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Research Article

Bayesian Spatial Analysis of Risk Factors Affecting Low Birth Weight in Nigeria

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Abstract

Low birth weight (LBW), defined by the World Health Organization as a birth weight of less than 2.5 kilograms, is a major public health concern with significant implications for neonatal morbidity, mortality, and long-term health outcomes. LBW prevalence is particularly high in developing countries, contributing to substantial healthcare challenges and socio-economic burdens. This study examines the determinants of LBW in Nigeria, focusing on socio-demographic, economic, and health-related factors. This cross-sectional study utilizes data from the 2018 Nigeria Demographic and Health Survey (NDHS). A stratified two-stage cluster sampling method was employed, and data were collected through structured interviews. The analysis included socio-demographic characteristics, economic status, health factors, and birth weights, which were classified into LBW and normal birth weight categories. Ethical approval was obtained, and informed consent ensured participant confidentiality. The analysis revealed significant associations between LBW and several factors. Higher maternal education levels were linked to lower odds of LBW. Religious affiliation also impacted LBW, with Muslim mothers having a lower likelihood of LBW compared to Christian mothers. Ethnicity influenced LBW outcomes, with Igbo mothers showing higher odds of LBW compared to Yoruba mothers. Economic stability and urban residency were associated with reduced LBW risk. Health factors such as maternal BMI and frequent antenatal visits were protective against LBW. Geographic disparities indicated higher risks in northern Nigeria. The study underscores the multifactorial nature of LBW, highlighting the importance of maternal education, socio-economic support, and healthcare access. Tailored interventions addressing ethnic and religious contexts, along with region-specific strategies, are essential. The Bayesian STAR model's superior performance suggests that spatial and non-parametric considerations provide deeper insights into LBW risk factors. Comprehensive, multifaceted strategies and policies are needed to address the determinants of LBW, focusing on vulnerable populations and regional disparities.

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Keywords

Low Birth Weight (LBW), Socio-Demographic Factors, Economic Status, Maternal Education, Bayesian STAR Model

1. Introduction

Low birth weight (LBW), defined by the World Health Organization (WHO) as a birth weight of less than 2.5 kilograms, remains a pressing public health concern worldwide. It is a major contributor to neonatal morbidity and mortality, with significant implications for long-term health outcomes. Globally, approximately 15% of all births are classified as LBW, with a disproportionate burden borne by developing countries. In these regions, LBW prevalence can be as high as 28%, particularly in South Asia and sub-Saharan Africa [1, 2].

LBW is a multifaceted issue, influenced by a range of prenatal and postnatal factors. It is closely associated with preterm birth (less than 37 weeks of gestation) and intrauterine growth restriction [3]. LBW infants are at a higher risk of infections, childhood illnesses, and reduced survival rates. Long-term consequences include physical and cognitive impairments, which can affect behavior, learning, and psychosocial development [2]. Notably, LBW accounts for 40% of all deaths in children under the age of five, with 75% of these deaths occurring within the first week of life and 25-45% within the first 24 hours [4].

The socio-economic impact of LBW is profound. It strains healthcare systems, particularly in low- and middle-income countries (LMICs), where resources are already limited. Furthermore, LBW is linked to an increased risk of non-communicable diseases such as diabetes and cardiovascular disease later in life. These conditions not only affect individual health but also have broader implications for public health systems and economic productivity [5].

Numerous factors contribute to the prevalence of LBW, including socio-demographic, economic, and environmental influences. Maternal factors such as age, educational status, marital status, weight gain during pregnancy, and pre-existing health conditions like hypertension and infections play critical roles [6]. In low-income countries, maternal malnutrition and health complications during pregnancy are significant contributors to LBW [6].

Environmental factors also play a crucial role. For instance, maternal exposure to air pollution has been linked to increased risks of LBW [3]. Additionally, socio-economic factors such as poverty, inadequate access to healthcare, and poor living conditions exacerbate the risk of LBW [2].

The prevalence of LBW varies widely across regions. In East Asia and the Pacific, approximately 6% of newborns are LBW, while in South Asia, the prevalence can reach up to 28%. In sub-Saharan Africa, the prevalence is around 13%, with significant variation within countries [7, 8]. In Nigeria, LBW affects approximately 5-6 million children annually, with regional prevalence rates varying significantly. For example, the incidence of LBW is 12.1% in Jos, 11.4% in Ogun, and 16.9% in Maiduguri [9].

