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A comprehensive model for studying unknown predictors of fertility among Nigerian women.

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Abstract

This study investigated unexplored predictors of fertility in Nigeria, integrating them with established global predictors to create a comprehensive fertility model. The base model used traditional predictors, while subsequent models evaluated new ones. Insignificant predictors were excluded based on Akaike Information Criterion corrected (AICc) values. The final model revealed significant regional variations in fertility rates. Women in the North-East, North-West and South-East regions had higher Total Children Ever Born (TCEB) than those in the North-Central region, while women in the South-West had lower TCEB. Educational attainment inversely affected fertility, with higher TCEB among women with no, primary and secondary education compared to those with higher education. Contraceptive methods significantly reduced TCEB, including female sterilization, injections, male condoms and emergency contraception.

Marital status and decision-making dynamics were important; married women, women living with their partner and widows had higher TCEB than divorced women. Women whose healthcare decisions were made solely by their husband had significantly higher TCEB. Additionally, internet use and terminated pregnancies were associated with lower TCEB. These findings align with existing literature on fertility determinants in Sub-Saharan Africa, highlighting regional disparities and the impacts of education, contraceptive use, marital status and decision-making dynamics. The results advocate for culturally sensitive, region-specific family planning interventions, promotion of female education, increased access to contraceptives and strategies empowering women in decision-making. Enhanced family planning efforts through information technology and continuous program adaptation are essential for sustainable population growth in Nigeria.

Keywords: Pregnancies; Fertility; Family planning; Anaemia

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Introduction

Nigeria, the most populous country in Africa, is dealing with the challenge of managing its rapid population growth, a phenomenon primarily driven by high fertility rates. Understanding the determinants of fertility is essential for policymakers who seek to design and implement effective interventions aimed at promoting sustainable development and improving maternal and child health outcomes. One of the important measures of fertility is the Total Children Ever Born (TCEB) metric, which offers valuable insights into reproductive behavior across various regions and socio-economic groups [1].

Extensive research has been conducted on fertility rates and their predictors in different countries. These studies utilized a range of predictors, depending on the country's structural, economic, social and demographic characteristics. The diversity in predictors underscores the complexity of fertility determinants, which vary significantly across different contexts [2].

Key studies on TCEB and its determinants, as summarized in Tables 1 and 2, draw on data from various demographic and health surveys. These tables provide a comparative analysis of predictors used in different countries, highlighting both commonalities and unique factors pertinent to specific regions. For instance, while some studies emphasize socio-economic factors such as education and income, others focus on cultural practices and access to healthcare services. In the context of Nigeria, the most recent Nigeria Demographic and Health Survey (NDHS) conducted in 2018 has shed light on several potential predictors of TCEB that have not been thoroughly explored in previous research. This study aims to fill this gap by examining the impact of these novel predictors on the TCEB of Nigerian women. By incorporating these new variables into the analysis, this research seeks to provide a more exact understanding of fertility determinants in Nigeria [3].

The novel predictors identified in the NDHS include factors such as duration of amenorrhea, anemia levels, the number of co-wives in polygamous marriages, the time since last sexual activity, health insurance coverage, the individual responsible for women's healthcare, house ownership, internet usage, the decision-maker for contraceptive use, years since first cohabitation, duration of abstinence, birth intervals, previous state of residence and the incidence of terminated pregnancies [4].

By investigating these predictors, this study not only contributes to the existing literature but also offers practical insights for policymakers and healthcare providers. Understanding these determinants can help in formulating targeted strategies that address the specific needs of different regions and socio-economic groups within Nigeria [5]. Consequently, this research aims to support efforts towards achieving sustainable population growth and enhancing the overall well-being of Nigerian families [6].

