

Original Article

Frequency of Iron Deficiency Anemia among Infants Less Than One Year Old

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Author's Contribution

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ABSTRACT

Objectives: To determine the prevalence of iron deficiency anemia (IDA) at a tertiary care Hospital.

Methodology: This cross-sectional study was conducted on 185 infants aged 6–12 months attending pediatric outpatient clinics at Islamabad Medical Complex Nescom. After obtaining the sociodemographic characteristics, feeding practices, maternal health, and birth history, the hemoglobin levels were measured, and iron deficiency anemia was defined as hemoglobin <11 g/dL with supportive clinical and laboratory findings. Statistical analysis was performed using SPSS version 26.

Results: The mean age of infants was 7.09 ± 2.34 months. The overall prevalence of IDA among infants was approximately 29.1%, with overall mean hemoglobin level among anemic infants was 10.11 ± 2.17 g/dL. Additionally, the IDA was significantly associated with Cow's milk-fed infants and low socioeconomic groups ($p=0.001$), while there was no significant association of IDA with age, gender and residential status of the ($p > 0.05$).

Conclusion: IDA was concluded highly prevalent among infants, which was further significantly linked to modifiable nutritional and maternal factors. The good feeding practices and maternal nutrition are very important to reduce the morbidity among infants.

Key words: Infants, IDA, Hb, Serum Iron

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Introduction

The IDA is recognized as the most prevalent nutritional disorder affecting children globally and a leading cause of preventable morbidity during early life. Its prevalence peaking during late infancy and toddlerhood when rapid somatic and neurodevelopmental growth markedly increases iron requirements beyond what dietary intake commonly used.¹ Besides its hematologic manifestations, it has broad systemic consequences, encompassing impaired cognitive development, behavioral changes, decreased physical capacity, and compromised immune function, and if left untreated during early life, may cause prolonged neurodevelopmental deficits that persist despite subsequent correction of hematological parameters.¹ In line with the recent Global Burden of Disease Study, the dietary iron deficiency was recognized as the single leading cause of anemia throughout the world, constituting 66.2% of total anemia cases, with

children under five years designated among the most vulnerable demographic groups.²

Additionally the infants represent a population of exceptional vulnerability to IDA. Greatest burden of IDA is observed among children aged 6 to 23 months, driven by a growth increase that surpasses the iron supply available from breastmilk alone, underscoring the pivotal role of iron-rich complementary feeding.³ Worldwide prevalence of anemia in children aged 6 months to 5 years was estimated at 40% during 2019.⁴ However among preterm infants specifically, the prevalence of IDA ranges from 25% to 80%,⁵ as preterm neonates are approximately 26.4 times more likely to develop iron depletion in the first week of life compared to term infants with normal birth weight, due to diminished iron stores at birth, early onset of erythropoiesis, rapid catch-up growth, iatrogenic blood loss, and limited dietary iron sources.⁵ According to a multicenter study IDA is a

prevalent disorder affecting infants worldwide and is independently linked to potential long-term cognitive and developmental deficits.⁶ Global prevalent cases of iron deficiency rose from 984.61 million in 1990 to 1,270.64 million in 2021 and are projected to reach nearly 1.44 billion by 2050, with the greatest vulnerability concentrated during periods of rapid growth like as early infancy.⁷ IDA during the critical 6- to 24-month postnatal window of rapid brain development specifically disrupts myelination, dopaminergic functioning, and brain connectivity, and has been independently associated with attention deficits and behaviors consistent with attention deficit hyperactivity disorder in later childhood.⁸

Numerous modifiable and non-modifiable risk factors contribute to the development of IDA in infants. The significant independent predictors include advancing infant age, maternal anemia during the 3rd trimester, spacing of the birth less than three years, exclusive breastfeeding beyond six months without iron supplementation, and both early and late introduction of complementary feeding.⁹ An updated narrative review further noted that IDA is most common among children aged nine months to three years, predominantly arising from increased iron demand, inadequate dietary intake, and decreased absorption during the transition to complementary foods.¹⁰

