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Study on Prevalence of Iron Deficiency Anaemia in Children of 6 Months - 12 Years of Age in Barabanki District, Uttar Pradesh

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Abstract: ***Background & Objectives: Iron Deficiency Anemia (IDA) is a major public health concern, particularly in developing countries like India. IDA affects various physiological functions, including cognitive and physical development in children, leading to decreased learning capacity and productivity. Thus, the objective of the study aims to determine the prevalence of IDA in children aged 6 months to 12 years in the Barabanki district of Uttar Pradesh, India. Material & Methods: An observational cross - sectional study was conducted over 18 months from July 2022 to January 2024 at the Dr. KNS memorial Institute of Medical Sciences, Barabanki. The study included 190 children aged 6 months to 12 years. The dataset categorizes children into three age groups: 6 - 59 months, 5 - 9 years, and 10 - 12 years. The distribution of these categories is fairly balanced between the first two groups, with 82 children (43.2%) in the 6 - 59 months group and 83 children (43.7%) in the 5 - 9 years group. The 10 - 12 years category is smaller, comprising 25 children (13.2%). Haemoglobin was estimated by sahli's method. Total iron, Total Iron - Binding Capacity (TIBC) was estimated by ferrozine method on an automated chemistry analyser with an available reagent kit and serum ferritin were assessed by Immunoenzymometric sequential assay. Results: For the combined group of 190 children, 89 (46.84%) were normal, in total, 101 children (53.16%) were anaemic.20 (10.53%) had mild anaemia, 66 (34.74%) had moderate anaemia, and 15 (7.89%) had severe anaemia. Conclusion: As prevalence of anemia is >50%, Addressing iron deficiency anemia in children is crucial for their overall growth and development. Health policies should focus on improving dietary iron intake, enhancing public awareness, and providing iron supplements to high - risk groups. Additionally, regular screening and monitoring of children's iron status can help in early detection and treatment of anemia.***

Keywords: Anemia, children, iron deficiency anemia, 6 months - 12 years

1. Introduction

Iron deficiency is a globally significant nutritional disorder, recognized as the most widespread deficiency worldwide. Iron plays a crucial role in various physiological processes, particularly in electron transfer essential for bodily functions. When iron levels are insufficient, conditions like hypoxia and secondary erythrocytosis can trigger increased iron consumption, exacerbating deficiencies. Additionally, factors such as bleeding disorders further deplete iron stores. Maintaining adequate iron levels is crucial not only for nutritional health but also for overall well - being, highlighting the importance of proactive management and prevention strategies beyond nutritional concerns [1]. The distribution of iron in the body includes active metabolites and storage pools. Efficient recycling of iron from aging red blood cells is a vital process in maintaining iron balance [2].

Iron deficiency anemia is characterised by defect in haemoglobin synthesis leading to hypochromic and microcytic red blood cells [3]. The progression of iron deficiency occurs in three stages: iron depletion, iron deficiency, and iron deficiency anemia. Iron depletion begins when the body's iron demand exceeds intake, leading to reduced iron stores marked by decreased serum ferritin levels. Iron deficiency follows, characterized by insufficient iron absorption to compensate for bodily losses, manifesting in lowered mean corpuscular haemoglobin (MCH), mean corpuscular volume (MCV), and serum ferritin levels. The final stage, iron deficiency anemia, represents severe iron inadequacy, resulting in low red blood cell iron content, diminished haemoglobin levels, and further declines in serum ferritin [4].

Pallor is the most perceived clinical indication of lack of iron yet isn't typically apparent until the haemoglobin tumbles to 7 - 8 g/dL. Pallor of the palms, palmar creases, nail beds, or conjunctivae is the most common sign. There were 269 million children with anemia worldwide in 2019, representing a prevalence rate of 39.8 % among children aged 6 to 59 months. The African Region had the highest rate of anemia in

children under the age of five, at 60.2%. [5] WHO aims to improve diagnostic precision, supporting effective public health measures to address iron deficiency on a global scale [6].

