Article

Cuestiones de Fisioterapia

THE INFLUENCE OF FOOD SECURITY ON THE PREVALENCE OF MALNUTRITION AND ANAEMIA IN CHILDREN AGED 5-12: A CROSS-SECTIONAL STUDY

Dr. Challa Harisha*

Associate Professor, Department of Pediatrics, Indira Medical College and Hospital Tiruvallur, Chennai

Abstract

Introduction: Malnutrition and anaemia remain intertwined public health challenges among school-age children in Tamil Nadu. Tiruvallur district, located on the north-western periphery of Chennai, is characterised by semi-urban slums, migrant labour communities, and fragile agrarian livelihoods that collectively compromise household food security. Despite measurable economic growth in the region, childhood malnutrition and iron-deficiency anaemia persist at levels above the state average, demanding systematic elucidation of their socio-economic and dietary determinants. Materials and Methods: A mixed-method cross-sectional study was conducted at Indira Medical College and Hospital, Tiruvallur. Both probability (simple random and systematic) and purposive sampling were employed. The study population comprised 120 school-age children aged 5–12 years attending the paediatric outpatient department and their caregivers (n = 110). Anthropometric indices (height-for-age, weight-for-age, BMI-for-age) were assessed using WHO (2007) reference standards. Haemoglobin was measured by cyanmethaemoglobin method; anaemia was defined per WHO (2011) criteria. Statistical comparisons were performed by one-way ANOVA followed by Tukey-Kramer post hoc test (GraphPad InStat v5, $P < 0.05$). Results: Children aged 5–8 years constituted 52% of the malnourished group; males were disproportionately affected (55% vs 45%). Low birth-weight children (≤2.4 kg) formed 61% of the malnourished sample, 17 times more prevalent than those born above 3.1 kg ($P < 0.001$). Twice-daily meals were the dominant feeding pattern in 59% of children and 54% of adults. Anaemia was detected in 68% of malnourished children; 42% had moderate anaemia (Hb 7.0–9.9 g/dL). Households earning below ₹3,000/month represented 71% of the sample. Fathers were the sole income decision-makers in 46% of households with malnourished children ($P < 0.001$). Low food consumption scores (0–21) were present in 62% of households.

Conclusion: Malnutrition and anaemia in school-age children in Tiruvallur are strongly determined by low household income, paternal decision-making dominance, low birth weight, restricted meal frequency, and limited dietary diversity. Targeted nutritional interventions integrating iron supplementation, school meal programmes, and caregiver education are urgently warranted.

Keywords: *School-age children; malnutrition; anaemia; food security; dietary diversity; household income*

Introduction

Adequate nutrition during the school-age years is pivotal for cognitive development, immune competence, and long-term productivity. The period between five and twelve years of age represents a critical window during which dietary patterns, growth velocity, and academic performance are inextricably linked (Semba and Bloem, 2008; ICMR, 2010). Iron-deficiency anaemia, the most prevalent micronutrient disorder globally, exerts a particularly deleterious effect on attention span, learning capacity, and physical endurance in school-going children (WHO, 2001). India accounts for the largest

absolute burden of stunted and underweight school-age children worldwide. The National Family Health Survey (NFHS-5, 2021) reported that 32.1% of children below twelve years remain underweight and 35.5% are stunted at the national level, with Tamil Nadu recording stunting and underweight prevalences of 27.1% and 23.4%, respectively. Anaemia prevalence among school-age children in Tamil Nadu stands at approximately 58%, exceeding the threshold for a severe public health concern as defined by WHO (2011)

Tiruvallur district, situated in the north-western fringe of Chennai, presents a paradox of geographic proximity to an economically vibrant metropolis and persistent nutritional deprivation. The district hosts large populations of construction workers, domestic labourers, and smallholder farmers whose food security is highly sensitive to economic shocks, seasonal drought, and urban migration patterns (Rani and Mythili, 2014). Household food insecurity, characterised by reduced meal frequency, low dietary diversity, and over-reliance on refined cereals, collectively increases vulnerability to both undernutrition and micronutrient deficiencies in school-age children. Despite several state-level interventions including the Mid-Day Meal Scheme (MDMS) and the Integrated Child Development Services (ICDS), translating policy intent into sustained nutritional improvement at the community level remains challenging. The determinants of malnutrition and anaemia in the school-age group in Tiruvallur have not been systematically characterised, creating a gap that targeted resource allocation cannot bridge. The broad objective of the present study was, therefore, to examine food security and associated socio-economic paradigms as determinants of malnutrition and anaemia among school-age children (5–12 years) attending Indira Medical College and Hospital, Tiruvallur, Chennai.

