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RESEARCH ARTICLE

Prevalence of anaemia among 6- to 59-month-old children in India: the latest picture through the NFHS-4

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Abstract

India is the highest contributor to child anaemia among developing countries. To see the latest picture of child anaemia in India, data for 6- to 59-month-old children were taken from the fourth round of the National Family Health Survey conducted in 2015–16 (NFHS-4). The study sample consisted of 1,37,347 children. The dependent variable was the anaemia status of the child. The objectives of the study were to assess (i) the distribution of anaemia prevalence by child age group, (ii) the prevalence of child anaemia by zone and state and (iii) the relation of child anaemia prevalence with social, demographic and economic variables, including maternal nutritional status and low birth weight. The study found that in India in 2015–16, 56% of 6- to 59-month-old children were anaemic – a decrease of only 13.5 percentage points since the NFHS-3 study conducted in 2005–06. It is well known that iron supplementation is necessary for child growth and brain development. This study suggests that, in addition, the socioeconomic conditions of households in India need to be improved to prevent child anaemia. Low birth weight and low maternal nutritional status are also responsible for the high prevalence of anaemia among children in India.

Keywords: Child Malnutrition; Anaemia; Logistic Regression

Introduction

Iron deficiency is one of the most leading causes of disability in developing as well as developed countries. About 90,000 maternal and neonatal deaths were due to iron deficiency anaemia in developing regions in 2013 (WHO, 2014). According to the World Health Organization, in 2015 more than 50% of people were suffering from anaemia in the South East Asia region, and about half of cases were due to iron deficiency (WHO, 2015). Though the primary cause of anaemia is iron deficiency, among pre-school children it is also caused by other factors such as vitamin A and vitamin B12 deficiencies, and hookworm and malaria infections (Pasricha *et al.*, 2010; Dey *et al.*, 2013). Iron deficiency anaemia has many harmful effects among pre-school children. For example, it reduces learning capacity, decreases attentiveness and causes low intelligence (Katzman *et al.*, 1972; Pablo *et al.*, 1985; Behrman *et al.*, 1994; Agaoglu *et al.*, 2007; Zhao *et al.*, 2012). Anaemia among children has also been indirectly linked to the developmental stage of a region, as is evident from region-wise data (WHO, 2008).

Among the many risk factors for death, iron deficiency anaemia used to be regarded as one of the 'Top Ten Risk Factors' (Dubey, 1994). Iron deficiency anaemia is still very common in South Asian countries, including India, Bangladesh and Pakistan. It causes many serious problems, especially among pregnant and lactating women, children and adolescents (Lokeshwar *et al.*, 2011). During the last decade, India was the largest contributor to child anaemia among developing countries (WHO, 2008; Pasricha *et al.*, 2010). In 2007, 69.5% of 6- to 59-month-old children in India were anaemic, of which 26.3% were mildly anaemic, 40.2% moderately anaemic and 2.9% severely anaemic (IIPS & ICF, 2007). The present paper aimed to assess the anaemia status of this age group of children using data from the most recent National Family Health Survey (IIPS & ICF, 2017), carried out in 2015–16. The objectives of the study were to assess: (i) the distribution of anaemia prevalence by child age group, (ii) the prevalence of child anaemia by zone and state and (iii) the relation of child anaemia prevalence with social, demographic and economic variables, including maternal nutritional status and low birth weight.

Methods

Data

Unit-level cross-sectional data were obtained from the National Family Health Survey (NFHS-4), conducted in India by the International Institute for Population Sciences in 2015–16. Data for 1,37,347 children aged 6–59 months living in 29 states and seven Union Territories were analysed. The child's anaemia status was the dependent variable. This was measured through the level of haemoglobin in the blood. Consent was obtained from a parent, or an adult member of the household responsible for the child, for collection of a blood sample from the youngest 6- to 59-month-old child in the household. A drop of blood was taken from a finger prick (or sometimes a heel prick) and collected in a micro-cuvette. Haemoglobin analysis was conducted on-site with a battery-operated portable Hemo CueHb 201+ analyser (IIPS and ICF, 2017). Levels of anaemia severity were as follows: mild (10.0–10.9 g/dl), moderate (7.0–9.9 g/dl) and severe (<7.0 g/dl).

