Mal J Nutr 17(3): 301 - 313, 2011

Prevalence and Causes of Low Birth Weight in India

Bharati P[1], Pal M[2], Bandyopadhyay M[3], Bhakta A [4], Chakraborty S[5] & Bharati P[5*]

[1] *Sociological Research Unit, Indian Statistical Institute, 203 BT Road, Kolkata 700108*
[2] *Economic Research Unit, Indian Statistical Institute, 203 BT Road, Kolkata 700108*
[3] *Department of Microbiology, RG Kar Medical College, Kolkata, West Bengal, India*
[4] *Department of Anatomy, NRS Medical College, Kolkata, West Bengal, India*
[5] *Biological Anthropology Unit, Indian Statistical Institute, 203 BT Road, Kolkata 700108*

ABSTRACT

Introduction: The aims of the study are (i) to understand inter-zone and inter-state variation of low birth weight (LBW) and (ii) to determine the key variables to reduce LBW in India. **Methods:** Using the latest National Family Health Survey (NFHS) data of 2005-06 which showed the percentage distribution of LBW infants, ANOVA and post-hoc test were performed to determine the spatial variation of birth weight. The covariates which influence LBW fell into three categories: (i) social variables which included location, mother's education, religion, access of mothers to newspapers, television and family structure; (ii) economic variable namely, the wealth index, and (iii) biological variables which consisted of sex of the children, birth order, and mother's body mass index (BMI). Three models of Logistic regression were carried out to examine the influence of the combinations of these direct and indirect factors. **Results:** In India, nearly 20% of new borns have LBW. Males have less frequency of LBW than females. The North-east zone has the lowest prevalence of LBW while the north zone has the highest. Mother's education, access to TV and nuclear family, and intake of iron tablets are the most important socio-economic influences on the determination of birth weight in India. **Conclusion:** It is essential to provide proper diet and nutritional care of mothers during pregnancy. Increased education of mothers through programmes in TV and newspapers articles have significant roles to play in reducing LBW in India.

Keywords: ANOVA, India, logistic regression, low birth weight, socioeconomic factors

INTRODUCTION

Birth weight of babies needs special attention as it is one of the major determinants of the future health of the babies. If the weight of the new born baby recorded just after birth is less than 2,500 gm irrespective of the gestational age, then the baby is considered as a low birth weight (LBW) baby (WHO, 1992). Low birth weight may be due to maternal malnutrition, poor antenatal care or socio-economic conditions of the family (Bamji, 1993). Babies with birth weight ranging from 1500 gm to 2500 gm are 20 times more prone to neonatal mortality than babies with normal birth weight, that is, with a weight of 2500 gm or more (UNICEF 2004). Babies with a birth weight of less than 1500 gm, which may be termed as Very Low Birth Weight (VLBW) are 200

* Correspondence author: Prof Dr Premananda Bharati; Email: *bharati@isical.ac.in; pbharati@gmail.com*

times more prone to neonatal death than normal birth weight babies (Dalavong, 2004).

In developing countries, a large number (58.0%) of birth weights remain unnoticed (UNICEF, 2004). In South Asia, 74% and in Sub-Saharan Africa, 65% of birth weights are not recorded because many deliveries occur at home or in small unregistered health units and this may result in a biased estimation of prevalence of low birth weight, unless the non-reported cases are not due to low or high birth weights. However, there is a possibility that there are more low birth weight babies in the unreported cases due to the fact that most of the families who resort to home deliveries are likely to be poor and cannot afford to go to the hospitals or nursing homes. Latin American and Caribbean countries, where 83% of birth weights are recorded, are in a better position in this respect than Europe, where recorded birth weight stand at 79% (UNICEF, 2004). In India, during the 1990s, unrecorded birth weight was 71% (UNICEF, 2004). The data collected by International Institute for Population Sciences (IIPS) are free from this bias as the sampling units are households and not records taken from hospitals, nursing homes etc.

