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Assessment of Anaemia and Its Predictors among Children under Five in southern West Bengal, India

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Abstract:

Background: Anaemia continues to pose a serious health challenge among young children below five years of age, predominantly in economically disadvantaged and resource-limited areas of India. It adversely affects physical growth, cognitive development, and immunity. Feeding practices, socio-demographic characteristics, and a child's prior illness history are important determinants of overall child health and growth outcomes.

Objective: To assess the enormity of anaemia and examine its association with feeding practices, socio demographic characteristics, and child prior illness history under 5 years children in North 24 Parganas district, West Bengal.

Methods: A community-oriented cross-sectional study was performed involving children between 1 and 5 years of age. Data regarding socio-demographic details, maternal characteristics, birth history, and child feeding patterns were gathered using a predesigned questionnaire and interview method. Haemoglobin levels were assessed to determine anaemia status. To examine the association of anaemia with other factors, the Chi-square test was utilized.

Results: Anaemia was observed in 86.3% of the study population, with moderate anaemia (52.0%) constituting the largest proportion. A higher proportion of female children (89.9%) were affected compared to males (83.0%), particularly in the 24–59 months age groups. Significant associations were identified with maternal occupation, maternal education, birth weight, and mode of delivery ($p < 0.05$). Dietary assessment demonstrated a marked inadequacy of iron intake despite adequate protein consumption, underscoring insufficient dietary iron as a major contributing factor.

Conclusion: Anaemia affects a substantial percentage of children between 1to 5 years in the study area, with moderate anaemia being the predominant form. Sociodemographic factors, birth characteristics, and feeding behaviors contribute to anaemia status. The marked inadequacy of dietary iron intake underscores the need for strengthened nutritional interventions, dietary diversification, and early screening to reduce the percentage of anaemia within the under-five age group facing increased health vulnerability.

Keywords: Anaemia, Feeding Practices, maternal factors, Children 1–5 Years, West Bengal

Introduction:

Anaemia represents a significant community health challenge affecting children within the 1–5 year age range in India . The World Health Organization reports that approximately 40% of preschool children worldwide are affected by anaemia , with the prevalence being particularly elevated in South Asia and Sub-Saharan Africa [1,2] According to the National Family Health Survey-5 (NFHS-5, 2019–21), anaemia affects 67.1% of children aged 6–59 months in India, reflecting a substantial public health burden despite ongoing national interventions .[3] In West Bengal, the prevalence is even higher, with approximately 69% of young children within the 6 to 59 months age group were found to have anaemia [3,4] Anaemia, defined as a reduced concentration of haemoglobin in the blood, is most commonly caused by iron deficiency and is connected with impaired mental and physical development, reduced resistance to infection, poor school readiness, and increased susceptibility to infections in early childhood . [5,6] Children aged 1–5 years are particularly vulnerable to anaemia due to rapid growth, increased iron requirements, inappropriate complementary feeding practices, frequent infections, and inadequate dietary diversity.[7,8] Despite implementation of national programmes such as Poshan Abhiyaan ,Anaemia Mukt Bharat**,** and the Integrated Child Development Services scheme, childhood anaemia remains inadequately controlled.[9,10] North 24 Parganas district of West Bengal represents a socio-economically and culturally diverse population where child nutrition and health outcomes may be influenced by contextual determinants. However, limited district-level evidence exists regarding the magnitude of anaemia and other connected determinants between children aged 1–5 years in this region. Therefore, this study seeks to determine the distribution of anaemia and explore its association to feeding practices , socio economic characteristics and child illness status among children aged 1–5 years in North 24 Parganas district, West Bengal. The findings may contribute to strengthening community-based nutritional interventions and inform policy measures intended to mitigate the magnitude of anaemia in the early years of life.

