INTRODUCTION

Anemia is defined as a condition in which the concentration of hemoglobin or the number of red cells, either singly or in combination, is reduced below the age-corrected values. The data from WHO shows that 40% of children less than 5 y of age and 37% of pregnant women worldwide are anaemic [1]. As many as 67.1% children aged 6 mo to 59 mo surveyed suffered from anemia in 2019 and 65.5% in Karnataka, according to NFHS-5. Nutritional anemia is most common but preventable cause for anemia in children in developing countries. This is due to improper feeding habits, especially during the initiation of complementary foods. Hence the present study is to know the pattern of anemia in infants of age group between 6 mo to 12 mo and to assess the nutritional and other associated risk factors contributing to Anemia.

Methods: This study was carried out in 193 children aged 6 mo to 12 mo admitted in our hospital. Detailed clinical evaluation and relevant laboratory investigations were done as per proforma.

Results: In our study majority were of age group 6 to 9 mo (52.8%). 40.4% of mothers of our study infants were anemic during pregnancy and 9.3% were blood transfused. Majority (53.4%) were exclusively breastfed. 45.6% were started on complementary feeding at 4 to 6 mo age.17.6% were moderately wasted and 9.3% of infants were severely wasted. There was a significant association between severity of anemia and mother’s anemia, inclusion of cow’s milk in diet, adequacy of complementary feeding, and inclusion of formula feeds (p<0.05).

Conclusion: Nutritional anemia is most common cause of anemia in childhood, especially in developing countries like India. Parents and caregiver need awareness regarding the effect, causes of anemia and how to prevent it.

Keywords: Anemia, Iron, Vitamin B12, Exclusive breastfeeding, Complementary feeding
Exclusion criteria
1. Parents of children not willing to give informed consent.
2. Infants who have H/O Bleeding disorder, H/O Blood transfusions, Hemolytic anemia, acute blood loss.

Method of data collection
- After obtaining approval and clearance from the institutional ethics committee, the individuals fulfilling the inclusion criteria were enrolled for the study
- Informed written consent was obtained from all the parents/legal representatives of study subjects. To collect the required information from the parents the "Direct interview method" of Primary source of information technique was used. The parents were interviewed for collection of necessary information using the pre-tested, semi structured questionnaire method. The questionnaire was prepared by a thorough review of literature.
- In order to obtain co-operation of the patient/parent, they were made comfortable and a positive reinforcement was exerted. No answers were influenced and were helped during difficulty.
- After taking the socio-demographic details like Age, Sex, Address, Maternal history and Feeding history of the infants were taken.
- Feeding pattern of the child from birth to present age like breast feeding, Complementary feeding was taken in detail.
- Socioeconomic status was assessed based on education, occupation, and incomes in the Modified Kuppuswamy’s SES.
- All the study subjects were examined in detail and all the data was filled in the pro-forma.
- Venous blood sampling is obtained from each patient enrolled in the study and is sent for estimation of Complete blood count using automated analyzer from 2 ml of EDTA blood sample collected under sterile technique. Peripheral smear study was done with Leishman’s stain and Reticulocyte count with New Methylene blue stain. Based on the blood picture, serum Ferritin, Vitamin B12 and folate acid levels were measured in the venous blood using Chemiluminescent technique, Serum iron was determined by calorimetric method and total iron binding capacity (TIBC) by Colorimetric were estimated. Anemia was diagnosed according to World Health Organization (WHO) criteria.

Table 1: Case definitions of classification of anemia

<table>
<thead>
<tr>
<th>Category</th>
<th>Non-anemia</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>6-12 mo of age</td>
<td>11.0 g/dl or higher</td>
<td>10.0-10.9 g/dl</td>
<td>7.0-9.9 g/dl</td>
<td>Lower than 7.0 g/dl</td>
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Majority of the children’s family followed non-vegetarian dietary habits (64.8%) and 35.2% followed vegetarian dietary pattern. We found that 51.3% of mothers had hemoglobin <11 gms% during pregnancy. However, there were 8.3% of mothers who did not know their hemoglobin status during pregnancy. We found that 9.3% of mothers had history of blood transfusion during pregnancy. We found that 53.4% of children in our study were exclusively breastfed till 6 mo of age. We found that majority were started on complementary feeding between 7 to 10 mo (38.3%). However, there were 16.1% of infants who were not yet started on complementary feeding. Among them, there were 11 infants aged about 6 mo, 9 infants were aged 7 mo, 4 infants were aged 8 mo and 9 mo each and 2 infants were aged 11 mo. Coming to the pallor distribution in infants of our study. 48.2% of infants had moderate pallor on examination and 21.8% had severe pallor.

