International Journal of Contemporary Pediatrics
Ray S et al. Int J Contemp Pediatr. 2016 May;3(2):403-408
http://www.ijpediatrics.com
pISSN 2349-3283 | eISSN 2349-3291

DOI: http://dx.doi.org/10.18203/2349-3291.ijcp20161023

Research Article

Determinants of nutritional anaemia in children less than five years age

Sandip Ray[1,2]*, Jagdish Chandra[1], Jayashree Bhattacharjee[3], Sunita Sharma[4], Anuja Agarwala[5]

[1]Department of Pediatrics, Kalawati Saran Children's Hospital, New Delhi, India
[2]Lady Hardinge Medical College (LHMC), Connaught Place, New Delhi, India
[3]Vardhaman Mahavir Medical College, New Delhi, India
[4]Department of Pathology, Lady Hardinge Medical College, New Delhi, India
[3]All India Institute of Medical Sciences, New Delhi, India

Received: 29 December 2015
Accepted: 04 February 2016

***Correspondence:**
Dr. Sandip Ray,
E-mail: raysandip09@yahoo.co.in

Copyright: © the author(s), publisher and licensee Medip Academy. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

ABSTRACT

Background: According to WHO, highest prevalence of anemia is found in pre-school aged children. The objective of this study was to determine demographic, socio-economic & nutritional factors for nutritional anemia in children <5 yrs.
Methods: We conducted a cross-sectional study of children aged 6 to 59 months. Hemoglobin, ferritin, folate, vitamin B12 levels were determined. Anthropometric measurements, nutritional intake, family income and other demographic data were recorded.
Results: Majority of cases (75.0%) were in 6months – 2 years age group. 139 (69.5%) subjects had iron deficiency, 86 (43.0%) had Vitamin B12 deficiency and 28 (14.0%) had folic acid deficiency. On multivariate regression the factors found to be associated were: increasing birth order, low iron intake & symptoms of anemia in mother.
Conclusions: Low iron intake, increasing birth order and symptoms of anemia in mother were significant factors associated with nutritional anemia in children less than 5 years age.

Keywords: Nutritional anemia, Children under-5 age, Iron, Pre-school age

INTRODUCTION

Globally, anaemia affects 1.62 billion people, which corresponds to 24.8% of the population, the highest prevalence being in preschool-age children. Of these 293 million anemic children, 89 million live in India.[1] Previous global estimates made by DeMaeyer indicated that 43% of preschool-age children were anemic, whereas, current estimates show this figure to be 47.4%, denoting a significant rise.[1,2] In India the scenario is quite similar. Compared to the NFHS-2 data which showed that 74% of pre-school children were anemic, in NFHS-3 this figure was 79%.[3] Other studies on prevalence of anemia in India show this rising trend.[4-11] Thus, despite recent economic development and the existence of a national anemia-control program, this rise in anemia is continuing.[12,13] This is being viewed with concern as the deficiency of hematopoietic micronutrients does not only result in anemia, it also leads to variety of other consequences including adverse effects on cognitive functions.[14]

Micronutrient deficiency, particularly that of iron, has a direct impact on the nutritional status of young children and is the most common cause of anaemia.[15] Other factors, including folate and vitamin B12 and Vitamin A deficiency, socio-economic status, parental education and many more are also associated with childhood anemia. To effectively control this problem, health care providers must have a comprehensive understanding of the etiologic factors associated with anemia. Pasricha et al from Bangalore have recently described the relative contribution of these factors to anemia in Indian children.[11] This study identified iron deficiency, maternal anemia and and food insecurity being associated with anemia among children between 12-23 months of age.[11] India being a vast country, there is a need to study factors associated with anemia in children in other geographical regions including northern India.

We hypothesized that low haemoglobin concentration in Indian children primarily results from micronutrient (especially iron) deficiencies attributable to poor nutritional intake compounded by adverse socioeconomic conditions. To test this hypothesis we conducted laboratory, nutritional, anthropometric, and socioeconomic evaluations in a cross-section of North-Indian children aged 6 to 59 months.

METHODS

This cross-sectional hospital based observational study was conducted on two hundred patients attending Out-patient and In-patient Department in the Kalawati Saran Childrens' Hospital, department of Pediatrics over a period of November 2010 - March 2012.

