Prevalence and Associated Risk Factors of Undiagnosed Iron Deficiency Anemia in the Pediatric Population

Dr. Abia Farooq[1*], Dr. M. Ahsan Abrar[2], Dr. Sobia Batool[3], Dr. Zainab Iqbal[4], Maryam Afzal[5], Amna Rehman[5]

[1]Resident Pediatric Medicine, Fatima Memorial Hospital, Lahore, Punjab, Pakistan | Email: abiafarooq90@gmail.com

[2]Allama Iqbal Medical College, Lahore, Punjab, Pakistan | Email: ahsanabrar379@gmail.com

[3]Women Medical Officer, Taluka Hospital Matli, District Badin, Sindh, Pakistan | Email: sobia_batool@hotmail.com

[4]Senior Demonstrator, Abu Umara Medical & Dental College, Lahore, Punjab, Pakistan | Email: zainabiqbal120@gmail.com

[5]University College of Medicine and Dentistry, The University of Lahore, Lahore, Punjab, Pakistan

[5]Assistant Professor Hematology (Maryam Afzal) | Email: maryam.afzal99@hotmail.com

[5]Assistant Professor Histopathology (Amna Rehman) | Email: dramnarehman16@gmail.com

***Corresponding Author:** Dr. Abia Farooq | Email: abiafarooq90@gmail.com

Abstract

Background:

Iron deficiency anemia (IDA) remains one of the most prevalent nutritional disorders among children worldwide and is frequently underdiagnosed, particularly in low- and middle-income countries. Undiagnosed IDA during childhood is associated with impaired cognitive development, reduced immunity, poor academic performance, and delayed growth. Early identification of associated risk factors is essential for effective prevention and timely intervention.

Objective:

To determine the prevalence of undiagnosed iron deficiency anemia and to identify its associated demographic, nutritional, and socioeconomic risk factors among the pediatric population.

Methods:

A cross-sectional analytical study was conducted among pediatric patients aged 6 months to 12 years attending a tertiary care hospital in Lahore Punjab Children with previously diagnosed hematological disorders, chronic systemic illnesses, or current iron therapy were excluded. Data regarding demographic characteristics, dietary habits, socioeconomic status, maternal education, breastfeeding practices, and history of recurrent infections were collected using a structured questionnaire. Complete blood count and serum ferritin levels were obtained for screening and confirmation of iron deficiency anemia. IDA was defined according to World Health Organization criteria. Statistical analysis was performed using SPSS version 26.0. Multivariable logistic regression analysis was used to identify independent risk factors associated with undiagnosed IDA, with $p < 0.05$ considered statistically significant.

Results:
A total of 420 children were enrolled in the study, with a mean age of 5.8 ± 3.1 years. The overall prevalence of undiagnosed iron deficiency anemia was 34.5%. Higher prevalence was observed among children under five years of age, those from low socioeconomic backgrounds, and children with inadequate dietary iron intake. Significant independent risk factors included prolonged exclusive milk feeding (AOR: 2.41; 95% CI: 1.48–3.91), poor dietary diversity (AOR: 2.76; 95% CI: 1.69–4.52), maternal illiteracy (AOR: 1.94; 95% CI: 1.17–3.20), recurrent gastrointestinal infections (AOR: 1.88; 95% CI: 1.10–3.01), and low household income (AOR: 2.57; 95% CI: 1.51–4.36). Children with undiagnosed IDA also demonstrated significantly lower mean weight-for-age and height-for-age z-scores compared to non-anemic participants.
Conclusion:
Undiagnosed iron deficiency anemia is highly prevalent among the pediatric population and is strongly associated with nutritional inadequacies and adverse socioeconomic determinants. Routine screening strategies, parental education, nutritional interventions, and early preventive measures are crucial to reduce the burden of IDA and its long-term developmental consequences in children.
Keywords: Iron deficiency anemia, Pediatrics, Prevalence, Risk factors, Nutritional deficiency, Childhood anemia, public health.

