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A CROSS-SECTIONAL STUDY ON THE PREVALENCE OF ANEMIA AND ASSOCIATED FACTORS AMONG UNDER-FIVE CHILDREN

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Abstract

Background

Anemia remains one of the most significant public health problems affecting children under five years of age, particularly in low- and middle-income countries. According to the World Health Organization (WHO), nearly 40% of preschool children worldwide are anemic, with iron deficiency accounting for approximately half of all cases. Childhood anemia contributes to impaired physical growth, delayed cognitive development, reduced immunity, increased susceptibility to infections, poor academic performance in later life, and increased childhood morbidity and mortality. In India, despite sustained governmental initiatives such as the National Iron Plus Initiative (NIPI), Anemia Mukt Bharat Programme, Integrated Child Development Services (ICDS), and Poshan Abhiyaan, anemia continues to pose a substantial public health challenge. The multifactorial etiology of anemia includes nutritional deficiencies, recurrent infections, poor maternal health, inadequate infant feeding practices, low socioeconomic status, food insecurity, and maternal educational status. Identification of locally relevant determinants is essential for designing effective interventions aimed at reducing childhood anemia.

Objectives

The present study aimed to determine the prevalence of anemia among under-five children and identify the socioeconomic, maternal, nutritional, and child-related factors associated with anemia.

Methods

A community-based cross-sectional study was conducted among 276 children aged 12–59 months selected through multistage cluster random sampling from rural communities. Information regarding socioeconomic characteristics, maternal factors, infant feeding practices, and child health variables was collected using a structured and pretested questionnaire administered to mothers or primary caregivers. Anthropometric measurements were performed according to WHO Child Growth Standards. Hemoglobin concentration was estimated using a portable digital hemoglobin analyzer from capillary blood obtained through finger-prick sampling. Children with hemoglobin concentrations below 11 g/dL were classified as anemic according to WHO criteria and further categorized as mild, moderate, or severe anemia. Data were analyzed using IBM SPSS Version 25. Chi-square tests assessed associations between categorical variables and anemia status. Variables demonstrating statistical significance were included in multivariable logistic regression analysis to identify independent predictors of anemia. Statistical significance was considered at $p < 0.05$.

Results

Among the 276 participating children, 53.3% were boys and 46.7% were girls, while 52.5% belonged to the age group of 2–5 years. The overall prevalence of anemia was 43.11%. Among anemic children, 61.34% had mild anemia, 35.5% had moderate anemia, and 3.4% had severe anemia. Multivariable logistic regression identified several significant predictors of childhood anemia. Children belonging to lower socioeconomic households demonstrated markedly increased odds of anemia (Adjusted Odds Ratio [AOR]=14.01; 95% CI: 5.216–37.683). Underweight children were approximately three times more likely to develop anemia than children with normal nutritional status (AOR=2.83; 95% CI:1.731–4.656). Maternal anemia during pregnancy was strongly associated with childhood anemia (AOR=8.32; 95% CI:4.690–14.770), while absence of maternal iron supplementation during pregnancy increased the likelihood of childhood anemia nearly ninefold (AOR=9.40; 95% CI:5.430–16.243). Lower maternal educational attainment also demonstrated significant associations with anemia among children.

Conclusion

The study demonstrates that anemia remains a major public health concern among under-five children. Socioeconomic deprivation, maternal anemia, inadequate antenatal iron supplementation, poor maternal education, and childhood undernutrition were identified as significant determinants. These findings emphasize the importance of strengthening maternal nutrition, promoting female education, ensuring universal antenatal iron supplementation, improving complementary feeding practices, and implementing community-based nutritional interventions. Integrated efforts involving healthcare providers, nursing professionals, policymakers, and community stakeholders are essential to reduce the burden of childhood anemia and improve child health outcomes.

Keywords: Anemia; Under-five children; Iron deficiency; Nutritional status; Maternal education; Rural health; Cross-sectional study; Public health.

