Original Article

Maternal Determinants of Low Birth Weight Newborns in Central India

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Abstract

Background: Low birth weight (LBW) is a major public health concern, especially in developing countries, and is frequently related to child morbidity and mortality. **Materials and Methods:** About 1000 live newborns on the 1st day of birth and their mothers were studied from the Department of Obstetrics and Gynaecology and Intensive neonatal care, Department of Pediatrics, Index Medical College Hospital and Research Centre, Indore, Madhya Pradesh, between January 2016 and December 2019. Examinations of mother and newborns were carefully carried out in all cases recorded on a pretested and predesigned data capturing form. **Results:** The present study comprises observations made on 1000 newborns and their mothers admitted to a tertiary care teaching hospital, Indore, Madhya Pradesh. In LBW group, 145 (29%) were preterm, 347 (69.4%) term, and 8 (1.6%) post term while in LBW group 399 (79.8%) were term. The mean birth weight of preterm babies was 1860 ± 442.044 g and of term babies 2570 ± 400.72 g. This observed difference was statistically significant ($t = 18.43$, $P < 0.001$). Primipara mothers had highest number of LBW babies (39.4%) whereas second para mothers had maximal normal birth weight (NBW) babies (38.2%). **Conclusion:** Mothers below 20 years and above 30 years of age, primipara, poor caloric, and protein intake during pregnancy gave births to more number of LBW babies than NBW babies. In multiparas with spacing of 2 years or less, the number of LBW babies was more than NBW babies. Maternal weight and weight gain during pregnancy also found to have a definite correlation with birth weight.

Keywords: Determinants, India, low birth weight, maternal factors, newborn, normal birth weight

Introduction

Low birth weight (LBW) is a major public health concern, especially in developing countries, and is frequently related to the child morbidity and mortality.[1] LBW is a major public health concern and one of the strongest single risk factors for early neonatal mortality and morbidity.[2] According to the World Health Organization (WHO), the prevalence of LBW is 15.5% globally, and 96.5% of LBW infants are born in developing countries.[3]

The birth weight of an infant is the first weight recorded after birth, ideally measured within the 1st h after birth, before significant postnatal weight loss has occurred. LBW is defined as a birth weight of <2500 g (up to and including 2499 g), as per the WHO.[4] This definition of LBW has been in existence for many decades. In 1976, the 29th World Health Assembly agreed on the currently used definition. Prior to this, the definition of LBW was "2500 g or less." LBW is further categorized into very LBW (<1500 g) and extremely LBW (<1000 g).[4] LBW is a result of preterm birth (short gestation <37 completed weeks), intrauterine growth restriction (also known as fetal growth restriction), or both.[5]

It is a significant factor associated with higher probabilities of infection, greater susceptibility to childhood illness, lower chances of child survival, long-term physical and mental deficiencies, and problems related to behavior, learning, and psychosocial improvements during childhood.[6] The determinants of LBW can be broadly classified as genetic, constitutional, obstetric, nutritional, related to maternal morbidities in the antenatal period, toxic exposure-related, and linked to antenatal care (ANC). Other factors including

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smoking, maternal age, birth spacing, ANC, anemia, genital infections, maternal ill health, and stress have also been reported.[7]

Socioeconomic, cultural, biological, maternal, obstetric, and fetal factors, identified in previous studies as contributory factors, were summarized. In regard to social, economic, and cultural factors, LBW is positively correlated with (1) low socioeconomic status; (2) poor maternal diet; (3) short birth intervals; (4) illegitimacy; (5) the performance of strenuous work during the past 6 weeks of pregnancy; (6) low maternal education; and (7) smoking. Biological factors positively associated with LBW include (1) early and late maternal age; (2) 1st births; (3) low maternal weight and short maternal stature; (4) the birth of females; (5) slow maternal growth patterns; and (6) high altitude pregnancies. Maternal factors positively associated with LBW include (1) the presence of maternal tuberculosis, heart disease, renal failure, and hypertension; (2) low maternal caloric and protein intake; (3) maternal anemia; (4) obstetric complications; (5) a history of previous low weight births, abortions, stillbirths, or premature births; (6) various uterine and placental factors; (7) multiple pregnancies; and (8) inadequate prenatal care. Fetal factors associated with low weight births include fetal infection and congenital abnormalities.[5,8,9]

A number of studies from India and abroad are published in literature dealing with this problem, but most of those studies have concentrated over one or few of the causative factors. The frequency of LBW as well as relative importance of its underlying causative factors varies from place to place and time to time.