The independent variables were type of place of residence (urban or rural), education of mother (illiterate, primary [(classes I–IV], secondary [classes V–XII] and higher than class XII), religious group (Hindu, Muslim, Christian and Other) and wealth index. The supplied NFHS-4 data contained the wealth index, which was calculated from the ownership scores for consumer goods such as TV, car and refrigerator. These scores were then combined to group households into quintiles, namely 'Poorest', 'Poorer', 'Middle', 'Richer' and 'Richest', including approximately 20% of the sample population in each group. These five categories were further modified and then categorized into three groups (Poor, Medium and Rich) by pooling 'Poorest' and 'Poorer' households into the 'Poor' category, and 'Richer' and 'Richest' households into the 'Rich' category. The middle category was kept unchanged.

Child's present health status was measured through *z*-score values, i.e. *z*-scores of the two nutritional indices weight-for-age and height-for-age. The *z*-score is defined as the deviation of the value observed for an individual from the median of the reference population, divided by the standard deviation (SD) of the reference population, i.e.:

$$z\text{-score} = \frac{\text{Observed value} - \text{Median of the reference population}}{\text{SD of the reference population}}$$

The classifications of the *z*-score (following NCHS/WHO) were below normal (<–2), normal (–2 to <+2) and above average (≥+2). Child's birth weight was classified into three categories, namely: very low (<1500 g), low (<2500 g) and normal (2500 g or above). Mother's nutritional status was measured through BMI (WHO, 1998), and classified into four categories: underweight (BMI<18.5), normal (BMI = 18.5–24.99), overweight (BMI = 25.0–29.99) and obese (BMI≥30.0). Anaemia was grouped into anaemic (<11.0 g/dl) and non-anaemic (≥11.0 g/dl).

Analysis

The sample children were divided into six groups by age (in months) to assess variation in anaemia rates by age group. The percentages of mild, moderate and severe anaemic children by zone

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and state were also computed. These were summed to give a total prevalence of anaemic children. In addition, the percentages of non-anaemic children were calculated. The relationships between the anaemia status of the child and socioeconomic and demographic variables (place of residence, mother's educational level, religion, wealth index, nutritional status of the child and mother, birth weight of the child and anaemia status of the mother) were assessed using bivariate analysis and the application of chi-squared tests.

The combined effects of the socioeconomic and demographic variables were assessed by carrying out binary logistic regression. All explanatory variables were taken as categorical. Anaemic condition was considered as the dependent variable, with anaemic children being coded '1' and the rest as '0'. The coefficient of each explanatory variable, along with its significance, determined how the variable influenced the level of anaemia. A positive coefficient implied a positive relationship. More specifically, an estimated odds ratio (OR) >1 (which is equivalent to the value of the coefficient being >0) indicated that the probability of becoming anaemic was more in this category compared with the reference category of the explanatory variable. If it was <1, then it was opposite to that of the '>1' case. An estimated OR of '1' indicates that the nature of the dependent variable was not different from that of the reference category. All calculations were carried out using SPSS (Statistical Package for Social Science) version 18.0. Significance levels of $p<0.01$ and $p<0.05$ were considered.

Results

Table 1 shows the distribution of anaemia prevalence in the sample children by age group, zone and state. At the all-India level, the percentage of anaemic children increased from 65.9% in the age group 6–8 months to 68.1% in the age group 12–23 months, then decreased to 42.7% in the older 48- to 59-month age group. At the regional level, this pattern was more or less the same, with only slight variations by state and zone. The requirement for iron decreases after the first year of life due to a decrease in growth rate. Still, iron intake during the second year might not always be adequate (Stekel, 1984; FAO/WHO, 1988). A balanced diet should contain the right amount of iron. A poor diet may contain insufficient iron, and this might be a reason for the increasing prevalence of anaemia in this age group.