We decided to study 25 parameters in relation to nutritional anemia and, hence, a sample size of 200 (8 study subjects for each parameters) was taken. The factors were: a) child related: Age, sex, birth order,exculsive breast feeding (EBF) and its duration, nutritional status, intake of iron, Vit.B_{12} and folate, serum levels of ferritin, Vit.B12 and folate; b) mother related : maternal age, weight, education, occupation, symptoms of anemia, Hb level, IFA intake in pregnancy, duration of IFA intake; and c) father / family related : education, per capita income, number of family members, dietary habit (vegetarian vs. non-vegeterian), residence (urban vs. rural).

Following were the inclusion criteria for the study: Age group: 6 months – 59 months, Hb level <11.0 gm/dl and clinically diagnosed to have nutritional deficiency as a cause of anemia. We excluded children receiving hematinics, or who received blood transfusion within last two months, and those with evidence of apparent chronic infection (Tuberculosis, malaria etc.). All patients at the time of admission /contact in outpatient department who appeared to be clinically having nutritional deficiency as a cause of anaemia were investigated. Only those having hemoglobin <11 mg/dl and satisfying other criteria were included in the study after informed written consent duly signed by patient's guardian.

A detailed history of each patient was taken to ascertain all the factors mentioned above. A complete physical examination was done for pallor, edema, hepatomegaly, knuckle hyper-pigmentation and involuntary movements. The dietary intake of the child was assessed by 24-hour recall method. The data were entered in a software - "Dietsoft" (Courtesy: Dept. of Nutrition and Dietetics, All India Institute of Medical Sciences, New Delhi) by which the intakes of iron, Vit B12 and folate were calculated with respect to the food items. All information obtained was recorded in a pre-designed and pre-tested proforma.

Samples were collected for CBC (complete blood count), peripheral smear examination, Vit B_{12}, folate and serum ferritin levels. Serum samples were separated in plastic vials and were stored in refrigerator at -70^0C. Tests performed included Complete blood counts using Sysmex KX-21 fully automated blood cell analyser and peripheral smear examination using Romanowsky-stained slide. Serum ferritin estimation was done by Microplate Immunoenzymometric Assay using CALBIOTECH USA Kit (Kit Category: FER-133WB). Serum Vit B_{12} and folate were measured by Chemiluminescent Immunoassay using Access Immunoassay System (Beckman Coulter).

Anemia was graded as mild (Hb 10-10.9 gm/dl for children and Hb 10-11.9 gm/dl for women), moderate (7-9.9 gm/dl) and severe (Hb <7 gm/dl).[1] Microcytosis and macrocytosis was defined using standards of Dallman and Simes.[16] Micronutrients cut off levels used were: folate deficiency <5 ng/ml; vitamin B_{12} deficiency <200 pg/ml and iron deficiency i.e. ferritin <12 ng/ml (<30 ng/ml for children having acute infections).

Statistical analysis

All results were analyzed using Windows SPSS software. For comparisons of proportions Chi-square test was used. Univariate and multivariate regression analysis were done to find out the significant factors associated with nutritional anemia.

RESULTS

Majority of cases (75.0%) of nutritional anemia were seen in 6months – 2 years age group, with an overall M: F ratio of 1.8: 1. Almost half of the study subjects (46.5%) had some grades of malnutrition and 28.5% had Severe Acute Malnutrition (SAM). Exclusive breast-feeding was present in 55.0% subjects. Majority (57.0%) of the subjects were in the middle lower middle class of socio-economic status using Modified Kuppuswamy scale.[17] 56% subjects were with percapita income Rs. >2000 per month. Almost 35% mother was clinically anemic. 55% were anemic as determined by haemoglobin estimation. Among the mothers, 90.5% took antenatal iron-folate supplements but only 60.7% among them continued up to $\geq$100 days. Of the subjects, 60.5% were of 2nd order. Majority group (46.7%) had a birth interval 12-24 months. Among the fathers, 54.5% had taken upto secondary education.

A total of 139 (69.5%) subjects had iron deficiency, 86 (43.0%) subjects had Vitamin B12 deficiency and 28 (14.0%) subjects had folic acid deficiency. Among these micronutrients, iron deficiency is significantly associated with severity of anemia (p-value <0.05) but not Vitamin B12 or folate deficiency (Table 1).

Micronutrient deficiency pattern among the study subjects showed that 37.5% had only iron deficiency; 4.5% had only folate deficiency and 15% had only Vitamin B12 deficiency. Combined iron and Vit.B12 deficiency was seen in 23%. Subjects having deficiency of all three micronutrients were 3% (Table 2).

