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RESEARCH

Spatial patterns and determinants of fertility levels among women of childbearing age in Nigeria

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Background: Despite aggressive measures to control the population in Nigeria, the population of Nigeria still remains worrisome. Increased birth rates have significantly contributed to Nigeria being referred to as the most populous country in Africa. This study analyses spatial patterns and contributory factors to fertility levels in different states in Nigeria.
Method: The 2013 Nigerian Demographic Health Survey (NDHS) data were used to investigate the determinants of fertility levels in Nigeria using the geo-additive model. The fertility levels were considered as count data. Negative Binomial distribution was used to handle overdispersion of the dependent variable. Spatial effects were used to identify the hotspots for high fertility levels. Inference was a fully Bayesian approach. Results were presented within 95% credible Interval (CI).
Results: Secondary or higher level of education of the mother, Yoruba ethnicity, Christianity, family planning use, higher wealth index, previous Caesarean birth were all factors associated with lower fertility levels in Nigeria. Age at first birth, staying in rural place of residence, the number of daughters in a household, being gainfully employed, married and living with a partner, community and household effects contribute to the high fertility patterns in Nigeria. The hotspots for high fertility in Nigeria are Kano, Yobe, Benue, Edo and Bayelsa states.
Conclusion: State-specific policies need to be developed to address fertility levels in Nigeria.

Keywords: Bayesian analysis, count data, fertility, Nigeria, spatial analysis

Introduction

Fertility trends in most of the developed world in the late 1990s showed a substantial decline to two children or fewer from the traditional six children per woman.[1,2] Despite the declining fertility rate, the total fertility rate (TFR) is still high in sub-Saharan Africa. In sub-Saharan Africa, the TFR is five children per woman on the average whereas countries like Chad, Mali, Niger and Nigeria record over six to seven children per woman.[3] Among sub-Saharan African countries, Nigeria is generally known as the most populous country in Africa with a population of over 174 million in 2013, which is approximately one-sixth of the total African population.[3] Nigeria is one of the sub-Saharan African countries with the fastest growing populations with a TFR of 6.8 in the early 1980s and 1990, 5.9 in 1991, 5.4 in 1994 and 5.2 in 1999.[3] In 2003, the TFR was 5.7; this dropped to 5.5 in 2013, which depicts a decline in the fertility pattern. However, this is relatively high compared with Latin America and Asia where fertility declined from 5.9 to 2.6 and less rapidly in North Africa and Western Asia from 6.6 to 3.5 births per woman. The transition is slowest in sub-Saharan Africa, especially in Nigeria where fertility declined by 1.3 only, from 6.8 to 5.5 children per woman.[4]

A high fertility rate, which is defined as a TFR of 5.0 or higher, is characterised among others by health risks for children and their mothers, food insecurity, high unemployment rate, slow economic growth and environmental threats.[5] Considerable evidence from economically advanced countries indicates that reduced fertility rates foster economic development and social well-being of the citizenry. The fertility level is undoubtedly conditioned by the cultural, health, political, demographic and socio-economic setting.[6–9] Proximate and socio-demographic determinants of fertility such as current marital status, polygyny, age at first marriage, first sexual intercourse and recent sexual activity, postpartum amenorrhea, abstinence, age at first birth as well as use of contraceptives, education, place of residence and wealth index have been found to significantly affect fertility patterns.[10]

Model-based analyses are becoming important sources of global information, largely because of the absence of reliable national-level empirical data in most developing countries like Nigeria. Fertility pattern is usually measured by the number of children ever born (CEB), which using count data is a measure of a woman's lifetime fertility.[9] The data-collection method of the Nigeria Demographic Health Survey (NDHS) followed a three-stage stratified design. Dependency is inevitable for observations in the same clusters because of shared beliefs and norms within the same community, which may vary from one community to the other, which in turn affects fertility behaviour.[11,12] Fertility levels maybe spatially clustered because fertility decisions spread across space. Communities that share boundaries are likely to display similar fertility behaviour, and thus spatial autocorrelation is possible.[9] Trivialising spatial effects of fertility may lead to misleading conclusions. For instance, Akpa and Ikpotokin[13] considered both proximate and some socio-demographic factors that affect fertility in Nigeria using the Poisson regression model without taking cognisance of the spatial effects. Similar studies have been considered on determinants of fertility in Nigeria.[14,15] However, in this study, the availability of geo-referenced data in NDHS allows the exploration of the geographical variation effects of fertility in Nigeria. The geo-additive model, which incorporates spatially structured effects and different effects of the variables as well as the nature of the dependent variable is considered suitable for this study.

