J Life Science, 10(1): 73-80 (2018)
DOI: 10.31901/24566306.2018/10.01.188

The Birth Weight of Newborn Babies in Kolkata is Associated with the Socio-economic Status and Nutritional Status of Mothers

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KEYWORDS Low Birth Weight. Nutritional Status. Nutrients Deficiency. Pregnant Women Socio-economic Status

ABSTRACT The birth weight of a baby may be influenced by several factors. The present study has been undertaken to assess the association between the birth weight of babies born in a government hospital in Kolkata and the nutritional status of mother and/or the SES of the family. In the present study the mean birth weight was found to be 2.56 kg, and 33.3 percent of the newborns were found to be low birth weight (LBW). The pregnant mothers were suffering from deficiencies in the intake of energy, protein, calcium and iron during 3rd trimester. The percent deficiencies of these nutrients and the post delivery body weight and BMI of mothers were found to be correlated with the birth weight of babies. The SES of the family along with the monthly income of the family, education level of parents and percent deficiency of energy during 3rd trimester were associated with the birth weight. Thus, the study indicates that the birth weight of the babies is associated with the SES and deficiency in the intake of energy, iron, calcium, protein during pregnancy.

INTRODUCTION

The weight of the newborn obtained after birth is taken as birth weight and it is measured preferably within the first hour of life (UNICEF 2004). The average birth weight of a newborn infant in the developed countries is about 3.3 to 3.5 kg while in the developing countries it is only 2.5 to 3.1 Kg (Mahmood et al. 2004). Though the birth weight of newborn infant is low in India like other developing countries, there are regional differences in the birth weights in various parts of India (Ashtekar et al. 2010; Joharpurkar and Sharma 2015; Ngaithianven and Pathak 2015). While the mean birth weight was reported to be 2.81 kg in North East India (Sengupta and Barua 2002), it was 2.6 kg in Kolkata (Bisai et al. 2006). The birth weight of a newborn may be influenced by genetic endowment and nutritional status of the mother and also by the socio-economic status of the family. The duration of gestation and the intra-uterine growth rate of the foetus are two major determinants of birth weight (Idris et al. 2000). Mother's age and parity of birth are also indicated to be related to the birth weight of newborn (Bisai et al. 2006).

A live born infant having birth weight of less than 2.5 kg regardless of gestational age is defined as Low Birth Weight (LBW) baby. There are subcategories of LBW, which include very low birth weight (VLBW), and extremely low birth weight (ELBW) where the birth weights are <1500 and <1000 g respectively (Janaswamy et al. 2015). The LBW of a baby may be due to mothers' health condition, illness and complication during pregnancy (Kabir 2002; Rafati et al. 2005). Joshi et al. (2005) showed that maternal education, occupation, and per capita income of the family were significantly correlated with birth-weight of the new born in Allahabad.

Several factors determining the occurrence of LBW babies have been indicated from different studies (Rajashree et al. 2015; Hosain et al. 2005; Dalal et al. 2014). The determinants of LBW as per a study carried out in Karnataka were age of the mother, literacy rate, weight gain during pregnancy, day time rest during pregnancy, birth interval and hemoglobin level of the mother at the time of delivery. A study from rural Bangladesh (Hosain et al. 2005) revealed that maternal age, hemoglobin levels at first visit to clinic and weight gain during pregnancy are significant predictors of LBW babies. However, no significant influence of mothers' age and parity on the birth weight of babies was found in Manipur

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(Ngaithianven and Pathak 2015). A significant association was observed between LBW and maternal age, maternal education, socio-economic status, inter-pregnancy interval, antenatal visit, maternal height, pre-pregnancy maternal weight, habit of tobacco chewing, previous history of abortion, maternal anemia in a study carried out in Ahmadabad (Dalal et al. 2014). The education of mothers was found to have a significant effect on birth weight of Ahom babies in Assam (Sengupta and Barua 2002). In Nepal, the birth weight of newborns was found to be significantly associated with per capita income of the families along with mothers' education (Joshi et al. 2010). The average birth weight of babies is not only low in Kolkata than that of other regions (Sengupta and Barua 2002; Bisai et al. 2006; Ashtekar et al. 2010; Joharapurkar and Sharma 2015; Ngaithianven and Pathak 2015) but the prevalence of LBW is also higher in Kolkata (Bisai et al. 2006). Bisai et al. (2006) found that the mean birth weight of babies in a Kolkata hospital was 2.6 kg and the prevalence of LBW was 36.5 percent. It was also noted in this study that the occurrence of LBW was related to the first parity of birth and younger age of mother. It appears from the previous studies that the birth weight of babies is associated with several factors such as height, weight gain during pregnancy, SES of the family, mothers' age and parity of birth. Though the influence of parity of birth and mother's age have been assessed on the birth weight of Kolkata children (Bisai et al. 2006), the role of other factors such as nutritional status of mother and SES of the family on the birth weight and prevalence of LBW of babies in Kolkata has not been assessed in recent times. Therefore, the present study has been undertaken to assess the association of nutritional status of mother and SES of the family with the birth weight of babies born in a government hospital in Kolkata.