S/N	Metrical	Author(s)
1	Woman's current age	Cherie et al., Mashood et al., Nibaruta et al., Adebowale et al.
2	Woman's age at first birth	Rahman et al., Mashood et al., Nibaruta et al., Ibeji et al., Adebowale et al., Alaba et al., Upadhyay et al.
3	Woman's age at first sex	Mashood et al.
4	Woman's age at first marriage/cohabitation	Rahman et al., Mashood et al., Nibaruta et al., Ibeji et al., Upadhyay et al.
5	Ideal number of children/family size preference/fertility preference	Mashood et al., Nibaruta et al., Ibeji et al., Adebowale et al.
6	Age of husband/household head	Mashood et al., Ibeji et al.
7	Number of living children	Mashood et al.
8	Number of dead children	Alaba et al.
9	Body mass Index	Alaba et al.
10	Number of daughters	Alaba et al.
11	Family income	Upadhyay et al.

Table 1. Metrical predictors of TCEB by women across the world in the literature.

S/N	Categorical	Author(s)
1	Level of education of woman	Cherie et al., Mashood et al., Rahman et al., Nibaruta et al., Ibeji et al., Adebowale et al.
2	Religion	Mashood et al., Rahman et al., Nibaruta et al., Ibeji et al., Adebowale et al., Alaba et al.
3	Wealth index	Cherie et al., Mashood et al., Rahman et al., Nibaruta et al., Adebowale et al., Alaba et al.
4	Geopolitical zone (Region)	Mashood et al., Rahman et al., Ibeji et al., Alaba et al., Nibaruta et al.
5	Level of education of husband/partner	Mashood et al., Rahman et al., Nibaruta et al., Alaba et al.
6	Type of place of residence/locality	Cherie et al., Mashood et al., Rahman et al., Nibaruta et al., Ibeji et al., Adebowale et al., Alaba et al.
7	Ethnicity	Mashood et al., Alaba et al., Upadhyay et al.
8	Family planning method	Alaba et al.
9	Marital status	Nibaruta et al., Adebowale et al., Alaba et al.
10	Desire for more children	Rahman et al.
11	Occupation of woman	Nibaruta et al., Ibeji et al., Upadhyay et al.
12	Occupation of husband	Nibaruta et al.

13	Working status/women empowerment	Cherie et al., Mashood et al., Rahman et al., Ibeji et al., Alaba et al.
14	Method of delivery	Alaba et al.
15	Currently breastfeeding	Mashood et al.
16	Currently pregnant	Ibeji et al.
17	Sex of household head	Rahman et al., Nibaruta et al.
18	Exposure to family planning messages/knowledge of contraceptives	Rahman et al., Nibaruta et al., Adebowale et al., Upadhyay et al.
19	Wanted last child/pregnancy or not	Ibeji et al.
20	Sex preference	Ibeji et al., Adebowale et al.
21	Child is twin or single birth	Ibeji et al.
22	Membership of NGO	Rahman et al.
23	Exposure to mass media	Cherie et al., Rahman et al.
24	Infant mortality experience	Nibaruta et al.
25	Family structure	Upadhyay et al.

Table 2. Categorical predictors of TCEB by women across the world in the literature.

Materials and Methods

Study area description

The study focuses on Nigeria, a country located between latitudes 4° and 14° north of the equator and longitudes 3° and 15° east of the Greenwich meridian. It is the most populous nation in Africa, with an estimated population of approximately 206 million as of mid, according to the USA. Nigeria is home to around 250 ethno-linguistic groups, making it one of the most diverse countries globally. Administratively, Nigeria is divided into 36 states and the Federal Capital Territory (FCT), Abuja. These are further grouped into six geo-political zones: North-East, North-Central, North-West, South-East, South-South and South-West. This regional division helps in understanding the socio-political and economic dynamics of the country [7].

Nigeria experiences a tropical climate characterized by a rainy season from April to October and a dry season from November to March, with variations across different regions. The temperature in Nigeria ranges from 18.45°C (65.21°F) to 36.9°C (98.4°F) and the country receives an average annual rainfall of approximately 1,500 mm. Covering a land area of 923,768 km², Nigeria is roughly four times the size of the United Kingdom and more than twice the size of California, USA. Geographically, Nigeria shares land borders with Benin to the west, Niger to the north, Chad to the northeast and Cameroon to the east. It also has maritime boundaries with Ghana, Equatorial Guinea and São Tomé and Príncipe. The federal capital territory, Abuja, is centrally located in the north-central zone of Nigeria, serving as the administrative and political center of the country. The map of Nigeria (Figure 1), illustrates the six geo-political zones, providing a clear visualization of the regional divisions essential for spatial analysis in the study [8].

