 24 months, 9 (19.1%) participants had Neurodevelopmental delay, while at follow-up, only 2 recovered, and 7 (17.9%) were found to have neurodevelopmental delay even after treatment and rehabilitation. **Conclusion:** The results show that once neurodevelopmental delay develops due to malnutrition during a vulnerable period, it will not improve even after treatment or rehabilitation.

Key words: Malnutrition, Child Development, Neurodevelopmental Disorders

In children aged 6–59 months, severe acute malnutrition (SAM) is defined by the World Health Organization (WHO) as weight-for-height/ weight-for-length of less than -3 Standard Deviation (SD), clinical signs of bilateral pitting edema, or mid-upper arm circumference < 115 mm [1]. General treatment for malnutrition involves an initial stabilization phase that focuses on restoring homeostasis and treating medical complications, and the rehabilitation phase, which focuses on rebuilding wasted tissues and may take several weeks. Delayed mental and behavioral development often occurs in severe malnutrition. So, SAM management focuses on addressing developmental delays. SAM is known to be a major risk factor for impaired motor, cognitive, and socio-emotional development [2, 3].

Adequate nutrition by nutrients such as folic acid, copper, and vitamin A is necessary for the formation of the neural

plate and neural tube, which is formed around 22 days after conception. The neurodevelopmental processes begin during gestation and continue throughout infancy. Activated cells and synapses are retained and strengthened, while unused ones are eliminated throughout childhood and adolescence [4]. Human autopsy studies have also shown that infants with SAM have fewer brain cells than well-nourished infants [5]. Intrauterine growth restriction (IUGR) in animals also shows similar effects [6].

Studies have found that 3–4-month-old infants with moderate malnutrition (low weight for age) had reduced dendritic span and arborization (the complexity of branching projections) compared with well-nourished infants [7]. Rodent models have found similar effects of early postnatal undernutrition on dendrite growth [8]. Saleem *et al.*, using the Denver Developmental Screening Tool II (DDST-II), showed

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that participants with SAM had delayed or unstable global development [9]. The children in their first 2 years of life were particularly at high risk due to insufficient breastfeeding. Developmental delay and malnutrition are two major interrelated public health problems that hinder the achievement of the Sustainable Development Goals for children in low-resource countries.

Thus, timely identification and proper management of developmental delays in children should be emphasized to support optimal growth and development. Still, there are insufficient studies on the developmental aspects of SAM in the Indian population and on developmental reassessment after a Nutritional rehabilitation program, using developmental scales. This study was thus done to assess the neuro-developmental delay in SAM children at the time of diagnosis and their follow-up after six months to assess the level of recovery, if any, after the treatment using the Trivandrum Developmental Screening Chart (TDSC) [10].

MATERIALS AND METHODS

Study Design: Prospective observational hospital-based cohort study.

Study Population: The children aged 6 months to 59 months fulfilling the inclusion criteria for SAM as defined by WHO (weight-for-height/weight-for-length < -3SD, or clinical signs of bilateral pitting edema, or mid-upper arm circumference <115 mm) were included in the study. The children who were previously treated for SAM, with serious life-threatening illness; with a previous history of developmental delay before developing SAM; with congenital malformations such as congenital heart diseases; or neurological diseases were excluded from the study.

Sample Size: The sample size (N) was calculated based on the prevalence rate of developmental delay of 55.3% [11]. Taking this value as a reference, the minimum required sample size with 5% margin of error and 5% level of significance was 95 patients. N was calculated using formula, $N \geq (p(1-p))/(ME/z\alpha)^2$, where $Z\alpha$ is the value of Z at a two-sided alpha error of 5%, ME is the margin of error, and p is the prevalence rate. After calculations ($N \geq ((.553*(1-.553)) / (.05/1.96)^2$), the N was determined as 94.96 or 95 (approx.)

To prevent dropout bias due to poor compliance or expiry, a total of 154 children were initially enrolled, fulfilling the inclusion criteria, of which 40 failed follow-ups, and 1 child expired. After 6 months of follow-up, a total of 103 children were assessed.

