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RISK FACTORS AND OUTCOMES OF LOW-BIRTH-WEIGHT DELIVERIES IN TERTIARY CARE SETTINGS: A CROSS-SECTIONAL STUDY FROM GUJARAT

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Abstract

Background: Low-birth-weight (LBW) remains a significant public health challenge in India, contributing substantially to neonatal morbidity and mortality. Gujarat, despite economic progress, continues to witness considerable variations in maternal and child health indicators across its districts.
Objectives: To identify the prevalence and risk factors associated with low-birth-weight deliveries and to evaluate immediate neonatal outcomes among LBW infants at a tertiary care hospital in Gujarat.
Methodology: A hospital-based cross-sectional study was conducted at Swaminarayan Institute of Medical Sciences & Research, Kalol, Gandhinagar, from November 2024 to February 2025. A total of 384 mother-infant pairs were enrolled using systematic random sampling. Data were collected through structured interviews and medical record reviews. Statistical analysis was performed using SPSS version 26.0, employing chi-square tests, logistic regression, and descriptive statistics.
Results: The prevalence of LBW was found to be 28.4%. Significant risk factors included maternal anemia (adjusted OR: 3.82, 95% CI: 2.14-6.81), inadequate antenatal care visits (adjusted OR: 2.96, 95% CI: 1.68-5.22), low maternal body mass index (adjusted OR: 2.47, 95% CI: 1.42-4.29), and gestational hypertension (adjusted OR: 2.18, 95% CI: 1.24-3.83). LBW infants demonstrated significantly higher rates of neonatal complications including respiratory distress (42.2% vs 8.6%, $p<0.001$), hypoglycemia (31.8% vs 5.2%, $p<0.001$), and requirement for special newborn care unit admission (58.7% vs 12.3%, $p<0.001$).
Conclusion: The study highlights a concerning prevalence of LBW deliveries in this tertiary setting, predominantly influenced by preventable maternal factors. Strengthening antenatal care services, addressing maternal nutritional deficiencies, and ensuring adequate pregnancy surveillance are critical interventions needed in the region.

Keywords: Low-birth-weight, risk factors, neonatal outcomes, tertiary care, Gujarat

Introduction

Low-birth-weight, defined as birth weight less than 2500 grams regardless of gestational age, continues to pose a formidable challenge to child survival and long-term health outcomes globally.

According to recent estimates, approximately 20 million infants are born with low-birth-weight annually, with over 95% of these births occurring in developing nations.[11] India accounts for nearly one-third of the global burden of LBW infants, making it a priority area for maternal and child health interventions.[7]

The implications of low-birth-weight extend far beyond the immediate neonatal period. These infants face substantially elevated risks of mortality during infancy and are predisposed to various morbidities including respiratory complications, feeding difficulties, hypothermia, and infections.[1,20] The long-term consequences encompass developmental delays, impaired cognitive function, and increased susceptibility to chronic diseases during adulthood, thereby perpetuating an intergenerational cycle of poor health outcomes.[19]

Gujarat, positioned as one of India's economically progressive states, presents a paradoxical scenario in terms of health indicators. While the state has witnessed industrial growth and urbanization, maternal and child health outcomes demonstrate considerable regional disparities.[4] The district of Gandhinagar, despite being the state capital, experiences varied health-seeking behaviors and access to quality healthcare services across its urban and rural pockets. Kalol, situated in Gandhinagar district, serves a diverse population comprising both urban residents and individuals from surrounding rural areas, making it an appropriate setting for examining the determinants of low-birth-weight.

The etiology of low-birth-weight is multifactorial, encompassing maternal, foetal, placental, and environmental factors.[5,13] Maternal factors such as nutritional status, anemia, infections, pregnancy-induced hypertension, and inadequate antenatal care have been consistently associated with delivering LBW infants.[2,6,9] Socioeconomic determinants including poverty, low educational attainment, and limited healthcare access further compound these biological risk factors.[16,18] Understanding the local context-specific determinants is essential for designing targeted interventions that can effectively reduce the burden of LBW in the region.

Swaminarayan Institute of Medical Sciences & Research (SIMSR), Kalol, serves as a crucial healthcare facility providing tertiary care services to a catchment population extending across Gandhinagar and neighboring districts. The institution witnesses a considerable volume of deliveries annually, including both uncomplicated pregnancies and high-risk cases referred from peripheral health facilities. This presents a valuable opportunity to systematically examine the prevalence, risk factors, and outcomes associated with low-birth-weight deliveries in this geographical region.