Table 2 shows the distribution of anaemia prevalence among the sample children by anaemia severity, zone and state. Overall, 56.3% of the children were anaemic in 2015–16; 1.5% were severely anaemic, 27.6% were moderately anaemic and 27.2% were mildly anaemic. The North-east region was the least affected (34.6%) and the Central region the most affected (62.3%). According to the NFHS-3, in 2005–06 the percentage of anaemic children in North-east India was 55.6%. It is surprising how much this zone improved within a decade. The Central zone had 71.9% anaemic children, so this had improved by only 10 percentage points over the same period. The only two states with less than 25% anaemic children in 2015–16 were Mizoram (22.4%) and Nagaland (24.8%). Both are in the North-east zone. The states with an anaemia rate over 60% were Bihar (62.2%), Jharkhand (68.8%), Madhya Pradesh (68.4%), Uttar Pradesh (63.5%), Gujarat (63.0%), Dadra & Nagar Haveli (84.7%), Daman & Diu (70.6%), Haryana (70.5%) and Chandigarh (73.5%). The Union Territories of Dadra & Nagar Haveli and Daman & Diu had a very high prevalence of anaemia among pre-school children. The reason for this is not clear, but it might be due to an improper diet (Zhang *et al.*, 2018), childhood illness such as diarrhoea (Tariq *et al.*, 2017), worm infestations (Seidelman *et al.*, 2016) or lack of appropriate iron supplementation (Okam *et al.*, 2017).

The relationship between child anaemia prevalence and different socioeconomic, child health and maternal health variables is presented in Table 3. Rural children were more anaemic than urban children ($p<0.001$). Mother's education has a significant role in reducing anaemia among the children: 71.7% of the children of illiterate mothers were anaemic while only 49.9% of those of higher educated mother were affected by anaemia. Hindu and Muslim children were highly

Table 1. Prevalence of anaemia in 6- to 59-month-old children in India by age group, 2015–16 (NFHS-4)

	Prevalence of anaemia					
Zone/state	6–8 months	9–11 months	12–23 months	24–35 months	36–47 months	48–59 months
North-east	**46.6**	**50.7**	**46.1**	**32.6**	**27.9**	**23.0**
Arunachal Pradesh	81.3	66.7	62.4	52.7	19.3	14.8
Assam	48.5	50.2	44.9	33.0	29.2	27.5
Manipur	38.5	48.7	40.9	22.6	14.1	9.4
Meghalaya	42.6	52.8	59.1	48.7	39.9	34.1
Mizoram	36.3	36.3	34.1	18.7	18.6	10.5
Nagaland	40.2	44.4	34.7	18.3	15.8	15.7
Sikkim	72.5	72.9	68.4	55.8	53.9	39.0
Tripura	78.8	70.0	60.2	41.0	40.0	36.8
East	**72.3**	**71.5**	**69.5**	**59.2**	**51.5**	**46.2**
Bihar	71.9	70.7	73.9	62.6	56.7	48.3
Jharkhand	79.1	83.5	82.2	70.6	58.6	53.9
Orissa	67.7	61.6	56.7	46.6	41.1	38.5
West Bengal	71.5	73.2	61.8	56.4	46.1	44.6
Central	**69.3**	**71.5**	**75.1**	**67.0**	**55.2**	**47.3**
Madhya Pradesh	73.3	74.8	80.6	**72.8**	62.7	55.0
Chhattisgarh	54.7	58.2	56.3	44.2	34.5	31.3
Uttar Pradesh	69.6	72.5	76.6	69.2	55.6	46.3
West	**62.0**	**64.4**	**70.5**	**62.3**	**51.3**	**41.8**
Goa	87.5	72.7	64.0	**47.2**	40.0	27.8
Gujarat	66.8	68.2	74.2	67.1	59.2	50.2
Maharashtra	55.3	60.3	67.2	58.3	43.9	34.8
Dadra &NH[a]	100.0	92.3	94.3	85.7	86.5	66.7
Daman & Diu	75.0	72.2	76.0	80.9	59.1	63.8
North	**68.8**	**70.9**	**73.3**	**64.9**	**54.8**	**47.0**
Haryana	85.3	71.8	81.9	**74.7**	63.1	57.0
Himachal Pradesh	65.7	65.9	65.3	61.6	49.5	47.4
Jammu & Kashmir	62.4	68.5	73.0	59.6	52.1	42.7
New Delhi	76.5	76.7	74.3	67.9	54.4	40.6
Chandigarh	75.0	66.7	86.7	82.9	56.3	67.9
Uttarakhand	71.5	82.1	73.6	61.8	47.8	41.6
Punjab	64.2	64.9	72.4	61.0	49.8	42.9
Rajasthan	63.4	67.3	70.7	64.0	56.0	46.8
South	**62.4**	**63.6**	**66.2**	**57.1**	**46.5**	**41.0**
Andhra Pradesh	63.6	65.6	72.6	58.5	56.1	39.3
Telangana	73.6	71.4	79.3	70.9	55.0	44.9