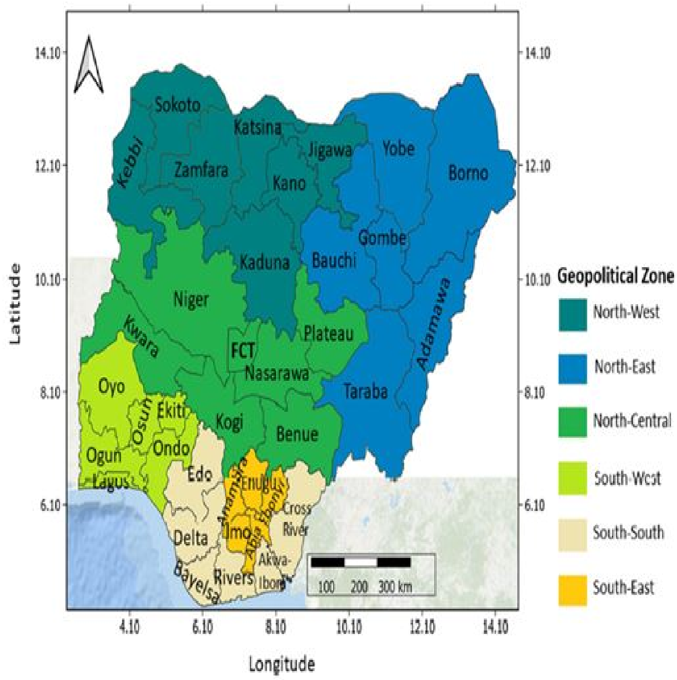

Figure 1. Map of Nigeria showing the 36 states and the FCT including their geo-political zones

Data source

The data for this study was drawn from the 2018 Nigeria Demographic and Health Survey (NDHS-6). The NDHS-6 provides comprehensive information on various health and demographic variables across Nigeria. The survey covers all women aged 15-49 years and all men aged 15-59 years across 42,000 selected households from all 36 states and the Federal Capital Territory (Abuja). The data collection process ensures a representative sample, facilitating robust statistical analyses and insights into the population's health and demographic trends. To access the NDHS-6 data, researchers must register and obtain the necessary approvals through the DHS programs. This process ensures that data usage complies with ethical standards and promotes the confidentiality of respondents. By utilizing this rich dataset, the study aims to explore the impact of other determinants of Total Children Ever Born (TCEB) that have not been examined in the literature [9].

Response variable

The response variable in this study is the total number of children ever born (whether dead or alive) to each woman in Nigeria at the time of the 2018 NDHS survey. This count variable ranges from 1 to 17, with a mean of 5.92 and a variance of 7.96. We assume a negative binomial distribution for the response variable because the variance is slightly higher than the mean, indicating over dispersion. The study data consist of 10,000 respondents who were randomly sub-sampled without replacement [10].

Model formulation

Traditional predictors of TCEB in the literature were used as predictors in Model 1 (base model). Subsequently, we added the newly identified predictors one at a time to the base model to examine their marginal effects on TCEB. A fully Bayesian approach was adopted to fit geo-additive models, with appropriate priors assigned to all predictors. This approach relies on Markov priors and support Monte Carlo Markov Chain (MCMC) techniques for inference and model validation, as proposed by Fahrmeir et al., Lang et al., and Besag et al. [5,11]. Given, $\upsilon i = (\upsilon_{i1},\dots,\upsilon_{iq})$ as vector of q categorical predictors; $x_{ij} = (x_{i1},\dots,x_{ip})$ as vector of metrical predictors and (k = 1, . . ., 37) as spatial variable, the geo-additive model that expresses the relationship between the response variable and the predictors is given by:

$$\ln(\lambda_i) = \beta_0 + \upsilon_i'\beta_i + \sum_{j=1}^{p} f_j(\chi_{ij}) + f_{spat}(\phi_k) \quad \text{...........(1)}$$

