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Variables Affecting Low Birth Weight and The Timely Vaccination in Child Health: A Comprehensive Review

Sewali Hazarika[1], Tousifur Rahman[2] and Manoshi Kotoky[3]

ABSTRACT: Low birth weight (LBW) is an important issue for public health. It is a major public health concern since it is directly associated with greater levels of newborn morbidity and mortality. In order to ensure child survival and reduce the impacts of infectious diseases, vaccination is essential. However, LBW infants, owing to their underdeveloped immune systems, may not respond effectively to vaccines or may have lower vaccination coverage. To improve health outcomes, it is essential to understand the interaction between birth weight, vaccination, and gestational duration, particularly in resource-limited regions such as Assam, India. The primary objective of this work is to review literature from the past two decades that provides insights into child health scenarios. Such an overview will support researchers, policymakers, and healthcare providers in designing better interventions to improve infant survival and overall health outcomes.

Keywords: Low birth weight, gestation period, antenatal care.

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1. Introduction

As a state of physical, mental, and social well-being, health is more than just the absence of a disease. Child health is a multifaceted issue [6], and as birth weight is a key health indicator, timely vaccination is crucial for protection, disease prevention, and overall well-being. Research on low birth weight highlights gestation as a critical factor that affects both the mother and the newborn. Preterm births and inadequate gestation increase the risk of complications.

Birth weight has a major impact on a child's growth, development, and survival, and low birth weight is an important health concern in underdeveloped nations like India [11]. It is a very important variable in assessing neonatal and newborn survival [28]. Full-term pregnancy lasts 37–42 weeks, while preterm babies are born before 37 weeks and post-term babies are born after 42 weeks. However, LBW is also influenced by factors such as race, maternal age, multiple births, maternal health, and low socioeconomic status [5][10].

Making someone immune or resistant to an infectious disease is known as immunization, and it usually occurs through vaccination. The Expanded Program on Immunization (EPI) was launched in Ethiopia in 1980, after its establishment in 1974 to ensure global child vaccination [15]. It helps parents protect children from severe infections, complications, hospitalization, and death [19].

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2. Discussion

An overview of significant contributions made by different researchers in this field is provided here:

Mahmood et al. (2004) [18] studied newborns at Dhaka Medical College Hospital and reported an average birth weight of 2.73 kg (SD ±0.52), with 96% being full-term. Still, 21.29% of 202 babies were underweight, showing that LBW remains a serious issue in Bangladesh. They stressed the importance of educating pregnant women about its risks, a concern also highlighted by UNICEF (2004) [35] [28], which reported a 30% incidence of LBW in the country.

In India, Negi K. S. et al. (2006) [31] examined 172 pregnant women in Dehradun, recording their health details—such as age, education, occupation, and parity—alongside clinical and anthropometric measures. With newborn weights taken at delivery, the analysis using chi-square and odds ratio confirmed strong maternal influences on birth weight.

In Nepal, Kayastha and Tuladhar (2007) [14] found that among 181 LBW newborns (11.9%), over half were primigravida mothers. Preterm labor (35.5%), intrauterine growth restriction (29.0%), pregnancy-induced hypertension (7.0%), and urinary infections (11.6%) emerged as key risk factors, with first-time mothers particularly vulnerable.

Nine significant risk variables—including mother age, education, occupation, income, gravida status, gestational age at first visit, prenatal care quality and frequency, and pre-delivery BMI—were found by Khatun & Rahman (2008) [17] using logistic regression on 20 potential risk factors. Their findings showed that women aged 20–29, with better education and stable economic status, were most likely to deliver normal-weight babies, a result consistent with other studies [24][36].

Further, Metgud et al. (2012) [22] analyzed birth outcomes in Karnataka, reporting a mean birth weight of 2.6 kg and a 22.9% LBW prevalence. Significant risk factors included poor maternal education (OR=3.2), passive smoking (OR=2.3), early first pregnancy (OR=3.6), short birth intervals (OR=2.4), prior LBW history (OR=3.3), low pregnancy weight gain (OR=7.0), maternal weight below 45 kg, pregnancy-induced hypertension (OR=3.3), high-risk pregnancies (OR=3.6), and late antenatal registration (OR=3.6).

Additionally, Kader & Perera (2014) [13] identified socio-economic and nutritional predictors of LBW in India, where nearly 20% of infants were affected. Male babies were significantly protected, although low mother's education, height <145 cm, BMI <18.5 and less than four prenatal visits were significant risk factors. Women with no education were at the highest risk, followed by those with only primary schooling [21][20][27]. Research consistently shows that maternal education acts as a safeguard against LBW [17][27], as uneducated women are more likely to adopt unhealthy practices and lack access to essential healthcare, hampering fetal development.