Efforts to reduce the prevalence of LBW have been articulated in global health policies. The 2012 World Health Assembly set a target to reduce the number of newborns with LBW by 30% by 2025. Achieving this goal requires a comprehensive approach that includes improving maternal nutrition, addressing pregnancy-related illnesses, and enhancing maternal care and perinatal services [10].

In Nigeria, understanding the spatial distribution of LBW and the socio-demographic, economic, and environmental factors influencing its prevalence is crucial for targeted interventions. A Bayesian spatial analysis offers a robust methodological approach to assess these factors and their regional variations. This study aims to provide a comprehensive analysis of LBW in Nigeria, using recent data to inform public health strategies and policies aimed at reducing the incidence of LBW and improving neonatal health outcomes.

This study is significant for several reasons. Firstly, it employs a Bayesian hierarchical model, specifically Markov Chain Monte Carlo (MCMC) methods, to provide more accurate estimates and inferences regarding the factors influencing LBW. This approach is less commonly used in LBW studies in Nigeria and other African countries, where traditional statistical methods like logistic regression are more prevalent [11]. Secondly, by mapping the spatial distribution of LBW across Nigeria, this study highlights regional disparities and identifies areas with high and low prevalence. This information is vital for policymakers and healthcare providers to allocate resources efficiently and implement targeted interventions. Understanding the maternal risk factors associated with LBW will help develop effective prevention and treatment strategies. These strategies can reduce LBW-related morbidity and mortality, ultimately contributing to improved health outcomes for mothers and infants. Addressing the socio-demographic, economic, and environmental factors affecting LBW through a Bayesian spatial analysis provides a nuanced understanding of this critical public health issue. This study aims to contribute to the global efforts to reduce LBW prevalence, enhance neonatal health, and support the well-being of future generations in Nigeria and beyond.

2. Method

2.1. Study Design

The study employs a cross-sectional design utilizing data from the 2018 Nigeria Demographic and Health Survey (NDHS). This survey captures a snapshot of the population's health status, including birth weights and associated factors, at a specific point in time. The cross-sectional design is appropriate for examining the prevalence of low birth weight and its associated determinants among women aged 15-49 years who have had at least one live birth.

2.2. Sampling Technique

The sampling technique used for the NDHS 2018 was a stratified two-stage cluster sampling method. In the first stage, enumeration areas (EAs) were selected based on the National Population and Housing Census (NPHC) of 2006. These EAs were stratified into urban and rural areas within each state and the Federal Capital Territory (FCT). In the second stage, households were systematically selected from the list of households in the chosen EAs. This method ensures a representative sample that can be generalized to the Nigerian population.

2.3. Data Collection

Data for this study were extracted from the NDHS 2018 women's recode. Information on birth weights, maternal demographic characteristics, socio-economic status, and health-related factors were collected through structured interviews conducted by trained interviewers. The interviews were conducted in pre-selected households, and no substitutions were allowed to minimize bias. Birth weights were reported by mothers and classified into various categories such as low birth weight (<2.5kg), very low birth weight (<1.5kg), and extremely low birth weight (<1.0kg). High birth weight (≥4.0kg) and normal birth weight (2.5kg-4.0kg) were grouped together as normal birth weight for the analysis.

2.4. Ethical Considerations

The NDHS 2018 data collection followed strict ethical guidelines. Approval was obtained from the National Health Research Ethics Committee of Nigeria (NHREC) and the Institutional Review Board (IRB) of ICF International. Informed consent was obtained from all participants, ensuring they were fully aware of the study's purpose, procedures, potential risks, and benefits. Confidentiality and anonymity of respondents were maintained throughout the data collection and analysis process. The dataset used in this study is publicly available and de-identified to ensure privacy and confidentiality.

3. Result

3.1. Parameter Estimation of the Parametric Variables of the Structural Additive Regression Model

***Table 1**. Parameter Estimates for Socio-Demographic, Economic and Environmental Factors.*

Variables	Levels	Posterior Mean	Odds Ratio	Posterior SD	Lower C. I.	Upper C. I.
Intercept		-1.124		0.3862	0.1524	0.6843
Level of Education	No education (RC)		1			
	Primary	-0.1514	0.86	0.2969	0.4778	1.5773
	Secondary	-0.5136	0.60	0.269	0.3612	1.0162
	Higher	-0.6228	0.54	0.2808	0.3146	0.9249
Religion	Christianity (RC)		1			
	Islam	-0.0474	0.95	0.2037	0.9481	2.1140
	Others	2.5698	13.06	1.4614	0.9850	339.75
Ethnicity	Yoruba (RC)		1			
	Hausa	-0.1758	0.84	0.3731	0.3997	1.7600
	Igbo	0.1273	1.136	0.2929	0.6311	2.0381
	Others	-0.156	0.86	0.2498	0.5332	1.3910
Gender of Child	Male (RC)		1			

