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ORIGINAL ARTICLE

Prevalence and Risk Factors of Iron-Deficiency Anemia in Children Under 5 Years in Urban vs. Rural Settings

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ABSTRACT

Background: Iron-deficiency anemia (IDA) is a leading cause of childhood morbidity, especially in low- and middle-income countries. Children under five years are particularly vulnerable due to rapid growth and increased iron demands.

Objective: To assess the prevalence of iron-deficiency anemia among children under five years of age and to compare associated risk factors between urban and rural settings.

Methods: This cross-sectional comparative study was conducted at Mayo Hospital Lahore from January 2023 to July 2023. The target population included children aged 6 to 59 months who were residents of either urban or rural areas and presented to the selected healthcare centers for routine medical services. Children were eligible if they were apparently healthy or had minor illnesses that did not interfere with hemoglobin status. A total of 455 children were enrolled in the study, comprising 230 children from urban settings and 225 from rural settings, selected through non-probability consecutive sampling.

Results: The overall prevalence of IDA was 52.5%, with significantly higher rates in rural children (62.7%) compared to urban children (42.6%) ($p < 0.001$). IDA was more prevalent among children aged 6–24 months (66.4%), those with low maternal education (71.3%), low dietary diversity (68.2%), and recent gastrointestinal infections (63.9%). Iron supplementation (29.4% prevalence) and exclusive breastfeeding (44.3%) were protective factors. Multivariate logistic regression identified rural residence (AOR: 2.44), poor dietary diversity (AOR: 2.89), low maternal education (AOR: 2.21), and recent GI infection (AOR: 1.67) as significant risk factors. Iron supplementation (AOR: 0.39) and exclusive breastfeeding (AOR: 0.63) were independently protective.

Conclusion: Iron-deficiency anemia remains alarmingly prevalent, particularly among rural children under five. Socioeconomic disparities, poor dietary practices, and limited healthcare access contribute to this burden. .

Keywords: IDA, Children, Urban, Rural, Diet, Education, Supplements, Breastfeeding

INTRODUCTION

Iron-deficiency anemia (IDA) remains one of the most pervasive nutritional disorders globally, with children under the age of five among the most vulnerable groups. This condition arises when the body's iron stores are insufficient to meet physiological needs, resulting in reduced hemoglobin synthesis and impaired oxygen delivery to tissues[1]. In early childhood a period marked by rapid growth and neurodevelopment iron deficiency can have profound consequences, including impaired cognitive development, delayed psychomotor skills, weakened immunity, and reduced physical capacity. According to the World Health Organization (WHO), approximately 40% of children aged 6 to 59 months are anemic worldwide, with iron deficiency being the leading cause in over half of these cases[2].

The burden of IDA is not evenly distributed; it varies widely based on geography, socioeconomic status, dietary practices, healthcare access, and sanitation standards. In low- and middle-income countries, particularly in South Asia and Sub-Saharan Africa, the prevalence remains alarmingly high[3]. Within-country disparities are also significant, especially between urban and rural settings. While urban areas may benefit from better access to fortified foods, healthcare, and education, they also experience rapid urbanization, overcrowding, and the emergence of low-income slums factors that can paradoxically increase the risk of malnutrition and anemia[4]. Conversely, rural communities may face distinct challenges, such as limited access to iron-rich foods, inadequate maternal education, higher rates of parasitic infections, and poor health service delivery, which cumulatively contribute to elevated IDA rates[5]. A growing body of research highlights that structural inequities and localized cultural practices play a significant role in the epidemiology of IDA[6]. In rural settings, traditional weaning practices may delay the introduction of iron-rich complementary foods. Additionally, agricultural dependence does not always translate to dietary diversity, as food insecurity and economic instability often lead families to rely on low-cost, high-carbohydrate staples that lack essential micronutrients. Iron bioavailability is another critical issue, particularly where plant-based diets dominate. Non-heme iron, primarily found in plant sources, has lower absorption rates and is further inhibited by the concurrent intake of phytates and tannins, commonly present in rural diets[7]. On the other hand, urban diets though more diverse may suffer from a heavy reliance on processed foods with low nutritional value, leading to a form of 'hidden hunger' despite caloric adequacy[8].

Moreover, maternal education and healthcare utilization serve as powerful mediators in the nutritional status of young children. Urban mothers are more likely to access antenatal care services, receive nutritional counseling, and utilize pediatric health services, including routine growth monitoring and supplementation programs. In contrast, rural mothers may face barriers such as long distances to health facilities, cultural taboos regarding iron supplementation, or lack of awareness regarding anemia symptoms in children[9]. These disparities are further compounded by variations in the effectiveness of public health initiatives across regions. For example, the implementation of national iron-folic acid supplementation or deworming campaigns often suffers from inconsistent outreach and follow-up in rural populations[10]. Environmental risk factors also significantly influence the prevalence of IDA in both urban and rural children. In rural communities, open defecation, unsafe water, and poor sanitation contribute to repeated gastrointestinal infections and parasitic infestations, which impair nutrient absorption and increase iron loss through intestinal bleeding. In urban slums, similar sanitary conditions exist, often exacerbated by industrial pollutants, lead exposure, and overcrowding all of which are emerging concerns in urban child health[11].

