ORIGINAL ARTICLE

Paedriatics Section

A study on the **Iron status** In **Iron Deficiency Anaemia** one month before and after **Iron Therapy** in school going children

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ABSTRACT

Objective

1) To determine the iron status (Hb, MCV, MCH, MCHC, RDW, Serum Iron, TIBC and Serum Ferritin) before iron therapy in school going children.

2) To determine the haemoglobin concentration after one month of iron therapy in children whose haemoglobin concentrations were lower for the given age and sex.

3) To evaluate the therapeutic outcomes of the oral iron therapy.

A total of hundred anaemic children from three government schools of Raipur city were subjected to anthropometric, iron status and clinical examinations before they underwent iron therapy and the response to therapeutic iron was assessed by the estimation of the haemoglobin percentage after one month following the administration of ferrous sulphate, 6mg/kg body weight along with folic acid. Not a single patient withdrew from the study because of adverse effects.

A significant increase in the haemoglobin ($p<0.009$) level was observed in both boys and girls after 30 days of iron supplementation.

A total of hundred anaemic children were subjected for the study. In all the 100 children, clinical pallor was the first finding (in 100%), followed by fatigue (in 54%), weakness (in 38%), anorexia (in 18%) and icterus (in 5%). The commonest blood picture was that of microcytic hypochromic. Age dependent MCV, MCH, MCHC and RDW showed that the maximum number of cases had below normal MCV, MCH and MCHC values. RDW values were increased in 74% cases, 82% cases had serum iron values below normal (<50µg/dl) and 91% cases had TIBC values above the normal range. The serum ferritin levels in 35% children was <15ng/ml (in 18% boys and in 17% girls). The nutritional status according to the IAP classification showed that by weight, 19% children were well nourished and that 81% were undernourished. The mean and SD of Hb before therapy was 8.60 ± 2.05 and after therapy, it was 9.55±1.88 respectively.

An early diagnosis of anaemia can be made by assessing the serum ferritin levels and this has been found to be more reliable. If iron is given in the early stages of anaemia to children, the response is quite significant.

Key Word: Anthropometric, MCV (Mean corpuscular volume), MCHC (Mean corpuscular haemoglobin concentration), MCH(Mean corpuscular haemoglobin), Serum ferritin.

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INTRODUCTION

One of the commonest forms of nutritional anaemia which is recognized throughout the world is iron deficiency anaemia. It is responsible for a higher incidence of morbidity because of the lack of proper investigation and prophylactic and therapeutic measures. The estimated prevalence of anaemia is 12% in developed countries, as compared to 51% in the developing countries.

There is a high prevalence of iron deficiency in our country amongst the preschool children. ICMR has shown that as many as 63% of the children between 1-3 years and 44% between 3-5 years have subnormal Hb levels [1]. According to the WHO, anaemia is second only to tuberculosis in terms of prevalence and as the world's most costly health issue [2]. Children, during their phase of rapid growth such as the preschool age and the adolescent age, are at a higher risk of developing iron deficiency anaemia. Iron deficiency anaemia is common in rural areas and in children from a poor socioeconomic status.

The incidence of iron deficiency anaemia is higher in infancy and also in school going children and preadolescents. Although no socioeconomic group has been spared from the incidence of iron deficiency in a large population group, it has been found to be inversely proportional to the economic status of the affected individual.

The trace amount of iron in many diets, the limited ability of the human body to absorb iron and the need for growth, as well as high parasitism and gastrointestinal blood loss, make children vulnerable to develop negative iron balance and iron deficiency anaemia.

The purpose of this study was to assess the iron status in school going children before iron therapy. The response of one month of iron therapy on these children was assessed by a change in the haemoglobin concentration after the therapy.

MATERIAL AND METHODS

The study population included 800 (368 males and 432 females) healthy school going children of ages between 6-14 years, from three government schools of Raipur city. Both anthropometrical and clinical examinations were carried on these children.

INCLUSION CRITERIA:

1. Iron deficiency anaemia cases (microcytic, hypochromic)
2. Haemoglobin <11gm%
3. Not received blood transfusion in the last one month.

