SPATIAL AND SOCIO-DEMOGRAPHIC DETERMINANTS OF BIRTH RATE IN NIGERIA: EVIDENCE FROM THE 2024 DEMOGRAPHIC AND HEALTH SURVEY

BY

Saheed Olalekan Jabaru
Department of Physical Sciences, Al-Hikmah University, Ilorin, Kwara State, Nigeria
Email: saheedjabar@alhikmah.edu.ng

Abstract
The need to understand the recent patterns and determinants of Nigeria's fertility data necessitates this study. This study utilized the 2024 Nigeria Demographic and Health Survey data to examine the contributing factors to Nigeria's ever-increasing birth rate. Four randomly selected samples of 5,000, 10,000, 20,000, and 30,000 respondents, without replacement, were analyzed using a geo-additive model with Bayesian inference. Results from the best model revealed that a high number of births is attributed to the following factors: living in the North-East, North-West, or South-East, being an urban dweller, being from a poor household, being married, living with a partner, being a widow, and a woman's age. Meanwhile, a lower number of births is associated with living in the South-South or South-West, belonging to the rich households, usage of contraceptives, never being in a union, and age at first birth. The total number of births to each woman fluctuates as the age at first sex increases. A higher number of births in the Northern region without corresponding provision might be responsible for the security challenges being witnessed for the past decade. Therefore, policymakers are urged to address the socioeconomic drivers of this high fertility to ensure that urban growth aligns with sustainable development goals.
Keywords: NDHS 2024, Spatial Statistics, Nonlinear Regression, Population Growth, Nigeria

Introduction

Nigeria is currently confronted with significant developmental challenges, particularly in the areas of insecurity and a low standard of living. A large proportion of the population continues to live below the poverty line, a condition often linked to the country's rapid and largely uncontrolled population growth. As of 2025, Nigeria ranks as the sixth most populous country in the world and the most populous in Africa. Projections indicate that, if current growth trends persist, the country could become the third most populous nation globally by 2050. This rapid population expansion places immense pressure on available resources, infrastructure, and social services, thereby exacerbating existing socio-economic difficulties. Despite the importance of understanding fertility patterns in shaping population growth, there is a noticeable gap in recent empirical studies that comprehensively examine the spatial, demographic, and socio-economic determinants of fertility in Nigeria. In particular, research focusing on total births per woman using up-to-date data remains limited. One major reason for this scarcity is the nature of data collection in the country. Reliable and nationally representative data on fertility and related indicators are primarily obtained through the National Demographic and Health Survey (NDHS). However, due to the substantial financial, logistical, and technical requirements involved, the NDHS is typically conducted at intervals of five years or more. This infrequency creates a lag in the availability of current data for research and policy analysis (Mashood et. al. 2022).

Prior to the release of the 2024 NDHS report in August 2025, most studies examining fertility rates and their determinants in Nigeria relied heavily on data from the 2013 and 2018 survey rounds. For instance, Mashood et al. (2022) utilized the 2018 NDHS dataset to investigate geographical variations and identify key demographic and economic factors influencing the number of children ever born to women aged 15–49 years. Similarly, Adebowale

(2019) drew on the 2013 NDHS data to conduct a multivariate analysis of fertility patterns among Nigerian women, while Alaba and Olaomi (2015) applied the same dataset to develop a geo-additive model for understanding the determinants of family size in the country. While these studies have made valuable contributions to the literature, their findings may no longer fully reflect the current realities of fertility behavior in Nigeria. Given the country's fast-growing population and evolving socio-economic landscape, there is a strong likelihood that fertility patterns and their underlying drivers have changed in recent years. Factors such as urbanization, education, economic pressures, cultural shifts, and access to healthcare services may have significantly influenced reproductive behavior since the last datasets were analyzed.

This situation underscores the necessity for updated research that incorporates more recent data to provide a clearer and more accurate picture of fertility dynamics in Nigeria. Consequently, the present study seeks to address this gap by examining the spatial distribution of recent birth patterns across the country using data from the 2024 NDHS. By leveraging this updated dataset, the study aims to generate insights that are more reflective of current demographic trends and better suited to inform policy decisions and development planning. Ultimately, a deeper understanding of fertility patterns and their determinants is essential for designing effective interventions aimed at managing population growth and improving the overall well-being of Nigerians.

