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An Epidemiological Model Investigating the Association between Mothers Nutritional Status and Low Birth Weight in India

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Abstract

Introduction: Low birth weight (LBW) is the dominating risk factor for infant morbidity and mortality. LBW infants were three times more likely than normal birth weight infants to have neuro developmental complications and congenital abnormalities. The World Health Organization (WHO) has defined the term Low Birth Weight (LBW) as birth weight less than 2500 grams. Objective: To develop epidemiological model investigating the association between mother's nutritional status and low birth weight in India. Data and Methods: Third round of the National Family Health Survey (NFHS-3) data collected during 2005-2006 is used for this study. This data provides a comprehensive picture of population and health conditions in India. To check the association between variables coefficient of contingency was calculated and multivariable logistic regression model was applied to check independent effect of covariates. Univariate, bivariate and multivariable logistics regression model has been developed to investigate the association between mother's nutritional status and low birth weight in India. Adjusted odds ratios were calculated with 95% confidence interval. Conclusion: The prevalence of low birth weight was observed high among those women who were underweight, anemic, never visited for any ANC checkup. Emphasis needs to be given to maternal nutritional factors which are more persistent across India than the impact of other factors on birth weight. This can be done by selectively targeting interventions to improve nutrition.

Keywords

Low Birth Weight, BMI, Anemia, ANC

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1. Introduction

Low birth weight is a strong predictor of an individual baby's survival. Infant mortality is a major public health problem in India. Low birth weight infant remains at much higher risk of mortality than the infant with normal weight at birth. Low birth weight (LBW) is the dominating risk factor for infant morbidity and mortality. LBW infants were three times more likely than normal birth weight infants to have neuro developmental complications and congenital abnormalities [1]. The prevalence of low birth weight (LBW) is higher in Asia than elsewhere, predominantly because of under nutrition of the mother prior to and during pregnancy [2]. Pregnancy outcome is worst in babies from mothers with low body mass index as compared to healthy weight mothers with respect to increased incidence of preterm birth, lower birth weight and increased neonate mortality [3].

Mothers' nutritional status is the most important determinant of newborn children's birth weight. Mothers' BMI impact was more pervasive across India than the impact of other factors on birth weight [4]. Low birth weight is a key indicator of the health trajectory of a child. In addition, to being an intrinsic endpoint, low birth weight is associated with increased risk of numerous adverse health outcomes in childhood and adulthood. Birth weight is a key variable for measuring the quality of the prenatal medical and social environment as well as predicting future individual health outcomes [5]. Low Birth Weight (LBW < 2.5 kg) has been a problem of constant worry in the world, especially in developing countries like India [6]. Low birth weight babies are more likely to have disabilities in form of developmental delay poor growth and mental disabilities. For reducing the prevalence of low birth weight, public health strategy needs to focus attention on better maternal nutrition and education [7].

Low birth weight (LBW) is a major public health problem in many developing countries, especially in India. The problem of LBW is multidimensional, and it needs an integrated approach incorporating medical, social, economical and educational measures to address issue [8]. Socio-demographic and maternal characteristics were examined and associated with the LBW [9]. The burden of low birth weight deliveries are associated with inadequate ANC service utilization and unwanted pregnancy [10]. The maternal risk factors associated with low birth weight babies. The most common causes of morbidity and mortality were found in low birth weight babies [11]. Low birth weight proportion was higher in teenage pregnancies & primiparous women [12]. Healthy diet providing before conception and throughout pregnancy had no overall effect on birth weight [13].