Methodology:

Research Design

A community-based observational study with a cross-sectional design was undertaken to determine the extent and distribution of anaemia and its associated factors among children aged 1–5 years. This study was conducted from January 2025 to December 2025. The research was conducted in North 24 Parganas district, West Bengal, a region characterized by both urban and rural populations with diverse socio-economic and cultural backgrounds.The study population comprised children aged 1–5 years residing in the district, along with their mothers or primary caregivers. Children aged 12–59 months who were permanent residents of the district were included in the study. However, children who were suffering from severe illness at the time of data collection, those diagnosed with chronic diseases (inborn) or congenital disorder and children whose caregivers declined to provide consent were excluded from participation.

Sampling method

Participants were selected using a simple random sampling approach. A list of households with children aged 1–5 years was prepared. Eligible children were then selected through simple random methods, ensuring that each child had an equal probability of selection, until the required sample size was achieved.

Estimation of the study sample

Sample size estimation was performed using the standard prevalence calculation formula applicable to cross-sectional studies:

$n = Z^2 \times (p \times q)/ d^2$

Where:

n = required sample size

Z= 1.96 at 95% confidence level

P = estimated prevalence of anaemia (69% or 0.69 based on NFHS-5 data)

q = 1-p = 0.31

d= sampling error or degrees of error (5 % or 0.05)

$n=(1.96)^2 \times 0.69 \times 0.31/ (0.05)^2$

n = 329

The initially estimated minimum sample size was 329 participants. To compensate for anticipated non-response and potential dropouts, a 10% increment was incorporated, resulting in a revised target of 362 children. During the field survey, a total of 541 children were assessed, among whom 496 satisfied the eligibility criteria andwere considered for the final analysis.[11]

Data Collection:

After obtaining informed consent, a predesigned questionnaire was used to collect the required data through direct interviews with mothers or primary caregivers. Information was obtained on socio-demographic characteristics (age, sex, maternal education, occupation), birth-related factors (birth weight, mode of delivery), early child feeding practices (exclusive reliance on breast milk for nourishment, colostrum feeding, self-feeding), feeding problems, and recent history of illness. Food consumption data were collected using a 24-hour recall approach based on the FAO standardized 24-hour recall questionnaire.[12] Nutrient intake was calculated using standard Indian food composition data, and the results were compared with the 2024 revised Recommended Dietary Allowances (RDA) and Estimated Average Requirements (EAR) as per the guidelines of the Indian Council of Medical Research (ICMR, 2024) [13,14] Haemoglobin levels were measured from capillary blood obtained through a finger-prick (digital puncture) using aseptic precautions. The blood sample was collected in a microcuvette, and haemoglobin concentration was determined immediately using a calibrated portable digital haemoglobinometer.[15] Children with haemoglobin concentrations under 11 g/dL were considered anaemic, and severity was classified based on World Health Organization standards as mild (10.0–10.9 g/dL), moderate (7.0–9.9 g/dL), or severe (<7.0 g/dL).[16]

Statistical Analysis:

The collected data were entered and processed using suitable statistical software, such as SPSS. Descriptive analyses, including frequencies were conducted to estimate the prevalence of anaemia. Associations between anaemia and various study variables were evaluated using the Chi-square test. Statistical significance was set at a p-value less than 0.05.

Ethical consideration:

The study received ethical clearance from the Institutional Ethical Review Board, West Bengal State University. Written informed consent was secured from all the primary caregivers before data collection.

