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Incidence of Low Birth Weight and Effect of Maternal Factors on Birth Weight of Neonates in Rural Areas of Uttar Pradesh

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Abstract

Background: Low birth weight is a major public health issue in developing countries like India where its prevalence is as high as 30%. The weight of infant at birth is a powerful predictor of infant growth and survival and its causes are multi-factorial. Most of these causes are modifiable and preventable by simple efforts. The aim of the study was to measure the rate of low birth weight and to quantify the influence of maternal age, education, socioeconomic status, parity, anthropometry, hemoglobin status and dietary intake by the rural expecting mother during third trimester pregnancy on the birth weight of the neonate for promoting better efforts to control the problem of low birth weight.

Methods: In 287 mothers with singleton births, anthropometric (height, weight, BMI) and hemoglobin measurements were taken. Newborn birth weight was taken within 24 hrs of birth. Furthermore, maternal education, socioeconomic status, obstetric history antenatal care related variables and dietary intake during the index pregnancy was also recorded. The effect of these maternal variables on birth weight was investigated by one way ANOVA and multivariate logistic regression analysis.

Results: Mean birth weight in the study was $2.62\text{gm} \pm 0.444\text{ SD}$. Out of 287 newborns, 28.6% had low birth weight. On multiple logistic regression analysis, maternal weight, calories intake, average weight gain in third trimester and haemoglobin level of the mothers were found as independent predictors for the low birth weight.

Conclusion: Adequate and quality dietary intake by mother is an important determinant for the birth weight of the newborn.

Keywords: Low Birth Weight, Rural, Third Trimester, Maternal Factors

1. Introduction

Period of intrauterine growth and development is one of the most vulnerable periods in the human life. Birth weight is the best single predictor of malnutrition. Low birth weight has a risk of neonatal and infant mortality, hence the proportions of babies with LBW are considered a sensitive index of nation's health and development and one of important indicators of quality of reproductive performance. [1]

LBW newborns represents homogenous group of term and pre term infants. A baby's weight at birth is either the result of preterm birth (<37 weeks gestation) or of restricted intrauterine fetal growth. Birth weight below 2500 gms. have been found to be very closely associated with poor growth not just in infancy but throughout childhood. LBW survivors demonstrate a significant growth and development retardation, reflected by lower body weight, heights and head circumference and poor motor, adaptive, social and language development in first five years of life. [2, 3, 4] Later in adult life, they are at increased risk of cardiovascular and metabolic disorders. [5]

The United Nations has set up seven major goals for the current decade. The reduction of prevalence of low birth weight will be an important contribution towards achieving MDG4 goal of reducing child mortality. Globally more than 20 million infants are born with low birth weight consisting of 15 percent of all live births [6]. The number of low birth weight babies is mainly concentrated in two regions of the developing world i.e., Asia and Africa. Prevalence of LBW is highest in south Asia than elsewhere [7]. India is a developing country with high infant mortality rate, which is characterized with substantial number of neonatal deaths. LBW is one of the major causes of neonatal and infant deaths in India. Since independence, prevalence of LBW in India has not shown any significant decline it remains high at 28.0%⁸. National Family Health Survey-III India, reported proportion of LBW babies

about 23% for rural and 19% for urban [9].

The percentage of low birth weight babies in Uttar Pradesh reported to be 17% in NFHS-III. As per the Annual Health Survey¹⁰ in Uttar Pradesh, out of total 26.1% children weighed at birth, 28.2% children were low birth weight. Despite launching of successive interventional programs; Child Survival and Safe Motherhood Program, RCH I and II for improvement of maternal and child health LBW reported remains consistently high in Uttar Pradesh.

In this context, the present study was designed to measure the rate of low birth weight in rural areas and to study effect of socio-demographic, anthropometric, and nutritional parameters of the expecting rural mothers in the third trimester of the pregnancy on the birth weight of neonate. This study will help in making decisions for better interventional efforts to tackle this enormous problem for the vulnerable rural population of the state.

Material and methods

Study Site: The present cross sectional study was conducted from October 2011 to May 2012 in Sarojini Nagar block, Lucknow, Uttar Pradesh. Lucknow is a capital city of Uttar Pradesh, a state in North India. According to census 2011, Lucknow had population of 45,88,455 and average literacy rate is 79.33%. Female literacy rate is 73.88%. There are eight development blocks in Lucknow district. Sarojini Nagar block is situated on Lucknow-Kanpur Highway. Study was conducted at the antenatal clinics of Primary Health Center and Community health centre of Sarojini Nagar. These health centers are well equipped with a lady medical officer, pediatrician and a full complement of field and hospital staff. Facility of 24 hr delivery is available at these centers.