(*Continued*)

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Table 1. (*Continued*)

Zone/state	Prevalence of anaemia 6–8 months	9–11 months	12–23 months	24–35 months	36–47 months	48–59 months
Karnataka	67.9	73.3	73.1	67.2	51.4	44.7
Kerala	54.3	44.8	47.1	34.0	29.1	28.0
Tamil Nadu	59.6	55.7	63.5	54.3	44.3	41.9
Puducherry	50.0	55.8	62.0	47.3	29.8	33.7
Lakshadweep	100.0	88.2	58.3	48.9	37.0	44.4
Andaman & NH[b]	32.0	54.8	50.0	51.1	52.8	55.6
All India	**65.9**	**67.2**	**68.1**	**58.7**	**49.4**	**42.7**

[a]Dadra & Nagar Haveli.
[b]Andaman & Nicobar Islands.

Table 2. Prevalence of anaemia among 6- to 59-month-old children in India by anaemia severity, zone and state, 2015–16 (NFHS-4)

	N	Percentage of anaemia: Severe	Moderate	Mild	Anaemic	Non-anaemic
North-east	**17,743**	**0.4**	**12.5**	**21.6**	**34.6**	**65.4**
Arunachal Pradesh	1550	0.6	23.9	25.6	50.1	49.9
Assam	5468	0.4	11.7	23.4	35.5	64.5
Manipur	2979	0.2	8.5	16.7	25.4	74.6
Meghalaya	1898	0.5	16.1	29.5	46.0	54.0
Mizoram	3210	0.6	7.1	14.7	22.4	77.6
Nagaland	1098	0.5	9.6	14.8	24.8	75.2
Sikkim	748	0.5	24.7	31.8	57.1	42.9
Tripura	792	0.3	17.3	29.5	47.1	52.9
East	**28,089**	**0.9**	**27.9**	**29.9**	**58.8**	**41.2**
Bihar	10,901	1.1	30.4	30.7	62.2	37.8
Jharkhand	6025	1.2	35.4	32.2	68.8	31.2
Orissa	7651	0.7	20.4	26.7	47.9	52.1
West Bengal	3512	0.5	24.0	30.3	54.7	45.3
Central	**34,888**	**2.0**	**32.6**	**27.7**	**62.3**	**37.7**
Madhya Pradesh	14,012	1.9	37.0	29.5	68.4	31.6
Chhattisgarh	5276	0.7	16.6	25.4	42.6	57.4
Uttar Pradesh	15,600	2.6	34.2	26.7	63.5	36.5
West	**11,743**	**1.3**	**26.2**	**29.4**	**56.9**	**43.1**
Goa	316	0.6	17.7	29.7	48.1	51.9
Gujarat	4711	1.8	29.3	31.9	63.0	37.0

(*Continued*)

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Table 2. (*Continued*)

	N	Percentage of anaemia			Anaemic	Non-anaemic
		Severe	Moderate	Mild		
Maharashtra	6308	1.0	23.3	27.3	51.5	48.5
Dadra & NH[a]	190	1.1	52.1	31.6	84.7	15.3
Daman & Diu	218	1.4	34.4	34.9	70.6	29.4
North	**27,390**	**2.3**	**32.5**	**26.5**	**61.3**	**38.7**
Haryana	4855	2.3	38.8	29.5	70.5	29.5
Himachal Pradesh	1664	3.9	30.6	22.6	57.2	42.8
Jammu & Kashmir	3995	3.2	33.4	21.9	58.5	41.5
New Delhi	754	4.5	35.9	21.0	61.4	38.6
Chandigarh	36	4.4	42.6	26.5	73.5	136
Uttarakhand	2595	2.4	29.4	27.7	59.4	40.6
Punjab	3809	1.3	28.9	27.0	57.3	42.7
Rajasthan	9582	1.9	31.0	27.5	60.4	39.6
South	**17,494**	**1.2**	**25.4**	**27.2**	**53.7**	**46.3**
Andhra Pradesh	1887	2.5	28.9	26.0	57.4	42.6
Telangana	1544	2.8	37.2	23.5	63.5	36.5
Karnataka	4901	0.9	29.4	30.3	60.6	39.4
Kerala	1833	0.4	12.5	22.9	35.8	64.2
Tamil Nadu	5820	1.0	23.3	27.1	51.5	48.5
Puducherry	819	0.4	14.3	28.9	43.6	56.4
Lakshadweep	213	0.0	25.8	25.4	51.2	48.8
Andaman & NH[b]	477	0.6	25.4	25.4	51.4	48.6
All India	**137,347**	**1.5**	**27.6**	**27.2**	**56.3**	**43.7**