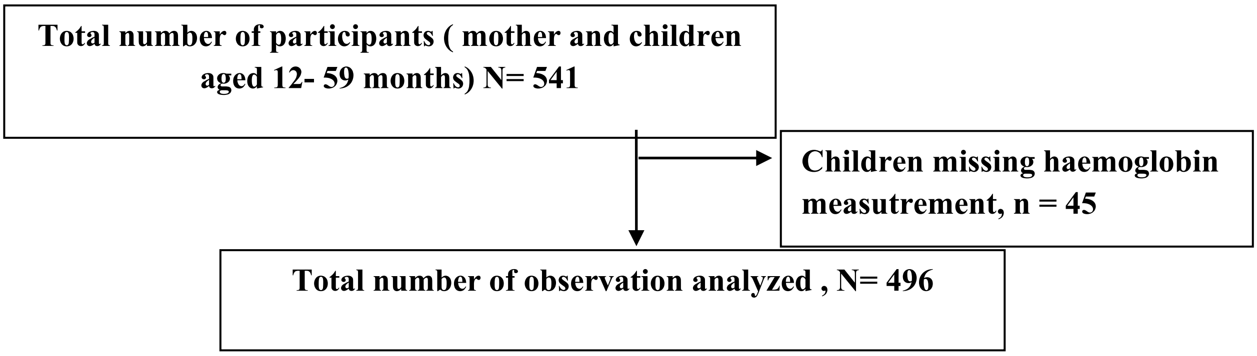

Figure 1 : Schematic diagram illustrating participant distribution

Results:

Table 1 presents the age- and sex-wise distribution of anaemia among children aged 12–59 months. Outof the 496 children studied, 428 (86.3%) were anaemic, while only 68 (13.7%) were non-anaemic, demonstrating a markedly high burden of anaemia in the study population. The most notable finding is the consistently high magnitude of anaemia across almost all ages , particularly among female children. In the 36–47 months ages , a striking gender disparity was observed, where 94.0% of females were anaemic compared to only 51.0% of males. Similarly, in the 24–35 months and 48–59 months groups, female children showed higher anaemia prevalence (93.0% in both groups) compared to males (82.0% and 89.0%, respectively).Although anaemia was highly prevalent in both sexes, female children demonstrated a higher magnitude in three out of four ages . The exceptionally high prevalence (above 90%) among females in multiple age categories represents the most critical observation of this table and warrants particular attention.

Table-1: Age and Sex-wise Distribution of Children According to Anaemic and Non-Anaemic Status

Age group(month)	Sex	Anaemic	Non-anaemic	Total
12-23	Male	23 (88.0%)	3 (12.0%)	26
	Female	39 (80.0%)	10 (20.0%)	49
24-35	Male	31(82.0%)	7 (18.0%)	38
	Female	54 (93.0%)	4 (7.0%)	58
36-47	Male	21 (51.0%)	20 (49.0%)	41

	Female	74 (94.0%)	5 (6.0%)	79
48-59	Male	114 (89.0%)	14 (11.0%)	128
	Female	72 (93.0%)	5 (7.0%)	77
Total		**428**	**68**	**496**

Table 2 presents the age-wise distribution of anaemia severity among male children aged 12–59 months (n = 259). Overall, 215 children (83.0%) were anaemic, while only 44 (17.0%) were non-anaemic, indicating a high prevalence of anaemia among male children. Among the different severity categories, moderate anaemia was the most common (49.8%)**,** followed by mild anaemia (25.5%) and severe anaemia (7.7%). The highest proportion of children belonged to the 48–59 months group (33.0%), which also accounted for the largest share of moderate (35.0%) and mild (31.8%) anaemia cases. Severe anaemia was uniformly distributed across all age groups (25.0% each). In contrast, non-anaemia was most frequently observed in the 36–47 months age group (45.0%).Overall, moderate anaemia predominated across all age groups, with the greatest burden observed among older preschool male children (48–59 months).

Table-2:Age-wise distribution of anaemia severity among male children aged 12–59 months

Age	Mild	Moderate	Severe	No Aneamia	Total
12-23	13 (19.6%)	27 (21.0%)	5 (25.0%)	3 (7.0%)	48(18.0%)
24-35	18 (27.2%)	34 (23.0%)	5 (25.0%)	7 (16.0%)	64 (25.0%)
36-47	14 (21.2%)	23 (18.0%)	5 (25.0%)	20(45.0%)	62 (24.0%)
48-59	21 (31.8%)	45 (35.0%)	5 (25.0%)	14(32.0%)	85 (33.0%)
Total	**66**	**129**	**20**	**44**	**259**

Table 3 shows the age-wise distribution of anaemia severity among female children aged 12–59 months (n = 237).Collectively **,** 89.9% of female children were anaemic, while 10.1% were non-anaemic, indicating a very high prevalence of anaemia. Moderate anaemia (54.4%) was the most common category, followed by mild (28.7%) and severe anaemia (6.8%). The largest proportion of participants was in the 48–59 months age group (33.0%), which also accounted for the highest share of mild (40.0%) and severe (50.0%) anaemia cases. Moderate anaemia was distributed across all age groups but was relatively higher in the 36–47 months (28.0%) and 48–59 months (29.0%) groups. Non-anaemia was most frequently observed in the 12–23 months age group (42.0%). In particular , moderate anaemia predominated across all age groups, with older preschool girls (48–59 months) contributing the largest proportion of anaemia cases.