Research Objectives

This study aims to determine significant predictors of the total number of children born per woman in Nigeria based on the 2024 NDHS data using geo-additive regression techniques. The specific objectives are to:

1. assess spatial variations and regional distributions of recent fertility levels in Nigeria;
2. examine the influence of socio-demographic factors on total births; and
3. Provide evidence-based policy recommendations for managing fertility rate and population growth in Nigeria.

Research Questions

This study will answer the following research questions:

1. What are the spatial patterns and regional variations in fertility levels across Nigeria?
2. How do socio-demographic factors influence fertility levels in Nigeria?
3. What policy-relevant factors can be identified from the analysis of fertility determinants to inform effective population and reproductive health interventions in Nigeria?

Methodology

Data for this study were extracted from the 7th NDHS, which was conducted in the year 2024 and released in the year 2025. The response variable is the total number of children ever born (TCEB), whether dead or alive, per woman as at the time of the survey. Four sub-samples of 5000, 10,000, 20,000, and 30,000 respondents were randomly selected without replacement from the total number of 104,557 respondents. However, due to the high computational cost of the Bayesian geo-additive model with geospline basis, model estimation became infeasible after 30,000 samples. The potential predictors of fertility identified in the 2024 NDHS are similar to those

examined by Mashood et al. (2022) and Adebayo & Gayawan (2022). The metrical and categorical predictors are presented in Tables 1 and 2 below:

Table 1: Description of metrical predictors

SN	Predictor
1	Respondent's current age
2	Respondent's age at first birth
3	Respondent's age at first sex

Table 2: Description of categorical predictors

S/N	Predictor	Categories
1	Respondent Region	North West
		North East
		North Central
		South East
		South South
		South West
		Not a de jure resident
2	Residence Type	Urban
		Rural
3	Wealth Index	Poorest
		Poorer
		Middle
		Richer
		Richest
4	Current Contraceptive method	None
		Folkloric
		Traditional
		Modern
5	Marital Status	Never in union
		Married
		Living with a partner
		Widowed
		Divorced
		Separated
6	Home Ownership	Does not own
		Alone only
		Jointly with husband
		Jointly with someone else
		Jointly with husband and someone else
		Both alone and jointly

Given the average number of children ever born by Nigerian women (otherwise called the respondent) as at 2024 NDHS as λ_i; then;

$ln(\lambda_i) = \beta_0 + \beta_1(Respondent\ region) + \beta_2(Residence\ type) + \beta_3(Wealth\ \text{index}) + \beta_4(Current\ contraceptive) + \beta_5(Respondent\ region) + \beta_6(Home\ ownership) + +f_1(Respondent\ age) + f_2(Age\ of\ respondent\ at\ 1st\ birth)) + f_3(Age\ of\ respondent\ at\ 1st\ sex)) + f_{spat}(States)$ (1)

where:

$\beta_0 = intercept$

$\beta_i = model\ parameters$

$f_i = smooth$ functions

$f_{spat} = spatial\ smooth$ functions

In (1), the negative binomial distribution, which introduces the dispersion parameter to quantify overdispersion, was assumed for the response variable because the variance (7.16) is higher than the mean (5.48). Monte Carlo Markov Chain (MCMC) simulation with 10,000 iterations was used to generate data for the analysis, while storing only every 10th sampled parameter to avoid autocorrelation. All metrical predictors were estimated nonlinearly, while all categorical predictors were estimated linearly. An independent flat prior was assumed for the categorical predictors to assign them equal weights, while metrical predictors were smoothened through a first-order random walk model to control their wiggliness and avoid overfitting (Echavarria, 2004; Brezger & Lang, 2006). Data analysis was achieved using the R2BayesX package, version 0.3-1, of the R statistical software.