The major challenges in the field of public health is to identify the factors influencing low birth weight [14]. The importance of pre-pregnancy screening, early antenatal booking and proper identification of high risk-mother needs to be strengthened and enforced in effort to reduce incidence of LBW infants [15]. Thus, LBW provides a target for interventions to improve infant survival. The prevention of LBW may be an explicit part of public health policy to decrease infant mortality. In this context, it is important to understand the various factors which are associated with the LBW in India. This study thus provides a national focus and examines the relationship between a number of proximate factors and low birth weight among Indian children. In particular, we investigate the role of mothers' nutritional status measured by their body mass index in determining the birth weight of their most recent births. We also explore the variation in the effect of maternal nutritional status on birth weight among the various states in India. **Research questions:** i) Do the women with poor nutritional status (measured in terms of body mass index) are more likely to produce children of low birth weight? ii) Do the women with poor nutritional status (measured in terms of anemia) are more likely to produce children of low birth weight? **Objective of the Study:** To develop epidemiological model investigating the association between mother's nutritional status and low birth weight in India.

2. Material and Methods

Third round of the National Family Health Survey (NFHS-3) data conducted during 2005-06 was used to fullfil the objective of the study. It provides a comprehensive picture of population and health conditions in India. Birth weight was used as dependent variable "Low birth weight" means children weighted less than 2.5 kilogrammes otherwise normal birth weight. In general, lower the weight, the higher a baby's risk of death. Low birth weight is associated with poor outcomes later in life. If LBW is caused by either preterm delivery or fetal growth retardation, then LBW is presumably completely preventable. Birth weight is usually divided for analysis into "low birth weight (LBW)" and "normal" birth weight. There were four epidemiological models developed. The significant factors identified in the univariate analysis were further examined using bivariate, trivarivate and Multivariable logistic regression models to estimate the effect of nutritional indicator body mass index (BMI)

and other proximate determinants on the likelihood of having a low birth weight baby [16]. The coefficient of contingency (as suggested by Karl Pearson) was also calculated for association between low birth weight and explanatory variables.

Model-I: An univariate logistic regression model has been developed wherein birth weight category (LBW = 1 and NBW = 0) was used as outcome variable and nutritional factor body mass index (BMI = x_1) considered as predictor variable.

Equation of this epidemiological model is:

$$\log\left[p/(1-p)\right] = b_0 + b_1 x_1$$

where b_1 was the regression coefficients and $\log\left[p/(1-p)\right]$ is called log odds or logit of the event.

Model-II: A bivariate logistic regression model has been developed wherein birth weight category (LBW = 1 and NBW = 0) was used as outcome variable and BMI = x_1 and Anemia = x_2 considered as predictor variable.

Equation of the epidemiological model is:

$$\log\left[p/(1-p)\right] = b_0 + b_1 x_1 + b_2 x_2$$

where b_1, b_2, bivariate regression coefficients and $\log\left[p/(1-p)\right]$ is called log odds or logit of the event.

Model-III: In model 3, we used three explanatory variables. In terms of three maternal factors trivariate logistic regression model has developed wherein birth weight category (LBW = 1 and NBW= 0) was used as outcome variable and BMI = x_1, Anaemia = x_2 and Antenatal care = x_3 considered as predictor variable.

Equation of the epidemiological model is:

$$\log\left[p/(1-p)\right] = b_0 + b_1 x_1 + b_2 x_2 + b_3 x_3$$

where b_1, b_2, b_3 were the logistic regression coefficients and $\log\left[p/(1-p)\right]$ is called log odds or logit of the event.

Model-IV: Here a multivariable logistic regression model has been developed wherein birth weight category (LBW = 1 and NBW = 0) was used as outcome variable and x_1 (Place of residence), x_2 (Age), x_3 (Wealth index), x_4 (Education), x_5 (Religion), x_6 (Caste), x_7 (Anaemia level), x_8 (Body mass index), x_9 (Antenatal care) and x_{10} (Birth order) were considered as predictor variables.

Equation of the epidemiological model is:

$$\log\left[p/(1-p)\right] = b_0 + b_1 x_1 + b_2 x_2 + b_3 x_3 + b_4 x_4 + b_5 x_5 + b_6 x_6 + b_7 x_7 + b_8 x_8 + b_9 x_9 + b_{10} x_{10}$$

where $b_1, b_2, b_3, \cdots, b_{10}$ are the logistic regression coefficients and $\log\left[p/(1-p)\right]$ is called log odds or logit of the event.