Sample size

The sample size was based on the prevalence of low birth weight (28%) in India. Based on this assumption, sample size of 323 pregnant women was calculated with relative precision of 20% and design effect of 1.25. Three hundred and twenty three pregnant women who were in the early third trimester (28 - 30 weeks) of pregnancy were registered at the two health centers at Sarojini Nagar. Out of these, 291 pregnant women could be followed up to the time of delivery. Out of these 291 deliveries, 287 were single live births; four were still births or twin deliveries. The birth weight was measured in 287 live births which were included in the final analysis.

Data Collection

A predesigned, pretested schedule was prepared, to obtain information on maternal socio demographic characteristics, obstetric history, anthropometric parameters, and dietary intake after obtaining informed consent from the study subjects. Socioeconomic status was assessed by using modified Pareek's socioeconomic class. All the registered pregnant mother were thoroughly examined for general and systemic disorders with special reference to anemia, hypertension, eclampsia, urinary tract infection and for gross signs and symptoms of nutrition deficiencies of vitamins and minerals. Hemoglobin estimation of the mother was also done at the time of enrolment. A written consent to participate in study was obtained from each participant.

Anthropometric measurements of mother and newborn

The WHO (1992) define low birth weight as weight at birth of less than 2.5 kg (up to and including 2.4999) irrespective of gestational age and recommended an additional demarcation of 1500 gms to define very low birth weight. The babies' weight was measured by a standard scale to the nearest 10 gms. The baby was weighed immediately at birth by the trained staff. In order to exclude inter observer variation the measurements were taken within 24 hours of the birth by the research investigator in the postnatal ward.

Gestation period was estimated using the date of last menstrual period, if it was available, and was within two weeks of the best clinical estimate of gestational age at birth; otherwise, the best clinical estimate was used.

Maternal anthropometry included mother's height and weight. Anthropometric examination of mother was done at the time of registration in the study and mother's weight was also measured second time at the time of delivery by the trained staff or research investigator. Mother weight was measured by using bathroom type weighing scale to the nearest 100 gms. Physical activities in the study were classified as mild (sedentary), moderate and heavy (hard) as per ICMR guidelines [11]. Non-stretchable measuring tape was used to record the height of the mother.

Assessment of Hemoglobin level

Blood specimen was analyzed by Sahli's method at the Primary Health Centre, Sarojini Nagar laboratory for haemoglobin estimation by the senior laboratory personnel.

Diet survey

The dietary assessment of the pregnant women was done at time of registration in the study. History of food intake was obtained by 24 hrs. dietary recall method for previous day. Questions were asked from the subject about all the food and drinks consumed by them during the previous day. They were also asked about method of food preparation, approximate size/portion of meals taken. Standard cups and measures were used to measure the quantity of intake of cooked food. The consumption of daily diet was calculated in terms of the following food groups (in gms): cereals, pulses, root / tubers, green leafy vegetables, fruits, milk, oil, sugar and meat/ fish poultry. The daily intake of Calories (Kcal), proteins (gms), Calcium (mg), iron(mg) and vitamins was calculated and compared with recommended daily allowances tables as provided by Indian Council of Medical Research [12].

Statistical Analysis

The data was entered on Microsoft excel sheet and was analyzed by using SPSS version 13.0. Means and standard deviations (SD) were calculated for all maternal anthropometric parameters, gestational age and weight. Numerical variables were analyzed by student's t- test and one way ANOVA. When the one-way ANOVA test results were found to be significant, the Scheff's test was applied to determine whether significant difference existed between different variables. For categorical variables, Chi- square test was used. A multivariate logistic regression analysis was performed to identify the independent relationship of the relationship which was found significant in the bivariate analysis, variables with low birth rate. Results were considered significant if $p < 0.05$

Results

Characteristics of pregnant women

The mean age of pregnant women was 24.6± 4.0 years and the age range was 18-40 years. Majority (76.0%) of pregnant women were in 21-30 years of age group. Two percent of women were < 20 years of age at the time of survey. Majority (91.6%) of women were Hindu. None of the mother belonged to socioeconomic class I and II and half of the pregnant women belonged to socioeconomic class IV. About forty percent of the women were illiterate and 17.6% of women had education intermediate or above. About 15% of the pregnant women were involved in agriculture activities or working as laborers. Mean monthly income of families was 4106.96± 2460.43 INR. The number of first-born babies was 41.5 %.