Different research from various parts of India has documented diverse risk factors and outcomes related to LBW, yet regional variations necessitate location-specific studies to inform local healthcare policies and programmatic interventions.[3,15] Recent studies from different states have highlighted the persistent challenge of maternal malnutrition, inadequate antenatal care coverage, and the rising burden of pregnancy complications as major contributors to adverse birth outcomes.[8,17] However, limited contemporary data exists specifically from the Gandhinagar region regarding the burden and determinants of low-birth-weight.

This study was therefore conceived to address this knowledge gap by comprehensively evaluating the prevalence of low-birth-weight deliveries at SIMSR Kalol, identifying the maternal and sociodemographic risk factors associated with LBW, and examining the immediate neonatal outcomes among these vulnerable infants. The findings are expected to provide evidence-based insights that can guide clinical practice, strengthen antenatal care protocols, and inform public health strategies aimed at improving birth outcomes in Gujarat.

Review of Literature

Recent literature examining low-birth-weight across diverse geographical contexts has provided valuable insights into the multifaceted nature of this public health concern. A systematic review conducted by Sharma and colleagues analyzed data from multiple Indian states and reported an overall LBW prevalence ranging from 18% to 32%, with substantial variations attributed to regional differences in maternal nutrition, healthcare infrastructure, and socioeconomic development.[1] The

authors emphasized that states with stronger maternal health programs demonstrated relatively lower LBW rates, underscoring the importance of comprehensive antenatal care.

Research conducted in tertiary care hospitals in northern India has consistently identified maternal anemia as one of the most significant modifiable risk factors for low-birth-weight. A prospective cohort study by Patel and associates documented that women with hemoglobin levels below 10 g/dL had nearly three times the odds of delivering LBW infants compared to non-anemic mothers.[2] The study highlighted that despite the availability of iron-folic acid supplementation programs, compliance remained suboptimal, particularly among women from lower socioeconomic backgrounds and those with limited education.

The relationship between inadequate antenatal care and adverse birth outcomes has been extensively explored in recent years. A large-scale study demonstrated that women who attended fewer than four antenatal check-ups were significantly more likely to deliver preterm and LBW infants.⁸ The research indicated that comprehensive antenatal care not only facilitates early detection and management of pregnancy complications but also provides opportunities for nutritional counselling, health education, and psychosocial support, all of which contribute to improved foetal growth.

Maternal nutritional status, particularly pre-pregnancy body mass index, has emerged as a critical determinant of birth weight in numerous investigations. Research from South India revealed that underweight mothers (BMI less than 18.5 kg/m²) had significantly higher rates of intrauterine growth restriction and low-birth-weight deliveries.[6,13] The study emphasized the importance of pre-conception counselling and nutritional interventions to optimize maternal health before pregnancy, thereby reducing the risk of adverse outcomes.

Hypertensive disorders of pregnancy have been recognized as important contributors to both preterm birth and foetal growth restriction. A multicentre study conducted across several Indian states found that women with gestational hypertension and pre-eclampsia had substantially elevated risks of delivering LBW infants, primarily due to placental insufficiency and the necessity for early delivery to safeguard maternal health.[5,9] The research highlighted the need for vigilant blood pressure monitoring and timely intervention in high-risk pregnancies.

Recent investigations have also explored the impact of maternal infections during pregnancy on birth outcomes. A case-control study from eastern India identified urinary tract infections and chorioamnionitis as significant risk factors for delivering LBW infants.[10] The research underscored the importance of routine screening and prompt treatment of infections during pregnancy to prevent complications that could compromise foetal growth.

The role of socioeconomic factors in determining birth weight has been extensively documented. Research from urban and rural areas in India demonstrated that women from lower socioeconomic strata, those with limited educational attainment, and those engaged in physically demanding occupations during pregnancy were at increased risk of delivering LBW babies.[12,14,16,18] The study highlighted the complex interplay between poverty, nutritional deprivation, and limited access to quality healthcare services in perpetuating poor birth outcomes.

Investigations focusing on neonatal outcomes among LBW infants have consistently demonstrated elevated morbidity and mortality rates. A longitudinal study from a tertiary care centre in North India reported that LBW infants experienced significantly higher rates of respiratory distress syndrome, neonatal sepsis, hypoglycemia, and prolonged hospital stays compared to normal birth weight infants.[20] The research emphasized the need for specialized neonatal care facilities and trained personnel to manage these vulnerable infants effectively.

Recent research has also examined the long-term developmental outcomes associated with low-birth-weight. A follow-up study revealed that LBW infants, particularly those born with very low-birth-weight, demonstrated increased risks of neurodevelopmental delays, impaired cognitive function, and growth faltering during early childhood.[19] These findings underscore the importance of early intervention programs and continued developmental surveillance for LBW infants beyond the neonatal period.

