ORIGINAL ARTICLE

Study of the anemia status in children attending a tertiary care hospital in Tamil Nadu

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Abstract

Background: Anemia is a pathological condition in which the blood hemoglobin concentration is reduced to a low level, due to deficiency of one or more nutrients. The nutrients required for the synthesis of hemoglobin are iron, folic acid, and vitamin B12. Anemia is one of the major global public health problems in the early stages of childhood, mainly in developing countries. *Aim and Objectives:* We aimed to assess the prevalence of anemia and associated factors in pediatric subjects. *Material and Methods:* Our study was conducted on children aged between 1 to 12 years attending the pediatric department in our hospital. A total of 200 children were selected as cases who fulfilled WHO criteria for anemia and another 200 normal healthy children of the same demographic data were recruited as controls. The serum ferritin values were compared between normal healthy children and children with various types of anemias. All control and patient samples were tested for Serum Iron, Ferritin, TIBC, Vitamin B12, and Folic acid. *Results:* Iron deficiency anemia (46%) was the most common type followed by megaloblastic anemia (20%), thalassemia (19%), sickle cell anemia (9%), and other causes of anemia (6.0%). *Conclusion:* Anemia among pediatric population needs to be addressed immediately in the form of supplementation and health education in a regular manner to prevent adverse health effects in children.

Keywords: Serum Ferritin, Iron Deficiency Anemia, Total Iron Binding Capacity, Thalassemia, Sickle Cell Anemia

Introduction

Anemia is a condition that causes a reduction in red blood cell concentration in circulation or a decline in hemoglobin in the blood and a concomitant impairment of oxygen transportation [1]. It can be a result of heavy blood loss, parasitic infections, deficiency of one or more important nutrients, and congenital hemolytic diseases [2]. Anemia is a global public health problem and it affects 1.62 billion (24.8%) people globally and mainly affects developing countries. Nearly 3.5 billion persons are affected in developing countries and India is among those depicting very high statistics of anemia. Anemia in children has been defined as the mean Hemoglobin (Hb) concentration below established cut-off levels. World Health Organization criteria for diagnosing anemia is a Hb level

of <11 gm % in children in the age group of below 5 years, <11.5 gm% of Hb in children in the age group of 5-11 years, and 12 gm % in older children (aged 13-14) [3].

Anemia is a critical health concern because growth and energy levels are affected adversely. Children and pregnant women are more prevalently affected by anemia but it occurs at all ages [4]. It mainly damages immune mechanisms and is also associated with increased morbidity [5]. Anemia in children affects the cognitive and physical development of the child.

Several factors contribute to the occurrence of anemia and nearly half (43%) are caused due to iron deficiency and a lesser proportion from deficient micronutrients (Vitamin A, Folic acid, and B12). The diseases that cause anemia are viral infections, hemolysis, malaria, filariasis, chronic diarrhea, bone marrow disorders, and hemoglobinopathies [6-9]. Our study aimed to assess the prevalence of anemia and associated factors in pediatric children.

Material and Methods

Our study was undertaken in the Department of Pediatrics, Annapoorana Medical College Hospital, Salem, after obtaining ethical clearance (No:81/AMCH/IEC/08-22). In this study, the samples were collected from the patients attending out-patient and in-patient section in the Department of Pediatrics, Annapoorana Medical College Hospital, Salem and other tertiary care hospitals in Puducherry.

Inclusion criteria

Two hundred anemic children in the age group 1 to 12 years having mean hemoglobin levels below 11 g % were considered for the case group and 200 healthy control subjects were recruited (sample size calculated by Epi Info 7 software for population surveys) after obtaining written informed consent.

Exclusion criteria

Children below 1 year of age and those suffering from serious infections, chronic infections, and anemia due to acute blood loss were excluded from the study.

Study design

A case control study and purposive sampling (hospital-based) method were used with random sampling technique.

