Original article:

A Study on Iron Deficiency Anaemia in Children up to 3 Years of Age in a Tertiary Care Hospital

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Abstract

Background: World Health Organisation estimates that anaemia, predominantly iron deficiency affects one third of the world's population, mainly affecting children. Iron deficiency anaemia in India is 79% in toddlers. In children from 6 to 35 months of age, the National Family Health Survey-3 showed an increased prevalence of anaemia of 79% from 74% reported in Survey-2.

Methods: We studied a sample size of 300 in the age group of 1 month to 3 years for iron deficiency anaemia.

Results: There were 193 (64.3%) males and 107(35.7%) females. In anaemic children, 177(59%) were asymptomatic and 123(41%) were symptomatic. Only 146 (48.7%) had signs of anaemia. Severe anaemia was seen in 66 (22%) children. There was a positive correlation found between the severity of anaemia and mean corpuscular volume (MCV) values.

Conclusion: Maternal iron intake, symptoms and signs of anaemia, MCV and height had significant association with severity of anaemia.

Keywords: iron deficiency anaemia; MCV; children

Introduction

Iron deficiency anaemia may result from inadequate intake, depletion of iron stores, absorption or blood loss. Iron deficiency anaemia may be *asymptomatic* or may *manifest* as irritability, lethargy, anorexia, paleness, weakness or may even affect the child's physical growth and development, leading to poor school performance or cardiac failure.[1]

During pregnancy and the perinatal period it can have devastating effects on both the mother and child. In children it causes reduced foetal brain maturation, cognitive defects and in mothers, maternal depression. [2] However, recommended daily allowance varies from 6-12 mg/day since only less than 20% of the ingested iron is actually absorbed.[3]

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The study was done to find out the clinical pattern of iron deficiency anaemia in children between the age group of 1 month to 3 years. We also attempted to find out the aetiology and risk factors associated with iron deficiency anaemia.

Materials and Methods

A prospective, cross sectional, single centre study in which children meeting the inclusion criteria were included in the study after taking valid, informed, written consent from the parent. The study was conducted over a period of one and a half years from February 2015 to May 2016, in children between 1 month to 3 years of age admitted to the paediatric inpatient department of G. S. Medical College and KEM Hospital, a tertiary care teaching hospital in Mumbai. Using prevalence from previous studies, with the formula mentioned below, estimated sample size was 150. Based on our hospitals previous years` admissions and considering the inclusion and exclusion criteria the corrected sample size was 300.

n = Z2P(1-P)/d2 (Daniel,2010) (59)

Where n= Sample size,

Z- Z statistics for a level of confidence (1.96),

P- Prevalence (10%), (25)

Two ml of blood was collected for routine investigations and analysed for haemoglobin, mean corpuscular volume, packed cell volume, reticulocyte count, red blood cell indices and peripheral smear. Children with anaemia were treated at the institute.

For the purpose of this study anaemia was defined as

1. Haemoglobin < 11gm/dl
2. Microcytic hypochromic anaemia
3. Increased Red Cell Distribution Width (RDW)
4. Decreased Mean corpuscular volume

Statistical analysis

Quantitative data was represented as mean and standard deviation. Qualitative data presented as frequency and percentage was compared using chi square test.

Results were graphically represented where necessary, using MS Excel deemed.

P value of less than 0.05 was considered as level of significance.

Results

In this study out of 300 subjects, 193 (64.3%) were males and 107(35.7%) were females with male: female ratio of 1.80:1. Among 193 males, number of children with mild, moderate and severe anaemia was 44(66.7%), 89(61.4%) and 60(67.4%) respectively. For 107 females, number of children with mild, moderate and severe anaemia was 22(33.3%), 56(38.6%) and 29(32.6%) respectively. The association between sex of the child and severity of anaemia was not found to be significant.The age group of 1 month to 12 months comprised of 129 (43%)subjects, followed by the age group of 13 to 24 months with 99 (33%) subjects and 72 (24%) from the age group of 24 to 36 months.

Among 129 children from the 1 to 12 months age group, 24(36.4%) had severe, 62(42.8%) had moderate and 43(48.3%) had mild anaemia .Similarly, in children aged between 13 to 24 months of age, the distribution was 26(39.4%) with severe, 42(29%) with moderate and 31(34.8%) with mild anaemia. And for the age group 25 to 36 months it was 16(24.4%) severe, 41(28.3%) moderate and 15(16.9%) mild anaemia. Severe iron deficiency

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anaemia was seen more in infants less than 12 months of age than the older children, but the value was not statistically significant (P=0.208). A total of 66(22%) had severe anaemia with haemoglobin levels less than 7 g%. Haemoglobin levels between 7 to 9 g% was seen in 145(48.7%) and haemoglobin between 9 to 11 g% was seen in 89 (29.3%) cases. Though the numbers were small, a larger number of prematurely delivered children had lower haemoglobin levels. Those delivered at term were equally distributed in the three anaemia severity groups. The correlation of birth weight and severity of anaemia was not significant. Table 1.

