Mal J Nutr 10(2): 159-171, 2004

Effect of Socio-economic and Biological Variables on Birth Weight in Madhya Pradesh, India

Som S[1], Pal M[1], Adak DK[2], Gharami AK[3], Bharati S[1] & Bharati P[1]

1 *Indian Statistical Institute, Kolkata, West Bengal*
2 *Anthropological Survey of India, Field Station, Sagar, Madhya Pradesh*
3 *Dr. Harising Gour University, Sagar, Madhya Pradesh*

ABSTRACT

A study on a few selected socio-biological and demographic determinants of birth weight was conducted at a hospital in Sagar town, Madhya Pradesh. Records of 2,680 single live births over a period of one year (1st January to 31st December 2000) were analysed. It was found that male infants were 124 g heavier than female infants. Tabular representation of data showed that maternal age, education, ethnicity, father's income and occupation, infant's sex and parity were strongly associated with birth weight of infants. Regression analysis gave a comprehensive picture of such associations and confirmed the above findings. The study showed that the socio-economic and biological variables considered in the analysis have significant effect on birth weight.

INTRODUCTION

Birth weight is a very important and potent indicator for both mortality and morbidity of the neonate. Low birth weight (LBW) is a major factor contributing towards high infant mortality in developing countries. The proportion of babies with low birth weight reflects the socio-economic development of any region or country (Murthy 1991). Low birth weight is a major public health problem in India, like other developing countries. Asia has the lowest mean birth weight in the world (about 2,900 g). India's mean birth weight ranges from about 2,700-2,800 g, which is lower than the mean birth weight in Asia. It is therefore important to understand the possible factors that influence birth weight, more specifically low birth weight. The World Health Organization (WHO) has defined low birth weight as baby's weight less than 2,500 g at birth, irrespective of their gestational age (WHO 1992).

The birth weight of a newborn depends on the maternal nutritional status both before and during pregnancy. Ramachandran (2000) in his review described maternal nutrition as the most important determinant of LBW in developing countries. It is quite common that in India, maternal malnutrition is caused by poverty as well as by the gender bias in food distribution within the family. In fact, a child's future health begins with the mother's nutritional status in pregnancy. Low birth weight occurs because of poor maternal health and nutrition, and poor foetal growth. A mother, chronically undernourished from youth, will likely give birth to an underweight baby, perpetuating the intergenerational cycle.

Recent studies have found some significant differences in birth weight among different social and economic groups; the more disadvantaged groups experiencing lower mean birth weights (Dickute *et al*., 2004; Radhakrishnan *et al*., 2000; Tuntiseranee *et al*., 1999; Ebomoyi, Adetoro & Wickremasinghe 1991). Birth weight of the newborn is believed to be influenced by a number of factors. The maternal age and parity have a significant effect on birth weight, as shown by Dhall & Bagga (1995). Along with maternal age and parity, number of antenatal visits has independent effects on birth weight even when the effects of gestational age and sex of infant were eliminated (Xu *et al*., 1995). Better antenatal care with special attention to primis and elderly women (>=35) also reduces the incidence of low birth weight babies (Nair *et al*., 2000). Mondol (2000) showed that socio-cultural variables like maternal education, hard manual labour, and place of residence have significant effects on birth weight. Biological factors like sex and parity of the baby also show differential impact on birth weight (Defo & Partin 1993). The causes of low birth weight are therefore multifactoral involving genetic, placental, foetal and maternal factors (Malik *et al*., 1997; Kamaladoss, Abel & Sampathkumar, 1992). LBW is considered the single most important predictor of infant mortality, especially of deaths within the first month of life (Ryan *et al*., 2000). It is also a significant determinant of infant and childhood morbidity, particularly of neuro-developmental impairments such as mental retardation and learning disabilities (Chiarotti *et al*., 2001). In this context, Boardman *et al*., (2002) showed that birth weight is significantly related to developmental outcomes.

The objectives of this study are to determine the prevalence of low birth weight among the population and the possible causes responsible for the low birth weight observed. It also aims to identify whether social, biological or economic factors play a significant role in birth weight determination.

