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Prevalence of Anemia in Children with Recurrent Infections: A Cross-Sectional Study

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ABSTRACT: ***Background:*** Anemia remains a significant public health issue, particularly in children with recurrent infections, contributing to increased morbidity and impaired development. ***Objective*****:** To determine the prevalence, severity, and associated factors of anemia in children with recurrent infections. ***Methods*****:** This cross-sectional study was conducted from June 2023 to July 2024, including 200 children aged 1–12 years with recurrent infections. Data were collected using structured questionnaires and medical record reviews. Sociodemographic, nutritional, and clinical information was analyzed alongside blood parameters, including hemoglobin, serum ferritin, serum iron, and C-reactive protein (CRP). Statistical analyses included chi-square tests, Pearson correlation, and multivariate logistic regression, with a significance threshold of $p < 0.05$. ***Results*****:** The prevalence of anemia was 66.0%, with mild anemia being the most common (37.0%), followed by moderate (23.0%) and severe (6.0%). Anemia was significantly associated with low socioeconomic status (54.0%), insufficient dietary iron intake (41.0%), and non-exclusive breastfeeding (43.0%). Recurrent infections, including fever (90.0%), cough and cold (82.0%), and diarrhea (61.0%), were significantly correlated with anemia. Blood analysis revealed lower hemoglobin (mean 8.4 ± 1.2 g/dL), serum ferritin (mean 8.5 ± 4.3 ng/mL), and elevated CRP (mean 8.1 ± 2.4 mg/L) among anemic children. Logistic regression identified low socioeconomic status, insufficient iron intake, and elevated CRP as significant predictors of anemia. ***Conclusion*****:** Anemia is highly prevalent among children with recurrent infections, driven by socioeconomic, nutritional, and clinical factors. Integrated interventions addressing dietary deficiencies and infection prevention are crucial.

Keywords: Anemia, Recurrent Infections, Children, Blood Parameters, Bangladesh.

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INTRODUCTION

Anemia is a condition characterized by either a low red blood cell count or reduced hemoglobin levels in the blood, leading to a diminished capacity for oxygen transport.[1] Iron deficiency is a primary cause of anemia, responsible for nearly half of the global anemic population; however, anemia can also stem from a deficiency of other micronutrients, such as riboflavin, vitamins A and B12, and folate.[2, 3] Chronic illnesses like tuberculosis, cancer, acquired immunodeficiency syndrome, and malaria, as well as inherited or acquired conditions like thalassemia, can also contribute to anemia.[4-6] Notably, chronic diseases and infections represent the second most common cause of anemia after

iron deficiency. Prior evidence suggests that individuals suffering from viral, bacterial, or parasitic infections, cancer, autoimmune disorders (e.g., rheumatoid arthritis, systemic lupus erythematosus), and gastrointestinal conditions (e.g., inflammatory bowel syndrome) frequently develop anemia due to increased production of proinflammatory cytokines and free radicals, which impair erythroid progenitor cells.[7] According to the World Health Organization (WHO), children are the most susceptible demographic for anemia, with a global prevalence of 42.6% among children aged 6 to 59 months as of 2011, while South-East Asia exhibited the second highest prevalence rate (42.0%) after Africa (60.2%).[4] A 2018 study involving over 163,000 children aged 6 to 59 months in low- and middle-income countries (LMICs) reported a higher prevalence of anemia (55.8%) compared to developed nations, with severe anemia found in 2.8% of cases.[8] Key factors contributing to the elevated prevalence of anemia in children in LMICs include low socioeconomic status, maternal anemia, and inadequate sanitation.[9, 10] Adolescent females are more prone to anemia due to excessive menstrual blood loss and pregnancy, with micronutrient-deficient diets and irregular eating habits serving as additional contributing factors.[11, 12] Furthermore, efforts to prevent anemia should also focus on pregnant and breastfeeding women, elderly individuals, and patients with chronic conditions such as cancer and renal disease. [13-15]

Iron deficiency anemia (IDA) in young adults is commonly attributed to iron-deficient diets, medications that hinder iron absorption, eating disorders, and menstrual blood loss[16, 11]. Maternal dietary patterns, including consuming iron-deficient and minimal animal-based food sources, are critical factors sustaining the high prevalence of IDA in pregnant women.[17-19] Among adolescents, anemia significantly impacts normal physical performance and cognitive development.[20, 21] Recent studies in Iran, Nepal, and Indonesia have reported that the prevalence of IDA among children and adolescents ranges between 13.9% and 31.0%.[22-24] This study aims to fill this knowledge gap by assessing the prevalence of anemia in children with recurrent infections and examining the sociodemographic, nutritional, and clinical factors associated with its occurrence. Conducted at Khulna Medical College and Shahid Sheikh Abu Naser Specialized Hospital, this study also evaluates key hematological and inflammatory biomarkers to comprehensively understand anemia in this high-risk group. By identifying actionable determinants, this research seeks to contribute to developing effective strategies to reduce anemia and its associated burden among children in Bangladesh.