The aim of the present study was to find out the incidence of LBW in this region and to identify various risk factors responsible for it so that high risk mothers can be detected earlier. It will help in future to suggest adequate measures to improve the birth weight of babies, which in turn will help in reducing the neonatal and infant mortality and morbidity and improve the wellbeing of children.

Aims and objectives

The study was done to find out the prevalence of LBW and prematurity in hospital deliveries. The study would reveal distribution of LBW in various socioeconomic, occupational, ethnic, environmental, and literacy groups and its comparison with normal birth weight (NBW). The study also aims to reveal the frequency and extent of various epidemiological factors affecting birth weight.

Materials and Methods

About 1000 live newborns on the 1st day of birth and their mothers were studied from the Department of Obstetrics and Gynaecology and Intensive Neonatal Care, Department of Pediatrics, Index Medical College Hospital and Research Centre, Indore, Madhya Pradesh, between January 2016 and December 2019. Selection of cases was done into two groups based on their birth weight. Institutional ethics committee permission and individual consent were taken before enrolment of the study participants. Newborns weighing ≤2500 g were put under category of LBW and those weighing >2500 g were designated as NBW babies (control group). After taking relevant history, examinations of mother and newborns were carefully carried out in all cases recorded on a pretested and predesigned case record form. Socioeconomic status of parents was noted. Maternal history such as obstetric, ANC, caloric intake, physical exertion during different trimesters, duration of rest in pregnancy, and any associated acute or chronic systemic disease before or during pregnancy and its duration were noted. Drug(s) intake (if any) and radiation exposure (if any) during 1st two trimesters were noted from subject's hospital records.

Besides anthropometric measurements, general and systemic examination was done. Whenever prepregnancy weight was known or recorded on antenatal examination cards was noted. Serial recordings of weight of mother, if available were noted for knowing weight gain. Hb estimation, blood pressure recording, and urine examination for albumin data were captured.

Weight of the baby was taken on a beam and pan type weighing scale (Detecto Scale). The scale was frequently checked with standard weight and zero error was adjusted each time before weighing. Detailed general and systemic examination of newborn was carried out for any evidence of congenital malformation, birth trauma, and birth asphyxia.

When the last menstrual period was known, gestational age was calculated by dates. Gestation was further assessed by modified Dubowitz scoring system.[10] If there was a difference of >2 weeks in the two values of gestational age, the gestational age was calculated by Dubowitz scoring system.[11] A beam and pan type weighing scale was kept in the labor room. Placenta of 297 newborns was weighed on that scale just after delivery and removal of maximum possible clots and cutting the cord.

The frequency distribution tables for various variables were calculated in the standard way, Chi-square test was used to test for dependence of one factor over the other.

Results

The present study comprises observations made on 1000 newborns and their mothers admitted in a tertiary care teaching hospital, Indore, Madhya Pradesh.

In LBW group, out of 500 babies 145 (29%) were preterm, 347 (69.4%) term and 8 (1.6%) post term while in LBW group 399 (79.8%) were term. Only 9 (1.8%) were borderline preterm and remaining 92 (18.4%) were postterm. This difference was statistically very highly significant [Table 1].

Table 2 shows that mean birth weight of preterm babies was 1860 ± 442.044 g and of term babies 2570 ± 400.72 g. This observed difference was statistically significant (t = 18.43, P < 0.001). Similarly, mean birth weight of postterm babies

Table 1: Distribution of cases according to weight and gestational age

Weight (g)	Total number (%)	Preterm (%)	Term (%)	Postterm (%)
1000-1500	37 (7.4)	35 (24.1)	2 (0.7)	-
1500-1750	35 (7)	25 (17.2)	10 (2.9)	-
1750-2000	78 (15.6)	35 (24.1)	41 (11.6)	2 (25)
2000-2250	142 (28.4)	30 (20.7)	108 (31.2)	4 (50)
2250-2500	208 (41.6)	20 (13.8)	186 (53.6)	2 (25)
Total	500 (100)	145 (100)	347 (100)	8 (100)
2500-3000	405 (81)	8 (88.9)	319 (80)	78 (85)
3000-3500	80 (16)	1 (11.1)	68 (17)	11 (12)
>3500	15 (3)	-	12 (3)	3 (3)
Total	500 (100)	9 (100)	399 (100)	92 (100)

χ^2=163.1829, P<0.001

Table 2: Birth weight in different gestational ages

Parameters	Preterm	Term	Postterm
Mean (g)±SD	1860±442.04	2570±400.22	2785±300.09
Range (g)	1050-3050	1250-3650	1850-3950
t	18.43	-	6.44
P	<0.001		<0.001

SD: Standard deviation

was 2785 ± 300.09 g. The difference from term babies was statistically very highly significant (t = 6.44, P < 0.001).

