Original Article

Retrospective analysis to identify the association of various determinants on birth weight

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Abstract

Objectives: LBW is the strong determinant of neonatal morbidity and mortality with a global prevalence of nearly 15%. India's prevalence, though not yet established, ranges from 16-30% and influenced by maternal nutritional status, antenatal care and associated maternal morbidity. Hence, the study was aimed to determine the influencing parameters for occurrence of LBW. **Study Design:** A retrospective observational study conducted for all live newborns delivered in a tertiary care centre during the study period of twenty four months. **Methods:** Data from institutional medical record section was recorded on predesigned questionnaire from a total of 1216 newborns. **Results:** The percentage of LBW was found to be 27.55% (335/1216) with a proportion of LBW to NBW babies was approximately 1:3. The occurrence of LBW was significantly higher in babies of anemic mothers (59.39%, $P < 0.0001$), young mothers (30.39%, $P < 0.01$), mothers with parity ≥ 3 (35.71%, $P < 0.05$), those with <3 ANC check-up (56.88%, $P < 0.0001$) and those with premature delivery (71.57%, $P < 0.0001$). Maternal anemia (OR 4.7, 95%CI 3.4-6.7, $P < 0.001$); ANC with <3 visits (OR 2.2, 95%CI 1.4-3.4, $P < 0.01$) and prematurity (OR 7.6, 95%CI 5.1-11.2, $P < 0.0001$) were considered as independent risk factor for LBW. Significant association of neonatal complications was found with LBW babies (OR 1.6, 95%CI 1.1-2.5, $P < 0.05$). **Conclusions:** Inadequate antenatal care, maternal anemia and other maternal illness causing premature delivery are considered critical determinants for LBW and thus associated with high neonatal mortality and morbidity. Continued focus for improving the overall maternal health status would lead to lowering burden of LBW.

Keywords: Antenatal care, low birth weight, maternal anemia, maternal determinants, neonatal complications, prematurity, tertiary care hospital

Introduction

Low birth weight (LBW) is considered both as a prospective predictor for child's physical and mental growth as well as a retrospective indicator of maternal health status and nutrition. LBW is defined as live born baby with birth weight less than 2500gm. As per recent survey, UNICEF ascribed a prevalence of LBW to be nearly 15% globally.[1] Birth weight is considered an important tool to predict the future trend of the physical growth in the child. It aid in identification of at-risk families in order to initiate the intervention at an early period in order to achieve a quality life in countries with limited resources. WHO has fixed the Sustainable Development Goal (SDG) to achieve 30% reduction in LBW burden by 2025.[2]

Studies have documented wide variations in prevalence of LBW in different regions within the countries. It is of major public health concern in low- and middle-income countries and especially those from rural areas and from low socioeconomic strata. Though the

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exact burden in India is yet to be published by UNICEF, studies have found the incidence of LBW in India varying from 16 to 30%.[3,4] Chhattisgarh state reported 15% prevalence for LBW in the National Family Health Survey (NFHS4) survey whereas Nahrel *et al.* in their study reported prevalence of 55% in a tertiary care level hospital of North Chhattisgarh.[5,6]

Influence on birth weight of a newborn starts during its fetal life in-utero, under the influence of intrauterine factors and effect of maternal overall systemic factors. In a comparison study between NFHS 3 and NFHS 4, conducted by Khan *et al.*, LBW was observed to be more among female children and those born to mothers of younger age group.[7] Apoorva *et al.* in their study recorded greater proportion of LBW babies in rural population. The study also depicted maternal anemia and premature delivery as independent risk factors for LBW.[8] Borah *et al.* study found association of LBW with inadequate antenatal care (ANC) but a negative association with parity upto three.[9]

A great deal of factors including both un-modifiable genetic and sociodemographic factors to modifiable risk factors like maternal nutrition, maternal morbidity during antenatal period, drug exposures, antenatal care and obstetric condition, have been reported to influence the prevalence of LBW. Understanding the influence of these contributory factors towards low birth weight is therefore of considerable importance so as to identify the modifiable risk factors and initiate the preventive measures. Therefore, identification of modifiable risk factors especially the maternal factors would be beneficial in primary health care services in order to identify the high-risk mothers and start intervention at an earliest by modulating the maternal nutritional status and associated morbid conditions in order to maintain an optimum maternal and child health.

