Discontinuity of Family Planning in Nigeria: A Geo-Additive Model Approach

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Abstract

This study explored the factors associated with discontinuance of Family Planning (FP) in Nigeria. A geo-additive model was specified to simultaneously measure the fixed, nonlinear, spatial and random effects inherent in the data. The fixed effect of categorical covariates was modelled using the diffuse prior, the nonlinear effect of continuous variable was modelled using the P-spline with second-order random walk, the spatial effects followed Markov random field priors while the exchangeable normal priors were used for the random effect of the community. Application was based on the 2013 Nigerian Demographic Health Survey (NDHS) data. Discontinuance of FP is positively associated with rural place of residence, no or primary education, Islamic religion, marital dissolution, health/body concern and northern region of Nigeria.

Keywords: Bayesian inference, family planning, Nigeria, spatial analysis

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1.0 Background

The high rate of childbearing among women has been a major public health concern. Nigeria is ranked the world's seventh highest population and projected to be the sixth most populous nation by 2050 [1]. Nigeria is the most populous country in Africa with a population of over 180 million and a growth rate of 2.8% [2]. In United States of America Total Fertility Rate (TFR) is 2.01 while in United Kingdom it is 1.9 [3]. In 1991 population census, Nigeria TFR was estimated at 5.9, 5.7 in 2003 and 2008 and 5.5 in 2013 [4]. This depicts a decreasing trend, however, when compared with other countries it is relatively high. Family planning programme is one of the measures that has been put in place to address rapid population growth. Family planning (FP) has been widely accepted as a means of combating high birth rate and a key part of any comprehensive development strategy [5]. Literatures abound on utilization and trend of usage FP in Nigeria [6, 7, 8, 9]. There has been an upward trend in the use of FP. Currently, fifteen percent of currently married women use a contraceptive method which is about two percent increase compared with 2003 [10]. Various factors such as education, wealth, religion, culture are responsible for women's attitude to contraceptive uptake. However, women tend to discontinue the use of FP shortly after its uptake [10]. Responses from discontinuity of FP can be dichotomous in nature. The basic model considered is the binomial logistic regression within the Generalized Linear Model (GLM). Data collection method of Nigeria Demographic Health Survey 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 [11]. Reasons for discontinuity of FP are influenced by factors both within and outside the family which may be expedient to quantify. Latent variables can be introduced to allow for unobserved covariates, while measuring the effect of individual factors as random effects [12]. Practical experience has shown that metrical covariates such as years and age of respondents often have nonlinear effects [13],

[14]. Rate and pattern of discontinuity of FP may differ in terms of geographical location. The binomial logistic regression framework allows investigations of those who are currently not on any FP method versus the reference group. The binomial models have been extended to flexibly model continuous variables, control for spatial random effects to handle heterogeneity that might be inherent in the data and the spatially structured variations within the framework of GLM [12]. This study is set to use geo-additive model to investigate the factors associated with discontinuity of FP by simultaneously modelling the fixed, nonlinear spatial and random effects within the Bayesian context in a single framework. The paper is organised as follows. The model was discussed in section 2. Full details of the data and variables used are discussed in section 3. Section 4 is devoted to data analysis and presentation of results and summary and conclusion in section 5.

2.0 Geo-Additive Model

Consider the covariates $x = (x_{r1}, \ldots x_{rk})$ of metrical or continuous covariates and a vector of categorical covariates, $f_{i,i=1,\ldots,k}$ are the unknown nonlinear effect of metrical or continuous covariates, γ is the effect of the categorical covariates, s_r is the spatially correlated effect of location , $b_g, g \in \{1,\ldots,G\}$ are uncorrelated (unstructured) random effects to model unobserved heterogeneity. Then the geo-additive model is specified as

$$\eta_r = f_1(x_{r1}) + \ldots + f_k(x_{rk}) + f_{spat}(s_r) + u_r'\gamma + b_g \quad (1)$$

For the continuous/metrical covariates, we assume Penalized Splines (P-spline) prior with second order random walk [14, 15].