Model selection in this study is based on the minimum value of the following criteria:

$AIC = -2\ell(\hat{\beta}) + 2k$ (2)

$BIC = -2\ell(\hat{\beta}) + plog(n)$ (3)

$AICc = AIC + \frac{2k(k+1)}{n-k-1}$ (4)

where:

$\ell(\hat{\beta})$ is the maximized log-likelihood;

n = number of parameters;

p = number of predictors

k = effective degree of freedom, which measures the model complexity

Results

Based on the sub-samples, four models were obtained using the same predictors and response variable with different sample sizes. The results are presented in Table 3 below:

Table 3: Model Comparison

Model	Sample size	AIC	BIC	AICc
1	5000	-42898.9	-42579.4	-42918
2	10000	-84480.2	-84105.9	-84488. 5

3	20000	-170894	-170450	-170904
4	30000	-257032*	-256554*	-257037*

* minimum values

The asterisked values of AIC, BIC, and AICc in Table 3 imply that Model 4 has the minimum values and hence, is adjudged the best model that captures the spatial and nonlinear relationship between the response variable and the predictors. Hence, the results for Model 4 are presented in Tables 4 and 5. In Table 4, it was shown that women in the North-East, North-West, and South-East have 16.63%, 17.25%, and 9.24% significantly higher TCEB, respectively, than those in the North-Central. Conversely, women in the South-South and South-West have 6.02% and 11.22% significantly lower TCEB, respectively, than those in the North-Central. Moreover, women living in the urban areas have 1.34% higher TCEB than those from the rural areas. Also, women from the households categorized as poorer and poorest have 2.49% and 4.71% higher TCEB, respectively, than those from the middle class. However, women from the households categorized as richer and richest have 5.82% and 14.73% lower TCEB, respectively, than those from the middle class. It was also observed that contraceptive usage reduces TCEB; with women using modern, traditional, and no method having 9.7%, 10.99%, and 9.85% lower TCEB, respectively, compared to those using the folkloric method. In terms of marital status, married women, women living with their partners, separated and widowed women have 22.03%, 19.89%, 1.61%, and 5.74% higher TCEB than divorced women, though the estimate for separated women is not significant at 5% level.

Table 4: Estimates for categorical predictors

Predictor	Category	Estimate (β)	SE	95% Credible Interval	IRR (Exp β)
	Intercept	0.809*	0.045	0.717, 0.891	2.245
Region of residence (Ref.:North-Central)	North-East	0.154*	0.008	0.139, 0.170	1.166
	North-West	0.159*	0.008	0.144, 0.174	1.173
	South-East	0.088*	0.011	0.068, 0.109	1.092
	South-South	-0.062*	0.011	-0.083, -0.040	0.940
	South-West	-0.119*	0.011	-0.141, -0.096	0.888
	Not a de jure resident	0.008	0.038	-0.064, 0.081	1.008
Type of residence (Ref.: Rural)	Urban	0.013*	0.006	0.001, 0.026	1.013
Wealth index (Ref.: Middle)	Poorer	0.025*	0.008	0.008, 0.040	1.025
	Poorest	0.046*	0.008	0.031, 0.062	1.047
	Richer	-0.060*	0.008	-0.076, -0.043	0.942
	Richest	-0.159*	0.010	-0.179, -0.139	0.853
Current contraceptive method (Ref.: Folkloric)	Modern	-0.102*	0.028	-0.156, -0.044	0.903
	None	-0.116*	0.028	-0.171, -0.060	0.890
	Traditional	-0.104*	0.030	-0.161, -0.046	0.902
Marital-status (Ref.: Divorced)	Living-with-partner	0.181*	0.028	0.128, 0.235	1.199
	Married	0.199*	0.023	0.153, 0.245	1.220
	Never-in-union	-0.185*	0.040	-0.260, -0.105	0.831
	Separated	0.016	0.033	-0.048, 0.078	1.016
	Widowed	0.056*	0.026	0.006, 0.106	1.057

Home Ownership (Ref.: Alone only)	Both alone and jointly	0.050	0.038	-0.027, 0.124	1.051
	Does not own	-0.002	0.017	-0.032, 0.028	0.981
	Jointly with husband and someone else	-0.015	0.026	-0.067, 0.036	0.986
	Jointly with husband only	-0.018	0.017	-0.053, 0.015	0.982
	Jointly with someone else only	-0.022	0.030	-0.081, 0.036	0.978

IRR: Incidence Rate Ratio Ref.: Reference category 95% Credible intervals are reported*

Meanwhile, women who have never been in a union have a 16.91% lower TCEB than divorced women. Lastly, women who own houses alone and jointly with their husbands have 5.08% higher TCEB than women who own houses alone. However, other categories of homeowners have lower TCEB than women who own their house alone.