MATERIALS AND METHODS

This paper examines the association of birth weight among hospital births in Sagar town, Madhya Pradesh (India) with the socio-biological characteristics of the infants and their families. Data were collected from hospital case cards pertaining to 2,789 deliveries in Duffrin hospital, Sagar. Necessary data for the present study were copied from the birth registers available in this hospital. For this purpose, the cases of births over a year i.e. from 1st January 2000 to 31st December 2000 were taken into consideration. Since the data were recorded primarily for the use of the hospital, these data may be regarded as secondary data. Out of a total of 2,789 births, data from 2,680 births were taken for analysis, because data from incomplete records and multiple births were excluded. Scheduled tribe and other groups based on religion representing very insignificant portions of the population were also kept aside. All these were done on the apprehension that these birth weights may impair the quality of the results. The biological data collected include age of mother at the time of delivery, parity, birth weight and sex of the child. Birth weights of newborns were measured without clothes within 15-30 minutes of birth to the nearest of 10 g, using an infant beam balance. The baby scale was calibrated daily for accuracy. The socio-economic data available from hospital case cards related to ethnicity, mother's education, family income and occupation of the father were also taken.

Data on socio-economic and biological determinants of birth weight in India is generally incomplete. The gathering of data from hospital records is generally associated with a certain degree of uncertainty. The Duffrin hospital in Sagar town was established in the year 1901. This hospital is run by qualified experienced doctors and nurses. Due to its low cost for treatment, one can always find an excessive number of patients. Duffrin hospital in Sagar serves as the biggest maternity centre in the town. Sagar is a small town located in Madhya Pradesh in India. Like other cities in India, Sagar city has all the facilities like hospitals, schools, colleges, universities etc. The main foods consumed by the people include cereals, pulses, vegetables etc. A significant proportion of people are non-vegetarians.

There are two religious groups in the study area, namely Hindus and Muslims. The Hindus, in turn, consist of different diverse groups, and is further subdivided into General Castes (GC), Scheduled Castes (SC) and Other Backward Classes (OBC). There are considerable differences in the level of socio-economic development among these three Hindu classes. The GC consist of Brahmin, Kayastha, Thakur and Patel Castes and are economically the best group. The SC consist of Chamar, Dhobi, Khatik and Kori castes. OBC are essentially economically and socially backward. Endogamy (marriage within the same group) generally exists among them and there by, biological isolation is by and large maintained by each of the caste groups. Thus the data for this study are divided into four categories, ie the three sub-classes of Hindus and the Muslims.

The mother's educational status is grouped into four categories - non-literate, and those who have been educated at primary, junior-high and IX & above. Non-literates are those who can neither read nor write. Primary educated mothers are those who reached the class IV or below standard. The third category is Junior-High where mothers attained the educational level between class V and VIII standard, and the last category is the IX and above group, in which mothers are at class IX level or above i.e. secondary (X), higher secondary (XII), Graduate etc.

In a similar way, income groups are divided into four categories, namely families with a monthly income (1) less than or equal to rupees 1000 (income 1000); (2) above rupees 1000 but less than or equal to rupees 2000 (1001 < income 2000); (3) above rupees 2000 but less than or equal to rupees 3000 (2001 < income 3000); and (4) greater than rupees 3000 (income > 3000). These class intervals for income were arbitrarily set, so that there should be at least 100 families in each category.

The occupational groups are categorised on the basis of the father's occupation. The first or "service group" covers the fathers who are engaged either in public or private sector i.e., salaried persons or professionals like doctors, teachers, advocates etc. The second category is the "labourer group", which covers labourers or majdoor, daily labourers, etc. Fathers who are engaged in their own businesses are categorised as "business". In the fourth category, the "cultivator" or "farmer" group are families tjat have their own land for cultivation. Cultivators cultivate their land themselves or use their family members whereas the farmers cultivate their land by hiring labourers. Generally, farmers are rich and havse more land than cultivators, but in the present study, quantity of land does not differ significantly. The fifth category in this study, termed as "others", include various other small occupational groups.

In this paper, some two-way tables from different bivariate observations have been prepared and regression analysis from the multivariate data performed. From the two-way tables (contingency tables) chi-square tests have been performed to determine if there was an association between the variables concerned. Tests of proportions have been carried out on one-way tables. For those tables where number of observations, mean of a given variable along with standard deviation in each category are given, ANOVA test was performed and the value of F-test along with their p-values have been presented. Since the aim of this paper is to see whether birth weight depends on variables like mother's age, parity order etc., the authors regress birth weight (BWT) on these variables to determine if the coefficients of the associated variables are significant. For categorical variables like ethnicity, occupation etc. of parents, appropriate transformation of the categorical data into binary variables was first done before performing regression analysis. All the analyses were performed using SPSS version 11.