Variables	Levels	Posterior Mean	Odds Ratio	Posterior SD	Lower C. I.	Upper C. I.
	Female	0.1259	1.14	0.1403	0.8626	1.4761
Birth Interval	1st Birth (RC)		1			
	<36 Months	-0.2022	0.82	0.0001	0.8168	0.8187
	36+ Months	-0.1666	0.85	0.0002	0.8454	0.8471
Employment Status	Not Working (RC)		1			
	Working	-0.0169	0.98	0.002	0.9822	0.9840
Wealth Index	Poorest (RC)		1			
	Poorer	0.3312	1.39	0.0016	1.3925	1.4002
	Middle	0.1228	1.13	0.0001	1.1299	1.1308
	Richer	-0.3438	0.71	0.3897	0.3160	1.4723
	Richest	-0.3611	0.70	0.3999	0.3421	1.7112
Maternal BMI	Under-weight (RC)		1			
	Normal weight	-0.4175	0.66	0.0001	0.6578	1.6019
	Obesity	0.4135	1.51	0.3264	0.7975	2.8207
No of Ante-natal visits	No Visit (RC)		1			
	1 - 3 Visits	-0.2367	0.79	0.3145	0.4142	1.4299
	4 - 7 Visits	-0.2539	0.78	0.1659	0.5626	1.7784
	Above 7 Visits	-0.1403	0.87	0.1992	0.5778	1.2799
Presence of Fever	No (RC)		1			
	Yes	0.2308	1.26	0.1759	0.8887	1.7818
Residential Type	Urban (RC)		1			
	Rural	0.2286	1.26	0.0011	1.2481	1.2572
Geographical Zone	North Central (RC)		1			
	North East	-0.2626	0.77	0.33	0.4070	1.4174
	North West	0.0721	1.08	0.3797	0.4933	2.3030
	South East	-0.9071	0.40	0.2981	0.2313	0.7344
	South South	-0.2238	0.80	0.2495	0.5030	1.2755
	South West	-0.0916	0.91	0.2375	0.5830	1.4566
Drinking Water	Unimproved (RC)		1			
	Improved	-0.186	0.8303	0.012	0.61348	1.12547
Type of Cooking Fuel	Electricity (RC)		1			
	Gas	-0.0135	0.9866	0.0111	0.51234	1.04142
	Smoking	0.1231	1.1310	0.0005	0.78121	1.56911
Type of Toilet Facilities	Unimproved (RC)		1			
	Improved	-0.1181	0.8886	0.022	0.53526	1.62466

N.B: RC stands for Reference Category. C.I stands for Credible Interval

Table 1 showed the effect of socio-demographic, socio-economic and social environmental factors on the risk of

Low birth weight among mothers. The table suggests that mothers that were surveyed whose educational background were primary, secondary and higher education had 14.0%, 40.0% and over 46.0% respectively lower odds of having low birth weight compared to child birth weight whose mothers had no educational qualification. The mothers whose religion were Islam had 5% lower odd while those practicing other religion were over 100% higher odd when compared with Christian mothers of having low birth weight babies.

Also, pregnant women who gave birth to female had 14% higher odds of having low birth weight birth compared to mothers who gave birth to male children. Mothers whose ethnicity were Igbo had 14% higher odds of having low birth weight babies compared to mothers whose ethnic group were Yoruba while mothers who were Hausa and Other ethnicity had 16% and 14% respectively lower odds of having low birth weight birth compared to mothers whose ethnic group were Yoruba. Mothers whose birth interval were <36 months and 36+ months had 18% and 15% lower odds of having low birth weight birth compared to mothers with 1st birth.

