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ORIGINAL ARTICLE

Clinical and nutritional assessment of iron deficiency anaemia in children under two years of age

Abeer Mansour Abdel Rasool[1], Abdul Hammeed Subhi Hameed[2], Liqaa Saeed Alkhalidy[3]

[1]Pharmacology Department, College of Pharmacy, University of Ninevah, [2]Al-Khansa Hospital, Nineveh Health Directorate, [3]Department of Environmental Health, College of Environmental Sciences, University of Mosul; Mosul, Iraq

ABSTRACT

Aim To determine the frequency of iron deficiency anemia IDA, its causes, feeding behaviors, and preventive measures among children under the age of two.

Methods This cross-sectional study included 110 children presenting with IDA and compared them with 100 children with normochromic normocytic anemia as the comparison group.

Results Pallor was observed in all patients. Other symptoms included lethargy (83%), anorexia (65%), splenomegaly (27%), delayed milestones (25%), and heart murmurs (30%). The majority of affected children were aged 9–12 months and had weights below the 5th percentile. A strong correlation was found between feeding type and IDA, with highest prevalence in children not receiving milk-based diets. Hemoglobin and serum iron levels were significantly reduced in IDA patients.

Conclusion The study's findings suggest that factors like starting foods early or not getting enough iron from diet or formula milk can increase the risk of iron deficiency anemia (IDA) in children between 9 to 12 months old. This research highlights the role of nutritional strategies like appropriate weaning methods and iron supplementation, in averting IDAs and related health issues.

Key words: anemia, feeding behavior, iron, nutritional assessment, pediatric

INTRODUCTION

Iron deficiency anemia (IDA) is the most prevalent form of anemia among children and young children (1). It appears frequently in children below the age of two years which's a stage for their growth and development. During this period the need for iron surges due, to growth and if there isn't iron consumed or absorbed through diet it can result in iron deficiency anemia (2). The illness is known for causing a decrease, in hemoglobin production that hinders the delivery of oxygen and can lead to symptoms such, as tiredness slowed physical and mental growth and additional issues (3). Iron deficiency, in neonates can occur when the amount of stored iron in their bodies is not enough to meet their growth needs during stages like infancy and adolescence Physiological factors play a significant role in this deficiency since growth is most rapid during these life stages making children and teenagers more vulnerable, to iron deficiency anemia (4).

The reasons, for iron deficiency anemia (IDA) in kids are varied. They Include factors like not getting iron through food intake or having trouble absorbing it properly due to issues like parasitic infections or long-term illnesses like chronic diseases or conditions that may be present in some instances too (5). Recognizing and addressing IDAs soon is crucial to prevent impacts it can have particularly affecting their growth and developmental stages. Diagnosing IDAs typically involves looking out for signs like paleness in the skin tone of children along with symptoms such as being easily irritable and delays in development alongside conducting tests, like measuring levels of hemoglobin and hematocrit in laboratory examinations (6,7). It's suggested begin iron supplements not before 2 months for neonates and 4 months old for full term neonates (7,8). Infants born prematurely or with low birth weight are more likely to develop iron deficiency anemia due to their limited iron storage and reduced ability to absorb iron from breast milk. When they reach six months of age and begin including iron-rich solid foods in their diet, it is recommended to avoid giving them cow's milk, as it lacks sufficient iron and may interfere with its absorption (9-11).

There is lack of information on the prevalence of iron deficiency anemia (IDA). Feeding habits in children under two years old, in the local area offering a fresh outlook by connecting clinical signs with biochemical measures and treatment outcomes.

The aim of this study was to investigate the prevalence and specific features of iron deficiency anemia in children under two years old through observing symptoms and physical assessments.

PATIENTS AND METHODS

Patients and study design

This cross-sectional study was conducted from March 1st to October 15th, 2024, and included 110 children under two years

***Corresponding author:** Liqaa Saeed Alkhalidy
Department of Environmental Health, College of Environmental Sciences, University of Mosul, Mosul, Iraq
Phone: +964 751 536 3497;
E-mail: liqaasaeed@uomosul.edu.iq
ORCID ID: https://orcid.org/0000-0002-4343-5683

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of age who were clinically and biochemically diagnosed with iron deficiency anemia (IDA). A structured questionnaire and clinical assessment were used to evaluate patient symptoms, dietary habits, and growth status. Children were selected based on low hemoglobin and serum iron level, and all underwent laboratory confirmation before inclusion.

The study group consisted of 110 children diagnosed with IDA based on laboratory criteria (hemoglobin < 6 g/dL and serum iron < 30 µg/dL), clinical signs, and exclusion of other causes such as thalassemia. The comparison group including 100 children with normochromic normocytic anemia (a type of anemia not related to iron deficiency) used for comparative purposes in certain hematological assessments.