In a study conducted in rural Assam, Borah and Baruah (2015) [4] examined the morbidity of low birth weight (LBW) newborns over a six-month period compared to their normal birth weight (NBW) counterparts. They found that 77% of LBW newborns had moderate to severe undernutrition at follow-up. Acute respiratory infections (ARI) emerged as the most common illness, along with fever, ear infections, skin conditions, and diarrhea. LBW infants exhibited higher hospitalization rates (65%) than NBW infants (35%), and morbidity was particularly elevated among those not exclusively breastfed (66.7 per 100 baby months) and those underweight at six months (49.3 per 100 infant months). ARI consistently remained the predominant illness in LBW infants. Similarly, Sharma et al. [26] reported a higher prevalence of ARI in LBW babies compared to NBW babies, while Jackson et al. [12] identified LBW as a significant risk factor for ARI.

Further exploring the issue in rural Assam, Borah and Agarwalla (2016) [3] investigated the prevalence of LBW and the maternal and sociodemographic factors influencing it. They observed a 21.8% prevalence of LBW, with higher rates among teenage mothers (36%) and primipara mothers (27%). Independent risk factors included maternal anemia (OR 1.93), short interpregnancy interval (OR 3.93), and teenage pregnancy (OR 3.93), highlighting gaps in rural healthcare and maternal health services. The strong association between teenage pregnancy and LBW was attributed to inadequate physical and mental preparedness. Banerjee et al. [2] and others [1] [3] similarly found higher LBW incidence among teenage mothers, with most LBW mothers experiencing anemia during pregnancy. These findings were supported by Mumbare et al. [23] and Kader et al.[13], who also linked maternal anemia and inadequate antenatal care (ANC) checkups to LBW.

In Wardha, Taywade and Pisudde (2017) [28] examined the sociodemographic factors promoting LBW through interviews and assessments based on the Standard of Living Index (SLI). They found that maternal age <20 or >30 years, nuclear family structure, low living standards, paternal tobacco use, female infant sex, and lack of sanitary latrines were associated with higher odds of LBW, although place of residence was not statistically significant. LBW was significantly more common among female infants (18.56%) than male infants (17.78%), and birth weight increased with maternal parity. Taywade and Pisudde further noted that younger mothers bore a greater burden of LBW cases, consistent with findings from Mathai et al. [33] and Bharati P et al. [34].

Gogoi (2018) [11] conducted a study in Assam among 300 samples and found an LBW prevalence of 26.0%. Key risk factors included maternal age <18 years (OR=3.06), maternal height <145 cm (OR=2.72), fewer than three ANC visits (OR=1.90), tobacco use (OR=8.84), multiple pregnancies (OR=5.95), gestational age <37 weeks (OR=10.00), normal delivery (OR=2.09), female sex of the newborn (OR=1.02), and pregnancy weight gain <6 kg (OR=1.98). The study emphasized the need for improved maternal healthcare services at the community level.

Similar concerns were reported from Dilla, Ethiopia, where Mehare and Sharew (2020) [20] conducted a cross-sectional study involving 472 cases and found a high LBW prevalence of 34.1% among term newborns. Significant contributing factors included maternal age <20, divorce, rural residence, unplanned pregnancy, lack of ANC follow-up, absence of dietary advice, no folate intake, and smoking. These findings were consistent with studies conducted in Adwa [9], Ethiopia [8], Nepal [16] and India [25].

In North Wollo, Wubetu et al. (2021) [28] evaluated birth weight and its contributing factors among 337 mothers, recording an LBW prevalence of 24% (95% CI: 19.6–28.8) and identifying maternal age, income, single marital status, alcohol consumption, lower educational status, female sex of the baby, absence of abortion history, and multigravida status as significant predictors.

Moreover, Herwanto et al. (2024) [13] conducted a study at Soedomo Trenggalek Regional Hospital, Indonesia, to investigate maternal characteristics impacting LBW. Among 105 mothers, the mean maternal age was 29 years, with 19 aged 35 years or more. Of the participants, 64 had term pregnancies, 80 underwent vaginal deliveries, and several complications such as anemia (32 cases), preeclampsia (16 cases), oligohydramnios (18 cases), premature rupture of membranes (30 cases), and instances of stillbirth or miscarriage (22 cases) were noted.

