

NUTRITIONAL RISK STRATIFICATION AMONG UNDER-FIVE CHILDREN USING THE ELIZ MODIFIED IMPACT TOOL AND ASSESSMENT OF PREDISPOSING FACTORS IN A TERTIARY CARE SETTING

Mohammed Shakeel M¹, Thangavel A², Vasanth Jeyaram¹, Senthil Kumar M K^{*3}

¹Department of Paediatrics, Institute of Child Health & Hospital for Children, Madras Medical College, Chennai, Tamil Nadu, India

²Department of Paediatrics, KAP Viswanatham Government Medical College, Trichy, Tamil Nadu, India

³Department of Paediatrics, Government Pudukottai Medical College, Pudukottai, Tamil Nadu, India

Corresponding author: dryemkay@gmail.com

ABSTRACT

Introduction: Malnutrition remains a critical public health challenge, contributing significantly to childhood morbidity and mortality globally and in India. Early identification and risk stratification are essential for effective intervention. The study aimed to classify malnourished children in a tertiary care hospital using the ELIZ Modified IMPACT Tool and to determine factors predisposing to malnutrition in children under 5 years of age. **Methods:** A prospective observational study was conducted over 18 months involving 200 children aged 1 month to 5 years. Participants included those with underweight, stunting, or wasting. The ELIZ Modified IMPACT Tool, a comprehensive scoring system covering anthropometry, clinical signs, dietary history, ecological factors, and functional status, was used to stratify children into risk categories (No, Low, Medium, High Risk). **Results:** Of the 200 participants, 54.5% were classified as Low Risk, 36% as Medium Risk, and 1% as High Risk. Poor mother's education ($p=0.029$), Low birth weight ($p=0.001$), Lack of Exclusive Breastfeeding ($p=0.003$), Failure to introduce semi-solids at 6 months ($p=0.016$), Lack of continued breastfeeding for 2 years ($p=0.013$), and Lack of family pot feeding by 2 years ($p=0.043$) were significantly associated with high risk of malnutrition. **Conclusion:** The ELIZ Modified IMPACT Tool provides a structured framework for nutritional severity stratification in clinical settings. This highlights the need for early identification and targeted nutritional interventions in high-risk children. Interventions focusing on maternal nutrition education and exclusive breastfeeding are crucial.

Keywords: Malnutrition, Under-5 Children, ELIZ Modified IMPACT Tool, Risk Stratification, Breastfeeding, Low Birth Weight

INTRODUCTION

Malnutrition remains a fundamental global health challenge, particularly in low- and middle-income countries like India, where it continues to be the predominant underlying cause of childhood mortality. In India, according to the National Family Health Survey-5 (NFHS-5), 35.5% of children under five are stunted, 19.3% are wasted, and 32.1% are underweight (National Family Health Survey (NFHS-5), 2019-21, 2021). These figures highlight a persistent burden that not only compromises immediate health but also causes enduring damage to cognitive development, educational attainment, and lifelong economic productivity (Vassilakou, 2021).

Early identification through systematic risk stratification is critical for preventing the progression of malnutrition to severe, life-threatening stages. Stratification tools allow healthcare providers to differentiate children based on clinical need, ensuring that high-risk cases receive intensive inpatient care. In contrast, moderate cases are managed via ambulatory follow-up (Kumari et al., 2026).

Widely utilized screening instruments include the STRONG kids tool, which assesses subjective clinical status and high-risk diseases, and the Pediatric Yorkhill Malnutrition Score (PYMS), often favoured for its high sensitivity in detecting patients at nutritional risk (Gerasimidis et al., 2010; Huysentruyt et al., 2013). However, there is no universally accepted tool to assess nutritional risk in hospitalized children. The ELIZ Modified IMPACT Tool, developed in India as part of the National IAP action plan, integrates multiple domains - anthropometry, biochemistry, clinical signs, dietary habits, ecology, and functional status- to provide a comprehensive risk profile (Elizabeth, 2017).