Above models were carried out for India and its **Empowered Action Group** (EAG) states including Assam. Third round of the National Family Health Survey included a special module on nutrition [17]. The women were selected using a complex multi-stage cluster sampling approach [17]. There were two weights in the data file to adjust for oversampling of respondents by certain states and categories, one for national level analysis and the other for state level analysis [17]. All the analyses presented here used the appropriate weight. We noted that NFHS -3 was designed to make estimates at both state and national level. Details of the dependent and predictors variable are briefed in the table number one for mother factors, child factor and socio-demographic factors.

Table 1 demonstrates the picture of created dummy variable from the original variables, which was used in analysis. The selection of variable was based on their availability in the data set. The proximate factors identified as a cause of low birth weight like, mother's factor, child factor and socio-demographic factors were considered in analysis. Mothers body mass index was divided into three categories, underweight (BMI < 18.5), normal weight (18.5 to <25) and Overweight **(**25 & above) and it was considered as a nutritional indicator. Body mass index was a reliable indicator of chronic energy deficiency [18]. BMI was measured during the preconception period to examine the effect on low birth weight. In NFHS-3, survey only 34% of birth weight data was reported. Under the sub-categories of ANC visit it was found that 23% of mothers had never visited for ANC check-up. Other sub-categories of the variable is explained in **Table 1**.

Table 1. Definition and classification of variables used in the analysis.

Variables	Response categories	Percent	Description of variables
Birth Weight	Low	21.50	Low birth weight < 2500 g
	Normal	78.50	Normal birth weight ≥ 2500 g
Body Mass Index (BMI)	<18.5 kg/m^2	38.84	The body mass index (BMI) is the ratio of the weight in kilograms to the square of the height in meters (kg/m^2). Underweight is Less than 18.5 kg/m^2; Normal weight = 18.5 to <25 kg/m^2; Overweight = 25 and above kg/m^2
	18.5 to <25 kg/m^2	54.18	
	25 & above kg/m^2	6.98	
Mother's Anemia Status/level	Anemic Mother's	61.00	Iron deficiency anemia characterized by low level of haemoglobin in the blood. If the haemoglobin level is 10.9 g/dl of pregnant women= No anemia and if Hb< 10.9 g/dl = anemia. We have combined mild, moderate and severe anemia into one category.
	Not anemic Mother's	39.00	
Antenatal care during pregnancy	No ANC Visit	23.00	Antenatal care during pregnancy created as dummy variable in three groups from original variable
	1 - 2 ANC Visit	24.70	
	3+ ANC Visit	52.40	
Wealth index	Poor	47.89	Wealth index created as dummy variable in three groups from original variable. It is as Poorer + poorest = Poor, Richer + Richest = High
	Middle	19.81	
	High	32.29	
Residence	Rural	25.34	Place of residence is used original
	Urban	74.66	
Education	Uneducated	50.03	Education is also used as dummy variable. It is categories into three groups from original variable
	Educated & < Secondary	41.28	
	Secondary & Above	8.69	
Age of mother	15 - 24 age group	42.03	Age of the mother at the time of survey in completed years but it is categories in three age groups from single years age variable
	25 - 34 age group	49.37	
	35 - 49 age group	8.59	
Birth order	First order	30.30	Birth order variable is categories only five orders for analysis purpose
	Second order	27.10	
	Third order	16.20	
	Fourth order	10.20	
	Fifth & above order	16.20	
Mother caste	Schedule Caste	21.50	Caste of mother is used as original
	Schedule tribe	9.90	
	Other backward class	42.00	
	Other Caste	26.60	
Religion	Hindu	78.23	Religion of mother is used as dummy variable in three groups from original variable. Others include (Christian, Sikh, Buddhist/Neo-Buddhist, Jain, Jewish, Parsi/Zoroastrian, No-religion, Donyi polo, Other).
	Muslim	17.08	
	Others	4.69	