Newborn characteristics

Out of 287 newborns, 55.9% of babies were male. Forty-eight (16.7%) infants were preterm births, thirteen percent of

newborns were small for gestational babies, and 0.4% was large for gestational age as per the foetal infant growth chart. Overall mean birth weight was 2.62gms±0.444 SD. Birth weight ranged from 1500 to 4000 gram. There were 13.6 % newborns with birth weight less than or equal to 2000gm and 9.8% were above 3000gm. Incidence of low birth weight was found to be 28.6% (Table 1). Mean birth weight of among low birth weight babies was 2.092gms+0.176 SD. Among LBW, 56.1% babies were preterm and 53.7% babies were small for gestational age (SGA). Prevalence of LBW was lower in term babies (14.8%) in comparison to preterm babies (95.8%) and post term (20.0%). In low birth weight group, 47.6% were males and 55.9% were females. The birth weight of male and female newborns was not significantly different. Mean weight of term babies was 2.72gms±0.399 SD and it was significantly higher than the mean birth weight of pre-term babies (2.14gms±0.357SD). Prematurity was found to be significantly associated with low birth weight.

Table I: Distribution of the Newborns by the birth weight and gestational age

	Total N=287	Pre term N=48, (16.7%)	Term N=229, (79.8%)	Post term N=10, (3.5%)	
<2500 gm	82 (28.6)	46 (95.8)	34(14.8)	02 (20.0)	2.09±0.176
2500-3000 gm	177 (61.7)	01(2.1)	168 (73.4)	08 (80.0)	2.76±0.257
>3000 gm	28 (9.8)	01(2.7)	27(11.8)	0	3.25±0.426
Birth weight (Mean±SD)	2.62±0.444	2.14±0.357	2.72±0.399	2.60±0.335	

Anthropometric and haemoglobin parameters of the mothers (LBW Vs NBW)

Anthropometric measurements of the women at time of enrolment in third trimester are given in table (II). Age of the expecting mothers of low birth weight group was significantly less than that of the mothers of the normal birth weight. The overall mean weight of the mothers was (47.7

Kg± 5.7 SD) in the third trimester; it was significantly higher in the normal birth weight group than low birth weight group. Average weight gain/week was 4.7 Kg± 1.2SD and mean haemoglobin level in the study participants was 10.08 g/dl ±1.2 SD. No significant difference in height of the two groups was observed.

Table 2: Anthropometric parameters and hemoglobin level of the mothers (NLBW Vs LBW babies)

Maternal characteristics	Overall Mean (±SD)	Normal weight Mean (±SD)	Low birth weight Mean (±SD)	P value
Age(yrs)	24.6± 4.0	24.9±3.9	23.7±4.17	0.021*
Weight (kg) at early third trimester	49.0±5.6	49.2±6.1	47.7±5.7	0.024*
Height (cm)	148.8 ± 5.6	149.0±5.8	148.3±5.6	0.383
BMI(Kg/m ²) at early third trimester		22.3±2.9	21.7±2.7	0.099
Hemoglobin levels (g/dl) in third trimester	10.08±1.2	10.2±1.13	9.62±1.48	0.001*
Average gain in weight in third trimester	4.7± 1.2	4.9±1.1	4.3±1.3	0.000*

*p<0.05

Dietary intake of the pregnant women

Energy and other nutrient intake of the pregnant women in the third trimester of the pregnancy are presented in table (III). Except Thiamine, Riboflavin and Vitamin C, intake of all other nutrients by the women in our study was less in

comparison to recommended daily allowance for Indian pregnant female. Dietary intake of energy, protein, calcium, iron, vitamin A, thiamine, Riboflavin, Niacin, Vitamin C and Folic acid was significantly higher in normal birth weight babies than the mothers of low birth weight babies.

