ORIGINAL ARTICLE

FREQUENCY OF IRON DEFICIENCY IN CHILDREN WITH HYPOCHROMIA AND MICROCYTOSIS ON BLOOD SMEARS

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ABSTRACT

Background: The relationship between iron deficiency and certain phenomenon like hematological alterations, inadequate growth, altered thermoregulatory function and reduced cognitive function have been well known.

Objective: To determine the frequency of iron deficiency in children with hypochromic and microcytic anemia on blood smears.

Methods: This case-control study was performed in the department of pediatrics, xyz Hospital, from May 2022 to April 2023. For cases, we included 179 children of both genders aged between 1 month and 15 years with hypochromia and microcytosis. Similar number of healthy children (n=179) of both gender and aged below 15 years were enrolled as controls. At the time of enrollment, socio-demographic information like gender, age and residential area were recorded. Local institutional laboratory was utilized for the hematological parameters. Hypochromia and microcytosis were labeled as MCV< 76fl and MCHC < 30 g/dl of red cells while blood film also depicted hypochromia and microcytosis. IDA was termed as serum ferritin < 12 ng/dl.

Results: In a total of 358 children, there were 192 (53.6%) boys. The mean age was 7.8±3.2 years while 184 (51.4%) children were between 6-15 years. Residential status of 196 (54.7%) children was rural. Overall, iron deficiency was diagnosed in 209 (58.4%) children. Among cases, 171 (95.5%) children had iron deficiency while among controls, 38 (21.2%) children had IDA (p<0.0001). Cases and controls were compared for various hematological laboratory parameters and statistically significant differences were observed for all parameters among cases and controls (p<0.0001).

Conclusion: The frequency of iron deficiency was 95.5% among children with hypochromia and microcytosis on blood smears. Hematological parameters were significantly deranged among children with hypochromia and microcytosis when compared to healthy children.

Keywords: Anemia, hemoglobin, hypochromia, iron, iron deficiency, microcytosis, serum ferritin.

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INTRODUCTION

Iron deficiency and anemia are the most important issues of contention for the entire world.[1] The relationship between iron deficiency and certain phenomenon like hematological alterations,

inadequate growth, altered thermoregulatory function and reduced cognitive function have been well known. Moreover, brain myelination also needs adequate prenatal iron.[2] In children, iron plays an important role in linear growth while among iron-deficient mothers, the occurrence of infant mortality and still birth is higher.[3] Maternal hemoglobin concentration has also been found to have a close relationship with birth weight as well as with preterm birth.[4]

Iron deficiency is frequently caused by nutritional deficiency or underlying illnesses and commonly exhibits as reduction in the measures of hemoglobin, red blood cell (RBC) count, packed cell volume (PCV), mean cell volume (MCV), mean cell hemoglobin (MCH), and mean cell haemoglobin concentration (MCHC).[5] Anisocytosis, microcytosis, hypochromia, and pencil cells are shown in a blood smear examination. The survival of red cells is reduced to 45-85 days, which is a significant decrease.[6] The absence of iron stores and erythroid hyperplasia is shown in the normocellular bone marrow and normal or decreased levels of serum iron, elevated total iron binding capacity (TIBC) and low transferrin saturation are manifested. Mainly, iron is stored in the body as ferritin, and a reduction in its level has an important role in making an investigation for iron deficiency.[7,8]

A study from Nepal revealed the prevalence of iron deficiency to be 35% in anemic patients.[9] In Pakistan, not much work analyzing the frequency of iron deficiency in children with hypochromic and microcytic anemia is known so this study was done to determine the frequency of iron deficiency in children with hypochromic and microcytic anemia on blood smears.

METHODS

This case-control study was performed at the department of pediatrics, xyz Hospital, from May 2022 to April 2023. Approval from "Institutional Ethical Committee" was taken. We obtained informed and written consents from parents/caregivers. Considering the frequency of iron deficiency as 35% in anemic patients[9] with 95% confidence level and 7% margin of error, the sample size turned out to be 179.

For cases, we included 179 children of both genders aged between 1 month and 15 years with hypochromia and microcytosis. Similar number of healthy children (n=179) of both gender and aged below 15 years were enrolled as controls. At the time of enrollment, socio-demographic information like gender, age and residential area were recorded. Local institutional laboratory was utilized for the assessment of important investigations like hemoglobin evaluation, RBC, Platelets count, PCV, MCV, MCH, MCHC, serum iron, TIBC and serum ferritin. Plasma iron and TIBC were evaluated calorimetrically. Quantification of ferritin was done using one-step immunoenzymatic assay. All laboratory investigations were performed in the institutional laboratory adopting standard protocols. Hypochromia and microcytosis were labeled as MCV< 76fl and MCHC < 30 g/dl of red cells while blood film also depicted hypochromia and microcytosis. IDA was termed as serum ferritin < 12 ng/dl.

Data analysis was done using "Statistical Package for Social Secrecies (SPSS)", version 26.0. Representation of qualitative variables was done through frequency and percentages while quantitative data was shown mean and standard deviation. Qualitative data was compared using independent sample t-test whereas chi-square test was performed for the comparison of categorical data. P-value < 0.05 was considered significant.

RESULTS

In a total of 358 children, there were 192 (53.6%) boys. The mean age was 7.8±3.2 years while 184 (51.4%) children were aged between 6-15 years. Residential status of 196 (54.7%) children was rural. Table-1 is showing comparison of baseline characteristics of children among cases and controls.