The last decade saw increased incidence of LBW or VLBW in many developed countries (Branum & Schoendorf, 2002; Kramer *et al*., 2005). More than half of the LBW are born in South Asia. Bangladesh has the highest prevalence at 50% (Branum & Schoendorf, 2002; Kramer *et al*., 2005) with India having the second highest prevalence, at 33% (Sachdev, 1997). To measure variation of low birth weight in India by state, the Child Survival and Safe Motherhood Programme (CSSM) worked on district-based data in 14 states and estimated that the states with the lowest and the highest prevalence in India are Madhya Pradesh and Orissa respectively. However, it must be stated that this data do not match with any national level data in India.

Low birth weight may be due to low maternal malnutrition, poor antenatal care or socio-economic conditions of the family as well as of the community. There are interstate and rural-urban variations of these factors with interstate variation being very pertinent in countries like India (Bhargava *et al*., 1985). In India, this disparity ranges from 10% to 56% depending on the socio-economic groups which cover a range from rich families to urban slum dwellers (Bhargava *et al*., 1985). The direct factors of low birth weight are inadequate intra-uterine growth and sub-normal duration of gestation period. In India, nearly one third of low birth weight is due to ill-development during intra-uterine growth.

Birth weight is dependent on several direct or indirect factors including socio-economic conditions of the family. Maternal malnutrition is one of the causal factors for low birth weight babies (Ramachandran, 2000). The low birth weight babies of poor economic groups continue to grow and develop during their childhood in the same sub-optimal conditions with low diets and sometimes as child labour and this leads to future low birth weight babies. Studies show that low maternal weight is responsible for a three-fold higher number of low birth weight babies; smoking among mothers also increases the risk of low birth weight (Kramer, 1987). Among Indian mothers, low body mass index (i.e., chronic energy deficiency (CED)) is three times more responsible for low birth weight compared to normal body mass index (WHO, 1995). Education, mainly maternal education and income has a positive impact on LBW (Sachdev, 2001). Many biological factors like sex and parity of the child have differential impact on birth weight (Defo & Partin, 1993). The causes of low birth weight are therefore a combination of many factors. Also, genetic, placental, foetal and other maternal factors should not be ignored (UNICEF, 2004).

In this analysis, we have used the data from the latest National Family Health Survey (NFHS) of 2005-06, that is, NFHS-3, to understand (i) the inter-zone and interstate variation of percentage distribution of low birth weight in India as

well as its differences by gender and (ii) to determine the key variables in reducing low birth weight in India.

METHODS

Data source

The problem of determining the reasons of low birth weight in India is very complicated as it is dependent on biology and socio-economic conditions of the mother at the time of birth of the baby. The problem becomes more severe due to non-sampling errors like non-reported cases. After 1990s, a more systematic search was initiated when the first set of national level data was made available to the public. The first National Family Health Survey (NFHS-1) data of 1992-93 provides large data sets of recorded birth weights by regions, social classes and other categories.

The National Family Health Survey (NFHS–3, 2005-06) (IIPS, 2007), conducted by the International Institute for Population Sciences (IIPS), Mumbai, is the third series of a nationally important source of data on population, health and nutrition for India that was designed to provide estimates of indicators of family welfare, maternal & child health, and nutrition. The sample size was 17,117 reproductive aged women (15 – 49) years who had at least one live birth in the last five years preceding the survey. Among these live births, only the last birth has been considered. A child whose birth weight is less than 2500 gm irrespective of its gestational age is considered as a low birth weight baby (WHO, 1992). In the NFHS-3, data on birth weight was collected through a questionnaire or from a recorded health card or as stated by mothers. The question was, 'Was (baby) weighed at birth'? And if the answer was 'yes', the next question was 'How much did the baby weigh?' Such birth weight was recorded for births in the five years preceding the survey through the questionnaire.

In this survey, independent variables were divided into two categories: (i) indirect factors, and (ii) direct factors. Indirect factors are those factors which have an indirect effect on birth weight such as socio-economic variables including rural / urban sectors, mother's educational status and religion. Mother's educational status was grouped into four categories :(i) illiterate (those who can neither read nor write), (ii) primary (literate up to class IV standard), (iii) secondary (class V to class X standard), and (iv) being class XI and onwards (i.e. Higher Secondary, Graduate or Post graduate etc). Religion has been categorised into four groups - Hindus, Muslims, Christians and 'Others'; the latter included all other religious groups like Sikhs, Buddhists, Jains, Parsees, Jewish and Donyipolo and others. Other influential factors were access to newspaper & TV, family type (either nuclear or joint families) and the wealth index.