Below 20 years of maternal age, 25.2% (8% +17.2%) were LBW babies and 12.6% NBW babies. After 30 years, again number of LBW babies was higher than control group [Table 3].

Primipara mothers had highest number of LBW babies (39.4%) whereas second para mothers had maximal NBW babies (38.2%) but third para and onward the number of LBW babies increased. This difference was significant [Table 4].

The number of LBW babies was more when birth spacing 3 years or more; number of NBW babies was higher than LBW. This was statistically very highly significant. About 366 primigravida mothers were excluded from this observation Table 5.

As many as 351 pregnant women had caloric intake <2000 calories. About 297 (84.6%) of them had LBW babies. Mothers who took >2200 calories resulted in progressively increased incidence of NBW babies [Table 6].

The number of LBW babies was more with protein intake <45 g. This was statistically very highly significant [Table 7].

Mothers weighing <45 kg delivered significantly higher number of LBW babies than normal birth babies. This is statistically very highly significant [Table 8].

In 82.3% of mothers, prepregnancy weight was not known hence weight gain could not be calculated. Only in 17% of women record of prepregnancy weight was found. Out of these mothers, with weight was gain more than 8 kg during pregnancy

Table 3: Distribution of cases according to maternal age

Maternal age (years)	LBW (%)	NBW (%)	Total (%)
<18	40 (8)	14 (2.8)	54 (5.4)
18-20	86 (17.2)	49 (9.8)	135 (13.5)
21-25	237 (47.4)	277 (55.4)	514 (51.4)
26-30	114 (22.8)	140 (28)	254 (25.4)
>30	23 (4.6)	20 (4)	43 (4.3)
Total	500	500	1000
Mean (years)	22.9	23.8	23.4

χ^2=32.3335, P<0.001. LBW: Low birth weight, NBW: Normal birth weight

Table 4: Distribution of cases according to birth order/ parity

Parity	LBW (%)	NBW (%)	Total (%)
1	197 (39.4)	169 (33.8)	366 (36.6)
2	129 (25.8)	191 (38.2)	320 (32)
3	103 (20.6)	85 (17)	188 (18.8)
4	40 (8)	38 (7.6)	78 (7.8)
5	20 (4)	11 (2.2)	31 (3.1)
>5	11 (2.2)	6 (1.2)	17 (1.7)
Total	500	500	1000

χ^2=21.9582, P<0.05. LBW: Low birth weight, NBW: Normal birth weight

gave birth to less number of LBW babies (4.6%) only. This difference is statistically very highly significant [Table 9].

Discussion

LBW is an important cause of morbidity and mortality in infancy and neonatal period.[12] Magnitude of problem of LBW varies from place to place. Even the various factors associated with LBW have shown regional variation.[13,14] Etiology of LBW is not simple. It is a complex interplay of various contributory factors that result in LBW. Weight of newborn is determined by a variety of maternal, placental, fetal as well as socioeconomic and environmental factors.[15]

In the present study, in LBW group, out of 500 babies 145 (29%) were preterm, 347 (69.4%) term and 8 (1.6%) post term while in LBW group 399 (79.8%) were term. Only 9 (1.8%) were borderline preterm and remaining 92 (18.4%) were postterm. In India, various authors have given incidence of LBW ranging from 20% to 48%.[16-18] More than 20 million infants worldwide, representing 15.5% of all births, are born with LBW, 95.6% of them in developing countries. The level of LBW in developing countries (16.5%) is more than double the level in developed regions (7%). The prevalence of LBW is estimated to be 15% worldwide with a range of 3.3%–38% and occurs mostly in developing countries. According to NFHS III, the prevalence of low birth in India is 22%.[17,18]

In the present study, as many as 25.2% of all LBW infants were born to mothers aged 20 years or below. The highest number of NBW babies, i.e., 277 (55.4%) was born to mothers aged were born to mothers aged 21–25 years. Mothers >20 years showed a steady increase in NBW babies in comparison to number of