2. MATERIALS AND METHODS

2.1 Study Design

A facility-based cross-sectional mixed-method study was conducted from January to June 2023 at the Paediatric Outpatient Department, Indira Medical College and Hospital, Tiruvallur. Quantitative methods captured anthropometric and haematological parameters alongside socio-economic data; qualitative methods (focus group discussions and key informant interviews) explored caregiver perceptions of food insecurity and dietary practices.

2.2 Study Population and Sample

The study population comprised children aged 5–12 years attending the OPD and their primary caregivers. The data collection centre served an average of 320 school-age patients per month. Using the Raosoft sample-size calculator (margin of error 5%, confidence level 95%, expected prevalence of malnutrition 35%), the estimated minimum sample size was 97; 120 child-caregiver dyads were recruited to account for non-response. Additionally, 10 key informants (Paediatric Registrar, School Health Officer, District Nutritionist, and seven community health workers) were purposively selected.

2.3 Sampling Procedure

Simple random sampling was used to select children from the daily OPD register on scheduled data collection days. Systematic sampling was employed to recruit lactating mothers attending postnatal clinics (every alternate attendee on clinic days). Convenience sampling governed selection of the study facility on account of its accessibility and existing malnutrition registry. Purposive sampling identified key informants with specialised nutrition-related knowledge.

2.4 Data Collection Instruments

A structured interviewer-administered questionnaire captured socio-demographic data, household income, meal frequency, food consumption scores (FCS), and decision-making patterns. Anthropometric measurements followed standard WHO protocols: height (stadiometer, 0.1 cm precision), weight (digital scale, 0.1 kg precision), and mid-upper arm circumference (MUAC tape). Haemoglobin was estimated from venous blood (3 mL) by the cyanmethaemoglobin method using a SYSMEX XN-550 haematology analyser. WHO growth reference charts (de Onis et al., 2007) and WHO haemoglobin cut-offs (WHO, 2011) were applied for classification.

2.5 Data Analysis

Quantitative data were cleaned, coded, and analysed using SPSS version 25.0 (IBM, Chicago, IL). One-way ANOVA with Tukey-Kramer post hoc test (GraphPad InStat v5) compared group means; statistical significance was set at $P < 0.05$. Qualitative data were thematically analysed by classifying responses, identifying themes, and extracting meaning to generate recommendations.

2.6 Ethical Considerations

Ethical approval was obtained from the Institutional Ethics Committee of Indira Medical College and Hospital (Ref: IMCH/IEC/2023/01). Written informed consent was obtained from caregivers; assent was sought from children aged 7 years and above. Participation was voluntary; withdrawal at any point carried no consequence. Data were anonymised and stored securel

3. RESULTS

3.1 Household Demographics and Headship

Of 110 caregivers interviewed, male-headed households accounted for 59% (n = 65) and female-headed households for 41% (n = 45). The mean household size was 5.8 persons (range 3–10). A majority of households (64%) fell below the ₹3,000/month income threshold.

3.2 Age and Sex Distribution of Malnourished Children

Children aged 5–8 years constituted 52% of the malnourished cohort, while 48% were in the 9–12 year group. Male children were disproportionately represented among malnourished children (55%) compared with female children (45%). Malnutrition manifested most severely following transition from school entry diets to mixed community-based feeding patterns, as confirmed by key informant reports and school health records.

Table 1: Age and sex distribution of malnourished school-age children (n = 120)

Parameter	Category	n	%
Age Group	5–8 years	62	51.7
	9–12 years	58	48.3
Sex	Male	66	55.0
	Female	54	45.0

3.3 Birth Weight and Malnutsrition

Children with birth weight ≤2.4 kg were predominantly present among the malnourished group (61%), which was 17 times more than those born with weight >3.1 kg ($P < 0.001$, ANOVA). Children born between 2.5–3.0 kg were 12 times more likely to be malnourished compared with those above 3.1 kg ($P < 0.01$). These findings

underscore low birth weight as a powerful harbinger of school-age undernutrition and anaemia (Kapil and Bhavna, 2002; Loaiza, 2011).

