Biomedical and Biopharmaceutical Research
Abbreviation: Biomed. Biopharm. Res.
Volume: 17: Issue: 02 |Year: 2020
Page Number: 15-21

Assessment of Serum Ferritin Levels in the Detection of Iron Deficiency Anaemia in Paediatric Patients: A cross-sectional study

Dr. Umesh Kumar[1], Dr. Sandeep Narayan Lal[2], Dr. Abhishek Reddy[3], Dr. Naresh Kumar Munda[4]

[1] Assistant Professor, Department of Paediatric, Faculty of Icare Institute of Medical Sciences and Research and Dr. B C Roy Hospital, Haldia, India.

[2] Assistant Professor, Department of Paediatric, Faculty of Gouri Devi Institute of Medical Sciences & Hospital, Durgapur, West Bengal

[3] Assistant Professor, Department of Paediatric, Faculty of Faculty of Jagannath Gupta Institute of Medical Sciences and Hospital, West Bengal.

[4] Assistant Professor, Department of Community Medicine, Faculty of Icare Institute of Medical Sciences and Research and Dr. B C Roy Hospital, Haldia, India

Corresponding Author

Dr. Naresh Kumar Munda

Assistant Professor, Department of Community Medicine, Faculty of Icare Institute of Medical Sciences and Research and Dr. B C Roy Hospital, Haldia, India

Received: 17-11-2020

Accepted: 01-12-2020

Published: 29-12-2020

Abstract

Background: Iron deficiency anemia (IDA) is the most prevalent nutritional deficiency worldwide among children. Serum ferritin is a useful biomarker for iron status and can aid early diagnosis of IDA. Objective: To assess the utility of serum ferritin levels in the detection of iron deficiency anemia in pediatric patients. Methods: A cross-sectional study was conducted on 34 pediatric patients (age 6 months to 12 years) clinically suspected of anemia. Hemoglobin and serum ferritin levels were measured. Demographic data and risk factors were analyzed. Results: Out of 34 children, 23 (67.6%) had low serum ferritin (<12 ng/mL) and hemoglobin (<11 g/dL), confirming IDA. Risk factors such as poor dietary intake, low socioeconomic status, and recent infections were commonly observed. Conclusion: Serum ferritin is a reliable and sensitive marker for diagnosing iron deficiency anemia in children. Early identification through ferritin assessment can enable timely intervention and prevent complications.

KEYWORDS: Serum ferritin, pediatric patients, hemoglobin.

INTRODUCTION

Iron deficiency anemia (IDA) is a global health problem affecting 30–40% of children, particularly in low- and middle-income countries. Iron plays a crucial role in cognitive development, immune function, and growth. Delay in diagnosis and treatment of IDA can lead to developmental delays and increased susceptibility to infections[1].

Iron deficiency anemia (IDA) is a widespread public health concern in India, particularly among women and children. The National Family Health Survey (NFHS) data indicates that over half of all women and two-thirds of children under the age of five in India are anemic. Specifically, NFHS-5 (2019-21) reported that 67.1% of children (6-59 months) and 59.1% of adolescent girls (15-19 years) in India are anemic. Among adults, 57.0% of women (15-49 years) and 25.0% of men (15-49 years) have anemia[2].

Key Factors Contributing to IDA in India: Dietary deficiencies: Low intake of iron-rich foods is a major contributor to IDA[3-8]. Early pregnancies and inadequate maternal care: These factors can increase the risk of

anaemia in both women and children. Poor sanitation and poverty: These socioeconomic factors can exacerbate the problem of anemia. Lack of awareness and access to healthcare: Limited access to iron supplements and healthcare services can also hinder efforts to combat anaemia. Government Initiatives: Anemia Mukt Bharat (AMB) program: This program utilizes a 6x6x6 strategy: 6 interventions, 6 target groups, and 6 institutional mechanisms to address anemia. Digital tools: These tools are used to track real-time anaemia screening and supply data. Integration with other programs: AMB is integrated with POSHAN Abhiyaan and the School Health Program to reach a wider population. Regional Variations: There are significant regional variations in the prevalence of anemia across India[9-11]. States like Assam, Gujarat, Jammu and Kashmir, and Madhya Pradesh have shown higher rates of anemia, particularly among children. States like Kerala have shown lower rates of anemia. The prevalence of anemia also varies among different districts within states. Addressing Anemia: Targeted interventions:
Programs need to focus on specific vulnerable groups, such as pregnant women, adolescent girls, and young children. Promoting healthy diets: Encouraging the consumption of iron-rich foods through education and awareness campaigns is crucial. Strengthening healthcare systems: Improving access to quality healthcare services, including iron supplementation and anemia screening, is essential[12-15].
Addressing socioeconomic factors: Poverty, sanitation, and access to education are important determinants of anemia and need to be addressed