RESULTS

Some descriptive features of the data through appropriate one-way and two-way tables are first presented and interpreted.

Table 1 gives the number of single live births and their distribution according to categories of birth weight and sex. Using the WHO classification, the overall prevalence of low birth weight (less than 2500 g) in this study population is 17.39%. The prevalence of low birth weight is 15.43% in male births and 19.37% in female births. There is thus a significantly higher proportion of low birth weight in female babies than male babies. The Table also shows that the percentage of babies with weight 4,000 g or more are much higher among male babies (2.08%) than female (0.60%).

Table 2 summarises the prevalence of low birth weight and the various family background categories. The different statistical tests were performed. First from the contingency tables, the usual Chi-square tests were done to see if the probability of low birth weights depends on the category. In other words, it is seen whether the proportion of low birth weight is the same in each category. In all the cases, Chi-square tests showed significant results as the corresponding p-values were close to zero (shown in the last row of each variable). Next, pair-wise test of difference of proportions was made for each pair of categories of the variables to determine if significant difference of proportions exists. Note that due to the large sample size, this test is approximately equivalent to normal test, which was done here. Significant differences were observed for most of the cases. However, the directions of such differences can only be discussed by looking at actual proportions. Specifically, the prevalence of low birth weight is high for (i) female, (ii) illiterate mothers, (iii) mothers aged 19 years or less, (iv) women with parity 1, (v) SC families, (vi) lower income families and (vii) fathers who earn their livelihood doing physical work. The pair-wise tests, however, did not show significant differ-

Table 1. Gender distribution of birth weights

Birth Weight (g)	*Male*		*Female*		*Significance of Chi Square test* (p-values)*
	N	*Per cent*	*N*	*Per cent*	
<1500	18	1.34	16	1.20	0.0004
1500-<2500	190	14.09	242	18.17	
2500-<4000	1112	82.49	1066	80.03	
4000 +	28	2.08	8	0.60	
Total	1348	100.00	1332	100.00	

*Test for Significance for this and subsequent tables was made by Chi Square statistic using the data of the contingency table of number babies born in each category (i.e., 'N' values).

Table 2. Percentage of low birth weight by family background

Family background	*% low birth weight (<2500 g)*	*N*	*p-values for the significance test of proportion & p-value for Chi Square test*				
Sex of the infant					Female		
Male	15.43	208			0.267		
Female	19.37	258			0.0083		
Mother's Education			Primary		Jun. High		IX & above
Illiterate	21.65	155	0.800		0.403		0.061
Primary	19.63	32			0.003		0.312
Junior High	17.99	177					0.226
IX and above	12.48	102			0.0000		
Mother's Age			20-24		25-29	30-34	=35
<=19	27.81	52	0.150		0.047	0.099	0.189
20-24	18.85	223			0.361	0.474	0.503
25-29	14.92	120				0.962	0.786
30-34	14.64	53					
>=35	12.50	18			0.0001		
Parity			2	3	4	5	>=6
1	21.77	261	0.054	0.364	0.219	0.631	0.685
2	12.07	81		0.389	0.878	0.595	0.697
3	16.93	74			0.485	0.922	0.966
4	10.90	23				0.586	0.662
5	16.83	17					0.977
>=6	16.39	10			0.0000		
Social class			OBC		GC		MS
SC	22.66	121	0.377		0.085		0.374
OBC	18.12	125			0.449		0.779
GC	14.86	177					0.822
MS	16.23	43			0.0011		
Income			1001-2000		2001-3000		3001-
<=1000	19.23	266	0.461		0.434		0.396
1001-2000	16.38	159			0.600		0.604
2001-3000	11.35	16					0.927
>3000	12.31	25			0.0127		
Father's occupation			Labour		Business	Cultiv.	Others
Service	11.81	62	0.110		0.609	0.129	0.677
Labour	20.84	209			0.201	0.898	0.563
Business	14.66	96				0.237	0.935
Cultivator	21.53	79					0.542
Others	15.38	20			0.0000		