Therefore, the current study was conducted to find out the prevalence of anemia in children of 6 months - 12 years age in a tertiary care hospital

2. Material and Methods

This cross - sectional study was conducted at Dr. KNS Memorial Institute of Medical Sciences, located in Barabanki, Uttar Pradesh, spanned a period of 18 months, from July 2022 to January 2024, ensuring a comprehensive collection of data. An informed written consent (including consent for blood sampling) was obtained from parents/ legal guardians of eligible children for participation in the study. Approval was taken from institutional ethics committee

Inclusion Criteria
All patients aged 6 months to 12 years who visited the Outpatient Department or admitted to the Inpatient Department of Dr. KNS Memorial Institute of Medical Sciences.

Exclusion Criteria
1) Children whose parents did not consent to participate in the study.
2) Children with fever within the last 4 weeks.
3) Children with acute and chronic medical disorders.
4) Children with haemolytic anemia.
5) Children who had taken iron/vitamin/mineral supplements (including herbal drugs) within the last 8 weeks.
6) Children who had received a blood transfusion within the last 3 months.
7) Children with malignancies or congestive cardiac failure.

A total of 190 children attending the paediatric OPD or IPD of Dr. KNSMIMS were taken as cases and the dataset categorizes children into three age groups: 6 - 59 months, 5 - 9 years, and 10 - 12 years. Estimation of blood haemoglobin, serum iron, TIBC and serum ferritin level was done

One milliliter of venous blood was drawn using full aseptic procedures in an EDTA - filled vacutainer to estimate the blood haemoglobin levels. Blood was carefully combined with the anticoagulant after collection. The Sahli technique was used to estimate haemoglobin levels

Blood was drawn into a plain vacutainer to measure the levels of iron, TIBC, and ferritin. It was allowed to clot for thirty minutes. Serum was then isolated after centrifugation. If serum estimation could not be completed that day, it was stored in a deep freezer.

Using a commercially available reagent kit, the Ferrozine technique was utilized to estimate total iron and TIBC using an Olympus AU 400 fully automated chemical analyser, ferritin was estimated Using the chemiluminescence immunoassay technique.

Statistical Analysis
The normality of data was assessed using the Kolmogorov - Smirnov test. If normality was rejected, non - parametric tests were applied.

Statistical Tests
Quantitative variables**:** Associated with iron deficiency anemia using the unpaired t - test or Mann - Whitney Test, depending on the distribution of data.

Qualitative variables**:** Associated using the Chi - Square test or Fisher's exact test. A p - value of <0.05 was considered statistically significant

3. Results

A total 190 children were taken as cases and the dataset categorizes children into three age groups: 6 - 59 months, 5 - 9 years, and 10 - 12 years. The distribution of these categories is balanced between the groups, with 82 children in the 6 - 59 months group and 83 children in the 5 - 9 years group. The 10 - 12 years category is comprising 25 children. Normal range of haemoglobin levels at different age groups [7] was mentioned in table.1

Table.1: Haemoglobin levels to diagnose anaemia (g/dl)

Age groups	No Anaemia	Mild	Moderate	Severe
Children 6–59 months of age	≥11.5	10 - 11.4	7 - 9.9	<7
Children 5–11 years of age	≥12	11 - 11.9	8 - 10.9	<8

Age and gender distribution of children included in the study
The table provides the age and gender distribution of children included in the study, categorized into three age groups: 6 - 59 months, 5 - 9 years, and 10 - 12 years. For the 6 - 59 months category, there are 48 females (58.54%) and 34 males (41.46%), totalling 82 children. In the 5 - 9 years category, there are 44 females (53.01%) and 39 males (46.99%), totalling 83 children. The 10 - 12 years category includes 13 females (52.00%) and 12 males (48.00%), totalling 25 children. Overall, the study includes 105 females (55.26%) and 85 males (44.74%), with a total of 190 children.