EXCLUSION CRITERIA:

1. Homozygous sickle cell disease
2. Sickle cell trait
3. Haemoglobin >11gm%
4. Menstruating girls
5. Patients with peptic ulceration, epistaxis, parasitic infestation and malabsorption
6. Septicaemia

Out of which 150 (73 males and 77 females) children were found to by clinically anaemic. These 150 clinically assessed anaemic children served as the subjects for haemoglobin estimation. Out of these 150, 100 (55 males and 45 females) cases were selected for the study which followed the WHO criteria for anaemia.

The WHO criteria for anaemia (WHO,1968):

The WHO experts have defined anaemia as a condition in which the concentration of haemoglobin is below the lower limit of the normal for a given age and sex.

Haemoglobin levels which are indicative of anaemia amongst children

Age/Sex	Hb level (g/dl)	MCHC(Percent)
6month-6years	<11	34
6-14 years	<12	34

Grades of anaemia:

MILD: When the haemoglobin concentration is above 80% of the cut off level

MODERATE: When the haemoglobin concentration is between 60%-80% of the cut off level

SEVERE: When the haemoglobin concentration is less then 60% of the cut off level

Haemoglobin levels were estimated in all the children by the cyanmethaemoglobin method. The serum ferritin concentration was determined by ELISA by using a reagent kit (ACCUBIND) which was obtained from Monobind Inc. from the local market and serum iron and TIBC levels were determined by the calorimeter ferrozine method. (both were obtained from Scientific Traders, Tatyapara, Raipur CG). (Siedel , J. et. al. 1984, Clin. 30:975).

Samples were collected for the estimation of haemoglobin by the cyanmethoglobin (HICN) method and for the estimation of serum ferritin by ELISA (UBI) (the Magiwel enzyme immunoassay method for haemoglobin estimation). 20 µl of capillary blood was collected by finger pricking into 5ml of Drabkins solution (which was obtained from Scientific Traders, Tatyapara, Raipur CG) from all the participating students and the haemoglobin and serum ferritin levels were assessed on the same day. For assessing serum ferritin, 3 ml of venous blood was collected in a test tube, left to stand at room temperature for half an hour and was centrifuged at 3500 r.p.m. for 10 minutes. The separated serum was transfused to fresh vials and was stored at 300C. The kit was calibrated against the WHO standard.

The haemoglobin and ferritin levels were estimated under strict quality control in the laboratory of our medical college. Haemoglobin was estimated by the Cyanmethaemoglobin (HICN) method, serum iron and total iron binding capacity were estimated by the Ferrozin method and serum ferritin was estimated by ELISA and was measured by using a spectrophotometer (Systronic Inc. in the Department of Biochemistry of Pt.JNM Medical College, Raipur and the Department of Pathology, Dr BRAM Hospital, Raipur (CG).

Anaemia was diagnosed as per the WHO guidelines (value less than 12g/dL) and iron deficiency was determined when the value of serum ferritin was less than 15ng/ml.

Statistical analysis was done by using the SPSS software and the Chi square test was used to calculate statistical significance.

Ethical Consideration

An informed and written consent was obtained from the Dean, Pt. JNM Medical College Raipur, Block Educational Officer Dharsiva, Raipur and from the parents of the children.

RESULTS

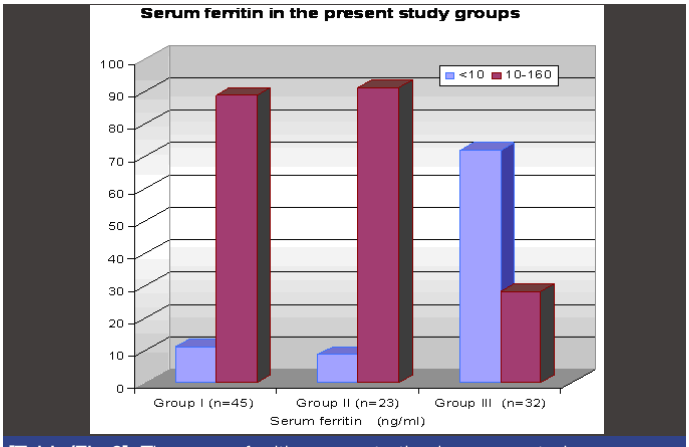
The study population comprised of 800 students from three government schools of Raipur city. Out of 100 anaemic children, 55% were males and 45% were females. A majority of the subjects belonged to 6 years (19%) and group I (45%) cases. A maximum number of patients (45%) had haemoglobin levels between 9.5-10.9gm / dl in group I.