METHODOLOGY

This cross-sectional study was conducted at Khulna Medical College and Shahid Sheikh Abu Naser Specialized Hospital, Khulna, Bangladesh, from June 2023 to July 2024. The study population included 200 children aged 1–12 years, presenting with recurrent infections and attending the outpatient department or admitted to the pediatric units of the mentioned hospitals. Data collection was performed using a structured questionnaire, which was developed based on a review of relevant literature and validated by a panel of experts. The questionnaire included sections on sociodemographic characteristics, clinical history, frequency and type of infections, dietary habits, and laboratory parameters related to anemia. Clinical data were collected through interviews with parents or guardians and a review of medical records. Blood samples were obtained from each child for laboratory analysis to determine hemoglobin levels and other relevant hematological parameters, including mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), and serum ferritin levels. Anemia was defined according to the World Health Organization (WHO) criteria, based on age-specific hemoglobin cut-off values. Prior to data collection, informed consent was obtained from the parents or legal guardians of all participating children. The purpose of the study, procedures, potential risks, and benefits were thoroughly explained to them, ensuring ethical standards were upheld throughout the research process. The collected data were entered into a database and analyzed using statistical software. Descriptive statistics, including frequencies and percentages, were used to summarize the data, while inferential statistics such as chi-square tests and logistic regression were employed to assess associations between anemia and recurrent infections.

RESULTS

Table 1: Sociodemographic Characteristics of Study Participants (n = 200)

Variables	Categories	Frequency (n)	Percentage (%)
Age (years)	1–3	54	27.0
	4–6	68	34.0
	7–9	42	21.0
	10–12	36	18.0
Gender	Male	112	56.0
	Female	88	44.0
Socioeconomic Status	Low	108	54.0
	Middle	72	36.0
	High	20	10.0
Parental Education	No Formal Education	40	20.0
	Primary	78	39.0
	Secondary	58	29.0
	Higher Secondary/More	24	12.0
Residence	Urban	64	32.0
	Rural	136	68.0

Table 1 shows that most participants were aged 4–6 years (34.0%), with a male predominance (56.0%). Over half of the children came from rural areas (68.0%), and the majority had parents with primary education (39.0%).

Table 2: Distribution of Clinical Features and Types of Recurrent Infections (n = 200)

Clinical Features	Present (n)	Percentage (%)	Absent (n)	Percentage (%)
Fever	180	90.0	20	10.0
Cough and Cold	164	82.0	36	18.0
Diarrhea	122	61.0	78	39.0
Skin Infections	72	36.0	128	64.0
Urinary Tract Infections	46	23.0	154	77.0
Otitis Media	40	20.0	160	80.0
Tonsillitis/Pharyngitis	64	32.0	136	68.0

Table 2 shows that fever (90.0%) and cough and cold (82.0%) were the most frequently reported clinical features, followed by diarrhea (61.0%) and tonsillitis/pharyngitis (32.0%).

Table 3: Hemoglobin Levels and Severity of Anemia (n = 200)

Anemia Status	Categories	Frequency (n)	Percentage (%)
Normal Hemoglobin	≥11 g/dL	68	34.0
Mild Anemia	10–10.9 g/dL	74	37.0
Moderate Anemia	7–9.9 g/dL	46	23.0
Severe Anemia	<7 g/dL	12	6.0

Table 3 shows that 66.0% of children were anemic, with mild anemia being the most prevalent (37.0%), while severe anemia was seen in 6.0% of cases.

Table 4: Detailed Blood Analysis and Biochemical Parameters (n = 200)

Parameters	Mean ± SD	Reference Range	Anemic Cases (n = 132)	Non-Anemic Cases (n = 68)	p-value
Hemoglobin (g/dL)	9.6 ± 1.8	11–15	8.4 ± 1.2	12.2 ± 0.8	<0.001
Serum Ferritin (ng/mL)	12.6 ± 8.9	>20	8.5 ± 4.3	28.2 ± 6.5	<0.001
MCV (fL)	72.4 ± 8.2	80–100	68.2 ± 5.4	84.5 ± 3.8	<0.001
Serum Iron (µg/dL)	46.8 ± 15.6	50–170	38.6 ± 10.2	78.4 ± 12.3	<0.001
CRP (mg/L)	6.4 ± 2.8	<5	8.1 ± 2.4	3.5 ± 1.2	<0.001

Table 4 highlights significantly lower hemoglobin, serum ferritin, mean corpuscular volume (MCV), and serum iron levels in anemic children ($p < 0.001$). CRP levels were elevated in anemic cases, suggesting inflammation.

Table 5: Association Between Anemia and Nutritional/Parental Factors (n = 200)

Factors	Categories	Anemia (n)	Percentage (%)	p-value
Dietary Iron Intake	Sufficient	50	25.0	<0.05
	Insufficient	82	41.0	
Parental Education	No Formal Education	38	19.0	<0.05
	Higher Secondary/More	18	9.0	
Breastfeeding History	Exclusive (6 mos.)	46	23.0	<0.05
	Non-exclusive	86	43.0	

Table 5 identifies significant associations between anemia and insufficient dietary iron intake (41.0%), low parental education levels (19.0%), and non-exclusive breastfeeding (43.0%).