The wealth index is a measure of the economic status of the household. Though it is an indicator of the level of the wealth in the household, it is consistent with expenditure and the income measure. It is based on 33 household assets and housing characteristics. It was computed and provided in the NFHS-3 data. In this survey, each household asset was assigned a weight generated through principal component analysis and the resulting score was standardised in relation to a normal distribution and each household was assigned a score for each asset; the scores were summed for each household and individuals were ranked according to the score of the household where they resided and the total sample number was divided into five quintiles from lower strata to higher strata, that is, poorest, poorer, medium, higher and highest (IIPS, 2007).

Place of delivery is an important factor so far as risk of mother and child during delivery are concerned. All the variables regarding place of delivery have been

condensed into five categories: (i) Home (own home, parent's home and other home); (ii) Public (Government or Municipal Hospital, Government dispensaries, rural hospital, primary health centre, sub-centre and other public hospitals), (iii) Private place (private hospital, or maternity clinic and other private medical places), (iv) NGO or trust hospital or clinic, and (v) Others.

Direct factors are the biological variables like sex of the children, birth order, mother's nutritional status (post-partum data), mother's weight (post-partum data) which is divided into two categories (i) 'below 40 kg' and '40 kg & above' and (ii) diabetic condition of mother (post-partum data) and intake of iron tablets during pregnancy. Mother's nutritional status is divided into three categories: (i) underweight (<18.5), (ii) normal (18.5 – 24.9), and (iii) overweight or obese (≥25.0), depending on the body mass index (BMI). The value of BMI is calculated for each subject by weight (kg) / height $(m)^2$.

Data analysis

In this analysis, percentage distribution of low birth weight by state and zone were obtained to determine the spatial variation of low birth weight babies in India. The *p*-values of the chi-square tests of the contingency tables of number of low and normal birth weights *vis-à-vis* the explanatory variables were worked out to see if the effects of the concerned variables on the number of low births were statistically significant. Means and standard deviations (SD) of live births were also calculated. ANOVA was performed to see within and between group variations. Subsequently, post-hoc tests were applied on mean birth weights in different states and zones to indicate whether the differences between the pair of means were significant or otherwise.

On the basis of the chi-square tests of the contingency tables of socio-economic variables, those variables which affect low birth weights most were first determined and then binary categorical logistic regression models were fitted, taking the value of low birth weight as '1' and otherwise as '0'. The Statistical Package for the Social Sciences (SPSS, version 12.0) was used for the analysis.

Limitations of the data

Data on some biological determinants like mother's nutritional status, mother's weight and 'suffers from diabetes' were post-partum data. Such data are not usually sufficient to determine actual effect on birth weight.

It is also necessary to mention that 60% of the recorded birth weights as covered in NFHS-3 were of urban children while only 25% were of rural children. According to NFHS-3 data, low birth weight children in India account for 22 % of the recorded births while in our analysis, it is 20 %. The reason for this difference is that we have not taken the entire data set provided by NFHS-3. In order to determine the relationship of low birth weight with the associated variables, we had to see simultaneous conformity of the data. If an outlying observation was detected for any of these variables, then all variables corresponding to the unit were deleted. Besides, from the many files of the NFHS-3 data, we have only considered here the IAKR files of NFHS-3 which only contains data on women and the last child.

RESULTS

In India, out of a total of 17,117 single live births, 19.73% were low birth weight infants (Table 1). The least prevalent low birth weight zone was seen to be the north-east zone (Figure 1). The highest percentage of LBW babies was found in the North zone (26.60). This was also true for male and female babies when considered separately. From the table, it can also be seen that low birth weight female babies are significantly higher than male babies.