Methods

Data

The data used for this study were drawn from the 2013 NDHS, which is a nationally representative sample. The 2013 NDHS was conducted by the National Population Commission (NPC) with funding support from the US Agency for International Development (USAID), the United Nations Population Fund (UNFPA), and the United Kingdom Department for International Development (DFID). Technical support was provided by ICF International. The 2013 NDHS sample was selected using a three-stage stratified design consisting of 904 clusters, 372 in urban areas and 532 in rural areas. In the 2013 NDHS dataset, 40 320 households were selected, of which 38 522 were interviewed. Data analysed were from 39 902 women of childbearing age (15–49 years). Although different covariates on population and health issues in Nigeria were presented in the comprehensive and well-detailed dataset, we focused on total CEB as the dependent variable. The mean of the total CEB is 4.35, variance = 6.786, skewness = 0.828, range = 17. The data are overdispersed.[16] Equidispersion is often a mirage in real-life studies; inappropriate imposition of a Poisson regression model will underestimate and overstate the significance of regression parameters.[17] Negative binomial distribution has been suggested as an alternative to Poisson regression when the data are overdispersed.[18–20]

The choice of explanatory variables was guided by the literature. Kazembe,[9] on modelling fertility in Malawian women, which was adapted in explaining fertility in Nigeria, includes: educational attainment, ethnicity, marital status, religion, place of residence, wealth index, family planning, number of daughters, number of dead children, method of delivery, work status, region, partner education, age at first birth and body mass index (BMI). All the categorical variables were effect coded. The clusters, 36 states and the Federal Capital Territory (FCT), were considered.

Data analysis

We used negative binomial distribution as a way out of overdispersed count data within the framework of generalised linear models to investigate fertility patterns in Nigeria.[20] We modelled fertility patterns using the number of children ever born, where CEB comprises count data, to investigate the fertility patterns.[9] Given a set of observations (y_{ijk}, x_{ijk}) where y_{ijk} is the total number of CEB for the kth woman in the jth community in the ith state and x_{ijk} is the corresponding vector of covariates and γ is the vector of regression parameters of the linear effect of categorical covariates, let us suppose some of the covariates are nonlinear: f_{ijk} and f_{spat} is the nonlinear effect of state i *for* $i = 1,2,\ldots 37$ where the women of childbearing age reside. Then y_{ijk}, that is, CEB as a count variable, can be modelled using a semiparametric spatial Poisson regression model. However, because the data are overdispersed we use negative binomial distribution.[18–20] The uncorrelated random effect can be controlled for using the community, which is given by b_{ij}. The semiparametric structured additive predictor is then given by:

$$y_{ijk}/\gamma,\ b_{ijk} \sim NB(\mu_{ijk})$$

Where the predictor $\eta_{ijk} = x'_{ijk}\gamma + f_{ijk}(x_{ijk}) + f_{spat} + b_{ij}$ (1)

Inference was a fully Bayesian approach based on Markov Chain Monte Carlo (MCMC) simulation techniques for the unknown posterior distribution. For the continuous/metrical covariates, we assume penalized splines (P-spline) prior with second-order random walk to ensure flexibility.[12,21] A suitable choice of diffuse prior is assumed for the fixed effect parameters γ. The Markov random field prior[22] allows a binary adjacency structure such that areas that share boundaries, which we assume to have similar patterns, are assigned a weight of 1, otherwise zero is given. The random effects were modelled from exchangeable normal priors to account for heterogeneity. The model was implemented in BayesX version 2.1.[23]