Hence, the models in this study are:

Model 1: All predictors in Table 3+spatial variable (2)

Model 2: All predictors in Table 3+Time_since_last_sex+spatial variable (3)

Model 3: All predictors in Table 3+Cowives+spatial variable (4)

Model 4: All predictors in Table 3+Months_of_abstinence+ spatial variable (5)

Model 5: All predictors in Table 3+Years_first_cohabitation+ spatial variable (6)

Model 6: All predictors in Table 3+Preceding_birth_interval+ spatial variable (7)

Model 7: All predictors in Table 3+Succeeding_birth_interval +spatial variable (8)

Model 8: All predictors in Table 3+Amenorrhea+spatial variable (9)

Model 9: All predictors in Table 3+Anaemia+spatial variable (10)

Model 10: All predictors in Table 3+Hinsurance+spatial variable (11)

Model 11: All predictors in Table 3+Internet+spatial variable (12)

Model 12: All predictors in Table 3+Previous_state+spatial variable (13)

Model 13: All predictors in Table 3+Respondent_healthcare +spatial variable (14)

Model 14: All predictors in Table 3+Howner+spatial variable (15)

Model 15: All predictors in Table 3 Had_terminated_pregnancy +spatial variable (16)

Model 16: All predictors in Table 3 Dcontraceptive+spatial variable (17)

Data analysis

All metrical predictors were modeled non-linearly, whereas all categorical predictors were modeled linearly. To obtain samples for posterior estimation, Monte Carlo Markov Chain (MCMC) simulations were employed, executing a total of 10,000 iterations. To mitigate autocorrelation, thinning was applied to the Markov Chain, retaining only every 10th sampled parameter. The penalized likelihood method for estimating the parameters of the STAR model was utilized in this study, facilitating simultaneous variable selection and model selection. This method determines whether:

- A predictor should be included in the model;
- A continuous variable should be included linearly or nonlinearly; and
- A spatial variable should be included in the model.

Data analysis was conducted using the R2BayesX package, version 0.3-1, of the R statistical software developed by Upadhyay et al. Model selection inference was based on the Akaike Information Criterion corrected (AICc) (Tables 3 and 4) [12].

Categorical	Metrical
Geopolitical zone (respondent_region)	Respondent's current age (respondent_age)
Type of place of residence (residence_type)	Respondent's age at first birth (age_at_first_birth)
Level of education of woman (education_level)	Respondent's age at first marriage/cohabitation (age_first_cohabitation)

Wealth index (wealth_index)	Respondent's age at first sex (age_first_sex)
Current contraceptive (current_contraceptive)	Age of partner (age_of_partner)

Table 3. Existing predictors in the literature for Model 1 (base model).

Categorical	**Metrical**
Anemia level (Anemia)	Time since last sex (time_since_last_sex)
Health Insurance Coverage (Hinsurance)	Number of co-wives (Cowives)
Use of internet (Internet)	Months of abstinence (Months_of_abstinence)
Respondent's previous state (Previous_state)	Years since first cohabitation (Years_first_cohabitation)
Respondent healthcare (Respondent_healthcare)	Preceding_birth_interval
Ownership of house (Howner)	Succeeding_birth_interval
Ever had terminated pregnancy (Had_terminated_pregnancy)	Duration of amenorrhea (Amenorrhea)

Table 4. New predictors for models 2–16.

Results

Based on the results in Table 5, variables residence_type, anaemia and dcontraceptive were dropped from further analysis while the remaining predictors that led to model improvement were included in Model 17.

Model 17: (All predictors in Table 3-residence_type)+(All predictors in Table 4-dcontraceptive-anaemia)+spatial variable.

The results of Model 17 with 12 metrical predictors and 11 categorical predictors are presented and interpreted below (Table 6) [13].