In Pakistan, the magnitude of IDA in infants intersects deeply with socioeconomic deprivation and suboptimal feeding practices. The Pakistan National Nutrition Survey 2018 revealed that anemia affected 53.7% of children aged 6 to 59 months and that 49.1% of children were iron deficient, with IDA disproportionately affecting those from low-income households.¹¹ A secondary analysis of the same survey, published in *Nutrients* in 2023, confirmed IDA as the predominant cause of anemia in children under five, estimating that IDA causes half of all anemia cases and one million deaths per year worldwide, with inadequate complementary feeding practices and poor maternal iron status as the most consistent local risk factors.¹² according to national study the cow's milk-fed infants face significantly higher rates of IDA compared to breastfed infants, and that Pakistani children with IDA frequently experience stunted growth, cognitive delays, and reduced physical activity.¹³ In spite of this substantial burden, systematically derived institutional data on the frequency of IDA specifically in infants remain scarce at local level, leaving a critical evidence gap that limits effective policy and clinical response. This study was conducted to determine the frequency of iron deficiency

anemia in infants attending a tertiary care Hospital, aimed to generate local relevant data to guide early screening protocols, counseling regarding nutritional status, and evidence-based preventive interventions.

Methodology

This cross-sectional study was conducted in the Department of Pediatrics at Islamabad Medical Complex, NESCOM. The study was carried out after obtaining approval from the Hospital Ethical Review Board (Ref. No. NESCOM-44(33)/2023-IMC) and approval of the study synopsis from the College of Physicians and Surgeons Pakistan (CPSP). The study duration was six months, from November 2023 to April 2024.

All infants aged more than 1 month and less than 12 months of either gender who presented to the pediatric outpatient department (OPD) for routine check-ups were included in the study. Infants with a history of iron supplementation, known hemoglobinopathies such as thalassemia (confirmed by hemoglobin electrophoresis), or whose parents declined to participate were excluded. A non-probability consecutive sampling technique was employed.

The sample size of 185 infants was calculated using the WHO sample size calculator, assuming a 95% confidence level, 7% absolute precision, and a previously reported prevalence of iron deficiency anemia of 37.7%. Written informed consent was obtained from the parents or legal guardians after explaining the purpose and procedures of the study.

Demographic and clinical data, including age, gender, gestational age at birth, type of feeding (breastfeeding, formula feeding, or cow's milk feeding), maternal educational level, socioeconomic status, place of residence, and vaccination status, were recorded. A detailed medical history was obtained, and a thorough physical examination was performed.

Under aseptic conditions, 2 mL of venous blood was collected from each infant by the on-duty staff nurse and sent to the hospital hematology laboratory for complete blood count, serum iron, and serum ferritin estimation according to the laboratory's standard protocol. The laboratory reports were reviewed by the principal investigator to determine the presence of iron deficiency anemia.

Iron deficiency anemia was defined as a hemoglobin level of <11 g/dL, mean corpuscular volume (MCV) <80

fL, mean corpuscular hemoglobin concentration (MCHC) <32 g/dL, serum iron level <50 µg/dL, and serum ferritin level <12 µg/L. Infants diagnosed with iron deficiency anemia were contacted by telephone and scheduled for follow-up to initiate appropriate treatment.

All data were entered and analyzed using SPSS version 26.0. Quantitative variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. Potential effect modifiers, including age, gender, type of feeding, maternal educational level, socioeconomic status, and place of residence, were controlled through stratification. Post-stratification, the chi-square test was applied to assess associations, with a p-value of ≤0.05 considered statistically significant.

Results

Overall 148 infants were enrolled; with the mean age of 7.09 ± 2.34 months and mean weight of 7.19 ± 2.03 kg. Mean hemoglobin level and serum iron level were 10.11 ± 2.17 g/dL and 59.10 ± 43.17 µg/dL respectively. Girls were slightly predominant (51.9%) over boys (48.1%), with majority of infants resided in urban areas (77.7%). The most mothers had secondary education (37.2%), followed by matriculation or above (31.1%), primary level (17.6%), and illiteracy around (14.2%).

Socioeconomic status was predominantly middle class (48.6%). Spontaneous vaginal delivery was the more common mode of delivery (54.6%) compared to caesarean section based on medical history. The most frequent reasons for OPD visits were routine check-up (26.5%), fever (24.9%), cough or upper respiratory tract infection (13.5%), poor weight gain (12.4%), and diarrhea (10.3%). However according to feeding practices, cow's milk was the most common feeding type (37.2%), followed by formula feed (32.4%), exclusive breastfeeding (28.4%), and combined mother and formula feed (2.0%) as presented in table I.

In this study out of all enrolled infants, IDA was identified in 43 infants, accounting for 29.1% of the study population, indicating a substantial burden of IDA during infancy as shown in figure 1.