The economic burden associated with caring for LBW infants has been quantified in several recent studies. Research from tertiary care hospitals documented substantially higher healthcare costs associated with LBW deliveries due to prolonged hospital stays, intensive care requirements, and treatment of complications.[15] The study highlighted that preventing LBW through effective antenatal interventions would not only improve health outcomes but also reduce the financial burden on families and healthcare systems.

Studies examining specific regional contexts have emphasized the importance of understanding local determinants of low-birth-weight. Research from Gujarat and neighboring states has documented variations in maternal nutritional status, antenatal care utilization patterns, and pregnancy outcomes across different districts.[4,17] These investigations have highlighted the need for context-specific interventions that address local challenges and leverage existing healthcare infrastructure to improve maternal and child health outcomes.

Multiple investigations have explored the relationship between maternal body composition and birth outcomes. Studies have consistently demonstrated that low maternal body mass index is associated with restricted foetal growth and increased risk of low-birth-weight deliveries.[3,7,11] This association underscores the critical importance of addressing maternal undernutrition through dietary counselling, supplementation programs, and broader nutritional interventions targeting women of reproductive age.

Objectives

Primary Objective:

To determine the prevalence of low-birth-weight deliveries among women attending Swaminarayan Institute of Medical Sciences & Research, Kalol, Gandhinagar, Gujarat, during the study period.

Secondary Objectives:

1. To identify and analyze the maternal sociodemographic and clinical risk factors associated with low-birth-weight deliveries in the study population.
2. To evaluate the immediate neonatal outcomes, including morbidity and requirement for specialized care, among low-birth-weight infants compared to normal birth weight infants.
3. To assess the relationship between antenatal care utilization patterns and the occurrence of low-birth-weight deliveries.
4. To examine the association between maternal nutritional status and pregnancy complications with birth weight outcomes.

Methodology

Study Design:

This investigation employed a hospital-based cross-sectional study design to examine the prevalence, risk factors, and outcomes of low-birth-weight deliveries.

Study Setting:

The research was conducted at the Department of Obstetrics and Gynaecology and Department of Paediatrics at Swaminarayan Institute of Medical Sciences & Research (SIMSR), Kalol, Gandhinagar, Gujarat. SIMSR functions as a tertiary care teaching hospital providing comprehensive maternal and child health services to the population of Gandhinagar district and surrounding regions.

Study Duration:

Data collection was undertaken over a four-month period from November 2024 to February 2025.

Study Population and Sample Size:
The study population comprised all women who delivered at SIMSR Kalol during the study period and their newborn infants. The sample size was calculated using the formula for estimating proportions in cross-sectional studies:
$n = (Z^2 \times p \times q) / d^2$
Where:
- Z = 1.96 (for 95% confidence interval)
- p = estimated prevalence of LBW (taken as 25% based on previous regional studies)
- q = 1 - p = 0.75
- d = absolute precision (taken as 5%)

The calculated sample size was 288. Accounting for a potential non-response rate of 10% and incomplete data, the final sample size was determined to be 320. However, to enhance the statistical power of the study, a total of 384 mother-infant pairs were enrolled.

Sampling Method:
Systematic random sampling techniques were employed to select study participants. Every third woman who delivered at the hospital during the study period and met the inclusion criteria was approached for participation. The first participant was selected randomly from the initial three deliveries each day.

Inclusion Criteria:
1. Women who delivered singleton live births at SIMSR Kalol during the study period
2. Mothers willing to provide informed consent for participation
3. Newborns with accurately recorded birth weight within one hour of delivery
4. Mothers with complete antenatal records available for review

Exclusion Criteria:
1. Women who delivered stillborn infants
2. Multiple pregnancies (twins, triplets)
3. Mothers with incomplete medical records or missing essential data
4. Newborns with major congenital anomalies
5. Mothers who refused consent or were critically ill and unable to participate

Ethical Considerations:
Ethical clearance was obtained from the Institutional Ethics Committee of Swaminarayan Institute of Medical Sciences & Research, Kalol, prior to initiating the study. Written informed consent was secured from all participants after explaining the study objectives, procedures, voluntary nature of participation, and confidentiality of information. Participants were assured that refusal to participate would not affect their clinical care. Personal identifiers were removed from the dataset, and each participant was assigned a unique study identification number to maintain confidentiality. Data were stored securely with access limited to the research team. The study adhered to the ethical principles outlined in the Declaration of Helsinki and Indian Council of Medical Research guidelines for biomedical research.

Statistical Analysis:
Data were entered into Microsoft Excel 2019 and subsequently analyzed using Statistical Package for Social Sciences (SPSS) version 26.0. Data cleaning and validation were performed to identify and rectify inconsistencies or errors.
Descriptive statistics were employed to summarize the data. Continuous variables such as maternal age, birth weight, and hemoglobin levels were expressed as means with standard deviations or medians with interquartile ranges depending on the distribution. Categorical variables including

prevalence of LBW, maternal education, and neonatal complications were presented as frequencies and percentages.