METHODOLOGY

Study Subjects

The present study was carried out in the obstetric ward of the Medical College and Hospital, Kolkata during a period of six months (March 2013 to August 2013). A total of 201 mother-baby pairs were included in the study randomly. Mothers with twin babies, babies born with inborn errors, women with post delivery complications and those unwilling to participate in the study were excluded.

Socio-economic Status (SES)

A pretested interview schedule was used for collection of general information of the subjects. The SES of the subjects was measured using the updated Kuppuswami scale (Ravi Kumar et al. 2013) which is based on monthly family income, spouse education and spouse occupation. Structured questionnaires were used to collect information on socioeconomic characteristics of the subjects.

Anthropometrics

Mothers

The height and weight of the mothers were measured within 1-2 days after the delivery by standard techniques (Lohman et al. 1988). Height and weight data were recorded to the nearest 0.5 cm and 0.5 kg respectively.

Babies

Body weight of the newborn was measured within half an hour after birth in a digital weighing scale.

Dietary Information

Diet history method (recent past) for diet survey (Thimmayama 1987) was used to collect dietary information of the mothers during their pregnancy.The amount of cooked food consumed in the recent past (during third trimester) that is, breakfast, lunch, evening snacks and dinner were recorded by using the household utensils (for example, table spoon, bowl, cup, glass etc.) Different sizes of utensils were used to assure the amount of food eaten by the subjects. Then the amount of cooked food was converted to raw foods. The raw food components were then classified into nine food groups (cereals, pulses and legumes, green leafy vegetables, roots and tubers, other vegetables, flesh foods, milk and milk products, fats and oils and sugars and jaggery) according to the classification of ICMR. The amount of nine food groups consumed by the subjects was calculated from the raw ingredients of cooked foods. The quantity of different macronutrients (energy, protein and

fat) and micronutrients (iron and calcium) in the food consumed by the subjects was calculated by using 'Nutritive Value of Indian Foods' (Gopalan et al. 2004).

Recommended Dietary Allowances (RDA) suggested by the ICMR (ICMR 2009) for pregnant women during third trimester were utilized as standard values of energy and nutrients under study (protein, iron and calcium) to assess the nutritional status of the subjects.

Statistical Analysis

Descriptive statistics such as mean and standard error of mean (SE) were computed for the socio-economic, anthropometric and nutritional data of the subjects. Analysis of variances (ANOVA) followed by Tukey HSD post hoc test were used to compare intake and deficiencies of nutrients among various social classes. Chi-square (χ^2) test were performed to determine the association between birth weight and socio-economic classes of the family. The correlation between birth weights and nutritional/SES components were calculated using Pearson's correlation coefficients. Multivariate forward regression analysis was used to examine the association between birth weight and other factors using birth weight as the dependent variable. The statistical analyses were performed using IBM SPSS statistical software version 22.

RESULTS

Maternal Age Groups

Mothers of 16 to 40 years of age participated in the present study. The mean height and weight of the mothers were 151.72 (±0.36) cm and 53.7 (±0.6) kg respectively, the mean parity was 1.4 and the mean birth weight was found to be 2.56 (±0.03) kg. In the present study 33.3percent of the newborn were found to be LBW (Table 1).

Distribution of Subjects among Various SES Classes

The distribution of the subjects in various SES classes are shown in Table 2 along with the SES scores of monthly family income, occupation of the head of the family and mean education of the subjects and their spouses. The majority of the observed subjects (71%) belong to the upper lower SES with a total SES score of 8.13. About twenty-five percent of the subjects belong to the lower middle SES whereas only four percent belong to the upper middle SES with the total SES scores of 12.5 and 20.25 respectively.