Model Number	**AICc**	**Predictor removed**	**Model improvement**
1	-102660	None	
2	-102661	Residence_type*	Improved
3	-102661	Residence_type*	Improved
4	-102699	Residence_type*	Improved
5	-102742	Residence_type*	Improved
6	-102957	Residence_type*	Improved
7	-102977	Residence_type*	Improved
8	-102664	Residence_type*	Improved
9	-102660	Residence_type and Anaemia*	Not Improved
10	-102666	Residence_type*	Improved
11	-102682	Residence_type*	Improved
12	-102688	Residence_type*	Improved
13	-102666	Residence_type*	Improved
14	-102664	Residence_type*	Improved
15	-102668	Residence_type*	Improved
16	-102660	Residence_type and Dcontraceptive*	Not Improved
Note: *: Not significant and hence removed from subsequent analysis.			

Table 5. Fitted models and assessment.

			95% Credible intervals			
Predictors	**Posterior mean (βi)**	**Standard deviation**	**Lower**	**Upper**	**IR=Exp(βi)**	**%change w.r.t Ref.category**
Intercept	1.2416*	0.2635	0.7458	1.74	3.4611	
Respondent_ region (Reference=North_ Central)	0				1	100
North_East	0.1144*	0.0143	0.0878	0.1429	1.1212	12.12
North_West	0.1566*	0.0134	0.1283	0.1826	1.1695	16.95
South_East	0.0346	0.0185	-0.0026	0.0705	1.0352	3.53
South_West	-0.0802*	0.0177	-0.1172	-0.0443	0.9229	-7.71
Education_level (Reference= higher)	0				1	100
No_education	0.1182*	0.0247	0.0724	0.1699	1.1255	12.55
Primary	0.1125*	0.0248	0.0637	0.162	1.1191	11.91
Secondary	0.0517*	0.0231	0.0061	0.0989	1.0531	5.31
Wealth_index (reference=middle)	0				1	100
Poorest	0.0214	0.0103	-0.0002	0.0415	1.0216	2.16
Current_contraceptive (Reference=emergency contraception)	0				1	100
Female sterilization	-0.1086	0.0679	-0.2367	0.0187	0.8971	-10.29
Injections	-0.0474	0.0248	-0.0964	0.0033	0.9537	-4.63
Male condom	-0.0976*	0.0504	-0.1953	-0.0024	0.907	-9.3
Not using	-0.0522*	0.0142	-0.0802	-0.026	0.9491	-5.09
Marital_status (reference=divorced)	0				1	100
Living_with_partner	0.1495*	0.0409	0.0627	0.2299	1.1613	16.13
Married	0.1369*	0.031	0.0743	0.1943	1.1467	14.67
Never_in_union	-0.3061*	0.0643	-0.4336	-0.1841	0.7363	-26.37
Widowed	0.0586	0.0348	-0.0103	0.1249	1.0604	6.04
Respondent_ healthcare (Reference=Husband/partner alone)	0				1	100
Others	-0.4088	0.276	-1.0574	0.0896	0.6644	-33.56
Respondent and partner	-0.0163	0.0105	-0.0368	0.0048	0.9838	-1.62
Internet (Reference=Never)	0				1	100

Yes, last 12 months	-0.1162*	0.0254	-0.1655	-0.0689	0.8903	-10.97
Had terminated pregnancy (Reference=No)	0				1	100
Yes	-0.0390*	0.0115	-0.0607	-0.0169	0.9618	-3.82
Previous_state (Reference=Abia)	0				1	100
Bauchi	0.0538	0.0269	-0.0011	0.1091	1.0553	5.53
Enugu	-0.0675	0.0364	-0.1394	0.0016	0.9347	-6.53
Imo	0.0747	0.042	-0.0107	0.1564	1.0776	7.76
Jigawa	0.0536	0.0318	-0.0086	0.1168	1.0551	5.51
Katsina	0.0615*	0.0278	0.0057	0.1121	1.0634	6.34
Niger	0.0666*	0.0355	0.0008	0.14	1.0689	6.89
Age at first birth	-0.0467*	0.0017	-0.0503	-0.0433	0.9544	
Age at first cohabitation	0.0017	0.0037	-0.0063	0.0078	1.0017	
Age at first sex	-0.0017	0.0011	-0.0041	0.0004	0.9983	
Cowives	-0.0016	0.001	-0.0038	0.0002	0.9984	
Note=*: Values are significant at 5% significant level, IR: Incidence Rate.						

