

Original Research Article

Iron deficiency anemia among hospitalized children in a rural teaching hospital: a cross sectional study

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ABSTRACT

Background: Iron deficiency anemia is the most common nutritional deficiency disorder in the world. The present study was conducted to know the prevalence and severity of iron deficiency anemia among of 6 months to 60 months old children. A large proportion of iron deficiency is preventable with appropriate and timely intervention.

Methods: This cross-sectional study was done on 100 children clinically suggestive of anemia with hemoglobin level less than 11gm/dl admitted in pediatrics ward of tertiary care hospital. 5 ml of blood sample was taken and complete hemogram, peripheral blood film and serum ferritin estimation was done. Case were studied in reference to history, age, clinical examination, hemoglobin level and confirmation of iron deficiency anemia was done by serum ferritin levels.

Results: The prevalence of iron deficiency anemia in present study was 56%. It was most prevalent in the age group of 6 to 24 months. Exclusively breastfed children showed higher prevalence of iron deficiency anemia in present study, however no statistical correlation was found. Low Serum ferritin levels have statistically significant result with socioeconomic status, with as many as 69.4% suffering from iron deficiency anemia belonging to low socioeconomic status.

Conclusions: Prevalence of iron deficiency anemia remains alarmingly high and major health problem in our country. All anemia are not iron deficiency anemia. Low socioeconomic status is a huge hurdle in child health and greatly influences prevalence of iron deficiency anemia. Serum ferritin is a most sensitive marker of iron deficiency anemia, helps diagnose it early in its course, which can be missed on clinical or routine blood investigations.

Keywords: Hypoferritinemia, Iron deficiency anemia, Prevalence, Socioeconomic status

INTRODUCTION

Iron deficiency anemia is the most common nutritional deficiency disorder in the world, reported to affect 50-60% of young children and pregnant women and 20-30% of non-pregnant females in developing countries.¹ Iron deficiency may be due to inadequate dietary iron intake, low absorption of iron because of small bowel pathology,

increased physiological requirements during growth spurts of infancy and adolescent and chronic blood loss usually from GI tract or because of menorrhagia in adolescent girls.³

As per WHO anemia defined as reduced hemoglobin level to less than 11g/dl in children aged 6 months to 60 months.⁴ In the clinical practice and also for diagnosis in

the hematological laboratories anemia constitutes a common problem. It can neither be called as a diagnosis in itself nor can be termed as a specific entity but is a manifestation of underlying disease process which is often related to the severity of disease process.⁵

Iron deficiency anemia and even iron deficiency without significant anemia, affects attention span, alertness and learning in both infants and adolescents. It leads to serious health problems such as poor cognitive, motor development and behavioral problems in children. Iron deficiency anemia affects neurological development by altering motor functions, decreasing learning ability, and permanently reducing the number of dopamine receptors and serotonin levels. The neurological changes that occur due to iron deficiency may be long term or even irreversible.⁶

The diagnosis of iron deficiency anemia can be done on the basis of clinical evaluation as well as laboratory diagnosis. Pallor being the most prominent and characteristic feature. Laboratory investigations done to diagnose iron deficiency anemia include complete blood counts, PBF (peripheral blood film), MCV (mean corpuscular volume), MCH (mean corpuscular hemoglobin), MCHC (mean corpuscular hemoglobin concentration), RDW (red cell distribution width), serum iron, serum ferritin, TIBC (total iron binding capacity), transferrin saturation. Despite several laboratory test available for its detection, mild iron deficiency is frequently undetected by hemoglobin or haematocrit method.⁷

The measurement of serum ferritin, in addition to be a confirmatory has particular characteristics of being the only test able to identify risk subjects before they become symptomatic. Interpretation of serum ferritin levels act as an indicator of the relative extent of depletion of iron stores. As per WHO the generally accepted cut-off level for serum ferritin, below which iron stores are considered to be depleted, is <12ng/ml and <30ng/ml in case of infection⁸.

In a young growing child, who has got a very delicate balance between iron stores, great requirements and limited supply, it is very essential to diagnose iron deficiency at a stage before it result in microcytic hypochromic anemia.

The present study is to know the prevalence of Iron deficiency anemia in the children of 6 months to 60 months of old confirmed by both hemoglobin and serum ferritin levels so as to diagnose anemia at an early age and to take the steps to minimize the sufferings of children and others who are concerned about them.

METHODS

This was a cross sectional, hospital-based study carried out at department of Pediatrics, Maharishi

Markandeshwar institute of medical sciences and Research, Mullana, Ambala Haryana over a period of two year from December 2014 to November 2016.

This study was conducted on 100 children in the age group of 6 months to 60 months who were hospitalized in pediatrics ward for some other illness, but incidentally were found to have anemia. These were subjected to s. ferritin levels, complete blood count and red cell indices.

