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Original Research Article

TO ESTIMATE THE PREVALENCE OF IRON DEFICIENCY ANEMIA IN INFANTS AGED 6 TO 12 MONTHS AND TO IDENTIFY ITS ASSOCIATED RISK FACTORS AT A TERTIARY CARE CENTRE

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ABSTRACT

Background: Iron deficiency anemia (IDA) is one of the most common nutritional disorders affecting infants, particularly during the period of rapid growth between 6–12 months. Increased iron requirements, inadequate complementary feeding, and maternal factors contribute to its high prevalence. This study aimed to estimate the prevalence of iron deficiency anemia in infants aged 6–12 months and to identify associated maternal, perinatal, and feeding-related risk factors.

Materials and Methods: This hospital-based cross-sectional observational study was conducted among 144 infants aged 6–12 months at a tertiary care centre. Data regarding sociodemographic characteristics, feeding practices, and maternal and perinatal factors were collected using a structured proforma. Hemoglobin levels, complete blood count, and serum ferritin were measured. Infants were classified based on WHO criteria. Statistical analysis was performed using SPSS version 25.0, with $p < 0.05$ considered significant.

Results: The prevalence of anemia was 45.8%, while 47.2% of infants had iron deficiency. Iron deficiency anemia was identified in 43.1% of cases, making it the most common diagnosis. A significant association was observed between anemia and age group ($p = 0.046$), with the highest prevalence in infants aged 6–8 months. Gestational age and birth weight were strongly associated with anemia ($p < 0.001$), with all preterm and 81.8% of low-birth-weight infants affected. Antenatal iron supplementation showed a significant protective effect ($p < 0.001$). Feeding practices did not show a statistically significant association.

Conclusion: Iron deficiency anemia is highly prevalent among infants aged 6–12 months, with perinatal and maternal factors playing a key role. Early screening, adequate maternal iron supplementation, and targeted nutritional interventions are essential to reduce the burden of anemia in this vulnerable population.

Keywords: Iron deficiency anemia, infants, prevalence, risk factors, antenatal iron supplementation.

INTRODUCTION

Iron deficiency anemia (IDA) is one of the most prevalent nutritional disorders globally, particularly affecting infants during periods of rapid growth and development. Infants aged 6–12 months are especially vulnerable due to increased iron requirements associated with expanding blood volume, rapid tissue growth, and ongoing neurodevelopment.[1] This period also represents a transition from exclusive breastfeeding to complementary feeding, which is often inadequate in iron content, thereby increasing the risk of deficiency and anemia.[2]

Iron is essential for hemoglobin synthesis, oxygen transport, cellular metabolism, and brain development. Deficiency during infancy results in reduced hemoglobin levels and impaired oxygen delivery. Beyond hematological effects, iron deficiency has been linked to delayed cognitive and motor development, behavioral disturbances, and increased susceptibility to infections due to compromised immune function.[3] These effects may persist even after correction, emphasizing the importance of early detection and prevention.

Globally, anemia affects a significant proportion of children, with nearly 43% of those under five years being affected, and iron deficiency accounting for a major share.[4] The burden is particularly high in low- and middle-income countries such as India, where poor maternal nutrition, inadequate complementary feeding, recurrent infections, and limited healthcare access contribute to high prevalence rates. Studies from India have reported that a substantial proportion of infants develop anemia during the first year of life.[4]

The etiology of IDA in infants is multifactorial. Inadequate intake of bioavailable iron remains the primary cause, particularly in cases of prolonged exclusive breastfeeding without appropriate complementary feeding or diets deficient in iron.[5] Additional contributors include prematurity, low birth weight, intrauterine growth restriction, recurrent infections, and malabsorption disorders.[6] Maternal factors such as anemia during pregnancy and poor nutritional status also significantly influence infant iron stores.[7]

Despite its high prevalence, IDA often remains underdiagnosed due to nonspecific clinical features, necessitating laboratory evaluation for confirmation.[8-10] In this context, the present study was undertaken to estimate the prevalence of iron deficiency anemia in infants aged 6–12 months at a tertiary care centre and to identify associated maternal, perinatal, and feeding-related risk factors. This would help in early detection and development of targeted preventive strategies to improve infant health outcomes.