Results

The results of the categorical covariates of the posterior negative binomial regression are presented in Table 1. The table presents the means, standard deviations and 95% CI. Findings indicated a significant relationship between high fertility in the north-east and the Hausa tribe. For instance, the results revealed that women of childbearing age in the north-eastern region have a higher risk for having more children (mean 0.010, CI 0.006, 0.050) as well as the Hausa tribe (mean 0.017, CI 0.005, 0.038). Women of childbearing age who lived in the south-western region tend to have relatively fewer children than women in the north-central region. Women of childbearing age who dwelt in the rural area have a desire for more children than women in the urban area (mean 0.013, CI 0.003, 0.023). There is distinct association between fertility patterns and education. Higher education of women of childbearing age is inversely related to high fertility level. For instance, findings showed that women who had at least secondary education (mean –0.076, CI –0.09, –0.063) showed less desire for more children relative to women who had no formal education. Similar results were obtained for partner's educational level. Contrary to expectations, the rich/richest wealth index of the mother showed a significant association with low fertility level. Mothers of childbearing age who were of the Islamic faith were more likely to have more children than those women who practised traditional religion or had no religion. Women who practised Christianity (mean –0.031, CI –0.051, –0.012) were significantly more likely to have lower fertility levels than women with no religion or those who practised traditional religion. Use of any type of family planning methods (mean –0.040, CI –0.048, –0.031) showed a significant negative effect on the number of children a woman will have compared with a woman who is not on any family planning method. Women who are married and living with partners as expected had more children relative to other marital status such as single, widowed or divorced. Marriage increased the risk of conception, which in turn increased the fertility level of women. The working status of a mother of childbearing age reflected a positive significant association with her fertility level. Working mothers are likely to have more children than women who are not working. The mode of delivery suggested that fertility level will decline in women who had previous Caesarean section compared

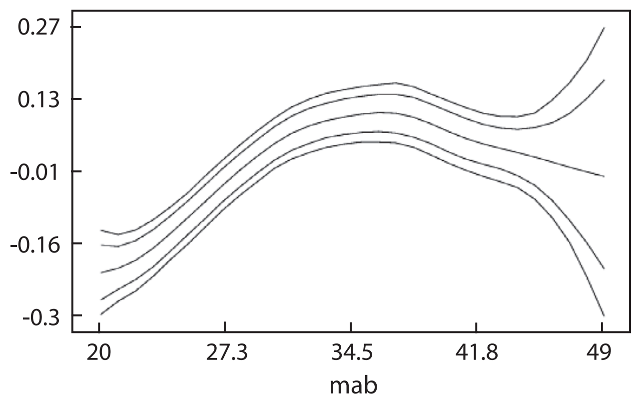

Figure1: Nonlinear effect of mother's age at birth (mab) on fertility.

Table 1: Posterior estimates within 95% credible interval (CI)

Variable	Mean	SD	95% CI
Constant	1.101	0.083	(0.913, 1.260)
Region			
North-central (ref.)	0		
North-east	0.010	0.024	(0.006, 0.050)*
North-west	–0.098	0.025	(–0.074, 0.029)
South-east	0.045	0.027	(–0.004, 0.100)
South-west	–0.064	0.022	(–0.016, 0.070)
South-south	0.024	0.026	(–0.050, –0.004)**
Place of residence			
Urban (ref.)	0		
Rural	0.013	0.005	(0.003, 0.023)*
Mother's educational attainment			
No education (ref.)	0		
Primary	0.085	0.006	(0.072, 0.097)*
Secondary	–0.076	0.007	(–0.090, –0.063)**
Higher	–0.123	0.013	(–0.148, –0.097)**
Ethnicity			
Other ethnic groups (ref.)	0		
Yoruba	–0.039	0.014	(–0.065, –0.011)**
Ibo	0.012	0.017	(–0.023, 0.043)
Hausa	0.017	0.011	(0.005, 0.038)
Wealth index			
Poorest/poorer (ref.)	0		
Middle class	0.006	0.005	(–0.004, 0.016)
Richer/richest	–0.009	0.007	(–0.004, –0.023)*
Religion			
None/traditional (ref.)	0		
Christianity	–0.031	0.010	(–0.051, –0.012)**
Islam	0.053	0.011	(0.034, 0.077)*
Family planning			
No method (ref.)	0		
Folkloric/traditional mode	–0.040	0.004	(–0.048, –0.031)**
Marital status			
Other (ref.)	0		
Married and living with partner	0.091	0.008	(0.076, 0.106)*
Mother's working status			
Not working (ref.)	0		
Working	0.058	0.003	(0.052, 0.064)*
Mode of delivery			
Normal delivery (ref.)	0		
Caesarean section	–0.049	0.012	(0.072, 0.026)*
Sex of children			
Boys (ref.)	0		
Girls	0.277	0.003	(0.271, 0.283)*

