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RESEARCH ARTICLE

Childhood Anemia in Bihar, India: Patterns and Determinants

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Abstract: Anemia is a significant global public health issue that is worse among children and pregnant women. World Health Organisation reported that 42% of children under five years of age and 40% of pregnant mothers worldwide are anemic. Anemia is one of the most commonly prevalent nutritional problems across the countries, affecting almost all ages, sex, and physiological groups especially the vulnerable groups. It adversely affects the morbidity and mortality among children. An assessment of the pattern and determinants of childhood anemia in Bihar is carried out in this study. The data from the National Family Health Survey conducted during 2015-16 is used in this study to examine the scenario of childhood anemia in Bihar. The bivariate and binary logistic regression models were used to accomplish the study objectives. The anemia prevalence is in Bihar (64%) is 5% higher than the national average (59%). The results from the binary logistic regression model show that the children with lower educated mothers, poor household wealth status, higher birth order, and female sex have a significantly higher risk of childhood anemia in Bihar. Further, Bhagalpur, Kosi, and Darbhanga division of Bihar have a higher risk of childhood anemia. Therefore, it is recommended that socioeconomically, demographically, and regionally backward sections should get focussed on policy modification and program interventions.

Keywords: *Anemia, Hemoglobin deficiency, Iron deficiency, Regional pattern, Kosi.*

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Introduction

Anemia is a problem in which is the shortage of red blood cells (RBC) or the concentration of hemoglobin in blood than normal RBCs. It is a symptom of inadequate nutrition and poor health. Anemia can cause many health problems, including fatigue, nausea, dizziness, and sleepiness. The prevalence of anemia continues to increase worldwide, especially in low-income settings- where a significant proportion of children and women of childbearing age can be believed to be anemic. Iron deficiency anemia has also been found to influence cognitive and physical growth in children and to decrease productivity in adults [1].

Anemia may also influence other major nutritional concerns such as wasting and stunting, low birth weight, and obesity due to lack of energy. When an anemic child becomes an adult, it affects adversely on additional physical and economic effects on individuals and to his/her communities. Childhood anemia remains one of the most significant nutritional disorders faced in India despite a substantial improvement in private and public humanitarian activities to improve child health in response to anemia recorded in previous demographic and health surveys [2- 3-1] According to the National Family Health Survey-3 (NFHS-3), the prevalence of childhood anemia in the age group 6-59 months was 68.9% whereas the state of Bihar had 9.1% higher prevalence than the national average (78%). In NFSH-4 national prevalence of anemia declined by 9.3% (58.6%), whereas the decline in childhood anemia is 5.5% in the state of Bihar (63.5%) and about 60.0% of children < 5 years of age are anemic [4].

Review of Previous Literature

The reasons for anemia are multiple. Amongst the plethora of reasons, there is the demarcation of "in" *i.e.* dietary iron intake

and "out" which corresponds to age, gender, physiological status, and pre-existing iron stores from which the body loses iron[5]. Earlier it was found that nutrition and development are linked [6-7].

Resource inferior settings reduce the development potential of a child and result in deficiencies [8]. Osaria and colleagues have cited some risk factors of anemia which include low family income and low maternal level of education with insufficiency of iron in children. The age of the child is found to be correlated with the vulnerability to anemia [9-10-11]. The incidence of anemia is also found to be varying trends with gender [12]. Community-level factors such as lower caste population in the Indian population and the population residing in the rural household has elevated prevalence of anemia [13-14].

Thus, it can be said that socioeconomic factors can affect the deficiency in nourishment. There is a huge burden of anemia among the children in low-and middle-income countries and the dearth of data is present regarding the exact prevalence of this deficiency in rural settings [15]. Iron deficiency particularly affects preschool-age children (0-5 years) because of the disequilibrium at this age between rapid growth and insufficient iron intakes [16].

A recent review reanalysed data from 1330 children aged 6-23 months with iron-deficient anemia and used to diagnose anemia and iron deficiency the WHO criteria and a serum ferritin level [1]. Bihar is one of the backward states in terms of socio-economic development and demographic transition as compared to many states of India particularly South Indian states. The state also has a relatively higher level of childhood anemia. Given the lack of studies in this state, this study tries to assess the effects of socioeconomic, demographic, and regional characteristics on childhood anemia in Bihar.