MATERIALS AND METHODS

After obtaining approval from the Institutional Ethics Committee, this hospital-based cross-sectional observational study was conducted among infants aged 6–12 months attending the Department of Paediatrics at Maharaja Yashwantrao Hospital (MYH), Indore, Madhya Pradesh, over a period of one year. Written informed consent was obtained from parents or legal guardians prior to enrollment. Confidentiality of participant data was strictly maintained, and participation was voluntary, with the option to withdraw at any stage without affecting medical care.

Inclusion Criteria

- Infants aged 6–12 months attending the pediatric outpatient department for routine follow-up or immunization and apparently healthy infant siblings of admitted patients were included in the study.

Exclusion Criteria

Infants were excluded if:

- They had conditions known to alter serum ferritin levels such as acute or chronic infections or hemoglobinopathies
- They were receiving iron supplementation
- They had a history of blood transfusion
- Parental consent for participation was not provided

Methodology

After obtaining informed consent, eligible infants were enrolled consecutively. A detailed history was obtained from parents or caregivers using a predesigned and pretested proforma. Information regarding sociodemographic profile, feeding practices (including duration of exclusive breastfeeding and timing/type of complementary feeding), maternal factors (such as anemia status and nutritional history), and perinatal details (birth weight, gestational age) was recorded. A thorough clinical examination was performed to assess general health and nutritional status.

Venous blood samples (2–3 ml) were collected under aseptic precautions and analyzed for hemoglobin concentration, complete blood count parameters (including mean corpuscular volume, hematocrit, and red cell distribution width), and serum ferritin levels. Mentzer's index was calculated to aid in differentiation of iron deficiency anemia from other microcytic anemias. Based on World Health Organization criteria, infants were classified as anemic or non-anemic, and further categorized according to iron status using serum ferritin levels.

Outcome Measures

The primary outcome was to determine the prevalence of iron deficiency anemia among infants aged 6–12 months. Secondary outcomes included identification of maternal, perinatal, and feeding-related risk factors associated with iron deficiency anemia and their correlation with laboratory parameters.

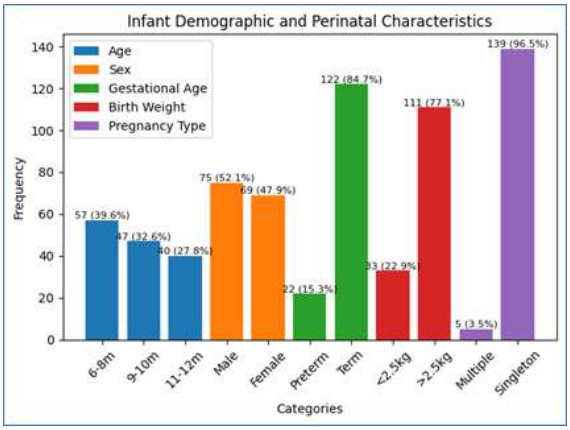
Statistical Analysis

All data were entered into Microsoft Excel and analyzed using Statistical Package for the Social Sciences (SPSS) version 25.0. Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. The Chi-square test and unpaired Student's t-test were applied where appropriate to assess associations and differences between groups. A p-value of less than 0.05 was considered statistically significant.