While haemoglobin levels indicate anemia, serum ferritin offers a more specific indication of iron stores in the body. This study aims to assess the role of serum ferritin as a diagnostic tool in detecting IDA in paediatric patients.

METHODOLOGY

This study was conducted in a tertiary hospital. After obtaining institutional ethical committee approval. It was Cross-sectional observational study conducted on 34 patients in the department of Paediatrics , at a tertiary care centre, from April / 2020 to October/2020
Total 34 participant were approached to project among them No one were excluded in this study and Total 34 Confirmed cases were included on the basis of fulfilling of the eligibility criteria.
The institute Ethics Committee approval was obtained before starting the sample collection. A written and informed consent was taken from the patient regarding the study in his/her vernacular language and English. In this study Patients were subjected to: A detailed history of sign & symptoms and its duration. Detailed history of systemic diseases and its duration, medication were noted. Patients were subjected to General physical examination.

Study Design:
Cross-sectional observational study
Study Setting:
Pediatrics outpatient and inpatient department of a tertiary care hospital
Sample Size:
34 children (aged 6 months to 12 years)
Inclusion Criteria:

- Children aged 6 months–12 years
- Clinical signs of anemia (pallor, fatigue, poor appetite)
- Informed parental consent

Exclusion Criteria:

- Children with chronic infections, hemolytic anemia, or liver disease
- Recent iron supplementation within the last 2 months

Investigations:

- Hemoglobin (Hb) estimation
- Serum ferritin measurement (using ELISA)
- Other supportive labs: peripheral smear, RBC indices

Flowchart: Study Methodology

Children Aged 6 Months to 12 Years with Clinical Signs of Anemia
↓
Consent Taken and Clinical Examination
↓
Hemoglobin and Serum Ferritin Levels Measured
↓
Classification into IDA and Non-IDA Groups
↓
Analysis of Demographic Factors and Risk Factors
↓
Statistical Interpretation of Results

RESULTS

In this study we found that Iron deficiency anemia (IDA) is associated with demographic profile of patient. 41.2% Iron deficiency anemia (IDA) is belong to 2–6 years age group followed by 35.3 Age 6 months – 2 years age group . Age is also associated factors for Iron deficiency anemia (IDA)

Male are more prone to suffered of Iron deficiency anemia (IDA) as compared to female its prevalence 52.9% .58.8% Iron deficiency anemia (IDA) were predominance among urban residence (Table 1)

Demographic Profile of Pediatric Patients Table 1 (n = 34)

Parameter	Number (n)	Percentage (%)
Age 6 months – 2 years	12	35.3%
Age 2–6 years	14	41.2%
Age 7–12 years	8	23.5%
Male	18	52.9%
Female	16	47.1%
Urban	20	58.8%
Rural	14	41.2%

Risk Factors of Iron Deficiency Anemia Table 2 (n = 34)

Risk Factor	Frequency (n)	Percentage (%)
Inadequate dietary iron intake	24	70.6%
Low socioeconomic status	21	61.8%
Recent or recurrent infections	10	29.4%
Poor weaning practices (infants)	12	35.3%
Parasitic infestation (e.g., worms)	8	23.5%
Lack of iron supplementation	16	47.1%

Haemoglobin and Serum Ferritin Analysis

- Total cases studied: 34
- Children with Hb <11 g/dL: 26 (76.5%)
- Children with low ferritin (<12 ng/mL): 23 (67.6%)
- Confirmed IDA (low Hb + low ferritin): 23 (67.6%)
- Normal ferritin with low Hb (non-IDA causes): 3 (8.8%)
- Normal Hb and ferritin: 8 (23.5%)

Clinical Symptoms Observed (in IDA cases)

Symptom	**n (% of 23)**
Pallor	23 (100%)
Fatigue/Irritability	17 (73.9%)
Poor appetite	15 (65.2%)
Pica	6 (26.1%)

DISCUSSION

This study highlights a high prevalence (67.6%) of iron deficiency anemia in the pediatric population. It emphasizes that serum ferritin, being a reflection of iron stores, is a superior biomarker compared to hemoglobin alone for diagnosing IDA[16].