Table 5: Distribution of cases according to birth spacing

Birth spacing (years)	LBW (%)	NBW (%)	Total
1	90 (29.7)	30 (9)	120
2	125 (41.2)	75 (22.7)	200
3	43 (14.1)	133 (40.1)	176
4	23 (7.6)	40 (12.1)	63
5	12 (4)	40 (12.1)	52
6	10 (3.4)	13 (4)	23
Total	303	331	634

χ^2=139.68, *P*<0.001. LBW: Low birth weight, NBW: Normal birth weight

Table 6: Distribution according to calories intake of mothers

Calories intake	LBW (%)	NBW (%)	Total (%)
<2000	297 (59.4)	54 (10.8)	351 (35.1)
2001-2200	154 (30.8)	46 (9.2)	200 (20)
2201-2400	31 (6.2)	63 (12.6)	94 (9.4)
2401-2600	18 (3.6)	271 (54.2)	289 (28.9)
>2600	-	66 (13.2)	66 (6.6)
Total	500	500	1000
Mean caloric intake	1950	2389	2170

χ^2=524.9288, *P*<0.001. LBW: Low birth weight, NBW: Normal birth weight

Table 7: Distribution according to protein intake of mothers

Protein intake (g)	LBW (%)	NBW (%)	Total (%)
<30	20 (4)	14 (2.8)	34 (3.4)
31-35	46 (9.2)	26 (5.2)	72 (7.2)
36-40	103 (20.6)	17 (3.4)	120 (12)
41-45	174 (34.8)	69 (13.8)	243 (24.3)
46-50	114 (22.8)	117 (23.4)	231 (23.1)
>50	43 (8.6)	257 (57.4)	300 (30)
Total	500	500	1000
Mean protein intake (g)	40.85	47.72	44.28

χ^2=266.3107, *P*<0.001. LBW: Low birth weight, NBW: Normal birth weight

LBW babies. However, after 30 years, this difference was not significant. These findings are in agreement with observations of the above-mentioned authors. In the present study, the mean age of mothers of LBW babies was found to be 23 years while that of mothers of NBW babies was 24 years.

Contributing factors for LBW are multifaceted and include factors such as maternal age, poor maternal nutritional status, and nonpregnant weight, gestational age, intervals between pregnancies, parity, educational status, violence during pregnancy, lack of ANC, and very low socio-economic status.[19,20] In India, low body mass index (BMI), short stature, anemia, and/or other micronutrient deficiencies are known to increase the risk of giving birth to a baby with LBW.[20,21] Kader *et al*.'s study showed women with poor nutritional status, reflected in low BMI (<18.5) had 49% higher odds of having LBW infants.[21] These findings are in agreement with our study and previous studies where low prepregnancy BMI

Table 8: Distribution of cases according to maternal weight

Maternal weight (kg)	LBW (%)	NBW (%)	Total (%)
<35	49 (9.8)	4 (0.8)	53 (5.3)
36-40	151 (30.2)	14 (2.8)	165 (16.5)
41-45	163 (32.6)	74 (14.8)	237 (23.7)
46-50	100 (20)	257 (51.4)	357 (35.7)
51-55	17 (3.4)	94 (18.8)	114 (11.9)
56-60	17 (3.4)	51 (10.2)	68 (6.8)
61-65	-	6 (1.2)	6 (0.6)
>65	3 (0.6)	-	-
Total	500	500	1000
Mean maternal weight (kg)	42	48.5	45.3

χ^2=333.944, *P*<0.001. LBW: Low birth weight, NBW: Normal birth weight

Table 9: Distribution according to maternal weight gain during pregnancy

Maternal weight gain (kg)	LBW (%)	NBW (%)	Total (%)
0-2	-	3 (0.6)	3 (0.3)
3-4	3 (0.6)	3 (0.6)	6 (0.6)
5-6	11 (2.2)	14 (2.8)	25 (2.5)
7-8	17 (3.4)	17 (3.4)	34 (3.4)
9-10	17 (3.4)	49 (9.8)	66 (6.6)
10-11	3 (0.6)	31 (6.2)	34 (3.4)
>12	3 (0.6)	6 (1.2)	9 (0.9)
Prepregnancy weight not known	446 (89.2)	377 (75.4)	823 (82.3)
Total	500	500	1000