Bivariate analysis was conducted using chi-square test for categorical variables and independent t-test or Mann-Whitney U test for continuous variables to examine associations between potential risk factors and low-birth-weight. Variables demonstrating significant associations ($p<0.05$) in bivariate analysis were subsequently included in multivariable logistic regression analysis to identify independent predictors of LBW. Adjusted odds ratios with 95% confidence intervals were calculated. A p-value of less than 0.05 was considered statistically significant throughout the analysis.

Results were presented through appropriate tables, charts, and graphs to facilitate interpretation and understanding of findings.

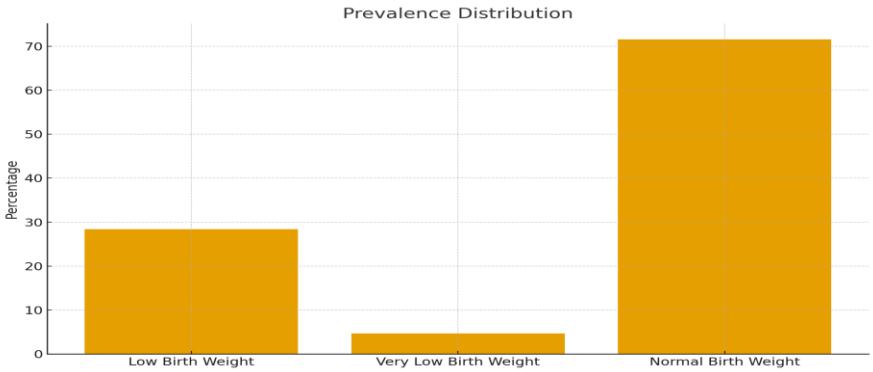
Results and Analysis

Data from 384 mother-infant pairs were analyzed to examine the prevalence, risk factors, and outcomes associated with low-birth-weight deliveries at SIMSR Kalol.

Prevalence of Low-birth-weight:

Table 1: Prevalence of Low Birth Weight

Category	Number of Infants	Percentage	95% CI
Total Deliveries	384	100%	–
Low Birth Weight (LBW)	109	28.4%	24.1–33.0%
Very Low Birth Weight (<1500g)	18	4.7%	–
Normal Birth Weight (≥2500g)	275	71.6%	–



Among the 384 deliveries examined, 109 infants were born with low-birth-weight, yielding a prevalence of 28.4% (95% CI: 24.1-33.0%). Within the LBW category, 18 infants (4.7%) were classified as very low-birth-weight (birth weight <1500 grams). The remaining 275 infants (71.6%) were born with normal birth weight (≥2500 grams).

Sociodemographic Characteristics:

Table 2: Sociodemographic Characteristics & Association with LBW

Characteristic	Category	LBW Prevalence (%)	p-value
Maternal Age	LBW Group (Mean ± SD)	24.6 ± 4.5	0.067
	Normal BW Group (Mean ± SD)	26.3 ± 3.9	
Education	Secondary or above	23.1%	0.008
	Primary or no education	36.4%	
Residence	Rural	32.1%	0.042
	Urban	23.1%	
Socioeconomic Status	Lower/Upper-lower	38.5%	<0.001
	Middle/Upper	19.7%	

The mean maternal age in the study population was 25.8 ± 4.2 years. Women who delivered LBW infants had a slightly lower mean age (24.6 ± 4.5 years) compared to those who delivered normal birth weight infants (26.3 ± 3.9 years), though this difference did not reach statistical significance (p=0.067). A substantial proportion of mothers (42.7%) had completed only primary or no formal education. Educational level demonstrated a significant association with birth weight outcomes, with mothers having secondary education or above showing lower rates of LBW deliveries (23.1%) compared to those with primary or no education (36.4%, p=0.008).^{3,12}