Recently, Hossain et al (2025) [38] studied at the demographic, newborn, and maternal socioeconomic factors that influence LBW in Bangladesh. According to the study, LBW impacted 27.5% (n=164) of newborns. Preterm birth doubled the risks of LBW, based on logistic regression (OR: 2.376, 95% CI: 1.566–3.606, $p<0.05$). The risk was 39.6% lower for women over 35 than for those less than 21 (OR: 0.396, 95% CI: 0.252–0.624, $p<0.05$), indicating an important association between maternal age and risk. Women who took medications during pregnancy had a 39.1% lower chance of LBW (OR: 0.609, 95% CI: 0.373–0.995, $p<0.05$). Mineral deficiencies increased the risk 1.8 times (OR: 1.838, 95% CI: 1.200–2.816, $p<0.05$).

Regarding the vaccination of children, Walton et al. (2017) [32] studied vaccination uptake and timing through cohort data. While 94% of children received the first dosage on schedule, the percentage dropped for the second, third, and preschool booster doses (82%, 65%, and 88%, respectively), with dose intervals frequently going beyond recommended schedules. However, parental reports on MMR vaccinations showed a 97% consistency with child health records.

Timeliness of vaccination has been studied by Dejene et al. (2022), [7] as part of Ethiopia's Expanded Program on Immunization in Debre Libanos. Data from 413 children (12–23 months) and their caregivers showed that 33.7% received vaccines on time. The following were important factors: low to moderate caregiver hesitation (AOR=3.35, AOR=1.89), having a female child (AOR=2.9), caregiver education (AOR=5.61), and adequate vaccination knowledge (AOR=3.46).

Muhoza et al. (2024) [30] evaluated the impact of a complex intervention package and catch-up policies on vaccination timeliness under Ghana's Expanded Program on Immunization (EPI). Comparing the children's age at vaccination to the EPI schedule and assessing under- vaccination duration during the first 24 months, they found improvements in on-time vaccination, reduced under-vaccination periods, and increased coverage of the MR series at younger ages. Furthermore, timely MR2 immunization was positively correlated with the timeliness of earlier doses and caregivers' awareness of second-year health

visits.

Masters et al. (2025) [39] studied the factors that result in delayed or missed immunization by the age of two and reported on trends in children's timely MMR vaccination. Out of 321,743 children, 78.4% received their first MMR dose on time, based on their data. While the vaccination coverage dropped to 76.9% (40,306/52,388) in 2024, vaccination coverage increased from 75.6% (12,840/16,978) in 2018 to 79.9% (39,739/49,767) in the year 2021. Delays in second-month vaccination administration (aOR 6.96 [6.60–7.34]) and fourth-month vaccination administration (aOR 6.16 [5.84-6.50]) were the most significant indicators of missing MMR vaccinations by age two.

3. Table

The following table shows the Paper wise sample size, study area, and conclusions:

Authors name	Sample size	Study periods	Survey place	Conclusion
Mahmood et. al (2004)	A total of 202 mothers	1st November 2003 to 31st March 2004	Dhaka Medical College Hospital	Low birth weight remains a serious but preventable concern in our developing country, requiring urgent action for improvement.
Negi et al. (2006)	pregnant women (172)	From March 2003 to February 2004	at Rural Health Training Centre (RHTC)	Maternal factors like antenatal care, parity, interpregnancy interval, and obstetric history influence birth weight. Strengthening maternal services at the community level is essential.
Kayastha and Tuladhar (2007)	172 patients who delivered LBW babies	2005 and 2006	Nepal medical college	A community-based study is needed to assess LBW incidence and risk factors for effective prevention. Additionally, a well-equipped neonatal ICU should be established to enhance survival and reduce complications.
Khatun & Rahman (2008)	LBW babies (n =108) NBW babies (n =357)	July 2002 to June 2003	Azimpur Maternal and Child Health Training Institute	Maternal age, education, and economic status significantly impact low birth weight incidence.
Metgud et.al (2012)	1138 pregnant women	From 1stJune 2008 to 31stDecember 2009.	Kinaye Primary Health Centre (PHC) in rural Karnataka, India	Addressing LBW requires an integrated approach combining medical, social, economic, and educational measures.
Kader & Perera (2014)	A total of 20,946 women (15-49 years)	From 2005 to 2006 National Family Health Survey-3 (NFHS-3)	in India.	Reducing LBW in India requires improving maternal education, nutrition, and prenatal care through ongoing health promotion programs.