Table-3:Age-wise distribution of anaemia severity among female children aged 12–59 months

Age	Mild	Moderate	Severe	No Aneamia	Total
12-23	11 (16.0%)	27 (21.0%)	0	10(42.0%)	48 (20.0%)
24-35	17 (25.0%)	28 (22.0%)	2 (13.0%)	4(16.0%)	51 (21.0%)
36-47	13 (19.0%)	36 (28.0%)	6 (46.0%)	5(21.0%)	60 (25.0%)
48-59	27 (40.0%)	38(29.0%)	8 (50.0%)	5(21.0%)	78 (33.0%)
Total	**68**	**129**	**16**	**24**	**237**

The figure 2 depicts the proportional distribution of anaemia severity among children aged 12–59 months in North 24 Parganas, West Bengal. Moderate anaemia constituted the largest proportion (52.0%), followed by mild anaemia (27.0%), whereas severe anaemia accounted for

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7.0% of cases. The predominance of moderate anaemia indicates that a substantial proportion of affected children fall within the clinically significant category, reflecting a considerable public health burden. Although the proportion of severe anaemia was comparatively low, its presence underscores the need for timely screening and intervention. Overall, the severity pattern demonstrates that moderate anaemia is the principal contributor to the anaemia burden in this population.

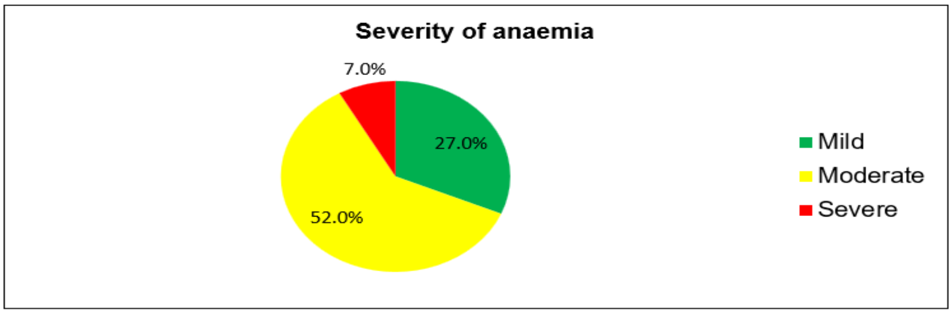

Figure 2: Proportional Distribution of Anaemia Severity Categories in Children Aged 12–59 Months

Table 4 examines the association between selected maternal and child characteristics and anaemia status . Maternal occupation was significantly associated with childhood anaemia ($\chi^2 = 8.821, p = 0.021$). A higher proportion of children of non-working/home-maker mothers were anaemic (87.0%) compared to those of employed mothers (78.0%). This suggests that maternal employment status may influence child health outcomes, possibly through differences in socioeconomic conditions or access to resources. Maternal education showed a statistically significant association with anaemia status ($\chi^2 = 21.659, p = 0.042$). Anaemia prevalence varied across educational levels: 83.0% among mothers with no formal education, 81.0% with primary education, 90.0% with secondary education, and 94.0% with tertiary education. Although anaemia was prevalent across all categories, differences in distribution indicate that maternal education level is significantly related to child anaemia status. Birth weight demonstrated a significant association with anaemia ($\chi^2 = 8.443, p = 0.038$). This indicates that birth weight is statistically related to anaemia status in this study population. Mode of delivery was also significantly associated with anaemia ($\chi^2 = 9.453, p = 0.024$). Anaemia prevalence was higher among children delivered by caesarean section (88.0%) compared to vaginal delivery (82.0%). A higher proportion of children who experienced illness in the preceding two weeks were anaemic, accounting for 87.4% (348 out of 398) of the cases, indicating a greater occurrence of anaemia among recently ill children.