Sample size calculation

The sample size was calculated based on the previous article. Sample size of 200 anemic pediatric patients and 200 age- and sex-matched healthy controls was calculated based on the formula:

$\alpha = 0.05$ (two-sided); $\beta = 0.080$

Formula

$$n = \{Z1\text{-}a/2 + Z1\text{-}8/2\}^2 \times [P1\,(1 - P1) + P2\,(1 - P2)] / (P1 - P2)^2$$

Calculation

$$n = \{1.96 + 0.84\}^2 \times [0.48(1 - 0.48) + 0.34(1 - 0.34)] / (0.48 - 0.34)^2 = 189$$

Collection and analysis of blood samples

After obtaining written consent, 5 ml blood was withdrawn aseptically from the large peripheral veins of all selected children and transferred into a plain tube, and centrifuged at 3000 rpm for 10 min to separate serum. Basic details of each participant (age, gender, height, weight, etc) were recorded. Children having mean hemoglobin levels below the cut-off of 11 g% were further processed for biochemical investigations. Serum Iron and TIBC were estimated by the Ferrozine method by using

semiautoanalyzer, (Erba Chem 5 plus). Serum Ferritin, Folic acid, and Vitamin B12 assay were performed by immunoassay technique using Enzyme-linked immune sorbent assay (Erba ELISA reader and washer).

Statistical analysis

Data were entered into MS Excel 2013 version and further analyzed using SPSS (version 23.0). Descriptive analysis – the categorical variables were analyzed by using frequency and percentages and the continuous variables were analyzed by calculating Mean ± Standard Deviation (SD). Inferential analysis – the numerical data were analyzed using "*t*-test", and the categorical data were analyzed using a Chi-square test with "*p*" <0.05 considered as statistically significant.

Results

Female children were present more than male children in both case and control group (Table 1).

Based on the age, 200 pediatric patients were classified into two groups – age less than 6 years and age between 6 to 12 years, in both case and control. Majority 74% of patients belonged to the 6-12 years age group while 26% were aged less than six. Among controls, 52% of children were aged between 6 to 12 and 48% less than six (Table 2).

Our study showed that all patient groups were anemic and showed significant differences from control groups. Except for TIBC, all other parameters of the iron profile were significantly lower in the patient group as compared with controls. TIBC values were higher than controls with statistical significance (Table 3).

Prevalence of anemia status in the study group

Based on the study results and clinical findings, iron deficiency anemia (46%) was the most common type followed by megaloblastic anemia (20%), thalassemia (19%), sickle cell anemia (9%) and other causes of anemia (6.0%) (Figure 1).

Table 1: Gender wise distribution of cases and controls

Sex	Cases N (%)	Controls N (%)	Total
Males	86 (43)	94 (47)	180
Females	114 (57)	106 (53)	220
Total	200 (100)	200 (100)	400

Table 2: Age-wise distribution of cases and controls

Age	Cases N (%)	Controls N (%)	$\chi 2$	*p*
< 6 Years	52 (26)	96 (48)	20.7636	<0.0001*
6-12 Years	148 (74)	104 (52)		
Total	200 (100)	200 (100)		

Table 3: Anemic profile result comparison in cases and controls

Etiology	Controls	Cases	*t*	*p*
Hemoglobin %	12.6 ± 1.5	8.1 ± 1.2	33.1295	**<0.0001***
Serum Iron (µg/dl)	78.5 ± 32.5	32.6 ± 10.3	19.0397	**<0.0001***
Total Iron Binding Capacity (µg/dl)	372.4 ± 32.9	508.0 ± 92.5	19.5329	**<0.0001***
Serum Ferritin (ng/ml)	148.8 ± 34.0	6.1 ± 2.34	59.2200	**<0.0001***
Vitamin B_{12} (pg/mL)	550.28 ± 253.63	397.79 ± 239.85	6.1778	**<0.0001***
Folic acid (ng/ml)	12.32 ± 3.1	7.72 ± 5.19	10.7610	**<0.0001***