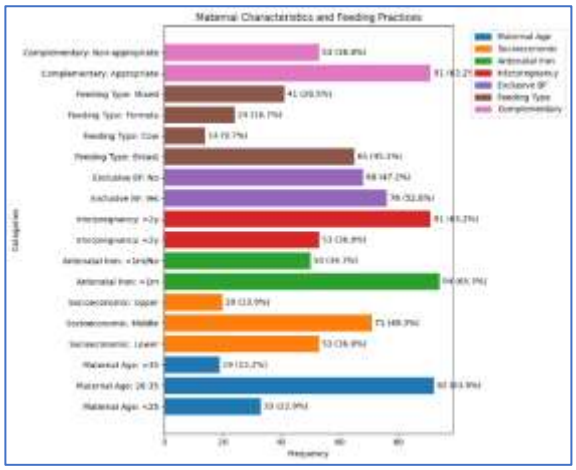
RESULTS

The present study included 144 infants aged 6–12 months. The majority of participants (39.6%) belonged to the 6–8 months age group, followed by 9–10 months (32.6%) and 11–12 months (27.8%), indicating a higher representation of younger infants. There was a slight male predominance (52.1%), although gender distribution was nearly equal. Most infants were born at term (84.7%), and a majority had normal birth weight (77.1%), suggesting a predominantly healthy baseline population. Singleton pregnancies accounted for 96.5% of cases. [Graph 1]

Among maternal characteristics, most mothers were aged 26–35 years (63.9%), followed by <25 years (22.9%) and >35 years (13.2%). Nearly half of the participants belonged to the middle socioeconomic class (49.3%). A majority of mothers (65.3%) had received antenatal iron supplementation for more than one month, and 63.2% had an interpregnancy interval greater than two years. Regarding feeding practices, 52.8% of infants were exclusively breastfed for 6 months, and 63.2% received complementary feeding as per IYCF guidelines. Breastfeeding was the most common feeding method (45.1%), followed by mixed feeding (28.5%), formula feeding (16.7%), and cow's milk (9.7%). [Graph 2]



Graph 1: Infant Demographic and Perinatal Characteristics (N = 144)



Graph 2: Maternal Characteristics and Feeding Practices (N = 144)

The overall prevalence of anemia was 45.8%, while 47.2% of infants had iron deficiency. Iron deficiency anemia (IDA) was the most common diagnosis (43.1%), followed by iron deficiency without anemia (4.2%) and anemia with normal iron (2.8%). Half of the infants (50%) were classified as normal. These findings indicate that iron deficiency is the predominant cause of anemia in this population. **[Table 1]**

Table 1: Prevalence and Diagnostic Distribution (N = 144)

Parameter	Category	Frequency (n)	Percentage (%)
Anaemia Status	Anaemia	66	45.8
	Normal	78	54.2
Iron Deficiency	Present	68	47.2
	Normal	76	52.8
Final Diagnosis	IDA	62	43.1
	Iron deficiency (no anaemia)	6	4.2
	Anaemia with normal iron	4	2.8
	Normal	72	50

A statistically significant association was observed between age group and anemia ($p = 0.046$), with the highest prevalence in infants aged 6–8 months (57.9%). Gestational age and birth weight showed highly significant associations ($p < 0.001$), with all preterm infants and a majority of low-birth-weight infants being anemic. In contrast, sex and type of pregnancy were not significantly associated with anemia. [Table 2]

Table 2: Association of Infant Factors with Anaemia (N = 144)

Variable	Category	Anaemia n (%)	Normal n (%)	p-value
Age Group	6–8 months	57.9	42.1	0.046*
	9–10 months	34.0	66.0	
	11–12 months	42.5	57.5	
Sex	Male	50.7	49.3	0.225
	Female	40.6	59.4	
Gestational Age	Preterm	100	0	<0.001*
	Term	36.1	63.9	
Birth Weight	<2.5 kg	81.8	18.2	<0.001*
	>2.5 kg	35.1	64.9	
Type of Pregnancy	Multiple	80.0	20.0	0.179
	Singleton	44.6	55.4	

Maternal factors such as antenatal iron supplementation showed a highly significant association with anemia ($p < 0.001$), with supplementation providing a strong protective effect. However, maternal age, socioeconomic status, and interpregnancy interval were not significantly associated with anemia. [Table 3]

Table 3: Association of Maternal Factors with Anaemia (N = 144)

Variable	Category	Anaemia n (%)	Normal n (%)	p-value
Maternal Age	<25 years	39.4	60.6	0.699
	26–35 years	47.8	52.2	
	>35 years	47.4	52.6	
Socioeconomic Status	Lower	52.8	47.2	0.43
	Middle	42.3	57.7	
	Upper	40.0	60.0	
Antenatal Iron	>1 month	34.0	66.0	<0.001*
	<1 month/Not given	68.0	32.0	
Interpregnancy Interval	<2 years	47.2	52.8	0.806
	>2 years	45.1	54.9	