Table 6. Parametric coefficients of Model 17.

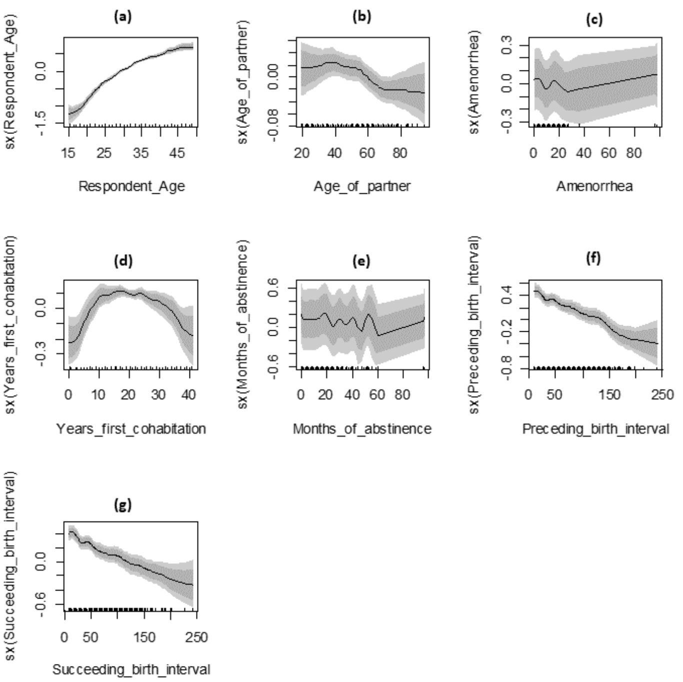

Figure 2. Effects of respondent age, age of partner, duration of amenorrhea, years since first cohabitation, months of abstinence, preceding birth interval and succeeding birth interval on TCEB. **Note:** (a): Respondent age; (b): Age of patner; (c): Amenorrhea; (d): Years first co-habitation; (e): Months of abstinence; (f): Preceding birth interval; (g): Succeeding birth interval.

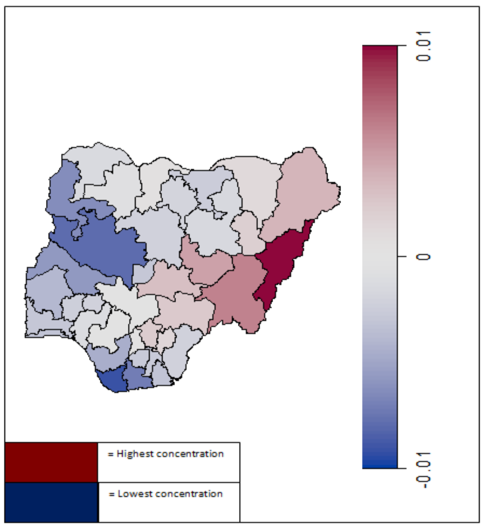

Figure 3. Posterior map on prevalence of TCEB in Nigerian states based on 2018 NDHS data.

Findings

This study identified and investigated the impact of several potential predictors of TCEB that have not been previously explored or thoroughly examined by past researchers. These new predictors were combined with existing global predictors of TCEB to develop a new model for women's fertility rates in Nigeria. The base model (Model 1) includes predictors already established in the literature, while 16 additional models assess the marginal effect of each newly identified predictor. Based on their AICc values, the variables "Residence type" and

"Anaemia level," as well as "Decision maker for using contraception," were found not to improve the base model and were thus excluded from the final model (Model 17). The results of Model 17 are presented under fixed effects, non-linear effects and spatial effects as follows.