Considering the overall un-definable risk factors for LBW in Indian newborns, we undertook the present study to identify and assess the various determinants of LBW in newborns delivered in our institute.

Methods

A retrospective observational study was conducted for all live newborns delivered in a tertiary care center in a period of 24 months. The study was approved by the institutional ethical committee. Data from institutional medical record section was recorded on predesigned questionnaire that included maternal and neonatal demographic profile, and clinical details along with relevant medical and obstetric history available in the record. Data of all live births were included in the study. Live birth which had records with missing data, still births and neonatal deaths were excluded (Institute Ethics Committee on 19.08.2016).

Total 1216 newborns were included in the study out of 1526 live births delivered or admitted during that period. Birth weight less than 2500 gm were considered as LBW. The data was analyzed using SPSS version 20.0. Chi-square test for independence was performed to examine the association for different variables with LBW. Univariate and multivariate logistic regression analysis were applied to estimate the association between risk factors and LBW, where LBW is dependent variable. To determine the independent risk factors, multivariate logistic regression analysis was applied for the variables that depicted significant relationship with LBW in univariate logistic regression. P value <0.05 was considered significant.

Results

A total 1216 newborn were included in the study. The percentage of LBW was 27.55% (n = 335) as against 72.45% (n = 881) normal birth weight (NBW) babies [Figure 1]. The proportion of LBW to NBW babies was approximately 1:3.

Chi-square test for independence was performed to examine the association for LBW with different variables as depicted in Table 1. The proportion of LBW newborns did not differ by gender, (χ^2 = 2.4, P > 0.05). There was a significant difference in the proportion of LBW between mothers from rural areas compared to urban areas. The prevalence was more in rural (36.05%) than urban (22.9%) (χ^2 = 24.1, P < 0.0001) population. The occurrence of LBW was significantly higher in babies delivered to anemic mothers (Hb level < 11 gm%) (59.39%, P < 0.0001), mothers below 30 years age (30.39%, P < 0.01), mothers with parity ≥3 (35.71%, P < 0.05), those with <3 ANC check-up (56.88%, P < 0.0001) and those with premature delivery (71.57%, P < 0.0001) [Table 1]. No significant difference was observed in percentage of LBW delivered to mothers with significant antenatal medical or obstetrical history (χ2 = 0.9, P > 0.05).

Regression analysis was applied to find out the relationship of LBW with other factors as depicted in Table 2.

Univariate regression analysis revealed that rural population (OR 1.9, 95%CI 1.5-2.5, P < 0.01);maternal anemia (OR 7.9, 95%CI 5.9-10.4, P < 0.0001);younger mothers (OR 0.7, 95%CI 0.5-0.9, P < 0.01); high parity (OR 1.5, 95%CI 1.1-2.2, P < 0.05); <3

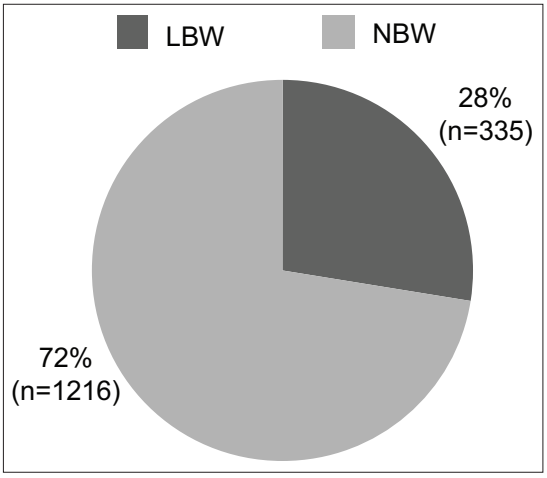

Figure 1: Prevalence percentage of LBW and NBW in the study population

Table 1: Distribution of socio-demographic and maternal factors affecting the Birth weight