Table 3. Mean birth weight along with standard deviation by family background

Description	*No*	*Birth Wt.*	*SD*	*p-values for the significance test oF mean and ANOVA along with p-value*				
Sex of Infant				Female				
Male	1348	2807.42	534.96	0				
Female	1332	2683.41	495.66	-				
Total	2680	2745.78	519.42	$F_{1,2678}$ = 38.726, p-value = 0.000				
Mother's Education				Primary	Junior High	IX & above		
Illiterate	716	2685.61	558.87	.287	.114	0		
Primary	163	2735.58	536.30	-	.858	.054		
Junior High	984	2727.54	514.63	-	-	0		
IX & above	817	2822.52	475.87	-	-	-		
Total	2680	2745.78	519.42	$F_{3,2676}$ = 9.665, p-value = 0.000				
Maternal Age				20-24	25-29	30-34	>=35	
<=19	187	2547.59	584.23	0	0	0	0	
20-24	1183	2711.24	492.29	-	.001	.001	0	
25-29	804	2786.94	519.95	-	-	.368	.047	
30-34	362	2817.40	541.47	-	-	-	.236	
>=35	144	2877.08	497.93	-	-	-	-	
Total	2680	2745.78	519.42	$F_{5,2675}$ = 13.650, p-value = 0.000				
Parity				2	3	4	5	>=6
1	1199	2652.21	517.11	0	0	0	0	.003
2	671	2822.80	492.18	-	.087	.083	.335	.692
3	437	2768.88	524.27	-	-	.004	.071	.242
4	211	2890.52	495.80	-	-	-	.876	.570
5	101	2880.20	567.10	-	-	-	-	.716
>=6	61	2849.18	498.54	-	-	-	-	-
Total	2680	2745.78	519.42	$F_{5,2674}$ = 16.481, p-value = 0.000				
Social Class				OBC	GC	MS		
SC	534	2645.51	541.18	.002	0	0		
OBC	690	2740.87	502.78	-	.084	.14		
GC	1191	2782.79	516.32	-	-	.738		
MS	265	2794.34	506.18	-	-	-		
Total	2680	2745.78	519.42	$F_{3,2676}$ = 9.532, p-value = 0.000				
Income of family				1001-2000	2001-3000	3001-		
<=1000	1383	2718.87	523.03	.398	.001	0		
1001-2000	953	2737.15	507.66		.005	0		
2001-3000	141	2866.67	509.43			.736		
>3000	203	2885.71	526.28					
Total	2680	2745.78	519.42	$F_{3,2676}$ = 8.859, p-value = 0.000				
Father's occupation				Labour	Business	Cultivator	Others	
Service	525	2844.19	508.51	0	.006	0	.031	
Labour	1003	2710.37	533.46		.034	.221	.463	
Business	655	2764.27	486.74			.006	.641	
Cultivator	367	2669.75	548.16				.144	
Others	130	2743.08	470.35					
Total	2680	2745.78	519.42	$F_{4,2675}$ = 8.137, p-value = 0.000				

ences for most cases. This will be evident from Table 3.

The birth weight varied distinctly with the gender of the infants. Male infants accounted for 50.30% of the newborns while females were 49.70%. On average, the male babies (mean 2,807 g) were 124 g heavier than the female babies (mean 2,683 g) (Table 3). The difference between the mean weights of male and female babies has been found to be significantly different from zero at 1% level (p value = 0, i.e., $p < 0.0005$).

The effect of mother's literacy level on birth weight of the newborn is presented in Table 3. With regard to maternal education, an increasing trend was observed, i.e., a higher level of educational status was related to a higher birth weight. The statistical significance test suggests that the mothers educated up to class IX or above gave birth to babies with much higher weights than those of mothers with comparatively lower education level. So far as weights of newborn babies are concerned, primary and junior high-level educated mothers can be put in the same group.

Mothers below age of 20 years gave birth to significantly lighter babies who were on an average about 160-330 g lighter than that of the higher age groups. There was an increasing trend of birth weight with mother's age.

Birth order is observed as a determining factor in birth weight. Birth weight was lowest in the first parity. Then from the second parity onwards, there was a significant jump in the weight except for third parity where the increase was not as high as others. Table 2 also shows that first parity showed the highest proportion of low birth weight (21.77 %). This suggests that parity of second order and above can be put in one group.