Dietary intake of iron showed a significant association with severity of anemia. Iron deficiency as estimated by low serum ferritin was seen in 69.5% subjects which was significant with respect to severity of anemia.

Table 3 shows mean intake of micronutrients of the subjects according to severity of anemia. The intakes were significantly associated with severity of anemia when iron is considered (P-value=0.009), but not with Vitamin B_{12} (P-value=0.592) and folate intake (P-value=0.343).

On univariate regression the following parameters were significantly associated: Low iron intake, Age of the child, Birth order, Symptoms of anemia in mother, Family income, Father's education, Number of family members, MCV (Table 4).

On multivariate regression the factors found to be associated with nutritional anemia in children less than 5 years age group were: Increasing birth order, Low iron intake, Symptoms of anemia in mother (Table 5).

DISCUSSION

Nutritional anemia is a very common cause of morbidity in children in a developing country like India in the pre-school age group. It shows a clear male preponderance. Despite the existence of an effective control measure since as early as 1970 (Nutritional Anemia Prophylaxis Programme) and constant updating by Government e.g. as in 1991 (National Nutritional Anemia Control Program) and later on as a part RCH programme, the prevalence of nutritional anemia is on the rise in the pre-school children, both in India and abroad.[3-11,18-26]

The factors contributing to nutritional anemia in children have been extensively studied both in India and other countries.[4-11,18-26] To name some of them, are: Poor nutritional intake, low iron bioavailability, low folate and Vitamin B_{12} intake, lower age, poverty, less maternal education, increasing family size, less iron intake, bottle-feeding, prolonged breast-feeding without proper weaning, malaria infection, lack of maternal antenatal care, Food insecurity, increasing birth order, less birth interval, low family income, lack of sanitation etc.[27]

Table 1: Hematopoietic micronutrient deficiency as related to severity of anemia.

Micronutrient deficiency[a]	Mild anemia, N (%)	Moderate anemia N (%)	Severe anemia N (%)	Total N (%)	P-value
Iron Deficiency[b]	23 (16.5)	63 (45.4)	53 (38.1)	139 (69.5)	0.000
Vit B_{12} Deficiency	18 (20.9)	42 (48.8)	26 (30.3)	86 (43.0)	0.871
Folate deficiency	5 (17.8)	14 (50.0)	9 (32.2)	28 (14.0)	0.817

a=as determined by low blood levels of these micronutrients; b=decided by low serum ferritin

Table 2: Different hematopoietic micronutrient deficiency in isolation or combination among the study subjects: (N=200).

	Iron def.	Folate def.	Vit. B_{12} def.	Iron+ folate def.	Folate+ Vit. B_{12} def.	Iron+ Vit. B_{12} def.	Triple def.
No. of subjects	75	9	30	11	2	47	6
%	37.5	4.5	15.0	5.5	1.0	23.0	3.0

Table 3: Dietary parameters of the child in relation to severity of anemia.

Intake of micronutrients	Mild anemia, Mean (95%CI)	Moderate anemia Mean (95%CI)	Severe anemia Mean (95%CI)	Total Mean (95%CI)	P-value
Iron (mg/d)	10.31 (9.83-10.78)	9.24 (8.77-9.71)	8.61 (8.20-9.01)	9.29 (8.83-9.74)	0.009
Vit.B_{12} (micg/d)	0.01 (0.001-0.018)	0.04 (0.018-0.061)	0.03 (0.011-0.048)	0.03 (0.011-0.048)	0.592
Folate (micg/d)	25.73 (24.93-26.52)	25.07 (24.08-26.05)	24.41 (23.26-25.55)	25.02 (24.02-26.01)	0.343

Table 4: Regression coefficients (univariate-linear) between Hemoglobin level and conditions in the child.