*Positively significant.
**Negatively significant.

with women who had a normal delivery. The sex of the children is another important factor. Women who had only daughters (mean 0.277, CI 0.271, 0.283) are likely to have more children than women who have at least one son.

The result of the nonlinear effects of the mother's age at birth and its effect on fertility at 95% CI is shown in Figure 1. Rigid assumption of the linear effect of mother's age at birth on number of children could have led to statistical error. The result confirmed the nonlinear relationship between mother's age at birth and the fertility patterns. There was an increase as women advanced in age; fertility peaked around 35 years of age. However, a steady decline in fertility started around 40 years of age. As the age of women of childbearing age advanced, the fertility patterns declined, and a rapid drop was noticed from around 45 years of age.

The 95% CI of fertility differential is presented in Figure 2, while Figure 3 is the corresponding labelled map of Nigeria. States shown in white denote a significant positive association with fertility while those in black denote a significant negative association with fertility. Those in grey denote states with insignificant fertility patterns at 95% CI. Yobe, Kano, Benue, Edo and Bayelsa states had significant higher likelihood for fertility. Kebbi, Niger, Kwara, Oyo and Lagos states exhibit significant lower effect for fertility.

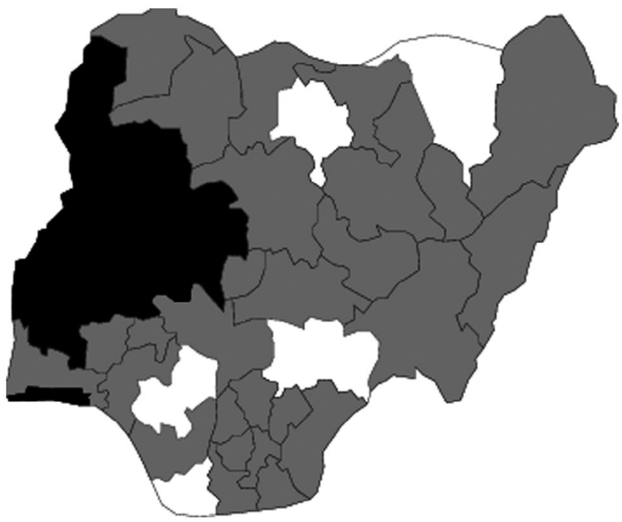

Figure 2: Spatial spread of fertility in Nigeria (95% CI).

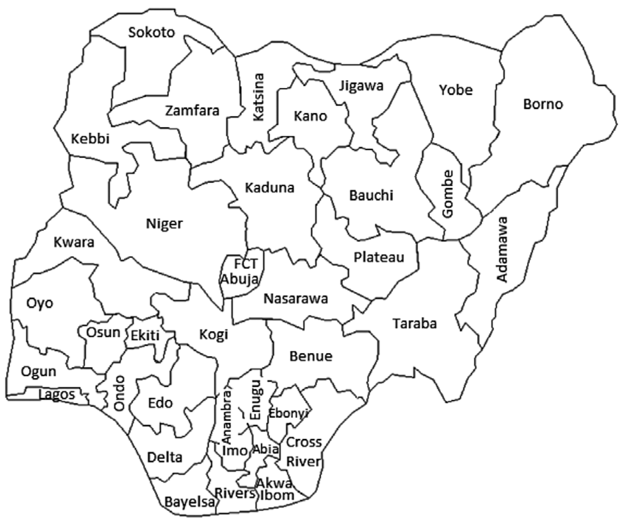

Figure 3: Labelled map of Nigeria.