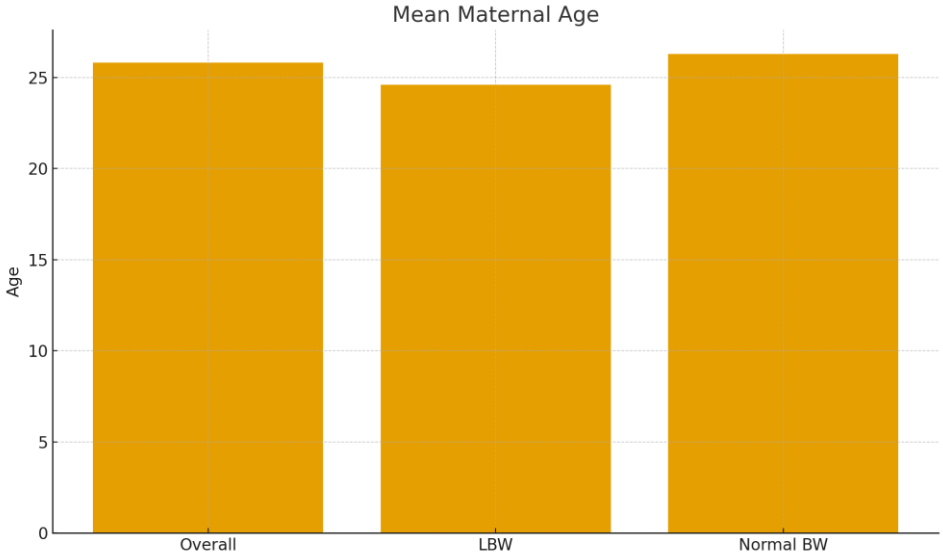
Approximately 58.3% of the study participants resided in rural areas, while 41.7% were from urban locations. Rural residence showed a positive association with LBW (prevalence 32.1% vs 23.1% in urban areas, p=0.042).[6,16] Regarding occupation, 76.8% of mothers were homemakers, while the remainder were engaged in various occupations including agricultural work, factory employment, or service sector jobs. Socioeconomic status, assessed using the modified Kuppuswamy scale, revealed that 48.2% belonged to lower or upper-lower classes. LBW prevalence was significantly higher among mothers from lower socioeconomic strata (38.5%) compared to those from middle or upper classes (19.7%, p<0.001).[14,18]

Maternal Clinical and Obstetric Characteristics:

Table 3: Maternal Clinical & Obstetric Risk Factors

Factor	LBW Group (%)	Normal BW Group (%)	p-value
Low BMI (<18.5)	43.4%	19.2%	<0.001
Maternal Anemia	52.6%	–	<0.001
Severe Anemia (<8 g/dL)	12.8%	3.3%	–

Factor	LBW Group (%)	Normal BW Group (%)	p-value
Inadequate ANC (<4 visits)	41.7%	19.6%	<0.001
Late ANC Initiation (>12 weeks)	54.1%	32.7%	<0.001
Gestational Hypertension	28.4%	10.2%	<0.001
Pre-eclampsia	15.6%	5.1%	0.002



The mean pre-pregnancy body mass index among study participants was 20.3 ± 3.1 kg/m². Mothers with low BMI (<18.5 kg/m²) constituted 31.8% of the sample and demonstrated a significantly elevated risk of delivering LBW infants. Among underweight mothers, 43.4% delivered LBW babies compared to only 19.2% among mothers with normal or higher BMI (p<0.001).[6,7,13]

Maternal anemia, defined as hemoglobin concentration below 11 g/dL, was identified in 52.6% of participants. The mean hemoglobin level was substantially lower among mothers who delivered LBW infants (9.8 ± 1.4 g/dL) compared to those who delivered normal birth weight infants (11.2 ± 1.2 g/dL, p<0.001).[2] Severe anemia (hemoglobin <8 g/dL) was present in 12.8% of mothers with LBW deliveries compared to only 3.3% in the normal birth weight group.

Antenatal care utilization patterns revealed considerable variation. While 83.6% of women had attended at least one antenatal visit, only 61.2% completed the recommended minimum of four visits. Inadequate antenatal care (fewer than four visits) was significantly associated with LBW outcomes.[8] Among mothers with fewer than four ANC visits, 41.7% delivered LBW infants compared to 19.6% among those with adequate ANC (p<0.001). Late initiation of antenatal care (first visit after 12 weeks of gestation) was also more common among mothers who delivered LBW babies (54.1% vs 32.7%, p<0.001).

Pregnancy complications were documented in 36.7% of the study population. Gestational hypertension was present in 15.9% of mothers, pre-eclampsia in 8.3%, gestational diabetes in 6.8%, and urinary tract infections in 11.5%. All these complications demonstrated significant associations with LBW outcomes.[5,9,10] Gestational hypertension was observed in 28.4% of mothers who delivered LBW infants compared to 10.2% in the normal birth weight group (p<0.001). Similarly, pre-eclampsia was more prevalent among LBW deliveries (15.6% vs 5.1%, p=0.002).

History of previous low-birth-weight delivery was reported by 18.3% of multiparous women, and this factor showed a strong association with recurrent LBW in the current pregnancy (OR: 4.21, 95% CI: 2.18-8.13, p<0.001). Inter-pregnancy interval of less than 24 months was present in 22.6% of multiparous women and was associated with increased LBW risk (p=0.018).