The WHO criterion (hemoglobin <11 g/dL) was used to diagnose anemia.⁴ To categorize the degree of anemia, the following cut-off points were used: 10.0-10.9 g/dl - mild anemia; 7.0-9.9 g/dl - moderate anemia; <7 g/dl - severe anemia. Since acute infections were not ruled out, cut off for S. ferritin <30ng/dl was taken as hypoferritinemia according to the WHO guidelines, hence diagnosed as iron deficiency anemia (IDA). Case were studied in reference to history, age, clinical examination, hemoglobin level, and confirmation of iron deficiency anemia will be done on the basis of serum ferritin levels. Children suffering from proven hemoglobinopathies and hemorrhagic disease were excluded. Written consent was obtained from guardians.

5 ml of venous blood was drawn under aseptic precautions in a sterile sample collection vial and serum was separated by centrifugation and was used for complete blood count and s. ferritin analysis. Hemoglobin, red blood cells count, platelet count, RBC indices, MCV, MCHC, MCH, were estimated using automated cell counter method using SYSMEX automated hematology analyser B226 04/2009 Japan. The principal of cell counting, and cell sizing is based on the detection and measurement of changes in electrical resistance produced by a particle suspended in a conductive diluent traversing a small aperture. A blood smear stained with Leishman's stain is examined under oil immersion lens, for study of white blood cells.

Peripheral film was read by a pathologist and on the basis of characteristics of cells, peripheral blood picture was labeled as Microcytic hypochromic, Microcytic normochromic or Normocytic Normochromic type. Serum ferritin measured by chemiluminescence immunoassay (Lilac Acculite CLIA) method.

Statistical analysis

Appropriate data entry and statistical analysis were performed on Microsoft excel using social package for social science (SPSS) version 21.0. Data was summarized using descriptive statistics.

Continuous variables were presented as mean and standard deviation (SD) while categorical variables as number and percentage. Chi-square test and "t" test were performed to compare the relationship among two or more categorical variables. A p value of <0.05 was taken as statistically significant.

RESULTS

In this study 42% cases were male and 58% were female. In gender wise distribution in present study 50% male and 60.3% female were suffering from IDA. There was no statistical significance (p value >0.05) of gender with IDA (Table 1).

Table 1: Gender wise distribution of iron deficiency anemia (serum ferritin <30ng/ml).

Sex-wise distribution of IDA	Serum ferritin <30ng/ml	Serum ferritin ≥30ng/ml	p value (Pearson chi square test)
Male children	No. 21 % 50%	21 50%	>0.05 (0.304)
Female children	No. 35 % 60.3%	23 39.7%	
Total children	Total 56 % with in sex 56%	44 44%	

No statistical significant correlation between gender and IDA.

Children were grouped on the basis of age, and 60% belonged to the age group 6 months to 24 months, 17% to 25 months to 36 months age group and 23% to 37 months to 60 months age group. Iron deficiency anemia was more prevalent in age group 6 months to 24 months being 65% (39/60); 25-36 months had prevalence of 41.2%

(7/17) and 37-60 months with a prevalence of 43.5% (10/23) and a p value (0.084) showing no statistical significance between age and serum ferritin levels (Table 2).

Table 2: Age wise distribution of iron deficiency anemia (serum ferritin levels<30ng/ml).

Age group (in months)	Serum ferritin <30ng/ml	Serum ferritin ≥30 ng/ml	Total children	p value (Chi-square Test)
6-24	39 (65%)	21	60	>0.05 (0.084)
25-36	07 (41.2%)	10	17	
37-60	10 (43.5%)	13	23	
Total	56	44	100	

Children included in the study were graded on the basis of severity of anemia on the basis of hemoglobin levels. Majority of the children (46%) suffered from moderate anemia (Hb 7- 9.9gm/dl), 37% mild and only 17% suffered from severe anemia (Hb<7gm%). 54.1% (20/37) children with IDA fall into mild anemia (Hb 10-10.9gm%), 54.3% (25/46) in moderate (7-9.9gm/dl) and 64.7% suffering from severe anemia with p value 0.730 showing no statistical significance to severity of anemia and serum ferritin levels (Table 3).

Table 3: Distribution of iron deficiency anemia (serum ferritin levels<30ng/ml) on the basis of severity of anemia.

Severity of anemia (Hb in g/dl)	Serum ferritin <30ng/ml	Serum ferritin ≥30 ng/ml	Total children	p value (Chi-square Test)
Mild (10-10.9)	20 54.1%	17 45.9%	37 100%	>0.05 (0.730)
Moderate (7.0-9.9)	25 54.3%	21 45.7%	46 100%	
Severe (<7.0)	11 64.7%	06 35.3%	17 100%	
Total	56 (56%)	44 (44%)	100 (100%)	

Above results showing no statistical significance to severity of anemia and serum ferritin levels.