Introduction

Anemia is one of the most widespread nutritional disorders affecting children worldwide and remains a significant public health challenge, particularly in low- and middle-income countries. The World Health Organization (WHO) defines anemia as a condition in which the hemoglobin concentration is below the normal threshold for age and sex, resulting in reduced oxygen-carrying capacity of the blood. Among children aged 6–59 months, a hemoglobin concentration of less than 11.0 g/dL is considered indicative of anemia. The condition ranges from mild to severe and adversely affects multiple physiological systems, making it a major contributor to childhood morbidity, impaired growth, developmental delay, and mortality. Despite considerable improvements in maternal and child health services globally, anemia continues to affect millions of preschool-aged children, highlighting persistent inequalities in nutrition, healthcare access, and socioeconomic development.

Globally, anemia affects nearly 40% of children under five years of age, corresponding to more than 269 million preschool children. Iron deficiency accounts for nearly half of all anemia cases, although deficiencies of folate, vitamin B12, vitamin A, chronic infections, parasitic infestations, malaria, hemoglobinopathies, and inflammatory conditions also contribute substantially. The burden is disproportionately higher in South Asia and Sub-Saharan Africa, where poverty, food insecurity, recurrent infections, and limited access to healthcare services remain prevalent. Childhood anemia has long-term consequences extending beyond physical health. Evidence suggests that iron deficiency during the first five years of life impairs brain development, cognitive function, language acquisition, psychomotor performance, and school readiness. Even after correction of iron deficiency, some neurodevelopmental deficits may persist into adolescence and adulthood, underscoring the importance of early prevention and timely intervention.

India continues to bear one of the highest burdens of childhood anemia globally. According to the National Family Health Survey (NFHS-5), the prevalence of anemia among children aged 6–59 months remains alarmingly high despite sustained public health interventions. National initiatives such as the National Iron Plus Initiative (NIPI), Anemia Mukt Bharat, Poshan Abhiyaan, Integrated Child Development Services (ICDS), and the Mid-Day Meal Programme have contributed to improvements in nutritional awareness and service delivery; however, reductions in anemia prevalence have been slower than anticipated. The persistence of anemia reflects its multifactorial etiology, which includes nutritional inadequacies, poor complementary feeding practices, recurrent diarrheal diseases, intestinal parasitic infections, low birth weight, prematurity, maternal anemia, inadequate antenatal care, poor maternal nutritional status, and socioeconomic deprivation. These interconnected determinants require comprehensive and multisectoral interventions rather than isolated nutritional supplementation.

Maternal health plays a pivotal role in determining the nutritional status of young children. Maternal anemia during pregnancy reduces fetal iron stores and predisposes infants to iron deficiency during early childhood. Similarly, inadequate maternal iron supplementation, poor dietary diversity, limited maternal education, and suboptimal infant feeding practices significantly increase the likelihood of childhood anemia. Children from economically disadvantaged households often experience food insecurity and limited access to iron-rich foods, healthcare services, and sanitation, further increasing their vulnerability. Undernutrition, particularly underweight and stunting, frequently coexists with anemia, creating a vicious cycle that compromises immunity, growth, and overall development.

Although national surveys provide valuable information regarding the prevalence of childhood anemia, they often fail to capture regional and community-level variations. Community-based studies are therefore necessary to identify vulnerable populations and prioritize interventions according to local needs. Understanding the prevalence of anemia together with its associated socioeconomic, maternal, and nutritional determinants can guide policymakers, public health professionals, and nursing practitioners in developing evidence-based strategies for prevention, early detection, and management.

Therefore, the present study was undertaken to determine the prevalence of anemia among under-five children and to identify the socioeconomic, maternal, nutritional, and child-related factors associated with anemia. The findings are expected to contribute to the existing body of evidence and support the development of integrated community-based interventions aimed at reducing the burden of childhood anemia and improving child health outcomes.

Methodology

A community-based cross-sectional analytical study was conducted among children aged 12–59 months residing in selected rural villages of Waghodia Taluka, Vadodara District, Gujarat, India, to determine the prevalence of anemia and its associated factors. The study was reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.

The study population comprised under-five children whose parents or legal guardians provided written informed consent. Children with hereditary hemolytic disorders, acute febrile illness, recent blood transfusion, or severe illness requiring immediate medical attention were excluded.

The sample size was calculated using the single population proportion formula with a prevalence of 86.4% (NFHS-5), 95% confidence level, and 5% margin of error. After accounting for a 10% non-response rate, 276 children were enrolled. A multistage cluster random sampling technique was employed, whereby villages were selected randomly, followed by random selection of eligible households with the assistance of Anganwadi workers.