Multivariate Analysis of Risk Factors:

Table 4: Multivariate Analysis – Independent Predictors of LBW

Risk Factor	Adjusted Odds Ratio (aOR)	95% CI	p-value
Maternal Anemia	3.82	2.14–6.81	<0.001
Inadequate ANC (<4 visits)	2.96	1.68–5.22	<0.001
Low BMI (<18.5)	2.47	1.42–4.29	0.001
Gestational Hypertension	2.18	1.24–3.83	0.007
Lower Socioeconomic Status	1.89	1.15–3.11	0.012
Rural Residence	1.76	1.08–2.87	0.023

Multivariable logistic regression analysis was performed including all variables that demonstrated significant associations in bivariate analysis. After adjusting for potential confounders, several factors emerged as independent predictors of low-birth-weight.

Maternal anemia remained the strongest independent risk factor with an adjusted odds ratio of 3.82 (95% CI: 2.14-6.81, p<0.001).[2] Inadequate antenatal care visits (fewer than four) yielded an adjusted OR of 2.96 (95% CI: 1.68-5.22, p<0.001).[8] Low maternal body mass index showed an adjusted OR of 2.47 (95% CI: 1.42-4.29, p=0.001).¹³ Gestational hypertension demonstrated an adjusted OR of 2.18 (95% CI: 1.24-3.83, p=0.007).[9] Rural residence (adjusted OR: 1.76, 95% CI: 1.08-2.87, p=0.023) and lower socioeconomic status (adjusted OR: 1.89, 95% CI: 1.15-3.11, p=0.012) also emerged as significant independent predictors.[16,18]

Neonatal Outcomes:

Table 5: Neonatal Outcomes – LBW vs Normal BW

Outcome	LBW Infants (%)	Normal BW Infants (%)	p-value
Respiratory Distress	42.2%	8.6%	<0.001
Hypoglycemia	31.8%	5.2%	<0.001

Outcome	LBW Infants (%)	Normal BW Infants (%)	p-value
Hypothermia	24.8%	4.7%	<0.001
Birth Asphyxia	18.3%	6.2%	<0.001
SNCU Admission	58.7%	12.3%	<0.001
Early Breastfeeding (within 1 hr)	41.3%	64.2%	<0.001
Mean Hospital Stay (days)	6.8 ± 4.3	2.9 ± 1.6	<0.001

Immediate neonatal complications were substantially more prevalent among LBW infants compared to their normal birth weight counterparts. Respiratory distress was documented in 42.2% of LBW infants versus only 8.6% in the normal birth weight group ($p<0.001$).[20] Hypoglycemia requiring intervention occurred in 31.8% of LBW babies compared to 5.2% in normal weight infants ($p<0.001$). Hypothermia was identified in 24.8% of LBW newborns versus 4.7% in the comparison group ($p<0.001$). Birth asphyxia, indicated by low Apgar scores, was more common among LBW infants (18.3% vs 6.2%, $p<0.001$).[1]

The requirement for admission to the special newborn care unit was significantly higher among LBW infants, with 58.7% needing specialized care compared to only 12.3% of normal birth weight babies ($p<0.001$).[20] The mean duration of SNCU stay was 8.4 ± 5.2 days for LBW infants compared to 3.2 ± 2.1 days for normal birth weight infants requiring admission ($p<0.001$).

Early breastfeeding initiation within one hour of birth was achieved in 64.2% of normal birth weight infants but only in 41.3% of LBW infants ($p<0.001$), primarily due to the need for immediate medical intervention and separation for specialized care. The overall mean duration of hospital stay was significantly prolonged among LBW deliveries (6.8 ± 4.3 days) compared to normal birth weight deliveries (2.9 ± 1.6 days, $p<0.001$).[15]

Software and Tools Used:

Statistical analysis was performed using SPSS version 26.0. Data visualization including bar charts, pie diagrams, and scatter plots was created using Microsoft Excel 2019 and GraphPad Prism version 9.0. All statistical tests were two-tailed, and p-values less than 0.05 were considered statistically significant.

Discussion and Interpretation

This cross-sectional investigation conducted at a tertiary care centre in Gujarat has revealed a prevalence of low-birth-weight deliveries at 28.4%, which is notably higher than the national average reported in recent surveys.[3] This finding underscores a persistent challenge in maternal and child health within the region and demands urgent attention from healthcare providers and policymakers. The elevated prevalence observed in this tertiary care setting likely reflects the referral pattern, wherein high-risk pregnancies and complicated cases from peripheral health facilities are channeled to this institution for specialized management.