Data and Methods

Data Sources

The data from the National Family Health Survey-4 (NFHS-4) was used in this study. The NFHS is a multi-round, large-scale study undertaken around the nation in 2015-16. This nationally representative survey is the Indian version of the Demographic and Health Survey (DHS), providing reliable and consistent estimates of mortality, fertility, family planning, morbidity, child nutritional status, anemia, utilization and quality of health and family planning, maternal and child health care services and other related indicators at the national, state and regional levels.

Outcome Variable

The outcome variable for this study is anemia in childhood. Anemia means the shortage of red blood cells (RBC) in the body. RBC is filled with hemoglobin, a special pigmented protein that makes it possible to carry and deliver oxygen to other cells in the body. The cells in your child's muscles and organs need oxygen to survive, and decreased numbers of red blood cells can place stress on the body [17].

Anemia will be prevented by making sure that your child has a balanced diet. A child may need to balance dietary support to prevent anemia. In this study, childhood anemia was used as the outcome variable. The prevalence of anemia is estimated based on hemoglobin levels, is adjusted for altitude using the formula in the Centre for Disease Control [4]. For the binary logistic regression model, the child with anemia status is coded as '1', otherwise '0'.

Independent Variables

The explanatory variables at the child, and household levels. We selected the confounders after an extensive review of existing literature. Sex of child (Male, Female), preceding birth interval (>48 months, 37-48, 25-36, < 25, first birth order), sibsize (1, 2, 3, 4, +5) child intendedness (wanted than, wanted later, no more) child age (1, 2, 3, 4, 5) are considered the child level variables. At the mother level, the confounders selected were mother's age at child's birth (years) (<19, 20-24, 25-30 and 30+), mother's education (No education, Primary, Secondary and Higher), mother's height (>145 cm, <=145 cm), social groups (Schedule tribe, scheduled caste, other backward class, and other castes), religion (Hindu, Islam and Other).

Wealth index (Poorest, Poorer, Middle, Richer, and Richest), area of residence (Urban and Rural), and region (Patna, Tarhut, Saran, Darbhanga, Kosi, Purnia, Bhagalpur, Munger, Magadh) were selected at the household level. The wealth status is used to measure the household's socioeconomic status in NFHS-4 and similar surveys, the details of the wealth status can

be found in the NFHS report (IIPS and ICF 2015-16).

Statistical Analyses

For the analysis, univariate, bivariate, and multivariate statistical analyses were performed. Univariate descriptive statistics have been measured to explain the features of the sample. The percentage of child anemia has been calculated to show the prevalence of childhood anemia by various socio-economic, demographic, and regional factors. The regional pattern of childhood anemia is presented in a map. The binary logistic regression model was used to analyze the determinants of childhood anemia prevalence in Bihar.

Results

Descriptive Statistics

Table 1 (Column 2) shows the sample distribution by socio-economic, demographic, and regional characteristics in Bihar in 2015-16. The sample size comprises 51.8% male and 48.2% female children, in which 28.2 % of the children are first-order birth, 22.7% of them are born after 25 months of preceding birth interval and 25.4% of them are born after an interval of 25-36 months.

Only 10.8% of the total sample space is born after 48 months of preceding birth interval. Sibling size in most of the family is 2 (30.8%) followed by 25.7% of 3. Only 15.6% of families have a single child whereas 13.2% of the sample space has more than 5 children. In his sample, 87.5% of the children are intended as were wanted at the time of birth, 4.5% of them were wanted later and a total of 8% were not wanted at all. The children by age group are almost equally distributed. The mothers of most of these children aged between 20-24 years, 9.1% of the females aged 25 and more, and 43.9 % aged less than 20 years. Among these mothers, about 56.9% are uneducated, 26.7% have attained secondary education, 12.3% have attended primary education and only 4% had higher education. About 80.4% of this female is more than 145 cm of height and the rest are below this level.