Additionally, mothers who lived in a rural residence had 26% higher odds of having low birth weight birth compared to mothers who lived in an urban residence. Also, mothers who were working had 2% lower odds of having birth weight birth compared to mothers who were not working. Likewise, mothers whose wealth index were poorer and middle wealth index had 39% and 13% respectively higher odds of having low weight birth compared to mothers whose wealth index were poorest while mothers whose wealth index were richer and richest had 29%, 30% respectively lower odds of having low birth weight birth compared to mothers whose wealth index were poorest. Also, mothers whose BMI were normal had 34% lower odds of having low birth weight birth compared mothers whose BMI were below underweight while mothers who are obese had 15% higher odds of having birth weight birth compared to mothers whose BMI were underweight. The mothers whose number of antenatal visits were between 1 to 3, 4 to 7 visits and above 7 visits and had 21%, 22% and 13% respectively lower odds of having low birth weight birth compared to mothers who had no antenatal visit.

Also, the mothers who had fever during pregnancy possessed 26% higher odds of having low birth weight birth compared mothers who had no fever in pregnancy. The mothers whose geopolitical zone were North East, South West, South East and South-South had 23%, 9%, 60%, and 20% respectively lower odds of having low birth weight birth compared to mothers whose geopolitical zone were North Central. Mothers whose geopolitical zone was Northwest had 8% higher odds of having low birth weight birth compared to mothers whose geopolitical zone were North Central.

3.2. Parameter Estimation of the Non-Parametric Variables of the Structural Additive Regression Model

Table 2. *Parameter Estimates for Non Parametric Variables.*

Variable	Posterior Mean	Posterior SD	2.50%	97.50%	Min	Max
Geographical location	0.7214	0.6203	0.0197	2.2897	0.0027	4.1629
Maternal Age	0.0087	0.0226	0.0005	0.0433	0.0003	0.4743

Table 2 showed the importance of the non-parametric variable in determining the risk of Low birth weight. The table suggests that the Geographical location had the higher importance in predicting the risk of low birth weight with a mean of 0.7214 compared to maternal age with mean of 0.0087. The effect of each of the non-parametric variables on the risk of low birth weight will be illustrated in figures 1-3 below.

Figure 1 shows the risk map of low birth weight. The risk map shows that the highest risk of Low birth weight (red colour) was found in Northern part of Nigeria while the lowest risk of Low birth weight (blue colour) was found in Southern part of Nigeria. This is also justified in figures 2 and 3 below.

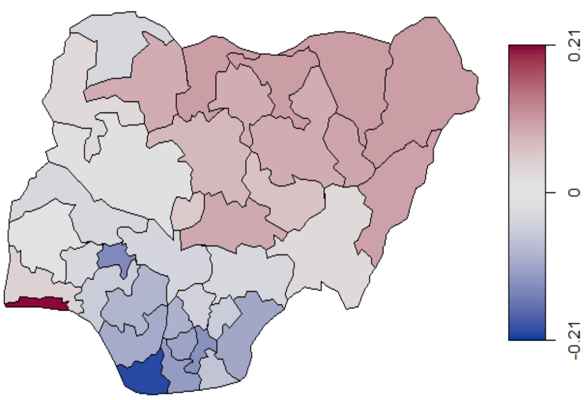

Figure 1. *The Posterior Means of the Spatial Effect on the Low Birth Weight.*

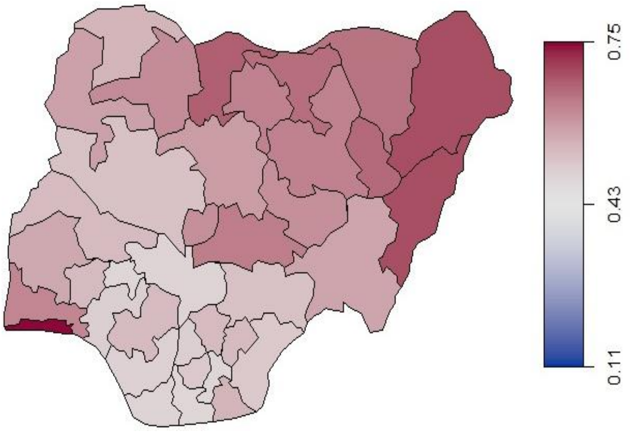

Figure 2. 97.5% C.I of the Spatial Effect on the Low birth weight.