Table 1 gives the percentage distribution of low birth weight babies in the states of India. The highest mean weight was seen in

Table 1. Percentage distribution of low birth weight (LBW) babies in different zones and states of India

Zones and States	*Percentage of low birth weight*					
	Male		*Female*		*Total*	
	N	*%*	*N*	*%*	*N*	*%*
North-east	1510	12.65	1460	14.73	2970	13.67
Arunachal Pradesh	102	12.7	115	14.8	217	13.8
Assam	159	20.1	148	20.3	307	20.2
Manipur	408	12.0	391	11.8	799	11.9
Meghalaya	135	17.0	117	23.9	252	20.2
Mizoram	307	5.5	320	7.8	627	6.7
Nagaland	117	14.5	105	12.4	222	13.5
Sikkim	154	7.1	133	12.8	287	9.8
Tripura	128	22.7	131	29.8	259	26.3
East	1196	20.73	1080	21.67	2276	21.17
Bihar	168	24.4	153	22.2	321	23.4
Jharkhand	144	22.9	135	17.0	279	20.1
Orissa	326	17.2	306	20.9	632	19.0
West Bengal	558	21.1	486	23.3	1044	22.1
Central	1043	21.47	892	24.9	1935	23.04
Chhatrisgarh	193	15.5	187	17.6	380	16.6
Madhya Pradesh	506	21.7	386	25.9	892	23.5
Uttar Pradesh	344	24.4	319	27.9	663	26.1
West	1675	20.59	1434	23.84	3109	22.09
Goa	345	20.0	328	25.9	673	22.9
Gujarat	409	20.0	339	24.5	748	22.1
Maharashtra	921	21.1	767	22.7	1688	21.8
North	1339	25.99	1029	27.40	2368	26.60
Haryana	190	33.2	136	33.8	326	33.4
Himachal Pradesh	237	22.8	191	29.3	428	25.7
Jammu & Kashmir	101	17.8	60	21.7	161	19.3
New Delhi	178	26.4	163	28.2	341	27.3
Punjab	280	27.1	183	25.1	463	26.3
Rajasthan	212	26.4	170	28.2	382	27.2
Uttaranchal	141	24.1	126	21.4	267	22.8
South	2354	14.31	2105	18.48	4459	16.28
Andhra Pradesh	698	13.8	623	17.7	1321	15.6
Karnataka	491	16.1	429	18.9	920	17.4
Kerala	456	13.8	419	18.4	875	16.0
Tamil nadu	709	14.0	634	19.1	1343	16.4
India	9117	18.57	8000	21.05	17117	19.73
Chi-square value (All states)	181.70 $p<0.001$ df = 28		142.75 $p<0.001$ df = 28		181.79 $p<0.001$ df = 28	

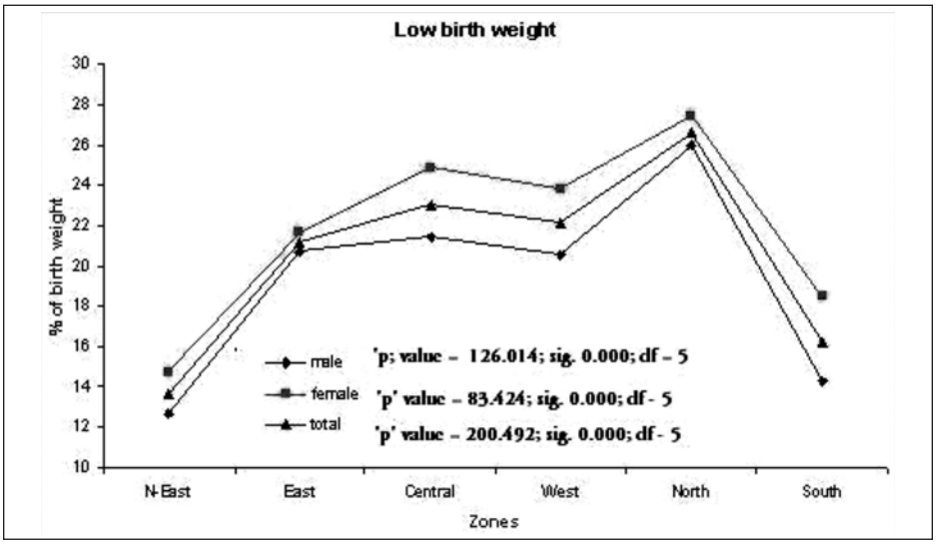

Figure 1. Percentage distribution of low birth weight babies in different zones of India by gender

the North-east zone followed by the south zone and the lowest mean birth weight was seen in the North zone for all children and also for male and female births (not presented in tabular form). The results of ANOVA (not shown in the table) on distribution of birth weight of all live births by zone show that inter-state variation is significantly higher than intra-state variation of birth weight for all babies as well as for male and female babies.

