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Original Article

Community Section

Dietary Predictors of Anaemia among Children Aged 12-35 Months

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ABSTRACT

Introduction: Children especially during the early years of life should have increased dietary iron and protein that needs to accommodate growth, development and the accompanying expansion of blood volume. An average Indian child can take up-to 2.5 to 3.5 mg iron per day leaving a deficiency of 4-6.5 mg/day deficiency of iron while 33% of Indian children are still suffering from protein malnutrition. This deficiency of iron and protein leads to high burden of Nutritional Anaemia in Children.

Aim: To find the average daily dietary consumption of iron and protein among the children aged 12-35 months and its association with anaemia.

Materials and Methods: The present cross-sectional study was carried out among 200 children aged 12-35 months (prevalence 79%, relative precision 7.5%, 95% CI) residing in a sub-centre village of Meerut district, Uttar Pradesh, India. The study was carried out between May 2016 and November 2017. Dietary information was collected by 24 hour recall method done for two consecutive days on a pretested, predesigned and semi-structured questionnaire. Iron and protein content in food was calculated as per ICMR guidelines, 2010, data was analysed using epi-info software 3.7.2.

Results: The present study inferred that mean dietary intake of iron (2.10±1.08) mg/day and protein (18.23±0.38) mg/day among the selected population is way less than the body daily dietary requirements (5-9 mg/day) and (10-14 gm iron/day). This inadequacy in diet is reflected as high prevalence of anaemia 155 (77.5%) and malnutrition 67 (33.5%) in this age group.

Conclusion: Dietary intake of iron, consumption of haem iron and non-heme iron and protein intake are not only but an important determinant of anaemia in children. Despite best of diet a child is unable to meet the dietary requirement of iron and lands up in anaemia. In this background, a daily iron supplementation regimen may play an important role to combat this disease burden.

Keywords: Child, Iron deficiency, Preschool, Protein deficiency

INTRODUCTION

Anaemia continues to be a major global health challenge affecting both developing and developed countries with major consequences for human health as well as social and economic development. It occurs in all stages of the life cycle but the most vulnerable age group being pregnant women and young children [1].

Nutritional Anaemia is the commonest cause of anaemia in developing countries, often results from deficiencies of vital nutrients necessary for red blood cell formation. It includes anaemia due to Vitamin B 12 deficiency and folate deficiency which is characterised by defective DNA synthesis and Iron Deficiency Anaemia (IDA) in which heme synthesis is impaired [2].

Children especially during the early years of life have increased dietary iron needs to accommodate growth, development and the accompanying expansion of blood volume. To maintain positive iron balance in the childhood about 0.8mg to 1mg of iron must be absorbed per day. Absorption of dietary iron is assumed to be about 10% thus a diet containing 8-10 mg of elemental iron is necessary for daily nutrition for children below 5 years of age [3]. As per ICMR 2010 recommendations iron needed for children 12 months-35 months is 4-9 + age mg/day [4] (National Institute of Health USA Recommends 7-11 mg/day) [5], Ghosh S et al., recommends 5.5-11 mg/dl [6]) and with best of meals (4 times/day) an average Indian child (12-23 months) can take up to 2.5 to 3.5 mg iron per day leaving a deficiency of 4 to 6.5 mg/day of iron. This deficit leads to fall in iron stores followed by development of IDA [7,8].

Protein is also required in the human body for the production of haemoglobin, serum ferritin, iron binding protein and erythropoietin. A dietary deficiency of protein is associated with low serum iron, serum ferritin levels total iron binding deficiency and reduced red blood cell count. ICMR, 2010 guidelines recommended daily protein intake of 15-20 gm required for maintenance of body metabolism and growth [4].

In this sense, it is important to verify the association between dietary iron intake and the presence of anaemia in pre-school children where the nutritional risk is greatest, and to provide information for the creation and implementation of effective food and nutrition security strategies. Thus, this study was planned with the aim to evaluate dietary consumption of iron and protein among the children aged 12-35 months and establish an association with anaemia and malnutrition.