The General Caste represented the major social group. Of the total mothers, 44.44% were from General Caste, 25.75% were from Other Backward Class and 19.93% were from Scheduled Caste. Only 9.89% were of Muslim religion. Comparison of averages revealed that birth weight of Scheduled Caste population (2,645 g) was much lower than the other castes and communities. Table 2 also showed that Scheduled Caste had the highest frequency of low birth weight babies (22.66%) whereas the General Caste groups had the lowest (14.86%). This indicates that SC population should be taken separately for further analysis.

The family income had a positive (i.e., increasing) relationship with birth weight. The income group <=1000 is close to the income group 1001-2000, whereas the income group 2001-3000 is close to the income group >3000, so far as birth weight is concerned (Table 3).

Table 4. Pearson Correlations among different variables

	BWT	*Age*	*Lit*	*Ethn*	*Gender*	*Occ*	*Parity*	*Inc*
BWT	1.000	.149 **	.070 **	.082 **	.119 **	.086 **	-.162 **	.102**
Age	.149 **	1.000	-.125 **	-.047 *	-.003	.049 *	-.492 **	.128**
Lit	.070 **	-.125 **	1.000	-.188 **	.005	.194 **	.085 **	.191**
Ethn	-.082 **	-.047 *	-.188 **	1.000	-.007	-.101 **	.004	-.154**
Gender	.119 **	-.003	.005	-.007	1.000	-.009	.000	.025
Occ	.08 6**	.049 *	.194 **	-.101 **	-.009	1.000	-.026	.485**
Parity	-.162 **	-.492 **	.085 **	.004	.000	-.026	1.000	-.026
Inc	.102 **	.128 **	.191 **	-.154 **	.025	.485 **	-.026	1.000

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Father's occupation also played a significant role in birth weight determination. The infants from "cultivators" families have the lowest birth weight (2,670 g) and the infants from service holder families have the highest birth weight (2,844 g) (Table 3). Birth-weight of babies with father's occupation as "service" is significantly different from the other categories. To some extent, "business" can also be put in a separate group by the same logic.

Results of Analysis of Variance (ANOVA) tests were also shown in Table 3. For each variable, the tests showed highly significant difference of mean values among different categories.

Table 4 shows the simple correlations among the different variables. Most correlations were highly significantly different from zero. If correlations with birth weight only (i.e., the first row of the correlation matrix) are considered, then it can be seen that all the correlations were significant at 1% level. Thus, all the variables have significant effects on the birth weight of babies if these effects are taken separately for each variable. It should be noted here that the correlations of variables were computed after making proper transformations of the variables. GENDER of a newborn baby was taken as '1' for male and '0' for others. Illiterate babies were given value '0' and others '1' for the variable named as LIT. PARITY took value '1' with parity 1 and '0' for all other parities. Similarly for ethnicity, SC and OBC were given value '1' and '0' for others. Lastly, labour, business or cultivators were given value '0' and 1 for others.

Appropriate statistics to measure correlations between categorical variables is 'eta' rather than product moment correlation coefficient. The product moment correlations in such cases gives only a rough idea about the relation between two variables. Moreover, since other variables usually vitiate the value of the simple correlation coefficients, not much importance should be given to these values.

Since simple correlations do not give the entire picture, regression analysis was carried out. Several regression equations were run, taking different sets of explanatory variables each time. Here only one which includes most of the explanatory variables and also gives very good fit to the data is reported. For regression analysis, it is also necessary to transform the variables. There are some categorical variables like ethnicity, occupation etc. of parents. Just putting some value against each category will not serve the purpose. The categorical data must be transformed into binary variables. Since there are some characteristics with observations in more than two categories, it is necessary to define more than one binary or dummy variables for those characteristics. For example, ethnicity has four categories. Thus, it is necessary to define three dummy variables. OBC has been taken as base category and the other three, namely SC, GC and MS, constitute each dummy variable. The value of the binary variable corresponding to SC category has been taken to be "1" and "0" for others. This variable has been named ETHN2. Similarly, ETHN3 corresponds to the dummy variable with value "1" for GC and "0" for others, and ETHN4 corresponds to the dummy variable with value "1" for MS and "0" for others. The reason for taking OBC as the base category is that the mean BWT of OBC babies is lower than the other categories. We have adopted similar techniques in defining dummy variables for other characteristics. Mother's Education might be defined with numbers that are in a natural increasing order. For example, an illiterate mother may be given number "0", a class one pass mother be given "1", a class two pass is "2" and so on. Thus it might not be necessary to transform these values. But it was thought that the increase in education by one unit might not imply the increase of the birth weight of a newborn baby by the same constant weight on the average, as it