Table 3: Dietary intake by pregnant women in third trimester of pregnancy (NLBW Vs LBW)

Dietary Intake (per day)	RDA during pregnancy	Overall intake Mean (±SD)	% Adequacy of intake	Normal weight Mean (±SD)	LBW Mean (±SD)	P value
Energy (Cal)	2250	2006.4± 340.0	89.1	2038.3 ± 340.0	1926.2±328.6	0.012*
Protein (gm)	78	57±11.7	74.1	58.8 ±11.8	54.6 ±11.1	0.006*
Calcium (mg)	1200	911.2±210.9	75.9	932.0 ±192.5	858.8±245.0	0.008*
Iron (mg)	35	29.9±5.5	86.1	31.1±5.2	26.9 ±5.3	0.001*
Vitamin A (µg)	800	608.4 ± 161.2	76.1	636±148.7	541.1±174.3	0.001*
Thiamine (mg)	1.2	1.2 ± 0.2	100.0	1.3±0.2	1.1±0.2	0.001*
Riboflavin (mg)	1.4	1.6± 0.2	114.3	1.7±0.2	1.5±0.3	0.001*
Niacin (mg)	14	11.9 ± 2.1	85.0	12.3±2.0	10.5±1.6	0.001*
Vitamin C (mg)	60	113.3 ±2.1	188.8	127.5±26.5	83.1±26.9	0.001*
Folic acid (µgm)	400	196.2 ±38.4	49.1	208.2 ± 30.6	165.1 ± 40.3	0.001*

Discussion

In the present study, the incidence of LBW, was found to be high (28.6%). Overall mean birth weight was 2.66gms+0.444 SD. Incidence of low birth weight has not shown any significant change in last three decades in Lucknow in last three decades, Azam *et al.* [13] reported LBW of 18.2% with mean birth weight of 2.8 kg in 1980. Krishnan *et al.* [14] reported it about 23.1% in their study in 1988. Idris *et al.* [1] reported overall incidence of LBW of 32.3% and mean birth weight of 2669.7 gm + 447SD in 2000 in Lucknow. Kaur S *et al.* [15] and Kaushal SK *et al.* [16] also reported similar high rates of LBW from other districts of Uttar Pradesh. Gagan *et al.* [17] reported overall prevalence (32.3%) of LBW in

Meerut, with high proportion of LBW among mother living in rural areas.

Maternal socio-demographic characteristics and birth weight of the newborn

The weight of the child at birth is a powerful predictor of infant growth and survival, and is dependent on maternal socio-demographic correlates (Table IV). In the present study, beneficial effect of maternal as well as father's education was observed; mean birth weight of newborns was significantly higher in families where mother or father were educated high school and above. Dasgupta *et al.* [18] and other researchers [19, 20] also found that duration of maternal education significantly affects the risk for LBW.

Table 4: Maternal socio demographic characteristics and its relationship with birth weight

Variable	Total N= 287,%	LBW n= 2,%	Birth weight Mean +SD	F/t value
Age (yrs)				
≤ 20	50 (17.4)	44.0	2.430±0.386 ^a	4.39*
21-25	136 (47.4)	29.4	2.634± 0.441 ^{abc}	
26- 30	82 (28.6)	18.3	2.707±0.437 ^{bc}	
>30	19 (2.6)	26.3	2.671±0.522 ^{abc}	
Maternal education				
Illiterate	102 (35.5)	29.4	2.554 ± 0.422 ^b	7.61*
Up to Junior High School	101(35.2)	32.7	2.556 ± 0.395 ^b	
High School and above	84 (29.3)	22.6	2.778 ± 0.490 ^a	
Paternal education				
Illiterate	66(23.0)	36.4	2.508 ± 0.428 ^b	5.27*
Up to Junior High School	93 (32.4)	30.1	2.589 ± 0.409 ^{a,b}	
High School and Above	128 (44.6)	23.4	2.708 ± 0.462 ^a	
Religion				
Hindu	262 (91.3)	27.9	2.630±0.446	1.08
Non- Hindu	25 (8.7)	36.0	2.534 ±0.417	
Caste				
General	25 (8.7)	20.0	2.710±0.378	2.30
OBCs	139 (48.4)	27.3	2.662±0.472	
SC/STs	123 (42.9)	31.7	2.554±0.418	
Socioeconomic status*				
III	58 (20.2)	15.5	2.812±0.405 ^a	8.78*
IV	169 (58.9)	29.6	2.597±0.453 ^b	
V	60 (20.9)	38.3	2.500±0.398 ^b	
Type of family				
Nuclear	127 (44.3)	28.4	2.593±0.427	8.41
Joint	160 (55.7)	28.7	2.643±0.458	
Gravida				
1	119 (41.5)	37.8	2.568±0.463	1.52
2	67 (23.3)	20.9	2.670±0.390	
>=3	101 (35.2)	22.8	2.633±0.453	
Inter pregnancy interval (yrs)				
<1	17 (10.2)	29.4	2.573±0.560	1.27
1-2	54 (32.3)	29.6	2.592±0.416	
2-3	61 (35.9)	18.0	2.695±0.386	
>3	36(21.0)	13.9	2.743±0.437	

Values of different superscripts are significantly different according to Scheffe's test

*p<.05

We found that proportion of low birth babies was significantly high among the mothers of lower socioeconomic status. However, it lost its significant effect on applying multivariate analysis. Elshibly *et al.* [19] also reported no association between maternal social class and birth weight of the baby.