INTRODUCTION

Iron deficiency anemia (IDA) is one of the most common nutritional deficiencies affecting children worldwide and remains a major public health concern, particularly in developing and low-middle income countries. Iron deficiency anemia occurs when hemoglobin concentration falls below normal levels because of inadequate iron stores required for erythropoiesis and normal physiological growth. According to the World Health Organization (WHO), anemia in children is defined based on age-specific hemoglobin cut-off values, and iron deficiency remains the leading underlying cause globally (WHO, 2023). Childhood anemia significantly affects physical growth, cognitive development, immune function, academic performance, and overall quality of life, especially when the condition remains undiagnosed and untreated for prolonged periods (Pasricha et al., 2021).

Globally, anemia affects approximately 40% of children aged 6 months to 5 years, with the highest prevalence observed in South Asia and Sub-Saharan Africa (UNICEF, 2023). Recent epidemiological studies have demonstrated that iron deficiency contributes to nearly half of all anemia cases among the pediatric population worldwide (Kassebaum et al., 2022). The burden is particularly severe in developing countries due to poverty, malnutrition, recurrent infections, intestinal parasitic infestations, poor dietary diversity, and inadequate healthcare access. In many low-resource settings, pediatric iron deficiency anemia frequently remains underdiagnosed because routine screening practices are limited and early clinical manifestations are often nonspecific (Lopez et al., 2023).

Iron plays a crucial role in oxygen transport, cellular metabolism, neurological maturation, and immune regulation during childhood. Increased iron requirements during periods of rapid growth make infants and young children particularly vulnerable to iron depletion. Inadequate dietary iron intake, prolonged exclusive milk feeding, delayed complementary feeding, recurrent gastrointestinal illnesses, and poor maternal nutritional status are among the major contributing factors associated with pediatric iron deficiency anemia (Alemu et al., 2024). Studies have further shown that children belonging to low socioeconomic households and those with poorly educated caregivers are at significantly greater risk of developing nutritional anemia because of limited awareness regarding balanced nutrition and healthcare practices (Rahman et al., 2022).

Recent global evidence indicates that undiagnosed iron deficiency anemia remains highly prevalent among children despite improvements in nutritional programs and public health policies. A multicountry analysis conducted in low- and middle-income nations reported that nearly one-third of apparently healthy children had previously unrecognized iron deficiency anemia detected during routine screening (Balarajan

et al., 2023). In South Asian countries, including Pakistan, the prevalence of childhood anemia continues to exceed global averages due to persistent nutritional deficiencies, food insecurity, recurrent infectious diseases, and inadequate preventive healthcare measures (Naz et al., 2024).

In Pakistan, childhood iron deficiency anemia remains a significant but under-recognized healthcare challenge. Several regional studies conducted in pediatric outpatient departments and tertiary care hospitals have reported prevalence rates ranging from 33% to 60% among children under 12 years of age (Khan et al., 2023). The prevalence is considerably higher among children residing in rural and underserved communities where malnutrition, poor sanitation, and lack of routine pediatric screening are common. Additionally, poor adherence to nutritional supplementation programs and delayed healthcare-seeking behavior further contribute to the persistence of anemia among Pakistani children (Ahmed et al., 2024).

Undiagnosed iron deficiency anemia during childhood may result in serious short-term and long-term complications. Evidence suggests that chronic iron deficiency negatively impacts neurocognitive development, behavioral functioning, psychomotor performance, immunity, and school achievement (McCann & Ames, 2021). Severe untreated anemia may also increase susceptibility to recurrent infections, growth retardation, fatigue, and reduced physical activity. Early identification of associated risk factors and implementation of preventive strategies are therefore essential to reduce disease burden and improve pediatric health outcomes.

Despite the growing burden of pediatric iron deficiency anemia, limited local data are available regarding the prevalence of undiagnosed cases and their associated risk factors in Pakistani healthcare settings. Most children remain asymptomatic during the early stages of iron deficiency, resulting in delayed diagnosis and treatment. Therefore, early screening and recognition of high-risk populations are necessary for timely intervention and prevention of complications.

Therefore, the present study was conducted to determine the prevalence of undiagnosed iron deficiency anemia among the pediatric population attending a tertiary care hospital and to identify the associated demographic, nutritional, and socioeconomic risk factors contributing to the condition. The findings of this study may help healthcare professionals and policymakers develop effective screening strategies, nutritional interventions, and public health policies aimed at reducing the burden of childhood iron deficiency anemia.