**p < 0.01 significantly different between two groups*

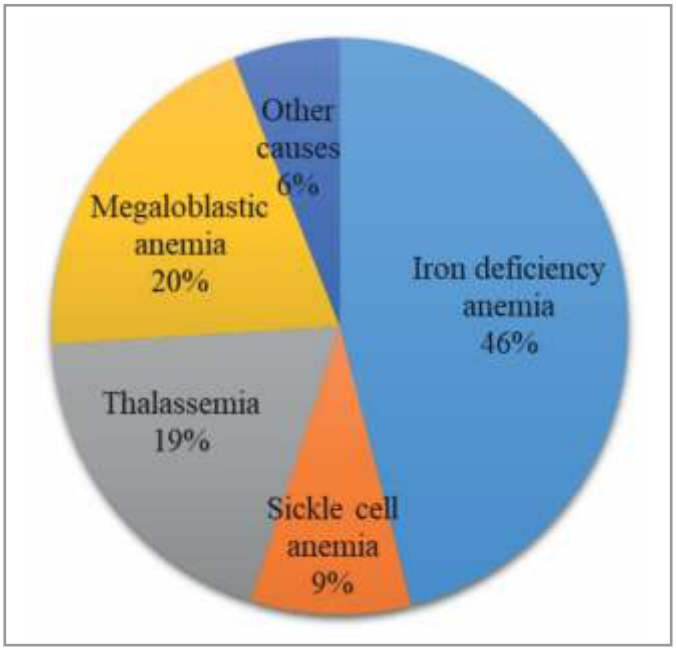

Figure 1: Distribution of anemia based on etiology

Discussion

Anemia is a major health problem globally, particularly in India. It is associated with other health consequences including impaired development of motor skills, retardation of physical and cognitive growth, along with increased morbidity and mortality. Anemia below five years of age in children is relevant because it affects the parameters of the physical, mental, and social development of the child. Anemia prevalence in developing countries is higher when compared to developed countries, and is believed to be due to more exposure to other health and socioeconomic problems that are directly or indirectly related to anemia [1, 6].

We found the prevalence of anemia to be 74% among patients aged between 6 to 12 and 26% in those aged less than six. Similar findings were reported by Garg and Bhalla [10]. The patients' hemoglobin percentage was 8.1% in the present study. Serum Iron levels were 32.6 mg/dl, which is lesser than the normal range in patient groups. In the present study, serum ferritin level was very low in the study group with a mean value of 6.1 ± 2.34 ng/ml. Earlier studies also showed similar observation [11-12].

The serum ferritin concentration reflects the size of iron stores under most of the conditions, with some exceptions like acute leukemia and infections. The high value of serum ferritin concentrations was reported in a few studies in adults with acute myeloblastic leukemia, Hodgkin's disease, chronic leukemia, and in children with acute lymphoblastic leukemia [13]. The Indian diet is based on pulses and cereals which contain more than 40% of total phosphorus as phytates and vegetables and plant food contain oxalates that interfere with the absorption of food iron despite high dietary intake [14]. In the present study control group, ferritin results showed that 92% of serum ferritin values in normal children were between 15-150 ng/ml. This report correlates with the studies done by earlier authors [15-17].

Findings of the present study showed 40 children having megaloblastic anemia whose mean serum ferritin was significantly higher than the mean of normal healthy controls. Vijay and co-workers' reports [18] are similar to the present study. Megaloblastic anemia is lesser than iron deficiency anemia, thereby showing the need for fortification of iron and iron supplementation in diet.

In the present study among 38 patients with Thalassemia, mean serum ferritin levels were very high. Ikram and co-workers' study results correspond to the present study reports [19]. This rise in serum ferritin in thalassemia patients is due to ineffective erythropoiesis, repeated blood transfusions, increased gastrointestinal iron absorption, etc. The present study found that among 18 patients with sickle cell anemia, values of serum ferritin were greater than controls which showed statistical significance and these findings are similar to the studies done by Johnkennedy and co-workers [20].

Observing such a high prevalence of anemia in the study population warrants immediate steps to be undertaken to reduce the issue. The government needs to take necessary action to implement hemoglobin estimation programs in rural areas and schools in pediatric populations. Health programs should be implemented regularly for all school children. Worm infestation is one of the important causes of anemia, so the biannual deworming

session needs to be included in school with the use of albendazole. The iron-folic acid syrup is prescribed for children up to five years of age. These children's parents have to advise them to improve dietary habits regarding the consumption of green leafy vegetables in the diet plan of their children.

Limitations of the study

This study has some limitations like it is a hospital-based study and the sample size is small. This may have overestimated the prevalence of anemia in our settings. A large sample requires community-based assessment. Other genetic markers also need to be studied with a larger sample size of children with anemia.

Conclusion

Iron deficiency is the most common cause of childhood anemia in India. This can be prevented by creating awareness among children via school and parents by organizing recurrent camps and workshops, dietary advice along with iron supplementation after the diagnosis of the disease. The government should implement programs that prevent anemia in children in a very strict manner. This may help prevent anemia among children in the future.

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