Table 4: Background Characteristics of Children and Their Mothers According to Anaemia Status

Characteristics	Aneamic	Non Aneamic	Total	x^2 value	P value
Mother occupation Employed or Working	51 (78.0%)	14 (21.0%)	65	8.821	**<0.021**
Not woking or home maker	377 (87.0%)	54 (12.0%)	431		
Mother education No formal education	10 (83.0%)	2 (17.0%)	12		
Primary education	217 (81.0%)	48(18.0%)	265		

Secondary education	110 (90.0%)	12 (10.0%)	122	21.659	**<0.042**
Tertiary education	91 (94.0%)	6 (6.0%)	97		
Birth weight				8.443	**<0.038**
<2.5kg	226 (80.0%)	56 (20.0%)	282		
>2.5kg	202 (94.0%)	12 (6.0%)	214		
Mode of delivery				9.453	**<0.024**
Vaginal delivery	92 (82.0%)	20 18.0%)	112		
Caesarean delivey	336 (88.0%)	48 (12.0%)	384		
Child having illness in last 2 week					
Yes	348	50	398	7.531	0.057
No	80	18	98		

Table 5 presents the association between young child feeding practices and anaemia status. Among the feeding-related variables, self-feeding practice and feeding problems demonstrated associations approaching statistical significance. Self-feeding showed a near-significant relationship with anaemia status (χ^2 = 7.586, p = 0.055). A slightly higher prevalence of anaemia was observed among non–self-feeders (88.0%) compared to self-feeders (85.0%), suggesting a potential influence of feeding autonomy on haemoglobin status. Feeding problems also exhibited a borderline significant association with anaemia (χ^2 = 20.808, p = 0.053), indicating a possible relationship between feeding behavior and anaemia. High proportions of anaemia were observed among children with little interest in feeding (94.0%), limited appetite (94.0%), and irrational fear of feeding (90.0%). These findings suggest that suboptimal feeding behaviors may contribute to increased anaemia risk. A higher proportion of children who experienced illness in the preceding two weeks were anaemic, accounting for 87.4% (348 out of 398) of the cases, indicating a greater occurrence of anaemia among recently ill children. Exclusive breastfeeding and colostrum feeding were widely practiced among the study children, with similar patterns observed across both anaemic and non-anaemic groups.

Table- 5: Association Between Infant and Young Child Feeding Practices and Anaemia Status

Characteristics	Aneamic	Non Aneamic	Total	χ^2 value	P value
Exclusive Breast feeding					
Yes	214 (88.0%)	28 (12.0%)	242	6.282	0.099
No	214 (84.0%)	40 (16.0%)	254		
Self feeder					
Yes	256 (85.0%)	44 (15.0%)	300	7.586	**< 0.055**
No	172 (88.0%)	24 (12.0%)	196		
Colostrum given					
Yes	202 (92.0%)	18 (8.0%)	220	1.279	0.734
No	226 (82.0%)	50 (18.0%)	276		
Feeding problem				20.808	**< 0.053**
Little interest in feeding	153 (94.0%)	10 (6.0%)	163		
Limited appetide	87 (94.0%)	6 (6.0%)	93		
Highly selective eating	26 (41.0%)	38 (59.0%)	64		

Irrational fear of feeding	36 (90.0%)	4 (10.0%)	40		
No feeding problem	126(93.0%)	10 (7.0%)	136		

Figure-3 shows the comparison of mean protein and iron intake among children aged 1–3 years with the ICMR recommended dietary allowance (RDA) and estimated average intake. Overall, protein intake was closer to recommended levels, whereas iron intake was substantially below the RDA and EAR, indicating inadequate dietary iron consumption in this age group.