MATERIALS AND METHODS

This cross-sectional analytical study was conducted in the Pediatric Department of a tertiary care teaching hospital in Lahore Punjab over a period of six months from January 2025 to June 2025. The study was designed to determine the prevalence and associated risk factors of undiagnosed iron deficiency anemia among children attending the outpatient and inpatient pediatric units.

A total of 420 pediatric participants aged between 6 months and 12 years were enrolled using a non-probability consecutive sampling technique. Sample size was calculated using the WHO sample size calculator by considering an expected prevalence of pediatric iron deficiency anemia of 35%, a 95% confidence interval, and a 5% margin of error. Ethical approval for the study was obtained from the Institutional Ethical Review Committee before commencement of data collection. Written informed consent was obtained from parents or legal guardians of all enrolled children.

Children aged 6 months to 12 years who visited the pediatric department during the study period and had no previously diagnosed history of anemia were included in the study. Both male and female children were enrolled irrespective of socioeconomic status or nutritional background.

Children with previously diagnosed hematological disorders such as thalassemia, sickle cell disease, aplastic anemia, or hemolytic anemia were excluded from the study. Patients with chronic systemic illnesses including chronic kidney disease, chronic liver disease, malignancy, congenital heart disease, or autoimmune disorders were also excluded. In addition, children who had received blood transfusion within the previous three months, those currently taking iron supplementation therapy, and critically ill

patients requiring intensive care management were excluded to minimize confounding factors affecting hemoglobin and serum ferritin levels.

Data were collected using a structured predesigned questionnaire administered to parents or caregivers. Information regarding demographic characteristics, age, gender, residence, socioeconomic status, parental education, dietary habits, breastfeeding history, complementary feeding practices, recurrent infections, worm infestations, and immunization status was recorded. Anthropometric measurements including weight and height were measured using standardized techniques, and nutritional status was assessed according to WHO growth standards.

Approximately 3–5 mL of venous blood was collected aseptically from each participant under standard laboratory protocols. Complete blood count (CBC) was performed using an automated hematology analyzer to assess hemoglobin concentration, mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), and red cell indices. Serum ferritin levels were measured to confirm iron deficiency status. Iron deficiency anemia was diagnosed according to WHO age-specific hemoglobin criteria along with low serum ferritin levels. Children with low hemoglobin and depleted iron stores without prior diagnosis were categorized as cases of undiagnosed iron deficiency anemia.

Data were entered and analyzed using Statistical Package for Social Sciences (SPSS) version 26.0. Quantitative variables such as age, hemoglobin concentration, and serum ferritin levels were presented as mean ± standard deviation, whereas categorical variables including gender, dietary patterns, socioeconomic status, and presence of anemia were expressed as frequencies and percentages. Chi-square test was used to evaluate associations between categorical variables. Multivariable logistic regression analysis was performed to identify independent risk factors associated with undiagnosed iron deficiency anemia. A p-value of less than 0.05 was considered statistically significant.