Subjects from upper middle class was 101(33.7%) and from lower middle class was 93 (31%) according to modified Kuppuswamy classification. The education of mothers ranged from Secondary School Certification (SSC) consisting of 181(60.3%) mothers, to those who had not studied till SSC which was 115(38%) mothers and 4(1.3%) were illiterate. Only 33(11%) were graduates. Most of our cases were from the moderate anaemia group irrespective of the level of maternal education. There was no statistical significance between the severity of anaemia and the education of the mothers(p=0.401).

In this study, there was a significant correlation (p=0.005) observed among children born to mothers who did not take iron supplements 171 (57%) during pregnancy vs children born to mothers who took iron supplements during pregnancy 129 (43%). Mild anaemia in 49(55.1%), moderate anaemia in 73(50.3%) and severe anaemia was seen in 49(74.2%) in children born to mothers with no iron supplementation. Mild anaemia was seen in 40 (44.9 %), moderate anaemia in 72(49.7%) and severe anaemia was seen in 17 (25.8%) children born to mothers who took iron supplements in pregnancy. Most of the children were appropriate for the gestational age at birth comprising 210 (70%) children, whereas 85(28.3%) were small for gestational age and 5(1.7%) were large for gestational age.

Exclusive breast feeding for six months was practised by 167(55.7%), while 58(19.3%) were breast fed for less than six months and 18(6%) were exclusively breastfed for more than six months. Among the exclusively breastfed children, 60.6% had severe anaemia,54.5% had moderate anaemia and 53.9% had mild anaemia. In the age group 1 to 12 months more than half that is 76(58%) children had either too early or late initiation of complementary feeding.

Majority of the participants 180 (60%) had iron intake less than the recommended for age. Predominantly 297 (99%) children were on vegetarian diet compared to 03 (1%) on non- vegetarian diet. The non-vegetarians were taking non vegetarian food only once in 5 to 10 days. Around 169(56.33%) children had a total iron intake less than 4 mg/day, whereas 129(43%) had an iron intake between 4 to 6 mg/day and only 02(0.67%) had iron intake above 6mg/day. Table 2.

Out of 300 subjects, one third (99) were admitted to hospital for respiratory complaints. Respiratory complaints of pneumonia/empyema in 85(28.3%) children and bronchiolitis/asthma in 14 (4.7%) children. Illnesses in the previous six months comprised of respiratory infections in (27.7%), gastroenteritis in (19%) and convulsions in (19.3%).

Despite having anaemia,177(59%) children were asymptomatic and only 123(41%) were symptomatic. Symptomatic children had severe anaemia seen in 17(25.8%) children, moderate anaemia in 73(53%) and mild anaemia in 40(44.9%) children. The correlation between the severity of anaemia and symptoms of anaemia was statistically significant (p=.005). Clinical signs of anaemia were detected in 59(89.9%) of children with severe

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anaemia, 70(48.3%) with moderate anaemia and 17(19.1%) with mild anaemia. The correlation between the severity of anaemia, and signs of anaemia was statistically significant (p=.005).

Out of 123 patients symptomatic for anaemia, paleness noticed by the parents was the most common symptom in 114(38%) children followed by easy fatigability and breathlessness. Conjunctival pallor was the most prominent sign in 143(47.66%) patients followed by pallor of palms and/or soles in 39(13%) and oral cavity in 19(6.33%). Twenty- seven patients (18.5%) out of the 146 (48.7%) children with signs of anaemia had congestive cardiac failure. Many had more than one sign, whereas 71(23.66%) had pallor of conjunctiva as the only sign of anaemia.

Children with height less than 3rd percentile was 110 (36.7%). For this height the number of children in mild, moderate and severe anaemia was 33(53%), 42 (23%) and 33 (77.1%) respectively and the association was significant (p=0.003).

Weight less than 3rd percentile (57%) was seen in a higher number of anaemic children compared to height less than 3rd percentile (36.7%). Head circumference was less than 3rd percentile in 106 (35.3%) children. Out of 300 participants, 55 (18.3%) had severe acute malnutrition with Z score less than -3, and 26 (12.7%) had moderate acute malnutrition with Z score between -3 to -2. [9] Table 3.

Normal MCV values of 80 and above was seen in only 14(4.7%) children. MCV values of less than 60 was seen in 65(21.7%) children,60 to 70 in 113(37.7%) children and70 to 80 in 108 (36%) children respectively. Lower MCV values was observed in children having increasing severity of anaemia. There was a positive correlation between the severity of anaemia and MCV values and that was statistically significant (p=0.000).