Risk factors for malnutrition are multifactorial. A study by Anusya et al. 2018 in Karnataka categorized risk factors into child-related (low birth weight, birth order), environmental (open defecation, maternal education), and feeding habits (pre-lacteal feeds, timing of complementary feeding) (Anusya et al., 2018). Similarly, Mishra et al. found significant associations with maternal illiteracy, daily family income less than Rs. 200, large family size, and lack of exclusive breastfeeding (Mishra et al., 2014). Systematic reviews have further highlighted gender, mother's educational status, and birth weight as significant risk factors (Mohseni et al., 2017). Conversely, protective factors include adequate antenatal visits, normal birth weight, deworming, and growth monitoring (Tette et al., 2015).

Only limited evidence exists on the application and utility of the ELIZ Modified IMPACT tool in tertiary care settings, and only a few studies in this population assess the nutritional risk by proactive assessment and determining the factors associated with the high malnutrition risk. This study aims to classify malnourished children in a tertiary care setting using the ELIZ Modified IMPACT Tool and to determine the specific factors predisposing children to malnutrition in this population.

METHODS

Study Design and Setting

This prospective observational cross-sectional study was conducted at a tertiary care hospital over 18 months (February 2018 – July 2019). Ethical approval was obtained from the Institutional Ethics Committee (IEC No. 10/2018).

Study Participants

The study population comprised children aged between 1 month and 5 years. Children presenting with underweight, stunting, or wasting were included after obtaining written consent from parents or caregivers. Children who were terminally ill or whose parents did not consent were excluded.

Sampling & Sample size

As per NFHS-5 data, considering the highest estimated prevalence of malnutrition (either stunting or wasting or underweight) (p) as 50%, with a precision (d) of 7%, at 95% confidence interval ($Z_{1-\alpha/2} = 1.96$), the sample size is calculated by $N = Z^2_{1-\alpha/2} * p * (1 - p) / d^2 = 196$ which is rounded off as 200. A total of 200 children were included in the final analysis. Systematic sampling of every 3rd malnourished child between 1 month and 5 years visiting the hospital during the study period was included in the study till the sample size was achieved.

Data Collection and Tools

Data were collected using a structured questionnaire, clinical examination, anthropometric measurements, and laboratory parameters. The questionnaire consisted of demographic details of the children and their families; antenatal, natal, and postnatal history of the child; feeding practices and current dietary patterns; and environmental factors affecting malnutrition. Clinical examination of the child included signs of malnutrition like loose skin folds, bilateral pitting edema, skin and hair changes, and features of vitamin A, B, C, or D deficiencies. Anthropometric measurements included weight, height, and Mid-Upper Arm Circumference (MUAC) using standardized procedures with periodic calibration, and Z-score charts were used for comparison. Biochemical and lab assessments included hemoglobin estimation using the cyanmethemoglobin method, liver function tests (LFTs), renal function tests (RFTs), serum albumin, and micronutrient levels. Anaemia was classified as moderate or severe according to WHO recommendations for Hemoglobin concentrations for the age group 6-59 months (*Haemoglobin Concentrations for the Diagnosis of Anaemia and Assessment of Severity*, 2021).

The primary instrument for risk stratification was the ELIZ Modified IMPACT Tool. The tool has limited validation data and has not been formally validated in this population. This tool assigns scores across six domains (ABCDEF) to stratify risk Field, (Elizabeth, 2017).

Table 1: ELIZ Modified IMPACT Tool Parameters

Parameters	Score
Anthropometry	
Underweight	
WFA/HFA/WFH <70%/1 st centile/<-3z score (Severe)	5
WFA/HFA/WFH <80%/1 st – 3 rd centile/<-2z score (Moderate)	4
WFA/HFA/WFH <90%/3 rd - 5 th centile/<-1z score (Mild)	3
Overweight	
WFA/WFH >99 th centile/>3z score	5
WFA/WFH >97 th centile/>2z score	4
WFA/WFH >95 th centile/>1z score	3
WFA/WFH >85 th centile	2
Birth Weight	
VLBW(<1.5 kg)	4
LBW (1.5 – 2.5 kg)	3
LGA (> 4 kg)	2
Normal	0
Biochemical parameters	
Moderate to severe Anemia	4
Any micronutrient (Vit A,B,C or D) deficiency	3
Serum albumin <3 g/dl	4
Clinical parameters	
Nutritional edema	5
Visible wasting	4
Skin changes	4
Hair changes	3
Dietary Factors	
IYCF	
Child not exclusively breastfed up to 6 months	2
Not given semisolids at 6 months	2
Not breastfed up to 2 years	2
Not given family pot feeding by 2 years	2
Current Diet pattern	
Meeting >80%RDA - 5 food groups, 5 colours, 5 days/week	0
High fat, salt and sugar, Junk foods intake	
Daily	4
4-6 days/week	3
1-3 days/week	2
Sugary drink/cola intake	
Daily	4
4-6 days/week	3
1-3 days/week	2

