Original Research Article

Determinants of anaemia among children aged under five years in Assam, India

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ABSTRACT

Background: Childhood anaemia is a major public health threat that can increase susceptibility to infections, risk of mortality together with serious degrading consequences on cognitive and physical development. The aim was to examine the prevalence of anaemia in children aged under-five years in Assam, India, exploring 2015-2016 National Family Health Survey (NFHS-4) data.
Methods: Statistical analysis is performed on the cross-sectional data of 10,309 children from 2015-2016 National Family Health Survey (NFHS-4), using binary logistic regression model, to assess the significance of some risk factors of child anaemia. Anaemia was diagnosed by WHO cut-off points on hemoglobin level.
Results: The prevalence of child anaemia was 35.7 per cent in Assam, India, with mean haemoglobin concentration 11.36 gm/dl (95% CI, 11.32-11.38); male and female being equaled proportionately anaemic. Out of 27 districts in Assam, the highest prevalence was found in Dibrugarh (52.2 per cent), followed by Nalbari (46.7 per cent) and Darrang (45.6 per cent); and the least prevalence was found in Karbi-Anglong (24.4 per cent). The findings indicate that rural children and lower age-groups were at greater risk of anaemia. Higher birth order, low level of maternal education, low level of maternal nutrition and non-intake of iron supplements during pregnancy increased the risk of anaemia among children ($p<0.05$).
Conclusions: The findings suggest a need for proper preventive measures to combat child anaemia. Rural population should be given special attention. Maternal education, nutrition, and birth control measures should be priorities in the programs.

Keywords: Anaemia, Assam, Children, Risk factors, Logistic regression

INTRODUCTION

Anaemia is a public health problem affecting approximately 2.36 billion people globally; with greater burden on children and women of child bearing age.[1,2] High prevalence of anaemia is found in both developing and developed countries and hampers human health, social and economic development.[3] Childhood anaemia, being a major public health threat, increases susceptibility to infections, risk of mortality together with serious degrading consequences on cognitive and physical development.[4] The condition, being the most common pediatric hematological disease, is widely prevalent in India affecting both males and females across all age groups.[5] National Family Health Survey (NFHS), Government of India, estimate an increase in anaemia prevalence from 74 per cent in 1992-93 to 79 per cent in 2005-06 among Indian children aged 6 to 36 months.[6,7] In India, the condition is mainly associated with iron deficiency and the possible reasons for this may be lack of balanced diet bereft of high iron content.[8,9] The existing literature also suggest some risk factors of

anaemia such as low family income, low level of maternal education, lack of access to healthcare services and inadequate sanitary conditions.[10] Plasmodium falciparum that causes malaria ruptures RBCs and prohibits their production; flukes and hookworm that cause iron drainage from excessive blood loss, are also responsible for anaemia.[11,12] In spite of a full-time anaemia control program, the condition is still rampant in India, especially, in rural population.

The pediatric population of Assam is an example of a mixed community covering the Ahoms, the tea garden community and other ethnic groups. Some studies reflect that the children of this region suffer from anaemia due to micronutrient deficiency together with an increased prevalence of HbE, sickle cell anaemia, thalassemia, etc.[13]

Though childhood anaemia has serious consequences on life-long health but an early detection and subsequent control measures can help the child grow into a healthy adult. So it is imperative to study the associated factors of child anaemia for the proper and effective implementation of anaemia-control programs. In this regard, several authors have discussed about the impact of the socioeconomic status (SES) on the prevalence of anaemia.[14,15] This study also aims to assess the prevalence of anaemia among the children aged 6-59 months in the state of Assam, India, and also, to explore the significant risk factors associated with anaemia. The paper also emphasizes on the socioeconomic differentials in order to fully understand the status and prevalence of anaemia.

METHODS

This study based on a cross-sectional study on children of Assam, exploring the database compiled in National Family Health Survey (NFHS-IV) under Ministry of Health and Family Welfare, Government of India, was carried over two years from January, 2015 to December, 2016 in all 29 States and 7 Union Territories of India.[16]

The NFHS-4 is a large-scale sample survey conducted to provide essential information on population, family planning, maternal and child health, child survival, HIV and sexually transmitted infections (STIs), reproductive health, and nutrition in India.

Sample from urban and rural areas were drawn separately. The rural sample was selected in two stages, with the selection of villages, with probability proportional to population size at the first stage, followed by the systematic selection of households within each village in the second stage. In urban areas, a three-stage procedure was followed. In the first stage, wards were selected with PPS sampling. In the next stage, one census enumeration block (CEB) was randomly selected from each sample ward. In the final stage, households were randomly selected within each selected CEB.