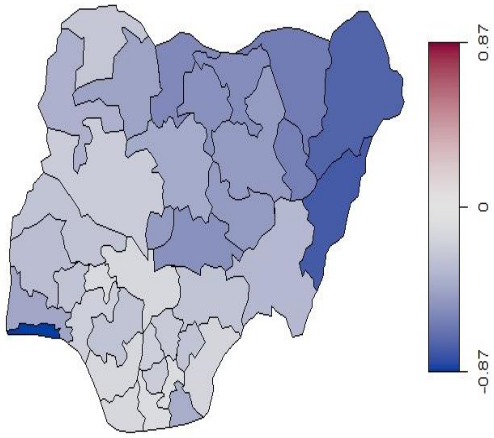

Figure 3. 2.5% C.I of the Spatial Effect on the Low birth weight.

It can be depicted from the Figure 2 above that the highest risks of Low birth weight were found in Bauchi, Borno, Kastina and Adamawa states.

It is indicated from the Figure 3 above that the lowest risk of Low birth weight was found in Bayelsa, Delta, Imo, Benue, Lagos and Oyo states.

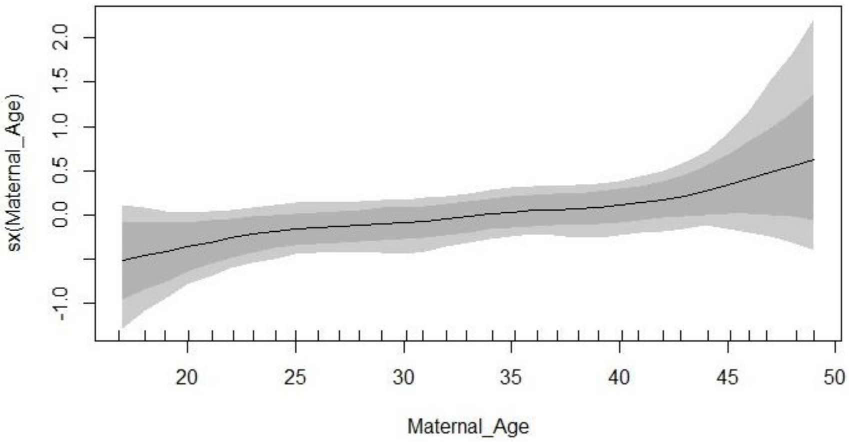

Figure 4. Smoothing Component of Low Birth Weight with Maternal Age.

Figure 4 suggest that as the maternal age increases, the risk of Low birth weight also increases.

3.3. Frequentist Parameter Estimation

Table 3 shown below contains the logistic regression results for the birth weight's model. The results indicate that the coefficients of all the variables of interest are statistically significant by the overall significance of (p=0.000) at 5% level of significance.

Table 3. Logistic Estimates of the Model.

Variables	Category	Exp (B)	Lower C. I.	Upper C. I.	Sig.
Intercept					
Level of Education	No education (RC)	1			
	Primary	2.12	1.111	4.028	0.023
	Secondary	1.78	1.055	2.995	0.031

Variables	Category	Exp (B)	Lower C. I.	Upper C. I.	Sig.
	Higher	1.22	0.834	1.773	0.309
Religion	Christianity (RC)	1			
	Islam	0.072	0.005	0.981	0.048
	Others	0.104	0.007	1.46	0.093
Ethnicity	Yoruba (RC)	1			
	Hausa	1.388	0.758	2.54	0.288
	Igbo	0.8	0.363	1.763	0.58
	Others	1.461	0.782	2.729	0.235
Gender of Child	Male (RC)	1			
	Female	0.915	0.692	1.208	0.53
Birth Interval	1st Birth (RC)	1			
	<36 Months	1.227	0.807	1.866	0.339
	36+ Months	0.864	0.607	1.229	0.417
Residential Type	Urban (RC)	1			
	Rural	1.963	0.429	8.995	0.385
Employment Status	Not Working (RC)	1			
	Working	1.07	0.755	1.517	0.703
Wealth Index	Poorest (RC)	1			
	Poorer	0.949	0.399	2.261	0.906
	Middle	1.386	0.755	2.544	0.292
	Richer	0.766	0.473	1.242	0.28
	Richest	1.118	0.774	1.614	0.553
Maternal BMI	Under weight (RC) (< 18.5)	1			
	Normal weight (18.5-24.9)	1.479	0.758	2.886	0.251
	Obesity (≥25)	1.675	1.218	2.303	0.001
No of Ante-natal visits	No Visit (RC)	1			
	1 - 3 Visits	1.201	0.812	1.776	0.359
	4 - 7 Visits	0.965	0.479	1.944	0.921
	Above 7 Visits	0.663	0.298	1.475	0.314
Malaria in pregnancy	No (RC)	1			
	Yes	0.99	0.692	1.418	0.958
Geographical Zone	North Central (RC)	1			
	North East	1.102	0.612	1.987	0.746
	North West	1.135	0.296	4.356	0.853
	South East	0.952	0.348	2.603	0.924
	South South	0.463	0.232	0.924	0.029
	South West	1.036	0.522	2.055	0.92