Analysis of the selected independent socio-biological variables with low birth weight babies (Table 2) indicates that the statistically significant variables are type of place, mother's education, religion, influence of mass media (newspaper & TV), wealth index of the family, mother's nutritional status and weight (below 40 kg), sex of the child and iron intake during pregnancy. A sharp decreasing trend of low birth weight babies was noticed among mothers in relation to very selective variables such as higher education, being Christian, having access to newspaper & TV, residing in a household with the highest category of wealth index, enjoying better nutritional status and possessing good weight (above 40kg) and regular intake of iron during pregnancy. These findings are statistically significant at 1 % level.

Further analysis through post-hoc tests to understand the nature of differences in mean birth weights of babies between different zones show that the north-east zone has the distinction of having significantly higher mean birth weight along with the south zone compared to other zones in India for both male and female births (not presented in tabular form). In addition to the North-east and South zones, the North zone holds the distinction of having the lowest mean birth weight. The mean birth weight of male/female children of Manipur, Mizoram and Nagaland are significantly higher than those of other states of India. Arunachal Pradesh also has a significantly higher mean birth weight than Madhya Pradesh, Haryana, Punjab and Rajasthan. Mizoram is the state where the mean birth weight is significantly higher than other states in respect of both male and female live births.

To see the effect of different factors on birth weight, three models of binary logistic regressions (Table 3) were fitted to gain a

Table 2. Relationship between percentage of low and normal birth weight with socio-biological variables

Variables	N	Low (<1500-2500)	Normal (2500-4000+)	Chi-square *p* value
Place of residence				14.711; p <0.001;
Rural	7612	21.0	79.0	df = 1
Urban	9505	18.7	81.3	
Mother's education				116.452; sig. p<0.001;
Illiterate	2680	24.8	75.2	df = 3
Primary	2121	23.8	76.2	
Secondary	9517	18.9	81.1	
Higher	2799	14.6	85.4	
Religion				75.393; sig. p<0.001;
Hindu	12285	20.9	79.1	df = 3
Muslim	2227	19.8	80.2	
Christian	1685	12.0	88.0	
Others	907	18.0	82.0	
Access to newspaper				87.795; sig. p<0.001;
No	7159	23.1	76.9	df = 1
Yes	9953	17.3	82.7	
Access to TV				50.778; sig. p<0.001;
No	2512	25.0	75.0	df = 1
Yes	14601	18.8	81.2	
Family type				2.156; sig. p = 0.146;
Joint	10384	20.1	79.9	df = 1
Nuclear	6733	19.2	80.8	
Wealth Index				93.598; *p <0.001;*
Poorest	889	25.4	74.6	df = 4
Poorer	1527	24.3	75.7	
Medium	2963	22.5	77.5	
Higher	4943	19.8	80.2	
Highest	6795	16.7	83.3	
Place of delivery				8.825; sig. p = 0.066;
Home	1931	21.6	78.4	df = 4
Public	7868	19.9	80.1	
Private	7038	19.1	80.9	
NGO/Trust	265	15.8	84.2	
Others	15	20.0	80.0	
Sex of the children				16.552; p <0.001;
Girl	8000	21.1	79.0	df = 1
Boy	9117	18.6	81.4	
Birth order				2.357; sig. p = 0.502;
1	7575	20.2	79.8	df = 3
2	5665	19.2	80.8	
3	2216	19.2	80.8	
4+	1661	20.2	79.8	
Mother's BMI				118.535; p <0.001;
Underweight	4326	25.1	74.9	df = 2
Normal	9803	18.5	81.5	
Overweight & obese	2899	15.6	84.4	