Table 2: Age and gender distribution of children included in the study

Age Category	Female	Female (%)	Male	Male (%)	Total
6 - 59 months	48	58.54%	34	41.46%	82
5 - 9 years	44	53.01%	39	46.99%	83
10 - 12 years	13	52.00%	12	48.00%	25
Total	105	55.26%	85	44.74%	190

Prevalence (%) of anaemia by haemoglobin (g/dL) among children
The analysis of anaemia prevalence among 190 children, split into boys and girls, revealed the following key findings

- **Boys:** Out of 85 boys, 36 (42.35%) were classified as having normal haemoglobin levels, 10 (11.76%) had mild anaemia, 32 (37.65%) had moderate, and 7 (8.24%) had severe anaemia. Overall, 49 boys (57.65%) were anaemic. The odds ratio (OR) for boys being anaemic compared to girls was calculated to be 4.0, with a 95% confidence

interval (CI) ranging from 0.033 to 486.485. However, the p - value was 0.571.

- **Girls:** Among 105 girls, 53 (50.47%) were classified as normal, 10 (9.52%) had mild anemia, 34 (32.38%) had moderate anaemia, and 8 (7.62%) had severe anaemia. The total number of anaemic girls was 52 (49.52%).
- **Total:** For the combined group of 190 children, 89 (46.84%) were normal, 20 (10.53%) had mild anaemia, 66 (34.74%) had moderate anaemia, and 15 (7.89%) had severe i anaemia. In total, 101 children (53.16%) were anaemic.
- The statistical analysis revealed no significant differences between the prevalence of anaemia in boys and girls, as indicated by the high p - values and wide confidence intervals for the odds ratios across different anaemia severities.

Table 3: Anaemia prevalence among 190 children

Group	Count	Normal (%) <11.5	Mild (%) (10 - 10.9)	Moderate (%) (7 - 7.9)	Severe (%) (<7)	Total Anemic (%)	p - Value	OR (95% CI)
Boys	85	36 (42.35)	10 (11.76)	32 (37.65)	7 (8.24)	49 (57.65)	0.571	4.0 (0.033 - 486.485)
Girls	105	53 (50.47)	10 (9.52)	34 (32.38)	8 (7.62)	52 (49.52)		
Total	190	89 (46.84)	20 (10.53)	66 (34.74)	15 (7.89)	101 (53.16)		

Distribution of various parameters categorized by age groups: 6 - 59 months, 5 - 9 years, and 10 - 12 years

The analysis of various parameters among different age groups reveals the following results:

For children aged 6 - 59 months, their mean haemoglobin (Hb) level was 10.87 g/dL (SD = 2.04 g/dL), serum ferritin was 83.09 ng/mL (SD = 37.97 ng/mL), serum iron was 95.38 µg/dL (SD = 40.44 µg/dL), and total iron - binding capacity (TIBC) was 336.19 µg/dL (SD = 88.83 µg/dL). The transferrin saturation was 30.48% (SD = 7.47%).

For children aged 5 - 9 years, their mean Hb level was 10.98 g/dL (SD = 2.31 g/dL), serum ferritin was 74.29 ng/mL (SD = 44.22 ng/mL), serum iron was 101.79 µg/dL (SD = 43.41 µg/dL), and TIBC was 340.48 µg/dL (SD = 85.84 µg/dL). The transferrin saturation was 30.13% (SD = 8.62%).

For children aged 10 - 12 years, their mean Hb level was 11.06 g/dL (SD = 2.36 g/dL), serum ferritin was 84.92 ng/mL (SD = 40.15 ng/mL), serum iron was 96.02 µg/dL (SD = 44.57 µg/dL), and TIBC was 342.40 µg/dL (SD = 88.50 µg/dL). The transferrin saturation was 28.16% (SD = 8.24%).

Table 4: Mean and standard deviation (SD) for various parameters categorized by age groups: 6 - 59 months, 5 - 9 years, and 10 - 12 years.

