Effectiveness of iron-fortified infant cereals on hemoglobin levels of children aged 12–24 months: A cross-sectional study from New Delhi, India

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ABSTRACT

Introduction: Iron deficiency anemia represents 3rd largest disease burden, with an estimated 6.9 billion disability-adjusted life years.Iron-fortified cereals (IFIC) can contribute substantially in preventing iron deficiency anemia and maintaining an adequate body iron status. The aim of this study is to assess the effectiveness of IFIC intake along with other complementary food/s on the hemoglobin (hb) level of children from 12 to 24 months of age. **Materials and Methods:** A cross-sectional study was conducted from November 2015 to February 2016 in three pediatric outpatient clinics of New Delhi, India. A predesigned questionnaire was used to elicit information on socio-demography, complementary feeding, and intake of IFIC from 66 mother and child pairs. Child's anthropometric measurement and hb levels were recorded by the pediatrician. Chi-square and Student's t-tests were used to compare the key study variables between IFIC (minimum 1–2 serving/day) and non-IFIC groups. Multiple logistic regression analysis was applied to explore the independent correlates of anemia in the study groups. **Results:** Out of 66 children, 60.6% ($n = 40$) of children were boys. The prevalence of anemia (hb% <11 g/dl) was 42.4% (95% confidence interval (CI): 30.5%–55.2%, $n = 28$). Multiple logistic regression analysis revealed that the children in IFIC group were unlikely to be anemic (adjusted odds ratio (OR): 0.007, 95% CI: 0.001–0.079, $P < 0.001$). On the contrary, boys (adjusted OR: 11.6, 95% CI: 1.23–108.9, $P = 0.032$) and children with low birth weight (adjusted OR: 11.7, 95% CI: 1.23–111.76, $P = 0.032$) were associated with anemic status. **Conclusion:** Intake of IFIC (minimum 1–2 serving/day) was associated with the lesser chance of anemia in children of 12–24 months. However, gender and low birth weight were also associated with anemia. IFIC may have a role in mass fortification programs. However, further larger and controlled studies are recommended to test this hypothesis.

Keywords: Anemia, children, iron-fortified cereal

Background

Iron deficiency anemia (inadequate amount of red blood cells caused by the lack of iron) is highly prevalent and severe in young children (6–24 months) in developing countries.[1] It rarely exists in isolation and has a huge impact on cognitive and psychomotor development which is indicative of high health-care costs, thwarted education efforts, less capable and productive workforce, and curtailed economic activity. An anemic child is likely to remain vulnerable to infection and continue to have lower immunity throughout childhood, overall appetite is reduced, and this vicious cycle perpetuates a series of events resulting the increased risk of child morbidity and policymakers often fail to recognize the massive economic costs.

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Iron deficiency anemia represents third largest disease burden, with an estimated annual cost of US$23.8 billion per annum of future production losses and 6.9 billion Disability adjusted life years (DALYs). Evidence have indicated that iron-fortified cereals (IFIC) can contribute substantially in preventing iron deficiency anemia and maintaining an adequate body iron status. A systematic review and meta-analysis conducted by Eichler *et al.*,[2] indicated that multi-micronutrient fortified milk and cereal products can be an effective option to reduce anemia of children up to 3 years of age in developing countries. Although anemia is multifactorial in etiology involving a complex interaction between nutrition, infectious diseases, and other factors, preventative efforts have/must predominantly focus on increasing iron intake, primarily through supplementation. It is preventable with appropriate and timely intervention.[3-8] However, evidences from developing countries like India are limited.

With this background, one can hypothesize that the intake of iron-fortified infant cereals (IFIC), along with the other complementary foods, maintain an adequate body iron status, as measured by the blood hemoglobin (hb) levels.

Objective

To assess the effectiveness of intake IFIC along with other complementary food/s on the hb level of children from 12 to 24 months of age

Methods

A cross-sectional study was conducted from November 2016 to February 2017 in three pediatric outpatient clinics of New Delhi, India. Children aged from 12 to 24 months visiting the pediatrician outpatient department, meeting inclusion/exclusion criteria were the study participants. Convenient sampling was followed as it was a pilot study.

Participant inclusion criteria as follows:
- Apparently healthy child aged from 12 to 24 months
- Breastfeeding (or formula feeding, or mixed feeding) is already complemented by other foods.

Participant exclusion criteria as follows:
- Chronic illness necessitating medical follow-up
- Acute ongoing or recent (last 2 weeks) illness necessitating medical follow-up
- Known parasitic infection
- Currently enrolled in a fortification program
- Documented intolerance to gluten, lactose, and allergy to bovine milk proteins
- Caregivers who are not likely to comply with the study procedures
- Currently participating or having participated in another clinical study during the past 4 weeks before the beginning of this.