Table 6: Correlation Between Recurrent Infections and Anemia (n = 200)

Types of Infections	Correlation Coefficient (r)	p-value
Fever Episodes	0.68	<0.05
Diarrheal Episodes	0.52	<0.05
Skin Infections	0.38	<0.05
Tonsillitis Episodes	0.45	<0.05

Table 6 shows a strong positive correlation between anemia and recurrent fever episodes ($r = 0.68$, $p < 0.05$), followed by diarrheal episodes ($r = 0.52$).

Table 7: Multivariate Logistic Regression Analysis of Predictors of Anemia

Variables	Odds Ratio (OR)	95% CI	p-value
Low Socioeconomic Status	2.8	1.6–4.3	<0.05
Non-exclusive Breastfeeding	2.2	1.3–3.7	<0.05
Insufficient Iron Intake	3.5	2.1–5.6	<0.05
Elevated CRP Levels	4.1	2.3–6.9	<0.05

Table 7 highlights elevated CRP levels (OR = 4.1), insufficient iron intake (OR = 3.5), and low socioeconomic status (OR = 2.8) as significant predictors of anemia.

DISCUSSION

This study investigated the prevalence of anemia and its association with recurrent infections in children, highlighting various sociodemographic, nutritional, and clinical factors. The results reveal significant insights into

the burden of anemia and its potential determinants in pediatric populations. The study found that 66.0% of the children were anemic, with mild anemia being the most common (37.0%), followed by moderate (23.0%) and severe anemia (6.0%). These findings align with a study conducted in rural India, where 68.9% of children under 12 years were reported anemic, with mild anemia constituting the majority.[10] The high prevalence in our cohort is likely due to factors such as low socioeconomic status, insufficient dietary iron intake, and frequent infections. Most anemic children (54.0%) came from low socioeconomic backgrounds, while parental education significantly influenced anemia prevalence, with 19.0% of anemic children having parents with no formal education. These findings are consistent with research in Bangladesh that identified low socioeconomic status and limited parental education as key risk factors for anemia.[25] Furthermore, rural residence was predominant in this study (68.0%), contributing to limited access to healthcare and nutritious foods. Insufficient dietary iron intake was reported in 41.0% of anemic cases, emphasizing the critical role of nutrition. Additionally, non-exclusive breastfeeding was significantly associated with anemia, affecting 43.0% of the anemic children. These findings are supported by previous studies demonstrating that children with suboptimal breastfeeding practices were significantly more likely to develop anemia.[26] Proper breastfeeding practices and iron-rich diets are essential preventive measures. Recurrent infections, including fever (90.0%), cough and cold (82.0%), and diarrhea (61.0%), were highly prevalent among the study participants. Anemia showed a strong correlation with recurrent fever episodes ($r = 0.68$, $p < 0.05$) and diarrheal episodes ($r = 0.52$, $p < 0.05$).

Inflammation induced by infections likely exacerbates iron deficiency and impairs erythropoiesis, as highlighted by elevated CRP levels (mean 8.1 ± 2.4 mg/L) among anemic children. A similar correlation between recurrent infections and anemia was reported in another study, with an increased risk for children experiencing frequent febrile illnesses [15]. Detailed blood analysis revealed significantly lower hemoglobin (mean 8.4 ± 1.2 g/dL), serum ferritin (mean 8.5 ± 4.3 ng/mL), and serum iron (mean 38.6 ± 10.2 µg/dL) in anemic children compared to their non-anemic counterparts. Elevated CRP levels (mean 8.1 ± 2.4 mg/L) in anemic cases further support the role of inflammation in anemia development. These findings align with studies reporting similar biochemical patterns in anemic children with recurrent infections.[27] Multivariate logistic regression identified low socioeconomic status (OR = 2.8, $p < 0.05$), insufficient iron intake (OR = 3.5, $p < 0.05$), and elevated CRP levels (OR = 4.1, $p < 0.05$) as significant predictors of anemia. These results are comparable to findings in a large-scale study conducted in sub-Saharan Africa, where low socioeconomic status and dietary deficiencies were key predictors of anemia among children[9]. The study's strengths include a comprehensive analysis of sociodemographic, nutritional, and clinical factors, supported by robust blood biomarkers. However, the study is limited by its cross-sectional design, which precludes causal inferences. Additionally, the sample was drawn from a single region, limiting generalizability to other populations. The high prevalence of anemia and its association with recurrent infections underscore the need for integrated interventions addressing both nutritional deficiencies and infection prevention. Awareness campaigns promoting breastfeeding, improved dietary practices, and timely healthcare access in rural and low-income populations are critical.[28]

CONCLUSION

This study highlights a significant burden of anemia among children with recurrent infections, driven by socioeconomic, nutritional, and clinical factors. Effective strategies to combat anemia must address its multifactorial etiology, emphasizing both preventive and therapeutic measures. Further longitudinal studies are recommended to explore causal relationships and evaluate the impact of targeted interventions.

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