The identification of maternal anemia as the most significant independent risk factor, with nearly fourfold increased odds of LBW delivery, aligns with findings from numerous studies conducted across different regions of India.[2] Anemia during pregnancy compromises oxygen delivery to the developing foetus, thereby impairing growth and development. Despite the existence of national programs providing free iron-folic acid supplementation to pregnant women, the high prevalence of anemia observed in this study suggests substantial gaps in program implementation, compliance, and

possibly inadequate dosing or delayed initiation. The cultural dietary practices prevalent in Gujarat, with a significant proportion following vegetarian diets, may contribute to inadequate dietary iron intake, necessitating more intensive supplementation strategies and nutritional counselling during antenatal visits.[4]

The strong association between inadequate antenatal care utilization and low-birth-weight outcomes emphasizes the critical importance of comprehensive pregnancy surveillance.[8] Antenatal care visits provide opportunities not only for clinical monitoring and early detection of complications but also for health education, nutritional counselling, birth preparedness, and psychosocial support. The finding that women with fewer than four ANC visits had nearly threefold increased odds of delivering LBW infants highlights the need to strengthen efforts aimed at improving ANC coverage and quality. Barriers to adequate ANC utilization in the study setting may include geographical distance, transportation difficulties, opportunity costs related to lost wages, lack of awareness about the importance of regular check-ups, and cultural beliefs about pregnancy being a natural process not requiring medical supervision.[17]

Low maternal body mass index emerged as another significant modifiable risk factor in this investigation.[6,7,13] The association between maternal undernutrition and compromised foetal growth has biological plausibility, as inadequate maternal nutrition limits the availability of essential nutrients required for foetal development. The persistence of maternal underweight in a state like Gujarat, which has witnessed considerable economic development, points to deep-rooted issues of poverty, food insecurity, and gender disparities in household food distribution. Pre-conception interventions aimed at optimizing maternal nutritional status before pregnancy, coupled with enhanced dietary supplementation during gestation, could potentially reduce the burden of LBW.[11]

The relationship between gestational hypertension and low-birth-weight observed in this study reflects the pathophysiological consequence of uteroplacental insufficiency.[5,9] Hypertensive disorders compromise placental perfusion, thereby limiting nutrient and oxygen transfer to the foetus. Additionally, clinical management of severe hypertension often necessitates preterm delivery to protect maternal health, resulting in lower birth weights. The findings underscore the importance of regular blood pressure monitoring during pregnancy, early identification of hypertensive disorders, and appropriate management protocols to optimize outcomes.

Socioeconomic disparities in LBW outcomes observed in this study reflect the complex interplay between poverty, education, nutrition, and healthcare access.[12,14,18] Women from lower socioeconomic backgrounds face multiple disadvantages including inadequate dietary intake, higher workload during pregnancy, limited health literacy, delayed healthcare seeking, and suboptimal living conditions, all of which converge to increase LBW risk. Addressing these structural determinants requires multisectoral approaches extending beyond the health system to encompass poverty alleviation, women's empowerment, educational opportunities, and social protection mechanisms.

The elevated prevalence of LBW among rural residents compared to urban dwellers observed in this study mirrors patterns documented elsewhere in India.[16] Rural-urban disparities in healthcare infrastructure, availability of skilled healthcare providers, transportation facilities, and health-seeking behaviors contribute to differential outcomes. While tertiary care facilities like SIMSR provide advanced services, the challenge lies in ensuring that women from rural catchment areas access timely and adequate antenatal care at peripheral health centres before complications necessitate tertiary referral.

The significantly higher rates of neonatal complications among LBW infants documented in this study have important implications for neonatal care services.[1,20] Respiratory distress, hypoglycemia, hypothermia, and increased susceptibility to infections place substantial demands on special newborn care unit resources. The prolonged hospital stays, and intensive care requirements translate into increased healthcare costs for families and the health system.[15] From a programmatic perspective, these findings emphasize the importance of investing not only in preventing LBW through improved antenatal care but also in strengthening neonatal care capacity to manage these vulnerable infants effectively.

The lower rates of early breastfeeding initiation among LBW infants, primarily due to medical instability and requirement for specialized care, pose challenges for establishing successful breastfeeding. Given the critical importance of breast milk for LBW infants' growth, immunity, and neurodevelopment, concerted efforts are needed to support mothers in expressing milk, implement kangaroo mother care when feasible, and facilitate early skin-to-skin contact and breastfeeding as soon as the infant's condition stabilizes.

