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PREVALENCE OF ANAEMIA IN SCHOOL-AGED CHILDREN PRESENTING TO THE PAEDIATRIC OUTPATIENT CLINIC AT A TERTIARY CARE FACILITY

Original Article

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Abstract

Background: Anemia in children remains a critical public health concern, particularly in low-resource settings across Asia and Africa. It contributes significantly to childhood morbidity, impaired growth, delayed cognitive development, and reduced physical capacity. Globally, anemia affects 43% of children under five, with iron deficiency anemia (IDA) accounting for nearly half of the burden. Resource-constrained regions, such as South Asia, continue to carry the highest prevalence, underscoring the need for localized screening and intervention strategies.

Objective: To ascertain how frequently anemia occurs among primary school-aged children who visit the paediatric outpatient department at a tertiary care hospital.

Methods: This cross-sectional study was conducted at the Pediatric Outpatient Department of Sharif Medical City Hospital, Lahore, from February 15, 2018, to August 14, 2018. A total of 150 primary school children aged 5 to 11 years presenting with minor acute illnesses were enrolled after obtaining informed parental consent. Demographic data were recorded using a structured proforma. Venous blood samples (5 mL) were collected under aseptic conditions and analyzed for hemoglobin levels using an automated hematology analyzer. Anemia was defined using WHO criteria. Body mass index (BMI) was calculated and socioeconomic status was categorized. Data were analyzed using SPSS, and chi-square test was applied for associations.

Results: Among the 150 participants, the average age was calculated as 8.10 ± 1.89 years. The recorded mean haemoglobin value stood at 12.47 ± 1.62 g/dL, whereas the mean BMI was found to be 15.52 ± 2.91 kg/m². Anaemia was identified in 21 children, accounting for 14% of the total sample. Statistically significant relationships emerged when anaemia was compared against age category ($p = 0.002$), socioeconomic class ($p = 0.001$), and BMI ($p = 0.001$). In contrast, gender did not show a meaningful association with anaemia ($p = 0.366$).

Conclusion: Anemia was detected in a notable proportion of school-aged children and was significantly linked to nutritional and socioeconomic factors. Early screening and targeted public health strategies are warranted.

Keywords: Anemia, Body Mass Index, Children, Hemoglobin, Outpatients, Socioeconomic Factors, Tertiary Healthcare

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Introduction

Anemia, a common clinical condition, is defined as a reduction in red blood cell (RBC) mass or hemoglobin concentration in the blood, leading to compromised oxygen delivery to tissues. In pediatric populations, anemia is particularly significant due to its impact on growth, neurodevelopment, and immune function. Clinically, it is typically identified by reduced hematocrit (HCT) or hemoglobin (HGB) levels, both of which must be interpreted in the context of age-, sex-, and race-specific reference ranges (1,2). Among children aged 6 to 12 years, for example, normal values are approximately 40% for HCT and 13.5 g/dL for HGB, though Black children may naturally present with HGB levels 0.5 g/dL lower than their white counterparts of similar age and sex (3). The pathophysiology of anemia in children is complex, shaped by dynamic physiological changes during development. Fetal erythropoiesis begins as early as four to five weeks gestation in the yolk sac and shifts sequentially to the liver, spleen, and finally to the bone marrow, which becomes the primary hematopoietic site by the fourth month of gestation (4,5). Postnatally, erythropoiesis declines rapidly due to rising oxygen tension and decreasing erythropoietin levels, leading to the physiologic anemia of infancy, which typically peaks between six to nine weeks of age (5-7). This decline may be more severe in preterm infants due to the shorter half-life of their RBCs (8). The etiology of anemia in pediatric patients is diverse, necessitating a systematic approach to diagnosis. Classification is often based on either the physiological mechanism—distinguishing between decreased production, increased destruction, or blood loss—or morphological characteristics, such as cell size and hemoglobin content (6,9). The reticulocyte count serves as a valuable marker for bone marrow response, with low counts indicating marrow suppression and high counts suggesting hemolysis or recovery from transient suppression (10). Morphologic indices like mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), and mean corpuscular hemoglobin concentration (MCHC) further help distinguish between microcytic, normocytic, and macrocytic anemias, aiding in the identification of underlying causes including iron deficiency, thalassemia, or vitamin deficiencies (11,12).