No statistically significant association was observed between feeding practices and anemia, although trends suggested higher anemia prevalence among non-breastfed infants and those receiving cow's milk or formula. [Table 4]

Table 4: Association of Feeding Practices with Anaemia (N = 144)

Variable	Category	Anaemia n (%)	Normal n (%)	p-value
Exclusive Breastfeeding	Yes	51.3	48.7	0.163
	No	39.7	60.3	
Type of Feeding	Breastfed	38.5	61.5	0.259
	Cow milk	64.3	35.7	
	Formula fed	54.2	45.8	
	Mixed fed	46.3	53.7	
Complementary Feeding	Appropriate	46.2	53.8	0.919
	Non-appropriate	45.3	54.7	

Descriptive analysis of hematological parameters showed a mean hemoglobin of 11.12 ± 1.44 g/dL and serum ferritin of 62.20 ± 36.80 µg/L. [Table 5]

Table 5: Descriptive Statistics of Haematological Parameters

Parameter	Mean ± SD	Minimum	Maximum
Haemoglobin (g/dL)	11.12 ± 1.44	8.6	13.8
Serum Ferritin (µg/L)	62.20 ± 36.80	8.1	140.0
MCV (fL)	77.01 ± 5.67	65.3	87.9
Haematocrit (%)	33.27 ± 4.40	25.3	42.2
RDW (%)	14.20 ± 1.88	11.5	18.8
RBC Count (million/mm³)	1.44 ± 0.14	1.14	1.87
Mentzer Index	53.74 ± 5.90	41.5	69.8

Multivariate analysis identified low birth weight as an independent risk factor (Adjusted OR 3.76, $p = 0.030$), while antenatal iron supplementation had a significant protective effect (Adjusted OR 0.19, $p < 0.001$). Age group was not significant after adjustment. [Table 6]

Table 6: Multivariate Logistic Regression Analysis

Variable	Adjusted OR	95% CI	p-value
Age group	0.88	0.53 – 1.46	0.615
Birth weight (<2.5 kg)	3.76	1.14 – 12.46	0.030*

Antenatal iron (>1 month)	0.19	0.08 – 0.43	<0.001*

DISCUSSION

The present cross-sectional study evaluated the prevalence of iron deficiency anemia (IDA) and its associated risk factors among infants aged 6–12 months in a tertiary care setting. The findings demonstrated a substantial burden of anemia, with 45.8% of infants being anemic and 47.2% exhibiting iron deficiency. Notably, 43.1% of infants were diagnosed with IDA, confirming that iron deficiency is the predominant cause of anemia in this population. These findings are consistent with global evidence highlighting infancy as a vulnerable period due to rapid growth and increased iron requirements.[11,12]

Age-wise analysis revealed a statistically significant association between age and anemia ($p = 0.046$), with the highest prevalence observed among infants aged 6–8 months (57.9%). This finding is in agreement with the physiological understanding that neonatal iron stores are depleted by 4–6 months, after which infants become dependent on dietary sources of iron.[11,12] Similar trends have been reported by Seyed Mohammad Riahi et al. and Weiwei Li et al., who identified early infancy as a high-risk period, with a gradual decline in anemia prevalence as age increases.[13,14] This emphasizes the importance of timely initiation of iron-rich complementary feeding during this critical period.[41]

No statistically significant association was observed between sex and anemia ($p = 0.225$), indicating that both male and female infants are similarly affected. This finding aligns with studies by Qinrui Li et al. and Riahi et al., which reported no significant gender-based differences in anemia prevalence during infancy.[74,75] Although some studies have reported a slight male predominance,[14,15] the overall evidence suggests that gender is not a major determinant in early life.