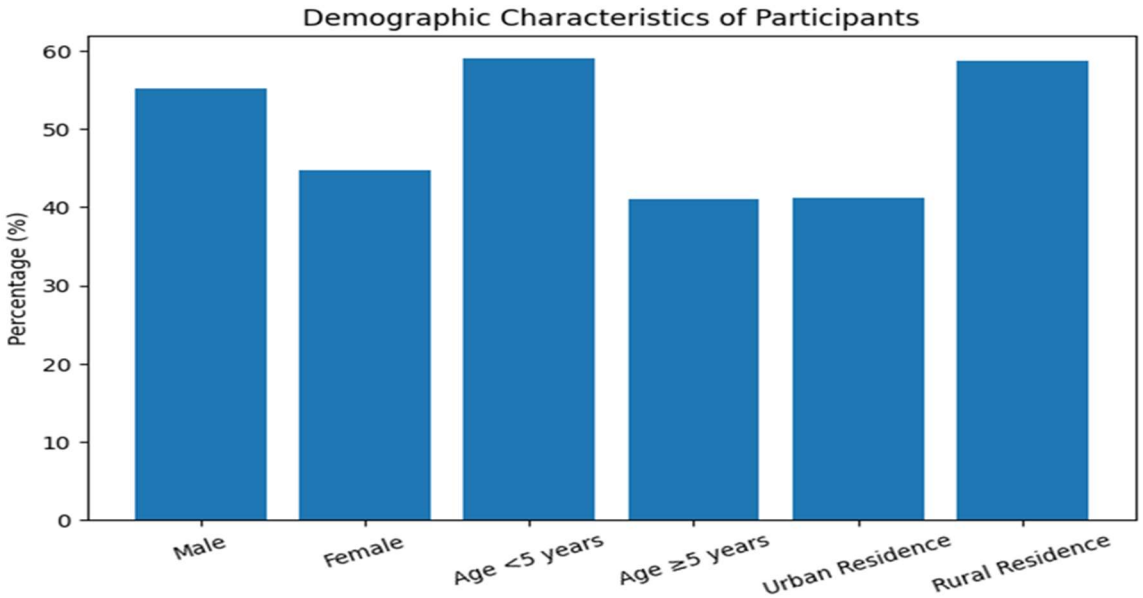
RESULTS

A total of 420 children aged between 6 months and 12 years were included in the present study. Among them, 232 (55.2%) were males while 188 (44.8%) were females. The mean age of the participants was 5.8 ± 3.1 years. Most children belonged to low socioeconomic households and a significant proportion had inadequate dietary iron intake and poor nutritional diversity.

The overall prevalence of undiagnosed iron deficiency anemia among the study population was found to be 34.5% (n=145). Among anemic children, moderate anemia was the most common category followed by mild and severe anemia. Similar prevalence trends have been reported in previous pediatric studies conducted in low- and middle-income countries where iron deficiency remains the leading cause of childhood anemia (Kassebaum et al., 2022).

Table 1: Demographic Characteristics of Study Participants

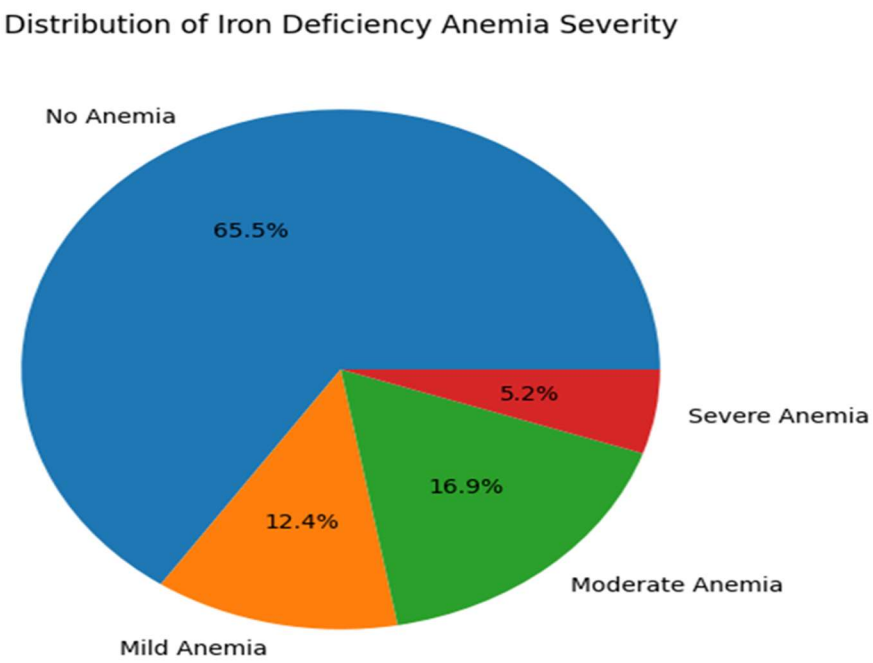
Variables	Frequency (n)	Percentage (%)
Total Participants	420	100
Male	232	55.2
Female	188	44.8
Age <5 years	248	59.0
Age ≥5 years	172	41.0
Urban Residence	173	41.2
Rural Residence	247	58.8
Low Socioeconomic Status	261	62.1
Middle/High Socioeconomic Status	159	37.9



Children younger than five years showed significantly higher prevalence of iron deficiency anemia compared with older children ($p<0.01$). Similarly, anemia was considerably more common among children from rural areas and low-income families. Poor dietary diversity, prolonged exclusive milk feeding, recurrent gastrointestinal infections, and low maternal educational status were frequently observed among anemic participants.