Iron deficiency anemia (IDA) remains the most prevalent cause of anemia globally, particularly in children from low- and middle-income countries, where nutritional deficits and parasitic infections such as hookworm are common. However, even in developed countries, IDA persists as a public health concern, largely attributed to poor dietary iron intake, rapid growth phases, and menstrual losses in adolescent females (12,13). Iron homeostasis is tightly regulated through the actions of hepcidin and other molecular mediators that influence iron absorption, storage, and utilization. Notably, chronic inflammation, gastrointestinal pathology (such as celiac disease or H. pylori infection), and certain surgical procedures can significantly impair iron absorption (14,15). Diagnosis of IDA requires careful interpretation of laboratory findings, including serum ferritin, transferrin saturation, and red blood cell indices. Serum ferritin is widely regarded as the most reliable marker of iron stores; levels below 15 ng/mL are almost diagnostic of iron deficiency, though higher cutoffs (30–41 ng/mL) are often used to improve sensitivity in the absence of

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inflammation (16,17). Confirmatory diagnosis may also involve therapeutic trials of iron supplementation or specialized testing, such as soluble transferrin receptor assays and the TfR-ferritin index, particularly in ambiguous cases or in the presence of chronic disease (17,18). Despite its well-established clinical features, iron deficiency anemia often presents subtly. Classic findings such as microcytosis and hypochromia are not universally seen, especially in early stages. Many children are asymptomatic or present with non-specific complaints like fatigue, pallor, or developmental delay. In some cases, manifestations such as pica, pagophagia, or restless legs syndrome may offer additional diagnostic clues (16-19). A thorough history—encompassing dietary intake, menstrual history, family background, and environmental exposures—is crucial to uncovering potential causes, particularly in cases of chronic blood loss or poor iron intake.

Given the broad differential diagnosis of anemia, which includes thalassemia, anemia of chronic inflammation, sideroblastic anemia, and bone marrow suppression, a comprehensive clinical and laboratory evaluation is essential for accurate diagnosis and appropriate management (11,12). Preventive strategies, particularly in at-risk populations such as adolescent girls and pregnant women, focus on routine screening and supplementation to mitigate the consequences of untreated iron deficiency (13). The objective of this review is to provide a comprehensive synthesis of the pathophysiology, classification, diagnostic approach, and clinical evaluation of anemia in pediatric populations, with a particular emphasis on iron deficiency anemia. By delineating key diagnostic strategies and highlighting gaps in clinical recognition, this study aims to enhance the timely identification and management of anemia in children.

Methods

The study was designed as a cross-sectional analysis conducted in the Pediatric Outpatient Department of Sharif Medical City Hospital, Lahore, over a six-month period from February 15, 2018, to August 14, 2018. The target population included primary school-aged children presenting with minor acute ailments. A total of 150 children aged 5 to 11 years were enrolled using convenience sampling. Children were eligible for inclusion if they were within the specified age range, clinically stable, and had no prior diagnosis of chronic illness, hematological disorders, or ongoing iron supplementation. Children with any known chronic disease, developmental disorder, recent hospitalization, or recent blood transfusion were excluded to avoid confounding factors that might influence hematological parameters. After obtaining informed written consent from parents or guardians, each child underwent a brief interview and clinical assessment. Demographic data, including age, sex, and socioeconomic status (categorized as low, middle, or high based on parent-reported occupation and income), were recorded using a structured proforma. Each participant's height and weight were measured to calculate body mass index (BMI), and all measurements were taken using calibrated equipment following standard protocols.