Table 1: The distribution of mothers according to age group with their height, weight, parity and birth weight of newborn babies

Age group of mothers	*Numbers (n)*	*Height (cm)*	*Weight (kg)*	*Parity*	*Birth weight*	*Number of LBW (%)*
16y-20y 12m	51	151.7± 0.70	50.49± 1.10	1.2	2.47± 0.06	21 (41.2)
21y-25y 12m	90	151.1± 0.45	53.92± 0.91	1.5	2.5± 0.05	32 (35.6)
26y-30y 12m	49	153.0± 0.67	55.97± 1.08	1.6	2.68± 0.04	09 (18.4)
31y-35y 12m	08	150.8± 1.59	53.75± 2.82	1.8	2.62± 0.21	04 (50.0)
36y-40y 12m	03	150.6± 0.94	62.33± 3.38	2.6	2.66± 0.42	01 (33.3)
16y-40y	201	151.72± 0.36	53.7± 0.6	1.4	2.56± 0.03	67 (33.3)

Values Mean ± SEM

Table 2: The distribution of mothers according to SES score with the scores of comonents of SES

SES	*Number of subjects (%)*	*Score of monthly income*	*Score of occupation*	*Score of education*	*Total SES score*
UM	8 (4)	11.00± 0.37	3.75± 0.09	5.37± 0.44	20.25± 0.72
LM	50 (24.9)	3.90± 0.21	3.62± 0.05	4.73± 0.13	12.50± 0.22
UL	143 (71.1)	2.26± 0.05	2.67± 0.04	2.96± 0.08	8.13± 0.11
Total	201 (100)	17.16	10.04	13.06'	40.88

Note: UM= Upper-middle class, LM= Lower-middle class and UL= Upper-lower class
Values Mean ± SEM

Nutrients Intake during 3rd Trimester

The intake and percent deficiency of energy, protein, calcium and iron during 3rd trimester with respect to the ICMR RDA are shown in the Table 3.The subjects were found to be suffering from deficiencies of energy, protein, calcium and iron during 3rd trimester with respect to corresponding RDA of ICMR in all the SES classes. It was found that the deficiencies of energy, protein, calcium and iron were significantly higher ($p< 0.01$) in the upper lower social class in comparison to the upper middle and lower middle social class.The deficiency of iron was also found to be significantly higher ($p<0.01$) in the lower middle social class in comparison to upper middle social class.

Distribution of Normal and Low Birth Weight Babies in Different Classes of SES

The number of newborn with normal birth weight was significantlyincreasing in the mothers from higher SES. On the other hand the number of LBW babies was decreasing significantly in the mothers of higher SES and the association between the birth weight of the babies and SES score of mothers' family was found to be significant (Table 4).

Table 5 shows the distribution of different categories of low birth weight babies in various social classes. It was found that only 2.2 percent of all the low birth weight babies are very low birth weight babies (>1.5 kg) and are present only in the upper lower social class.

Table 4: The distribution of normal and low birth weight babies according to SES classes

SES	*Normal birth weight (%)*	*Low birth weight (%)*	*χ^2 (p value)*
UL	80 (55.9)	63 (44.1)	23.454
LM	45 (90)	05 (10)	(0.000)
UM	08 (100)	00 (0)	df= 2
Total	133 (66.2)	68 (33.8)	

*Significant at $p<0.01$, UM=Upper-middle class, LM=Lower-middle class and UL= Upper-lower class

Table 5: The percentage of normal, low and very low birth weight babies according to SES classe

Socio-economic classes	*Very low birth weight (>1.5 kg) (%)*	*Low birth weight (2.49 kg-1.5 kg) (%)*	*Normal birth weight (>2.5 kg) (%)*
UL	2.2	41.9	55.9
LM	0	10	90
UM	0	0	100

UM=Upper-middle class, LM=Lower-middle class and UL= Upper-lower class

Correlation between Birth Weight and Other Factors

Pearson's correlation coefficients (Table 6) showed that among other factors only SES class, percent deficiencies of energy, iron, calcium, protein, post delivery mothers weight and mothers BMI were found to be significantly correlated with the birth weight of the baby.