Any food addictions/picky eating	2
Environmental Factors	
Child Abuse/Neglect/Labor	5
Parental disharmony/Poor family Support	4
Congenital/ chromosomal anomalies/ other comorbidities	4
Similar illness in the family	2
Functional Factors	
Developmental delay/ disability	5
Special sense organ defects like Vision, hearing, speech difficulties	4
Short / Tall stature / Delayed bone age	2

Scoring Interpretation:

- **>43:** Red flag (Critically ill & ICU care)
- **22–43:** High Risk (Close observation & Hospital care)
- **11–21:** Medium Risk (Close follow-up & Ambulatory care)
- **<11:** Low/No Risk (Periodic screening & Home care).

Statistical Analysis

Data analysis was performed using SPSS software v21. Descriptive statistics were presented as frequencies and percentages, and associations were tested for significance using the chi-square test, with Fisher's exact test as a correction for values <5 ; a p-value <0.05 was considered significant.

RESULTS

A total of 200 children were included in the study. The majority of participants were aged between 1 and 3 years (48.0%), followed by the 3–5 years age group (20.5%) and infants aged 0–6 months (20.0%). Boys constituted 59.0% of the study population, while girls accounted for 40.5%. The majority of families practiced Hinduism (83.5%), followed by Islam (13.0%). Regarding socioeconomic status (SES), 82.5% of families belonged to the Upper Lower class, while 9.0% belonged to the Lower Middle class. Regarding maternal education, 72.0% of mothers had completed high school, 17.5% had primary school education, and 6.0% were graduates.

Table 2: Demographic characteristics

Demographic variables	N	%
Age		
0-6 months	40	20.0
6-12 months	23	11.5
1-3 years	96	48.0
3-5 years	41	20.5
Gender		
Male	118	59.0
Female	81	40.5
DSD	1	0.5
Religion		
Hindu	167	83.5
Islam	26	13.0
Christianity	7	3.5
Socioeconomic Status		
Lower	17	8.5
Lower Middle	18	9.0
Upper Lower	165	82.5
Mother's Education		
Primary School	35	17.5
Middle School	9	4.5
High School	144	72.0
Graduate	12	6.0

Antenatal, Postnatal, and Feeding History

Antenatal complications were reported in 38.5% of mothers. History of preterm delivery was present in 10.5% of cases, and 31.5% of children required NICU admission. Low Birth Weight (LBW) was highly prevalent; 43.5% of children were born with LBW, and 3.5% were Very Low Birth Weight (VLBW). Only 52.5% of children had a normal birth weight.

Regarding Infant and Young Child Feeding (IYCF) practices, only 40.5% of children were exclusively breastfed for 6 months. Complementary feeding (semi-solids) was introduced at 6 months for only 34.5% of children. Continued breastfeeding for 2 years was practiced in only 15% of cases. Family pot feeding by 2 years was achieved in 41% of children.

Table 3: Antenatal and Postnatal factors of malnutrition

Antenatal & Postnatal History	N	%
Antenatal Complications of mother	77	38.5
Preterm delivery	21	10.5
NICU Admission	63	31.5
Birth Weight		
Normal	105	52.5
LBW	87	43.5
VLBW	7	3.5
LGA	1	0.5
IYCF		
Exclusive Breast Feeding	81	40.5
Semi solids feed at 6 months	69	34.5
Breast fed for 2 years	30	15.0
Family pot feeding by 2 years	82	41.0

Nutritional Status and IMPACT Score Components

Anthropometric assessment revealed severe malnutrition in a significant portion of the cohort. Weight for Age: 62.5% of children were severely underweight (<-3Z), and 36.0% were moderately underweight (<-2Z). Height for Age: 26.5% were severely stunted (<-3Z), and 30.5% were moderately stunted (<-2Z). Weight-for-Height: 43.0% were severely wasted (< -3 Z).