Interpretation of fixed effects estimation results

Table 6 presents the posterior mean estimates of predictors modeled parametrically, along with their 95% credible intervals. Additionally, it includes estimates for four metrical predictors (age at first birth, age at first cohabitation, age at first sex and number of Co-wives), which were initially assumed to have a non-linear effect on the response variable but were modeled linearly. The findings indicate that the TCEB for women in the North-East, North-West and South-East regions are 12.12%, 16.95% and 3.53% higher, respectively, than those in the North-Central region. In contrast, women in the South-West have a 7.71% lower TCEB than those in the North-Central. The posterior mean estimates for the North-East, North-West and South-West are significant at the 5% level [14].

Furthermore, women with no education, primary education and secondary education have 12.55%, 11.91% and 5.31% higher TCEB, respectively, compared to those with higher education. These estimates are all significant at the 5% level. In terms of wealth index, women in the poorest category have 2.16% more children than those in the middle category, although this estimate is not significant at the 5% level. Women using female sterilization, injections, male condoms, or no contraceptive have 10.29%, 4.63%, 9.3% and 5.09% fewer children, respectively, than those using emergency contraception [15].

Additionally, women living with their partner, married women and widowed women have 16.13%, 14.67% and 6.04% more children, respectively, than divorced women. Women who have never been in a union have 26.37% fewer children than divorced women. Only the estimate for widowed women is not significant at the 5% level. Women whose healthcare decisions are made solely by their husband/partner have 33.56% more children than those whose healthcare decisions are made by others. Women who share healthcare decision-making with their husband have 1.62% fewer children than those whose husband alone decides. Both estimates are not significant at the 5% level [16].

Women who used the internet in the last 12 months have a TCEB that is 10.97% lower, significant at the 5% level, compared to those who never used the internet. Women who have had a terminated pregnancy have 3.82% fewer children, significant at the 5% level, compared to those who never had. Women whose husbands previously lived in Bauchi, Imo, Jigawa, Katsina and Niger states have 5.53%, 7.76%, 5.51%, 6.34% and 6.89% higher TCEB, respectively, than those whose husbands previously lived in Abia state. Conversely, those whose husbands previously lived in Enugu state have 6.53% significantly lower TCEB compared to Abia state, at the 5% significance level. Finally, increases in age at first birth, age at first cohabitation, age at first sex and number of co-wives increased the TCEB by 0.9544, 1.0017, 0.9983 and 0.9984, respectively. Only the estimate for age at first birth is significant at the 5% level [17].

Interpretation of fixed effects estimation results

Figure 2, displays plots illustrating the relationship between various factors and TCEB: respondent age, age of partner, duration of amenorrhea, years since first cohabitation, months of abstinence, preceding birth interval and succeeding birth interval. The TCEB increases with the age of the respondents. Similarly, the TCEB increases with the age of the partner up to 40 years, after which it declines. For women with amenorrhea, the TCEB fluctuates for periods shorter than 25 months before stabilizing [18].

The relationship between "years since first cohabitation" and TCEB is "∩"shaped, with an increase in the number of children born up to 15 years of cohabitation, followed by a decline. The TCEB also fluctuates as the months of abstinence increase up to 60 months, after which a continuous increase is observed. Increases in the preceding birth interval and succeeding birth interval are associated with a decrease in TCEB [19].

Spatial effects

Figure 3 illustrates the spatial effects on TCEB. The reference region is depicted in grey. Regions colored red indicate states in Nigeria with higher TCEB compared to the reference region, while regions colored blue indicate states with lower TCEB. The states with the highest number of children born are Adamawa, Taraba, Borno, Plateau, Nasarawa, Benue and Enugu. Conversely, the states with the lowest birth rates are Bayelsa, Niger, Kebbi, Kwara and rivers.

Discussion

This study's findings regarding predictors of Total Children Ever Born (TCEB) in Nigeria present several notable parallels and contrasts with existing literature on fertility determinants in sub-Saharan Africa and other developing regions.