Table 1: Iron intake

Age group	**Appropriate for age** **Number (%)**	**Not appropriate for age** **Number (%)**
1-12 months	57(44.2)	75(55.8)
13-24 months	39(39.4)	60(60.6)
25-36 months	24(33.3)	48(66.7)
Total	**120(40%)**	**180(60%)**

Table 2: Iron Intake of Participants

Iron intake (mg/day)	**Number (%)**
Less than 4	169(56.33)
4-6	129(43)
6 and above	02(0.67)

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Table 3: Nutritional status of the subjects as per WHO standards

Z score	**Number**	**(%)**
Less than -3	64	21.3
-3 to less than -2	76	25.3
-2 and above	160	53.4
Total	300	100

Table 4: Relation of MCV values with Severity of Anemia

Mean corpuscular Volume	**Hb<7 No. (%)**	**Hb7-9 No. (%)**	**Hb9.1-11 No. (%)**	**Total No. (%)**
<60	36(54.5)	21(14.5)	08(9)	65(21.7)
60 to 70	22(33.3)	70(48.3)	21(23.6)	113(37.7)
70 to <80	06(9.1)	50(34.5)	52(58.4)	108(36)
80 and above	02(3)	04(2.8)	08(9)	14(4.7)
Total	66(100)	145(100)	89(100)	300(100)
Chi-Square test	Value	df	P value	Association
Pearson Chi-Square	83.201	6	0.000	Significant

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Discussion

We studied 300 children between the age group of 1 month to 3 years, whose haemoglobin level was below 11 g/dl. Risk factors of iron deficiency anaemia between three haemoglobin level groups of less than 7 gm/dl, 7 to 9 gm/dl and 9.1-11g/dl was analysed.

Male: female ratio was higher in smaller children less than 2 years of age (2:1) while it was nearly one in children between 25 and 36 months of age. As we could not include all cases of anaemia during the study period the prevalence rates could not be determined. Other studies also had a male to female ratio of nearly one in their study.[4]

According to modified Kuppuswamy classification of socioeconomic status, subjects belonging to upper middle class comprised 101(33.7%) and lower middle class comprised of 93 (31%).

Majority of our subjects were Hindus 211(70.3%), this again would reflect the pattern of admission in our hospital. Muslims generally have a larger portion of diet in non-vegetarian form, which is richer in iron. We found 99% of cases were on a vegetarian diet irrespective of religion. Table 1.

Anaemia was prevalent in 13 (59.09%) out of 22 preterm children as compared to 116(41.72%) out of 278 full term children. Hence prematurity should be considered as one of important risk factors of iron deficiency anaemia in children, especially below 1 year of age.

More children were appropriate for the gestational age at birth consisting of 210 (70%) while 85(28.3%) were small for date. This is in accordance with our national low birth weight prevalence of about 30%. In the subjects less than 1 year, the small for date births accounted for 40(47%) while appropriate for gestational age was 87(41%). The correlation of birth weight and severity of anaemia was not statistically significant(p=0.483). However, this was different from study by *Granado* et al where birth weight of less than 3500 g was significantly associated with iron deficiency anaemia. [5]

In our study most of the mothers i.e. 171(57%) were not on iron supplements. Iron supplements administered to mothers will be important to prevent anaemia in their infants. *Geltman* et al in their study showed that the infants whose mothers were anaemic during pregnancy were 2.15 times more likely to have anaemia. [6] Also anaemic mothers did not recover iron status 6 months' post-partum. [7]

Those presenting with respiratory infection were 85(28.3%), asthma were 14(4.6%), febrile convulsions 27 (9%) and gastroenteritis 21(7%). Malaria along with dengue accounted for 24(6.9%).

The common paediatric illnesses problems seen in the preceding 6 months included: respiratory infections (27.66%), gastroenteritis (19%) and convulsions (19.3%). Factors known to contribute towards development of anaemia like measles, worms, pica, malaria, accounted for a total of 48(16%) cases. In our study 16(5.33%) had history of worm infestations and 16(5.33%) had pica. Wheezing episodes like Asthma and Bronchiolitis were present in a total of 32(10.6%) cases. *Ramakrishnan* et al in their study showed that 74% of anaemic children had asthma while only 33% controls (non-anaemic) had asthma. Implying that anaemic children were 5.75 times more susceptible to asthmatic attacks compared with non-anaemic children.[8]

Children having a respiratory infection, febrile convulsions and heart disease along with anaemia had more cases in the milder anaemia group. This was not so in other conditions and was not found to be significant (p=0.550) Association between febrile convulsions and anaemia was also noted by *Sharif* et al in their study.[9]

Symptoms of anaemia was seen in 123(41%) of children. Paleness was the commonest symptom noticed in 114 children followed by easy fatigability and breathlessness. Signs of anaemia were seen in 48.7% of cases. The

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clinical signs of anaemia were detected in 59(89.9%) of children with severe anaemia, 70(48.3%) with moderate anaemia and 17(19.1%) with mild anaemia. Although this was found to be statistically significant, we could not find individual signs of anaemia like conjunctival pallor, pallor over the palms etc. correlating directly with the severity.