Objective: To assess the prevalence of iron-deficiency anemia among children under five years of age and to compare associated risk factors between urban and rural settings.

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METHODOLOGY

This cross-sectional comparative study was conducted at Mayo Hospital Lahore from January 2023 to July 2023. The target population included children aged 6 to 59 months who were residents of either urban or rural areas and presented to the selected healthcare centers for routine medical services. Children were eligible if they were apparently healthy or had minor illnesses that did not interfere with hemoglobin status. A total of 455 children were enrolled in the study, comprising 230 children from urban settings and 225 from rural settings, selected through non-probability consecutive sampling. The sample size was calculated based on previously reported prevalence rates of anemia among under-five children in similar settings, with a 95% confidence level and 5% margin of error.

Data Collection: Data collection was performed using a structured, pre-tested questionnaire to the child's primary caregiver. The questionnaire gathered information on socio-demographic characteristics, feeding practices, maternal education, family income, sanitation facilities, recent infections, and iron supplementation history. Physical measurements including weight and height were obtained using standardized procedures and calibrated equipment. Hemoglobin levels were measured using capillary blood samples drawn via finger prick, analyzed on-site. Children with hemoglobin levels below 11 g/dL were classified as anemic, in accordance with WHO standards, and those with suggestive clinical or dietary risk factors were diagnosed with iron-deficiency anemia. Iron-deficiency anemia (IDA) was defined as a hemoglobin concentration of less than 11 g/dL in association with dietary inadequacy or clinical features indicating iron deficiency. Urban and rural status was determined based on national census classifications and administrative boundaries.

Statistical Analysis: Data were analyzed using SPSS version 17. Descriptive statistics were used to present the mean and standard deviation for continuous variables, and frequencies with percentages for categorical variables. The chi-square test was applied to examine associations between categorical variables, while the independent samples t-test was used to compare mean hemoglobin levels across urban and rural groups. Adjusted odds ratios (AOR) with 95% confidence intervals were calculated, and a p-value less than 0.05 was considered statistically significant.

RESULTS

The study included a total of 455 children aged between 6 and 59 months, with 230 (50.5%) from urban areas and 225 (49.5%) from rural settings. Younger children were more affected, particularly those aged 6–24 months, who had the highest prevalence at 66.4%, followed by 54.2% in the 25–36-month group, and 37.1% in the 37–59 month group. Maternal education showed a strong protective effect; children whose mothers had no formal education had an IDA prevalence of 71.3%, compared to 49.4% for primary education and only 34.8% for secondary education or higher, indicating that both geographic and educational disparities significantly influence anemia risk in early childhood.

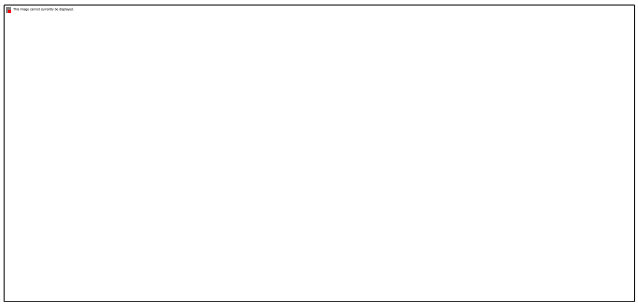
Table 1: Prevalence of Iron-Deficiency Anemia by Area

Setting	No. of Children	No. with IDA	Prevalence (%)
Urban	230	98	42.6%
Rural	225	141	62.7%
Total	455	239	52.5%
Age Group (months)			
6–24	140	93	66.4%
25–36	150	81	54.2%
37–59	165	61	37.1%
Maternal Education			
No Formal Education	145	103	71.3%
Primary	160	79	49.4%
Secondary or Higher	150	52	34.8%

Children who were not exclusively breastfed had a higher prevalence of iron-deficiency anemia (58.9%) compared to those who were exclusively breastfed (44.3%), highlighting the protective role of breastfeeding in early infancy. Similarly, dietary diversity emerged as a significant determinant of anemia status; children with low dietary diversity had a markedly higher prevalence of IDA (68.2%) than those with adequate dietary diversity (38.5%).

Table 2: Association of IDA with Feeding and Dietary Diversity

Variable	Total Children	No. with IDA	Prevalence (%)
Not Exclusively Breastfed	215	127	58.9%
Exclusively Breastfed	240	106	44.3%
Low Dietary Diversity	220	150	68.2%
Adequate Dietary Diversity	235	89	38.5%



Children from households with poor sanitation had a higher anemia prevalence (61.6%) compared to those with adequate sanitation (46.3%). Similarly, recent gastrointestinal infections significantly increased the risk of IDA, with a prevalence of 63.9% versus 49.0% in those without recent infections. Iron supplementation proved to be a strong protective factor, as only 29.4% of supplemented children were anemic compared to 57.8% of those who did not receive supplementation.