Factors	Coefficient	95% CI	P-value
Age	-0.241	-0.472 to -0.011	0.04
Mother's age when index child was born	-0.241	-0.647 to -0.166	0.24
Birth order	-0.520	-0.825 to -0.214	0.001
Interval before index child	0.136	-0.187 to 0.459	0.408
Mother's education	0.07	-0.2 to 0.339	0.611
Symptoms of anemia in mother	1.519	0.202 to 2.837	0.024
Mother's hemoglobin	0.077	-0.118 to 0.272	0.78
Duration of IFA intake	0.367	-0.083 to 0.816	0.109
Duration of EBF	-0.067	-0.243 to 0.108	0.45
Father's education	-0.291	-0.553 to -0.029	0.03
Father's occupation	0.006	-0.232 to 0.243	0.96
Per-capita income	-0.116	-0.351 to 0.119	0.33
Family income	-0.393	-0.644 to -0.142	0.002
No.of family members	-0.258	-0.43 to -0.86	0.003
Iron intake	0.07	0.008 to 0.133	0.028
Vit B_{12} intake	-0.892	-2.48 to 0.696	0.27
Folate intake	0.01	-0.019 to 0.039	0.50
Weight for age z-score	-0.007	-0.103 to 0.088	0.878
Height for age z-score	-0.034	-0.1 to 0.033	0.322
Weight for height z-score	0.075	-0.036 to 0.187	0.184
Malnutrition grades	-0.033	-0.305 to 0.238	0.81
MCV[a]	0.039	0.019 to 0.059	0.000
Serum ferritin	0.001	0.000 to 0.002	0.17
Serum Vit.B_{12}	0.000	0.000 to 0.001	0.753
Serum folate	0.008	-0.027 to 0.043	0.651
Still breastfeeding	-0.328	-0.744 to 0.088	0.122

a= Mean Corpuscular Volume

Table 5: Multiple Regression models of factors associated with haemoglobin.

Factors	Coefficient	Standardised coefficient	95% CI	P-value
Birth order	-0.529	-0.222	-0.878 to -0.179	0.003
Low Iron intake	0.102	0.205	0.026 to 0.178	0.008
Symptoms of anemia in mother	1.611	0.158	0.162 to 3.059	0.03

Age of the child is known to be a significant factor associated with nutritional anemia in children. Many authors from all over the world have shown that younger age is associated with nutritional anemia.[18-26,29-30] This has been attributed to the incompleteness of weaning practices, exclusive breast feeding till late age or top feeding with predominantly diluted feeds. All of these studies are prevalence studies on population groups. In our study also, majority (75%) of the children were <2 years age. The correlation we found in regression analysis is an inverse relation between age and haemoglobin levels as evident by higher proportion of older children having severe anemia. The possible explanation for this may be, as age increases, the deficient child on account of inappropriate feeding practices becomes more and more deprived of micronutrients making him severely anemic.

Iron deficiency anemia is the most common type of nutritional anemia in children of less than five year age group, cobalamin deficiency being the next most common.[10,31-32] In our study, 37.5% had only iron deficiency, whereas this figure for VitB12 and folate deficiency are 15% and 4.5% respectively. Combined Iron and VitB12 deficiency was seen in 23% of the children.

Almost half of the subjects had some grades of malnutrition and our study revealed a clear evidence of improper breast feeding practices, inadequate IFA supplementation strategies and awareness regarding this practices.

'Low iron intake, Increasing birth order, History suggestive of anemia in mother' were the factors which if modified would bring out a change in the outcome of anemia in these subjects.

Low intake of iron has emerged as a significant determinant for nutritional anemia in several studies around the world.[18,30,33,34] In our study as well, this finding was corroborated and after multiple regression analysis, this factor remained to be significant, suggesting, improvement in intake of iron via nutrition will definitely improve the hemoglobin level of the child.

Birth order was also a significant factor (p-value=0.001) on multivariate analysis. However, this factor has not yet been described as significant in any study around the world. Increasing birth order might well be related to maternal depletion of micronutrients. Mild maternal iron deficiency and anemia have few significant repercussions on the iron status of the newborn but severe anemia does have a strong influence.[35] A negative coefficient for birth order suggest inverse relation with child's hemoglobin levels i.e. as birth order increases hemoglobin level falls. In our study, 60.5% were of 2nd order. Majority group (46.7%) had a birth interval 12-24 months.

Important factors which are well described in studies all around the world, but were not found to be significant in our study were: maternal haemoglobin level, mother's education, antenatal iron – folate prophylaxis status and socio-economic status.

CONCLUSION

In a developing country like India where 28.6% of the population is below poverty line, nutritional anemia constitutes a major disease burden, with iron deficiency contributing to majority of cases.

Many workers from all over the world have shown that socio-economic status, age of the child, parental education , sanitary habits and many other factors to be associated with anemia in this age group. We lack data in Indian scenario; only one study from southern India cast some light over this topic. In northern parts of India, the dietary and living habits as well as atmospheric conditions are completely different. This study was an attempt to delineate factors associated with anemia and contribute to the ongoing search of preventing this dreadful morbidity.