Table 2. From previous page

Mother's weight (post partum)				118.535; p <0.001; df = 2
<40 kg.	2643	28.1	71.9	
40 kg	14394	18.2	81.8	
Suffers from diabetes				138.518; p <0.001;
No	17012	19.7	80.3	df = 1
Yes	99	22.2	77.8	
Taking iron tablet during pregnancy				33.148; p <0.001; df = 1
No	1907	24.2	75.8	
Yes	11596	18.6	81.4	

more comprehensive understanding of the relationship between dependent and independent variables. The dependent variable of birth weight takes the binary variable value '1' for low birth weight babies, while the independent variables are divided into two groups such as socio-economic variables or indirect factors, which are thought to influence birth weight indirectly and biological variables or direct factors, which influence birth weight directly. Models 1 and 2 show the effects of the indirect and direct factors separately on birth weight whereas Model 3 shows the effects of all factors on birth weight. Results are presented using the odds ratio (OR). In model 1 of Table 3, it is observed that among the secondary and higher educated mothers, the odds ratios of low birth weight are lower than illiterate and primary educated mother (OR = 0.857, and OR = 0.670, significant at 1 % level). Proportion of low birth weight children is significantly lower among the Christians compared to Hindus, Muslims and others, though the Muslims and Others have a significantly lower odds ratio than Hindus. Mothers who have access to newspaper & TV have a significantly lower percentage of low birth weight compared to those with no such access. In relation to family type and wealth index, it is seen that the occurrence of low birth weight in the nuclear families is lower than in the non-nuclear families and this is significant at 1 % level. In the case of wealth index, only the highest group has a significantly lower percentage of birth weight children compared to other groups.

Model 2 represents the impact of biological factors on low birth weight. Male children have significantly lower odds of being low birth weight in Models 2 & 3 (OR = 0.815, and OR = 0.809, significant at 1 % level) compared to female children. The data also indicate that birth weight is significantly positively related with birth order (3rd birth order) of children in the family, mother's nutritional status and intake of iron tablets during pregnancy.

Model 3 shows the impact of socio-economic status as well as biological factors on low birth weight. In other words all the variables considered in Models 1 and 2, have also being considered in Model 3. The results are similar to those of Models 1 & 2. It is seen from the three models that the most important socio-economic factors are mother's education at secondary and above, access to TV, nuclear family, 3rd birth order and intake of iron tablets during pregnancy.

DISCUSSION

Our analysis of the NFHS-3(2005-06) data indicates that almost 20% new born babies have low birth weight. Gender differences also exist in the occurrence of low birth weight and mean birth weight with mean

Table 3. The odd ratios of logistic regression of low birth weight on direct and indirect factors

Variables	*Model 1*	*Model 2*	*Model 3*
Place of residence			
Rural®	1.042		1.002
Urban			
Mother's education			
Illiterate®			
Primary	1.033		1.068
Secondary	0.857**		0.833**
Higher	0.670**		0.650**
Religion			
Hindu®			
Muslim	0.896*		0.944
Christian	0.550**		0.564**
Others	0.860*		0.929
Access to newspaper			
No®			
Yes	0.897**		0.910
Access to TV			
No®			
Yes	0.864**		0.871**
Family type			
Joint®			
Nuclear	0.885**		0.888**
Wealth Index			
Poorest®			
Poorer	1.003		1.049
Medium	1.004		1.091
Higher	0.906		1.037
Highest	0.801**		0.970
Place of delivery			
Home®			
Public	1.001		0.964
Private	1.077		1.052
NGO/Trust	0.850**		0.789**
Others	0.927		0.300**
Sex of the children			
Girl®			
Boy		0.815**	0.809**
Birth order			
1®			
2		0.938	0.934
3		0.832**	0.836**
4+		0.839**	0.847**
Mother's BMI (post partum)			
Underweight®			
Normal		0.728**	0.873**
Overweight & obese		0.663**	0.795**

Continued on next page

Table 3. From previous page

Mother's weight (post partum)		
<40 kg. ®		
40 kg	674**	0.718**
Suffers from diabetes (post partum)		
No ®		
Yes	1.335**	1.463**
Taking iron tablet during pregnancy (post partum)		
No ®		
Yes	0.736**	0.761**

BW <2500 gm = 1, ® Reference group; *p<0.05, **p<0.01.

birth weight of male babies being higher than female babies. According to UNICEF the proportion of low birth weight was 30% in 1991, increasing to 33 % in 1995, but decreasing to 26% from 1995 to 2000 (UNDP, 2002). It is seen from comparative zonal differences that the North-east zone has the least prevalence of low birth weight. In the North-east zone, states with below 10 % occurrence of LBW babies are Mizoram and Sikkim. The probable reason for the low occurrence of LBW in North-east India may be that the proportions of working and self-employed women are very high in North-east India compared to other regions and the tribal societies are usually matriarchal and thus it is believed that women have more autonomy here than in other states. In Mizoram, literacy rates are high with female literacy rate being very high. The literacy gap between male and female is the lowest in Mizoram and Meghalaya. The beneficiaries of Integrated Child Development Services(ICDS) are the highest in Manipur, Mizoram, Nagaland and Sikkim which provide more options for iron supplementation and antenatal care. Poverty rates in Assam and the North-eastern states have declined more sharply compared to other states (Singh, 2006).