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A 5 mL venous blood sample was drawn aseptically from each child and placed in an ethylenediaminetetraacetic acid (EDTA) tube. Samples were sent immediately to the hospital's pathology laboratory for complete blood count (CBC) analysis using an automated hematology analyzer. Hemoglobin levels were assessed, and anemia was defined as hemoglobin concentration below 11.5 g/dL, consistent with age-specific cutoffs based on WHO criteria for school-aged children. Age- and sex-adjusted reference values were applied to ensure diagnostic accuracy. Laboratory quality control procedures, including daily calibration of equipment and blinded duplicate testing of random samples, were maintained throughout the study to ensure validity and reliability of results. Children identified as anemic were later contacted and managed according to institutional clinical protocols. Data were entered and analyzed using SPSS software (version not specified). Descriptive statistics such as mean, standard deviation, and frequency distributions were computed. Associations between anemia and categorical variables such as age group, gender, socioeconomic status, and BMI were evaluated using the chi-square test. A p-value less than 0.05 was considered statistically significant. Ethical approval was obtained from the Institutional Review Board (IRB) of Sharif Medical City Hospital prior to study initiation. The study followed ethical guidelines for human research as outlined in the Declaration of Helsinki. Participant confidentiality and data protection were ensured throughout the study.

Results

A total of 150 children aged between 5 and 11 years were included in the study. The mean age of the participants was 8.10 ± 1.89 years. The gender distribution was relatively balanced, with 78 males (52%) and 72 females (48%). Regarding socioeconomic status, 32 children (21.3%) belonged to the lower class, 55 (36.7%) to the middle class, and 63 (42%) to the high class. The mean hemoglobin concentration was found to be 12.47 ± 1.62 g/dL, ranging from a minimum of 7.8 g/dL to a maximum of 14 g/dL. The mean body mass index (BMI) among participants was 15.52 ± 2.91 kg/m², with a range of 10 to 20 kg/m². Anemia was identified in 21 children (14%), while the remaining 129 (86%) were non-anemic. Stratification by age revealed that anemia was significantly more prevalent among children under 8 years of age, with 18 out of 81 children (22.2%) in this group affected, compared to only 3 out of 69 children (4.3%) above 8 years of age ($p = 0.002$). Gender-based analysis showed that 9 of 78 males (11.5%) and 12 of 72 females (16.7%) were anemic; however, this difference was not statistically significant ($p = 0.366$). Socioeconomic status was strongly associated with anemia. Among children from the lower socioeconomic class, 14 out of 32 (43.8%) were anemic. In contrast, only 4 out of 55 (7.3%) from the middle class and 3 out of 63 (4.8%) from the high class were found to be anemic, showing a statistically significant association ($p = 0.001$). A significant relationship was also observed between anemia and nutritional status. Children with a BMI less than 15 kg/m² showed a markedly higher prevalence of anemia, with 18 out of 33 (54.5%) affected, compared to only 3 out of 117 (2.6%) among those with BMI above 15 kg/m² ($p = 0.001$). In addition to overall anemia

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prevalence, further analysis was performed to assess the severity of anemia based on hemoglobin concentration thresholds defined by WHO. Among the 21 children diagnosed with anemia, 3 (14.3%) had severe anemia (Hb <8 g/dL), 10 (47.6%) had moderate anemia (Hb 8–10.9 g/dL), and 8 (38.1%) had mild anemia (Hb 11–11.4 g/dL). These findings provide a clearer picture of the clinical burden and spectrum of anemia in the study population.