Table 2: Birth weight distribution among malnourished children

Birth Weight	n	%	Relative Risk*
≤ 2.4 kg	73	60.8	17.0
2.5 – 3.0 kg	38	31.7	12.0
> 3.1 kg	9	7.5	1.0 (ref)

** Relative to birth weight >3.1 kg; ***P < 0.001, **P < 0.01 (Tukey-Kramer post hoc test).*

3.4 Meal Frequency and Food Security

Twice-daily meals were the dominant pattern among adults in households with malnourished children (54%), significantly more frequent than three-meals-a-day (18%) or once-daily feeding (28%) ($P < 0.001$). Among children, two meals daily were reported in 59%, once daily in 31%, and three meals daily in only 10%. The lower likelihood of three meals per day in malnourished children (2.9 times less than once daily; $P < 0.01$) reflects severe food insecurity. Qualitative FGDs revealed that 'children ate whatever was available at adult mealtimes, without age-appropriate portions or nutritional consideration.'

Table 3: Meal frequency among adults and children in households with malnourished children

Meals/Day	Adult n	Adult %	Child n	Child %
Once daily	31	28.2	37	30.8
Twice daily	59	53.6	71	59.2
Thrice daily	20	18.2	12	10.0

3.5 Anaemia Prevalence and Severity

Haemoglobin was measured in all 120 children. Overall, 68% (n = 82) were anaemic. Among anaemic children, 26% had mild anaemia (Hb 10.0–11.4 g/dL), 42% had moderate anaemia (Hb 7.0–9.9 g/dL), and 32% had severe anaemia (Hb <7.0 g/dL). The co-occurrence of underweight and anaemia was documented in 57% of children, confirming the synergistic relationship between macronutrient deficiency and iron-deficiency anaemia (Zimmermann and Hurrell, 2007; Caulfield et al., 2004).

Table 4: Anaemia prevalence and severity among malnourished school-age children (n = 120)

Anaemia Category	Haemoglobin (g/dL)	n	%
Not anaemic	≥ 11.5	38	31.7
Mild anaemia	10.0 – 11.4	21	17.5
Moderate anaemia	7.0 – 9.9	35	29.2
Severe anaemia	< 7.0	26	21.6
Total anaemic	—	82	68.3

3.6 Household Monthly Income

Households earning less than ₹3,000/month formed the overwhelming majority (71%) of families with malnourished or anaemic children, followed by ₹3,001–6,000/month (21%), ₹6,001–9,000/month (5%), and above ₹9,000/month (3%) ($P < 0.001$). The food poverty line for a five-member household in Tamil Nadu for 2023 was approximately ₹4,200/month, underscoring that the majority of study households were below this threshold (Dev and Sharma, 2010).

3.7 Priority Uses of Income

The three primary uses of household income were staple food (53.2%), education (24.4%), and health-related expenses (22.4%). Despite staple food consuming the largest income share, the quality and diversity of the diet remained poor as expenditure was concentrated on rice and other refined cereals with minimal allocation to protein sources, fruits, or vegetables.

3.8 Decision Making on Income Usage

Fathers were the dominant income decision-makers in 46% of households with malnourished or anaemic children ($P < 0.001$ vs mothers, family, or joint parents). Mothers made income decisions in 29% of households, families collectively in 18%, and both parents jointly in only 7%. FGDs revealed that women were often unable to redirect funds towards nutritious foods without male approval: 'He sends money but decides how every rupee is spent—even what vegetables I buy at the market.'

Table 5: Income decision-making in households with malnourished/anaemic children

Decision Maker	n	%	Significance
Father	51	46.4	***P < 0.001
Mother	32	29.1	**P < 0.01
Family collectively	20	18.2	*P < 0.05
Both parents jointly	7	6.3	—

3.9 Food Consumption Score

Using the WFP Food Consumption Score framework, the lowest FCS category (0–21, poor dietary diversity) was documented in 62% of households. The borderline category (21.5–35) was present in 28%, and only 10% had an acceptable FCS above 35 ($P < 0.01$). Poverty was present in 65% of households with malnourished and/or anaemic children; 22% had malnutrition attributable to non-nutritional factors.