Table 4: Correlation between exclusive breast feeding and iron deficiency anemia (serum ferritin <30ng/ml).

Breast feeding for 4-6 months	Serum ferritin <30ng/ml	Serum ferritin ≥30ng/ml	Total	p value
Yes	No of children 32 % 52.5%	29 47.5%	61 100%	>0.05 (0.372)
No	No of children 24 % 61.5%	15 38.5%	39 100%	
Total	No of children 56 % 56%	44 44%	100 100%	

This table gives the relation between exclusive breastfeeding and IDA, showing 61.5% children breastfeed but suffering from IDA.

Table 5: Profile of iron deficiency anemia on the basis of diet.

Diet	Hypoferritinemia (serum ferritin <30ng/ml)	Serum ferritin ≥30ng/ml	P value
Mixed	22	17	>0.05 (0.974)
Veg	34	27	
Total	56	44	100

Dietary habits of children do not show a relation with iron deficiency anemia according to present study.

More than half of the children (61%) were not exclusively breastfed for 4 to 6 months and were weaned off early. In present study 61.5% children who were breastfed for up to 4-6 months still developed iron deficiency anemia (Table 4). Dietary habits of children

do not show a relation with IDA according to present study, showing 56.4% (22/39) cases with mixed diet and 55.7% (34/61) with vegetarian diet with a p value of 0.97, showing no statistical significance between diet and IDA in present study (Table 5).

Children were also grouped on the basis of socio economic status according to modified kuppuswamy classification showing 36% in lower class, 32% each in both middle and upper class. However, socioeconomic status showed a significant correlation with IDA having p value of 0.024 (<0.05), prevalence of IDA progressively decreasing with improving socioeconomic status. 69.4% (25/36) children from lower socioeconomic status suffered from IDA, followed by 59.4% (19/32) children of middle and 37.5% (12/32) of upper class (Table 6).

Table 6: Iron deficiency anemia (Hypoferritinemia) on the basis of socio-economic status.

Socio-economic status (as per modified Kuppuswamy classification)	S. ferritin<30ng/ml	S. ferritin ≥30ng/ml	Total	p value
Lower	25	11	36	<0.05 (0.027)
Middle	19	13	32	
Upper	12	20	32	
Total	56	44	100	

However socioeconomic status showed a significant correlation with IDA having p value of 0.027, prevalence of IDA progressively decreasing with improving socioeconomic status.

Out of 56 children suffering from IDA (hypoferritinemia), 45 children had microcytic hypochromic peripheral blood film (PBF); i.e. microcytic hypochromic RBCs. However, 11 children, only showed hypoferritinemia and no PBF changes. and out of 72 children with microcytic hypochromic PBF; 45 had IDA, rest 27 had other types of anemia. it clearly concludes that serum ferritin is a sensitive marker of IDA and helps identify iron deficient children even before any red cell changes appear (Table 7).

Table 7: Comparison of children with microcytic hypochromic peripheral blood film and serum ferritin levels.

S. Ferritin (ng/ml)	Microcytic hypochromic Peripheral Blood Film (PBF)		Total
	Yes	No	
<30	45	11	29
≥30	27	17	44
Total	72	28	100

This table help us conclude that serum ferritin is a sensitive marker of IDA and that its levels fall even before any cell changes are evident. Also, that all microcytic hypochromic PBF are not IDA, and it should be confirmed by serum ferritin levels. All the children taken in the study had anemia clinically and with Hb levels <11g/dl iron deficiency anemia was

confirmed in children with serum ferritin levels below 30ng/ml (cut off value by WHO in children with infection). The overall prevalence of IDA in present study was 56% (Figure 1).

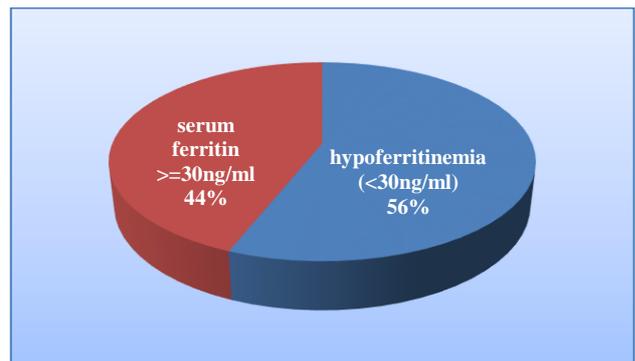


Figure 1: Number of children with iron deficiency anemia (serum ferritin <30ng/ml).

DISCUSSION

Iron deficiency anemia is the most common nutritional deficiency disorder in the world in the amongst Anemia.² The present study was conducted to know the prevalence and severity of iron deficiency anemia among of 6 months to 60 months old children. The irreparable

damage that anemia in childhood can cause on one hand and the knowledge and mechanism available for control on the other, makes this silent morbidity completely unacceptable in modern times where we strive for millennium development goals.