3. Results

Table 2 shows the percentage of the low birth weight under the sub categories of the predictor variables. The contingency coefficient was calculated for the association between low birth weight and explanatory variables. The prevalence of the low birth weight was found 22% in India. Low birth weight was found 23% in rural and 19% in urban. In respect of age, highest prevalence of the LBW was found in early age group (24%) in comparison to middle (20%) & older age group (17%). In terms of wealth index, prevalence of LBW was found highest in poor (25%) & lowest in rich (19%). In the category of education, low birth weight was found highly variable at different level of the education. Under the uneducated category LBW was found highest (26%). In religion, LBW was highest in Hindu (22%). In caste, LBW was found highest in schedule caste (24%) comparable to schedule tribe (22%) and OBC (21%). In anemia level, LBW was shown high (23%) in anemic mother in comparison to non anemic mother (21%). In BMI, LBW was varied under sub-categories of the body mass index (BMI), highest (26%) in underweight, moderate in normal weight (21%) & lowest in overweight (17%). If mothers had never visited for antenatal checkup then LBW was found highest (33%). In birth order, under the fifth and above birth order category LBW was found highest (26%) and in second birth order it was lowest (20%). Contingency of coefficients was found significant ($p < 0.05$) for all predictor variables except religion. **Figure 1** was shown for prevalence of LBW out of total reported birth weight in NFHS-3 data set.

Table 3 reveals the scenario of low birth weight for every state. In Haryana, prevalence of LBW was found highest (33%) and lowest was found in Mizoram (7%). Punjab and Bihar were shown similar prevalence low birth weight (28%). Himanchal and Uttar Pradesh were found 25% LBW. Tripura was shown 27% LBW and Maharashtra was found 22% LBW. Orissa was shown 21% LBW. Details are available in the same table.

Table 4 presents findings from logistics regression analysis using different models. In model 1, mothers' nutrition measured by their body mass index (BMI); underweight mothers were 32% more likely to have a low birth weight baby than those mothers who weighed normal. In model 2, anemic mothers were 8% more likely to have LBW than not anemic and model was shown significant impact on the likelihood of having low birth weight babies. Therefore, mothers' nutritional status was a large independent and statistically significant effect on the birth weight of newborns. In model 3, those who were not visited for antenatal checkup increased 93% more likely to have LBW than those who used the antenatal services frequently (3 or more visits). In model 4, those who never visited for any ANC checkup also increased 73% more likely to have LBW than used ANC checkup. Rural residents were 9% more likely to have LBW than urban. Early age mothers were 41% more likely to have LBW than older age mothers. Uneducated mothers were 48% more likely to have LBW than those mothers were educated up to secondary and above level. Fifth and above birth order of baby was 21% more likely to have a low birth weight than first order of the baby.

Table 5 represents the adjusted logistic regression model for empowered action group (EAG) including Assam states. The critical relevance of mothers nutritional status was emphasized by the fact that in all the EAG including Assam states mothers, who were underweight were more likely to have LBW than normal weight. Although the effect was statistically significant found in Bihar, Orissa & Assam. Mothers who were anemic were more likely to have LBW in all EAG states except UP & MP. Although the effect was statistically significant found in Orissa and Rajasthan. Mothers who had never visited for ANC checkup were more likely to have LBW than those who visited in all EAG states except Orissa and Assam (for more detail see **Table 5**).

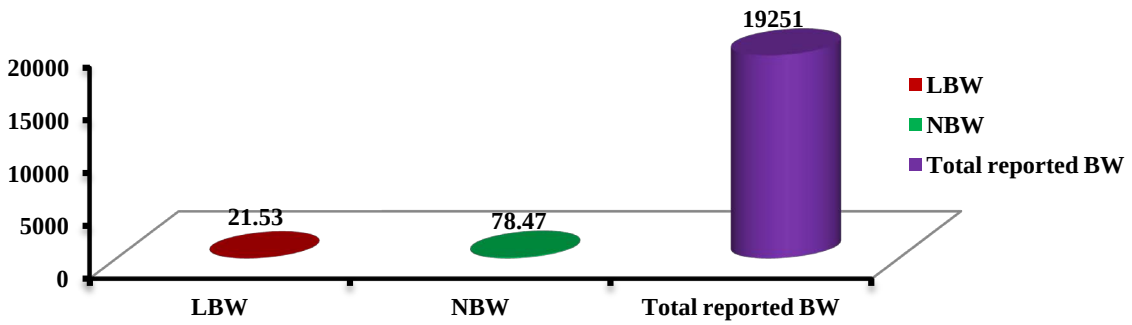

Figure 1. Prevalence of low birth weight in India.