Coming to the mean and standard deviation of CBC profile of infants, the mean hemoglobin of infants in our study was 8.5±1.8 gms, mean MCV was 71.6±13.9 fl and mean MCHC was 26.4±4.5%. Coming to the severity of anemia, our study shows the severity of anemia as per WHO classification where Majoritiy had moderate anemia (54.9%) with majority of MCV falling between 60 to 75 fl MCV in our study (46.1%) and majority had MCHC<30 g/dl in our study (69.95%).

Coming to the type of anemia according to peripheral smear in our study. Majority of our study infants had microcytic hypochromic anemia, followed by normocytic normochromic anemia. We had 18 infants with normocytic anemia also. We did iron profile to all the study population to know the type of anemia. The mean reticulocyte count was 1.5±0.51, mean TIBC was 355.7±65.9 µmol/L, mean transferrin saturation was 17.4±22.6% and mean serum ferritin was 174.4±190.4 ng/ml.

We tried to identify the cause of anemia among the study population of our study, where the prevalence of iron deficiency was 82.3% and Vitamin B12 deficiency was 15.5%.

We tried to find out the association between various risk factors and severity of anemia among the study subjects in our study which included presence of anemia in pregnant mother, consumption of cow’s milk, Socioeconomic status, initiation of complementary feeding, exclusive breast feeding and formula feeds. Among these risk factors, There was significant association between severity of anemia and mother’s anemia, inclusion of cow’s milk in diet, late initiation of complementary feeding, and inclusion of formula feeds (p<0.05).
**DISCUSSION**

This study was primarily designed to determine the clinical and laboratory profile of nutritional anemia among infants attending the Pediatric outpatient Department of a tertiary care hospital. A total of 193 children were recruited, following confirmation of anemia with hemoglobin estimation. After a targeted history and detailed clinical examination, they were subjected to red cell indices and iron studies, reticulocyte count and peripheral smear. Serum vitamin B12 and folic acid levels were estimated in all cases. Based on the above investigations, anemia was grouped into microcytic hypochromic anemia (115 cases), normocytic normochromic anemia (38 cases), macrocytic anemia (22 cases) and dimorphic anemia (18 cases).

A higher prevalence of anemia was noted in male children in this study. Male to female ratio was 1.2:1. This is comparable with studies done by R. G. Goel et al. [11] (male: female ratio 1:1) Manchanda et al. [12] (male female ratio 2:1:1) and M. M. Kumbhat et al. [13] (1:5:1). The male predominance may be due to sheer coincidence or may be because of increased concern of parents towards male children leading to increased incidence of male admissions or this can be explained by hyperactive male children not having feeds.

On the socio-economic front, most of the cases belonged to a lower middle class (43.5%) and upper lower class (37.8%). The presence of anemia, in this socioeconomic group, is explained by the vicious cycle of poverty and malnutrition. Chellan et al. [14] also observed a greater prevalence of anemia in higher socioeconomic strata. In a study conducted by Kanchana et al. in 2018 in 6m-59 months found that 90% children with anemia belonged to lower SES (Kuppuswamy’s classification) and 10% belongs to lower middle class [15]. Mehrotra SK et al. had reported that 78.4% of anemic children in their study belonged to lower socio-economic status [16].

In our study, on dietary assessment it was found that 35.2% were vegetarians and rest of them were non vegetarians (64.8%). In a study conducted by George KA et al. in 2000 in rural preschool children of Kerala found that among 927 vegetarians, 86 (9.27%) were anemic and among 2,706 non-vegetarians, 328 (12.1%) were anemic [17].