$$f(x) = \sum_{t=1}^{k} \alpha_t B_t(x) \quad (2)$$

where

$B_t(x)$ are B-splines, α_t are defined to follow a first order or second order random walk prior. The second order random walk is given as

$$\alpha_t = 2\alpha_{t-1} - \alpha_{t-2} + \varepsilon_t \quad (3)$$

with Gaussian errors $\varepsilon_t \sim N(0, \tau_\varepsilon^2)$ where τ_ε^2 controls the smoothness of f . This variance is estimated jointly with the coefficients of the basis function by assigning a weakly informative inverse Gamma prior with $\tau_\varepsilon^2 \sim IG(\varepsilon, \varepsilon)$. A suitable choice of diffuse prior is assumed for the fixed effect of categorical covariates given as (4)

The spatial effects follow Markov random field priors [16].

$$\{f_{spat}(s_r) \mid f_{spat}(t); t \neq i, \tau_s^2\} \sim N\left(\sum_{t \in \partial_i} \frac{f_{str}(t)}{N_i}, \frac{\tau_s^2}{N_i}\right) \quad (5)$$

where

N_i is the sum of adjacent sites

τ_s^2 is the spatial variance which controls the spatial smoothness

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where τ_b^2 is the variance that accounts for overdispersion and heterogeneity. We assigned highly dispersed but proper prior for all variance components. An inverse Gamma distribution with hyperparameters a and b is chosen, such that $\tau^2 \sim IG(a,b)$.

Standard choices of hyperparameters are a=1 and b=0.005 or a=b=0.001(which is close to Jeffrey's non-informative prior) [15, 17]. These values can be varied to examine the sensitivity of the choices of hyperparameters to the inverse Gamma distribution.

Letting $\alpha = (f, f_{spat})$, τ to represent the vector of all variance components, and β is the vector of fixed effects parameters, then the posterior probability distribution is given as:

$$p(\alpha,\tau,\beta \mid y) \ \alpha \ p(y \mid \alpha,\beta,\tau)p(\alpha)p(\beta)p(\tau) \quad (6)$$

where

$p(y|\alpha, \tau, \beta)$ is the likelihood function of the data given the parameters of the model (based on the dependent variable) are the prior densities of all the parameters

The Bayesian framework based on Markov Chain Monte Carlo (MCMC) simulation techniques from full conditionals for nonlinear, spatial, fixed effects and smoothing parameters will be used for the posterior analysis. The Deviance Information Criterion (DIC) [18] is employed for comparison of the models. The DIC is defined as

$$DIC = \bar{D}(\theta) + pD \quad (7)$$

where

$\bar{D}$ is the posterior mean of the deviance

pD is the effective number of parameters (not equal to degrees of freedom)

Small values of and indicate a better and parsimonious model respectively. The model with the lowest DIC is the best.

3. Data

The data used for this study were drawn from the Nigerian Demographic and Health Survey (NDHS) 2013 (www.measuredhs.com). The 2013 NDHS was conducted by the National Population Commission (NPC) with funding support from U.S 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 urban areas and 532 in rural areas. In the 2013 NDHS dataset, 40,320 households were selected, out of which 38,522 were interviewed. In the interviewed households, 39,902 women in the childbearing age (15 – 49 years) and 18,229 men were found eligible for the interview. This represents a response rate of 99% for households, 98% for women and 95% for men. This study is based on the survey data with all participant identifiers removed. Although, different covariates on population and health issues in Nigeria were presented in the comprehensive and well detailed dataset, we focused on number of women who are not currently on any type of contraceptives.

Table 1 presents the different types of family planning available methods and the percentage usage in Nigeria. Of all the women surveyed 85.1% are currently not on any family planning method.

Table 1: Frequency of Women Currently on Family Planning

Current use by method use		
	Frequency	Percentage (%)
No method	26798	85.1
Folkloric method	201	0.6
Traditional method	1437	4.6
Modern method	3046	9.7
Total	31482	100

The socio-economic variables used as explanatory variables in explaining discontinuity of FP are grouped into category A (categorical variables) and category B (continuous variables).