MATERIALS AND METHODS

The present cross-sectional, observational study was a part of a randomised control trial titled "A randomised control trial on different oral treatment regimens in anaemia among children aged 12-35 months in a rural area of Meerut" [9] which was conducted in a sub-centre village of Primary Health Center, Amarpur under CHC Machhra among children 12-35 months of age. The study was carried out between May, 2016 and November, 2017. Ethical Clearance was obtained from the ethical committee of the LLRM Medical College, Meerut with reference number LLRM/IIEC/Jan/3580/18.

Study area: The sub-center village was selected by using multistage simple random sampling technique where a primary health centre was selected from the Machhra Block (Field practice area of Department of Community Medicine, LLRM Medical College, Meerut), Uttar Pradesh, India followed by selection of Rachoti Sub-centre village.

Sample size: The sample size was calculated as 182 by taking the prevalence of Anaemia as 79% (National Family Health Survey-3) [7] and relative precision as 7.5% with 95% CI. Taking 10% drop out rate into consideration the sample was increased to 200. A list of all children age 12-35 months was obtained from the Maternal and Child Tracking System (MCTS) data, out of 404 children registered, 200 children were selected randomly (lottery method).

Inclusion criteria: Age between 12 months to 35 months on the day of interview, children whose parents were the permanent residents of the village (staying in the village for 5 years or more).

Exclusion criteria: Children who were seriously ill or suffering from any chronic disease (congenital heart disease, liver diseases, renal disorders, or any chronic disease having documentary proof).

Parents who refused consent for participation in the study.

Data collection and analysis: The data regarding dietary intake of food was obtained from the parents preferably mother by 24 hours recall method. Mean food intake was calculated from the data of last two days. The iron and protein amount in the food was calculated according to ICMR standards, 2010 [4].

Calculation of heme and non-heme iron consumption in the food: The heme iron and non-heme iron in the foods were calculated considering that heme iron is obtained from the foods of animal origin (meats in general, including organ meats) while non-heme iron by foods of plant origin (grains, legumes, and vegetables). For the foods of plant origin, 100% of the iron was considered non-heme; for those of animal origin, 60% of the iron was considered non-heme using the method given by Monsen R and Balintfy L [10].

Calculation of protein from the food: The protein in the food was calculated using ICMR standards, 2010 where the information regarding the food consumed (type of food and amount) by the child was gathered by 24 hour recall method. According to the amount of food consumed the protein content was calculated as given by ICMR guidelines [4]. The protein values for each food consumed was calculated individually which was later added up to get the final amount of protein consumed.

This was followed by detailed examination of the child for weight and height characteristics using the Omron weighing scale and stadiometer for height. The children were classified as malnourished and normal according to their weight using WHO growth standards, where a child having weight below 2 standard deviations was considered malnourished [11].

Haemoglobin levels were estimated after obtaining consent from one of the parents, using paper chromatography method by haemo check rapid diagnostic kit, Plasti surge industries pvt., ltd., (Sensitivity 55.5 % and specificity 30 %) [12]. Children with haemoglobin levels below 11gm/dL were considered anaemic, according to WHO guidelines, 2011 [13].

STATISTICAL ANALYSIS

The collected data was compiled using epi info software version 3.7.2 followed by statistical analysis using Student's t-test (unpaired) and Chi-square test.

RESULTS

A total of 200 children were evaluated in the present study, out of which 155 (77.5%) children were found to be anaemic (Hb <11gm/dL). The prevalence of anaemia was found to be higher among the children who were strictly on vegetarian diet 86 (78.9%) compared to those children having both vegetarian and non-vegetarian meals 69 (75.8%) in their diet [Table/Fig-1].

Type of diet	Total children		Anaemia	
	Number	Percentage (%)	Number	Prevalence (%)
Vegetarian	109	54.5	86	78.9
Mixed	91	45.5	69	75.8
Total	200	100.0	155	77.5

[Table/Fig-1]: Prevalence of anaemia and its association with type of diet consumed by study population.

The mean iron consumption in diet was found to be 2.1±1.08 mg/day [Table/Fig-2] with the iron intake of 2.01±0.92 mg/day among the anaemic children and 2.39±1.49 mg/day among non-anaemic children. This difference in mean iron consumption in two groups was found to be statistically significant. 95% CI, (p=0.0285) [Table/Fig-3].