Table 1: Combined Descriptive Statistics and Demographic Distribution of Study Participants (n = 150)

Variable		Minimum	Maximum	Mean	Std. Deviation	Frequency	Percent
Age (years)		5	11	8.10	1.89	—	—
Hemoglobin Level (g/dL)		7.8	14	12.47	1.62	—	—
Body Mass Index (kg/m²)		10	20	15.52	2.91	—	—
Gender	Male	—	—	—	—	78	52%
	Female	—	—	—	—	72	48%
Socioeconomic	Lower	—	—	—	—	32	21.3%
	Middle	—	—	—	—	55	36.7%
	Higher	—	—	—	—	63	42.0%
Total Participants		—	—	—	—	150	100.0%

Table 2: Distribution of Presence of Anemia

Presence of Anemia	Frequency	Percent
Yes	21	14%
No	129	86 %
Total	150	100.0

Table 3: Stratification of Presence of Anemia with Respect to Age (n = 150)

Age	Presence of Anemia		Total	P-value
	Yes	No		

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<8 Years	18	63	81	0.002
>8 Years	3	66	69	
Total	21	129	150	

Table 4: Stratification of Presence of Anemia with Respect to Gender (n = 150)

Gender	Presence of Anemia		Total	P-value
	Yes	No		
Male	9	69	78	0.366
Female	12	60	72	
Total	21	129	150	

Table 5: Stratification of Presence of Anemia with Respect to Socioeconomic Status (n = 150)

Socioeconomic Status	Presence of Anemia		Total	P-value
	Yes	No		
Lower Class	14	18	32	0.001
Middle Class	4	51	55	
High Class	3	60	63	
Total	21	129	150	

Table 6: Stratification of Presence of Anemia with Respect to BMI (n = 150)

BMI	Presence of Anemia		Total	P-value
	Yes	No		
< 15 Kg/m2	18	15	33	0.001
> 15 Kg/m2	3	114	117	
Total	21	129	150	

Table 7: Anemia Severity Stratification

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Anemia Severity	Frequency
Mild (Hb 11.0–11.4 g/dL)	8
Moderate (Hb 8.0–10.9 g/dL)	10
Severe (Hb <8.0 g/dL)	3
Total	21