In the age group of 1 to 12 months, 76(58%) of the children had either too early or late initiation of complementary feeding. Late initiation of complementary feeding was the most important predictor of iron deficiency anaemia in the 1 to 2 years of age in the study conducted by *Zuberi* et al.[8]Among the breastfed children, 28(9.33%) belonged to the age group more than 2 years in our study. Also 114(38%) of children below 2 years of age were not breast fed. In a study by *Gunnarsson* et al, half of infants consuming more than 500 g cow's milk/day were iron-deficient, while only one child in 58 consuming less than 500 g cow's milk/day had iron deficiency.[10] *Assiss* et al. also showed in their study that exclusive breast feeding up to six months ensured high haemoglobin. When children were predominantly breast fed along with complementary feeding, haemoglobin levels fell by 1.02 g/dl.[11] In the current study, 298(99.3%) had poor iron intake.

Anthropometry

Anaemia was more common children with height less than 3rd percentile in 110 subjects (36.7%) and weight below 3rd percentile in 171 subjects (57%). Severe acute malnutrition was seen in 64 (21.3%) children and moderate acute malnutrition in 76(25.3%).

Severe anaemia with haemoglobin less than 7 g/dl, moderate anaemia with haemoglobin between 7 to 9 g/dl and mild anaemia with haemoglobin between 9.1 to 11 g/dl was seen in 66(22%), 145(48.7%) and 89(29.3%)respectively. In our study the incidence of mild/severe anaemia was seen more in children aged less than 2 years. This is comparable to the study by *Luo* et al. conducted in infants from rural China.[12]

In the present study, the severity of anaemia correlated strongly with the presence or absence of maternal iron intake. All grades of anaemia were more common in children whose mother had not taken iron supplementation. Severe anaemia was seen in 49(74.2%) children, whose mother had not taken oral iron as against only 17 (25.8%) in children whose mothers took iron supplements regularly. In our study, literacy of the mother did not affect the status of anaemia in the child.

Less than half, 129(43%) children had symptoms of anaemia. Symptoms were more common in mild anaemia group (44.9%) and moderate anaemia group (49.7%) as compared to severe anaemia group (25.8%). The correlation between the severity of anaemia and symptoms of anaemia was statistically significant (p=.005). The symptoms were more in mild and moderate anaemia group because of associated co-morbid conditions due to which the anaemia presented earlier. Though a large number of children were asymptomatic careful clinical examination revealed signs of anaemia. Clinical signs of anaemia were absent in more than 50% of cases. However, the clinical signs of anaemia were detected in 59(89.9%) of children with severe anaemia, 70(48.3%) with moderate anaemia and 17(19.1%) with those having mild anaemia.

Children with short stature and severe anaemia (31%) was almost twice as compared to children with normal height (16.3%) and the association was significant (p=0.003). *Angeles* et al did a case control study for iron deficiency with determination of weight and height before and after iron supplementation for 2 months. Height and weight of all children increased. Iron supplementation may be a relatively inexpensive way to help decrease the high prevalence of stunting.[13]

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In our study there was a strong correlation between MCV value and severity of anaemia. In all patients with MCV values less than sixty, 54.5% had severe anaemia,14.5% had moderate anaemia and only 9% had mild anaemia. Haemoglobin along with MCV can diagnose majority of patients with iron deficiency anaemia and MCV could also grade the severity of anaemia. Both tests are economical and should be the first tests to be done in suspected iron deficiency anaemia especially when serum iron studies cannot be done due to financial constraints .The correlation of severity of anaemia with respect to age, sex, parental education, socioeconomic status, gestational age, birth weight, various illnesses, the duration of exclusive breast feeding, weight and head circumference was not found to be significant in the present study. Table 3.

Conclusion

Out of the300 subjects examined, 66(22%) had severe, 45(48.7%) had moderate and 89 (29.3%) had mild anaemia. Dietary iron intake less than the recommended for age was seen in 180 (60%) subjects. Children who were asymptomatic was 177(59%). Clinical signs of anaemia were seen in 146(48.7%). Sixty-four children (21.3%) had severe acute malnutrition and 76 (25.3%) had moderate acute malnutrition. Only 14(4.7%) had normal MCV values of 80 and above. Maternal iron intake, symptoms & signs of anaemia, MCV and height had significant association with severity of anaemia.

The study had some limitations because it pertained only to ill children requiring admissions. The serum iron, TIBC, serum ferritin was not done and there was no follow up of the cases after receiving iron supplementation.

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125

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