χ^2=18.9093, *P*<0.001. LBW: Low birth weight, NBW: Normal birth weight

was significantly associated with LBW of an infant.[22,23] Low maternal BMI is a marker for marginal tissue nutrient reserves and a predictor of protein-energy malnutrition, which may affect fetal growth.[24]

Borah *et al*.'s study found a significant association between the birth weight and teenage pregnancy. It may be due to the fact that teenage mothers are both physically and mentally less capable for bearing the burden of pregnancy.[25]

Banerjee *et al*. also found that the incidence of LBW was significantly higher among the teenage mothers.[26] A significant association was found between mother's education status and birth weight of babies in the present study. Similarly, Kader *et al*. also reported that the percentage of LBW babies among illiterate mothers was high.[21] Borah *et al*.'s study found most of the mothers of LBW babies were found to be anemic during the antenatal period.[25]

Similarly, Mumbare *et al*. observed that maternal anemia is associated with delivery of a LBW infant.[27] Borah *et al*.'s study found that short inter-pregnancy interval (IPI) was significantly associated with LBW of the baby.[25] Metgud *et al*. also had similar findings.[28] The study found that among those mothers who had less weight gain during pregnancy, mothers with previous history of abortion, and mothers of short stature,

the percentage of LBW was more. A study by Phaneendra Rao *et al*. also found that maternal height and weight gain during pregnancy were associated with birth weight.[29]

Babies with first birth order were associated with a 13% increased risk of LBW as compared to the second birth order in the multivariate analysis. This is similar to the previous literature which showed that birth weight increases up to 3rd birth order and decreases thereafter.[30-32] Both maternal age and birth order are important determinants of LBW and having first pregnancy at an adolescent (<18 years) or advanced (>35 years) age is associated with increased risk of LBW.[33] A true picture of incidence of LBW is possible if country wide registration of birth with birth weight is done. The birth weight increases steadily between 21 and 30 years and again falls when mothers were between 31 and 40 years.

The influence of parity on birth weight has been observed since long by many workers. In the present study, primiparae mothers had maximum number of LBW babies than the subsequent parties and mothers with 2nd parity had the maximum number of NBW babies. The pattern of variation is just reversed in 3rd parity and onward. Raman *et al*.'s study revealed maternal age, parity, and spacing interval are important epidemiological causative factors for the high incidence of LBW babies. Sixty-one percent of SGA neonates were born to mothers in the age group of 19–25 years. Mother below 18 years of age delivered 4.6% of SGA neonates.[33] There is general agreement that pregnancy outcomes are more favorable for multiparae than primiparae, with the exception of grand multiparity.[34] In a prospective Raman *et al*.'s study have reported primiparas contributing significantly to the incidence of LBW neonates. They also showed 40.7% of SGA neonates were born to primipara mothers as compared to 37.6% to 2nd para and 17.5% to third para.[33] Another Indian study has observed that newborn of primiparae were 150 g lighter than those of the second para.[35] Short spacing interval between pregnancies is a confounding factor to nutritional deficiency and inadequate physiological recovery.[9]

In the present study, with the spacing of 2 years or less between 2 successive births, the number of LBW babies was more (70.6%), while the spacing of >2 years the number of NBW babies was higher than the LBW babies. Parity may modify the association between short birth spacing and LBW. Women with very short IPI and high parity may have a higher risk of having LBW infants than those with very short IPI but low parity.[36]

In the present study, a good correlation was found between daily caloric intake during pregnancy and birth weight of child. As many as 297 mothers (59.4%) who gave birth to LBW babies had caloric intake <2000 kcal/day. The corresponding figure in mothers who gave birth to NBW babies was 54 (10.8%). Durrani's and Rani's study showed protein intake in all trimesters found to be positively correlated with birth weight (r = 0.237, 0.279, 0.348 in the first, second, and third trimesters, respectively).[37] A higher prevalence of LBW babies was observed in pregnant women with mean protein intake of <40 g ($P < 0.001$).[38]

Conclusion

Mothers below 20 years and above 30 years of age, primipara, poor caloric, and protein intake during pregnancy gave births to more number of LBW babies than NBW babies. The mothers with 3rd parity onward also tend to have LBW babies. In multiparas with spacing of 2 years or less, the number of LBW babies was more than NBW babies. Maternal weight and weight gain during pregnancy also found to have a definite correlation with birth weight.

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Conflicts of interest

There are no conflicts of interest.

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