The household working status depicts that only 2% were working 14.4% were non-working and 83.5% were not asked the question because this question is in state module. Most of the respondents in the sample size reside in rural areas (89.6%). About 83.2% of the total sample follows Hinduism as a religion of practice and most of the population (59.6%) belong to the OBC category and SC and ST constitutes 25.6%, 22.4%, and 3.2% respectively.

Most of the household has poorer (22.2%) wealth status, 22% poorest, 21.1% middle, and 19.6% richer and the least belong to the richest wealth status (15.2%). Bihar has eight administrative divisions. The sample is 17.1% in Patna, followed by 16.5% in Munger, 14.4% in Turhut, 12.7% in Magadh, 10.9% in Purnia, 9.4% in Kosi, and 7.5% in Darbhanga. Saran and Bhagalpur constitute the least of the population in this survey with 6.1 % and 5.4% respectively.

Table 1: Sample distribution and prevalence of anemia by the socioeconomic, demographic, and regional characteristics in Bihar, 2015-16

Background characteristics	Sample distribution in percent (95% CI)	Prevalence of anemia in percent (95% CI)
Sex of the child		
Male	51.8 (51.1, 52.5)	62.1 (61.3, 63.0)
Female	48.2 (47.5, 48.9)	65.0 (64.2, 65.9)
Preceding birth interval		
>48 months	10.8 (10.4, 11.2)	62.4 (60.6, 64.2)
37-48 months	13.0 (12.6, 13.5)	64.9 (63.2, 66.5)
25-36 months	25.4 (24.8, 25.9)	65.0 (63.9, 66.2)
<25 months	22.7 (22.1, 23.2)	65.3 (64.1, 66.6)
First birth order	28.2 (27.6, 28.8)	60.6 (59.5, 61.7)
Sibsize		
1	15.6 (15.1, 16.1)	65.3 (63.8, 66.8)
2	30.8 (30.2, 31.4)	61.5 (60.4, 62.6)
3	25.7 (25.1, 26.3)	62.0 (60.8, 63.1)
4	14.7 (14.2, 15.2)	64.5 (6.03, 66.0)
5+	13.2 (12.8, 13.7)	68.2 (66.6, 69.7)
Child intendedness		
Wanted then	87.5 (87.0, 87.9)	63.5 (62.9, 64.1)
Wanted later	4.5 (4.3, 4.8)	66.0 (63.4, 68.6)
Wanted no more	8.0 (7.6, 8.4)	62.7 (60.7, 64.7)
Child age (years)		
1	11.3 (10.8, 11.7)	72.1 (70.4, 73.7)
2	22.6 (22.0, 23.1)	75.6 (74.5, 76.7)