Ethics approval and consent to participate

Ethical approval was obtained from the Institutional Ethic Committee -DDUH (IEC-DDUH/upn37/2021-03-18/37/v1,

dated 31/03/2021). Written informed consents were secured from the children's parents.

Study Method

Children who were diagnosed as SAM and who satisfied the inclusion criteria of the study were examined, and a history was taken according to a proforma. TDSC, which consists of 54 items, of which 22 belong to motor development, and 32 belong to mental development, was used to assess the chronological age of the child and marked on the chart accordingly, and a vertical line was drawn above [10]. The performance of the child was assessed based on items of the scale. The items with upper limit ending to the left of the line were expected to be attained by the child normally. If any item was not attained by the child by that age, that item's delay is assumed for the child, and a vertical line was drawn to the bottom line, which indicates the developmental age of the child, and then the delay in development, if any, was observed, marked, and it had been filed.

After 6 months of the diagnosis, post-rehabilitation and treatment, the same screening chart was used, and the chronological and developmental ages were assessed and marked again. This analysis gave the developmental delay for that age, and to see any improvement in the developmental delay compared to the previous screening at the time of diagnosis.

Statistical Analysis

Data was entered into a Microsoft Excel worksheet (Microsoft, USA). Data analysis was done using IBM Statistical Package for Social Sciences (Statistics for Windows, Version 21.0. Armonk, NY: IBM Corp.) Normality of the data was tested by the Kolmogorov-Smirnov test. Comparison of means was done using the unpaired 't' test, the paired 't' test, the Wilcoxon signed rank test, and the Mann-Whitney U test (when data were not distributed normally).

For categorical data, the chi-square test was used to compare the proportions. For analysis, a p-value less than 0.05 was considered statistically significant.

RESULTS

Demographics

In the present study, a total of 114 children were enrolled, of whom 10 failed follow-up, and 1 child expired. After 6 months of follow-up, a total of 103 children were assessed.

Out of 103 participants, 47 out of 103 children showed neurodevelopmental delay, of which 24 (51%) were males, and 23 (47%) were females, with a 1:1 ratio. The age and gender characteristics of the study subjects are shown in Table 1.

Table 1: Gender-wise distribution of study participants:

Gender		Frequency and Percentage			
Males		55	53.4%		
Females		48	46.6%		
Total		103	100%		
Age group		Frequency		Percentage	
0-24 months		85	82.5%		
25-60 months		18	17.5%		
Total		103	100%		
Mean	Median	Mode	SD	Minimum	Maximum
18.57	17	18	10.69	7	59

There were 85 (82.5%) participants with an age of less than or equal to 24 months, while 17 (17.5%) had an age of 25-59 months. The mean age of participants was 18.57±10.69 months with median and mode as 17 and 18, respectively. The minimum age was 7 months, while the maximum age was 59 months.

Comparison of developmental delay

Compared to the baseline, at 6 months follow-up post-diagnosis/ treatment, there was notable reduction in the number of children with Neurodevelopmental delay measured using TDSC. Although the proportion of developmental delays between the groups did not show a statistically significant difference, the changes show that through the proper diagnosis and management, there will be improvement in the developmental delays in children, which is a clinically relevant finding. These findings are shown in Table 2.

Table 2: Comparison of developmental delay at baseline with 6 months follow-up

Parameter	At baseline		At 6 months post diagnosis / treatment	
	n	percentage	n	percentage
Normal development	56	54.4%	64	62.1%
Developmental delay	47	45.6%	39	37.9%
Total	103	100%	103	100%
p value	z=-1.142, p=0.888 NS			

Age-wise comparison of participants

On age-wise comparison of participants at baseline and at 6 months follow-up. There was a reduction in the number of participants with an age of less than 24 months, and for those who were > 24 months. The difference between the

proportions was not statistically significant, but the results show a clinically significant observation, as it shows that with proper diagnosis and treatment, there will be improvement in the condition. These results are shown in Table 3.