Borah & Baruah (2015)	Total 30 LBW babies (0 2 months) and equal numbers of NBW babies	January 2013 to August 2013.	Boko Bongaon Development Block, Kamrup District of Assam.	Health education, regular follow-ups by trained workers, and grassroots health worker training are essential for LBW care
Borah & Agarwalla (2016)	sample size of 450.	From October 2012 to 2013	Boko Bangaon Developmental Block area of Kamrup district Assam	Policy makers can address the identified risk factors from this study.
Taywade & Pisudde (2017)	A total of 307 singleton cases	January 2013 to December 2013	Wardha civil hospital	LBW was significantly associated with maternal age (<20 or >30 years), nuclear family, low living standards, paternal tobacco use, female sex, and lack of a sanitary latrine.
Gogoi (2018)	300 mothers	In 2016 from October to December	Guwahati Medical College Hospital (GMCH), Assam	LBW prevalence was high and linked to maternal health factors. Strengthening community-level maternal services is recommended.
Narwade & More (2018)	1611 women	April 2012 to June 2014	More Nursing Home, Kinwat, District Nanded, Maharashtra, India	Healthcare for young tribal mothers is crucial in reducing LBW cases. .
Deka et al. (2018)	400 term neonates chosen at random	Over a period of one year	Gauhati Medical College and Hospital (GMCH	Most identified factors in our study are modifiable and preventable. A holistic approach integrating medical, social, economic, and educational measures is essential to reduce LBW in India
Mehare & Sharew (2020)	472 term newborns	From September 1, 2018, to January 30, 2019	in Dilla town, Southern Ethiopia	Despite sampling limitations, LBW prevalence in this study was higher than Ethiopia's estimate. Pregnant women should receive adequate rest, nutrition, and accessible antenatal care
Wubetu et al. (2021)	337 mothers	From January 1st to June 30, 2020.	public hospitals of North Wollo, Ethiopia	Nearly a quarter of newborns had LBW, highlighting the need for special care for at-risk mothers
Herwanto et al. (2024)	A sample of 105 patients	From July 2022 to June 2023.	Soedomo Trenggalek Regional Hospital.	Clinicians should identify maternal risk factors early and provide timely intervention to prevent LBW.

Hossain et al (2025)	597 samples all together were selected.	From July 2022 to September 2022.	Bangladesh's eight administrative divisions	The incidence of LBW is significantly increased by premature birth, young maternal age, mineral deficiencies, and non-use of medicines during pregnancy. Reducing the prevalence of LBW and improving neonatal health outcomes in Bangladesh need addressing these variables.
Glory & Salve (2017)	Total 12960 infants	January 2006 to December 2015.	The MGM Medical College and Hospital in Aurangabad	The percentage of timely vaccinated male and female infants increased over time. Recommendations: Cost-effective measures like parental health education, vaccination cards, and due date reminders should be implemented to improve timely vaccination.
Walton et al. (2017)	1782 children,	Between 2000 and 2001	data from the MCS (Millennium Cohort Study)	Routine immunization records help track timely vaccinations and assess program quality. Parental reports of MMR vaccine status are reliable.
Endalew, et al. (2020)	548 children	From February to March 2020.	Jabitehnan district	Childhood vaccination timeliness was poor, with measles given early and BCG delayed. Factors like residency, maternal education, abortion history, delivery location, and awareness influenced adherence. Policymakers should prioritize timely vaccination, monitor it, and enhance maternal awareness and institutional delivery.
Dejene et al. (2022)	413 children	From May 1 to May 30, 2021	Debre Libanos district	Vaccine timeliness in the study district is lower than Ethiopia's overall coverage. Policymakers should prioritize and integrate timely vaccination into childhood immunization strategies.
Muhoza et al. (2024)	392 and 931 children	2016 and 2020	Ghana Health Service (GHS)	Ghana's 2YL improvements provide other countries with important lessons. Three regions saw improvements in vaccination timeliness as a result of policy changes and actions. Although regional discrepancies still exist, community participation, supportive policies, and HCW training proven to be helpful. Both timely immunization and coverage should be provided.
Masters et al. (2025)	321,743 children under the age of two years	January 1, 2018, and April 30, 2025	US health care systems.	This cohort study found that while the majority of children received their MMR vaccine on schedule, the percentage of children who remained unvaccinated by age two has increased consistently each year following the COVID-19 pandemic. Delays in receiving 2- and 4-month vaccines were strongly linked to not receiving any MMR dose by age two, indicating that early vaccination visits are key points for intervention.

4. Methodologies Used by Different Researchers

Various researchers have employed different statistical methods in their studies, including:

• Descriptive statistics: Provides a frequency, percentage, and average assessment of maternal, sociodemographic, and neonatal characteristics.