Another maternal correlate, which turned out to be a risk factor for the birth weight of the newborn, was age of the mother. In our study, mean birth weight (2.44gms±0.386 SD) was significantly lowest in the mothers less than 20 years of

age than the mothers of other age group. Researchers [18, 20] from other parts of the country reported, also reported that mothers aged below 20 years had significantly greater chance to deliver low birth weight baby than the mothers of 20 years of above age group. Contrary to this, Negi *et al.* [21] did not observe any association of LBW with the age of the mother.

We observed that incidence of the low birth weight was significantly high (37.8%) in the primigravida mothers. Hirve *et al.* [22] found a 1.3 higher relative risk for LBW in

primipara mothers. In the present study, rate of LBW fell upto gravida four and again rose in gravid five and was highest for gravid six (66.7%) women. Among gravid six mothers, mean birth weight of neonate was lowest (2.25gms \pm 0.423SD). Gagan *et al.* [17] have reported similar trends for association of parity with birth weight.

Anthropometric parameters and haemoglobin level of the mothers and birth weight of the newborns

On multivariate analysis, weight of the mother in the third trimester and average gain in weight/ week by the mother in

third trimester was found to be significantly associated with the rate of low birth weight (Table V). Agarwal *et al.* [20] found a highly significant association between maternal weight and birth weight of the baby. Mumbrae *et al.* [23] reported maternal weight as one of the important risk factor for low birth weight. Pregnant women with weight less than 45 kg in third trimester of pregnancy gave birth to neonate with mean birth weight of 2.5kg \pm 0.402 SD while pregnant women more than 55 kg in weight gave birth to 2.7kg

Table 5: Antenatal Care Related Variables and Its Relationship with Birth Weight

	N = 287	LBW n = 82	Birth weight Mean + SD	F/t value
Consumed IFA supplementation		%		
0-30	128 (44.6)	35.9	2.543 + 0.437 ^a	4.49*
31-60	82 (28.6)	24.4	2.642 + 0.440 ^{ab}	
>60	77 (26.8)	20.8	2.731 + 0.440 ^b	
Rest during day (hrs)				
<2 hrs	107 (37.3)	44.9	2.442 \pm 0.420	4.48*
\geq 2 hrs	180 (62.7)	18.9	2.729 \pm 0.424	
Consumed Supplementary nutrition from AWCs				
Yes	119 (41.5)	21.0	2.705 \pm 0.416	2.4*
No	168 (58.5)	33.9	2.563 \pm 0.455	
Physical Activity*during pregnancy				
Mild	247 (86.7)	26.3	2.654+ 0.447 ^b	5.83*
Moderate	35 (12.2)	37.1	2.461 \pm 0.378 ^{ab}	
Heavy	05(1.7)	80.0	2.160 \pm 0.260 ^a	
Tobacco intake during pregnancy				
No	254 (88.5)	26.8	2.642 \pm 0.443	2.1*
Yes	33 (11.5)	42.4	2.470 \pm 0.438	
<i>Tobacco chewing</i>	30	36.7	2.501 \pm 0.432	
<i>Smoking</i>	03	100	2.083 \pm 0.144	
BOH in past				
Yes	40 (13.9)	40.0	2.501+ 0.432	1.87
No	247 (86.1)	26.7	2.600 \pm 0.438	
<i>H/O Abortions</i>	24 (8.4)	30.7	2.514 \pm 0.507	
<i>H/O still births</i>	11 (3.8)	54.6	2.372 \pm 0.405	
<i>Others</i>	05 (1.7)	40.0		
UTI during pregnancy				
Yes	43(15.0)	44.2	2.570 \pm 0.512	2.4
No	244 (85.0)	25.8	2.631 \pm 0.432	
Chronic illness at time of pregnancy				
Yes	09(3.1)	55.6	2.623 \pm 0.437	.069
No	278(96.9)	27.7	2.586 \pm 0.657	
<i>Hypertension</i>	04	100.0	2.212 \pm 0.217	
<i>Diabetes</i>	03	0.0	3.316 \pm 0.633	
<i>Tuberculosis</i>	02	50.0	2.250 \pm 0.353	
<i>Hydraamnios</i>	02	100.0	1.950 \pm .212	

\pm 0.464 SD neonate. This finding supports the view of Rao *et al.* [24] that efforts through interventions should be made to increase the mother weight by the time she reached the third trimester.