N.B: RC stands for Reference Category. C.I stands for Credible Interval

The Table 3 above established the effect of socio-demographic and socio-economic factors on the risk of birth weight using Logistic regression model. According to the table, mothers that were surveyed whose educational background were primary, secondary and higher education had 112%, 78% and 22% respectively higher odds of having low birth weight birth compared to mothers with no educational qualification. Mothers whose religion were Islam and other type of religion had 93% and 89% respectively lower odds of having low birth weight birth compared to mothers whose religion were Christianity. Also, mothers who gave birth to females had 9% lower odds of having low birth weight babies compared to mothers who gave birth to male children. Likewise Mothers whose ethnicity were Igbo had 20%lower odds of having low birth weight babies compared to mothers whose ethnic group were Yoruba, while mother whose ethnic group were Hausa and other ethnic groups had 39% and 46% respectively higher odds of having low birth weight birth compared to mothers whose ethnic group were Yoruba. The maternal women whose birth interval were <36 months and 36+ months had 19% and 39% respectively lower odds of having low birth weight birth compared to mothers who had their 1st birth.

In addition, Mothers who lived in a rural residence had 96% higher odds of having low birth weight birth compared to mothers who lived in an urban residence. Mothers who were working had 7% higher odds of having low birth weight birth compared to mothers who were not working. Mothers whose wealth index were poorer and Richer had 5% and 23% respectively lower odds of having low birth weight birth compared to mothers whose wealth index were poorest while those middle and richest had 39% and 5% respectively higher odds of having low birth weight birth compared to mothers whose wealth index were poorest. Also, the mothers whose BMI were normal weight and Obesity had 48% and 68% higher odds respectively of having low birth weight birth compared to mothers whose BMI were underweight. Mothers whose number of antenatal visits were between 1 to 3 had 20% higher odds of having low birth weight birth compared mothers who did not visit antenatal while the mothers whose number of antenatal visits were between 4 to 7 and above 7 visits had 5% and 34% respectively lower odds of having low birth weight birth compared to mothers who did not visit antenatal. Also, mothers who had fever had 1% lower odds of having low weight birth compared to mothers who had no presence of fever. Mothers whose geopolitical zone were North East, North West and South West had 10%, 14% and 4% respectively higher odds of having low birth weight birth compared to mothers whose geopolitical zone were North Central. Mothers whose geopolitical zone were South East and South South had 5% and 54% lower odds respectively of having low birth weight birth compared to mothers whose geopolitical zone were North Central.

3.4. Comparison of Bayesian STAR and Logistic Model

This aspect of Analysis gives the comparison of Bayesian STAR and Logistic Models using the response variable of Birth Weight with the explanatory variables.

Table 4. *Model Diagnostics of Bayesian STAR and Logistics.*

	Models	
Statistitcs	Logistic	Bayesian STAR
-2 log likelihood	1391.069	917.671
Cox and snell R^2	0.065	0.093
P-value of Models	0.000	0.000
Chi-Square	135.085	140.055

The joint significance of the explanatory variables was found to be statistically significant at 5 percent level with the two models as shown by the corresponding probability value ($p<0.05$). The Cox and Snell estimated that 9.3 percent total variation in the birth weight model of Bayesian STAR compared to 6.5% of Logistics as explained by the socio-demographic and socio-economic in the regression equation. Also, the STAR model possessed the least log-likelihood value of 917.671 which affirmed its goodness compared to Logistics.

4. Discussion

4.1. Impact of Socio-Demographic Factors on Low Birth Weight

The analysis indicates significant associations between socio-demographic factors and low birth weight (LBW) in infants. Mothers with higher educational levels had lower odds of delivering LBW infants compared to those with no education. Specifically, primary, secondary, and higher education levels were associated with 14%, 40%, and 46% lower odds of LBW, respectively. This finding is consistent with the literature, which often highlights the role of maternal education in improving pregnancy outcomes through better health literacy and access to healthcare services [12, 13]. Religious affiliation also showed a notable impact. Mothers practicing Islam had a 5% lower odd of having LBW babies compared to Christian mothers, while those practicing other religions had significantly higher odds (13.06 times) of LBW. This disparity could be reflective of varying cultural practices and access to prenatal care among different religious groups, as suggested by previous studies [14, 15]. Ethnicity emerged as another significant factor. Mothers of Igbo ethnicity had 14% higher odds of LBW compared to Yoruba mothers, while Hausa and other ethnicities had 16% and 14% lower odds, respectively. These differences may stem from genetic, cultural, and socio-economic variations among these groups, influencing maternal and fetal health differently [16].