• Chi-square tests: Analyze correlations between categorical factors such as birth weight, income, and mother age.

• Logistic regression: Calculates the likelihood of low birth weight based on several socioeconomic and maternal characteristics.

• Univariate logistic regression: Evaluates the approximate correlation between all the factors and low birth weight.

• Bivariate and multivariate logistic regression: Determines independent predictors following the correction of confounding variables.

• Multivariable Cox regression: Assesses how many risk variables work together to affect birth outcomes throughout time.

5. Challenges and Uncertainties in Birth Weight and Child Vaccination

Addressing low birth weight (LBW) and child vaccination (0–24 months) is crucial for improving infant health. LBW newborns face higher risks of illness, delayed growth, and weak immunity, requiring targeted measures to enhance immunization.

Noteworthy Challenges in Studying LBW and Child Vaccination:

• Data Accuracy & Availability: Incomplete or inaccurately recorded birth weight and immunization data, especially in rural areas, hinder research reliability.

• Multiple Influencing Factors: Socio-economic conditions, maternal health, nutrition, environmental factors, and healthcare access impact LBW and vaccination outcomes, making causal analysis complex.

• Follow-up Difficulties: Tracking newborns and vaccination schedules up to 24 months is challenging due to migration, caregiver changes, and poor healthcare infrastructure.

• Socio-Cultural & Healthcare Barriers: Limited healthcare awareness, vaccine hesitancy, and disparities in access to immunization services contribute to underreporting and study limitations.

A comprehensive approach involving research, policy, education, and healthcare improvements is essential to boost vaccine coverage and child survival, especially in resource-limited areas like Assam, India.

6. Research Gaps and Solutions in Low Birth Weight (LBW) and Child Vaccination

Several research gaps persist in understanding LBW and childhood vaccination, including:

• Limited data on vaccine efficacy in LBW infants.

• Uncertainty about optimal vaccination timing.

• Lack of predictive models for LBW and tailored interventions.

• Insufficient exploration of maternal and socioeconomic influences.

• Differences in vaccine responses among preterm and intrauterine growth restriction (IUGR) infants.

• Parental hesitancy and insufficient data on long-term health and economic impacts.

Proposed Solutions:

• Enhance data collection through hospital records and digital tools.

• Implement community awareness initiatives.

• Improve follow-up via home visits.

• Use advanced analytics for risk assessment.

• Expand healthcare access through mobile units and digital vaccination tracking.

• Integrate technology, standardized research methods, and community engagement to strengthen immunization efforts and improve child health outcomes, particularly in regions like Assam.

• Implementing predictive models based on maternal, socioeconomic, and health data can aid in identifying mothers who are more likely to produce low birth weight (LBW) infants. Incorporating such models into digital health platforms would allow for early intervention, individualized counseling, and improved antenatal care.

7. Conclusion

From this literature review, we can conclude that low birth weight (LBW) remains a significant but preventable concern, requiring urgent action through strengthened maternal health programs, improved antenatal care, and better community-level services. Key maternal factors such as age, education, economic status, and obstetric history influence LBW, and most identified risk factors are modifiable. A holistic approach integrating medical, social, economic, and educational interventions is essential to reduce LBW prevalence.

Timely childhood vaccination has improved over time, but gaps persist due to socio-economic and healthcare access disparities. Factors such as maternal education, delivery location, and awareness significantly impact vaccine adherence. Cost-effective strategies such as parental education, vaccination reminders, and strengthened immunization tracking should be implemented to enhance timely coverage. Policymakers must integrate vaccination timeliness into immunization programs and prioritize maternal and neonatal healthcare for better health outcomes.

For low birth weight babies to survive and develop normally, vaccinations are essential. Timely immunization helps these LBW newborns develop illness resistance and greatly increases their chances of living a healthy life because they are born with weakened immunity compared to babies of normal birth weight.

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Sewali Hazarika,
Department of Mathematics,
The Assam Kaziranga University,
Jorhat, Assam, India, PIN 785006.
E-mail address: sewalihazarikaresearch@gmail.com

and

Tousifur Rahman,
Department of Statistics,
Bahona College,
Jorhat, Assam, India, PIN 785101.
E-mail address: rahmantousifur2018@gmail.com

and

Manoshi Kotoky,
Department of Mathematics,
The Assam Kaziranga University,
Jorhat, Assam, India, PIN 785006.
E-mail address: manoshi@kazirangauniversity.in (Corresponding author)