3	21.5 (20.9, 22.0)	65.1 (63.9, 66.4)
4	23.2 (22.7, 23.8)	58.4 (57.1, 59.6)
5	21.5 (20.9, 22.0)	50.6 (49.3, 51.9)
Mothers' age at birth		
<20 years	43.9 (43.3, 44.6)	64.3 (63.4, 65.2)
20-24 years	47.0 (46.3, 47.7)	63.1 (62.2, 64.0)
25+ years	9.1 (8.7, 9.5)	62.2 (60.3, 64.1)
Mothers' height		
<145 cm	19.6 (19.1, 20.2)	65.7 (64.3, 67.0)
145+ cm	80.4 (79.8, 80.9)	63.0 (62.4, 63.7)
Mothers' level of education		
No education	56.9 (56.2, 57.6)	66.7 (66.0, 67.5)
Primary	12.3 (11.9, 12.8)	62.3 (60.6, 64.0)
Secondary	26.7 (26.1, 27.3)	59.0 (57.8, 60.2)
Higher	4.0 (3.8, 4.3)	51.5 (48.4, 54.6)
Working status		
Not working	14.4 (13.9, 14.9)	62.1 (60.6, 63.7)
Working	2.2 (2.0, 2.4)	65.7 (61.7, 69.7)
Missing/Not reported	83.5 (82.9, 84.0)	63.7 (63.1, 64.4)
Place of residence		
Urban	10.4 (10.0, 10.8)	58.6 (56.7, 60.5)
Rural	89.6 (89.2, 90.0)	64.1 (63.5, 64.7)
Religion		
Hindu	83.2 (82.7, 83.7)	63.5 (62.9, 64.2)
Others	16.8 (16.3, 17.3)	63.5 (62.1, 64.9)
Caste		
Others	14.8 (14.4, 15.3)	61.1 (59.5, 62.6)
SC	22.4 (21.8, 23.0)	67.8 (66.5, 69.0)
ST	3.2 (3.0, 3.5)	71.6 (68.8, 74.4)
OBC	59.6 (58.9, 60.2)	62.1 (61.3, 62.9)
Wealth status		
Poorest	22.0 (21.4, 22.5)	68.2 (67.0, 69.4)
Poorer	22.2 (21.6, 22.7)	66.1 (64.9, 67.3)
Middle	21.1 (20.6, 21.7)	64.2 (62.9, 65.5)
Richer	19.6 (19.1, 20.2)	61.0 (59.6, 62.4)
Richest	15.2 (14.7, 15.7)	54.6 (53.0, 56.1)
Regions		
Patna	17.1 (16.6, 17.6)	59.2 (57.6, 60.7)
Turhut	14.4 (14.0, 14.9)	64.6 (63.3, 65.8)
Saran	6.1 (5.8, 6.5)	62.9 (60.7, 65.1)
Darbhanga	7.5 (7.2, 7.9)	66.2 (64.6, 67.8)
Kosi	9.4 (9.0, 9.8)	67.3 (65.2, 69.4)
Purnia	10.9 (10.5, 11.3)	63.9 (62.2, 65.6)
Bhagalpur	5.4 (5.1, 5.8)	70.1 (67.7, 72.5)
Munger	16.5 (16.0, 17.0)	63.3 (61.4, 65.2)
Magadh	12.7 (12.2, 13.1)	58.2 (56.2, 60.1)
India	100	63.5 (63.0, 64.1)

Note: CI stands for confidence interval; Source: Estimated from National Family Health Survey (2015-16); State weight is applied for prevalence of anemia

Prevalence of Child Anemia

Column 3 of Table 1 illustrates the patterns of prevalence of child anemia in different districts of Bihar in 2015-16. In India, about 63.5% of the total under-five children are anemic in Bihar. In the state of Bihar, the prevalence varies across the divisions. It is maximum in Bhagalpur 70.1% followed by 67.3% in Kosi and 66.2% in Darbhanga. Most of the regions have a more than 60% prevalence of anemia. Patna has a 64.6% prevalence of anemia, Turhut has 62.9%, Purnia 63.9%, and Munger 63.3%. The least prevalence is in Patna and Magadh with 59.2% and 58.2% respectively.

The hemoglobin deficiency is found to be more in female children with 65% than in male 62.1%. The deficiency is seen maximum (65.3%) in the children who are born within 25 months of the preceding birth followed by the interval of 25 to 36 months (65%), 37-48 months (64.9%) and first-order births (60.6%). An interval of more than 48 months sows the prevalence of deficiency of 62.4%. Sibling size of 1 shows the prevalence of 65.3% and the anemia increases with increasing birth siblings.

For instance, the prevalence is 61.5% among the children with two sibsize, 62% with three, 64.5% with four, and 68.2% with 5+. The unwanted children have the least prevalence of anemia among all children. Several other child and mother level factors are also related to the child anemia. The highest prevalence of anemia is seen in children age 2 years (75.6%) followed by children age 1 year.

The prevalence of this hemoglobin deficiency decreases with the age from three, four, and five 65.1%, 58.4%, and 50.6% correspondingly.

The mothers bearing the children at the age of less than 20 years have a higher prevalence of anemia than the age group 20-24 years and that is lowest among the children who are born to females age 25 years or more. The table that the prevalence of anemia is higher among the mothers with less than 145 cm of height (65.7%) than the mothers with 145cm of height (63%). A similar trend can be seen with the increase in the level of education of mothers.