Table 5. Transformation of categorical and other variables into binary variable taken for the regression

Variable Name	*Explanation*	*Categories*	*Value*
GENDER	Gender of new born baby	Male	1
		Female	0
LIT	Status of education of mother of new born baby	Illiterate	0
		Otherwise	1
PARITY2	Parity of new born baby	2	1
		Otherwise	0
PARITY3		3	1
		Otherwise	0
PARITY4		4	1
		Otherwise	0
PARITY5		5	1
		Otherwise	0
ETHN2	Ethnicity of mother of new born baby	SC	1
		Otherwise	0
ETHN3		GC	1
		Otherwise	0
ETHN4		MS	1
		Otherwise	0
OCCN2	Father's occupation of new born baby	Labour	1
		Otherwise	0
OCCN3		Business	1
		Otherwise	0
OCCN4		Cultivator	1
		Otherwise	0
OCCN5		Service, Lab, Bus, or Cultivation	0
		Otherwise	1
AGE2	Age of mother (in years)	20-24	1
		Otherwise	0
AGE3		>=25	1
		Otherwise	0
INCOME2	Monthly income of Family	>1000 and <=2000	1
		Otherwise	0
INCOME3		Income > 2000	1
		Otherwise	0

should be for a linear relation. Thus, again a binary transformation was taken for this case also. The value is "0" for an illiterate mother and "1" for all others. It should also be mentioned here that the binary number "1" has been taken for male baby and "0" for female baby. A comprehensive summary of values taken for different variables can be found in Table 5.

The dependent variable of the regression analysis is obviously birth weight (BWT) of a newborn baby. The variation in the birth weight is assumed to be due to GENDER, LIT, PARITY, ETHN, OCCN, AGE and INCOME. The regression is based on observations from 2,680 newborn babies. The fitted regression equation is:

$$BWT = \underset{(43.467)}{2.407} + \underset{(6.313)}{0.123}\ GENDER + \underset{(3.032)}{0.0717}\ LIT + \underset{(5.468)}{0.139}\ PARITY2 + \underset{(3.055)}{0.0934}\ PARITY3$$

$$+ \underset{(5.223)}{0.212}PARITY4 + \underset{(4.615)}{0.211}PARITY5 + \underset{(3.260)}{0.0953}ETHN2 + \underset{(3.990)}{0.109}ETHN3$$

$$+ \underset{(3.573)}{0.136}ETHN4 + \underset{(-1.870)}{0.099}AGE2 + \underset{(-1.522)}{0.126}AGE3 - \underset{(-2.559)}{0.0085}INCOME2 + \underset{(-1.353)}{0.0647}INCOME3$$

$$- \underset{(2.464)}{0.0631}OCCN2 - \underset{(2.943)}{0.0507}OCCN3 - \underset{(-0.392)}{0.101}OCCN4 - \underset{(1.703)}{0.0706}OCCN5.5$$

(Figures in the parentheses are the t-ratios)

Most of the coefficients are highly significant. The signs of the coefficients need proper attention. Gender of the new-born baby, literacy, parity, ethnicity and age of mother have positive association with the birth weight. Recall that male babies were given binary value "1" and female babies "0". Clearly, male babies have higher weight than female babies on the average as reflected by the positive sign of the coefficient of GENDER. Since illiterate mothers were given value "0", the positive value of the coefficient clearly implies higher weights for babies of literate mothers. S imilarly the base group of parity is "parity 1" which has been given value "0" implying higher weight for babies with parity more than 1 since there are positive values of the regression coefficients of each parity dummy. By the similar logic ethnic classes other than OBC have higher baby weight. Mother's age also has a positive effect. However, there is some problem with interpreting the effect of income of the family and father's occupation. All interpretation should be made with respect to the base category, i.e., the category with dummy variables taking value "0" always. The base category of father's occupation is "service." Thus, negative coefficient attached to any occupation variable will imply less body weight of babies in that category with respect to that of families with father's occupation as "service." All the categories except "service" thus have higher birth weight of babies. Fathers who do more physical work have babies with less weight than those of the fathers in "service". The base category for income is the families with income less than or equal to Rs. 1000. It means that negative coefficient for the INCOME2 implies less weight of babies in the income group that is a category higher. It is pertinent to mention here that we also regressed BWT on variables including literacy, age of mother and income of family taking natural order (not shown in this paper). The coefficients attached to these variables were found to be positive. Thus literate mothers give birth to higher weight babies than illiterate mothers. The same is true for older mothers and mothers with higher level of income in the family.

