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Cross-Sectional Study Of Socio-Economic And Demographic Predictors Of Child Anaemia In India Using Multilevel Modelling

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Abstract

Childhood anaemia, a widespread nutritional deficiency globally, profoundly affects lifelong health. Key consequences include weakened immunity, developmental problems, hindered learning capacity, and decreased workplace efficiency. However, early detection and preventative measures can foster a child's development into a healthy adult. The study aims to analyze key determinants of child anaemia through the exploration of NFHS-5 data, conducted by Govt. of India during 2019 to 2021. Two-level binary logistic regression analysis was performed, with children as first level and households as second level, to assess the significance of some socio-economic and demographic predictors, as well as the variation of the child level predictors across the households. The findings reveal that a significant proportion of children were anaemic, specifically 67% overall, with highest prevalence among those in the poorest demographic, lower age group and those with higher birth order. Though the cross-household variability was not significant, but the condition was predicted by a combination of factors, including household wealth, parents' educational background, and maternal anaemia

Key words: Risk factors, Child anaemia, India, NFHS, Multilevel analysis

Introduction

Anaemia is a condition where the body has a reduced capacity to carry oxygen due to lack of healthy RBCs or haemoglobin, and often leading to fatigue, weakness, and other symptoms. The condition is an indicator of both poor nutrition and health and is a major public health issue affecting population in rich and poor countries, with major consequences on cognitive and motor development [1,2,3]. Globally, anaemia is one of the most widespread nutritional disorders, affecting nearly 40.0% of children aged 6 months to 59 months [4]. Bbesides biological and physiological determinants, it is also influenced to a considerable extent by various other factors including socio-economic and demographic aspects of families and parents' knowledge about the adverse effects of anaemia, child-feeding practices, infectious disease.[5,6]. The literature suggests that the major cause of all types of anaemia in the world is due to iron deficiency and young children during first 2 years of life are more vulnerable, primarily due to the substantial iron requirements associated with accelerated growth during this developmental stage [7]. However, proactive measures and implementing early support strategies can pave the way for a healthy adulthood.

According to the National Family Health Survey, conducted during 2019–21, 67.1 % of Indian children aged between of 6–59 months were anaemic. Though the prevalence varied significantly across different regions of the country, but a substantial rise observed from previous survey, conducted during 2015-16. It can be observed that India has surpassed the 40% anaemia prevalence rate, a level at which the WHO defines a health crisis. In India, the first Anaemia Control programme was launched 1970, but an evaluation of the ICMR program conducted after 15 years demonstrated no significant reduction in the incidence of anaemia. In 2018, Ministry of Health and Family Welfare, India, implemented the "Anemia Mukt Bharat", a strategy to address this issue through a life-cycle approach with interventions like prophylactic iron-folic acid supplementation for children, adolescents, and women. But instead of all efforts, it seems that the condition is predominant in the country.

Keeping in mind the severe consequence of anaemia, the study aimed to examine the key predictors of anaemia among children aged 6–59 months in India by conducting multilevel modelling.

Data and Methods

This study utilized secondary cross-sectional data from the compiled database of fifth National Family Health Survey (NFHS-5), conducted during 2019 to 2021 under directives of the Government of India. The relevant outlier-free information of 62540 children aged 6 to 59 months, who were tested for haemoglobin concentration, were analyzed using SPSS and MLwiN software. In the study, 68% children lived in rural areas while 32 % lived in urban areas, with overall sex ratio as 916 females per 1000 males. Two-level Logit model, with child as first level and household as second level, was fitted to the observed data to assess child anaemia status in relation to different socio-economic and demographic characteristics of the study population. The model also estimated the variation of the condition across the households. Using the WHO classification criteria, a hemoglobin concentration of less than 11g/dL was used to diagnose anemia in children. Outcome variable was dichotomous child anaemia level (0=non anaemic, 1=anaemic), and the potential predictors were defined hierarchically nesting child level predictors into household level predictors (fig 1). The covariates were introduced in a phased manner starting with a random intercept null model, child level predictors and finally adding all the predictors at individual level and household level to assess the variations of the effects of child level predictors across the households. PQL-2 (Penalized Quasi Likelihood) method was used for estimation of parameters in the model [8].