Table 3: Nutrient intake with their percent deficiencies from recommended values (ICMR) during 3rd trimester

Nutrients	*ICMR RDA during 3rd trimester*	*Intake* (% deficiency) in different SES*			*F ratio*	*Post-hoc results (Tukey HSD method)*
		UL	*LM*	*UM*		
Energy (kcal)	2250	1533.38±13.18 (31.8)	1791.79±29.61 (20.37)	2045.69±28.81 (9.09)	30.12	UL>LM,UM
Protein (g)	78	45.13±0.76 (42.1)	56.78±1.18 (27.20)	74.41±1.0 1(4.61)	16.03	UL>LM,UM
Iron (mg)	35	13.13±0.43 (62.5)	20.01±0.68 (42.82)	32.83±0.64 (6.20)	34.99	UL>LM>UM
Calcium (mg)	1200	510.88±22.99 (57.4)	1003.10±17.05 (16.41)	1137.38±8.35 (5.23)	29.19	UL>LM,UM

*Note:**values are given in Mean± SEM,
* Significant at $p<0.01$, UM=Upper-middle class, LM=Lower-middle class and UL= Upper-lower class

Table 6: Pearson's correlation between birth weight and SES class, percent deficiency of energy, iron, calcium and protein, mothers weight and mothers' BMI

		Social class	*Energy deficiency*	*Iron deficiency*	*Calcium deficiency*	*Mothers weight*	*Protein deficiency*	BMI
Birth weight	Pearson's correlation	0.376***	0.263***	0.196**	0.191**	0.187**	0.184**	0.170*
	Significance level	0.000	0.000	0.005	0.007	0.008	0.009	0.019
	n	201	201	201	201	201	201	201

Significant at *p<0.05,**p<0.01, ***P<0.001

Table 7: Stepwise linear regression models for the association between birth weight and energy deficiency of mothers/SES of family

	Beta 95% confidence interval				
	Unstandardised	*Standardized*	*P value*	R^2	*Changes in R^2 from previous model*
Model 1					
SES class	0.050	0.358	0.000***	0.128	0.128
Model 2					
SES class	0.043	0.302	0.000***	0.148	0.020
% deficiency of energy	0.008	0.151	0.034**		

Dependent variable: birth weight,**P<0.05, ***P<0.001,

Association between Birth Weight and Nutritional Deficiency of Mothers/SES of Family

Stepwise linear regression analysis (Table 7) identified SES of family and percent deficiency of energy of mother during pregnancy as the significant predictors for birth weight (dependent variable) among all the correlated factors.

To determine which SES factors significantly contributed as predictors of birth weight stepwise, the linear regression analysis (Table 8) was conducted. Monthly income of the family and education level of the parents were found to be the important factors in predicting the birth weight.

DISCUSSION

The present study has been carried out in mothers having age of 16 to 40 years. The mean birth weight was found to be 2.56 kg in the present study and birth weight of babies reported from earlier studies at Purulia (Biswas et al.

Table 8: Stepwise linear regression models for the association between birth weight and energy deficiency of mothers/components of SES of family

	Beta 95% confidence interval				
	Unstandardised	*Standardized*	*P value*	R^2	*Changes in R^2 from previous model*
Model 1					
Family income/month	0.0000478	0.341	0.000***	0.116	0.116
Model 2					
Family income/month	0.0000394	0.281	0.000***	0.136	0.02
% deficiency of energy	0.008	0.155	0.032**		
Model 3					
Family income/month	0.0000309	0.22	0.005**	0.154	0.018
% deficiency of energy	0.009	0.155	0.030**		
Education level of parents	0.046	0.147	0.042**		

Dependent variable: Birth weight, **P<0.05, ***P<0.001

2008), Aligarh (Juneja et al. 2016) and Kolkata by different investigators (Pakrasi et al. 1985; Bisai et al. 2006; Bisai 2010) were similar (2.58-2.6 kg) to the present observation.The higher birth weight values (2.71- 3.1 kg) were also found in studies at Bhopal (Joshi et al. 2013), Assam (Sengupta and Barua 2002), and Manipu r(Ngaithianven and Pathak 2015). The prevalence of the LBW babies in the present study was found to be 33.8 percent in the observed population. According to NFHS 3 (2008) the prevalence of LBW in India is 21.5 percent. Higher prevalence was observed in Kolkata, (36.5% by Bisai et al. 2006 and 38% by Sain et al. 2014) and in Agra (38% by Kaushal et al. 2012). In some studies lower prevalence of LBW were observed in Purulia (31.3% by Biswas et al. 2008), Nashik (26.8% by Mumbare et al. 2012), Assam (14.22% by Sengupta and Barua 2002), Bhopal (11.8% by Joshi et al. 2013) and Manipur (4.56% by Ngaithianven and Pathak 2015).