Table 2. Shows the prevalence of the low birth weight according to different sub-categories of the background characteristics.

Predictors variable	LOW (<2500 g)	Normal (≤2500 g)	Total	*p*-value
Place of residence				0.0
Urban	19.34 (1668)	80.66 (6956)	8624	
Rural	23.32 (2478)	76.68 (8147)	10,625	
Age				0.0
15 - 24	23.99 (2021)	76.01 (6402)	8423	
25 - 34	19.91 (1960)	80.09 (7882)	9842	
35 - 49	16.79 (165)	83.21 (818)	983	
Wealth index				0.0
Poor	25.38 (1055)	74.62 (3101)	4156	
Middle	23.69 (889)	76.31 (2864)	3753	
Rich	19.42 (2202)	80.58 (9138)	11340	
Education				0.0
No Education	26.22 (1034)	73.78 (2910)	3944	
Educated &< secondary	21.95 (2483)	78.05 (8827)	11,310	
Secondary and above	15.74 (629)	84.26 (3366)	3995	
Religion				0.1
Hindu	21.84 (3351)	78.16 (11,992)	15,343	
Muslim	20.18 (529)	79.82 (2093)	2622	
Others	20.78 (267)	79.22 (1018)	1285	
Caste				0.0
Schedule caste	23.52 (784)	76.48 (2549)	3333	
Schedule tribe	23.31 (266)	76.69 (875)	1141	
Other backward class	21.25 (1578)	78.75(5845)	7423	
General Caste	20.60 (1402)	79.40 (5419)	6821	
Anemia level				0.0
Anemic	22.60 (2277)	77.40 (7776)	10,053	
Not anemic	20.73 (1670)	79.27 (6385)	8055	
BMI level				0.0
Under weight (<18.5 Kg)	25.63 (1454)	74.37 (4219)	5673	
Normal (18.5 - 24.99 Kg)	20.72 (2119)	79.28 (8108)	10,227	
Overweight (25& above)	17.18 (448)	82.82 (2159)	2607	
Antenatal care				0.0
No ANC Visit	33.00 (179)	67.00 (364)	543	
1 - 2	26.00 (461)	74.00 (1310)	1771	
3+	19.50 (2429)	80.50 (10,022)	12,451	
Birth order				0.0
1st birth order	22.30 (1912)	77.70 (6645)	8557	
2nd birth order	19.80 (1261)	80.20 (5121)	6382	
3rd birth order	21.30 (513)	78.70 (1890)	2403	
4th birth order	22.20 (226)	77.80 (793)	1019	
5th & above birth order	26.40 (234)	73.60 (654)	888	
Total	21.53 (4146)	78.47 (15,103)	19,249	

Table 3. Shows the prevalence of the low birth weight according to every state of India.