[a]Dadra & Nagar Haveli.
[b]Andaman & Nicobar Island.

affected (57.9% and 57.8% respectively). Christians were the least affected (35.3%) ($p<0.001$). Wealth affected the incidence of anaemia: the level among the poorest group was 60.0%, while that among the richest group was 52.4% ($p<0.001$). Children's nutritional status and birth weight both had an inverse relationship with the children's level of anaemia ($p<0.001$). In other words, the better the health status and higher the birth weight of the children, the lower the prevalence of anaemia. Similarly, the better the health status and lower the level of anaemia of the mothers, the lower the prevalence of anaemia in the children.

Table 4 shows five binary logistic regressions models assessing the differential impact of socio-economic and demographic variables on children's anaemia status. Model 1 included the socio-economic conditions of the household, Model 2 the socioeconomic conditions of the household and child nutritional status, Model 3 the socioeconomic conditions of the household and mother's health, Model 4 only included child's nutritional status and mother's health, and Model 5 included socioeconomic conditions of the household, mother's health and child's nutritional status. Model 5 included all the variables. No marked differences in the direction of influence were observed among the five models. Place of residence did not show any significance in any of the models. All other variables had significant effects in the expected direction. When all the variables were

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Table 3. Relationship between anaemia prevalence among 6- to 59-month-old children in India and household socioeconomic conditions and child and mother health factors

Dependent variable	*N*	Anaemic (%)	Non-anaemic (%)	χ^2
Socioeconomic factors				
Type of place of residence				
Rural	99,434	57.2	42.8	140.571 df = 1 $p<0.001$
Urban	37,913	53.2	46.3	
Mother's education				
Illiterate	321,113	64.2	35.8	1363.306 df = 3 $p<0.001$
Primary	18,944	58.5	41.5	
Secondary	70,274	53.4	46.6	
Higher	16,016	49.9	50.1	
Religion				
Hindu	103,898	57.9	42.1	1803.522 df = 3 $p<0.001$
Muslim	18,191	57.8	42.2	
Christian	9373	35.3	64.7	
Other	5885	55.8	44.2	
Wealth Index				
Poorest/poorer	56,788	60.1	39.9	658.455 df = 2 $p<0.001$
Middle	29,697	55.4	44.6	
Richer/richest	50,862	52.4	47.6	
Child's health				
Nutritional status				
Underweight	45,235	62.5	37.5	1083.309 df = 1 $p<0.001$
Not underweight	92,112	53.2	46.8	
Stunted	50,481	61.7	38.3	958.29 df = 1 $p<0.001$
Not stunted	86,866	53.1	46.9	
Birth weight				
Very low (<1500 g)	1361	63.4	36.6	193.775 df = 2 $p<0.001$
Low (<2500 g)	21,657	60.2	39.8	
Normal (≥2500 g)	114,329	55.4	44.6	
Mother's health				
Nutritional status (BMI)				
Underweight	33,181	61.9	38.1	193.775 df = 2 $p<0.001$
Normal weight	82,425	55.7	44.3	
Overweight or obese	21,741	49.7	50.3	
Anaemia status				
Anaemic	61,319	63.6	36.4	3767.073 df = 1 $p<0.001$
Not-anaemic	76,028	47.1	52.9	

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Table 4. Categorical logistic regression analysis of anaemia prevalence among 6- to 59-month-old children in India by household socioeconomic conditions and child and mother health factors