The relevant information of 10309 children between the ages 6-59 months, whose haemoglobin concentration was measured, were taken for the State of Assam, India to examine the effect of certain socio-economic and demographic factors on child anaemia. Haemoglobin concentration was measured by finger-prick blood specimens using a portable Hemocue Hb201+ analyzer, and WHO classification criteria were used to categorize a child anaemic as concentration level fell below 11 gm/dl.

The binomial logistic regression was used to develop a projecting model on anaemia, and also to examine dependence of anaemia on the risk factors taken into study. Odds ratios were computed using SPSS 18.0 software, with reference category as the first category for all the factors; and Hosmer and Lemeshow test statistic was evaluated to test the goodness of fit of the model. The test statistic is a chi-square statistic with a desirable outcome of non-significance, indicating that the model prediction does not significantly differ from the observed.[17,18] The response variable was designed as a binary 'anaemia level' (non-anemic, anemic); and the predictors as: age of child in years (less than 1, 1-2, 2-3, 3-4, and 4-5), birth order of child (1, 2, 3, and 4 and above), place of residence (urban, rural), religion (Hindu, Muslim, and others), wealth index (poorest, poorer, middle, richer, and richest), maternal BMI (under-weight, normal, and over-weight and obese), maternal education (no education, primary, secondary, and higher), and iron supplements for mother during pregnancy (no, yes). Wealth indices indicated economic status of households and was developed using household asset information, and in relation to inequalities in household income, use of health services, and health outcomes. Maternal education was categorized on the basis of years of completion of formal school education; no education referred those who never attended school; primary, secondary and higher education included individuals of 5 years, 10 years and 12 or higher years of completed schooling respectively. Multicollinearity test was performed to justify the independence of risk factors in the study. Logistic regression model gives the risk of anaemia for a child for given predictors as:

$$\frac{e^{t(x)}}{1 + e^{t(x)}},$$

Where $t(x) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_r x_r$, is the logit transformation of the logistic regression model.

RESULTS

The anaemia status of 10,309 children aged under-five years of Assam, India, was studied including its association with some risk factors. The study undertook 52.5% males and 47.5% females covering both rural and urban areas. Overall, 35.7% children were anaemic with mean haemoglobin concentration 11.36 gm/dl (95% CI, 11.32-11.38) (Table 1).

Table 1: Prevalence rates of child anaemia by population subgroup.

Subgroup	N (%)	Haemoglobin concentration (g/dl)		Prevalence of anaemia
		Mean	**95% CI**	**%**
Gender				
Male	5360 (52.5)	12.9	12.64-13.18	35.7
Female	4949 (47.5)	13.2	12.90-13.53	35.7
Age of child (years)				
Less than 1	1842 (18.8)	12.4	12.07-12.91	49.6
1-2	1935 (19.8)	12.4	12.06-12.7	45.8
2-3	2007 (20.5)	12.3	12.08-12.7	34.1
3-4	2092 (21.4)	13.2	12.6-13.7	30.3
4-5	1915 (19.6)	12.9	12.4-13.4	27.4
Birth order				
1	4359 (42.3)	12.9	12.5-13.2	35.2
2	2907 (28.2)	12.7	12.3-13	36.4
3	1547 (15)	12.4	12-12.8	37.1
4 and above	1496 (14.5)	12.0	11.7-12.3	36.8
Place of residence				
Urban	938 (9.1)	14.08	13.14-15.02	27.5
Rural	9371 (90.9)	12.4	12.31-12.67	36.5
Religion				
Hindu	5779 (56.1)	12.6	12.3-12.8	37.0
Muslim	4034 (39.1)	12.7	12.4-13	34.6
Others	494 (4.8%)	11.9	11.4-12.4	30.1
Wealth index				
Poorest	3256 (31.6)	12.04	11.8-12.2	38.3
Poorer	4016 (39)	12.5	12.2-12.8	36.1
Middle	1782 (17.3)	12.9	12.4-13.3	34.2
Richer	924 (9.0)	12.9	12.3-13.6	29.6
Richest	331 (3.2)	16.3	14.1-18.5	29.9
Mother's BMI				
Underweight	2739 (26.9)	12.3	12.06-12.7	39.4
Normal	6491 (63.7)	12.5	12.3-12.7	35.1
Overweight and obese	955 (9.4)	13.9	13.1-14.8	29.6
Mother's education				
No education	2507 (24.3)	12	11.7-12.3	40.0
Primary education	1680 (16.3)	12.2	11.8-12.5	35.0
Secondary education	5668 (55.0)	12.8	12.5-13.1	34.4
Higher education	454 (4.4)	14.3	12.9-15.7	30.9
ISMP				
No	1259 (14.8)	12.68	12.1-13.2	39.6
Yes	7271 (85.2)	12.64	12.4-12.8	36.4
All children	10309 (100)	11.36	11.32-11.38	35.7