Age Group	Hb (g/dL)	Serum Ferritin (ng/mL)	Serum Iron (µg/dL)	TIBC (µg/dL)	Transferrin Saturation (%)
6 - 59 months	10.87 ± 2.04	67±20.76	80.74±39.51	360.65±55.87	31.46±19.86
5 - 9years	10.98 ± 2.31	32.88± 22.67	57.68±18.54	410.65±85.94	24.68±18.57
10 - 12 years	11.06 ± 2.36	110.56±40.32	104.62±57.89	341.54±96.46	36.67±26.71

4. Discussion

Iron deficiency anemia is a common condition around the world. According to previous studies, Iron is essential for many bodily processes, including electron transport, DNA synthesis, and oxygen transfer [8]. According to WHO estimates, around two billion individuals suffer from anemia, with iron deficiency accounting for about half of these cases. [9]

The prevalence of anemia was high at all ages, with a more alarming prevalence occurring in the group of one to two years of age [10]. Potential factors that may explain the highest prevalence in young infants are, among others a) prenatal iron deficiency is highly prevalent and commonly affects the development of restricted fetal iron stores [11]. b) During the first two years of life, the shift from complete lactation to the family diet takes place, and during this time, weaning foods are typically low in energy and micronutrient density, particularly for iron [12]. c) breast milk secretes just 3 mg of iron per day, which is not enough to meet an infant's daily iron needs of 9 mg [13].

Similar to our study **Keikhaei *et. al;*** conducted a study in Brazil, **Desalegn *et. al;*** conducted a study in Iran, **Kapoor *et. al;*** conducted a study in India, the prevalence rates of iron deficiency in children under 5 years of age were 43.9%, 43.7%, 64% respectively. [14 - 16]

Awasthi *et. al;* reported that the highest prevalence of iron - deficiency anemia was observed in the 12 - to 24 - month age group. According to a multicentre cross - sectional study conducted in India, the prevalence of iron deficiency among urban school - going children aged 6 - 11 years was found to be 49.4% for iron deficiency anemia, being more common among females [17]

In our study it has been observed that children with iron deficiency anemia exhibited significantly lower serum iron levels with a mean of 49.87 µg/dL compared to the normal group which had a mean of 120.98 µg/dL, similar studies such as **Bonamico *et. al;*** another study **Brugnara *et. al;*** these researches indicate that children with iron deficiency anemia have lower serum iron levels compared to healthy children, highlighting the importance of serum iron levels as a diagnostic marker for iron deficiency anemia in paediatric patients. [18, 19]

In our study it has been observed that the transferrin saturation percentages show a stark contrast between iron - deficient anaemic children at 10.62% and non - anaemic children at 43.35%, similarly **Koerper *et. al;*** and another study **Hershko *et. al;*** reported that among children aged 0.5 to 12 years, transferrin saturation was significantly lower in those with iron deficiency anemia compared to those without iron deficiency anemia. [20, 21]

Therefore, our study underscores the critical prevalence of iron deficiency and iron deficiency anemia (IDA) among children, highlighting significant regional and gender variations. The data reveal a higher prevalence of anemia in younger age groups, particularly among infants and toddlers. Additionally, our findings indicate a higher prevalence of anemia among female children, stressing the need for gender - specific interventions. These findings highlight the urgent need for targeted public health strategies to address iron deficiency and anemia, particularly in vulnerable populations, to mitigate their adverse effects on growth and development.

5. Limitation

Many children and their parents, refused to cooperate with the study's enrolment efforts due to their fear of getting pricked by needles during sample collection.

Since this study was conducted in a tertiary care hospital, more research in other areas should be conducted to reflect the iron status of children in those areas and aid in the planning and formulation of policies for the prevention and control of anemia.

6. Conclusion

The study found a high prevalence of iron deficiency anemia among children aged 6 months to 12 years in the Barabanki district, with poor socioeconomic status and breastfeeding history being significant risk factors. Early diagnosis and intervention, including nutritional supplementation and education on proper breastfeeding practices, are essential to address this public health issue. Further research is needed to explore other potential risk factors and develop targeted strategies to reduce the prevalence of anemia in this population.

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Conflicts of Interest: None

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