In the study, 40% of the pregnant women had less than 0.25kg/week weight gain in the third trimester of pregnancy. Mean weight gain during third trimester was 5.2kg \pm 1.1SD, 4.8kg \pm 1.1SD, 4.3kg \pm 1.0SD respectively in >3000gm, 2500-3000gm and <2500 gm respectively (p=0.000). Mean birth weight (2.26gm \pm .369SD) was significantly lower in women who gain <0.25kg weight per week than the other women groups. This shows it is very important to follow the weight gain recommendations during pregnancy. Improving maternal weight prior to conception and pregnancy weight gain are potential strategies to improve the birth weight [25].

Contrary to findings of other studies [23, 20] that taller women gave birth to heavy neonates, we found no significant association between the height of the mother and rate of low birth weight.

Among the enrolled study participants, only 29.3% of the mothers had normal (more than >11.9gm/dl) haemoglobin in the third trimester. Incidence of low birth weight was inversely proportional to the haemoglobin level. Proportions of low birth weight was significantly lower (17.9%) in the women with normal haemoglobin level as compared to anaemic mothers. The mean birth weight of severe anaemic mother group was 2.25gms \pm 0.362 SD. Difference in mean birth weight of 520 gms was observed between newborns with normal haemoglobin mothers and severe anaemic while in moderate anaemic mothers this difference was 268 gms.

Khatar *et al.* [26] reported relative risk of 1.82(1.04-3.18) of LBW in severe anaemic women in comparison to controls. Idris *et al.* [1] also reported high incidence of LBW (45%) in severe anaemic women. Others studies [20, 18, 27] also indicated the importance of normal haemoglobin and the birth weight of the babies and their results agree with findings of current study.

Antenatal care and birth weight of the newborn

Among antenatal care variables, (Table VI) we observed that proportion of birth with low birth weight was significantly lesser in mothers who had consumed more than 60 IFA

tablets during pregnancy. Mean birth weight of those newborns whose mothers had consumed more than 60 tablets of iron folic acid during pregnancy was 2.73gms±0.437 SD. Birth weight these babies was higher by 188 gms from those babies whose mothers had consumed no or less than 30 iron tablets. A placebo – controlled study [28] demonstrated that a supplemental of 60 mg of ferrous iron and 0.4 mg of folic acid daily from 11 weeks gestation significantly increases the birth weight. However the debate concerning prophylactic iron supplementation to pregnant women is still controversial and there exists no consensus on this important issue [25].

Table 6: Anthropometric parameters and hemoglobin level of the mothers and its relationship with the birth weight

	N = 287	LBW n = 82	Birth weight Mean ± SD	F/t value
Height (cm)				
<145	74 (25.8)	31.1	2.572 ±0.403	ns
145-150	109 (38.0)	25.1	2.663 ± 0.454	
150-155	80 (27.9)	31.3	2.584 ±0.480	
≥155	24 (8.4)	25.0	2.714 ± 0.383	
Weight(kg) at early third trimester				
<45	68 (23.7)	38.2	2.511±0.402 ^a	
45-55	164 (57.1)	28.7	2.610±0.440 ^a	6.58*
>55	55 (19.2)	16.4	2.795±0.464 ^b	
Average gain in weight/week in third trimester				
<0.25Kg/wk	124(43.2)	41.1	2.269±0.369 ^a	3.66*
0.25-0.50 Kg/wk	139 (48.4)	18.7	2.710±0.440 ^b	
>0.50 Kg/wk	24 (8.4)	20.8	2.735±0.511 ^b	
Hemoglobin level (g/dl) in third trimester				
<7.0	8 (2.8)	75.0	2.250±0.362 ^a	6.81*
7.0-8.9	33 (11.5)	39.4	2.510±0.428 ^b	
9.0-10.9	162 (56.4)	29.6	2.582±0.407 ^b	
>11.9	84 (29.3)	17.9	2.778±0.481 ^c	

Important mother related variables could be physical activity and rest by the pregnant women during pregnancy. It was found to be significantly associated with the birth weight of the baby. In the study, 18.5% women were working outside, in addition to domestic household works, during third trimester of the pregnancy. Most of them were working as labourers, involved in moderate to heavy physical activity. Among women involved in heavy activity, mean birth weight was found to be very low (2.16gms±0.260 SD). Mean birth weight of their babies was 300gm less than birth weight of babies of moderate worker. Other researchers in India have also demonstrated an inverse relationship between daily physical activity and birth weight in rural women, the majority of whom were involved in high level of physical activity related to the agriculture and domestic activities²⁴. Rest of two hours or more by pregnant women during day period was found to be significantly associated with low birth weight in the present study.