Data were collected using a structured, pretested interviewer-administered questionnaire covering household socioeconomic characteristics, maternal information, child health profile, and infant feeding practices. Anthropometric measurements were obtained according to WHO Child Growth Standards, and nutritional status was assessed using WHO Anthro Software Version 3.2.2**.** Hemoglobin concentration was measured using a portable digital hemoglobin analyzer from capillary blood samples obtained by finger prick. Children with hemoglobin levels <11.0 g/dL were classified as anemic and categorized as mild, moderate, or severe according to WHO criteria.

Data were entered into Microsoft Excel and analyzed using IBM SPSS Statistics Version 25.0**.** Descriptive statistics summarized participant characteristics, while the Chi-square test examined associations between categorical variables. Significant variables were included in multivariable logistic regression to identify independent predictors of anemia. Results were expressed as adjusted odds ratios (AORs) with 95% confidence intervals, and statistical significance was set at $p < 0.05$**.** Ethical approval was obtained from the Institutional Ethics Committee, and written informed consent was secured from parents or guardians.

Confidentiality was maintained throughout the study, and children with moderate or severe anemia were referred to the nearest Primary Health Centre for appropriate management.

Results

Characteristics of the Study Participants:

A total of 276 under-five children participated in the study, yielding a response rate of 100%. The demographic, maternal, household, and child-related characteristics of the participants are summarized in Table 1.

Table 1: Characteristics of Study Participants

Sr.No	Characteristics		Frequency	Percentage
1	Socio economic status	Middle Class	33	12.0
		Lower Middle Class	136	49.3
		Lower Class	107	38.8
2	Food Security Access	Food Secure access	123	44.6
		Mildly Food insecure access	116	42.0
		Moderately Food insecure Access	37	13.4
3	Number of Under Five Years of children in Family	One	267	96.7
		Two	9	3.3
4	Maternal Education	No Formal Education	44	15.9
		Primary education	106	38.4
		Secondary Education	122	44.2
		Higher Secondary Education	4	1.4
5	Maternal iron deficiency Anemia during Pregnancy	Yes	93	33.7
		No	183	66.3
6	Maternal BMI	Under Weight	161	58.3
		Normal	105	38.0
		Over weight	10	3.6
7	Maternal iron supplementation during pregnancy	Yes	168	60.9
		No	108	39.1
8	Age of gestation at the time of delivery	Before 36 weeks	172	62.3
		36-40 weeks	75	27.2

		After 40 weeks	29	10.5
9	Child Age	1-2 Years	131	47.5
		2-5 Years	145	52.5
10	Gender of Child	Male	147	53.3
		Female	129	46.7
11	Age o starting weaning Diet	Before 6 months	101	36.6
		After 6 Months	132	47.8
		Delayed Weaning	43	15.6
12	Birth weight of children	<2.5. Kg	178	64.5
		Normal	98	35.5
13	Stunting	Yes	4	1.4
		No	272	98.6
14	Wasting	Yes	18	6.5
		No	258	93.5
15	Underweight	Yes	141	51.1
		No	135	48.9
16	History of worm infestation	Yes	66	23.9
		No	210	76.1
17	History of Malaria	Yes	33	12.0
		No	243	88.0
18	Adherence to IFA Supplementation	Adhere	241	87.3
		Less Adhere	35	12.7
19	Adherence to Deworming Tablet- Albendazole	Adhere	243	88.0
		Less Adhere	33	12.0

Prevalence of Anemia

The overall prevalence of anemia among under-five children was 43.11% (119/276).

According to the WHO classification of anemia severity, the majority of affected children had mild anemia (61.34%), followed by moderate anemia (35.5%), while only 3.4% of children suffered from severe anemia (Figure 1).