	TOTAL NEWBORNS (*n*)	LBW *n* (%)	Chi square value	*P*
MALE	625	160 (25.6)	2.4	0.12
FEMALE	591	175 (29.61)		
URBAN	786	180 (22.90)	24.1	<0.0001
RURAL	430	155 (36.05)		
MATERNAL Hb <11 gm%	330	196 (59.39)	230.1	<0.0001
MATERNAL Hb ≥11gm%	886	139 (13.69)		
MATERNAL AGE <30	770	234 (30.39)	8.5	0.004
MATERNAL AGE ≥30	446	101 (22.65)		
PARITY <3	1076	285 (26.49)	5.3	0.022
PARITY ≥3	140	50 (35.71)		
ANC VISIT <3	218	124 (56.88)	114.5	<0.0001
ANC VISIT ≥3	998	211 (21.14)		
GESTATIONAL AGE <37 WKS	204	146 (71.57)	237.96	<0.0001
GESTATIONAL AGE ≥37 WKS	1012	189 (18.68)		
SIGNIFICANT ANTENATAL HISTORY +	399	117 (29.32)	0.9	0.3
SIGNIFICANT ANTENATAL HISTORY -	817	218 (26.68)		

Table 2: Univariate and multivariate logistic regression analysis of LBW with the variables

Characteristics	Univariable odds ratio (95% CI)	*P*	Multivariable odds ratio (95% CI)	*P*
Female	Ref	0.11	Ref	--
Male	0.9 (0.6-1.1)		---	
Urban	Ref	0.01		0.17
Rural	1.9 (1.5-2.5)		0.7 (0.5-1.1)	
MATERNAL Hb ≥11gm%	Ref	<0.0001	Ref	<0.001
MATERNAL Hb <11 gm%	7.9 (5.9-10.4)		4.7 (3.4-6.7)	
MATERNAL AGE <30	Ref	0.004	Ref	0.3
MATERNAL AGE ≥30	0.7 (0.5-0.9)		0.8 (0.6-1.2)	
Parity <3	Ref	0.02		0.47
Parity ≥3	1.5 (1.1-2.2)		1.2 (0.7-1.9)	
ANC VISIT ≥3	Ref	<0.001	Ref	<0.01
ANC VISIT <3	4.9 (3.6-6.7)		2.2 (1.4-3.4)	
GESTATIONAL AGE ≥37 WKS	Ref	<0.0001	Ref	<0.0001
GESTATIONAL AGE <37 WKS	10.9 (7.8-15.4)		7.6 (5.1-11.2)	
SIGNIFICANT ANTENATAL HISTORY-	Ref	0.33	--	-
SIGNIFICANT ANTENATAL HISTORY +	1.1 (0.8-1.5)		--	
NEONATAL COMPLICATIONS -	Ref	<0.001	Ref	0.02
NEONATAL COMPLICATIONS +	3.9 (2.8-5.4)		1.6 (1.1-2.5)	

ANC visits (OR 4.9, 95%CI 3.6-6.7, $P < 0.001$); and preterm delivery (OR 10.9, 95%CI 7.8-15.4, $P < 0.0001$) were significantly associated with LBW.

Multivariable analysis depicted significant association of maternal anemia (OR 4.7, 95%CI 3.4-6.7, $P < 0.001$); <3 ANC visits (OR 2.2, 95%CI 1.4-3.4, $P < 0.01$) and prematurity (OR 7.6, 95%CI 5.1-11.2, $P < 0.0001$) with LBW [Table 2].

The prevalence of neonatal complications was found to be significantly more ($\chi^2 = 73.7$, $P < 0.0001$) in LBW (29.55%; $n = 99$) than NBW babies (9.76%; $n = 86$) [Figure 2]. The common complications in LBW and NBW babies respectively were neonatal jaundice (8.96% and 2.5%), respiratory distress syndrome or neonatal asphyxia (7.16% and 2.95%) and neonatal infections (1.79% and 0.79%). Significant association of neonatal complications was found with LBW babies in the multivariate regression analysis (OR 1.6, 95%CI 1.1-2.5, $P < 0.05$).