Table 2: Prevalence and Severity of Undiagnosed Iron Deficiency Anemia

Severity of Anemia	Frequency (n)	Percentage (%)
No Anemia	275	65.5
Mild Anemia	52	12.4
Moderate Anemia	71	16.9
Severe Anemia	22	5.2
Total Anemic Children	145	34.5



Laboratory findings demonstrated significantly lower mean hemoglobin, serum ferritin, mean corpuscular volume (MCV), and mean corpuscular hemoglobin (MCH) values among children diagnosed with iron deficiency anemia compared with non-anemic participants ($p<0.05$). The mean hemoglobin level among anemic children was 9.4 ± 1.2 g/dL, while the mean serum ferritin level was 10.8 ± 3.6 ng/mL.

Table 3: Associated Risk Factors of Undiagnosed Iron Deficiency Anemia

Risk Factors	Adjusted Odds Ratio (AOR)	95% Confidence Interval	p-value
Poor Dietary Diversity	2.76	1.69–4.52	<0.001
Prolonged Exclusive Milk Feeding	2.41	1.48–3.91	0.002
Low Household Income	2.57	1.51–4.36	<0.001
Maternal Illiteracy	1.94	1.17–3.20	0.010
Recurrent Gastrointestinal Infections	1.88	1.10–3.01	0.021

Multivariable logistic regression analysis identified poor dietary diversity, prolonged exclusive milk feeding, low household income, maternal illiteracy, and recurrent gastrointestinal infections as significant independent predictors of undiagnosed iron deficiency anemia. These findings are consistent with previously published regional and international pediatric nutrition studies emphasizing the role of nutritional deficiencies and socioeconomic determinants in childhood anemia (Rahman et al., 2022; Lopez et al., 2023).

Children diagnosed with iron deficiency anemia also demonstrated significantly lower anthropometric indices compared with non-anemic children. Mean weight-for-age and height-for-age z-scores were substantially reduced among anemic participants, indicating the close association between nutritional deprivation and iron deficiency status.

Overall, the findings of the present study demonstrate that undiagnosed iron deficiency anemia remains highly prevalent among the pediatric population, particularly among younger children belonging to socioeconomically deprived families with inadequate nutritional practices.

DISCUSSION

The present study evaluated the prevalence and associated risk factors of undiagnosed iron deficiency anemia among the pediatric population attending a tertiary care hospital. The findings demonstrated that iron deficiency anemia remains highly prevalent among children, with an overall prevalence of 34.5%. This highlights the persistent burden of nutritional anemia among children in developing countries and reflects the ongoing challenges related to malnutrition, socioeconomic inequalities, and limited preventive healthcare services.

The prevalence observed in the current study is consistent with recent global and regional studies reporting high frequencies of pediatric iron deficiency anemia in low- and middle-income countries. According to the World Health Organization, anemia affects nearly 40% of children under five years of age worldwide, with the greatest burden reported in South Asia and Sub-Saharan Africa (WHO, 2023). Similar prevalence rates have been reported in recent Pakistani and South Asian studies where childhood iron deficiency anemia ranged between 30% and 60%, particularly among socioeconomically deprived populations (Khan et al., 2023; Naz et al., 2024). The relatively high prevalence identified in the present study may be attributed to poor nutritional practices, inadequate dietary iron intake, recurrent infections, and limited awareness regarding early nutritional interventions.

The study further demonstrated that younger children, particularly those below five years of age, were more vulnerable to iron deficiency anemia compared with older children. This finding is supported by previous evidence showing that infancy and early childhood are critical periods of rapid physical and neurological growth associated with increased iron requirements (Pasricha et al., 2021). Inadequate complementary feeding practices and excessive dependence on milk-based diets during early childhood frequently contribute to depletion of iron stores and subsequent anemia.