The present study showed that the highest number of babies with normal birth weight was born in the mothers having age of 26-30 years which can be supported from similar observation by others (Ngaithianven and Pathak 2015). It has been also found in the present study that the highest birth weight was observed in the mothers of age group 26-30 years. However, Bishai et al. (2006) reported the occurrence of baby with highest birth weight in mothers' age group of 24-28 years. In the present study fifty percent babies were found to be LBW in the mothers of 31-35 years age group, whereas Sengupta and Barua (2002) found in Assam that twenty-five percent of the babies were LBW among the mother's of same age group.

It is evident from the present study that the mothers were deficient in energy, protein, calcium and iron during the third trimester of pregnancy. The extent of deficiencies of these nutrients in mothers was also found to vary according to their socio-economic classes. Subjects belonging to lowermost SES are found to be more deficient in the nutrients than those in the upper SES. A similar relation between SES and dietary intake of pregnant mothers was reported from a study carried out in Bangladesh (Islam et al. 2004). Northstone et al. (2008) studied the association between socio-economic and lifestyle factors, diet pattern during 3rd trimester pregnancy in the women of South-West England and found a strong association between socio-economic variables and all dietary components. They also conclude that a health conscious diet was positively associated with increasing education and age. In India, Hira et al. (1986) concluded that energy and protein intake by the Punjabi pregnant women were significantly increased with improvement in educational status, whereas protein and calcium intake were significantly affected by economic status. This is also evident in the nutrient intake and deficiencies during the third trimester in various social classes in the present study where mothers belonging to upper social classes with higher educational and economic status suffer from lesser deficiencies than those belonging to the lower classes.

The maternal deficiency of all the nutrients under study has been found to be significantly correlated to the birth weight of the new born. Similarly, Doyle et al. (1992) found a dose response relation between nutrient intake and birth weight in a low-SES population in East London. As the nutritional status is influenced by SES, it is obvious that the SES will be a determinant of the birth weight of babies. In the present study the SES class of the mother was also found to be associated with the birth weight of the new born. This is evident from the fact that higher numbers of low birth weight babies were found in the lower socio-economic class than that in the upper class. Such association of SES class and the birth weight of the new born were also found atNasik (Ashtekaret al. 2010) and Orissa (Suryawanshi and Kaveri 2015) where lower numbers of LBW babies were found in the upper SES classes. The regression results suggest that monthly family income, percent deficiency of energy during third trimester and education level of the parents as the predictors of the birthweight of the new born. The income of the family per month was found to be significantly associated with birth weight of the newborn in other studies at Allahabad (Joshi et al. 2005), Nasik (Mumbare et al. 2012), Haryana (Rao et al. 2007), Orissa (Suryawanshi and Kaveri 2015) and Nepal (Joshi et al. 2010).

Educational level has been the strongest and most consistent SES predictor of health. A low educational level limits access to jobs and other social resources, especially in industrialized countries, and thus increases the risk of poverty (Abu-Saad and Fraser 2010). In the present study, regression results showed education level

of the parents to be a predictor for birth weight. Likewise in a study at Karachi (Rizvi et al. 2007) education of both the parents were found to differ among the normal and LBW groups but the difference was only significant for the mothers. However, maternal education level has proven to be a significant factor associated with the birth weight of the baby in many studies at Assam (Sengupta and Barua 2002), Haryana (Rao et al. 2007), Orissa (Suryawanshi and Kaveri 2015), West Bengal (Manna et al. 2013) and Nepal (Joshi et al. 2010).

Thus, the present study shows that the percent of LBW babies are more in mothers from lower SES who are deficient in the intake of protein, energy calcium and iron. The poor nutrients intake in lower SES may be the result of the lack of awareness of nutrient requirement in pregnancy and nutrients content of food in addition to their economic constraint to purchase sufficient nutritious food.

CONCLUSION

Thus, the study indicates that the birth weight of the babies are influenced by the SES and deficiency in the intake of energy, iron, calcium, protein during pregnancy.

ACKNOWLEDGEMENTS

The authorities of Medical College, Kolkata and the staff of the antenatal clinic of Kolkata Medical College are acknowledged for the cooperation they extended for this study. The pregnant woman who gave consent and participated in the study are gratefully acknowledged.

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Paper received for publication on June 2017
Paper accepted for publication on January 2018