Most of the affected children belonged to low socioeconomic groups and had poor dietary habits. Infants and preschoolers were more vulnerable, underscoring the need for early weaning education and preventive iron supplementation[17-20].

In this study we found that Iron deficiency anemia (IDA) is associated with demographic profile of patient. 41.2% Iron deficiency anemia (IDA) is belong to 2–6 years age group followed by 35.3 Age 6 months – 2 years age group. Age is also associated factors for Iron deficiency anemia (IDA)

Male are more prone to suffered of Iron deficiency anemia (IDA) as compared to female its prevalence 52.9% .58.8% Iron deficiency anemia (IDA) were predominance among urban residence (Table 1)

Iron deficiency anemia (IDA) in children is a common condition with several risk factors, including prematurity, dietary deficiencies, and certain medical conditions. Premature infants and those with low birth weight are at higher risk due to lower iron stores at birth and rapid growth. Dietary factors like excessive cow's milk consumption, inadequate intake of iron-rich foods, and early introduction of cow's milk before 12 months can also contribute to IDA[21-23]. Additionally, chronic illnesses, exposure to lead, and conditions like celiac disease can impair iron absorption, increasing the risk.

Here's a more detailed breakdown of the risk factors: Prematurity and Low Birth Weight:

Premature infants and those with low birth weight are born with lower iron stores and experience rapid growth, increasing their iron needs. Dietary Factors: Excessive Cow's Milk Consumption: Drinking more than 24 ounces (710 millilitres) of cow's milk per day can displace iron-rich foods in the diet and interfere with iron absorption. Inadequate Iron Intake Not consuming enough iron-rich foods, such as red meat, poultry, fish, leafy green vegetables, and iron-fortified cereals, can lead to deficiency. Early Introduction of Cow's Milk: Introducing unmodified cow's milk before 12 months can also increase the risk of IDA[24].

Medical Conditions: Chronic Infections or Inflammatory Diseases: These can lead to increased iron loss or impaired iron absorption. Celiac Disease or Other Malabsorption Syndromes: These conditions can interfere with the body's ability to absorb iron from food[25-29].

Gastrointestinal Blood Loss: Conditions like chronic diarrhoea or gastrointestinal bleeding can lead to iron loss. Other Risk Factors: Exposure to Lead: Lead exposure can interfere with iron absorption and utilization. Poverty and Low Socioeconomic Status: Poverty can limit access to nutritious foods and healthcare,

increasing the risk of IDA. Certain Ethnic Groups: Some ethnic groups may have a higher prevalence of genetic conditions that affect iron metabolism[30]. Infants of Iron-Deficient Mothers: Babies born to mothers with IDA may have lower iron stores at birth. Specific Populations: Adolescents: Rapid growth and, in females, the onset of menstruation can increase iron requirements[31].
Vegetarians and Vegans: Individuals following these diets may be at higher risk if they do not consume sufficient iron-rich plant-based foods or iron-fortified foods

The findings support WHO and IAP guidelines promoting routine screening for anemia and iron supplementation in high-risk age groups.

CONCLUSION

Serum ferritin is an effective diagnostic marker for iron deficiency anemia in children. The study establishes a significant burden of IDA in the pediatric population, primarily due to modifiable risk factors. Public health efforts must focus on nutrition education, routine screening, and timely iron supplementation to prevent the long-term consequences of anemia in children.

SOURCE OF FUNDING: No

CONFLICT OF INTEREST

The authors report no conflicts of interest

SUBMISSION DECLARATION

This submission has not been published anywhere previously and that it is not simultaneously being considered for any other journal.