This study shows that the highest percentages of LBW babies are found in the North zone (26.60%) for all babies and also for male and female babies. In India, nearly 50% of the states have more than 20-30% of babies with LBW. Inter-state variation also shows that the highest rate of KBW babies are found in Haryana, followed by New Delhi, Punjab, Rajasthan, Uttar Pradesh, Tripura and Himachal Pradesh. Among these states, Haryana, Punjab, Delhi and Himachal Pradesh are not economically poor and Punjab is the major contributor to agricultural production in India (UNICEF, 1997). Probably, females in these states are possibly not aware of health care during pregnancy as available data on dietary consumption among 1-18 years old show that females consume much less than males (NNMB, 1980). These findings support the view that economic growth does not resolve such problems and what is important is to have overall development which includes a reduction in gender disparity and deprivation.

In the present study, bivariate analysis shows that both socio-economic and biological factors influence the birth weight of a new born baby. Prominent associated variables that were found to have an effect on the reduction of low birth weight babies are higher education of mother, being Christian, access to newspapers &TV in the household, households in the highest category of wealth index, better nutritional status and good weight (above 40kg) of

mother and intake of iron during pregnancy. It is seen from our study that male babies have a lesser frequency of low birth than female babies which supports the view of Defo & Partin (1993). Association of higher education of mother with the decreasing trend of LBW in our study also supports the findings of another study (Karim & Mascie-Taylor, 1997). From our study, it is seen that Kerala has a LBW of 16.0%. But in Kerala, nearly all deliveries occur in hospitals which provide essential intra-partum and neonatal care. Besides, literacy rate, mainly female literacy is very high in Kerala (Census of India, 2001). So the reason for this high rate in our results is not clear.

Different models of logistic regression support the same view as found in the combined model. The combined model of our study clearly shows that mothers' education and age during child birth, living in a nuclear family, awareness of mothers through newspapers & TV and iron tablet supplementation during pregnancy are the most influencial factors towards a reduction in LBW. Prevention of mothers' anaemia through supplementation of iron tablet during pregnancy has already been established (Steer, 2000).

The findings from our study support the view that the main cause of LBW in developing countries is intrauterine growth retardation. About 17 million infants are born with low birth weight in developing countries (Pojda & Laura, 2000). The factors behind this are socio-economic conditions of the family, antenatal care, nutritional status and health status of mothers and health care of mothers during pregnancy. Due to poor diet, low antenatal check-ups and heavy work activity during pregnancy, women deliver low birth weight babies and these babies grow up to be future mothers with the chances of having low birth weight babies being very high (UNICEF, 2004). It has been found that more than 30% of babies are born with low birth weight in South Asia compared to 15% in Africa (Ramalingaswami, Jonson & Roude,1997) where the GDPs are much lower than in most Asian countries. The term 'South Asian enigma' (Ramalingaswami *et al*., 1997) states that the lower status and less decision making power of women especially in India limits women's ability to access the resources needed for their child's health and nutrition which is strongly associated with low birth weight. Adolescent delivery is also responsible for low birth weight in India though it has a great inter-state variation. About one-quarter of the babies conceived or delivered in West Bengal and Bihar is from adolescent girls (Ramchandran, 2007).

Urbanisation is another development indicator. In the context of urban populations in different states, Delhi and Mizoram are mostly urbanised. In Maharastra, Tamilnadu, Gujarat, Punjab and Karnataka, more than 35% of the population live in urban areas. On the other hand, only 10% of the population in Himachal Pradesh, Bihar, Assam and Orissa constitute urban (Report of the Technical group on Population Projections, 2004). Urban areas have greater access to health services, safe drinking water and sanitation facilities. There is also a large gap between health facilities in rural and urban areas. The differences in the health facilities are expected to have a greater impact on the health status of women during pregnancy which ultimately leads to more LBW babies.