For instance, the children of women with no education have an anemia prevalence of 66.7%, which is only 62.3% and 59% for primary and secondary education respectively. The children of women with higher education show the least prevalence of this deficiency. The working mothers have anemia prevalence of 62.1% and non-working mothers have 65.7%.

The prevalence is seen more in rural (64.1%) than the urban areas (58.6%). On the religious ground, the Hindu community and the other community show an equal level of anemia i.e. 63.5%. An elevated prevalence is seen among SC and ST categories with 67.8% and 71.6% correspondingly. The OBC category shows the prevalence as 62.1% and others show 61.1%. The prevalence of anemia increases with decreasing wealth status.

Regional Pattern of Child Anemia

The present figure of giving an immediate visual summary of the regional distribution of childhood anemia in Bihar (2015-16). The darker the colour, the higher the prevalence of anemia, thus showing a positive correlation of colour to this anemia prevalence. The districts like Patna, Aurangabad, and Nalanda have the least anemia prevalence and it lies between 51.6% to 55.8%. Gaya, Nalanda, Jamui, etc have a range of 55.9% to 61.4% prevalence of anemia.

In districts like Gopalganj, Siwan, Begusarai, Khagaria, and so forth, anemia has occupied its place in border way as the percentage range of anemia in their districts in 61.5% to 64.2%. The situation became worst in Vaishali, Samastipur, Saharsha, Purnia, etc. and the range of percentage of anemia in these districts is from 64.3% to 67.7%. The most affected districts are Sitamarhi, Darbhanga, Bhagalpur, Supaul, Kishanganj, Bhojpur, and Banka. The percentage of anemia is between 67.8% and 73.5% in these districts.