Pallor was observed in moderate to severe anemia cases (70%). This is the most prominent and characteristic sign in patients with anemia. Pallor of palpebral conjunctival skin is more visible than other signs. Though pallor was the most striking feature in the study, it has no direct relationship to the severity of anemia. Studies by Patel et al. [18] Manchanda et al. [12] Sharma et al. [17] reported that the pallor was seen in 100% of patients.

In the present study, 36 children (18.6%) had Hb less than 7g/dl and 80 children (54.9%) had Hb between 7 and 9.9 g/dl. The lowest Hb recorded in the study was 2.4g/dl seen in 2 female children aged 8 mo old. Goel et al. [11] in their study found Hb<5g/dl in 52% cases and between 5-7g/dl in 48.5% cases. Pramila Ramawat et al. [6] reported that as per hemoglobin level according to WHO guideline for anemia 25.4% had mild anemia, 49.2% had moderate anemia and 25.4% had severe anemia.

In our study, microcytic hypochromic anemia (59.60%) was found to be the most common etiology of nutritional anemia followed by normocytic normochromic anemia (19.70%), macrocytic anemia (11.40%) and dimorphic anemia (iron deficiency with vitB12 and folic acid deficiency) (9.30%). We found that 15.5% of our study infants had vitamin B12 deficiency and 5.2% had folic acid deficiency. In a study conducted by Ray S et al. among 6m-59 mo found that iron deficiency was present in 75% iron with B12 deficiency in 47%, iron and folate deficiency in 11%, Vitamin B12 and folate deficiency in 25% and triple deficiency in 6% [19]. In a study conducted by Kanchana et al. showed iron deficiency was found to be 61% in age group 2y-5y and dimorphic anemia in 18% in age group of 6m-5y [16].

Serum ferritin was done in all the cases. It is a sensitive indicator of iron status. In only 16 cases (8.3%) serum ferritin was less than 15 mg/dl. Ferritin is an acute phase protein that rises in response to inflammation. The presence of normal ferritin in cases of IDA can be explained by the fact that in a hospital-based study like ours, subclinical infection or latent inflammation could well be the cause for such an elevation, thus masking the true size of the iron store [20]. This association with inflammation will also be suggested by the elevated CRP in and elevated ESR. When such confounders are encountered; the estimation of RDW may help in identifying true IDA. However, we did not include these investigations in our study. Hence decreased serum ferritin alone was not taken for diagnosis of iron deficiency anemia.

Transferring saturation index is the ratio of the serum iron to total iron-binding capacity, expressed in percentage. The threshold of 16% is used to diagnose iron deficiency. TSAT reflects iron availability for erythropoiesis. Hence in our study TSI was used as reliable indicator of iron status than serum ferritin. In our study 159 children (82.4%) had TSI<16%. In a study, conducted by Chithambaram NS et al. among 6m-5years age group in 2015 at Vidyabai institute Bangalore found that transferrin saturation was affected in 51% children with iron deficiency anemia whereas serum ferritin in 16% children [21].

In terms of correlation of the hemoglobin with the red cell indices, we found a positive correlation between hemoglobin and MCV and MCH which was statistically significant and a statistically significant positive correlation with S. folate. This has been borne out amply in many studies.

**CONCLUSION**

Thus, nutritional anemia is most common cause of anemia in childhood especially in developing countries like India. This can be prevented by...
proper nutritional support in growing age more so in the age group of 6m–1 y where they introduce complementary feeding. Though Iron deficiency is the most common cause of nutritional anemia, other causes like vitamin B12 deficiency is also not uncommon.

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AUTHORS CONTRIBUTIONS
Dr. Supriya M A-Intervention and Data collection, Dr. Ravichandra Kothur Rangegowda—Manuscript preparation and Literature review, Dr. Shilpa Krishnapura Lakshminarayana—Data interpretation and review, Dr. Lakshmi M—Conception and Planning

CONFLICT OF INTERESTS
Declared none

REFERENCES