In our study, we found that Low bio-available iron intake is a significant determinant towards causing nutritional anemia. This should be given importance while deciding policies for National Nutritional Anemia Control Programme. Increasing birth order is a factor that needs attention specially while setting up policies for Family Planning and Child Welfare. Control of family size will bring a multi-pronged benefit to our society. The third factor, symptomatic anemia in mother is a significant determinant. Anemia in mother should be diagnosed and treated in the antenatal period; thus improving micronutrient status of infant at birth. Children born to anemic mothers should be closely followed up and looked for anemia.

ACKNOWLEDGEMENTS

I would, at the outset, like to express my sincere regards and profound gratitude to Dr. Jagdish Chandra, Dr. Jayashree Bhattacharjee, Dr. Sunita Sharma, for their invaluable guidance, keen interest, meticulous supervision, sincere criticism, immense patience and valued association throughout the execution of this study, without which this work would not have come to its logical conclusion.

My profound regards and gratitude to Dr. Satinder Aneja, Director Professor and Head of the Department of Paediatrics, Dr. A. K. Dutta, Director Professor, Department of Paediatrics, for their keen interest, valued association and constant encouragement during the study period.

I must extend my sincere thanks to Dr. Guresh Kumar, Professor, Department of Biostatistics, All India Institute of Medical Sciences, for his generous help in my thesis work.

I sincerely thank Dr. Bhawna Dhingra, Professor, Department of Paediatrics, for her generous support and constant inspiration.

I gratefully thank all the residents and staff of haematology laboratory who extended their sincere help and kind co-operation even at odd hours. I acknowledge all the patients, especially mothers of children without whose co-operation the study would have not been carried out. Words are inadequate to express heartfelt thanks to my family for their constant emotional and moral support throughout the study.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: Approved by the ethical committee of Lady Hardinge Medical College, New Delhi

REFERENCES

1. World Health Organization. Iron Deficiency Anaemia: Assessment, Prevention, and Control-A Guide for Programme Managers. Geneva, Switzerland: World Health Organization. 2001. www.who. int/nutrition/publications/micronutrients/ anaemia_iron_deficiency/WHO_NHD_01.3/en/ index.html. Accessesd at April 12, 2010
2. DeMaeyer E, Adiels-Tegman M. The prevalence of anaemia in the world. World Health Statistics Quarterly. 1985;38:302-16.
3. National Family Health Survey (NFHS-3). 2005-2006: Key Findings. Mumbai, India: International Institute for Population Sciences; 2007.Available at: www.measuredhs.com/pubs/ pdf/SR128/SR128.pdf. Accessed April 11, 2010.