4.2. Socio-Economic and Environmental Influences

Economic status, as reflected by wealth index, demonstrated a complex relationship with LBW. While poorer and middle-class mothers had higher odds of LBW, the richest mothers showed a trend towards lower odds. This aligns with the understanding that economic stability often translates to better nutrition and healthcare access, crucial for favorable birth outcomes [17]. Employment status had a marginal impact, with working mothers having slightly lower odds of LBW. This finding may be context-specific, as the nature of employment and associated stress or benefits can vary widely [18]. Living in rural areas was associated with higher odds of LBW, likely due to limited access to quality healthcare services, poor nutritional status, and higher prevalence of infections [10]. Similarly, maternal fever during pregnancy increased the odds of LBW, consistent with research showing infections as a risk factor for adverse birth outcomes [19].

4.3. Health and Prenatal Care Factors

The study underscores the importance of maternal BMI and antenatal care in determining birth weight. Normal weight and obesity in mothers were associated with significantly higher odds of LBW compared to underweight mothers. This contrasts with some studies suggesting underweight mothers are at higher risk, indicating the need for balanced nutrition [20]. Frequent antenatal visits were protective against LBW, affirming the role of regular prenatal care in monitoring and managing potential complications [21]. Mothers with 1 to 3, 4 to 7, and more than 7 visits had progressively lower odds of LBW.

4.4. Geographic and Non-Parametric Factors

Geographic location was a significant predictor of LBW, with northern Nigeria showing higher risks compared to the south. This spatial variation is depicted in the risk maps, highlighting the need for region-specific interventions [22]. Maternal age had a smaller but significant effect on LBW, with older mothers generally having higher risks. This is consistent with studies indicating increased pregnancy complications with advancing maternal age [23].

4.5. Comparative Analysis of Bayesian STAR and Logistic Models

The Bayesian STAR model outperformed the logistic regression model in explaining the variation in LBW. The STAR model had a lower log-likelihood value and higher Cox and Snell R-squared value, indicating better fit and explanatory power. This suggests that incorporating spatial effects and non-parametric variables provides a more nuanced understanding of LBW risk factors [24].

4.6. Implications for Policy and Practice

The findings emphasize the multifactorial nature of LBW and the need for comprehensive strategies addressing educational, economic, and health-related determinants. Policies should focus on improving maternal education, economic support for low-income families, and enhancing healthcare access, especially in rural and high-risk areas. Tailored interventions considering ethnic and religious contexts can also be more effective [25].

5. Conclusion

This study highlights the intricate relationships between socio-demographic, economic, environmental, health, and geographic factors and the incidence of low birth weight (LBW) in infants. Maternal education, religious affiliation, and ethnicity were found to significantly influence LBW outcomes, emphasizing the importance of tailored health education and cultural sensitivity in maternal care. Economic stability and urban residency were associated with lower odds of LBW, pointing to the critical role of socioeconomic support and healthcare access. Health factors such as maternal BMI and frequent antenatal visits were protective against LBW, underscoring the necessity of balanced nutrition and regular prenatal care. Geographic disparities, particularly higher risks in northern Nigeria, call for region-specific interventions. The superior performance of the Bayesian STAR model over logistic regression suggests that spatial and non-parametric considerations provide deeper insights into LBW risk factors. These findings advocate for comprehensive, multifaceted strategies and policies to address the educational, economic, and health determinants of LBW, with a focus on vulnerable populations and region-specific needs. However, we recommend that future studies should be directed at exploring the best methods to prevent LBW among different population in Nigeria and African continent in general.

Abbreviations

LBN	Low Birth Weight
MCMC	Markov Chain Monte Carlo
WHO	World Health Organisation

LMICs	Low and Middle-Income Countries
GLM	Generalized Linea Model
GAM	Generalized Additive Model

Conflicts of Interest

The authors declare no conflicts of interest.

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