Table 3: Age-wise comparison of participants at baseline and at 6 months follow-up:

Parameter	At baseline		At 6 months post diagnosis/treatment	
	n	percentage	n	percentage
< 24 months	38	80.9%	32	82.1%
> 24 months	9	19.1%	7	17.9%
Total	47	100%	39	100%
p value	z= 0.142, p value=0.888 NS			

DISCUSSION

This study was done to determine the prevalence of neurodevelopmental delay among SAM children between the ages of 6 months and 59 months, tested using TDSC. The results showed that, on comparing with the 6th-month values, on proper diagnosis/ treatment, there was a reduction in the number of children with developmental delay.

Ali et al. stated that SAM is more prevalent among boys around the world [12, 13, 14, 15]. But they also mentioned that some studies from Pakistan also reported a higher proportion of females with SAM [16, 17]. Bhargava et al. showed a M: F ratio of 1.8:1 among malnutrition cases, whereas Adhulia A et al. had found a ratio of 1.2:1 [18]. Dwivedi et al. stated that there is no statistically significant difference between the developmental quotient (DQ) and gender, similar to the observations of the present study [11, 19]. The current study did not show a significant association between gender and developmental delay, with an observed p-value of 0.833.

The age group commonly affected by neurodevelopmental delay was variable in different studies. According to the present study, the maximum number of children with neurodevelopmental delay was found in the age group of 6-24 months. However, there was no significant association between age and developmental delay between the two groups of children (>24 months and >24 months). Adhulia et al, Abessa et al, and Van del et al recorded a mean age of 14.15±10.26m, 30.7m and 27.2 months, respectively [11, 20, 21]. Adhulia et al stated that developmental delay was significantly present in children below 2 years of age, as was observed in the present study [11]. Chattopadhyay et al. stated that the maximum incidence of developmental delay has been

detected in the age group of 12–23 months [22]. According to Tette *et al.*, 24 months or less are the most vulnerable ages to malnutrition and its effects [23].

Adhauia A *et al.*, conducted a prospective observational study on 103 malnourished children using the Vineland Social Maturity scale (VSMS) and stated that 55.3% children were found with developmental delay [11]. A cross-sectional study by Dwivedi D *et al.*, among 102 SAM children and 101 controls using the Developmental Assessment Scale of Indian Infants (DASII), concluded that a high incidence of developmental delay was present in SAM children [19]. A cross-sectional study by Wondemagegn *et al.*, on 390 children using the Ages and Stages Questionnaire-3, showed that 22.6% were noted with developmental delay [24].

Bhargawa *et al.* performed a prospective cross-sectional study on 52 SAM children using the Denver Development screening test II (DDSTII) and stated that 50% of children had developmental delay [18]. Khandelwal *et al.* conducted a cross-sectional study on 100 SAM children using the Bayley Scales of Infant and Toddler Development III (BSIDIII) and stated that 42% of children showed delay in motor, cognitive, and language domains [25]. In our study of 103 participants with SAM, using TDSC, 45.6% of children were noted with developmental delays. These children, after rehabilitation, when reassessed after 6 months, only 7.7% of children showed improvement with normal development.

The present study can be considered as primary evidence, as there is a need for larger sample sizes to establish the result. The etiology and onset of developmental delays were not evaluated here, and a comparative analysis was not done, as no control group was taken into consideration. Since TDSC is a screening chart, further developmental assessment was not conducted using developmental assessment scales. A longer follow-up could have revealed any improvement in the later stages of life of the SAM children. The problem of Malnutrition can be mitigated by following proper breastfeeding and complementary feeding as advised by Infant and Young Child Feeding (IYCF) guidelines, strengthening and following national health programs and strategies like POSHAN ABHIYAN.

CONCLUSION

The present study shows that SAM causes developmental delay in children aged 0 to 60 months. Proper diagnosis and treatment couldn't reverse the condition, as after 6 months of follow-up, there was no improvement in the number of affected children. Further studies with longer follow-up and larger study participants can establish the study findings.

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