State	LOW (<2500 g)	Normal (≤2500 g)	Total
[JM] Jammu and Kashmir	19.10 (13)	80.90 (55)	68
[HP] Himachal Pradesh	24.50 (27)	75.50 (83)	110
[PJ] Punjab	27.80 (125)	72.20 (325)	450
[UC] Uttaranchal	24.20 (24)	75.80 (75)	99
[HR] Haryana	32.80 (101)	67.20 (207)	308
[DL] Delhi	26.60 (71)	73.40 (196)	267
[RJ] Rajasthan	27.40 (202)	72.60 (534)	736
[UP] Uttar Pradesh	25.20 (245)	74.80 (729)	974
[BH] Bihar	27.50 (200)	72.50 (527)	727
[SK] Sikkim	7.70 (01)	92.30 (12)	13
[AR] Arunachal Pradesh	15.80 (03)	84.20 (16)	19
[NA] Nagaland	10.00 (01)	90.00 (09)	10
[MN] Manipur	13.20 (07)	86.80 (46)	53
[MZ] Mizoram	7.10 (03)	92.90 (39)	42
[TR] Tripura	26.80 (19)	73.20 (52)	71
[MG] Meghalaya	18.00 (11)	82.00 (50)	61
[AS] Assam	19.40 (56)	80.60 (232)	288
[WB] West Bengal	22.90 (409)	77.10 (1376)	1785
[JH] Jharkhand	19.20 (61)	80.80 (256)	317
[OR] Orissa	20.50 (147)	79.50 (570)	717
[CH] Chhattisgarh	17.40 (47)	82.60 (223)	270
[MP] Madhya Pradesh	23.40 (200)	76.60 (656)	856
[GJ] Gujarat	22.00 (305)	78.00 (1081)	1386
[MH] Maharashtra	22.10 (685)	77.90 (2411)	3096
[AP] Andhra Pradesh	19.30 (381)	80.70 (1588)	1969
[KA] Karnataka	18.70 (317)	81.30 (1378)	1695
[GO] Goa	21.70 (10)	78.30 (36)	46
[KE] Kerala	16.20 (160)	83.80 (830)	990
[TN] Tamil Nadu	17.20 (315)	82.80 (1513)	1828
Total	21.53 (4146)	78.47 (15105)	19,251

Table 4. Estimated effects of the proximate factors on birth weight, India. ($p < 0.05$ and confidence intervals are given for model 4).

Predictors variable	Estimated Odds Ratio				95% C.I.	
Place of residence	Model 1	Model 2	Model 3	Model 4	Lower	Upper
Urban				1.00		
Rural				1.09	0.99	1.20
Age of Women						
15 - 24				1.41	1.13	1.74
25 - 34				1.15	0.94	1.40
35 - 49				1.00		
wealth index						

Continued

Poor				1.01	0.89	1.16
Middle				1.09	0.97	1.22
Rich				1.00		
Education of women						
No Education				1.48	1.25	1.74
Educated &< secondary				1.35	1.19	1.53
Secondary and above				1.00		
Religion of women						
Hindu				0.83	0.70	0.98
Muslim				0.75	0.60	0.93
Others				1.00		
Caste						
Schedule caste				1.05	0.92	1.19
Schedule tribe				0.93	0.77	1.12
Other backward class				0.95	0.86	1.05
General Caste				1.00		
Anemia level						
Anemic		1.08*	1.06	1.03	0.95	1.13
Not anemic		1.00	1.00	1.00		
BMI level						
Under weight (<18.5 Kg)	1.32	1.31	1.33	1.25	1.14	1.37
Normal (18.5 - 24.99 Kg)	1.00	1.00	1.00	1.00		
Overweight (25 & above)	0.79	0.78	0.81	0.93	0.81	1.07
Antenatal care						
No ANC Visit			1.93	1.73	1.42	2.11
1 - 2			1.37	1.25	1.10	1.42
3+			1.00	1.00		
Birth order						
1st birth order				1.00		
2nd birth order				0.90	0.82	0.99
3rd birth order				0.91	0.79	1.05
4th birth order				0.96	0.78	1.17
5th & above birth order				1.21	0.98	1.51
−2 log likelihood	19,283.45	18,862.95	14,132.63	13,662.49		
Model chi square	88.41	93.29	146.17	245.87		
N	20,080	19,336	14,962	14,345		

Table 5. Estimated effects (adjusted odd ratios) of the proximate determinants on birth weight by Empowered Action Group (EAG) states including Assam in India. ($^{*}p < 0.05$).