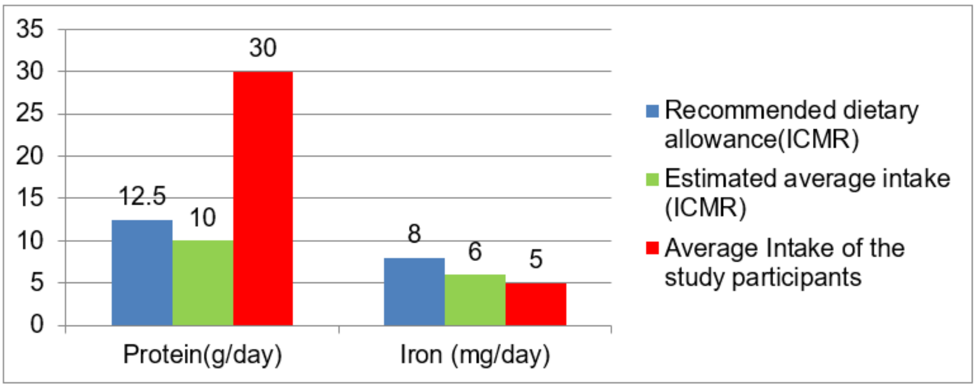

Figure:3 Comparison of average daily Protein and Iron Intake with ICMR Recommended dietary Allowances among Children Aged 1-3 Years

Figure-4 presents the average protein and iron intake among children aged 4–6 years**,** compared with ICMR recommended dietary allowances and estimated average intake. Protein intake was relatively closer to recommended levels, whereas iron intake was considerably lower than the RDA and EAR, indicating inadequate dietary iron consumption in this age group.

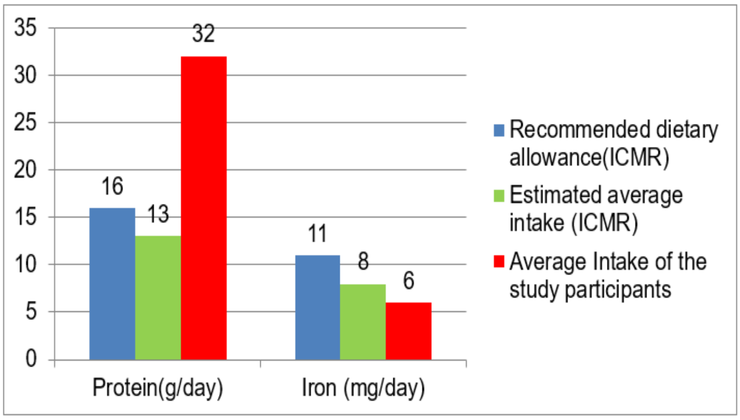

Figure: 4 Comparison of average daily Protein and Iron Intake with ICMR Recommended dietary Allowances among Children Aged 4-6 Years

Discussion:

Anaemia in early childhood remains a major global public health challenge, particularly in low and middle-income countries, where nutritional deficiencies and socio-demographic vulnerabilities intersect. It is widely recognized as a multifactorial condition influenced by dietary inadequacies, maternal factors, birth outcomes, and caregiving practices.[17,18]

The outcomes of the present study showed an alarmingly elevated proportion concerning anaemia (86.3%) between children aged 12 to 59 months, indicating a substantial public health concern in the study area. The predominance of moderate anaemia (52.0%) suggests that a large segment of affected children falls within a clinically significant category that may impair growth, immunity, and cognitive development. Although severe anaemia constituted a smaller proportion (7.0%), its presence underscores the need for early identification and intervention.[17,19]

A notable sex disparity was observed in the distribution of anaemia (86.3%), with female children demonstrating a higher proportion of anaemia compared to male children across multiple age groups. The persistence of higher anaemia percentage among female children highlights the need for gender-sensitive nutritional interventions and targeted public health strategies to address underlying socio-cultural determinants contributing to this disparity.[20,21]

Significant associations ($P<0.05$) were observed between anaemia (86.3%) and maternal education, maternal occupation, birth weight, and mode of delivery, supporting the multifactorial etiology of childhood anaemia. Children of non-working mothers and those with lower maternal education had a higher proportion of anaemia (86.3%)**,** emphasizing the role of socio-demographic determinants in the community setting.[22,23] Self-feeding practices and feeding problems showed an association approaching statistical significance, suggesting that caregiving and feeding behaviours may influence anaemia status among the children (86.3%).[24]