According to the post-stratification analysis there was no significant association of IDA with age, gender and residential status of the ($p > 0.05$), while Cow's milk-fed infants and low socioeconomic groups had the highest IDA frequency ($p=0.001$). Table II

Table 1: Demographic and clinical characteristic of the infants. (n=148)

| Variables | Statistics | |
|----------------------|---------------------|----------|
| Mean age if infants | 7.09±2.34 months | |
| Weight | 7.19±2.03 kg | |
| Hemoglobin level | 10.11±2.17 g/dl | |
| Serum iron level | 59.10±43.17 | |
| Mean gestational age | 36.50±2.38 weeks | |
| Gender of infants | Male | 89 48.1 |
| | Female | 96 51.9 |
| | Urban | 115 77.7 |
| Residential status | Rural | 33 22.3 |
| | Illiterate | 21 14.2 |
| Maternal education | Primary education | 26 17.6 |
| | Secondary education | 55 37.2 |
| | Matric and above | 46 31.1 |
| Socioeconomic status | Low | 38 25.7 |
| | Middle | 72 48.6 |
| | High | 38 25.7 |
| Birth weight | Low (<2.5 kg) | 70 37.8 |
| | Normal (≥2.5 kg) | 115 62.2 |
| MOD | LSCS | 84 45.4 |
| | SVD | 101 54.6 |
| Reason of OPD visits | Cough/URTI | 25 13.5 |
| | Developmental check | 02 01.1 |
| | Diarrhea | 19 10.3 |
| Types of feeding | Fever | 46 24.9 |
| | Pallor/lethargy | 14 07.6 |
| | Poor weight gain | 23 12.4 |
| | Routine check-up | 49 26.5 |
| | Vaccination | 07 03.8 |
| | Cow's milk | 55 37.2 |
| | Formula feed | 48 32.4 |
| Types of feeding | Mother feed | 42 28.4 |
| | Mother feed+ | 03 02.0 |
| | Formula feed | |

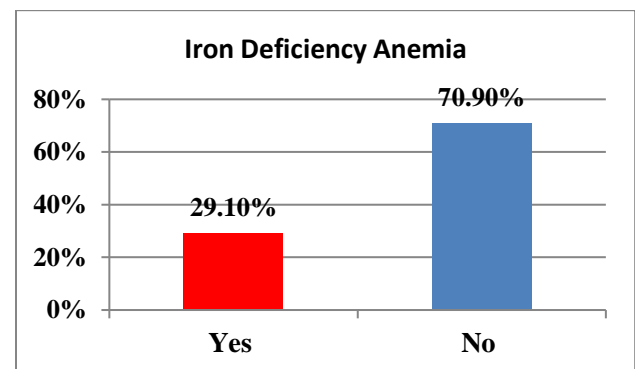


Figure 1. Frequency of iron deficiency anemia. (n=148)

Discussion

The infants and young children are specifically susceptible to anemia, particularly IDA, which is recognized as a significant public health concern with well-established effects on health of population. This study observed the IDA around 29.1% of enrolled infants

(n=43/148), the findings are consistent with regional and international as a national study from the Children's Hospital, Lahore, by Saleem MU et al¹⁴ reported the IDA approximately 34.5% among infants, with the mean hemoglobin level of 11.00 ± 1.98 g/dL and average serum iron level of 67.94 ± 22.99 μ g/dL, values slightly higher compared to our recorded mean of hemoglobin and serum iron levels 10.11 ± 2.17 g/dL and 59.10 ± 43.17 μ g/dL respectively, potentially reflecting a higher burden of nutritional deficiency in our cohort. Our findings were also supported by the study from Uganda, enrolling 364 children aged 6–23 months, reported the overall IDA prevalence around 41.5% (151/364).¹⁵ in the comparison of our findings, study from Tanzania, also a higher prevalence of IDA around 44.2% among infants aged 6 to 12 months, indicating one of the highest reported burdens of IDA in East Africa and highlighting the critical nutritional susceptibility in sub-Saharan regions.¹⁶ On the other hand, a multicenter retrospective study from Saudi Arabia by Almutairi AM et al⁶, reported the overall IDA prevalence around 9.2% among children, with infants carrying the highest subgroup prevalence around 16.9%, considerably lower than our findings. In the study by Bai A et al¹⁷ also reported the frequency of IDA around among 18.6% infants which, also lower than our results, the difference justifiably may due to the higher socioeconomic standard and greater healthcare access in that regions and strong history of Cow's milk and formula feed consumption and preterm births in this study.