Clinical pallor was the most common finding in all the children (in 100%), followed by fatigue (in 54%), weakness (in 38%), anorexia (in 18%) and icterus (in 5%). The commonest blood picture was microcytic, hypochromic, which was seen in 66.6% children in group I, 95.6% children in group II and 87.5% children in group III. Age dependent MCV, MCH, MCHC and RDW values showed that the maximum number of cases had below normal MCV, MCH and MCHC values. The RDW (Red cell distribution width) value was increased in 74% of the cases. [Table/Fig 1]

	Group I (n=45)		Group II (n=23)		Group III (n=32)	
	No	%	No	%	No	%
MCV (fl)						
Below normal	15	33.3	16.	69.5	10	31.2
Normal	11	24.4	3	13	7	21.8
Increase	19	42.2	4	17.3	15	46.8
MCH (pg)						
Below normal	33	73.3	23	100	26	81.2
Normal	8	17.7	0	0	6	26.0
Increase	4	8.8	0	0	0	0
MCHC (g/dl)						
Below normal	45	100	23	100	29	90.6
Normal	0	0	0	0	3	9.3
RDW (%)						
Below normal	10	22.2	0	0	0	0
Normal	7	15.5	3	13	6	18.7
Increase	28	62.2	20	86.9	26	81.2

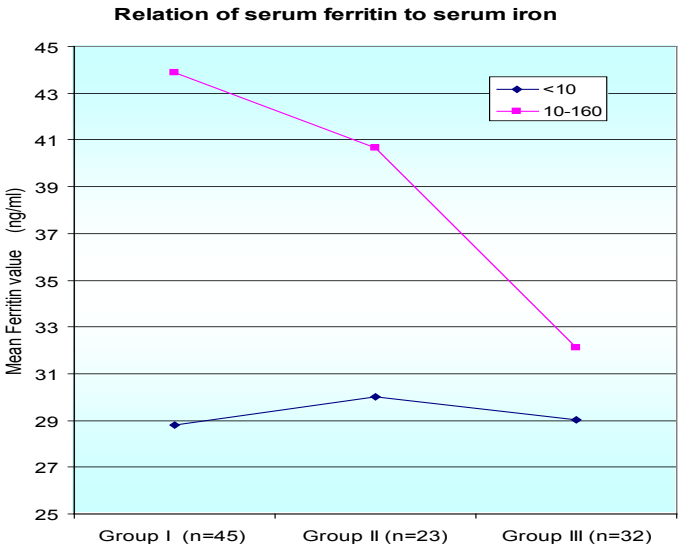
[Table/Fig 1]: Age dependent MCV, MCH, MCHC and RDW in the study

82% cases had serum iron levels below the normal range (<50µg /dl). 91% cases had serum TIBC levels above the normal range. There was an increase in the serum iron levels in a maximum number of cases. Serum ferritin levels were estimated in all the hundred anaemic children, of which 35% showed below < 15ng / ml values (18% in boys and 17% in girls). The serum ferritin concentration in the three groups is represented in the diagram below. [Table/Fig 2]