Participants were divided into four groups based on feeding type: breastfeeding (exclusive natural feeding), artificial feeding (exclusive formula milk), mixed feeding (combination of breastfeeding and formula), mixed diet (inclusion of solid foods along with milk/formula).

Cut-off (12) values for diagnosis were used as follows: hemoglobin level - IDA was defined when Hb < 6 g/dL, indicating moderate to severe anemia; serum iron level - IDA was confirmed with level < 30 µg/dL; total Iron Binding Capacity (TIBC) - was used as a biochemical marker of iron deficiency (12). TIBC is a laboratory measurement that reflects the maximum amount of iron that plasma transferrin can bind. Elevated TIBC level is typically seen in iron deficiency anemia, and in this study, the most frequent value was 170 µmol/L, indicating significant iron depletion.

Children with non-nutritional causes of anemia, such as thalassemia (confirmed by hemoglobin electrophoresis and ferritin levels), or those with normal iron status despite anemia, were excluded from the study group. Children with hemoglobin <7 g/dL received transfusions before beginning oral iron therapy (3–6 mg/kg/day elemental iron).

The parents of the children were interviewed systematically to collect data, on their eating habits and health status.

Methods

Each participant underwent a assessment to detect symptoms linked to IDA. The evaluation involved checking for indicators, like paleness in skin coloration or lips (pallor) inflammation of tongue (glossitis) abnormal heart sounds during heartbeat (murmurs) delayed progress in gross motor skills. The manifestations such, as irritability, loss of appetite (anorexia) and craving to eat food items (pica) were also taken into consideration.

The research examined how children with iron deficiency anemia (IDA) responded to a one-month treatment plan using oral ferrous sulfate. The prescribed dosage was 3–6 mg/kg/day of elemental iron, given once or twice daily, following pediatric guidelines for IDA (13). Patients were followed up for signs of improvement, such as increased hemoglobin level, reduced fatigue, and improved skin color. Five children who did not show expected clinical or blood test improvements underwent further evaluation, including hemoglobin electrophoresis (14) and serum ferritin testing (15). These tests confirmed that they had thalassemia, not nutritional IDA, so they were excluded from the study group. Additionally, five other patients had normal iron levels despite being anemic, suggesting that their anemia was not due to iron deficiency and they were also excluded from the study. Some patients with severe IDA (with hemoglobin below 7 g/dL) needed blood transfusion before starting iron therapy to stabilize their condition.

Statistical analysis

The research employed both inferential techniques and descriptive methods in its analysis approach. The descriptive statistics focused on presenting participants' characteristics and feeding habits using measures like frequencies, percentages, means, and percentiles to provide a clearer view of the data distribution. Inferential statistics, such as the χ^2 test, were used to explore associations between feeding practices and the prevalence of iron deficiency anemia (IDA), as well as to identify any significant differences in IDA occurrence across different age groups. To compare hemoglobin and serum iron levels among different groups, independent T-tests and one-way ANOVA were utilized where appropriate. A significance threshold of $p<0.05$ was considered statistically significant.

RESULTS

Among the 110 patients diagnosed with iron deficiency anemia (IDA), pallor was observed in 100% of cases, making it the most consistent clinical sign. Lethargy was reported in 91 (84%), followed by anorexia in 73 (66%) and irritability (inutility) in 66 (60%) children. Other noted symptoms included heart murmur (27%), pica (26%), splenomegaly (24%), and delayed developmental milestones (22%).

Table 1. Distribution of age groups, clinical signs, and body weight centiles in patients with iron deficiency anemia (IDA)

Variable	No (%) of children
Age Group (months)	
1–8	5 (4.5)
9–12	35 (32)
13–16	20 (18)
17–21	33 (30)
22–24	17 (15)
Clinical signs and symptoms	
Pallor	100 (90.9)
Lethargy	84 (76.4)
Anorexia	66 (60.0)
Irritability	60 (54.5)
Heart murmur	27 (24.5)
Pica	26 (23.6)
Splenomegaly	24 (21.8)
Delayed milestones	22 (20.0)
Atrophy of tongue papillae	20 (18.2)
Koilonychia	14 (12.7)
Cardiac dilatation	4 (3.6)
Heart failure	2 (1.8)
Body weight centile range	
>50th	4 (3.6)
10th–50th	6 (5.5)
5th–10th	20 (18.2)
<5th	70 (63.6)

Less common findings included atrophy of tongue papillae (20%), koilonychia (14%), cardiac dilatation (4%), and heart failure (2%).

In terms of growth status, a significant proportion, 77 (70%) children, fell below the 5th weight percentile, indicating a strong association between IDA and undernutrition. The age group most affected was 9–12 months, 35 (32%), highlighting this as a critical period for early detection and intervention (Table 1).