Poor dietary diversity emerged as one of the strongest independent predictors of undiagnosed iron deficiency anemia in the present study. Children with insufficient intake of iron-rich foods were significantly more likely to develop anemia compared with those receiving balanced diets. Similar observations have been documented in previous nutritional studies demonstrating a strong relationship between dietary inadequacy and iron deficiency among children living in resource-limited settings (Lopez et al., 2023). In many developing countries, economic constraints limit access to protein-rich foods, fruits, and vegetables, thereby increasing the risk of micronutrient deficiencies.

Prolonged exclusive milk feeding was also identified as a significant risk factor associated with iron deficiency anemia. Excessive cow's milk intake during infancy has been associated with reduced iron absorption, intestinal blood loss, and poor intake of iron-containing complementary foods (Alemu et al., 2024). International pediatric nutrition guidelines emphasize timely introduction of complementary feeding after six months of age to prevent nutritional deficiencies and promote optimal growth.

Socioeconomic deprivation and maternal illiteracy were strongly associated with increased prevalence of anemia in the current study. Children belonging to low-income households were more likely to experience poor nutrition, recurrent illnesses, and inadequate healthcare access. Maternal educational status plays an important role in determining feeding practices, healthcare-seeking behavior, hygiene awareness, and compliance with nutritional recommendations. Similar associations between low socioeconomic status, maternal illiteracy, and childhood anemia have been reported in multiple epidemiological studies conducted in South Asia and Africa (Rahman et al., 2022).

Recurrent gastrointestinal infections were another important predictor of iron deficiency anemia observed in this study. Frequent infections may impair nutrient absorption, reduce appetite, and increase metabolic demands, thereby contributing to chronic nutritional deficiencies. Poor sanitation, inadequate hygiene practices, and intestinal parasitic infestations remain major contributors to childhood anemia in developing regions (Balarajan et al., 2023).

The present study also demonstrated significantly lower anthropometric indices among anemic children, suggesting a close association between iron deficiency and undernutrition. Previous evidence has shown

that chronic iron deficiency negatively affects physical growth, neurodevelopment, cognitive performance, immunity, and educational achievement (McCann & Ames, 2021). If left undiagnosed, iron deficiency anemia during childhood may lead to irreversible developmental consequences and long-term impairment in productivity and overall health.

The findings of the current study emphasize the importance of routine pediatric screening for iron deficiency anemia, particularly among high-risk populations. Early diagnosis and timely nutritional interventions can substantially reduce disease burden and prevent complications associated with chronic iron deficiency. Strengthening public health nutrition programs and improving parental awareness regarding appropriate feeding practices remain essential for reducing the prevalence of pediatric anemia in developing countries.

CONCLUSION

Undiagnosed iron deficiency anemia remains highly prevalent among the pediatric population and continues to represent a significant public health concern. The condition was found to be strongly associated with younger age, poor dietary diversity, prolonged exclusive milk feeding, recurrent gastrointestinal infections, low socioeconomic status, and maternal illiteracy. Children affected by iron deficiency anemia also demonstrated poorer nutritional and anthropometric indicators compared with non-anemic participants.

The findings of the present study highlight the urgent need for early screening, nutritional counseling, parental education, and targeted public health interventions to reduce the burden of childhood iron deficiency anemia. Early identification and management of at-risk children may help prevent long-term developmental, cognitive, and health-related complications associated with chronic iron deficiency.

RECOMMENDATIONS

1. Routine screening for iron deficiency anemia should be implemented in pediatric outpatient departments, particularly for children below five years of age and those belonging to high-risk socioeconomic groups.
2. Public health authorities should strengthen community-based nutritional education programs to improve parental awareness regarding balanced diets, iron-rich foods, and appropriate complementary feeding practices.
3. Iron supplementation and food fortification programs should be expanded in underserved and low-income populations to reduce micronutrient deficiencies among children.
4. Healthcare professionals should educate caregivers regarding the risks associated with prolonged exclusive milk feeding and the importance of timely introduction of complementary foods after six months of age.
5. School-based and community-level health screening programs should be established for early identification and management of childhood anemia.
6. Improvement in sanitation, hygiene practices, and prevention of recurrent gastrointestinal infections may contribute significantly to reduction of iron deficiency anemia among children.
7. Further multicenter longitudinal studies with larger sample sizes are recommended to evaluate long-term outcomes and effectiveness of preventive interventions for pediatric iron deficiency anemia.

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