4. Rao NP, Singh D, Swaminathan MC. Nutritional Status of Preschool children of rural communities near Hyderabad city. Ind J Med Res. 1969;57:2132-48.
5. Gupta N, Agarwal KN. Hematological Investigations and plasma proteins in pre-school children. Ind Jour Pediatr. 1972;39:48-51.
6. Uberoi IS, DeSweemer C, Taylor CE. A study of anemia among rural Punjabi children. Ind Jour Med Res. 1972;60:793-99.
7. Preschool children studies on anemia: Indian Council of Medical Research. Technical Report Series, No. 26:22. 1977.
8. Singla PN, Gupta HP, Ahuja C, Agarwal KN. Deficiency Anemia in preschool Children-Estimation of prevalence based on response to haematinic supplementation, Jour Trop Pediatr. 1982;28:77-80.
9. Agarwal DK, Bharadwaj B, Singla PN, Tripathi AM, Agarwal KN. Etiology of maternal and early childhood deficiency anemia. Ind Jour Pediatr. 1986;53:389-96.
10. Gomber S, Kumar S, Rusia U, Gupta P, Agarwal KN, Sharma S. Prevalence and etiology of nutritional anemia in early childhood in an urban slum. Ind J. Med Res. 1998;107:269-73.
11. Pasricha SR, Black J, Muthayya S. Determinants of Anemia Among Young Children in Rural India. Pediatrics. 2010;126:e140-9.
12. Chatterjee P. Child malnutrition rises in India despite economic boom. Lancet. 2007;369(9571):1417-8.
13. Kumar A. National nutritional anaemia control programme in India. Indian J Public Health. 1999;43(1):3-5.
14. Yadav D, Chandra J. Iron deficiency: beyond anemia, Indian J Pediatr. 2011;78(1):65-72.
15. PHNI/MEDS/USAID. Anaemia prevention and control: What works; Part I; The Population, Health and Nutrition/Monitoring, Evaluation and Design Support/US USA: Assistance for International Development. 2003.
16. Dallman PR, Simes MA. Percentile curves for hemoglobin and red cell volume in infancy and childhood. J Pediatr. 1979;94:28.
17. Patro BK, Jeyashree K, Gupta PK, Kuppuswamy's socioeconomic status scale 2010-the need for periodic revision, Indian J Pediatr. 2012;79(3):395-6.
18. Osório MM, Lira PI, Ashworth A. Factors associated with Hb concentration in children aged 6–59 months in the State of Pernambuco, Brazil. Br J Nutr. 2004;91(2):307-15.
19. Adish AA, Esrey SA, Gyorkos TW, Johns T. Risk factors for iron deficiency anaemia in preschool children in northern Ethiopia. Public Health Nutr. 1999;2(3):243-52.
20. Almeida CA, Ricco RG, Ciampo LA, Souza AM, Pinho AP, Oliveira JE. Factors associated with iron deficiency anemia in Brazilian preschool children. J Pediatr (Rio J). 2004;80(3):229-34.
21. Tengco LW, Rayco-Solon P, Solon JA, Sarol JN, Solon FS. Determinants of Anemia among Preschool Children in the Philippines, J Am Coll Nutr. 2008;27(2):229-43.
22. Nawal. Assessment of the prevalence and potential determinants of nutritional anaemia in Upper Egypt. Food and Nutrition Bulletin. 1997;20(4):417-21.
23. Duque X, Flores-Hernández S, Flores-Huerta S. Prevalence of anemia and deficiency of iron, folic acid, and zinc in children younger than 2 years of age who use the health services provided by the Mexican Social Security Institute. BMC Public Health. 2007;7:345.
24. Keikhaei B, Zandian K, Ghasemi A, Tabibi R. Iron-deficiency anemia among children in southwest Iran. Food Nutr Bull. 2007;28(4):406-11.
25. Souganidis ES, Sun K, De Pee S. Determinants of Anemia Clustering Among Mothers and Children in Indonesia. Journal of Tropical Pediatrics. 2011.
26. Bortolii GA, Vitolo MR. Relationship between iron deficiency and anemia in children younger than 4 years. J Pediatr (Rio J). 2010;86(6):488-92.
27. www.fantaproject.org/downloads/pdfs/HFIAS_v3_ Aug07.pdf
28. Chandra J, Jain V, Narayan S. Folate and Cobalamin Deficiency in Megaloblastic Anemia in Children. Indian Pediatr. 2002;39(5):453-7.
29. Schneider JM, Fujii ML, Lamp CL, Lönnerdal B, Dewey KG, Zidenberg-Cherr S. The use of multiple logistic regression to identify risk factors associated with anemia and iron deficiency in a convenience sample of 12–36-mo-old children from low-income families. Am J Clin Nutr. 2008;87(3):614-20.
30. Cotta RM, Oliveira Fde C, Magalhães KA. Social and biological determinants of iron deficiency anemia, Cad Saude Publica. 2011;27(2):S309-20.
31. Sharma A, Sharma SK, Grover AK, Tewari AD, Abrol P. Anemia in protein-energy malnutrition. Indian Pediatr. 1985;22(11):841-4
32. Monarrez J, Martinez H, Martinez V, Greiner T. Nutritional status of indigenous children at boarding schools in Nortern Mexico. Eur J. Clin Nutr. 2004;58:532-40.
33. Pasricha SR, Black J, Muthayya S. Determinants of Anemia Among Young Children in Rural India. Pediatrics. 2010;126;e140-9.
34. Halileh S, Gordon NH. Determinants of Anemia in Pre-School Children in the Occupied Palestinian Territory ; J Trop Pediatr. 2006;52(1):12-8.
35. Kotecha PV. Nutritional anemia among young children withfocus on Asia and India. Indian J Community Med. 2011;36:8-16.

Cite this article as: Ray S, Chandra J, Bhattacharjee J, Sharma S, Agarwala A. Determinants of nutritional anaemia in children less than five years age. Int J Contemp Pediatr 2016;3:403-8.