The details of the significance tests of the regression coefficients including the p-values are given in table 6. The R-squared value is higher than the other regressions tried (not shown here).

Table 6: Results of the regression analysis taking all available regressors

Variables	*Coefficients*	*Std. Error*	*t-ratio*	*Significance*
INTERCEPT	2.4074	0.055	43.467	0.00
GENDER	0.1227	0.019	6.313	0.000
LIT	0.0717	0.024	3.032	0.003
PARITY 2	0.1394	0.026	5.468	0.000
PARITY 3	0.0934	0.031	3.055	0.002
PARITY 4	0.2121	0.041	5.223	0.000
PARITY 5	0.2115	0.046	4.615	0.000
ETHN 2	0.0953	0.029	3.260	0.001
ETHN 3	0.1091	0.027	3.990	0.000
ETHN 4	0.1360	0.038	3.573	0.000
OCCN 2	-0.0631	0.034	-1.870	0.062
OCCN 3	-0.0507	0.033	-1.522	0.128
OCCN 4	-0.1008	0.039	-2.559	0.011
OCCN 5	-0.0706	0.052	-1.353	0.176
AGE 2	0.0994	0.040	2.464	0.014
AGE 3	0.1262	0.043	2.943	0.003
INCOME 2	-0.0085	0.022	-0.392	0.695
INCOME 3	0.0647	0.038	1.703	0.089

DISCUSSION

The mean birth weight of newborn babies was 2,746 g. The prevalence of low birth weight was 17.39%. This percentage is lower than that reported by other studies, like Sharma *et al*. (1999) who studied the effect of maternal nutrition on birth weight using data from Rajendra Hospital, Patiala and reported a prevalence of 19.1%. Though Madhya Pradesh is dominated by Scheduled Tribe (approximately 20%) compared to the other states, in the present study, the representation was insignificant and was not taken into consideration for the present analysis. Moreover, a good number of people in Sagar town live in squatter settlements. Their economic condition is generally far below the poverty line. It has been noted that most of these women abstain from hospital deliveries and prefer home deliveries with the help of indigenous "Dai's". The birth weights of these babies are usually very low. As these cases are not recorded in the hospital register, the prevalence of low birth weight in Sagar town is found to be lower than Sharma's study. However, this percentage is higher than that reported by Nair *et al*. (2000). It should be noted that where the study area of Nair *et al*. had several positive factors like antenatal care, good health facilities, education and overall development of the area.

A bivariate analysis showed that maternal age, sex of the newborn, mother's education, parity, family income and ethnic groups all had a significant influence on birth weight. The results of the present study also corroborate the findings from other studies, that male babies were generally heavier than the female babies (Mondol, 1998; Defo & Parkin, 1993). There was a strong association between mother's educational status and birth weight, and a trend of increasing birth weight with higher education, as has been observed by other investigators, such as Karim & Mascie-Taylor (1997). Parity has usually been associated with an increase in the birth weight. Studies of the effect of sex and parity on birth weight was also observed by Gage & Therriault (1998) and Defo & Parkin (1993). Most studies have documented a tendency of increasing birth weight with maternal age (Madebo 1994, Yadav 1994, and Eberstein, Nam & Hummer 1990). Similar findings have been obtained in this study.

It is also seen from the bivariate analysis that there is a significant relationship between birth weight with sex, maternal education, maternal age, parity and family income. Younger mothers have comparatively lower birth weight children than the older mothers. The correlation coefficient of parity and maternal age was found to be -0.49. The possible cause for this high value may be that parity and maternal age are related to foetal growth in general and consequently to birth weight in particular. The correlation coefficient of income and mothers' education was found to be positive. This might be due to the fact that educated mothers are well informed about antenatal care and other precautions to be taken during the child bearing period, which obviously favourably affect the weight of the newborn babies.