	Model 1	Model 2	Model 3	Model 4	Model 5
Socioeconomic factors					
Type of place of residence					
Rural (Ref.)	1.00	1.00	1.00		1.00
Urban	0.998	0.993	1.015		1.009
Mother's education					
Illiterate (Ref.)	1.00	1.00	1.00		1.00
Primary	0.834**	0.845**	0.849**		0.859**
Secondary	0.702**	0.730**	0.724**		0.748**
Higher	0.621**	0.665**	0.662**		0.701**
Religion					
Hindu (Ref.)	1.00	1.00	1.00		1.00
Muslim	0.978	0.987	1.024		1.029
Christian	0.417**	0.431**	0.458**		0.469**
Other	0.971	0.991	0.996		1.011
Wealth Index					
Poorest/poorer (Ref.)	1.00	1.00	1.00		1.00
Middle	0.938*	0.967*	0.977		0.999
Richer/richest	0.884**	0.935**	0.951**		0.992
Child's health					
Nutritional status					
Underweight (Ref.)		1.00		1.00	1.00
Not underweight		0.826**		0.816**	0.857**
Stunted (Ref.)		1.00		1.00	1.00
Not stunted		0.828**		0.813**	0.832**
Birth weight					
Very low (<1500 g) (Ref.)		1.00		1.00	1.00
Low (<2500 g)		0.908		0.899*	0.908
Normal (≥2500 g)		0.819**		0.796**	0.825**
Mother's health					
Nutritional status (BMI)					
Underweight (Ref.)			1.00	1.00	1.00
Normal weight			0.867**	0.850**	0.895**
Overweight or obese			0.750**	0.731**	0.789**
Anaemia status					
Anaemic (Ref.)			1.00	1.00	1.00
Not anaemic			1.852**	1.900**	1.841**

See text for explanation of Models 1–5. Ref.: reference category.
$^{**}p<0.01$; $^{*}p<0.05$.

taken together in Model 5, the wealth index ceased to have a significant effect on the children's anaemia status, though the direction remained the same as in the other models.

Discussion

This study attempted to provide an overview of the most recent situation for the anaemic condition of 6- to 59-month-old children in India and to assess the influence of the socioeconomic conditions of the mother and children's health status. The most common cause of anaemia is iron deficiency, but it may occur for other reasons such as malabsorption of the nutrients in the diet, chronic disease (e.g. cancers such as leukaemia, lymphoma and multiple myeloma), radiation, blood loss, drugs and medications (antibiotics and medicines for rheumatoid arthritis) and infections such as malaria and hepatitis. It may also be an inherited disease, such as thalassaemia or sickle cell disease (NIH, 2011, WHO, 2014; Wikipedia). Iron is necessary for effective immune system function. It is also needed by pathogenic organisms such as non-typhoid Salmonella. Thus, iron is needed by both the host and pathogen and therefore in some cases iron in the body may have an adverse effect (Doherty, 2007).

From the analysis of NFHS-4 data, the study found that the percentage of anaemia among children in India was 65.9% at 6–8 months, increased to 68.1% at 12–23 months then decreasing to 42.7% at 48–59 months. The trend was the same over different zones and states, but varied slightly in magnitude. The probable cause of this increasing then decreasing trend is that, from the 6th to 12th months, iron requirements increase with body weight as the infant's weight triples by the end of the first year of life. For this, 30% of iron is required from food (Osorio, 2002). If this supplementation is not fulfilled, a child in this age group has a high chance of being anaemic. After 2 years, as growth becomes stable and the requirement for iron becomes less, the percentage of anaemic children goes down. The requirement for absorbed iron is 0.96 mg for age 3 months to 1 year, 0.61 mg between 1 and 2 years and 0.70 mg from 2 to 6 years (FAO/WHO, 1988). If these requirements are not fulfilled by food, then the child may become anaemic.

Iron supplementation is necessary for child growth and brain development in the age group 6–24 months. Earlier studies have shown that iron-deficient children have low IQ scores, less attentiveness and lower scores on academic IQ tests (More *et al.*, 2013). Iron deficiency anaemia is caused by many factors. Also, poor brain development is associated with multiple factors such as low socioeconomic status, poverty, lack of stimulation at home, poor parental education, maternal depression, low birth weight, faulty feeding, malnutrition, parasitic infection. Many studies have shown that iron deficiency in infancy may be associated with impaired cognitive function during the school years (Lozolff *et al.*, 1987).

The prevalence of anaemia in 6- to 59-month-old children by different levels of severity gave a clearer picture. The prevalence of severe anaemia was 1.5%, and those of moderate and mild anaemia were 27.6% and 27.2%, respectively. Overall in India, 56.3% of 6- to 59-month-old children were anaemic in 2015–16. Compared with the previous national survey conducted in 2005–06 (NFHS-3), this had decreased by 13.5 percentage points. The North-east zone was found to be the least affected (34.6%) and the Central zone the most affected (62.3%) by anaemia. According to the NFHS-3, the prevalence of anaemia in children in the North-east region in 2005–06 was 55.6%. Thus, it had reduced by 20 percentage points over a 10-year period. The Central zone had 71.9% anaemic children during NFHS-3. This improved by 10 percentage points over the decade to 2015–16. This is a commendable achievement.