In conclusion, this study shows that mother's higher education, access to health education and increased awareness of women's status are conducive to a reduction in low birth weight babies. However, the process of eradication of low birth weight is very slow as it is strongly affected by regional factors including local religious beliefs, cultural traditions and other factors, the understanding of which needs in-depth studies.

REFERENCES

Bamji MS (2003). Early nutrition and health - Indian perspective. *Current Sci* 85: 1137-1142.

Bhargava SK, Iyer PU, Dutta V, Nafde S, Ramji S & Sachdev HPS (1985). Perspective in low birth weight- survival and outcome. Proceedings III, IV and V Annual Convention of National Neonatology Forum, Indore, Naidunia Printery, pp. 44-52.

Branum AM & Schoendorf KC (2002). Changing patterns of low birth weight and preterm birth in the United States, 1981-98. *Paediat Perinatology Epidemil* 16: 8-15.

Census of India (2001). Final Population Totals. Registrar General and Census Commissioner, Controller of Publications, New Delhi, India.

Dalavong C (2004). Determinants of Low Birth Weight among Laoloum Infants in LaoPDR. Faculty of Graduate Studies, Mahidol University, Thailand.

Defo BK & Partin, M (1993). Determinants of low birth weight: A comparative study. *J Biosoc Sci* 25: 87-100.

International Institute for Population Sciences (IIPS) and ORC Macro (2007). National Family Health Survey (NFHS-3), 2005-06, Vol. 1: India, Mumbai, IIPS.

Karim E & Mascie-Taylor CG (1997). The association between birthweight, socio-demographic variables and maternal anthropometry in an urban sample from Dhaka, Bangladesh. *Ann Hum Biol* 24: 387-401.

Kramer MS, Barros FC, Demissie K, Shiliang L & Kiely JKS (2005). Does reducing infant mortality depend on preventing low birth weight? An analysis of temporal trends in the Americas. *Paediat Perinatology Epidemiol* 19: 445-451.

Kramer MS (1987). Determinants of low birth weight: methodological assessment and meta-analysis. *Bull WHO* 65: 663-737.

National Institute Monitoring Bureau (NNMB) (1980). Survey on the Status (1975-80). National Institute Monitoring Bureau, Hyderabad.

Pojda J & Laura K (2000). Low birth weight. ACC / SCN Nutrition Policy Paper No. 18, Geneva, World Health Organization.

Ramchandran P (2007). Nutrition transition in India,1947-2007. Nutrition Foundation of India, New Delhi, India.

Ramachandran U (2000). A review of low birth weight. *J Nepal Med Assoc* 39: 377-381.

Ramalingaswami V, Jonson U & Roude J (1997). The Asian Enigma. In: *The Progress of Nations*. UNICEF, New York.

Report of the Technical group on population projections (2004). Population Projection for India and States 2001-2026. RGI, New Delhi, India

Sachdev HPS (1997). Low birth weight in South Asia, In: *Malnutrition in South Asia: A Regional Profile*, ed. Gillepsie, S. UNICEF Regional Office for South Asia, pp: 23-50.

Sachdev, HPS. (2001). Low birth weight in South Asia: *Int J Diab Dev Countries*. 21:13-31.

Singh MK (2006). BPL population up in Delhi, Maharastra and Haryana. *The Times of India*, 19 October, 2011

Steer PJ (2000). Maternal haemoglobin concentration and birth weight. *Am J Clin Nutr* 71 (Suppl): S1285-S1287.

UNDP (2002). Human Development Report. Deepening Democracy in a Fragmented World. Oxford University Press, Oxford, UK.

United Nations Children's Fund (UNICEF) (1997). The Progress of Nations. New York, United Nations Children's Fund.

United Nations Children's Fund and the World Health Organization (2004). Low Birth Weight: Country, Regional and Global Estimates. New York and Geneva, UNICEF and WHO.

World Health Organization (WHO) (1992). Low Birth Weight: A Tabulation of Variable Information. Geneva, World Health Organization.

World Health Organization (WHO) (1995). Maternal anthropometry and pregnancy outcomes: A WHO collaborative study. *Bull WHO* 73: 1-98.