Clinical and biochemical assessments showed that 39.5% of children had moderate to severe anemia, and an equal percentage (39.5%) had micronutrient deficiencies. Hypoalbuminemia (<3g/dl) was present in 34.5% of children. Clinical signs included hair changes (33.5%), skin changes (28.5%), and visible wasting (9.0%). Notably, only 22.0% of children met >80% of their Recommended Dietary Allowance (RDA) for daily intake.

Table 4: Factors constituting the IMPACT score

IMPACT factors	N	%
Weight for Age		
N	3	1.5
<-2Z	72	36.0
<-3Z	125	62.5
Height for Age		
N	86	43.0
<-2Z	61	30.5
<-3Z	53	26.5
Weight for Height		
N	19	9.5
<-1Z	35	17.5
<-2Z	60	30.0
<-3Z	86	43.0
Moderate to severe anemia	79	39.5
Micronutrients deficiency	79	39.5
Serum Albumin < 3g/dl	69	34.5
Visible Wasting	18	9.0
Skin Changes	57	28.5
Hair Changes	67	33.5
Daily Intake >80% RDA	44	22.0
Picky Eating	33	16.5
Child Abuse/ Neglect	5	2.5
Parental disharmony	13	6.5
Comorbidities	34	17
Similar illness in the family	23	11.5
Developmental Delay	45	22.5
Special sense organ defects	57	28.5
Short stature / Delayed bone age	38	19

Risk Stratification and Factors Associated with Malnutrition

Based on the ELIZ Modified IMPACT Tool, 74 children (37%) were classified into the "Medium to High Risk" category, while 126 children (63%) were classified into the "Low to No Risk" category. Significant risk factors associated with higher IMPACT scores (Medium to High Risk) included birth weight, maternal education, and IYCF practices.