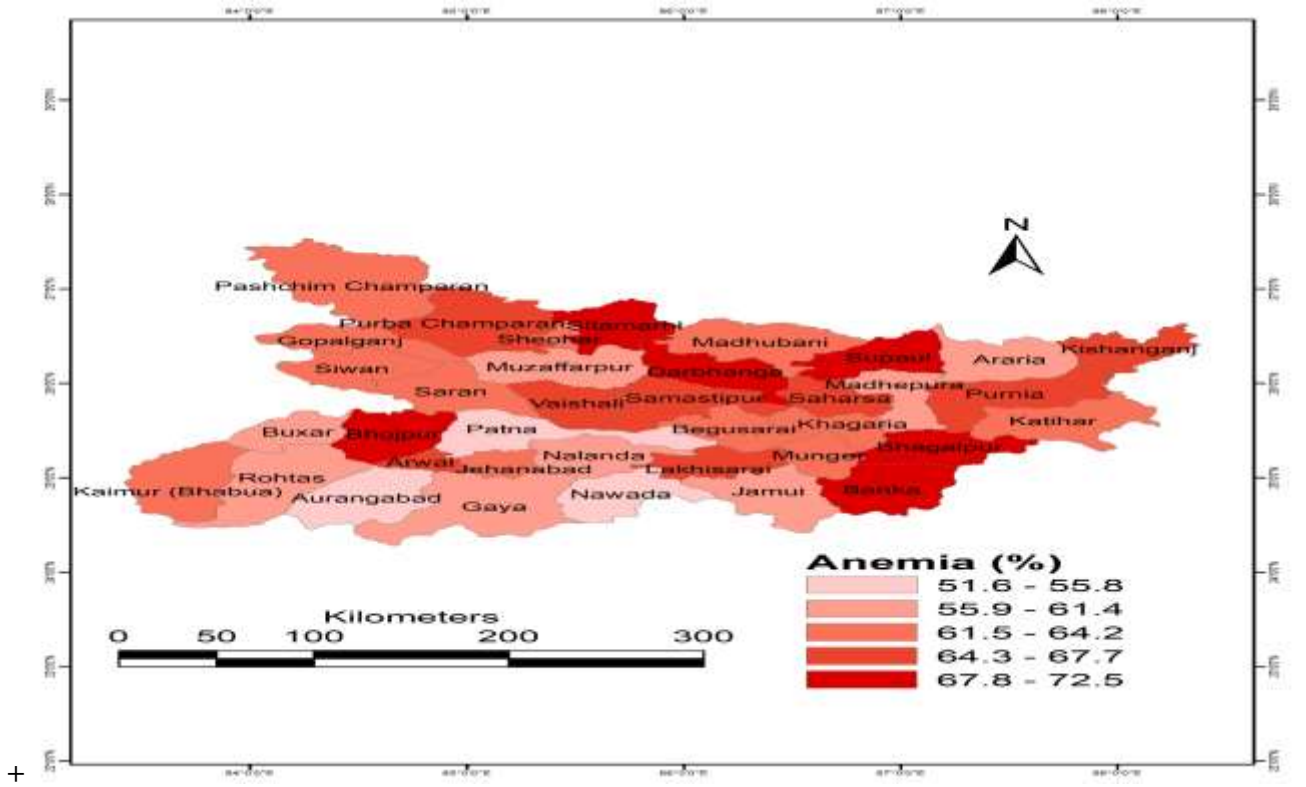

Figure 1: Regional distribution of childhood anemia in Bihar, 2015 -16

Note: Estimated from National Family Health Survey (2015-16)

Results from the Logistic Regression model: Likelihood of Child Anemia

Table 2 presents the adjusted odds ratio of socioeconomic, demographic, and regional factors of childhood anemia in Bihar (2015-16). The table contains a range of variables such as sex of the child, preceding birth interval, sibsize, child intendedness, mothers' age at birth, mothers' level of education, working status, place of residence, religion, caste, wealth status, and regions.

The female children have 1.12 times higher risk of childhood anemia than the male children. The adjusted odds ratios of children with preceding birth interval of 37-48 months and 25-36 months are 1.06 and 1.04 times higher respectively than the children with >48 months of preceding birth interval. The children with sibsize of 2, 3, 4, and 5+ have 1.02, 1.07,1.16, and 1.34 times higher likelihood of anemia than the sibsize 1.

The odds of anemia is 1.11 times higher and 0.94 times lower among the children with wanted later and wanted no more correspondingly than the children with wanted then. The risk of anemia is 1.14 times higher and 0.68, 0.47, and 0.34 times lower among the children of 2 years, 3 years, 4 years, and 5 years as compared to the children with one year. The mothers with age groups in 20-24 years and 25+ years are 0.96 and 0.92 times less likely to have anemic children than the mothers in <20 years of age at childbearing. The mothers with a higher height 145 cm and more have a lesser likelihood to have anemic children (AOR: 0.93) than their counterparts. The risk of child anemia is lower among the mothers who have primary (AOR: 0.88), secondary (AOR: 0.83), and higher (0.67) education than those who have no education.

Rural children have a relatively lesser likelihood of childhood anemia (AOR: 0.90) than the urban area. Other than Hindu community has relatively less childhood anemia (AOR: 0.94). The children in poorer, middle, richer, and richest households have 0.94, 0.90, 0.81, and 0.71 times lesser risk of anemia than the poorest counterpart. As compared to the Patna region, Turhut, Saran, Darbhanga, Kosi, Purnia, Bhagalpur regions have 1.11, 1.13, 1.17, 1.20, 1.06, 1.45, and 1.10 times higher likelihood of child anemia in Bihar.

Table 2: Results from the logistic regression model: Adjusted odds ratio of socioeconomic, demographic, and regional factors of childhood anemia in Bihar, 2015-16