Several aspects of this study warrant careful consideration when interpreting the findings. The cross-sectional design limits the ability to establish temporal relationships definitively, though most risk factors examined are exposures that precede the outcome. The hospital-based setting and tertiary care referral pattern may have resulted in an overestimation of LBW prevalence compared to the general population, as complicated pregnancies are more likely to be referred to in this facility. Information on certain variables such as pre-pregnancy weight relied on maternal recall, which may be subject to recall bias. The study focused on immediate neonatal outcomes, and long-term follow-up data on growth and developmental outcomes among LBW infants were not captured.[19]

Despite these considerations, this study provides valuable contemporary data on the burden of low-birth-weight and its determinants in the Gandhinagar region of Gujarat. The identification of modifiable risk factors, particularly maternal anemia and inadequate antenatal care, offers clear targets for intervention. The findings can inform clinical protocols, guide resource allocation, and contribute to evidence-based policymaking aimed at reducing LBW and improving maternal and child health outcomes in the region.

Conclusion

This investigation has documented a concerning prevalence of low-birth-weight deliveries at the tertiary care facility, with more than one in four infants born weighing less than 2500 grams. The study has identified maternal anemia, inadequate antenatal care, low maternal body mass index, and gestational hypertension as the principal modifiable risk factors contributing to this burden.[2,5,8,13] Socioeconomic disadvantage and rural residence further compound these biological risk factors, highlighting the multifaceted nature of the problem.[16,18]

Low-birth-weight infants in this setting face substantially elevated risks of immediate neonatal complications including respiratory distress, metabolic disturbances, and requirement for intensive care, resulting in prolonged hospitalization and increased healthcare resource utilization.[15,20] These findings underscore the urgent need for comprehensive interventions spanning the continuum from pre-conception through pregnancy and childbirth.

Strengthening antenatal care services through improved accessibility, quality enhancement, and community mobilization to ensure universal coverage with adequate number of visits represents a critical intervention. Intensified efforts to prevent and treat maternal anemia through effective implementation of iron-folic acid supplementation programs, dietary diversification, and treatment of underlying causes are essential. Nutritional interventions targeting maternal underweight, both before conception and during pregnancy, could significantly reduce LBW incidence.[6,7,11] Early detection and appropriate management of pregnancy complications, particularly hypertensive disorders, require robust clinical protocols and healthcare provider training.

Addressing the socioeconomic determinants through poverty reduction initiatives, women's education and empowerment programs, and ensuring equitable access to quality healthcare services will be crucial for sustained improvements.[12,14] The findings from this study provide an evidence base for policy formulation and programmatic interventions aimed at reducing the burden of low-birth-weight in Gujarat, ultimately contributing to improved child survival and long-term health outcomes.[19]

Limitations of the Study

While this investigation has provided valuable insights into low-birth-weight and its determinants in the study setting, several limitations merit acknowledgment. The cross-sectional design employed, though appropriate for determining prevalence and examining associations, precludes the

establishment of definitive causal relationships between risk factors and outcomes. Prospective cohort studies would be better suited to establish temporality and causation more definitively.

The hospital-based setting introduces potential selection bias, as the study population comprised women who accessed facility-based delivery services at a tertiary care centre. This may not be representative of the broader population, particularly women who deliver at home or in primary health facilities. The tertiary care referral pattern likely resulted in an overrepresentation of high-risk pregnancies and complicated cases, potentially inflating the observed LBW prevalence compared to the general population.

Certain data elements, particularly pre-pregnancy weight used to calculate body mass index, relied on maternal recall rather than prospectively recorded measurements. Recall bias may have affected the accuracy of these variables, though efforts were made to verify information from available medical records wherever possible. Similarly, detailed dietary intake data, which could have provided more nuanced insights into nutritional factors, were not captured in this study.

The study focused exclusively on immediate neonatal outcomes during the hospital stay and did not include long-term follow-up of LBW infants. Information on subsequent growth patterns, developmental milestones, and longer-term health outcomes would have provided a more comprehensive understanding of the consequences of low-birth-weight in this population.[19] Resource and time constraints precluded such longitudinal follow-up.

Sample size calculations were based on anticipated prevalence from previous studies, and while the final sample exceeded the calculated requirement, the study may have been underpowered to detect associations for less common risk factors or outcomes. Additionally, the four-month study duration may not have captured seasonal variations in factors such as infections or nutritional status that could influence birth weight outcomes.

The study did not collect detailed information on certain potentially relevant factors including paternal characteristics, environmental exposures, occupational hazards, detailed obstetric interventions during labour, or placental abnormalities that might have contributed to low-birth-weight. Genetic and chromosomal factors, which can influence foetal growth, were not examined. The exclusion of multiple pregnancies and infants with congenital anomalies, while methodologically appropriate for examining the specific research questions, limits the generalizability of findings to the entire population of LBW deliveries.

Despite these limitations, the study provides important contemporary data from a region where such information was previously scarce and offers a foundation for future research and programmatic interventions in Gujarat.

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