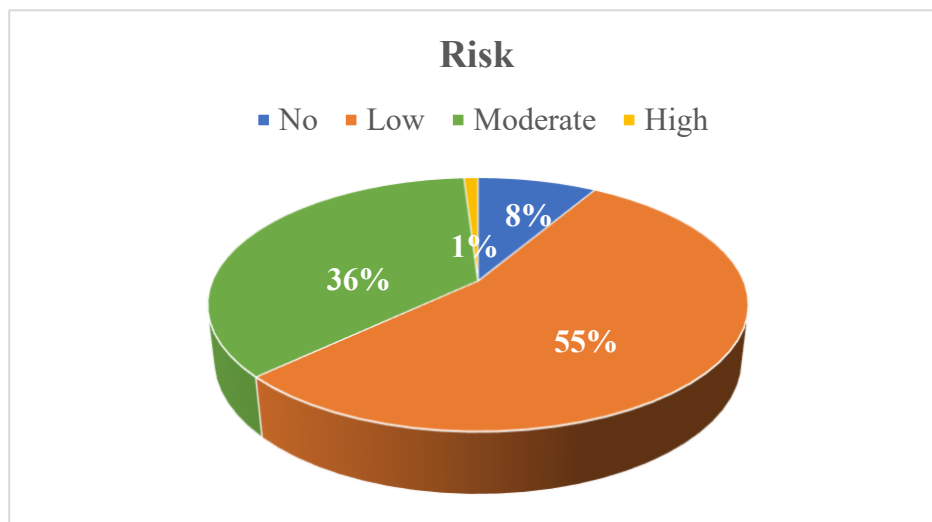


Figure 1: Risk Stratification based on ELIZ Modified IMPACT Tool

There was a significant association between birth weight and risk category ($p=0.001$). 85.71% of VLBW and 47.13% of LBW infants were in the Medium-High risk group, compared to 25.71% of normal birth weight infants. Maternal education showed a significant association with the risk of malnutrition ($p=0.029$). Mothers with only primary school education had children with a higher risk prevalence (62.86%) compared to those with high school education (29.86%). IYCF Practices showed significant associations with a medium-to-high risk of malnutrition. Lack of Exclusive Breastfeeding ($p=0.003$), Failure to introduce semi-solids at 6 months ($p=0.016$), Lack of continued breastfeeding for 2 years ($p=0.013$), and Lack of family pot feeding by 2 years ($p=0.043$) were significantly associated with high risk of malnutrition. Factors such as age ($p=0.45$), gender ($p=0.28$), antenatal complications ($p=0.763$), and socioeconomic status ($p=0.056$) did not show statistically significant associations with the risk categories in this study.

Table 5: Risk Factors for malnutrition and IMPACT risk

Risk Factors	Medium to High Risk		Low to No Risk		P value
	n = 74	%	n = 126	%	
Age					
0-6 months	8	20.00	32	80.00	0.45
6-12 months	12	30.00	28	70.00	
1-3 years	30	31.25	66	68.75	
3-5 years	15	35.71	27	64.29	
Gender					
Male	39	33.05	79	66.95	0.28
Female	35	43.21	46	56.79	
DSD	0	0.00	1	100.00	
Socioeconomic Status					
Lower	4	23.53	13	76.47	0.056
Lower Middle	62	37.58	103	62.42	
Upper Lower	22	62.86	13	37.14	
Mother's Education					
Primary School	22	62.86	13	37.14	0.029*
Middle School	5	55.56	4	44.44	
High School	43	29.86	101	70.14	
Graduate	4	33.33	8	66.67	
Antenatal & Natal history					
AN Complications of mother	32	41.56	45	58.44	0.763
Preterm delivery	9	42.86	12	57.14	0.464
NICU Admission	27	42.86	36	57.14	0.158
Birth Weight					
Normal	27	25.71	78	74.29	0.001*
LBW	41	47.13	46	52.87	
VLBW	6	85.71	1	14.29	
LGA	0	0.00	1	100.00	
IYCF					
Exclusive Breast Feeding	18	22.22	63	77.78	0.003*
Semi solids feed at 6 months	18	26.09	51	73.91	0.0168

Breast fed for 2 years	10	33.33	20	66.67	0.013*
Family pot feeding by 2 years	39	47.56	43	52.44	0.043*

DISCUSSION

The present study utilized the ELIZ Modified IMPACT Tool to stratify nutritional risk among 200 children in a tertiary care setting. The results highlight a considerable burden of malnutrition, with 37% of the cohort stratified into the Medium to High-Risk category. The prevalence of severe anthropometric deficits was alarmingly high, with 62.5% of children being severely underweight (Weight for Age <-3Z) and 43% being severely wasted (Weight for Height <-3Z).

Low Birth Weight was a predominant risk factor in our study, observed in 43.5% of participants, with an additional 3.5% classified as Very Low Birth Weight (VLBW). The study found a statistically significant association between birth weight and the malnutrition risk score. Specifically, 85.7% of VLBW children fell into the Medium-High risk category compared to only 25.7% of those with normal birth weight. These findings are consistent with a study by (Debnath & Parulekar, 2014) conducted in Pune, which reported that 69.2% of children with a history of low birth weight had moderate-to-severe malnutrition. Similarly, a systematic review by (Mohseni et al., 2017) and a study by (Ansuya et al., 2018) identified low birth weight as one of the most significant child-related risk factors for malnutrition. Our data reinforce that intrauterine growth restriction remains a foundational determinant of nutritional status in childhood.

Inappropriate feeding practices were highly prevalent and significantly associated with the risk of malnutrition in our cohort. Only 40.5% of children were exclusively breastfed for the first 6 months. Lack of EBF was significantly associated with higher risk scores. This prevalence is similar to findings from Jafar et al., 2016 in a peri-urban North Indian city, where only 42.1% of infants were exclusively breastfed. Mishra et al. 2014 also established that the lack of exclusive breastfeeding is significantly associated with severe acute malnutrition (SAM). Timely introduction of semi-solids at 6 months was achieved in only 34.5% of our study population, and delayed or early weaning was significantly associated with a higher risk. Mishra et al. noted that the consistency of complementary feeds had a greater influence on the development of SAM than the timing of initiation alone.