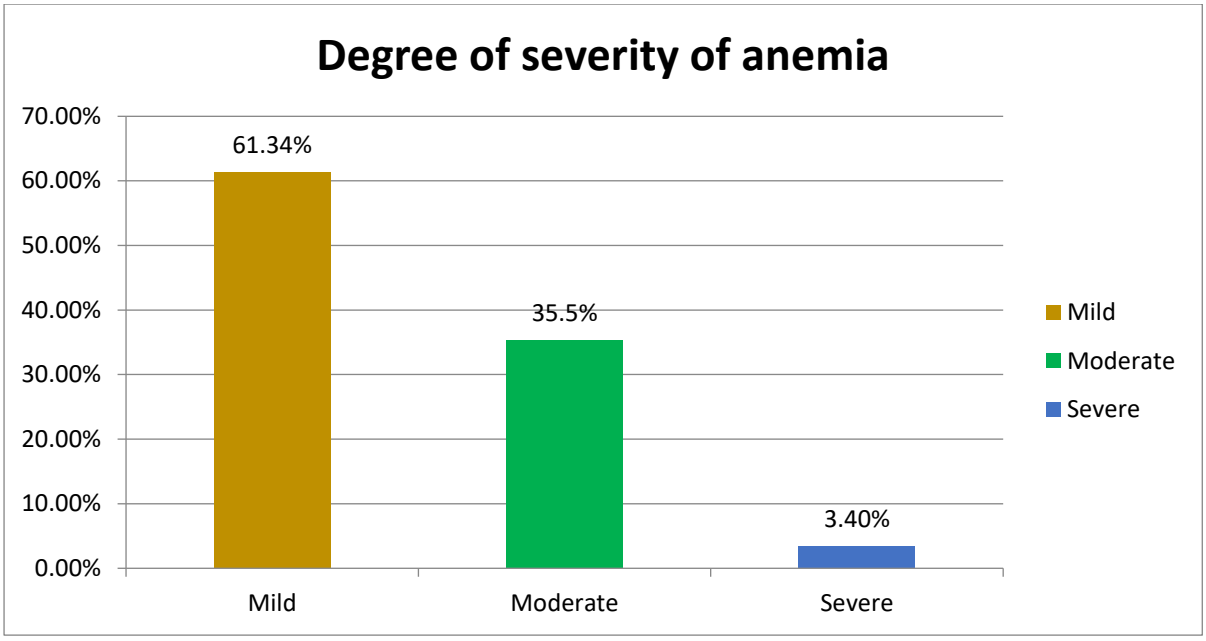

Fig 1. Distribution of anemia by severity among the under five years of children with anemia

These findings suggest that although severe anemia was relatively uncommon, nearly one out of every two preschool children was affected by anemia, representing a moderate-to-severe public health burden requiring immediate preventive and therapeutic interventions.

Association Between Participant Characteristics and Anemia

Bivariate analysis demonstrated statistically significant associations between childhood anemia and several socioeconomic, maternal, and nutritional variables.

Table:2: Factors associated with Anemia

Variable	Anemia		AOR (95% CI)
	Yes n (%)	No n (%)	
Socioeconomic Status			
Lower Class	81 (68.1%)	26 (16.6%)	14.01 (5.216- 37.683)
Lower Middle Class	32 (26.9%)	104 (66.2%)	1.4 (0.525- 3.650)
Middle Class	6 (5%)	27 (17.2%)	1
Maternal Education			
No Formal Education	30 (25.2%)	14 (8.9%)	2.14 (0.273-16.814)
Primary Education	71 (59.7%)	35 (22.3%)	2.02 (0.274-15.009)
Secondary Education	16 (13.4%)	106 (67.5%)	0.15 (0.20 – 1.148)
Higher Secondary Education	2 (1.7%)	2 (1.3%)	1
Maternal Iron Deficiency Anemia			

Yes	70 (58.8%)	23 (14.6%)	8.32 (4.690- 14.770)
No	49 (41.2%)	134 (85.4%)	1
Maternal Iron Supplementation during Pregnancy			
No	88 (73.9%)	20 (12.7%)	9.4 (5.43- 16.243)
Yes	31 (26.1%)	137 (87.3%)	1
Under Weight			
Yes	78 (65.5%)	63 (40.1%)	2.83 (1.731- 4.656)
No	41 (34.5%)	94 (59.9%)	1

AOR- Adjusted Odds ratio, CI- confidence Interval, 1= Reference

Children belonging to lower socioeconomic households exhibited a significantly higher prevalence of anemia (68.1%) compared with children from middle-class families (p=0.01). Similarly, maternal educational status demonstrated a significant association with childhood anemia (p=0.005). Children whose mothers had only primary education or no formal education experienced substantially higher rates of anemia than children of mothers with secondary or higher education.