In this study the feeding type emerged as the most statistically significant determinant of IDA, it was most prevalent among cow's milk-fed infants (25.7%) and formula-fed (12.2%) compared to exclusively breastfed infants (2.7%). A recent cross-sectional study from Peshawar, carried out among 340 infants with a mean age of 3.71 ± 1.84 months, consistently confirmed significantly higher rates of IDA among cow's milk-fed infants compared to breastfed infants, supporting the well-established role of breastfeeding as a protective factor. Lower bioavailability of iron in cow's milk, combined with its potential to cause occult gastrointestinal blood loss among infants, instantly explains this correlation. Another study by Siddique AW et al¹⁸, further corroborated that cow's milk consumption among infants infancy has detrimental effects on blood indices and serum ferritin, with 75.3% of enrolled infants found to be anemic, and concluded that the breast milk remains the optimal source of nutrition.

Table II: Post stratification for IDA. (n=148)

| Variables | IRON DEFICIENCY ANEMIA | | | p-value | |
|---------------|------------------------|-------------|-------------|--------------|-------|
| | Yes | No | Total | | |
| | | | | | |
| Age groups | 1-6 months | 15 10.1% | 44 29.7% | 59 39.9% | 0.428 |
| | >6 months | 28 18.9% | 61 41.2% | 89 60.1% | |
| Gender | Boys | 25 16.9% | 52 35.1% | 77 52.0% | 0.341 |
| | Girls | 18 12.2% | 53 35.8% | 71 48.0% | |
| Residence | Urban | 30 20.3% | 85 57.4% | 115 77.7% | 0.138 |
| | Rural | 13 8.8% | 20 13.5% | 33 22.3% | |
| Types of feed | Cow's milk | 30 20.3% | 25 16.9% | 55 37.2% | 0.001 |
| | Formula feed | 10 6.8% | 38 25.7% | 48 32.4% | |
| | Mother feed | 3 2.0% | 39 26.4% | 42 28.4% | |
| | Mother feed+ | 0 0.0% | 3 2.0% | 3 2.0% | |
| | Formula feed | 0 0.0% | 3 2.0% | 3 2.0% | |
| | Socioeconomic status | Low | 20 13.5% | 18 12.2% | |
| Middle | 19 12.8% | 53 35.8% | 72 48.6% | | |
| High | 4 2.7% | 34 23.0% | 38 25.7% | | |

In this study the socioeconomic status was the second significant predictor of IDA, with the highest frequency observed in low-income families (16.2%) and the lowest among high-income families (4.1%). In aligns to this series a study evaluating IDA in breastfed infants aged 3 to 5 months reported a similar inverse relationship, with IDA prevalence significantly high in the lowest socioeconomic group (25%) and lowest in the upper class (6%), consistent with our findings.¹⁹ This pattern is attributed to limited dietary diversity, reduced access to iron-rich foods, and lower maternal health literacy in economically deprived households. However another retrospective cohort study also confirmed that IDA was more prevalent among infants of low socioeconomic status and among rural residents.²⁰ Overall higher prevalence of IDA across studies reflects shared risk factors including inadequate dietary iron intake, cow's milk feeding type, maternal iron deficiency, low SES, rapid infant growth velocity exceeding dietary iron supply, and the limited access to supplementation of iron and education related to nutritional status collectively rising this burden across diverse limited resource regions. Moreover the findings of this study cannot be considered finally conclusive owing to the several limitations, like a

cross-sectional single-center design study to frequency estimation with limited sample size, without maternal anemia analysis, incomplete nutritional and dietary evaluation, all of which collectively deserve cautious interpretation of the results and underscore the requirement of further relevant comprehensive research investigations.

Conclusion

This study concluded a substantial burden of IDA among infants, with cow's milk feeding and the low SES observed as the most significant modifiable risk factors, while exclusive breastfeeding found to be a clear protective factor. Such findings emphasize the global evidence of IDA as a preventable yet persistently prevalent condition in limited resource regions, driven by suboptimal feeding practices and inadequate awareness regarding nutritional. Moreover early routine screening, breastfeeding promotion, and timely management are imperative public health significances. Due to several study limitations, future prospective multicenter studies with comprehensive nutritional and maternal profiling are strongly recommend to explore the more authentic evidence for IDA prevention in this population.

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