Perinatal factors showed a strong influence on anemia risk. A highly significant association was observed between gestational age and anemia ($p < 0.001$), with all preterm infants being anemic compared to 36.1% of term infants. This is consistent with existing literature indicating that iron accretion primarily occurs during the third trimester, and preterm infants have reduced iron stores at birth.[16,17] Similarly, low birth weight was strongly associated with anemia, with 81.8% of low birth weight infants affected compared to 35.1% of normal birth weight infants ($p < 0.001$). This supports previous findings that reduced fetal iron stores and increased postnatal requirements predispose these infants to early iron deficiency.[15,16] Multivariate analysis further confirmed low birth weight as an independent predictor of anemia, reinforcing its clinical significance.

Maternal factors, particularly antenatal iron supplementation, demonstrated a strong protective effect ($p < 0.001$). Infants whose mothers did not receive adequate supplementation had a significantly higher prevalence of anemia (68.0%) compared to those who received supplementation for more than one month (34.0%). This finding is supported by studies showing that maternal iron status directly influences fetal iron stores and infant outcomes.[18-20] In contrast, maternal age and interpregnancy interval did not show statistically significant associations, suggesting that their effects may be indirect or less influential compared to nutritional factors.

Socioeconomic status was not significantly associated with anemia ($p = 0.43$), although a higher prevalence was observed among lower socioeconomic groups. This trend is consistent with studies indicating that socioeconomic factors influence dietary quality, healthcare access, and overall nutritional status.[21-23] The lack of statistical significance may be attributed to the relatively uniform healthcare access in a tertiary care setting and the predominance of middle socioeconomic class participants in the study.

Feeding practices, including exclusive breastfeeding, type of feeding, and complementary feeding, were not significantly associated with anemia. Although a higher prevalence of anemia was observed among exclusively breastfed infants (51.3%) and those receiving cow's milk (64.3%), these differences were not statistically significant. This highlights the multifactorial nature of IDA. While exclusive breastfeeding is recommended for the first six months, breast milk alone may not meet the increasing iron requirements beyond this period without appropriate supplementation.[9,24] Additionally, cow's milk is known to have low iron content and may interfere with iron absorption.[25] However, the absence of statistical significance suggests that feeding practices alone may not independently determine anemia risk without considering other contributing factors.

Similarly, complementary feeding practices, as assessed using IYCF guidelines, did not show a significant association with anemia ($p = 0.919$). This finding differs from several studies that have identified inappropriate complementary feeding as a major risk factor.[20,26] The discrepancy may be due to limitations in assessing the qualitative aspects of diet, such as iron content, bioavailability, and dietary diversity. As emphasized in previous research, the composition and quality of complementary foods play a crucial role in iron absorption and overall nutritional status.[10]

Overall, this study demonstrates a substantial burden of iron deficiency anemia among infants aged 6–12 months, with perinatal and maternal factors—particularly prematurity, low birth weight, and inadequate antenatal iron supplementation—playing a significant role. Feeding practices alone did not

independently predict anemia, highlighting the need for a comprehensive approach that integrates maternal nutrition, early screening, and targeted preventive strategies. Strengthening antenatal care and optimizing infant feeding practices remain essential to reduce the burden of anemia in this vulnerable group.

Despite offering important insights into the prevalence and determinants of iron deficiency anemia, the study has certain limitations. Its hospital-based design and use of convenience sampling may limit generalizability, while the cross-sectional nature precludes causal inferences. Additionally, lack of detailed dietary assessment, absence of inflammatory markers, and smaller subgroup sizes may have influenced the findings and statistical strength of some analyses.

CONCLUSION

Iron deficiency anemia remains a major public health problem among infants aged 6–12 months, affecting a substantial proportion of this vulnerable population. Iron deficiency is identified as the leading cause of anemia. Perinatal factors such as prematurity and low birth weight significantly influence infant iron status due to reduced iron stores at birth. Maternal factors, particularly antenatal iron supplementation, show a strong protective effect. Feeding practices appear to play a secondary role, possibly influenced by dietary quality. These findings highlight the importance of maternal nutrition, early screening, and targeted iron supplementation to reduce anemia and prevent adverse developmental outcomes in infancy.

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