Effect of health related variable like addiction to tobacco on the birth weight of the neonates were also observed. Among participants, 11.5% women were either tobacco chewers or smokers. Unlike to the findings of the Agawral *et al.* [20], Bernstein *et al.* [29] and Gagan *et al.* [17], in our study consumption of tobacco in any form during pregnancy was not found to be a significant risk factor associated with the incidence of low birth weight. However all the smokers in

study had gave birth to low birth weight baby with mean birth weight of 2.083±0.144gms.

Similar to other Idris *et al.* [1], mothers with concomitant illness during pregnancy had higher proportion of LBW babies (55.6%) in comparison to healthy mothers. Rafati *et al.* [30] reported higher prevalence of LBW (60%) in women with history of UTI in comparison to 28% in women with no UTI. In our study UTI was reported by 15% of mothers and 44.2% of them delivered low birth weight babies.

Nutrient intake by the mothers and birth weight of the babies

Nutrient intake of almost all the nutrients was lower as compared to RDA by the pregnant women in the study (Table VII). Durrani *et al.* [31] also observed lower intake of calories, protein, calcium, iron, and folic acid in all trimesters of pregnancy. Significantly, high incidence of low birth weight was observed in the group who were taking less than recommended daily allowance of energy, protein, calcium and iron in their diet. Pregnant women with higher intake of folic acid, thiamine, niacin, riboflavin, and vitamin C gave birth to neonates with normal birth weight. This shows that dietary intake by the pregnant women as per recommended daily allowance can reduce the incidence of LBW significantly.

Table 7: Nutrient intake of mothers in third trimester of pregnancy and Its Relationship with Birth Weight

	N = 287	Low birth weight n = 82	Birth weight Mean + SD	F/t value
Calories (kcal/day)		%		
RDA ±10%	146 (50.9)	15.8	2.766± 0.416 ^b	35.7*
Deficiency > 10% -20% of RDA	52 (18.1)	19.2	2.725 ± 0.336 ^b	
Deficiency >20% RDA	89 (31.0)	55.1	2.326 ± 0.402 ^a	
Protein				
RDA ±10%	67 (23.3)	9.0	2.803 ± 0.349 ^b	14.3*
Deficiency > 10%- 20% of RDA	65 (22.6)	20.0	2.725 ± 0.428 ^b	
Deficiency >20% RDA	155 (54.0)	40.6	2.500 ± 0.452 ^a	
Iron				
RDA ±10%	142 (49.5)	19.7	2.711 ± 0.412 ^b	8.9*
Deficiency > 10% -20% of RDA	45 (15.7)	33.3	2.601 ± 0.515 ^{ab}	
Deficiency >20% RDA	100 (34.8)	39.0	2.505 ± 0.430 ^a	
Calcium				
RDA ±10%	73 (25.4)	17.8	2.768 ± 0.419 ^b	6.5*
Deficiency > 10% -20% of RDA	55 (19.2)	18.2	2.702 ± 0.430 ^b	
Deficiency >20% RDA	159 (55.4)	37.1	2.527 ± 0.434 ^a	
Folic acid				
RDA ±10%	169 (58.9)	35.5	2.548 ± 0.417	3.15*
Deficiency > 10% 20% of RDA	118 (41.1)	18.6	2.728 ± 0.433	
Deficiency >20% RDA	0	0	-	
Vitamin A				
RDA ±10%	78(27.2)	24.4	2.637 ± 0.417	0.079
Deficiency > 10% 20% of RDA	103 (35.9)	29.1	2.613 ± 0.433	
Deficiency >20% RDA	106 (36.9)	31.1	2.618 ± 0.476	
Thiamine				
RDA ±10%	207 (72.1)	25.6	2.637 ± 0.422 ^b	6.9*
Deficiency > 10% 20% of RDA	64 (22.3)	28.1	2.669 ± 0.497 ^b	
Deficiency >20% RDA	16 (5.6)	68.8	2.231 ± 0.323 ^a	
Riboflavin				
RDA ±10%	243 (84.3)	25.1	2.644 ± 0.426	2.89
Deficiency > 10%- 20% of RDA	22 (7.7)	59.1	2.411 +0.473	
Deficiency >20% RDA	22 (7.7)	36.4	2.586 ± 0.560	
Niacin				
RDA ±10%	136 (47.4)	21.3	2.683 ± 0.417	2.54
Deficiency > 10% -20% of RDA	32 (11.1)	34.3	2.587 ± 0.494	
Deficiency >20% RDA	119 (41.5)	35.3	2.561 ± 0.460	
Vitamin C				
RDA ± 10%	275 (95.8)	27.3	2.629± 0.442	2.34*
Deficiency >20% RDA	12 (4.2)	58.3	2.450±0.470	