Background characteristics	Adjusted odds ratio (95% CI)
Sex of the child	
Male (Ref.)	1.00
Female	1.12 (1.06, 1.19)***
Preceding birth interval	
>48 months (Ref.)	1.00
37-48 months	1.06 (0.94, 1.20)
25-36 months	1.04 (0.94, 1.16)
<25 months	1.10 (0.99, 1.23)
First birth order	1.09 (0.96, 1.24)
Sibsize	
1 (Ref.)	1.00
2	1.02 (0.91, 1.13)
3	1.07 (0.94, 1.23)
4	1.16 (1.00, 1.35)*
5+	1.34 (1.14, 1.56)***
Child intendedness	
Wanted then (Ref.)	1.00
Wanted later	1.11 (0.96, 1.28)
Wanted no more	0.94 (0.84, 1.05)
Child age (years)	
1 (Ref.)	1.00
2	1.14 (1.02, 1.28)*
3	0.68 (0.61, 0.76)***
4	0.47 (0.42, 0.53)***
5	0.34 (0.31, 0.38)***
Mothers' age at birth	
<20 years (Ref.)	1.00
20-24 years	0.96 (0.90, 1.02)
25+ years	0.92 (0.83, 1.03)
Mothers' height	
<145 cm (Ref.)	1.00
145+ cm	0.93 (0.86, 1.00)*

Mothers' level of education	
No education (Ref.)	1.00
Primary	0.88 (0.80, 0.97)**
Secondary	0.83 (0.76, 0.90)***
Higher	0.67 (0.57, 0.79)***
Working status	
Not working (Ref.)	1.00
Working	1.21 (0.98, 1.51)
Missing/Not reported	1.08 (0.99, 1.17)
Place of residence	
Urban (Ref.)	1.00
Rural	0.9 (0.82, 1.00)
Religion	
Hindu (Ref.)	1.00
Others	0.94 (0.86, 1.03)
Caste	
Others (Ref.)	1.00
SC	1.10 (0.98, 1.22)
ST	1.24 (1.03, 1.50)*
OBC	0.94 (0.86, 1.03)
Wealth status	
Poorest (Ref.)	1.00
Poorer	0.94 (0.86, 1.03)
Middle	0.90 (0.82, 0.98)*
Richer	0.81 (0.73, 0.89)***
Richest	0.71 (0.63, 0.81)***
Regions	
Patna (Ref.)	1.00
Turhut	1.11 (1.00, 1.23)
Saran	1.13 (0.99, 1.30)
Darbhanga	1.17 (1.03, 1.33)*
Kosi	1.20 (1.06, 1.36)**
Purnia	1.06 (0.94, 1.19)
Bhagalpur	1.45 (1.25, 1.68)***
Munger	1.10 (1.00, 1.22)
Magadh	0.92 (0.83, 1.02)
Constant	3.03 (2.36, 3.88)***
Number of observation	20926
Log likelihood	-13138.366
LR chi^2 (40)	1208***

Note: CI stands for confidence interval; Source: Estimated from National Family Health Survey (2015-16); Ref. stands for reference category; State weight is applied for the estimates; *** p <0.001, ** p <0.01, * p <0.05,

Discussion

This study attempts to investigate the effects of socioeconomic, demographic, and regional characteristics on child anemia in Bihar. The 2015-16 NFHS indicates a decline of just 11% from 69.5% to 58.5% of childhood anemia in India. The progress in terms of child anemia is not satisfactory in both Bihar in particular and India in general. It remains a major public health issue in India.

Elimination of hemoglobin deficiency anemia in children is a public health concern considering the correlation of anemia with compromised cognitive and psychomotor development [18-19]. The findings show that the children with short preceding birth interval, high sibling size, early age, poor wealth status, the mothers had no education or primary education, and from Bhagalpur and Sitamarhi divisions have a significantly higher risk of anemia than their counterparts. From the policy perspective and program intervention, these socioeconomically and demographically groups should attract special attention. Some reports have shown that IFA tablets offered to children (under three years) are not readily appropriate and recommended liquid IFA for small children [20]. In 2007, the Government of India changed its strategy and replaced tablets with liquid IFA. According to the current regulation, small children (6–59 months) will earn one ml of IFA syrup for a total of 100 days each year. Contains 20 mg of elemental iron and 100 µg of folic acid [21].

Although the Government has introduced the weekly iron and folic acid supplementation tablets for the adolescent [22], the specific supplementation in the age group 0-5 years is also needed in Bihar. Since the elimination of any form of malnutrition by 2030 is a goalpost for sustainable development goas as

endorsed by the Government of India, disadvantageous groups as found in this study need attention [23-26].

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