Regional differences

The study indicates significant regional variations in TCEB 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 findings by Mberu et al., who highlighted similar regional fertility disparities, attributing them to differences in socio-economic conditions, cultural norms and access to healthcare services [20]. Additionally, Garenne et al., noted that fertility rates are often higher in rural and less developed regions, which often correspond to the northern areas of Nigeria identified in this study [12, 21-23].

The significant geographical variations in fertility rates is also supported by the work of Guilmoto et al., who demonstrated that regional disparities in socio-economic development and cultural practices lead to varied fertility patterns across different areas [13]. 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 [1].

Educational impact

The inverse relationship between educational attainment and fertility observed in this study is consistent with numerous studies across Africa. For instance, a study by Gyimah et al., found that higher levels of female education significantly reduce fertility rates due to delayed marriage and increased use of contraception [14]. Similarly, Caldwell et al., emphasized that education empowers women with better knowledge and resources for family planning, leading to lower fertility rates [7].

Contraceptive use

The study's findings that various contraceptive methods reduce TCEB align with Bongaarts et al., research, which demonstrated the effectiveness of modern contraceptive methods in lowering fertility rates across different contexts [6]. The significant impact of female sterilization, injections and male condoms on reducing fertility in this study is in line with previous findings by Cleland et al., who reported similar trends in family planning studies globally [9].

Marital status and household decision-making

Marital status and decision-making dynamics within households also play an important role in fertility, as evidenced by the study. This is consistent with the findings of Dodoo et al., who reported that marital stability and male dominance in household decision-making significantly influence fertility rates in sub-Saharan Africa [10]. Furthermore, Bankole et al., highlighted that women's autonomy in decision-making correlates with lower fertility rates, underscoring the importance of empowering women in reproductive health decisions [4].

Internet use and pregnancy termination

The study's finding that internet use correlates with lower fertility reflects the growing body of literature suggesting that access to information technology can enhance knowledge and adoption of family planning practices. Jensen et al., found that exposure to media and information technology increases awareness and use of contraceptives, subsequently reducing fertility rates [16]. Additionally, the association between pregnancy termination and lower fertility aligns with the study by Rosier et al., which documented how access to safe abortion services can contribute to reduced fertility rates [24].

Temporal effects

The study's findings on the relationship between respondent age, age of partner and fertility are consistent with existing literature that shows a curvilinear relationship between age and fertility rates. For instance, Leridon et al. noted that fertility increases with age until the mid-30s, after which it declines due to biological constraints [18,25].

Conclusion

In conclusion, this study's identification of various predictors of Total Children Ever Born (TCEB) in Nigeria provides a comprehensive understanding that aligns with and expands upon existing literature. By incorporating both traditional and novel predictors, this research offers valuable insights into the multifaceted determinants of fertility rates, emphasizing the need for region-specific and culturally sensitive family planning interventions. The regional disparities highlight the importance of tailoring policies to address the unique socio-economic, cultural and healthcare challenges in different areas. The strong influence of educational attainment underscores the critical role of female education in reducing fertility rates, reinforcing the need for policies that promote educational opportunities for women.

Additionally, the significant impact of contraceptive use on fertility rates supports ongoing efforts to increase access to and education about family planning methods. The findings regarding marital status and household decision-making dynamics call for strategies that empower women and promote gender equality in decision-making processes. The correlation between internet use and lower fertility rates suggests that expanding access to information technology can further enhance family planning efforts. Finally, the spatial and temporal effects identified in this study underline the necessity of continuous monitoring and adaptation of family planning programs to address changing demographic patterns and regional variations. Overall, this study contributes to a deeper understanding of fertility determinants in Nigeria, offering practical recommendations for targeted interventions that can effectively address high fertility rates and promote sustainable population growth.

Declarations

Competing interests

The authors have no competing interests to declare that are relevant to the content of this article.

Authors' contribution

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Saheed Olalekan Jabaru. The first draft of the manuscript was written by Saheed Olalekan Jabaru and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Data/code availability statement

We used secondary data from the website of Nigeria Demographic and Health Surveys. (NDHS) programme. The data are available online. Additional data and R code for data analysis are available on request.

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