Data collection

A predesigned and semi-structured questionnaire was used for the data collection. Accompanying mother was the key informant. All the data were collected by a qualified pediatrician. Key sociodemographic profile, birth weight (from the records), anthropometric measurements, and details of feeding pattern were collected [Figure 1].

Anthropometric measurements (weight and length/height) were recorded following standard procedures. In addition, hb estimation was done as a part of normal examination done/ordered by the pediatrician. According to the WHO classification, the child was considered as anemic and normal if the hb was <11 g/dl and ≥11 g/dl, respectively.[9] A child was considered in the IFIC group if a minimum 1–2 serving/day was feed along with homemade complementary foods.

Statistical analysis

Data thus generated was coded, entered, and analyzed using Statistical Package for the Social Sciences (SPSS) for Windows, Version 16.0., SPSS Inc., Chicago, IL, USA. Results were expressed as frequencies and proportions for categorical variables and mean and standard deviations (SDs) for continuous variables. Chi-square and unpaired *t*-tests were applied to assess the significant differences across study variables. A multivariate logistic regression was run to examine the simultaneous impact of several factors on the anemic status of the child. A two-sided $P < 0.05$ was considered to be statistically significant.

Ethical approval

Approval of the institutional review board and ethics committee of B. L. Kapur Super Speciality Hospital, New Delhi was obtained. Informed written consent was obtained from all the parents for voluntary participation in local language, Hindi. The whole observations were recorded with the intent to treat the child.

Results

A total of 66 children completed the study. Forty (60.6%) children were boys and the remaining 26 (39.4%) were girls. Their mean age (SD) was 14.9 ± 4.11 months and the mean hb (SD) was 11.4 ± 1.6 g/dl. The overall prevalence of anemia (i.e., hb% <11 g/dl) was 42.4% (95% confidence interval (CI):
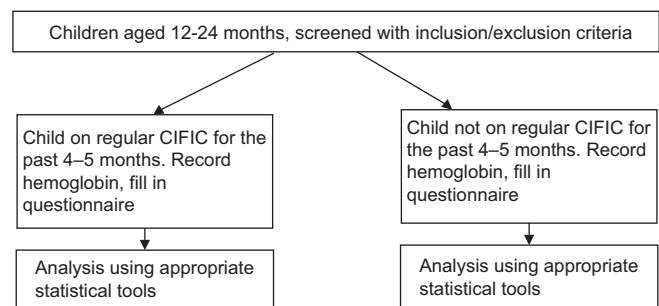
Figure 1: Schematic flow of study

30.5%–55.2%, *n* = 28). As many as 12 children (18.2%) were born with low-birth weight, i.e., <2500 g. Their mean present weight, length/height, and Body mass index (BMI) were 9.9 ± 1.7 kg, 77.4 ± 5.8 cm, and 16.9 ± 1.4 kg/m², respectively. Out of 66 children, 36 (54.5%) were in IFIC group and the remaining 30 (45.5%) were in non-IFIC group.

Table 1 shows the mean age of the children in IFIC group was higher than those in non-IFIC group and it was statistically significant (*P* = 0.01). Similarly, mean hb levels in the IFIC group was significantly higher than non-IFIC group (12.5 ± 1.2 vs. 10.2 ± 1.0, *P* = 0.01). The BMI for age between both the study groups were similar (*P* = 0.191); although, the present weight (*P* = 0.005) and height/length (*P* = 0.03) were significantly higher in IFIC group.

Table 2 shows that anemia was significantly higher (*P* < 0.05) among children from non-IFIC group (odds ratio [OR]: 31.8, 95% CI: 8.1–126.1) and those who were born with low-birth weight, i.e., <2500 g (OR: 5.5, 95% CI: 1.3–22.8).

Multiple logistic regression analysis revealed that the children in IFIC group were unlikely to be anemic (adjusted OR: 0.007, 95% CI: 0.001–0.079, *P* < 0.001). On the contrary, boys (adjusted OR: 11.6, 95% CI: 1.23–108.9, *P* = 0.032) and children with low birth weight (adjusted OR: 11.7, 95% CI: 1.23–111.76, *P* = 0.032) the associated with anemic status [Table 3].

Discussion

In the present study, four out of every ten children were anemic (hb <11 g/dl). IFIC intake, along with homemade complementary foods, was not associated with anemia in children. However, being a boy and low-birth weight were the correlates of anemic status.