Factor	Mean intake (n=200)	Standard error
Iron intake (mg/day)	2.10	±1.08
Protein intake (mg/day)	18.23	±0.38

[Table/Fig-2]: Mean iron and protein intake by children 12-35 months.

Factor	Anaemia		t-value	Df, p-value
	Yes	No		
Iron intake (mg/day)	2.01±0.92	2.39±1.49	2.20	Df=198, p=0.0285
Haem iron intake (mg/day)	0.36±0.46	0.49±0.57	1.78	df=198, p=0.0758
Non-haem iron intake (mg/day)	1.55±0.88	1.91±1.43	2.18	df=198, p=0.0304
Protein intake (gm/day)	16.75±5.10	19.36±6.09	3.29	Df=198, p=0.0012

[Table/Fig-3]: Distribution of dietary haem iron, non-heme iron, total iron and proteins according to anaemia in study population (unpaired student t-test).

With the vegetarian meal being the preferred food among the residents, non-heme iron contributes major part of dietary iron intake with the mean intake of 1.7±1.03 mg/day. The consumption of non-heme iron was found to be significantly lower (p=0.03) among the anaemic children (1.55±0.88 mg/day) as compared to non-anaemic children (1.91±1.43 mg/day) [Table/Fig-3].

Normal healthy children were found to be consuming more of haem iron rich food (0.49±0.57 mg/day) compared to anaemic children (0.36±0.46 mg/day) though this difference in mean iron consumption was not found to be statistically significant (p>0.05) [Table/Fig-3].

The mean protein intake among the children was found to be 18.23±0.38 gm/day [Table/Fig-2] where the mean intake among anaemic children was 16.75±5.10 gm/day while among the nonanaemic children it was 19.36±6.09 gm/day. This difference in mean protein intake was found to be statistically significant (p=0.0012) [Table/Fig-3].

The prevalence of anaemia was found to be 86.6% among the children who were malnourished (weight for age < 2 SD) while 72.9% children were anaemic among the normal weight children and a statistically significant association was observed (p=0.029) [Table/Fig-4].

Nutrition status	Total children		Anaemia	
	Number	Percentage (%)	Number	Prevalence (%)
Normal weight	133	66.5	97	72.9
Under weight	67	33.5	58	86.6
Total	200	100.0	155	77.5

[Table/Fig-4]: Association between malnutrition and prevalence of anaemia among the study population (Chi-Square Test).
χ^2=4.75, df = 1, p-value = 0.029

DISCUSSION

Pregnant women and under five children are the two most vulnerable sections of the society where the severity of anaemia varies from fatigue, weakness, dizziness and drowsiness to impaired cognitive development in under five children while in pregnancy it is associated with high risk of postpartum haemorrhage, neural tube defects, low birth weight, premature births, stillbirths and maternal deaths [8].

The pre-school period is characterised by rapid growth phase associated with increase in red blood cell counts and high iron and protein requirements. The growth velocity decreases after third year which leads to fall in daily iron requirements. The pre-school children become ambulant and more likely to acquire intestinal parasitic infections leading to IDA. Young children after six months of age are being weaned from breastfeeding but foods being given may be inadequate for their iron needs [14].

The present study highlighted the gap in iron requirement and dietary consumption. In this study of 200 children, 155 (77.5%) children were found to be anaemic which was comparable to the findings of NFHS-3 [7] but higher than findings from NFHS-4 [15] Clinical, Anthropometry and biochemistry study by Census, India reported [16] similar prevalence in this age group.

In this study, diet was calculated using 24 hour recall method. The same method was recommended and validated in the studies by Beaton E et al., and Nightangle H et al., for all dietary supplements among children under five years [17,18]. A sensitivity and specificity in detecting accurate levels of iron and protein intake was taken as 78% and 93%, respectively as revealed by Messerer M and Wolk A among adult interviewers, considering the informant being the mother of the child [19].

The mean consumption of iron by children aged between 12-35 months in the present study was found to be 2.10±1.08 mg/day which was much lower than the recommended intake of 4-9+age mg/day as per ICMR guidelines [4] and 5.6-11 mg/day Ghosh S et al., [6]. No Indian study has been conducted or reported mean iron intake among children under five years while the studies by Silva D et al., in Brazil showed mean intake of 5.03±3.08 mg/day of iron by children age less than five years and study by Dunn MG et al., showed mean uptake of iron 1.57 mg/day (0.69-2.58) among children 1-3 years in Dominican Republic [20,21]. A comparison of results between the different studies is shown in [Table/Fig-5].