REFERENCES

1. Le CH, Collins JF. The prevalence of anemia and moderate-severe anemia in the US population (NHANES 2003–2012). *PLoS One*. 2016;11(11):e0166635. doi: 10.1371/journal.pone.0166635 [DOI] [PMC free article] [PubMed] [Google Scholar]
2. Aliyo A, Jibril A. Anemia and associated factors among under five year old children who attended Bule Hora general hospital in West Guji zone, Southern Ethiopia. *J Blood Med*. 2022;13:395–406. doi: 10.2147/jbm.S363876 [DOI] [PMC free article] [PubMed] [Google Scholar]
3. Carlo Brugnara FAO, David G. Nathan diagnostic approach to anemic patient. In: *Nathan and Oski's Hematology and Oncology of Infancy and Childhood*. 8th ed. WB Saunders; 2015:293. [Google Scholar]
4. Ocas-Córdova S, Tapia V, Gonzales GF. Hemoglobin concentration in children at different altitudes in Peru: proposal for [Hb] correction for altitude to diagnose anemia and polycythemia. *High Alt Med Biol*. 2018;19(4):398–403. doi: 10.1089/ham.2018.0032 [DOI] [PMC free article] [PubMed] [Google Scholar]
5. World Health Organization. *Haemoglobin Concentrations for the Diagnosis of Anaemia and Assessment of Severity*. World Health Organization; 2011. [Google Scholar]
6. Zanetti R, Feldman B, Porea T. Microcytic anemia. *Pediatr Rev*. 2021;42(1):41–43. doi: 10.1542/pir.2019-0295 [DOI] [PubMed] [Google Scholar]
7. 8.World Health Organization (WHO). *Worldwide Prevalence of Anaemia 1993–2005*. World Health Organization; 2008. [Google Scholar]
8. McEvoy MT, Stuckert AJ, Castellanos MI, et al. Management of nutritional iron deficiency anemia for young children in the emergency department. *Pediatr Blood Cancer*. 2023;70(3):e30181. doi: 10.1002/pbc.30181 [DOI] [PubMed] [Google Scholar]
9. Janus J, Moerschel SK. Evaluation of anemia in children. *Am Fam Physician*. 2010;81(12):1462–1471. [PubMed] [Google Scholar]
10. Kazal LA Jr. Prevention of iron deficiency in infants and toddlers. *Am Fam Physician*. 2002;66(7):1217–1224. [PubMed] [Google Scholar]