The regression results confirm all the findings described above. Moreover, while interpreting the coefficient of any factor for explaining the degree of relationship with the birth weight, it takes care of other variables which may vitiate our result. Thus it is regarded as a superior method. However, the particular regression equation cannot be regarded as the best model because there is always the scope of redefining the dummy variables. The type of dummy variables to be taken depends on the purpose of the analysis. We have taken that regression which best suits our purpose. It is true that some degrees of freedom are lost due to inclusion of so many explanatory variables. This is evident from the fact that this regression has lower value of the F-statistic compared to the corresponding value in some other regressions (not shown here). Moreover, introducing too many dummy variables make it difficult to interpret all the results in a meaningful way. The present regression equation gives the highest R2 value compared to the other regression equations tried for the purpose.

REFERENCES

Boardman JD, Powers DA, Padilla YC & Hummer RA (2002). Low birth weight, social factors and developmental outcomes among children in the United States. *Demography* 39: 353-368.

Chiarotti F, Castignani AM, Puopolo M, Menniti-Ippolito F, Minniti De Simeonibus E & Di Paolo A (2001). Effects of socioenvironmental factors on neurocognitive performance in premature or low-birth weight preschoolers. *Ann Ist Super Sanita* 37: 553-559.

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

Dhall K & Bagga R. (1995). Maternal determinants of birth weight of North Indian babies. *Ind J Pediat* 62: 333-344.

Dickute J, Padaiga Z, Grabauskas V, Nadisauskiene RJ, Basys V & Gaizauskiene A (2004). Maternal socio-economic factors and the risk of low birth weight in Lithuania. *Medicina (Kaunas)* 40: 475-482.

Eberstein IW, Nam CB & Hummer RA (1990). Infant mortality by cause of death: Main and interaction effects. *Demography* 27: 413-430.

Ebomoyi E, Adetoro OO & Wickremasinghe AR (1991). Birth weight an sociobiological factors in Illorin, Nigeria. *J Biosoc Sci* 23: 417-423.

Gage TB & Therriault G (1998). Variability of birth weight distributions by sex and ethnicity: Analysis using mixture models. *Hum Biol* 70: 517-534.

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

Kamaladoss T, Abel R & Sampathkumar V (1992). Epidemiological co-relates of low birth weight in rural Tamil Nadu. *Ind J Pediat* 59: 299-304.

Madebo T (1994). A two year retrospective study of birth weight in Sidamo Regional Hospital. *Ethiopian Med* J 32: 255-260.

Malik S, Ghidiyal RG, Udani R & Waingankar P (1997). Maternal bio-social factors affecting low birth weight. *Ind J Pediat* 67: 373-377.

Mondol B (1998). Low birth weight in relation to sex of baby, maternal age and parity: A hospital based study on Tangsa tribe from Arunachal Pradesh. *J Ind Med Assoc* 96: 362-364.

Mondol B (2000). Risk factors for low birth weight in Nepali Infants. *Ind J Pediat* 67: 477-482.

Murthy HVV (1991). Birth weight and the associated factors-a review. *Ind J Soc* Work L11, 151-156.

Nair NS, Rao RS, Chandrashekar S, Acharya D & Bhat HV (2000). Socio-demographic and maternal determinants of low birth weight: A multivariate approach. *Ind J Pediat* 67: 9-14.

Radhakrishnan T, Thankappan KR, Vasan RS & Sarma PS (2000). Socio-economic and demographic factors associated with birth weight: A community based study in Kerala. *Ind Pediat* 37: 872-876.

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

Ryan CA, Ryan F, Keane E & Hegarty H (2000). Trend analysis and socio-economic differentials in infant mortality in the Southern Health Board, Ireland (1988-1997). *Ireland Med J* 93: 204-206.

Sharma RK, Cooner PPS, Sekhon AS, Dhaliwal DS & Singh K (1999). Study of effect of maternal nutrition on incidence of Low birth weight. *Ind J Commu Med* 24: 64-68.

Tuntiseranee P, Olsen J, Chongsuvivatwong V & Limbutara S (1999). Socioeconomic and work related determinants of pregnancy outcome in Southern Thailand. *J Epidemiol Commu Health* 53: 624-629.

Xu B, Jarvelin MR, Lu H, Xu X & Rimpela A (1995). Maternal determinants of birth weight: A population based sample from Qing dao, China. *Soc Biol* 42: 175-184.

Yadav H (1994). Low birth weight incidence in Lundu, Sarawak. *Med J Mal* 49: 164-168.

WHO (1992). Low birth weight: A tabulation of variable information. World Health Organization, Geneva.