S. No.	Study	Year	Place	Result
				Iron consumption
1.	Silva D et al., [20]	2007	Brazil	5.03±3.08 mg/day
2.	ICMR [4]	2010	India	5-9 mg/day
3.	Ghosh S et al., [6]	2019	India	5.6-11 mg/day
4.	Dunn MG et al., [21]	2020	Dominican republic	1.57 mg/day (0.69-2.58)
5.	Agarwal A et al., (present study)	2020	Meerut	2.10±1.08 mg/day

[Table/Fig-5]: Comparison of results with other studies. (Average dietary iron consumption recommendations and results).

The importance of consuming foods rich in iron for the occurrence of anaemia in the study population was also evidenced by the direct moderate correlation between the haemoglobin level and dietary iron intake. Such associations were corroborated by Abdullah H and Al-Assaf A, Rodríguez C et al., in their study corroborated these associations by reinforcing the proposition that inadequate iron intake and low bioavailability are the main determinants of anaemia [22,23].

The low intake of food rich in heme iron may be explained by the poor dietary consumption of animal diet by this population. (Meat is consumed habitually by less than 55% of the study population). These animal foods are high in heme iron and are the ones that are forbidden due to cultural and religious reasons along with its high expense.

The present study revealed a significant association between the consumption of protein source food in diet and high prevalence of anaemia. The results were similar to results interpreted in the study by Desalegn W et al., and Kokubo Y et al., where they conducted studies on children 6-12 years and among Japanese college girls and concluded that protein deficiency in daily diet affects haemoglobin levels thus causes anaemia [24,25]. However, there was no evidence over such findings in children aged 12-35 months as observed in present study. The results of the studies is tabulated and compared in [Table/Fig-6].

This relationship is further strengthened by the association of malnutrition with anaemia which is also found to be significant in this study. The results were further supported by the similar findings by

S. No.	Study	Year	Place	Age group	Result
1.	Desalegn W et al., [24]	2016	Ethiopia	5-11 years	66% of the children who were non-consumers of protein rich food were anaemic while among the children who were consumers of protein rich food only 35% were suffering from anaemia.
2.	Kokubo Y et al., [25]	2016	Japan	Adolescent girls	73% of the women who were low protein consumers were anaemic while only 11% of the women were anaemic whose dietary intake of protein was high.
3.	Agarwal A et al., (present study)	2020	Meerut	12-35 months	Average consumption of protein was found to be lower among the anaemic children

[Table/Fig-6]: Comparison of results with other studies. {Average dietary protein consumption and its association with Iron Deficiency Anaemia (IDA)}.

Rao T and Tuhina V, Thakur N et al., who reported prevalence of 78% and 80% of anaemia in malnourished and severely malnourished children in their respective studies [26,27]. Limited haemoglobin production caused by a low protein intake impairs the production of usual amount of globin even in the presence of excessive iron.

Limitation(s)

Despite the best possible efforts there were some limitations identified. The paper chromatography method had limitation of low sensitivity but since the study was done under resource constrained settings thus using other methods like cyan-meth-haemoglobin laboratory testing for haemoglobin and serum ferritin levels was beyond the scope. This study used 24 hour recall method for dietary calculations, the validity of which is still questionable under existing conditions.

CONCLUSION(S)

The present study showed that mean iron intake by under three children is much less than the recommended daily requirements of iron among Indian children. This reduced iron intake is reflected as high prevalence of anaemia in this age group. Dietary intake of iron is one of the important determinant of anaemia but is missing from the existing government policies. This study concludes that an inclusion of iron rich food like cereals, pulses, green leafy vegetables, nuts and spices (Plant products) and meat or chicken, fish and other seafood (animal food) in the diet of every child. Food rich in haem iron and low in phytates may further enhance the iron absorption.

The present study thus recommends requirement for further research focused on accurately establishing iron requirements in young children and the need to strengthen existing policy of combating iron deficiency and incorporate dietary counselling along with iron supplementation as part of preventive strategy.

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