Discussion of results

The objective of this study was to investigate spatial patterns and factors associated with the fertility levels of women of childbearing age in Nigeria. Fertility level is a crucial developmental factor that is related to growth of the economy[24,25] as well as child and maternal health.[9,26] Notable literature abounds on fertility in Nigeria; however, this article contributes to the existing literature. The negative binomial model was used to handle overdispersion after running descriptive statistics on the fertility levels of women, which naturally comprises count data.

The geo-additive model was used to simultaneously capture the continuous nature of the dependent variable, the continuous and categorical forms of the independent variables as well as the spatial and random effects on fertility levels. The posterior estimates of the categorical variables show that women who are residents of rural areas are more susceptible to high fertility levels than their counterparts in rural areas. Low or no education, inaccessibility to basic amenities, early marriage, infant and child mortality, no contraceptive use, and need for labour for agricultural practices are major determinants of high fertility levels in rural areas.[27,28] In Nigeria, in addition to the factors already stated, high fertility patterns in the rural areas have been found to be associated with patriarchal and hierarchical households, and polygamy in which women compete regarding the number of children.[4] Although Nigerian civil law does not recognise polygamy, 12 out of 36 states are governed by Sharia law, which encourages the practice of polygamy.[16] In Nigeria, a larger percentage of women in rural areas believe that contraceptives destroy the womb and abortion is murder.[29] This belief and the illegality of abortion gives rise to unwanted children with a resultant effect of high fertility in rural areas.

The underpinning effect of education on fertility levels cannot be overemphasised. Leon[30] found that education is an important determinant of fertility with several causal relationships from a theoretical perspective. Schultz[31] has long established a strong negative association between a mother's education and fertility. In fact, female education has been proposed as a major means of reducing fertility and population growth.[2,32,33] The greater the educational level of a woman, the lower her fertility level relative to women without education, which further corroborates our findings in this study.[34–36]

Akpa and Ikpotokin[13] opined that fertility levels in Nigeria are associated with ethnicity. They found that Hausa and Ibo women have higher fertility than those from the minority ethnic groups. Age at first marriage, education and socio-economic factors are some of the contributory factors to the decline in fertility among the Yoruba tribe relative to the Hausa and Ibo tribes.[37,38] Ajala[39] found that women in the richest quintile households are likely to give their children quality education, thereby giving birth to just the number of children they can cater for. However, some women from the poor and poorer quintile actually see childbearing as a means of acquiring cheap labour, especially for agricultural purposes. Skirbekk[10] found that high income/wealth, high occupation/social class favours fewer children relative to other classes. Religion plays a significant role in shaping people's beliefs and values. In Islam, polygamy, conservatism, association of contraception with prostitution, and a large age gap between husbands and wives explains the high fertility among Muslims.[40–42] Differences in fertility levels for Christianity and Islam can be linked to mean age at marriage. Christianity reduces the desire for high fertility, which can be explained by the fact that modern Christianity encourages monogamy.[41]

Any form of contraception inhibits the natural process of procreation. Family planning would prevent at least 53 million unintended pregnancies each year, thereby causing a decline in fertility levels.[12] One would not be surprised that a married woman who stays with her spouse will be at higher risk of having more children, as shown in our results.[7] Mothers whose first delivery was through Caesarean section do not desire more than three children. The desire for more children is high for women who have only daughters. In fact, Ali[34] concluded that until an African woman has at least one son, her desire for children is incomplete.

Conclusion

This study has broadened our knowledge on the spatial patterns and factors associated with fertility levels among women of childbearing age in Nigeria. It is hoped that the identified factors will assist in intervention programmes directed towards a downward shift in the fertility levels in Nigeria. The findings can be used for developing integrated support tools for the government, health policy-makers and international agencies interested in fertility-related issues.

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