Variables	Empowered Action Group (EAG) States								
	UP	MP	Bihar	UK	CH	JH	Orissa	RJ	Assam
Anemia level									
Anemic	0.97	0.84	1.02	1.14	1.73	1.37	1.64*	1.83*	1.20
Not anemic	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
BMI level									
Under weight (<18.5 Kg)	1.39	1.36	1.65*	2.87	1.20	2.07	1.77*	1.15	2.73*
Normal (18.5 - 24.99 Kg)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Overweight (25& above)	0.47*	0.33*	0.48	0.95	1.27	0.54	1.38	0.68	1.60
Antenatal care									
No ANC Visit	1.90	1.87	1.43	4.76	2.41	2.57	0.65	1.92	0.74
1-2	1.01	0.81	1.32	1.00	1.70	0.60	0.94	1.48	0.75
3+	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Birth order									
1st birth order	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2nd birth order	0.71	0.84	1.28	1.12	0.92	0.96	0.86	0.93	0.68
3rd birth order	0.72	0.55	0.81	1.73	1.22	0.15*	0.62	1.54	0.36
4th birth order	0.23*	0.57	0.60	1.60	1.15	0.30	1.04	0.86	0.72
5th & above birth order	0.63	0.90	2.12*	0.46	0.47	0.54	1.03	1.02	1.40
−2 log likelihood	683.98	661.60	570.61	74.25	182.61	188.10	534.84	597.78	214.30
Model Chi square	27.46	15.51	28.70	4.37	6.22	17.03	14.23	18.49	11.03
N	533	787	266	214	323	235	538	327	298

4. Discussion and Conclusions

The objective of the study is to develop the epidemiological model investigating the association between mother's nutritional status and low birth weight in India. The prevalence of the low birth weight was found 22% in India. Contingency of coefficients was found significant ($p < 0.05$) for all predictors variable except religion. The most important socio-economic influences on the determination of low birth weight in India [19]. Mothers' nutrition, measured by their body mass index (BMI) have the greatest effect. Underweight mothers were more likely to have a low birth weight baby than those women who weighed normal. Anemic mothers were more likely to have LBW than not anemic and model was shown significant impact on the likelihood of having low birth weight babies. Existing evidence suggests that factors associated with underweight, obesity or overweight are very similar, information and health education programs for women are needed to help them to understand the components of a healthy diet and to ensure adequate access to health services [20].

Prevalence of LBW can be reduced by increasing the gestational age, regular antenatal checkup, balanced diet during antenatal period, adequate rest during antenatal period, and avoiding the tobacco chewing [7]. Those who did not visit for antenatal checkup were more likely to have LBW than those who visited for antenatal services. Birth weight was low in undernourished pregnant women and women were unhealthy. So health policies should aim at early detection and effective management of under nutrition to reduce the burden of Low birth weight [21]. Higher birth order babies were more likely to have a low birth weight than first ordered babies. The critical relevance of mothers nutritional status was emphasized by the fact that in all the EAG including Assam state

mothers, who were underweight were more likely to have LBW than normal weight. Literature suggests that increasing BMI and the gestational weight gain was found to have strong association with the birth weight of the newborns among the ethnic community [22].

The magnitude of the effect varies as we included other proximate determinants in the model: body mass index (BMI), antenatal care, ANC, education of mother, birth order, age of mother and other factors. All these variables had a significant impact on the likelihood of low birth weight. Across EAG including Assam states level analysis were also showed that mothers' nutritional status had more consistent relationship with low birth weight than any other sub-categories of covariate included in the analysis. For instance, underweight mothers increased the risk of low birth weight almost three times in Uttaranchal state. Other papers addressing similar issue reveals that role of mothers' nutritional status accounted for over 50% of the low birth weight babies in the developing world [23] [24].

The results of this study suggest that low birth weight is more common among those women who are underweight, compared to women with normal BMI. Further, this was found low among non-anemic mothers compared to anemic mothers. The prevalence of low birth weight can be reduced by selectively targeting interventions to improve nutritional status of mothers (BMI), their anemia level including educational status of women.

Conflict of Interest

None.

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