Iron deficiency is the predominant cause of childhood anemia globally and in developing countries. Commonly used complementary foods may not suffice the high iron requirement in this age.[10,11] Iron fortification appears to be the most practical and feasible approach for anemia prevention and control although it has multifactorial etiology.[12,13] The present study provides a preliminary evidence about the benefit of IFIC in the Indian setting, and similar effects are reported by others.[14,15] Bhutta *et al*. concluded that fortification would also have an impact on morbidity and mortality, although a conclusive answer cannot yet be given.[15] Food fortification is the best approach to address the iron deficiency as it has the potential to reach all sections of the society, compliance is not dependent on the cooperation of the individual, the initial cost is low, and the maintenance expenses may be less than that of medicinal iron supplementation.[16] In addition, existing evidence suggests that such an intervention yields maximum improvements at lower baseline hb level.[17]

To be more effective and acceptable, fortification should be done commonly used foods.[18,19] In the present study, cereal-based

Table 1: Comparison of iron-fortified cereals* and noniron-fortified cereals groups across various study variables attending selected pediatric clinics in New Delhi, India, November 2016-February 2017 (*n*=66)

Study variable	Mean±SD		*t*	*P*
	IFIC group (*n*=36)	Non-IFIC group (*n*=30)		
Age (months)	16.1±3.3	13.4±4.5	8.29	<0.01#
Hemoglobin (g/dL)	12.5±1.2	10.2±1.0	2.66	0.01#
Birth weight (kg)	2.9±0.4	2.8±0.5	0.86	0.38
Present weight (kg)	10.4±1.4	9.3±1.8	2.86	0.005#
Height/length (cm)	78.9±3.7	75.7±7.3	2.22	0.03#
BMI for age (kg/m²)	16.68±1.49	16.14±1.83	1.322	0.191

*Iron-fortified infant cereals; #statistically significant. IFIC: Iron-fortified cereals; BMI: Body mass index, SD: Standard deviation

Table 2: Association between hemoglobin status and various study variable among children aged 12-24 months attending selected pediatric clinics in New Delhi, India, November 2016-February 2017 (*n*=66)

Study variable	Haemoglobin status		χ^2	*P*
	Anemia (<11 g/dL), *n* (%)	No anemia (≥11 g/dL), *n* (%)		
Study group				
Non-IFIC*	24 (80)	6 (20)	31.8	<0.001#
IFIC	4 (11.1)	32 (88.9)		
Gender				
Boy	19 (47.5)	21 (52.5)	1.07	0.301
Girl	9 (34.6)	17 (65.4)		
Birth weight				
Low birth weight	9 (75)	3 (25)	6.4	0.012#
Normal	19 (35.2)	35 (64.8)		

*Iron-fortified infant cereals; #statistically significant. IFIC: Iron-fortified cereals

Table 3: Multiple logistic regression analysis for the anemic status among children aged 12-24 months attending selected pediatric clinics in New Delhi, India, November 2016-February 2017 (*n*=66)

Predictor variable	Adjusted OR	95.0% CI		*P*
		Lower	Upper	
IFIC versus non-IFIC*	0.007	0.001	0.08	<0.001#
Age	1.01¶	0.84	1.21	0.911
Boy versus girl	11.6	1.23	108.97	0.032#
Low- birth weight versus. normal	11.7	1.23	111.76	0.032#
Constant	0.77			

*Iron-fortified infant cereals; ¶regression co-efficient; #statistically significant. OR: Odds ratio; CI: Confidence interval

iron fortification was used. Cereals are used worldwide as staple foods and more so in the Indian subcontinent.[20] Cereals are considered as functional food as their benefits are beyond basic nutrition[20,21] and have been found to be useful in fortification.[22]

Therefore, it is an apt approach in Indian setting where childhood anemia is a major public health problem. Multicentric controlled trials are needed to test this hypothesis.

Strengths and limitations

Based on the observed mean hb% difference of 2.3 between IFIC and non-IFIC groups, a sample size of 66 and 5% significance level, this study had >90% power.[23] In addition, the data were collected in the real world settings. However, the selected facilities based study sample may not represent the children of 12–24 months in the community. In addition, due to cross-sectional nature of the study, associations observed in this study may not infer causality.

Conclusion

Intake of IFIC (minimum 1–2 serving/day) was associated with the lesser chance of anemia in children of 12–24 months. However, male gender and low birth weight were also associated with anemia. IFIC may have a role in mass fortification programs with a positive public health impact by limiting DALYs and other costs. However, due to limited geographic location and small sample size, further, larger and controlled studies are recommended to confirm this hypothesis.

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Conflicts of interest

There are no conflicts of interest.

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