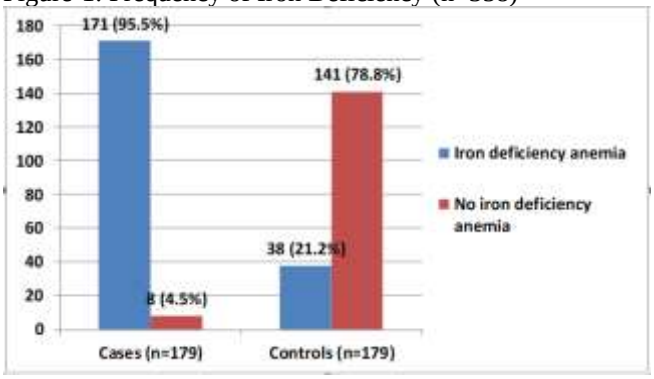
Table-1: Comparison of Baseline characteristics (N=358)

Baseline characteristics		Cases (n=179)	Controls (n=179)	P-value
Gender	Boy	98 (54.7%)	94 (52.5%)	0.6716
	Girl	81 (45.3%)	85 (47.5%)	
Age	<1	21 (11.7%)	14 (7.8%)	0.1338
	1-5	61 (34.1%)	78 (43.6%)	
	6-15	97 (54.2%)	87 (48.6%)	
Residence	Rural	104 (58.1%)	92 (51.4%)	0.2026
	Urban	75 (41.9%)	87 (48.6%)	

Overall, iron deficiency was diagnosed in 209 (58.4%) children. Among cases, 171 (95.5%) children

had iron deficiency while among controls, 38 (21.2%) children had IDA (p<0.0001) as shown in figure-1.

Figure-1: Frequency of Iron Deficiency (n=358)



Cases and controls were compared for various hematological laboratory parameters and statistically significant differences were observed for all parameters among cases and controls (p<0.0001) as shown in talbe-2.

Table-2: Comparison of Laboratory Parameters (N=358)

Parameters	Cases (n=179)	Controls (n=179)	P-value
Hemoglobin (g/dl)	8.4±1.8	11.3±0.8	<0.0001
RBC (x^{10}/l)	4.2±0.8	4.6±0.5	<0.0001
PCV (I/I)	26.1±5.6	36.8±3.3	<0.0001
MCV (fl/cell)	67.3±6.9	80.4±4.1	<0.0001
MCH (pg/cell)	17.8±2.6	27.2±2.4	<0.0001
MCHC (g/dl)	26.6±2.9	32.5±1.2	<0.0001
Serum Iron (ug/dl)	37.1±12.7	78.4±12.0	<0.0001
TIBC (ug/dl)	468.4±71.8	339.8±31.6	<0.0001
Serum ferritin (ng/ml)	7.9±4.6	88.6±61.3	<0.0001

DISCUSSION

The prevalence of iron deficiency is widespread, particularly in underdeveloped nations and people of all ages and socioeconomic backgrounds are impacted.[10,11] The extremely young, people with poor diets, and those who are close to becoming mothers are more likely to have it. Given that iron deficiency is more prevalent in developing nations especially in Asia and Africa, there is a need to identify the presentation, extent and underlying causes of iron deficiency.[12]

Bellamy and Gedney discovered functional iron shortage in 35% of individuals receiving treatment for serious illnesses.[13] Iron deficiency was shown by Paracha et al. to be the primary cause of anaemia in children under the age of two.[14] Another study noted that 62% of kids with MCV<70 had iron insufficiency.[15] In our study, 58.4% of the children had an iron deficit. James et al. used MCV<75 and hemoglobin<10.5 g/dl as indicators of iron insufficiency in children.[16] Hematological indicators were significantly deranged in this study among cases compared to controls, and our results are similar with those found in the published literature.[17] Hemoglobin concentration and red cell variables are not accurate indicators of iron deficiency anemia, but they are straightforward and simple to detect at a community clinic.[18] Hemoglobin reflects both stored and functional iron, which may account for its poor ability to distinguish between iron shortage, particularly in its early stages. A helpful late sign of an iron shortage is hemoglobin.[19]

When comparing iron deficient individuals to healthy controls, Reinhart found a substantial anisocytosis (p=0.005).[20] We discovered that all individuals with iron deficiency had anisocytosis, hypochromia, and microcytosis. Jacobs et al noted that iron-deficient individuals had blood iron levels of 20.47.8 ug/dl.[21] The mean blood ferritin level in this research was 7.9±4.6 ng/ml. In a recent study by Sherali A et al while screening children for iron deficiency anemia, 763.2% had serum ferritin below 12 ng/ml which emphasizes that there is a need for the screening of serum ferritin levels among children who are suspected to have iron deficiency.[22] In this study, when the mean serum ferritin values of patients with iron deficiency and controls were compared, the difference was extremely significant (p<0.0001). In the situation where hypochromia and/or microcytosis coexist with a normal serum ferritin level, the hematological response to a diagnostic trial of intravenous iron replacement therapy could be crucial in validating or refuting a provisional diagnosis of iron deficiency anaemia with everything it implies for future management.[23]

Being a single center study with a relatively small sample size, the findings of this study cannot be generalized. There is need for prospective trials to determine the impact of iron deficiency among local pediatric population.

CONCLUSION

The frequency of iron deficiency was 95.5% among children with hypochromia and microcytosis on blood smears. Hematological parameters were significantly deranged among children with hypchromia and microcytosis when compared to healthy children.

Ethical Approval: *Submitted*

Conflict of Interest: *Authors declare no conflict of interest.*
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