A strong association was found between type of feeding and IDA prevalence, with non-milk diets accounting for 77 (70%) of affected cases (Table 2).

Table 2. Distribution of patients by feeding type

Feeding type	No (%) of children
No milk (milk diet)	42 (61.8)
Mixed	30 (45.4)
Breastfeeding	22 (32.0)
Artificial	36 (52.7%)

Most patients had hemoglobin level <6 g/dL and serum iron <30 µg/dL, reflecting severe anemia (Table 3 and 4).

Table 3. Distribution of patients by hemoglobin level

Hemoglobin level (gm/dL)	No (%) of children
6	8 (7.3)
5	15 (13.6)
4	20 (18.2)
3	22 (20.0)
2	21 (19.1)
1	24 (21.8)

Table 4. Distribution of patients by serum iron level

Serum Iron Level (µmol/L)	No (%) of children
6	5 (4.5)
5	10 (9.1)
4	7 (6.4)
3	5 (4.5)
2	41 (37.3)
1	43 (39.1)

Variability in total iron binding capacity (TIBC) level was also observed, with the highest frequency at 170 µmol/L (Table 5).

Table 5. Distribution of patients by total iron binding capacity (TIBC) level

TIBC Level (µmol/L)	No (%) of children
200	6 (5.5)
180	13 (11.8)
170	20 (18.2)
150	7 (6.4)
140	10 (9.1)
120	11 (10.0)
90	3 (2.7)

DISCUSSION

The study's observations of iron deficiency anemia (IDA) emphasize the diversity of symptoms associated with the condition, ranging from mild to severe manifestations. These findings align with existing literature highlighting the impact of iron deficiency on health, both immediate and long-term. Pallor, found in all participants, remains a key diagnostic indicator, resulting from reduced oxygen transport due to low hemoglobin (11,12).

Lethargy, observed in 83% of patients, further supports the link between anemia and decreased energy and physical capacity (12). Anorexia, present in 65% of cases, is consistent with gastrointestinal disturbances caused by iron deficiency, which further exacerbates nutritional deficits (13). Delayed milestones in 25% of children underscore iron's crucial role in neurodevelopment and motor skills, reinforcing the need for early diagnosis and management (1).

Splenomegaly, found in 27% of cases, may result from increased clearance of defective red blood cells in prolonged anemia (14). Additionally, 61% of children showed poor functional ability due to weakness and fatigue. Heart murmurs in 30% of cases could indicate the cardiovascular system's adaptation to chronic hypoxia (15).

Pica was reported in 30% of the children, a behavioral symptom often associated with iron deficiency and disturbed appetite regulation (16,17). Atrophic tongue papillae (27%) and koilonychia (18%) further reflect systemic effects of chronic iron deficiency on epithelial tissues (18,19).

Cardiac complications like dilatation (5%) and heart failure (3%) may reflect severe and prolonged anemia, leading to compensatory strain on the heart muscle (20).

The age group analysis revealed a peak in IDA prevalence at 9–12 months (25%), coinciding with depleted neonatal iron storage and suboptimal dietary iron intake during weaning (21). Lower IDA prevalence at 1–8 months (4%) was likely due to adequate iron in breast milk and/or fortified formulas. The IDA rise in prevalence at 13–21 months may be attributed to poor weaning practices, while the decline at 22–24 months (13%) may reflect improved feeding practices or maternal education. These patterns highlight the need for targeted nutritional support during dietary transitions (22).

Our findings further indicate a strong correlation between feeding type and IDA risk. Children on non-milk- or cow's milk-based diet exhibited the highest rates of anemia. Cow's milk is low in iron and may inhibit absorption or cause gastrointestinal blood loss (23,24). In contrast, exclusive breastfeeding for six months appears protective, though prolonged exclusivity without iron-rich food introduction may increase risk (25).

The observed hemoglobin level (especially 1–3 g/dL) highlight the severity of anemia in our patients and the need for urgent interventions like iron supplementation or transfusion. Level between 4–6 g/dL also point to moderate anemia requiring monitoring and dietary correction (1).

Variations in TIBC values, with peaks around 170 µmol/L, support the diagnosis of IDA and reflect varying iron status among patients. Elevated TIBC is a hallmark of iron depletion, requiring tailored interventions to address dietary and physiological causes (26).

IDA continues to be an issue that affects young children under the age of two and can be avoided with proper care and attention to nutrition practices such as introducing iron

rich foods and supplements in a timely manner as preventive measures are essential for ensuring the wellbeing of these children in the long run, through early detection and necessary actions to address any developmental concerns that may arise over time.

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