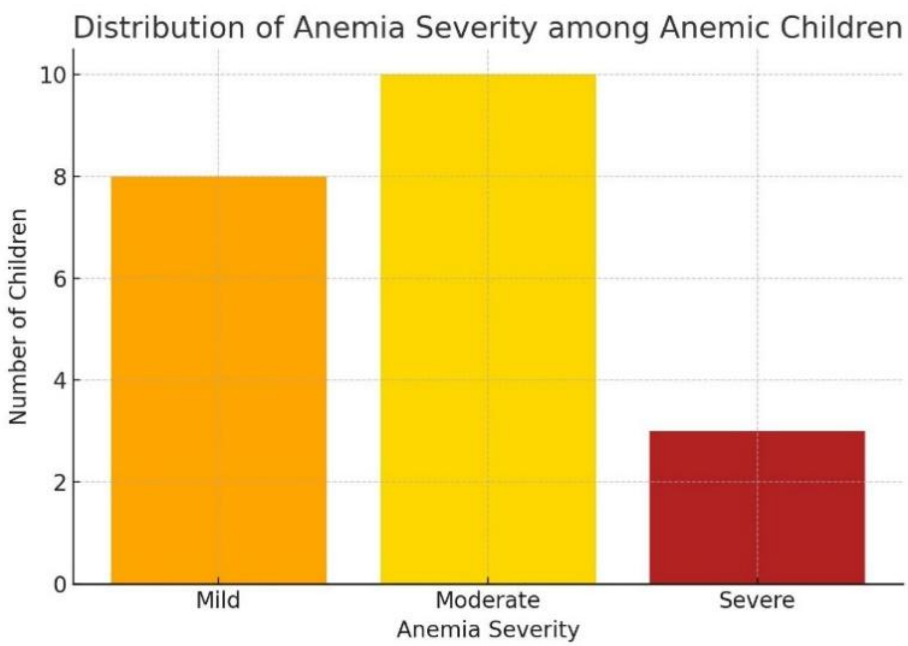

Figure 1 Distribution of Anemia Severity among Anemic Children

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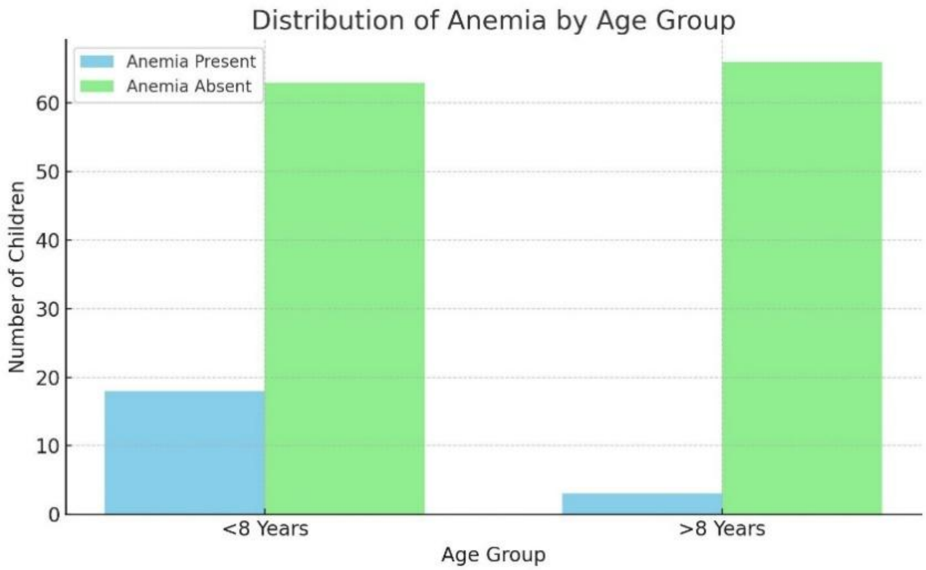