Maternal education emerged as a significant protective factor in our study ($p=0.029$). Children of mothers with only primary school education had a higher prevalence of Medium-High risk (62.9%) compared to those whose mothers completed high school (29.9%). This aligns with global consensus. Shaji et al., 2019 and (Mohseni et al., 2017) both identified low maternal education as a significant risk factor for childhood malnutrition. Mishra et al., 2014 also found maternal illiteracy to be significantly associated with severe malnutrition. The protective effect of maternal education likely operates through better hygiene practices and improved knowledge of child nutrition.

The current study found a high burden of anemia, with 39.5% of children suffering from moderate to severe anemia. This finding corroborates the study by (Rose et al., 2023) in Madhya Pradesh, which reported that 51.9% of children with SAM and complications had severe anemia. The co-existence of anemia and malnutrition emphasizes the need for comprehensive micronutrient supplementation alongside macronutrient rehabilitation.

Interestingly, while Socioeconomic Status (SES) is traditionally a strong predictor of malnutrition, as noted by (Mishra et al., 2014) regarding family income, our study found only borderline significance ($p=0.056$). This may be due to the homogeneity of our sample, where 82.5% of families belonged to the Upper Lower class. Similarly, regarding gender, (Shaji et al., 2019) and (Mohseni et al., 2017) reported female sex as a significant risk factor. However, our study did not find a statistically significant difference in risk between males and females ($p=0.28$), suggesting that, in our specific study population, malnutrition affected both genders to a similar extent.

The significant associations with modifiable risk factors—specifically IYCF practices and maternal education—suggest that hospital-based interventions can be effective. Sharma et al. (Sharma et al., 2020) demonstrated that culturally appropriate nutrition education interventions delivered through health services significantly reduced undernutrition. Similarly, a pilot study by Savitha et al. (Naik et al., 2025) in Mangaluru concluded that nutritional education can substantially improve mothers' knowledge and practices.

The study is not without limitations. The study population was limited to malnourished children, which may introduce selection bias and limit generalizability. The study is confined to a hospital-based setting, limiting its generalizability. Due to limitations in sample size and study design, multivariate analysis was not performed. Feeding practices were based on caregiver recall, which may introduce recall bias.

The ELIZ Modified IMPACT Tool, advocated by the Indian Academy of Pediatrics (IAP), represents a significant shift from reactive anthropometry to proactive risk assessment. A primary strength of this tool is its comprehensive, multi-domain framework, which integrates traditional anthropometry with clinical signs, dietary history, and environmental/functional factors to create a more holistic risk profile. Like many pediatric screening tools, the IMPACT tool lacks validation against a universally accepted "gold standard" for pediatric malnutrition. Instead, it often relies on charts or subjective clinical assessments for criterion validity (Klanjsek et al., 2019). While research indicates the tool is effective at differentiating children by clinical need and guiding intervention planning, further large-scale studies are required to confirm its consistent ability to predict specific long-term outcomes, such as 30-day readmission or mortality, compared to established tools like STRONGkids or PYMS (Chen et al., 2026).

CONCLUSION

The application of the ELIZ Modified IMPACT Tool in this tertiary care setting is a useful method for risk stratification, identifying 37% of the children studied as falling into the Medium- to High-Risk categories for malnutrition. The findings suggest that Low Birth Weight (LBW), low maternal education, and inappropriate Infant and Young Child Feeding (IYCF) practices are the most significant determinants of nutritional risk in this population. Specifically, the lack of exclusive breastfeeding, delayed introduction of complementary foods, and failure to sustain breastfeeding for two years were strongly associated with higher malnutrition risk scores.

To address this "double burden" of malnutrition and developmental risk, interventional strategies should focus on Targeted Nutritional Education for mothers on exclusive breastfeeding and timely, appropriate complementary feeding; early risk identification, by utilizing tools like ELIZ Modified IMPACT to screen children with a history of Low Birth Weight for closer monitoring; and integrating developmental assessments with nutritional rehabilitation.

Conflicts of Interest

The authors declare no conflicts of interest.

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