Discussion

LBW has been a major challenging concern in developing countries like India. In India, according to National Family Health Survey conducted in 2015-16 (NFHS 4), prevalence of LBW was 16.4%.[7] In our study, proportion of LBW was found to be 27.55% [Table 1]. It was comparable to the prevalence percentages of 21.5% and 26% reported by Yadav *et al.* ($n = 306$) and Apoorva *et al.* ($n = 204$) in their studies on risk factors for LBW in newborns delivered in their respective institutions.[8,10]

Identifying the determinants of LBW can help in prioritizing high-risk mothers and thus enabling early intervention. Maternal

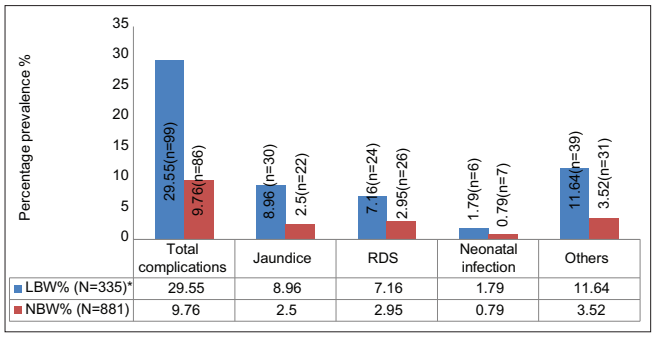

Figure 2: Neonatal complications in the study population *Neonatal complications in LBW in comparison to NBW, $\chi 2 = 73.7$, $P < 0.0001$

age, maternal nutrition, parity, birth spacing interval, maternal anemia are important risk factors associated with high incidence of LBW babies.

The present study did not reflect any significant association between gender and LBW though prevalence of LBW was higher in female newborns (29.6%) as compared to males (25.6%) [Table 1]. Onyekwelu *et al.* ($n = 961$) conducted a statistical analysis to explore the relationship between gender and birth weight. The data reported no significant difference in birth weight between the genders in low birth weight category.[11] Similarly, Oladeinde *et al.* ($n = 780$) in their study on determinants of low birth weight found that the prevalence of LBW was higher in female newborns but not statistically significant.[12] In contrary, Khan *et al.* in their comparative study between NFHS 3 and NFHS 4 reported significantly higher prevalence of LBW in female children which could be ascribed to gender discrimination in India.[7] Though no gender association could be established in the present study, however, the mean birth weight of male newborns was calculated to be 104 gm greater than those of female newborns ($P < 0.001$) (not reflected in tables). The result was in agreement to the finding reported by Valero de Bernabe´ *et al.* The study revealed that male newborns were 150 gm heavier than female newborns due to influence of certain chromosomal factors on birth weight.[13]

The occurrence of LBW was significantly associated with rural population included in the present study [Table 1] but not considered as a significant independent risk factor for LBW [Table 2]. This could be due to the fact that the rural population being mostly from the nearby areas and had better access for medical facilities. The finding is in concurrence to lower prevalence in rural areas (OR = 0.8, 95% CI 0.8-0.8; $P < 0.001$) observed by Khan *et al.* as maternal health services has been tremendously improved over the past decades.[7]

A significant association between maternal anemia and LBW was observed [Table 1]. The proportion of LBW among anemic mothers was 59.39% [Table 1]. This is in concurrence with various other studies in India that had reported higher proportion of LBW among anemic mothers as compared to non-anemic mothers.[14-16]

Low birth weight incidence increases in the extremes of women's reproductive life. The present study report did not reflect advanced age of mothers as an independent risk factor for LBW [Table 2]. Goisis *et al.* reported that maternal age is not an independent risk factor for LBW.[17] Similarly, Khan *et al.* depicted negative association between LBW and mother's age.[7] Advanced maternal age is a known risk factor for adverse birth outcome and thus treated as high risk mothers. In present scenario, mothers at advanced age are engaged in better health behaviors, better care and monitoring, thus seek adequate antenatal care resulting in low rate of pregnancy complications including LBW.[18]