[Table/Fig 2]: The serum ferritin concentration is represented

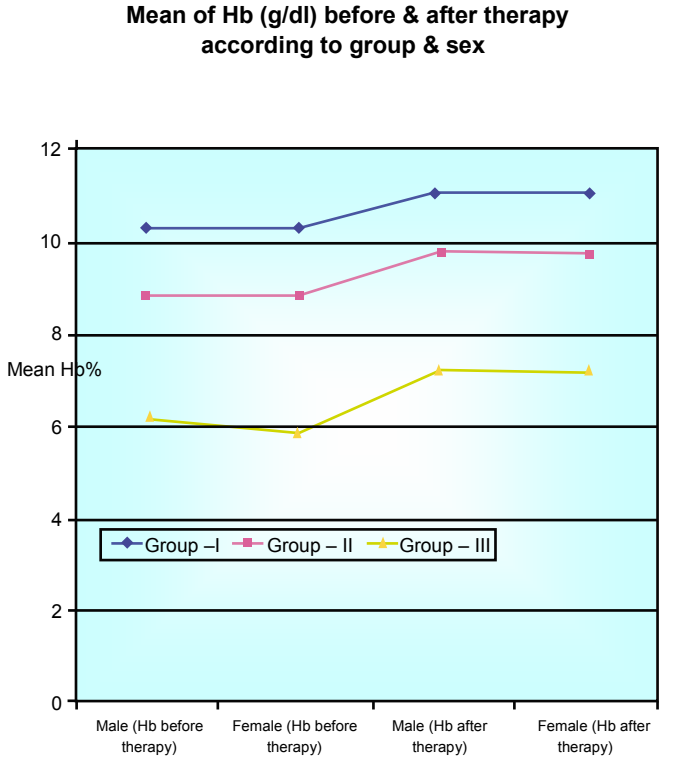
Correlation of serum ferritin and iron indices – The estimation of serum iron and TIBC levels in the subjects did not have any correlation with the serum ferritin concentration, as shown in the diagram. [Table/Fig 3]



[Table/Fig 3]: Correlation of serum ferritin and iron

Assessment of the nutritional status of the children in the 6-14 years age group according to the IAP classification by weight showed that 19% of the children were well nourished and that 81% of the children were undernourished.Out of this, 29% were in the grade I undernutrition, 29% children were in the grade II undernutrition, 21% children were in the grade III undernutrition and 2% were in the grade IV undernutrition category.

The haemoglobin values at the beginning of the study and after 4 weeks (30 days) of haematinic supplementation are shown in the Fig below. [Table/Fig 4]



[Table/Fig 4]: haematinic supplementation are shown

The mean and SD of Hb before therapy was 8.60±2.05 and after therapy, it was 9.55±1.88 respectively. The present study in the all age groups showed that the tablet, ferrous sulphate 6mg/kg body weight, significantly increased the Hb (P<0.009) concentration after 30 days of supplementation.

DISCUSSION

Nutritional anaemia is global in occurrence and is more of a concern in the developing countries because of the high prevalence in these regions [3].

In the present study, the diagnosis of iron deficiency was based on the finding of a microcytic, hypochromic blood picture, low serum iron levels, a high total iron binding capacity and finally, the response to the iron therapy [4].

A majority of the subjects belonging to the 6 year age comprising 19% of subjects were more in group I. The overall male to female ratio in the study was 1.2:0.8. Dhar et al (1969) [5], Duggal et al (1977) [6], Singla et al (1981) [7] and Gopal Das et al (1985) [8] had studied the same age group.

The clinical features which were observed in this study were very much similar to those reported by other studies.

In a majority of patients, the peripheral smear was microcytic and hypochromic (in 80%), normocytic, normochromic (in 13%) and normocytic, hypochromic (in 7%) and this could be well compared with those reported by Thaman et al (1969), (57%, 31% and 3%), Dhar et al (1969)5 (64.02% and 15.8%), Gupta et al (1971) [9] (64.68%, 21.5%, and 1.8%), Duggal et al (1977)6 (47%, 44% and 1%)[10], [11] and Verma et al (1979) (55.4% and 37.5%) [12], [13]. The most common symptoms which were observed in the present study were fatigue (in 54%), followed by weakness (in 38%) and anorexia (in 18%). These were similar to those observed by Patel et al (1959) [14] and Dhar et al (1969) [5].

The ranges of the haemoglobin percentage in the present study was 9.5-10.9 in group I, 8-9.4 in group II and <7.8 in group III, which can be well compared with those reported by Thaman et al (1968)(15), Dhar et al (1969)(16), Gupta et al (1971) [17], [18], [19], Verma et al (1979), Singla et al (1981) [7] Raman et al (1992) [15], Sood et al (2002) [19] and Basu et al (2004) [14] by using the same technique.