Different programmes have been initiated by the Government of India for the reduction of anaemia among children over recent years. The National Nutritional Anaemia Prophylaxis Programme (NNAPP), introduced by the Ministry of Health and Family Welfare, is one such programme. Vitamin A and IFA supplementation to children was done through this programme. Other important programmes include the National Nutritional Anaemia Control Programme

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(NNACP) and the Integrated Child Development Services (ICDS) Scheme. However, it is doubtful whether these programmes were fully implemented, because it was found that many of the intended beneficiaries were not even aware of all the programmes. The supply of Iron/Folic Acid (IFA) tablets was lower than expected. The IFA tablets given to children below 3 years of age were not easily acceptable by them, so liquid IFA was recommended for young children (Gragnolati *et al.*, 2005). In 2007, the Government of India modified the policy and replaced tablets with liquid IFA. Young children aged 6–59 months then received 1 ml IFA syrup for 100 days in a year containing 20 mg elemental iron and 100 mg folic acid. It seems likely that the reduction in anaemia among children seen over the study decade was due to these Government policies.

Rural children were found to be more anaemic than urban children. The relationship between anaemia and different socioeconomic variables was profound. Mother's education was found to have a very significant role in the reduction in child anaemia as 71.7% of the children of illiterate mothers were anaemic compared with only 49.9% of the children of higher educated mothers. Hindu and Muslim children were more highly affected (57.9% and 57.8% respectively) than Christians (35.3%). Among the children of poor households, anaemia was 60.0%, whereas among the rich households it was only 52.4%.

The binary logistic regression analysis found no marked differences in the direction of influence among the five models. There is no marked difference in anaemia status between rural and urban children. Mother's education has a profound effect on reducing the incidence of anaemia: the higher the level of education of a mother, the lower the incidence of anaemia among children. Christian children are uniformly in a much better position. Wealth index has some effect in reducing anaemia and the effect is most conspicuous among the richest households. The health status of children has a negative effect on the level of anaemia. Mother's nutritional status is also very much effective. Non-anaemic mothers have fewer children with anaemia than anaemic mothers.

This study shows that, besides iron supplementation, the socioeconomic conditions of households need to be improved to reduce child anaemia in India. Low birth weight and low maternal nutritional status were also found to be responsible for the high occurrences of anaemia among children in India.

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References

Agaoglu L, Torun O, Unuvar E, Sefil Y and Demir D (2007) Effects of iron deficiency anemia on cognitive function in children. *Arzneimittelforschung* **57**(6A), 426–430.

Akhzer A (2018) 2015–16 National Family Health Survey report: anaemia among kids aged 6–59 months highest in Chandigarh. *The Indian Express*, 12 January 2008. URL: https://indianexpress.com/article/cities/chandigarh/national-family-health-survey-anaemia-kids-highest-chandigarh-5021402/.

Behrman RE, Kleigman RM and Nelson (1994) *Essentials of Pediatrics: Hematology*, 2nd Edition. WB Saunders, Philadelphia.

Dey S, Gosawmi S and Dey T (2013) Identifying predictors of childhood anaemia in north-east India. *Journal of Health and Population Nutrition* **31**, 462–470.

Doherty CP (2007) Host–pathogen interactions: the role of iron. *Journal of Nutrition* **137**, 1341–1344.

Dubey AP (1994) Iron deficiency anemia epidemiology, diagnosis and clinical profile. In Sachdev HPS and Choudhury P (eds) *Nutrition in Children: Developing Country Concerns*. Cambridge Press, New Delhi, pp. 217–235.

FAO/WHO (1988) Food and Nutrition Series, 23. Requirements of Vitamin A, Iron, Folate and Vitamin B12. *Report of a Joint FAO/ WHO Expert Consultation*. FAO, Rome.

Gragnolati M, Shekar M, Gupta MD, Bredenkamp C and Lee YK (2005) *India's Undernourished Children: A Call for Reform and Action*. Health, Nutrition and Population, World Bank, Washington, DC.