BMI, Body mass index; ISMP, Iron Supplement to mother during pregnancy.

The findings showed, though male and female population were equally affected with anaemia, the rural children were affected more (36.5%) than urban children (27.5%). Children aged less than 1 year were observed with highest prevalence rate (49.6%); however as age increased, the prevalence decreased linearly. Throughout the state, 31.6% children belonged to households of poorest wealth index; 39% poorer, 17.3% middle, 9% richer and 3.2% belonged to richest households. The prevalence of anaemia showed a decreasing trend from poorest (38.3%) to the richest (29.9%). As regards maternal education, 40% children of formally uneducated mothers were anaemic, and the prevalence showed a decreasing trend as maternal education increased. Anaemia was also dominant among the children of under-nutritious mothers. The findings corresponding to maternal BMI revealed anaemia prevalence as 39.4% for children of under-weight mothers, as against 35.1% for those of normal-weight mothers. In the study, 56.1 percent population was from Hindu religious group, 39.1 percent from Muslims, and the rests from others. Hindu

population was affected more (37%) as compared to Muslims (34.6%) and others (30.0%). The findings also reflect higher incidence rate among the children of higher birth order. Intake of iron supplements during pregnancy decreased the incidence of anaemia among children.
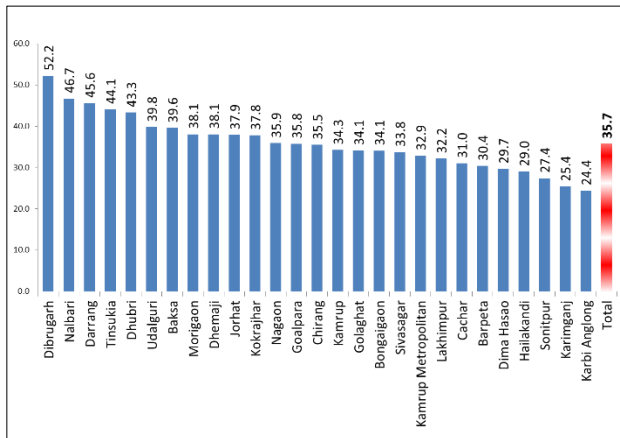

Figure 1: District-wise prevalence of child anaemia in Assam.

Out of 27 districts in Assam, the highest prevalence was found in Dibrugarh (52.2%), followed by Nalbari (46.7%) and Darrang (45.6%); and the least prevalence was found in Karbi-Anglong (24.4%), followed by Karimganj (25.4%) and Sonitpur (27.4%), as is indicated by Figure 1. The results of binary logistic risk factors showed higher likelihood of anaemia for lower age groups, with decreasing risks as age increased (p<0.01). Higher likelihood of anaemia was also observed for children of birth order 3 (OR- 1.426, 95% CI- 1.394-1.860) as compared to those of birth order 1 (Table 2). The risk was also higher for children of birth order 4 and above. The odds ratio revealed that the children in the rural areas had a greater risk of anaemia as compared to their urban counterparts (OR- 1.539, 95% CI- 1.289-1.837). Muslim children were relatively less prone to anaemia as compared to Hindu children (OR- 0.871, 95% CI- 0.788-0.963). Wealth index also had significant effect on anaemia. The estimates revealed that a child of richest category was at lower risk of anaemia than a child of poorest category (OR- 0.724, 95% CI- 0.513-0.922). The risks increased as wealth index score decreased. Normal status of maternal BMI had lower risk of anaemia for children as against those of under-weight status (OR- 0.849, 95% CI- 0.755-0.954). Maternal education was also a significant predictor of child anaemia. The relative odds reflected significant lesser chances of anaemia for the children of higher educated mothers (OR- 0.810, 95% CI- 0.595-0.762), and also for secondary educated mothers (OR- 0.825, 95% CI- 0.713-0.953) and primary educated mothers (OR- 0.830, 95% CI- 0.702-0.981), in reference to the children of uneducated mothers. Intake of iron supplements during pregnancy reduced the likelihood of anaemia for children (OR- 0.773, 95% CI- 0.758-0.886). Hosmer and Lemeshow test value for the

model was 8.672 (p-value 0.282), i.e., the model fitted the data at an acceptable level.