The present study showed that a maximum number of cases had below normal MCV, MCH and MCHC values and that the RDW value was increased in 74% of the cases. These values are in accordance with the observations made by Smith et al (1959) [18], Dhar et al (1969) [5], Gupta et al (1971) [9] and Raman et al (1992) [15].

82% of the patients had low serum iron levels and 91% cases had serum TIBC levels above the normal level, irrespective of their peripheral smear morphology. These results are in accordance with those reported by Thaman et al (1968) [20] Dhar et al (1969) [5] and Smith et al (1988) [18].

Various studies have confirmed that the assessment of the serum ferritin levels is one of the most sensitive methods for the assessment of iron stores and for the detection of mild iron depletion. The serum levels of ferritin are directly related to the bone marrow iron content in all the disease groups, except in those involving a chronic inflammatory stage, malignancy and an increased red cell turnover.

However, the students who were enrolled for this study were healthy and did not have any apparent clinical disorder. In our study, 70% cases were in the pre latent phase of iron deficiency anaemia (serum ferritin <10ng/ml and Haemoglobin <12g/dl). These values are in accordance with the observations made by Martti et al (1974)13, Thomas et al (1977)22 and Thavaraj et al (1985)21 et al.

In the present study, there was no correlation between the serum ferritin and the serum iron levels. Krause et al (1980) [19] and Frank et al (1981) [20] also did not find any correlation between the two.

Nutritional status out of 100 children had a different grade of malnutrition. The maximum number of cases belonged to grade I and grade II malnutrition (29%) and there was 21% in grade III and 2% in grade IV.

An effort was made to find the incidence of the iron deficiency with respect to various grades of malnutrition. It was found that the maximum number of anaemic cases were seen in grade II malnutrition i.e. 29% and 26%. In the same way, in the malnutrition grade I category, anaemia was present in 22% [16] and 12% % had grade III malnutrition and a minimum number of cases of IDA (2% and 1%) were observed in the grade IV malnutrition category. Manchanda et.al. (1969) [21], Sharma et. al. (1985) [22] and Sood et. al. (2002) found that 100%, a moderate degree and 97% of the children who were studied were malnourished.

Response to therapy

The response to therapeutic iron was taken as the most reliable evidence of iron deficiency anaemia in a study of this kind and the group that was given iron in the treatment trial showed a significant increase in the mean haemoglobin values at all ages.

The iron supplementation with ferrous sulphate 6mg/kg containing folic acid 0.5mg was given twice a day after breakfast and after dinner to reduce gastric irritation.

Folic acid was added because the children who were suffering from various grades of malnutrition demonstrated folate deficiency. Hence, until a clear evidence of folate deficiency is available, folate may not be required to be given. It may be more prudent to include it in the prophylactic iron supplement.

All the children in our study were free from worm infestation. Only one (2.2%) case in group I showed worm infestation, which was treated with antihelminthic tablets along with haematinic supplementation.

A significant increase in the Hb levels was observed in both boys and girls in all the three groups after 30 days of iron supplementation. The effect of the supplementation on the mean Hb levels showed an increase in the Hb levels in group I who were mildly anaemic (0.78 gm/ dl), in group II who were moderately anaemic (0.97 gm/ dl) and in group III who were severely anaemic (1.17gm/ dl). In the severe anaemic cases, the response was better. It was also noted that the effect on the Hb levels was more in the lower age groups. These results are in accordance with those reported by Single et al (1981) [7], Dallman et al (1981) [22], Chwang et al (2001) [23], Zlotkin et al (2001) [24] and Sood et al (2002) [25].

CONCLUSION

It has been concluded from this study, that an early diagnosis of anaemia can be made by the assessment of the serum ferritin levels and that this method is more reliable. If iron is given at an early stage of anaemia to the children, the response is quite significant.

The children studying in government schools are found to be malnourished as per the guidelines of IAP. Their poor health and nutritional status warrants an improvement in the socioeconomic status by the inclusion of green leafy vegetables in the diet, increasing the level of education and by a well planned school health service programme according to the local needs.

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