11. Kibangou IB, Bouhallab S, Henry G, et al. Milk proteins and iron absorption: contrasting effects of different caseinophosphopeptides. *Pediatr Res*. 2005;58(4):731–734. doi: 10.1203/01.PDR.0000180555.27710.46 [DOI] [PubMed] [Google Scholar]
12. Scheers N. Regulatory effects of Cu, Zn, and Ca on Fe absorption: the intricate play between nutrient transporters. *Nutrients*. 2013;5(3):957–970. doi: 10.3390/nu5030957 [DOI] [PMC free article] [PubMed] [Google Scholar]
13. World Health Organization. *Nutritional Anaemias: Tools for Effective Prevention and Control*. Geneva: World Health Organization; 2017. [Google Scholar]
14. Camaschella C. Iron-deficiency anemia. *N Engl J Med*. 2015;372(19):1832–1843. doi: 10.1056/NEJMra1401038 [DOI] [PubMed] [Google Scholar]
15. American Academy of Pediatrics. *Bright Futures Guidelines for Health Supervision of Infants, Children, and Adolescents*. American Academy of Pediatrics; 2017. [Google Scholar]
16. Haamid F, Sass AE, Dietrich JE. Heavy menstrual bleeding in adolescents. *J Pediatr Adolesc Gynecol*. 2017;30(3):335–340. doi: 10.1016/j.jpag.2017.01.002 [DOI] [PubMed] [Google Scholar]
17. Philipp CS, Faiz A, Heit JA, et al. Evaluation of a screening tool for bleeding disorders in a US multisite cohort of women with menorrhagia. *Am J Obstet Gynecol*. 2011;204(3):209.e1–7. doi: 10.1016/j.ajog.2010.10.897 [DOI] [PMC free article] [PubMed] [Google Scholar]
18. Cendan MD. Screening and management of bleeding disorders in adolescents with heavy menstrual bleeding: ACOG COMMITTEE OPINION SUMMARY, number 785. *Obstet Gynecol*. 2019;134(3):658–659. doi: 10.1097/AOG.0000000000003412 [DOI] [PubMed] [Google Scholar]
19. Trillo A, Kronenfeld R, Simms-Cendan J, Davis JA, Corrales-Medina FF. High prevalence of congenital factor VII (FVII) deficiency in adolescent females with heavy menstrual bleeding and iron deficiency anemia. *J Pediatr Adolesc Gynecol*. 2022;35(6):647–652. doi: 10.1016/j.jpag.2022.07.013 [DOI] [PubMed] [Google Scholar]
20. Cooke AG, McCavit TL, Buchanan GR, Powers JM. Iron deficiency anemia in adolescents who present with heavy menstrual bleeding. *J Pediatr Adolesc Gynecol*. 2017;30(2):247–250. doi: 10.1016/j.jpag.2016.10.010 [DOI] [PubMed] [Google Scholar]
21. Short MW, Domagalski JE. Iron deficiency anemia: evaluation and management. *Am Fam Physician*. 2013;87(2):98–104. [PubMed] [Google Scholar]
22. Ko CW, Siddique SM, Patel A, et al. AGA clinical practice guidelines on the gastrointestinal evaluation of iron deficiency anemia. *Gastroenterology*. 2020;159(3):1085–1094. doi: 10.1053/j.gastro.2020.06.046 [DOI] [PubMed] [Google Scholar]
23. Richardson M. Microcytic anemia. *Pediatr Rev*. 2007;28(1):5–14. doi: 10.1542/pir.28-1-5 [DOI] [PubMed] [Google Scholar]
24. Gelaw Y, Woldu B, Melku M. The role of reticulocyte hemoglobin content for diagnosis of iron deficiency and iron deficiency anemia, and monitoring of iron therapy: a literature review. *Clin Lab*. 2019;65(12). doi: 10.7754/Clin.Lab.2019.190315 [DOI] [PubMed] [Google Scholar]
25. Corrales-Medina FF, Grant L, Egas-Bejar D, Valdivia-Ascuna Z, Rodriguez N, Mancias P. Cerebral sinovenous thrombosis associated with iron deficiency anemia secondary to severe menorrhagia: a case report. *J Child Neurol*. 2014;29(9):Np62–4. doi: 10.1177/0883073813500715 [DOI] [PubMed] [Google Scholar]
26. Lozoff B, Jimenez E, Hagen J, Mollen E, Wolf AW. Poorer behavioral and developmental outcome more than 10 years after treatment for iron deficiency in infancy. *Pediatrics*. 2000;105(4):E51. doi: 10.1542/peds.105.4.e51 [DOI] [PubMed] [Google Scholar]
27. Tolkien Z, Stecher L, Mander AP, Pereira DI, Powell JJ, Strnad P. Ferrous sulfate supplementation causes significant gastrointestinal side-effects in adults: a systematic review and meta-analysis. *PLoS One*. 2015;10(2):e0117383. doi: 10.1371/journal.pone.0117383 [DOI] [PMC free article] [PubMed] [Google Scholar]

28. Auerbach M, Gafter-Gvili A, Macdougall IC. Intravenous iron: a framework for changing the management of iron deficiency. *Lancet Haematol*. 2020;7(4):e342–e350. doi: 10.1016/s2352-3026(19)30264-9 [DOI] [PubMed] [Google Scholar]
29. Ning S, Zeller MP. Management of iron deficiency. *Hematology*. 2019;2019(1):315–322. doi: 10.1182/hematology.2019000034 [DOI] [PMC free article] [PubMed] [Google Scholar]
30. Caimmi S, Crisafulli G, Franceschini F, et al. Hypersensitivity to intravenous iron preparations. *Children*. 2022;9(10):1473. doi: 10.3390/children9101473 [DOI] [PMC free article] [PubMed] [Google Scholar]
31. Mütze U, Walter M, Keller M, et al. Health outcomes of infants with vitamin B(12) deficiency identified by newborn screening and early treated. *J Pediatr*. 2021;235:42–48. doi: 10.1016/j.jpeds.2021.02.009