To find out the most important predicting factors for birth weight, the binary logistic regression analysis was carried out on variables found to be statistically associated in univariate analysis : socioeconomic status, parity, consumption of IFA tablet, rest during day, type of physical activity, H/O UTI, age of mother, weight in third trimester and average gain in weight, haemoglobin level in third trimester, intake of

calories, protein, iron, calcium, folic acid , thiamine, riboflavin, Niacin and vitamin C, the results are presented in table VIII. The findings showed that haemoglobin level, maternal weight energy intake and gain in weight in third trimester by pregnant women could be considered as primary predictors for birth weight of neonates.

Table 8: Multivariate logistic regression analysis for determinants of low birth weight

	B	S.E.	Sig.	Exp(B)	95.0%CI.for EXP(B)	
					Lower	Upper
Maternal weight						
<45 kg					Reference	
45-55kg	-.462	.463	.319	.630	.254	1.563
>55 kg	-1.581	.669	.018	.206	.055	.763
Haemoglobin level						
<7.0					Reference	
7.0-8.9	-2.671	1.170	.022	.069	.007	.685
9.0-10.9	-3.190	1.116	.004	.041	.005	.367
>11.9	-2.958	1.186	.013	.052	.005	.530
Calorie intake						
RDA ±10%					Reference	
Deficiency > 10% -20% of RDA	.671	.715	.348	1.956	.482	7.942
Deficiency >20% RDA	2.125	.691	.002	8.374	2.162	32.433

Average weight gain		Reference				
<0.25Kg/wk						
0.25-0.50 Kg/wk	-1.117	.404	.006	.327	.148	.722
>0.50 Kg/wk	-.578	.706	.413	.561	.141	2.237

In the study, we observed increase in birth weight with proportionate increase in the energy consumption by the mothers. Mean intake of energy was 2006.4 Cal \pm 340 SD. An increase of more than 400 grams in mean birth weight was observed in the newborns of those mothers who had consumed energy equal or more to the RDA in their diet. Contrary to this, Durrani *et al.* [31] in their study at Aligarh reported no association between intakes of calories in third trimester by women with birth weight of the babies. However, Rao *et al.* [24] reported positive association between calorie intake in third trimester and birth weight of babies and opined that energy demand of foetus is higher in later half of the pregnancy. Similarly, Khoushabi *et al.* [27] reported energy, protein, and calcium intakes in third trimester are significantly correlated to the birth weight of the neonates. To bridge the gap of energy and protein intake in the diet of pregnant women, government is making an effort to provide energy and protein rich supplementary diet especially to poor women through ICDS. However, in our study, only about forty percent of women received the supplementary nutrition from AWW and half of them have taken major portion themselves.

Haemoglobin level of the mother was identified as one the independent predictor for the birth weight of the baby. About 70.0% of the pregnant women had haemoglobin less than 11.9 g/dl. But the problem is, among study participants, about forty percent of women had consumed diet >20% RDA iron deficient during their pregnancy and only 20% women had consumed more than 60 tablets of IFA during pregnancy

Conclusion

Thus, the results of the present study reveal that the incidence of low birth weight is still high in the area. Maternal weight, haemoglobin level, energy intake by the mother in third trimester and average gain in weight in third trimester were significantly associated with birth weight of the neonates. This indicates that adequate nutrient intake by the mother is most important determinant for pregnancy outcome. Improving weight gain through with the effective reach of nutrition related programs (ICDS) to rural women along with nutrition education is needed to improve their dietary intake. It will optimise women health and will go a long way in improving the birth weight of the babies born to these undernourished mothers. Regular check-up of pregnant women for required gain in weight, haemoglobin estimation and consumption of recommended iron folic acid supplementation during antenatal period should be addressed on priority basis.

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