IIPS and ICF (2007) *National Family Health Survey (NFHS-3), 2005–06: India*. International Institute for Population Sciences (IIPS), Mumbai. URL: https://dhsprogram.com/pubs/pdf/frind3/frind3-vol1andvol2.pdf.

IIPS and ICF (2017) *National Family Health Survey (NFHS-4), 2015–16: India*. International Institute for Population Sciences (IIPS), Mumbai.

Katzman R, Novack A and Pearson H (1972) Nutritional anemia in an inner-city community. Relationship to age and ethnic group. *Journal of the American Medical Association* **222**, 670–673.

Lokeshwar MR, Mehta M, Mehta N, Shelke P and Babar N (2011) Prevention of iron deficiency anemia (IDA): how far have we reached? *Indian Journal of Pediatrics* **78**, 593–602.

Lozoff B, Brittenham GM, Wolf AW, McClish DK, Kuhnert PM, Jimenez E, *et al*. (1987) Iron deficiency anemia and iron therapy: effects on infant developmental test performance. *Pediatrics* **79**, 981–995.

More S, Shivkumar VB, Gangane N and Shende S (2013) Effects of iron deficiency on cognitive function in school going adolescent females in rural area of central India. *Anemia 2013*. URL: https://www.ncbi.nlm.nih.gov/pubmed/24386560.

NIH (2011) *Your Guide to Anemia*. NIH Publication No. 11–7629. US Department of Health and Human Services, National Institute of Health.

Okam MM, Koch TA and Tran MH (2017) Iron supplementation, response in iron-deficiency anemia: analysis of five trials. *American Journal of Medicine* **130**(8), e1–991.e8.

Osorio MM (2002) Determinant factors of anaemia in children. *Journal de Pediatria* **78**(4), 269–278.

Pablo VS, Windom R and Pearson HA (1985) Disappearance of iron deficiency anemia in a high risk infant population given supplemental iron. *New England Journal of Medicine* **313**, 1239–1240.

Pasricha SR, Black J, Muthayya S, Shet A, Bhat V, Nagaraj S, *et al*. (2010) Determinants of anemia among young children in rural India. *Pediatrics* **126**, e140–e149.

Seidelman J, Zuo R, Udayakumar K and Gellad ZF (2016) Caught on capsule: iron-deficiency anemia due to hookworm infection. *American Journal of Medicine* **129**(2), 167–169.

Stekel A (1984) Iron requirements in infancy and childhood. In StekelA (ed.) *Iron Nutrition in Infancy and Childhood*. Nestlé Nutrition Workshop Series, 4, Nestlé, Raven Press, New York, pp. 1–10.

Tariq H, Kamal MU, Reddy P, Bajantri B, Niazi M, Matela A, *et al*. (2017) Anemia, intractable vomiting, chronic diarrhea and syndrome of inappropriate antidiuretic secretion: a diagnostic dilemma: disseminated strongyloidosis in a patient with newly diagnosed HTLV infection-case report and review of literature. *Medicine (Baltimore)* **96**(52), e9229.

WHO (2008) *Worldwide Prevalence of Anaemia 1993–2005: WHO Global Database on Anaemia*. WHO, Geneva.

WHO (2015) *The Global Prevalence of Anaemia in 2011*. WHO, Geneva.

WHO (2014) *WHO Global Nutrition Targets 2025: Anaemia Policy Brief*. URL: https://www.who.int/nutrition/topics/globaltargets_anaemia_policybrief.pdf (accessed 23 February 2019).

WHO (1998) *Obesity: Preventing and Managing the Global Epidemic. Report of a WHO Consultation on Obesity*. World Health Organization, Geneva.

Wikipedia (2019) *Anemia*. URL: https://en.wikipedia.org/wiki/Anemia (accessed 23 February 2019).

Zhang Q, Qin G, Liu Z, Li Z, Li J, Varma DS, *et al*. (2018) Dietary balance index-07 and the risk of anemia in middle aged and elderly people in southwest China: a cross sectional study. *Nutrients* **10**, 162.

Zhao A, Zhang Y, Peng Y, Li J, Yang T, Liu Z and Wang P (2012) Prevalence of anemia and its risk factors among children 6–36 months old in Burma. *American Journal of Tropical Medicine and Hygiene* **87**, 306–311.

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