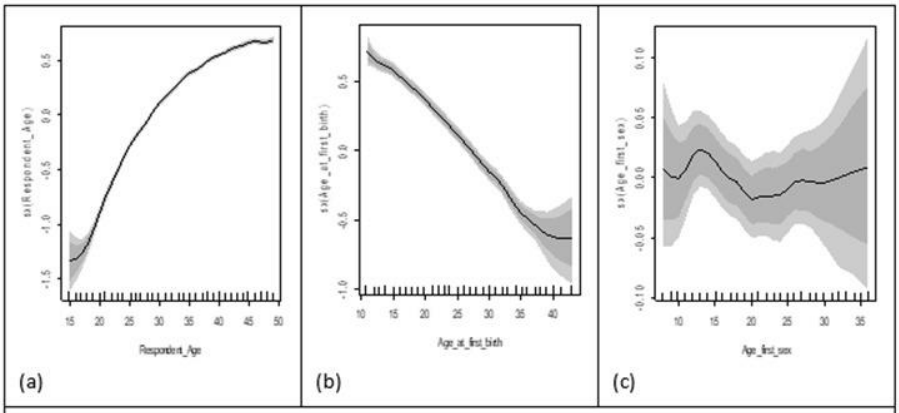

Fig. 1: Nonlinear effects of metrical predictors: (a) respondent age; (b) age of women at first birth; and (c) age of women at first sex; on TCEB in Nigeria

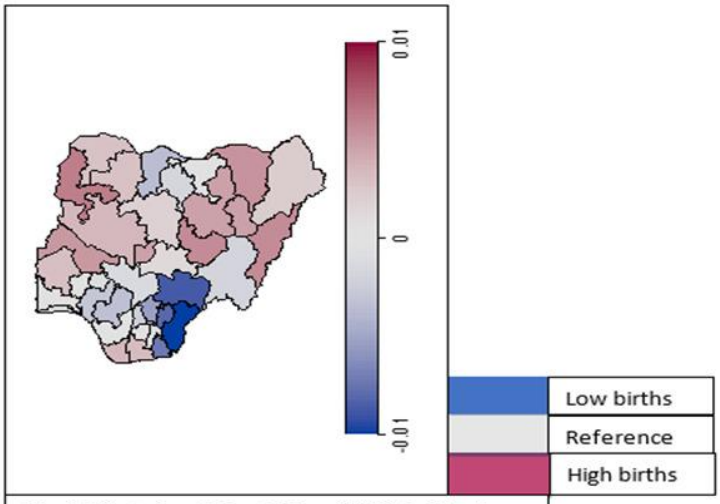

Fig. 2 Effect of spatial variable on TCEB in Nigeria

In Fig. 1a, TCEB consistently increases with a woman's age, though a slight decrease was noticed at 4 years upward. Fig. 1 b, however, shows that the higher the age at first birth, the lower the total number of children. Lastly, Fig. 1c indicates a fluctuating pattern in the cumulative number of children as the age at first sex increases. In Fig. 2, with the grey areas as the reference, a lower number of births is noticeable in Cross-River, Benue, Ebonyi, Akwa-Ibom, Enugu, Edo, Ondo, and Katsina States. However, higher births are observed in Adamawa, Kebbi, Yobe, Kwara, Plateau, Bauchi, Gombe, Rivers, Bayelsa, FCT, and Oyo States. Only three of these States are in the Southern part of Nigeria, while the rest are in the North.