Category A: place of residence, educational attainment, wealth index, work status, effect of advert on family planning (radio, television, newspaper/magazine), number of children, reasons for discontinuity of FP (breastfeeding, husband disapprove, inconvenient to use, health concern, access/availability, infrequent sex, cost, menopause, marital dissolution)
Category B: Body Mass Index (BMI), age of respondent.

4.0 Data Analysis and Presentation of Results

4.1 Data Analysis

Given a dichotomous variable that classifies current use of any method of FP into yes or no. This follows a Binomial distribution whose dependence is modelled through logit link model given as:

$$y_{ij} / \gamma, b_i \sim Bin(n_i, \pi_i)$$

Where

$$\pi_i = \Pr(Y_i = 1 / \eta_i) = \frac{e^{\eta_i}}{1 + e^{\eta_i}}$$

$$\log it(\pi_i) = \log\left(\frac{\pi_i}{1 - \pi_i}\right) = \eta_i$$

$$\eta_i = w'\gamma + f'x + f(spat) + b_{i1} + b_{i2} \quad (8)$$

where

η_i is the mean number of women who are not currently on FP

$w'\gamma$ is the vector of fixed effect of the categorical covariates of Category A

$f'x$ is the vector of unknown smooth functions for Category B that are continuous and nonlinear

$f(spat)$ is the spatial effect

b_{i1}, b_{i2} are the community and household effects

This model was implemented in BayesX version 2.1 [19]. We carried out 20000 iterations with the first 2000 considered as a burn-in sample. We thinned every 10th iteration of the remaining 18000 used for parameter estimation. Convergence and mixing were monitored through plotting and estimation of sampling paths and autocorrelation. Sensitivity analysis was carried out by varying the hyperparameters. The different choices of hyperparameters considered were a=1 and b=0.005, a=b=0.005 and a=b=0.001 (default) [20]. We report the latter as the results were less sensitive to variation of the choices of the parameters [21].

4.2 Presentation of Results

The posterior estimates and 95% Credible Intervals (CI) of the binary logistic regression model are given in Table 3. Women who stay in the rural area are significantly more likely to discontinue FP than those who stay in the

urban areas [OR: 0.8309, CI: 0.7603, 0.9027]. Respondents with no primary education tend to discontinue FP more than those without education. The odds of discontinuing FP with secondary or higher education significantly decreased by 11% and 34% respectively than women without education. The higher the level of education, the lower the tendency for a woman to discontinue FP. The women in the middle class wealth quintile [OR: 0.9567, CI: 0.8847, 1.0355] are 4% less likely to discontinue FP than women in the poorer or poorest wealth quintile. Similarly, the richest or richer wealth quintiles are 23% significantly less likely to discontinue FP. The odds of discontinuing FP among Muslim women significantly increased by 28%, while it decreased for Christian women [OR: 0.8024, CI: 0.6574, 0.9810] than the atheist or traditional worshippers. The working class women are 6% significantly less likely to discontinue FP than women that are working. Considering the effect of media on discontinuation of FP, women that heard of FP on radio [OR: 0.9067, CI: 0.8518, 0.9660], television [OR: 0.9062, CI: 0.8440, 0.9725] and newspaper/magazine [OR: 0.8967, CI: 0.8438, 0.9500] are 9%, 9% and 10% significantly less likely to discontinue FP. The number of children in the household was also considered to know its effect on FP. Women with less than three children are 30% significantly less likely to discontinue FP than women with more than three children. We also investigate why women tend to discontinue FP. Women who are currently breastfeeding are 50% significantly more likely to discontinue FP. The odds of discontinuing FP because husband disapproves it [OR: 1.3220, CI: 1.2987, 1.3471] increased by 32%. Women are likely to discontinue to FP because its inconvenient to use [OR: 1.3986, CI: 1.2016, 1.7772] and because of health/body concern [OR: 1.5946, CI: 1.3992, 1.8933]. Access/availability of FP, cost and menopause are 46%, 46% and 69% significantly more likely to make women discontinue FP. Women tend not to discontinue FP because of infrequent sex [OR: 0.9597, CI: 0.5180, 1.7722]. The highest odd is from discontinuity of FP because of marital dissolution [OR: 9.5756, CI: 7.2705, 13.0932]. The 95% CI of the nonlinear effects of age and BMI on discontinuity of FP are given in Figs. 1 and 2. The younger women tend to utilize and continue the use of FP, however in Fig. 1, it was noticed that there is a gradual increase at the rate at which women discontinue FP from age group 30+. In Fig. 2, there is an inverse relationship of discontinuity of FP with BMI. Women with lower BMI discontinue FP more than women with higher BMI.