The dietary assessment indicates adequate protein intake in both age groups; however, iron intake was substantially inadequate relative to ICMR recommendations. Among children aged 1–3 years, mean iron intake was 37.5% below the RDA . In children aged 4–6 years, mean iron intake was about 45% below the RDA and approximately 14% below the EAR.As the Estimated Average Requirement (EAR) serves as the appropriate reference for evaluating nutrient inadequacy at the population level, these findings suggest that inadequate dietary iron intake is a key underlying determinant of the high proportion of anaemia (86.3%) observed in this study population.[25,26]

Acoording to a study in Tanzania, more than half of children under five were reported to be anaemic, with maternal socio-demographic factors significantly influencing anaemia prevalence, including maternal education and employment status, similar to our findings that children of non-working mothers had higher anaemia prevalence than those of employed mothers, and maternal education was significantly associated with anaemia status. [27-29]

Maternal education has been widely reported as an important determinant of childhood anaemia. [30,31] In addition, national surveys in India have also highlighted maternal education as a significant predictor of childhood anaemia, with higher maternal education being protective, likely due to better childcare knowledge, feeding practices, and health service utilization. [32]

Birth weight has consistently been identified as a risk factor for anaemia. Findings from studies in rural China and other settings indicate that low birth weight is associated with lower haemoglobin levels in infants, corroborating our observation of significant association between birth weight and anaemia status. [32] In the present study, exclusive breastfeeding and colostrum feeding were commonly practiced among the children, reflecting favourable early infant feeding practices. Furthermore, self-feeding practices and feeding problems showed an association approaching significance, indicating the potential influence of caregiving and feeding behaviours on anaemia status. Evidence from multicountry studies also suggests that optimal infant and young child feeding practices, including adequate dietary diversity and appropriate complementary feeding, contribute to improved nutritional outcomes and a lower risk of anaemia and related conditions such as stunting.[34]

A demographic analysis conducted across 45 low- and middle-income countries reported that children born by caesarean delivery had a higher risk of anaemia compared to those delivered vaginally, suggesting that mode of delivery may influence early iron status and haemoglobin levels.[34]

According to a study in Indonesia , low dietary iron intake and poor complementary feeding practices were associated with higher odds of anaemia among young children.[26] Similarly, an Indian study identified poor dietary intake, delayed introduction of complementary foods, and inadequate consumption of iron-rich foods as key determinants of nutritional anaemia among children below five years.[25,7]

These findings suggest that while early feeding practices alone may not determine anaemia status, the overall quality of diet and feeding behaviors during the complementary feeding period may play an important role. Socio-economic status and caregiving practices have been consistently implicated as underlying determinants of anaemia in under-five children across diverse contexts.[24,31] Caesarean delivery may limit placental transfusion at birth, potentially leading to reduced neonatal iron stores and suboptimal haematological indices.[34] Low dietary iron intake is primarily associated with iron deficiency anaemia (IDA), which is the most common type of anaemia globally, particularly among infants and under-five children. Inadequate iron consumption leads to depleted iron stores (low ferritin), reduced haemoglobin synthesis, and eventually microcytic, hypochromic anaemia, characterized by small, pale red blood cells.[35]

Conclusion :

The findings indicate a high magnitude of anaemia (86.3%) among children aged 12–59 months, with moderate anaemia emerging as the most common form. Female children demonstrated a relatively higher occurrence of anaemia across several age groups. Maternal occupation, maternal education, birth weight, mode of delivery , self feeding practice and feeding problem showed significant associations with anaemia status ($p < 0.05$). In addition, insufficient dietary iron intake, despite relatively adequate protein consumption, appears to contribute substantially to the anaemia burden in this population. Strengthening maternal education, improving feeding practices, and ensuring adequate iron intake are essential for reducing childhood anaemia.

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