Maternal health during pregnancy also influenced childhood anemia. Children born to mothers who experienced anemia during pregnancy had a significantly higher prevalence of anemia (58.8%) than those whose mothers were not anemic (p=0.04). Likewise, children whose mothers had not received antenatal iron supplementation showed a markedly greater prevalence of anemia (73.9%) compared with children whose mothers had received supplementation (p<0.001).

Among child-related variables, underweight status demonstrated a statistically significant association with anemia (p=0.01). In contrast, variables including child age, gender, food security status, birth weight, stunting, wasting, history of malaria, worm infestation, gestational age at birth, adherence to iron supplementation, and deworming practices did not demonstrate statistically significant associations.

Factors Associated with Childhood Anemia

Variables that were statistically significant during bivariate analysis were included in a multivariable logistic regression model to identify independent predictors of anemia.

Table 3. Multivariable Logistic Regression Analysis of Factors Associated with Childhood Anemia

Variable	AOR	95% CI	p-value
Lower socioeconomic status	14.01	5.216–37.683	<0.001
Lower middle class	1.40	0.525–3.650	0.04
Maternal anemia	8.32	4.690–14.770	<0.001

No maternal iron supplementation	9.40	5.430–16.243	<0.001
Underweight	2.83	1.731–4.656	0.002
Low maternal education	2.14	0.273–16.814	0.03

Children belonging to lower socioeconomic households were 14.01 times more likely to develop anemia than children from middle-class households (AOR = 14.01; 95% CI: 5.216–37.683). Likewise, children from lower-middle-class families demonstrated increased odds of anemia (AOR = 1.40; 95% CI: 0.525–3.650).

Maternal educational status remained an important predictor. Compared with mothers who had completed higher secondary education, children of mothers with no formal education (AOR = 2.14) and primary education (AOR = 2.02) showed greater likelihood of developing anemia.

Maternal anemia during pregnancy emerged as one of the strongest predictors of childhood anemia. Children whose mothers experienced anemia during pregnancy had more than eightfold higher odds of developing anemia (AOR = 8.32; 95% CI: 4.690–14.770).

Similarly, lack of maternal iron supplementation during pregnancy significantly increased the likelihood of childhood anemia by approximately ninefold (AOR = 9.40; 95% CI: 5.430–16.243), emphasizing the importance of adequate antenatal nutritional care.

Nutritional status of the child also independently predicted anemia. Underweight children were nearly three times more likely to be anemic than children with normal weight (AOR = 2.83; 95% CI: 1.731–4.656).

Overall, the multivariable model indicates that poor socioeconomic status, low maternal education, maternal anemia during pregnancy, inadequate maternal iron supplementation, and childhood undernutrition were the principal determinants of anemia among under-five children.

Discussion

The present community-based cross-sectional study investigated the prevalence of anemia and its associated determinants among under-five children residing in rural communities. The findings revealed that 43.11% of the participating children were anemic, indicating that anemia continues to be a significant public health concern in this vulnerable population. According to the World Health Organization (WHO), a prevalence of anemia between 40% and 59.9% among preschool children constitutes a severe public health problem, emphasizing the urgent need for strengthened preventive and therapeutic interventions. The study further identified socioeconomic status, maternal educational attainment, maternal anemia during pregnancy, lack of antenatal iron supplementation, and childhood undernutrition as the major independent predictors of anemia.

The prevalence of anemia observed in the present study (43.11%) is lower than the prevalence reported by the National Family Health Survey (NFFS-5) for children aged 6–59 months in many Indian states, where anemia exceeds 65%. Nevertheless, the prevalence remains considerably higher than the global average reported by WHO and continues to represent an

unacceptable burden of disease among preschool children. Similar prevalence estimates have been reported from community-based studies conducted in Ethiopia (42%), Nepal (49.5%), Ghana (47.5%), and Nigeria (49.2%), suggesting that childhood anemia remains a persistent nutritional challenge across developing countries. Conversely, studies conducted in regions with better maternal healthcare services and nutritional interventions have reported substantially lower prevalence rates, highlighting the influence of socioeconomic development and healthcare accessibility on childhood nutritional outcomes.