Table 3: Environmental and Health-Related Risk Factors

Risk Factor	Total Children	No. with IDA	Prevalence (%)
Poor Sanitation	185	114	61.6%
Adequate Sanitation	270	125	46.3%
Recent GI Infection	108	69	63.9%
No Recent GI Infection	347	170	49.0%
Iron Supplementation	85	25	29.4%
No Supplementation	370	214	57.8%

Table 4: Multivariate Logistic Regression for Risk Factors of IDA

Variable	Adjusted Odds Ratio (AOR)	95% CI	p-value
Rural Residence	2.44	1.62–3.67	<0.001
Low Maternal Education	2.21	1.45–3.36	<0.001
Poor Dietary Diversity	2.89	1.93–4.33	<0.001
Recent GI Infection	1.67	1.10–2.54	0.015
Iron Supplementation	0.39	0.25–0.61	<0.001
Exclusive Breastfeeding	0.63	0.42–0.94	0.027

Multivariate logistic regression analysis revealed that rural residence significantly increased the odds of iron-deficiency anemia (AOR: 2.44; 95% CI: 1.62–3.67; p < 0.001), as did low maternal education (AOR: 2.21), poor dietary diversity (AOR: 2.89), and recent gastrointestinal infection (AOR: 1.67), all with statistically significant confidence intervals and p-values. Conversely, iron supplementation (AOR: 0.39; 95% CI: 0.25–0.61; p < 0.001) and exclusive breastfeeding (AOR: 0.63; 95% CI: 0.42–0.94; p = 0.027) were independently protective against anemia.

DISCUSSION

This study aimed to compare the prevalence and risk factors of iron-deficiency anemia (IDA) among children under five years in urban and rural settings. The findings reveal a disturbingly high overall prevalence of IDA (52.5%), with a significantly higher burden in rural children (62.7%) compared to their urban counterparts (42.6%). These results align with national trends in low- and middle-income countries, where rural populations consistently exhibit poorer nutritional and health outcomes due to systemic inequities in access to resources, healthcare, and education[12]. The elevated risk among rural children may be attributed to multiple interrelated factors. First, the socioeconomic divide plays a prominent role, as rural families often experience food insecurity, lack dietary diversity, and have limited access to iron-rich or fortified foods. In this study, low maternal education emerged as a significant predictor of childhood anemia, consistent with earlier reports from Bangladesh and Nepal that linked maternal illiteracy to suboptimal child feeding and healthcare practices[13,14]. Children of mothers with no formal education had more than twice the odds of developing IDA compared to those whose mothers had secondary education or higher, highlighting the role of health literacy in anemia prevention[15].

Age-related trends also support the established biological vulnerability of younger children, particularly those between 6 and 24 months of age, who are undergoing rapid growth and transitioning from breast milk to complementary foods. This age group showed the highest IDA prevalence (66.4%), suggesting inadequate iron intake during a critical developmental window. Similar age-group vulnerability was noted in studies conducted in India and Sub-Saharan Africa, which emphasized the importance of early dietary interventions[16]. Exclusive breastfeeding for six months and appropriate complementary feeding were found to be protective in this study. Children who were not exclusively breastfed or had low dietary diversity scores had significantly higher anemia prevalence. This supports WHO and UNICEF recommendations regarding the importance of exclusive breastfeeding and diverse complementary feeding to prevent micronutrient deficiencies[17]. Furthermore, iron supplementation demonstrated a strong protective effect, reinforcing the effectiveness of targeted nutritional interventions. However, the uptake of iron supplementation remained low (only 18.7%), indicating possible gaps in coverage or caregiver awareness that require urgent policy attention. Environmental and health-related determinants such as poor sanitation and recent gastrointestinal infections were also significantly associated with anemia. Repeated infections may impair nutrient absorption and exacerbate iron loss, particularly in children with parasitic infestations or recurrent diarrhea[18]. The results from multivariate logistic regression further confirmed that rural residence, poor dietary diversity, low maternal education, and gastrointestinal infections were independent risk factors for IDA, while exclusive breastfeeding and iron supplementation remained significant protective factors. This multivariable approach strengthens the study's internal validity and confirms the multifactorial nature of pediatric anemia[19]. Our findings emphasize the urgent need for geographically tailored interventions. While urban areas may benefit from fortified foods and greater access to care, rural communities require expanded nutrition education, access to low-cost iron supplements, and improved WASH infrastructure. Limitations of this study include its cross-sectional design, which restricts causal inference, and reliance on Hemocue testing without confirmatory serum ferritin, which may overestimate IDA in the presence of infections. Moreover, dietary diversity was measured based on 24-hour recall, which may not reflect long-term nutritional status.

CONCLUSION

It is concluded that iron-deficiency anemia remains a highly prevalent and pressing public health issue among children under five years of age, with significantly higher rates observed in rural areas compared to urban populations. The study identified multiple modifiable risk factors strongly associated with IDA, including rural residence, low maternal education, inadequate dietary diversity, and recent gastrointestinal infections. Conversely, protective factors such as exclusive breastfeeding and iron supplementation were associated with lower prevalence rates.

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