We had hypothesized that parity >3 could be an independent risk factor for LBW but found no association [Table 2]. Hinkle *et al.* found that infants of nulliparous women were larger. Birth weight continued to increase up to 3rd parity, but with a smaller difference.[19] Similar findings were also published by Borah *et al.* ($n = 450$).[9] Recent studies denote that the incomplete reversal of physiological changes after first pregnancy provide a better facilitative environment in-utero, including better uteroplacental blood flow. In addition, there may be structural factors which limit uterine capacity in the first pregnancy.[19]

In agreement with previous studies in India, a significant relation between lack of ANC and LBW was observed in this study [Table 2]. Hong *et al.* ($n = 8964$) in their study found that <5 ANC visit had higher chances of LBW. Early detection ensures timely diagnosis and therapeutic interventions lowering any risk of LBW. In present study, proportion of LBW was 56.88% in those with <3 ANC visits [Table 1]. Acharya *et al.* revealed that chances for LBW was three times for babies born to mothers with inadequate ANC visits.[20] Our findings are in agreement to previous studies depicting positive association of LBW and under utilization of antenatal health care facilities.[8,9]

A significant association of gestational age (<37 weeks) with LBW was observed [Table 1], though there was no significant difference in the mean birth weight between preterm and term newborns. Prematurity was found to be asignificant and independent contributor towards LBW [Table 2]. Nearly 72% preterm babies were LBW as against 49.3% depicted by Apoorva *et al.* ($n = 204$) and 25% reported by Bhimwal *et al.* ($n = 8266$).[8,21] The higher prevalence could be due to high proportion of anemic mothers in mothers with preterm delivery. A cross sectional study by Kumari *et al.* ($n = 515$) found that maternal anemia can influence preterm delivery and identified it as an independent risk factor for both preterm labor and LBW. The study reported maternal anemia in 90% preterm deliveries.[22] The present study revealed a high percentage of maternal anemia, 53.9% in mothers with premature delivery. Poor antenatal nutritional status might lead to compromised uteroplacental circulation leading to adverse pregnancy outcome.[23]

Maternal illness and obstetric complications lead to LBW as it increases the chances of premature delivery and poor fetal growth. In this study significant antenatal history was not a

significant independent risk factor for LBW. Proportion of LBW was 29.32% in mothers with significant antenatal history. Apoorva MS *et al.* showed 41.2% prevalence of LBW in mothers with significant antenatal history.[8] This difference could be because most of the population belonged to urban area and had knowledge and access to antenatal care.

Low birth weight neonates are at high risk to develop complications because of their weight, relative immaturity of vital organs and lack of immunological response. In present study, significant (P = <0.05) association was found between LBW and neonatal complications [Table 2]. Nearly 7.16% LBW babies develop respiratory distress syndrome or asphyxia as against 2.95% in NBW babies. Occurrence of neonatal infection in LBW newborns was 1.79% which was more than double as against NBW babies (0.79%). The percentages of neonatal jaundice in LBW and NBW newborns were respectively 8.96% and 2.5% [Figure 2]. Bhatnagar *et al.* (n = 5211) found 40.18% prevalence of neonatal asphyxia, 39.26% of neonatal jaundice, 15.88% of neonatal infections and 4.68% of gastroenteritis in LBW babies.[4]

Conclusion

The study results suggested that anemia, younger age, multiparity, inadequate antenatal care, and preterm deliveries had significant impact on birth weight of the newborn. We also observed that neonatal complications were significant association with LBW and the frequency of complications was 20% times more in them. Most LBW can be prevented with quality maternal care and identification of high-risk pregnancies. Efforts should be made to strengthen health facilities and to provide adequate nutrition, antenatal care to mothers. Knowledge regarding the modifiable risk factors would aid the primary health care physicians in identifying the high risk pregnant females and optimizing the maternal factors by enabling proper education to mothers regarding nutrition and antenatal care, moderating the associated medical disorders like hypertension, diabetes mellitus, thyroid diseases, and any other as well as identifying the obstetric condition well ahead to avoid complicated labor process. The midwifery's may also be involved to decipher community education in improving reproductive health outcome. Together, these efforts would help reduce the burden of LBW in the country.

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Conflicts of interest

There are no conflicts of interest.

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