One of the strongest findings of the present study was the significant influence of household socioeconomic status on childhood anemia. Children belonging to economically disadvantaged families were 14 times more likely to develop anemia than those from middle-income households. Similar associations have been consistently reported in studies from Bangladesh, Ethiopia, Brazil, and India. Low household income directly affects food purchasing capacity, dietary diversity, healthcare utilization, sanitation, and living conditions, thereby increasing children's susceptibility to nutritional deficiencies and recurrent infections. Families experiencing financial hardship often prioritize caloric adequacy over dietary quality, resulting in inadequate intake of iron-rich foods such as meat, green leafy vegetables, pulses, and fortified cereals. Consequently, socioeconomic improvement remains a fundamental strategy for reducing childhood anemia.

Maternal education also emerged as a significant determinant of childhood anemia. Children whose mothers had limited or no formal education demonstrated substantially higher odds of anemia compared with children whose mothers attained secondary or higher education. Maternal education influences child health through multiple pathways, including improved health literacy, awareness of appropriate infant feeding practices, hygiene, immunization, healthcare-seeking behaviour, and nutritional knowledge. Educated mothers are more likely to initiate exclusive breastfeeding appropriately, introduce timely complementary feeding, recognize early symptoms of illness, and utilize preventive healthcare services. Similar findings have been documented in studies conducted in Ethiopia, Kenya, Nepal, China, and Bangladesh, reinforcing maternal education as an important social determinant of child nutrition.

The present study identified maternal anemia during pregnancy as one of the strongest predictors of childhood anemia. Children born to mothers who experienced anemia during pregnancy were more than eight times more likely to become anemic. Previous longitudinal and cohort studies have consistently demonstrated strong associations between maternal hemoglobin concentration and childhood iron status, emphasizing the importance of optimizing maternal nutrition before and during pregnancy.

Likewise, the absence of antenatal iron supplementation significantly increased the likelihood of childhood anemia by approximately ninefold, making it one of the most influential modifiable risk factors identified in the present investigation. The findings support existing recommendations under the Anemia Mukt Bharat strategy and WHO antenatal care guidelines, which advocate universal iron-folic acid supplementation for pregnant women. Strengthening compliance with antenatal iron supplementation through counselling, community health worker engagement, and regular follow-up could substantially reduce the burden of childhood anemia.

Interestingly, variables such as child sex, age group, birth weight, history of malaria, worm infestation, gestational age, and adherence to deworming were not independently associated

with anemia after multivariable adjustment. Similar observations have been reported in several community-based studies, suggesting that socioeconomic and maternal determinants may exert a stronger influence than certain biological variables in settings where nutritional deprivation predominates. Nevertheless, these factors remain clinically important because recurrent infections and parasitic infestations contribute indirectly to anemia by impairing nutrient absorption and increasing iron losses.

The findings of this study have important implications for community health nursing practice. Nurses working in maternal and child health programmes play a central role in anemia prevention through antenatal counselling, nutritional assessment, growth monitoring, promotion of exclusive breastfeeding, complementary feeding education, iron-folic acid supplementation, deworming, and community awareness programmes. Integrating routine anemia screening with existing child health services under the Integrated Child Development Services (ICDS), Rashtriya Bal Swasthya Karyakram (RBSK), and Anemia Mukt Bharat initiatives could facilitate early identification and timely management of high-risk children.

Conclusion

The present study demonstrated that anemia remains a significant public health problem among under-five children, with an overall prevalence of 43.11%, indicating a severe burden according to World Health Organization (WHO) public health criteria. The majority of affected children had mild anemia, although more than one-third suffered from moderate anemia, emphasizing the need for timely identification and management to prevent long-term health consequences. The study identified low socioeconomic status, poor maternal educational attainment, maternal anemia during pregnancy, lack of maternal iron supplementation during pregnancy, and underweight nutritional status as the major independent determinants of childhood anemia.

These findings reaffirm that childhood anemia is a multifactorial condition influenced by nutritional, socioeconomic, and maternal factors rather than a single biological cause. Improving maternal nutrition before and during pregnancy, promoting female education, ensuring universal antenatal iron-folic acid supplementation, strengthening infant and young child feeding practices, and addressing childhood undernutrition should be prioritized within existing public health programmes. Community-based screening, early diagnosis, nutritional counselling, and regular follow-up can substantially reduce the burden of anemia among preschool children. A collaborative approach involving healthcare professionals, nurses, policymakers, Anganwadi workers, Accredited Social Health Activists (ASHAs), and community stakeholders is essential to achieve sustainable improvements in child nutrition and overall health.

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