Table 2: Estimates of parameters of binomial logistic regression model.

Predictor	P value	OR	95% CI for OR
Age of child (years)			
Less than 1*	-	-	-
1-2	0.077	0.852	0.713,1.017
2-3	<0.001	0.522	0.435,0.627
3-4	<0.001	0.442	0.366,0.534
4-5	<0.001	0.377	0.308,0.461
Birth order			
1*	-	-	-
2	0.075	1.172	.938, 1.178
3	0.012	1.426	1.394, 1.860
4 and above	0.022	1.315	1.266, 1.459
Place of residence			
Urban*	-	-	-
Rural	<0.001	1.539	1.289, 1.837
Religion			
Hindu*	-	-	-
Muslim	0.007	0.871	0.788, 0.963
Others	0.004	0.714	0.568, 0.898
Wealth index			
Poorest*	-	-	-
Poorer	0.078	0.890	0.783, 1.013
Middle	0.030	0.831	0.703, 0.982
Richer	0.001	0.705	0.569, 0.873
Richest	0.036	0.724	0.513, 0.922
Mother's BMI			
Underweight*	-	-	-
Normal	0.006	0.849	0.755, 0.954
Overweight and obese	0.000	0.692	0.567, 0.845
Mother's education			
No education*	-	-	-
Primary education	0.029	0.830	0.702, 0.981
Secondary education	0.009	0.825	0.713, 0.953
Higher education	0.040	0.810	0.595, 0.962
ISMP			
No*	-	-	-
Yes	0.011	0.773	0.758, 0.886
*Reference category	Hosmer and Lemeshow Test value: 8.672 (p-value 0.282)		

OR, odds ratio; CI, confidence interval; BMI, Body mass index; ISMP, Iron Supplement to mother during pregnancy.

DISCUSSION

As the childhood anaemia has serious consequences on growth, development, and survival of a child; so the factors influencing anaemia among children in a population are fundamental to the implementation of control measures. The findings showed that more than one-third children in Assam were anaemic, with more burdens on rural population and lower age groups. This

was in confluence with the findings of the study conducted in Assam by Dutta et al.[13] Similar results were observed by Arlappa et al and Balakrishnan et al in their respective studies.[19,20] A possible explanation is that at lower ages, the requirement of iron is higher than any other group.[21] A diet low in iron can also be described as a cause of such condition. Higher birth order had a significant positive association of anaemia. Muslim population was relatively less prone to anaemia as compared to Hindu children, which may be due to the differences in dietary practices. Poorest and poorer household wealth indices determined child anaemia significantly, which highlight the plight of the families in the lower socio-economic strata. Similar findings were seen in a study conducted in Brazil in 2011 and 2010; and in northern Ethiopia in 2007.[22] The reason may be due to fact that children from poor households are less likely to get iron and vitamin rich food especially vitamins A and C which are very important for iron absorption. In addition, these households are less likely to afford health service during illness. Maternal education also predicted child anaemia significantly, as higher educated mothers showed lower likelihood of anaemia for their children. The reason may be described as educated mothers may affect healthy decision making and consequently influence the chance of a child meeting nutritional requirements.[23]

Some studies have also shown that, in developing countries children of formally educated mothers had a reduced risk of stunting.[24,25] The findings also substantiate the necessity of intake of iron supplements during pregnancy to reduce the likelihood of anaemia for children.

CONCLUSION

The prevalence of child anaemia in Assam seems to be very high and the findings revealed significant adverse effect of anaemia on rural children, lower age groups, higher birth order, and economically weaker section. Further, poor maternal nutrition, low level of maternal education, and no antenatal care with iron supplements increased the likelihood of child anaemia. So the findings suggest a need of implementation of preventive measures to combat child anaemia, with special consideration to those clusters where the prevalence rate is very high.

Iron supplementation to children and their dietary habit was not analysed, because of lack of adequate information, which may be taken as a limitation of the study. Further, there was some possibility of confounded effects of risk factors in this cross-sectional study, though multicollinearity test justified the independence of the factors.

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