Results and Discussion

The findings showed, the expected log-odds of child anaemia as 0.7083, which corresponded to a predicted probability of 0.6708 (95% CI: (0.392, 0.824]), i.e., on an average 67.07 percent of the children were anaemic (table1). The findings further showed, the rate of child anaemia varied from 27.8 percent to 75.4 percent across the households. The child level predictors, in particular, age of child, higher birth order, and iron supplements to mother in pregnancy time were significantly associated with child anaemia. Children in the age group 1-2 years were most vulnerable towards anaemia, with relative odd 1.836, as compared to those of less than 1 year. The estimates of odds clearly indicated a decreasing tendency in the risk of anaemia as age increased. This decline, observed from the 24th month onwards, is consistent with other research findings also, and this happens because of adoption of varied diets as a child grows up [9]. Gender of children in this study did not show any significant association with anaemia, though some studies suggest that male infants may have a higher risk of iron deficiency anemia [10]. The risk of anaemia increased with higher birth order number, as 1.556 times among children of birth order 5 or above. This may happen due to several factors, like short birth intervals and advanced maternal age, which can lead to depleted maternal iron stores. Moreover, higher birth order is often associated with lower socioeconomic status, which is linked to poor nutrition, limited access to healthcare, and inadequate antenatal care [11]. The household level predictors viz. place of residence, wealth index, household size, religion of household head, type of caste or tribe, parents' education, mother's age at first birth, mother's anaemia level, dietary habit of mother were significantly linked with child anaemia. Parameter estimates of wealth index showed that, as compared to the poorest, the richest people were at significantly less prone to anaemia with relative odd 0.399. Also, the risks showed decreasing tendency as the index of wealth increased. This happens because limited access to iron-rich food is linked to low income and very often explains the higher risk of anemia among children [12]. Size of household influenced on child anaemia as children belonging to a household of 8 or more members showed 1.346 times risk to anaemia as

against those in a family of 4 or less members. In the religious categories, Muslim children showed greater risk and Christians showed lesser risk of anaemia as compared to Hindus with relative odds 1.296 and 0.602 respectively. Children of ST (scheduled tribe) category were more vulnerable and those of General Category were at less vulnerable to anaemia, in reference to SC (scheduled caste), with relative odds 1.306 and 0.712 respectively. The combination of inherited conditions like sickle cell anemia and socioeconomic factors also play a vital role for such condition, and some previous studies also highlighted Caste as an independent determinant of anaemia in India [13]. Parents' education predicted child anaemia significantly, establishing that formally educated parents had lesser chance of anaemia in their children. The study showed, as compared to uneducated mother, the relative odds of child anaemia for primary, secondary and higher educated mothers were 0.856, 0.764 and 0.592 respectively. Such findings can be correlated with the fact that educated mothers are more likely to understand and implement appropriate child-feeding practices, including a diet rich in iron, vitamin A, vitamin B12, and folate [14]. Mother's anaemia had a strong association with child anaemia; the children of anaemic mothers were at 1.616 times risk of the condition as compared to those of non-anaemic mothers. An obvious reason is that mother's anemia during pregnancy leads to the fetus having insufficient iron stores. As mother's age at first birth increased, the risk of anaemia for child decreased. Some other studies also documented that mother's age at first birth is linked with the risk of child anemia as the maturity of reproductive organs decreases after the age 35 as compared to the age group 20-35 [15]. The findings further showed intake of non-vegetarian diet decreased the likelihood of child anaemia 0.812 times. The estimate of VPC (Variance Partition Coefficient) showed 28.21% of the variability in anaemia was due to the differences amongst the households. [16,17].

Conclusion

Using multilevel approach, the study provides a detailed understanding of the socio-economic and demographic determinants of child anemia in India, and also assesses the variation of the prevalence across the households. Findings show that, despite the launch of numerous anemia control programs, India's condition remains largely unchanged. The findings call for immediate and comprehensive intervention strategies to address the burden of child anemia, with special importance to rural population, maternal education, antenatal healthcare, wealth indices of households and dietary practices during pregnancy.