Figure 2 Distribution of Anemia by Age Group

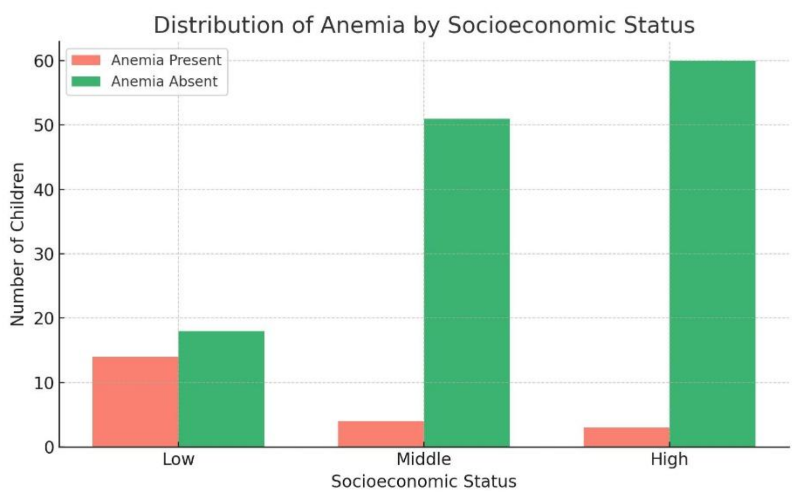

Figure 3 Distribution of Anemia by Socioeconomic Status

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Discussion

The findings of this study contribute to the growing body of evidence indicating that anemia remains a relevant public health issue among primary school-aged children, particularly in low- and middle-income countries. With a prevalence rate of 14% in this cohort, the overall burden appears lower compared to figures reported in similar regional and international studies. For example, a cross-sectional study found anemia prevalence to be as high as 35.7% among schoolchildren, with risk factors closely linked to nutritional deficiencies and socioeconomic deprivation (17). Another study conducted reported even higher rates, noting that anemia affected 43.3% of primary school-aged children, predominantly due to iron-deficient diets and parasitic infections (18). The current study's findings indicate a statistically significant association between anemia and age, body mass index (BMI), and socioeconomic status, whereas gender did not appear to play a significant role. These associations are consistent with previous studies. Lower socioeconomic status often correlates with limited access to nutrient-rich food and health services, thereby increasing susceptibility to nutritional deficiencies. Similar observations were made in a large-scale analysis, where children from the poorest households were 3.5 times more likely to be anemic than those from wealthier families (19). Undernutrition, represented by lower BMI in the present study, further strengthens the relationship between inadequate nutrient intake and compromised hematologic health. A particularly relevant strength of this study lies in its stratification of anemia severity, providing a nuanced understanding of disease burden. While the majority of cases were either moderate or mild, the presence of severe anemia in even a small proportion of children underscores the need for early detection and intervention. Stratifying severity, although often overlooked, is vital as the consequences of anemia—such as impaired cognitive and physical development—are often dose-dependent and more pronounced in severe forms (20).

However, there are limitations that should be acknowledged. The study lacked documentation of clinical symptoms such as fatigue, pallor, or cognitive delays, which are important for correlating laboratory findings with functional impairments. The absence of such data reduces the ability to fully capture the clinical burden of anemia. Additionally, the cross-sectional nature of the study precludes any conclusions about causality between risk factors and anemia. More critically, the absence of multivariate analysis restricts the capacity to control for potential confounders. As seen in related studies, age and nutritional status often overlap with socioeconomic conditions and may obscure the identification of independent risk factors (21). Another limitation includes the reliance solely on hemoglobin concentration to define anemia without assessing iron status through serum ferritin or transferrin saturation. Several studies emphasize the importance of such parameters for distinguishing iron deficiency anemia from other causes such as thalassemia trait or anemia of

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chronic disease (22). Incorporating these would have improved diagnostic accuracy and informed more targeted interventions.

Despite these limitations, the study offers valuable insights and serves as a foundational step for broader surveillance and intervention strategies in school health programs. Routine screening in school settings, particularly for children in low socioeconomic strata and those with undernutrition, could lead to earlier diagnosis and treatment. Additionally, health education campaigns addressing balanced nutrition and iron-rich diets may serve as effective preventive tools, especially when coupled with deworming strategies in areas with high parasitic load (23,24). Future research should aim to employ longitudinal designs to better elucidate temporal associations and causality. It would also be beneficial to include more robust laboratory diagnostics and incorporate neurodevelopmental assessments to measure the functional impact of anemia. Furthermore, policy-driven studies evaluating the effectiveness of school-based nutritional interventions could offer actionable pathways to reduce the burden of anemia in children. In conclusion, while the observed prevalence of anemia in this population was lower than in many comparable settings, its association with modifiable factors such as nutrition and socioeconomic status suggests ample opportunity for public health intervention. Addressing these determinants through integrated school health programs and targeted screening can contribute significantly to reducing childhood anemia and its long-term consequences.

Conclusion

This study concluded that anemia remains a clinically relevant concern among primary school-aged children seeking care in an outpatient setting of a tertiary hospital. The findings highlight the role of key influencing factors such as age, nutritional status, and socioeconomic background, which demonstrated significant associations with the presence of anemia. These results underscore the importance of early screening and targeted interventions, particularly in children from underserved communities. Strengthening nutritional support, promoting health education, and integrating routine anemia screening into school health programs can contribute meaningfully to reducing the burden of childhood anemia and its long-term developmental consequences.

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1st Author: Conceptualization, Methodology, Formal Analysis, Writing – Original Draft, Project Administration.

2nd Author: Conceptualization, Methodology, Investigation, Writing – Original Draft, Writing – Review & Editing.

3rd Author: Investigation, Data Curation, Formal Analysis.

'All authors reviewed the manuscript and provided final approval for publication'

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