There are no current estimates of total iron deficiency anemia cases, but based on anemia is an indicator, it is estimated that most pre-school children in developing countries are iron deficient, because anemia is the indicator used for screening iron deficiency, the terms, 'anemia', 'iron deficiency' and iron deficiency anemia are often used interchangeably.

The prevalence of iron deficiency anemia on the basis of hypoferritinemia (<30ng/ml) among present study cases is 56%. This is less than 66% prevalence in under 5 years children studied, by Hanumante et al.⁹

However, 90% of the cases in this study had low S. ferritin levels. studies done prior to 1985 in India, also gave a lot of significance to hypoferritinemia in diagnosing iron deficiency anemia; by national institute of nutrition, Rao VRK, Singla PN et al gave an average prevalence rate of 68% of iron deficiency anemia in pre-school children.¹⁰⁻¹² According to a study by national nutrition monitoring bureau in 2003 anemia prevalence among children one to five years of age is around 66%, with a wide range of 33-93% across different states.¹³

Our prevalence is in accordance to WHO, giving a prevalence of iron deficiency of anemia of 10-20% in industrialized countries and 50-60% in non-industrialized countries, India falling in latter category (WHO 2001). Globally the prevalence of IDA in the preschool children (0-59 month) is 47.4% (WHO 1993-2005, WHO 2008).

There was no statistical significance of gender with iron deficiency anemia. Similar result were found in a study done by Kadivar MR et al in southern Iran.¹⁴ Bratlid D et al and Birdah MM et al where no statistically significant results were found between iron deficiency anemia and gender.^{15,16} However, Keikhari B et al in their study in southern Iran and Kaur IP and Kaur S in their study in India found a statistical significant correlation between gender and iron deficiency anemia and girls bearing the brunt of the disease.^{17,18} on other hand Torres MA et al and Oliveira RS et al reported iron deficiency anemia to be more common in boys.^{19,20}

In present study the prevalence of IDA being highest in children aged 6 months to 24 months, finding being consistent with studies done by Veira AC et al, Keikhari B et al, Passicha SR et al and Tengo LW et al.^{17,21-23} Hence concluding that the youngest children have highest prevalence of iron deficiency anemia due to rapid growth and expanding red cell mass. Data according to NFHS III study also supports the highest prevalence of IDA among 6-23 months of age.

In present study, 61.5% children who were breastfed for up to 4-6 months still developed hypoferritinemia (IDA). However no statistically significant correlation between s. ferritin levels and breast feeding for first 4-6 months was established (p value >0.005). Similar results were obtained in a study by Kadiver MR et al and Kotecha PV et al, regarding breastfeeding and serum ferritin levels, supporting present high prevalence of IDA in exclusively breast-fed children.^{14,24}

In present study socio economic status showed a significant correlation with low serum ferritin levels (p value <0.005). The number of iron deficiency anemia diagnosed on the basis of low serum ferritin level progressively decreased with rising socio-economic status; as many as 69.4% (25/36) children suffering from hypoferritinemia belonged to low socioeconomic status group. similar results were obtained by Verina M et al and Bharti S et al in their study.^{25,26}

In present study out of the 56 (56%) children diagnosed an iron deficiency anemia on the basis of Hemoglobin <11gm% and hypoferritinemia (serum ferritin levels <30ng/ml); 45 out of them showed microcytic hypochromic RBCs with all the characteristics of IDA; but the rest of the 11 children having hypoferritinemia, did not show microcytic hypochromic peripheral blood film changes of iron deficiency anemia, hence confirming serum ferritin as a sensitive marker of IDA, even before any peripheral blood film changes being evident. similar emphasis on serum ferritin being the only reliable and sensitive parameters for diagnosing iron deficiency anemia, has been put forth by Khan AS and Shah SA in their study on iron deficiency children and significance of serum ferritin in 2005.²⁷ When significant inflammation is present, serum ferritin levels may not reflect accurate iron stores. The serum ferritin being a sensitive marker is a boon to diagnose IDA in early stages, as the manifestations of anemia or microcytosis is usually delayed, relative to the loss of body iron stores.

CONCLUSION

Prevalence of iron deficiency anemia remains alarmingly high and major public health problem in our country. All anemia are not iron deficiency anemia. Prevalence of iron deficiency anemia (56%) noted in present study is in accordance to the data by WHO, NFHS III, and national nutrition monitoring bureau. Low socioeconomic status is a huge hurdle in child health and greatly influences prevalence of iron deficiency anemia.

Serum ferritin is a most sensitive and early marker of iron deficiency anemia, helps diagnose it early in its course, which can be missed on clinical or routine blood investigations. National efforts to alleviate the burden of IDA should involve both short term vertical programs such as iron supplementation and long term horizontal programs including wheat flour fortification.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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