Discussion

This study's findings present several notable parallels and contrasts with existing literature on fertility determinants in Nigeria, Africa, and other parts of the world. The higher number of children observed for urban women compared to the rural women in this study could be attributed to the recent massive rural-urban migration in the country, whereby most rural areas are now inhabited by older men and women who are above childbearing age. This finding contradicts those of Ibeji et al. (2020), Rahman et al. (2022), and Cherie et al. (2023), who concluded in their studies that rural women have a higher number of children than urban women. This study's findings align with those of Adebowale (2019) and Ibeji et al., who all affirmed that the Northern part of the country has a higher number of children than the South. This may be attributed to a higher percentage of educated couples in the latter, who believe in using contraceptives to control births. However, the findings of Nibaruta et al. (2021) contradict those in this study in terms of the North-South fertility rate. While the former discovered higher births in the Southern region, the latter found otherwise. This study also found a high birth rate associated with women from poor households. This may be because they have no means of acquiring modern contraceptives to control their births. This is similar to the findings of Nibaruta et al. (2021) and Cherie et al. (2023). The use of contraceptives was also found to reduce the number of children ever born, which supports the findings of Rahman et al. (2022) and Gebre (2024), who conclude that the usage of modern contraceptives by women of reproductive age led to a reduction in fertility rate. It also aligns with Bongaarts and Westoff's (2000) research, which demonstrated the effectiveness of modern contraceptive methods in lowering fertility rates.

Age at first birth has an inverse relationship with the total number of births in this study, which contradicts the finding of Adebowale (2019), who concluded otherwise. However, women who are exposed to childbirth early are expected to have a higher number of children. Marital status also plays a crucial role in fertility, as evidenced by the study. Women who are married, those living with their partner, separated, and widows have a higher number of children than those who are divorced. This conclusion is similar to the findings of Alaba et al. (2017) as well as Adebowale (2019). Being married or living with a man always increases the chances of getting pregnant and giving birth; this finding is expected. This is also consistent with the findings of Dodoo (1998), who reported that marital stability significantly influences fertility rates in sub-Saharan Africa. The study's finding that increases in the respondent age are accompanied by an increase in total children ever born aligns with the conclusion of Adebowale (2019). As the age of respondents increases, the number of children born also increases, which is similar to the findings of Amusa and Yahya (2019), in which the number of children ever born is positively related to respondent age. It also agrees with the findings of Cherie et al. (2023), whereby there is a 2.4% increase in children ever born for every unit increase in respondent age. All the categories of home ownership are not significant to the number of children born by women in this study at 95% credible interval. This study also revealed significant regional variations in fertility rate within Nigeria, with higher fertility rates in the North-East, North-West, and South-East regions compared to the North-Central region. This aligns with the findings of Mashood et al. (2022), who

highlighted similar regional fertility disparities, attributing them to differences in socio-economic conditions, cultural norms, and access to healthcare services. The significant geographical variations in fertility rates are also supported by the work of Guilmoto (2009), who demonstrated that regional disparities in socio-economic development and cultural practices lead to varied fertility patterns across different areas. The identification of states with high and low fertility rates in this study echoes the findings of previous regional fertility studies in Nigeria, which also highlighted similar spatial differences.

Conclusions and Recommendations

Based on the findings in this study, categorical factors that significantly contribute to the population growth rate of Nigeria based on the 2024 NDHS data include living in the North-East, North-West, or South-East, living in an urban area, belonging to the poorer and poorest wealth index, being married, living with a partner, or being a widow. However, living in the South-South or South-West, belonging to the richer and richest wealth index, usage of contraceptives, and never being in a union are factors that significantly contribute to a lower number of births.
Also, it was discovered that as women grow old, their number increases, while a higher age at first birth is accompanied by a decrease in the number of children. However, the number of children born to women fluctuates with an increase in the age at first sex. In terms of spatial factor, except for a few States in the South, a high number of births is dominant in the Northern part of the country. The high number of births in some parts of the country without corresponding provision for the children might have sparked the recent security challenges being witnessed in the Northern part of Nigeria. Hence, government and stakeholders are enjoined to look into the correlation between the number of births vis-à-vis the facilities on the ground to cater to their needs. Additionally, the significant impact of contraceptive usage on fertility rates revealed ongoing efforts in terms of awareness about family planning methods. Overall, this study is an eye-opener for the government and stakeholders in birth control on the recent fertility spread and determinants in Nigeria, offering suggestions on factors that should be controlled in order to address high fertility rates and promote sustainable population growth. The practical implications of the urbanization of high fertility are potentially linked to demographic transition in Northern Nigerian cities. This shift of high fertility to the urban centres will put more pressure on the infrastructure and healthcare systems of the cities, and hence, there is a need for re-designing their family planning services. Therefore, policymakers are urged to address the socioeconomic drivers of this high fertility to ensure that urban growth aligns with sustainable development goals. This study is, however, limited by the number of predictors used; only predictors without missing values in the survey report are used. This is because the percentages of missing values in the other potential predictors of fertility rate are too high (above 70%). Meanwhile, the results reported in this paper belong to 30,000 respondents (approximately 29% of the total respondents), which is considered to be high enough for a robust estimation.