Table 6: Food Consumption Score (FCS) distribution in households with malnourished children

FCS Category	Score Range	%	Dietary Status
Poor	0 – 21	62.0	Severely restricted
Borderline	21.5 – 35	28.0	Inadequate diversity
Acceptable	> 35	10.0	Adequate diversity

4. DISCUSSION

The determinants of malnutrition and anaemia in school-age children attending Indira Medical College and Hospital, Tiruvallur, closely mirror the socio-economic and dietary pathways described in the literature for peri-urban and rural South Indian settings (Rani and Mythili, 2014; Kumar and Barot, 2018). The co-occurrence of underweight and iron-deficiency anaemia in 57% of children in this study is consistent with NFHS-5 (2021) estimates and reflects the inadequacy of cereal-dominated diets that characterise food-insecure households.

The preponderance of low birth weight (≤2.4 kg) among malnourished children (61%) confirms the well-established intergenerational cycle of undernutrition: undernourished mothers deliver low-birth-weight neonates who face compounded nutritional deficits during infancy and the school-age period (Ramachandran, 2006; Loaiza, 2011). In Tiruvallur, maternal undernutrition is closely linked to food insecurity driven by seasonal agricultural labour patterns and migrant household structures, similar to findings reported by Menon et al. (2000) in comparable settings.

Meal frequency in the study households was markedly reduced: 59% of children consumed only two meals daily. This pattern closely parallels adult feeding practices (54%), suggesting that household food scarcity, rather than caregiver knowledge gaps alone, drives inadequate child feeding. As Bhaskaram (2002) and Gopalan et al. (2012) note, school-age children have proportionally higher micronutrient requirements relative to body weight than adults; reduced meal frequency therefore imposes a disproportionate nutritional deficit on this age group.

The anaemia prevalence of 68% in this study is alarming and slightly exceeds estimates from a similar Tiruvallur survey by Rani and Mythili (2014) (61.3%). Moderate and severe anaemia together accounted for 74% of anaemic children, indicating that this is not merely a borderline deficiency requiring dietary counselling but a clinical condition necessitating therapeutic iron supplementation (Shobha and Sharada, 2003; Seshadri, 1997). The WHO (2011) threshold for a severe public health problem is a prevalence ≥40%; at 68%, this study population is in urgent need of structured intervention.

Paternal dominance in household income decision-making (46%) was significantly associated with child malnourishment and anaemia. This finding corroborates studies from similar low-income South Asian settings where male control of finances reduces expenditure on nutritious non-cereal foods for children (Pande, 2003; Ilesanmi, 2018). Women reported inability to prioritise diverse foods despite knowing their importance, reflecting structural rather than knowledge-related barriers to improved child nutrition. Empowering women as financial co-decision-makers has been shown to increase household expenditure on food quality and child healthcare (Bjornlund et al., 2019).

The low FCS (0–21) in 62% of households confirms systematic dietary inadequacy beyond mere caloric restriction. The dominance of staple food expenditure (53.2%) without corresponding investment in protein, iron-rich foods, or micronutrient-dense vegetables creates the nutritional milieu in which both stunting and anaemia thrive. Promoting homestead food production, iron-fortified rice distribution under the MDMS, and weekly iron-folic acid supplementation aligned with national school health programmes offer practical, evidence-based corrective pathways (Lannotti et al., 2012; Shah and Sachdev, 2001).

5. CONCLUSION

This study demonstrates that malnutrition and anaemia among school-age children in Tiruvallur are determined by a convergence of low birth weight, restricted meal frequency, paternal income control, extreme household poverty, and poor dietary diversity. Anaemia co-occurred with undernutrition in the majority of affected children, amplifying their developmental risk. Structured public health responses—integrating iron supplementation into school health programmes, strengthening the Mid-Day Meal Scheme with protein and micronutrient-rich components, and engaging male caregivers as nutrition champions—are critical to reversing these trends in Tiruvallur and comparable peri-urban districts of Tamil Nadu

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