Conflicts of interests

There are no conflicts of interests

Figure1: Conceptual framework of variables (abbreviation) in multi-level study

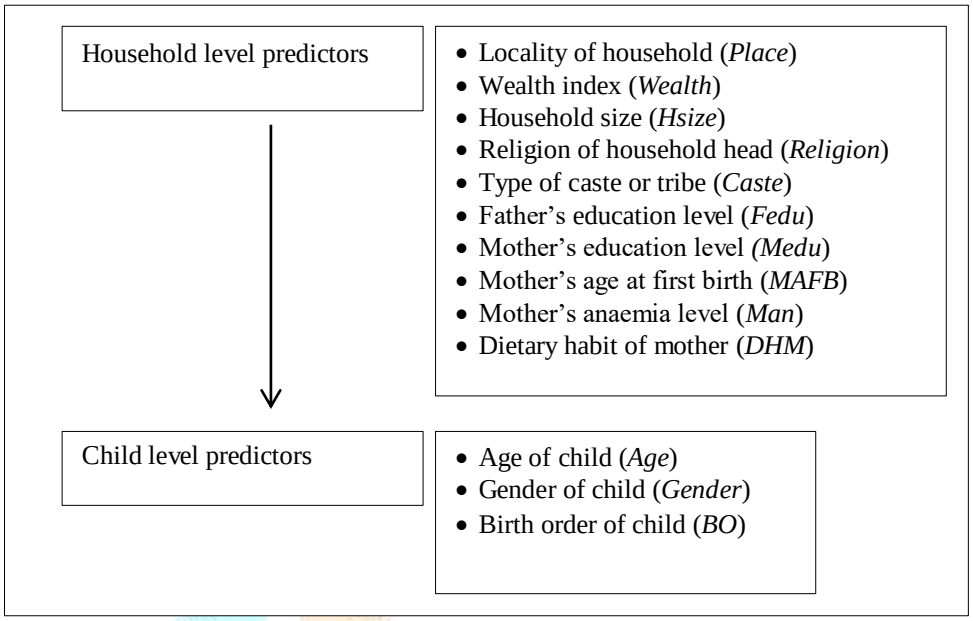

Table1: Estimates of parameters in two-level logistic regression analysis

Predictors	Intercept only model (Phase1)		Model with child level predictors (Phase2)		O.R.	Final Model with all predictors (Phase3)		O.R.
Fixed part	**Coeff (SE)**	**Z=Coeff/ SE**	**Coeff (SE)**	**Z=Coeff/ SE**		**Coeff (SE)**	**Z=Coeff/ SE**	
Intercept	0.708(0.016)							
Age		44.213						
Below 1			-		-	-		1
1-2			0.862(0.006)		2.356	0.602(0.022)	-	1.836
2-3			0.100(0.011)	142.000	1.105	-	26.862	0.803
3-4			-	9.022	0.712	0.219(0.003)	-73.000	0.467
4-5			0.340(0.018)	-18.889	0.326	-	-23.061	0.401
Gender			-	-37.367		0.761(0.033)	-8.161	
Male			1.121(0.030)		-	-		-
Female					1.152	0.914(0.112)	-	1.112
BO			-	1.831			0.955	
1 or 2			0.141(0.077)		-	-		-
3 or 4				-	1.223	0.106(0.111)		1.298
5 or above			-	10.990	1.664		12.788	1.556
			0.201(0.018)	63.625		-	27.091	
			0.509(0.008)			0.093(0.007)		
						0.376(0.013)		
Place								
Urban						-	-	-
Rural						0.084(0.007)	13.373	1.488
Wealth								
Poorest						-	-	-
Poorer						-	-4.500	0.912
Middle						0.092(0.020)	-40.75	0.722
Richer						-	-24.455	0.584
Richest						0.326(0.008)	-91.900	0.399

Hsize						-		
Up to 4						0.538(0.022)	-	-
5-7						-	1.027	1.122
8 or above						0.919(0.010)	99.000	1.346
Religion								
Hindu						-	-	-
Muslim						0.115(0.112)	10.272	1.296
Christian						0.297(0.003)	-84.500	0.602
Others							-2.163	0.646
Caste						-		
SC						0.174(0.016)	-	-
ST						-	4.618	1.306
OBC						0.507(0.006)	-1.432	0.939
Gen &						-	-9.039	0.712
Others						0.437(0.202)		
Fedu								-
No						-	-1.061	0.966
Education						0.267(0.057)	2.501	1.118
Primary						-	-19.826	0.798
Secondary						0.063(0.044)		
Higher						-	-	-
Medu						0.208(0.023)	-4.844	0.856
No							-13.450	0.764
Education						-	-87.333	0.592
Primary						-		
Secondary						0.035(0.033)		
Higher						0.018(0.007)	-1.545	0.934
MAFB						-	-11.9	0.888
Below 18						0.226(0.011)		
18-24							-	-
25 or above						-	34.286	1.616
Manaemia						-		
Non						0.155(0.032)	-	-
anaemic						-	-18.909	0.812
Anaemic						0.269(0.020)		
DHM						-		
Vegetarian						0.524(0.006)		
Non vegetarian								
						-		
						0.068(0.044)		
						-		
						0.119(0.010)		
						-		
						0.480(0.014)		
						-		
						-		
						0.208(0.011)		

|Z| > 3 indicating the significance of the estimates in the final model.

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