References

Adebayo, S. B., & Gayawan, E. (2022). Exploring spatial variations, trends, and the effect of exposure to media as an enhancer to uptake of modern family planning methods: Evidence from the 2003-2018 Nigeria Demographic and Health Survey. *Spatial Demography, 10*, 229-254.

Adebowale, A. S. (2019). Ethnic disparities in fertility and its determinants in Nigeria. *Fertility Research and Practice, 5*, 1-16.

Alaba, O. O., & Olaomi, J. O. (2015). Geo-additive modelling of family size in Nigeria. *Journal of Biometrics & Biostatistics, 6*, 1-6.

Alaba, O. O., Olubusoye, O. E., & Olaomi, J. O. (2017). Spatial patterns and determinants of fertility levels among women of childbearing age in Nigeria. *South African Family Practice, 59*, 143-147.

Amusa, L., & Yahya, W. (2019). Stepwise geo-additive modelling of the ideal family size in Nigeria. *Turkiye Klinikleri Journal of Biostatistics, 11*, 123-132.

Bongaarts, J., & Westoff, C. F. (2000). The potential role of contraception in reducing abortion. *Studies in Family Planning, 31*, 193-202.

Cherie, N., Getacher, L., Belay, A., Gultie, T., Mekuria, A., Sileshi, S., & Degu, G. (2023). Modelling the number of children ever born and its determinants among married women of reproductive age in Ethiopia: A Poisson regression analysis. *Heliyon, 9*, e13151.

Dodoo, F. N. A. (1998). Marriage type and reproductive decisions: A comparative study in sub-Saharan Africa. *Journal of Marriage and the Family*, 232-242.

Gebre, M. N. (2024). Number of children ever born and its associated factors among currently married Ethiopian women: Evidence from the 2019 EMDHS using negative binomial regression. *BMC Women's Health, 24*, 95. https://doi.org/10.

Guilmoto, C. Z. (2009). The sex ratio transition in Asia. *Population and Development Review, 35*, 519-549.

Ibeji, J. U., Zewotir, T., North, D., & Amusa, L. (2020). Modelling fertility levels in Nigeria using a generalized Poisson regression-based approach. *Scientific African, 9*, e00494.

Mashood, L. O., Ani, C. I., Balogun, O. S., & Abdulazeez, S. A. (2022). A geo-additive model of fertility level on female education among women of childbearing age in Nigeria. In *Proceedings of the 1st Faculty of Science International Conference (FSIC)* (pp. 175-188).

Nibaruta, J., Adebowale, M., & Alate, K. (2021). Understanding fertility patterns in sub-Saharan Africa: A comprehensive analysis of socio-economic and cultural determinants. *Journal of Population Studies, 45*, 234-250.

Rahman, A., Hossain, Z., Rahman, M. L., & Kabir, E. (2022). Determinants of children ever born among ever-married women in Bangladesh: Evidence from the Demographic and Health Survey 2017-2018. *BMJ Open, 12*, e055223.

Worldometer. (2025). *Nigeria population (live)*. Retrieved October 15, 2025, from https://www.worldometers.info/world-population/nigeria-population/