The spatial results are given in Figs 3 and 4 for the model presented in (8). The posterior mean is given in Fig. 3 while the 95% CI for the significance of the spatial effect is reported in Fig. 4. States with black colour are significantly associated with higher discontinuity of FP; those in white are associated with lower discontinuity of FP; grey are insignificant. Women in Kebbi, Sokoto, Zamfara, Katsina, Kano, Jigawa, Bauchi, Gombe, Adamawa, Yobe and Borno are likely to discontinue FP more than women in Kwara, Oyo, Osun, Ogun, Lagos, Ondo, Edo, Delta, Anambra, Imo, Rivers, Akwa Ibom, Abia, Cross River, Ebonyi, Enugu, Benue, Nassarawa. Discontinuity of FP is insignificant in all other states.

Table 3: Posterior estimates of M4 within 95% Credible Interval (CI)

Variable	OR	95% CI
Constant	11.6167	(7.0122, 19.9652)
Place of Residence		
Rural (ref.)	1.0000	
Urban	0.8309	(0.7603, 0.9027)
Educational Attainment		
No education (ref.)	1.0000	
Primary	1.0435	(0.9566, 1.1407)
Secondary	0.8923	(0.8289, 0.9636)

Higher	0.6586	(0.5788, 0.7494)
Wealth Index		
Poorest/Poorer (ref.)	1.0000	
Middle Class	0.9567	(0.8847, 1.0355)
Richer/Richest	0.7722	(0.6989, 0.8511)
Religion		
None/Traditional (ref.)	1.0000	
Christianity	0.8024	(0.6574, 0.9810)
Islam	1.2774	(1.0385, 1.5566)
Working Status		
Not working (ref.)	1.0000	
Working	0.9394	(0.8880, 0.9907)
Heard of Family Planning on Radio		
No (ref.)	1.0000	
Yes	0.9067	(0.8518, 0.9660)
Heard of Family Planning on Television		
No (ref.)	1.0000	
Yes	0.9062	(0.8440, 0.9725)
Heard of Family Planning on Newspaper/magazine		
No (ref.)	1.0000	
Yes	0.8967	(0.8438, 0.9500)
Number of Children		
Greater than three (ref.)	1.0000	
Less than three	0.6975	(0.6641, 0.7351)
Discontinued FP because of Breastfeeding		
No (ref)	1.0000	
Yes	1.5010	(1.0001, 1.6901)
Discontinued FP because husband disapproved it		
No (ref)	1.0000	
Yes	1.3220	(1.2987, 1.3471)
Discontinued FP because its inconvenient to use		
No (ref)	1.0000	
Yes	1.3986	(1.2016, 1.7772)
Discontinued FP because of health /body concern		
No (ref)	1.0000	
Yes	1.5946	(1.3992, 1.8933)
Discontinued FP because of access/availability		
No (ref)	1.0000	
Yes	1.4606	(1.1375, 1.5300)
Discontinued FP because of infrequent sex		
No (ref)	1.0000	
Yes	0.9597	(0.5180, 1.7722)
Discontinued FP because of cost		
No (ref)	1.0000	
Yes	1.4606	(1.1375, 1.5300)
Discontinued FP because of menopause		
No (ref)	1.0000	
Yes	1.6911	(1.0002, 1.7139)
Discontinued FP because of marital dissolution		
No (ref)	1.0000	
Yes	9.5756	(7.2705, 13.0932)

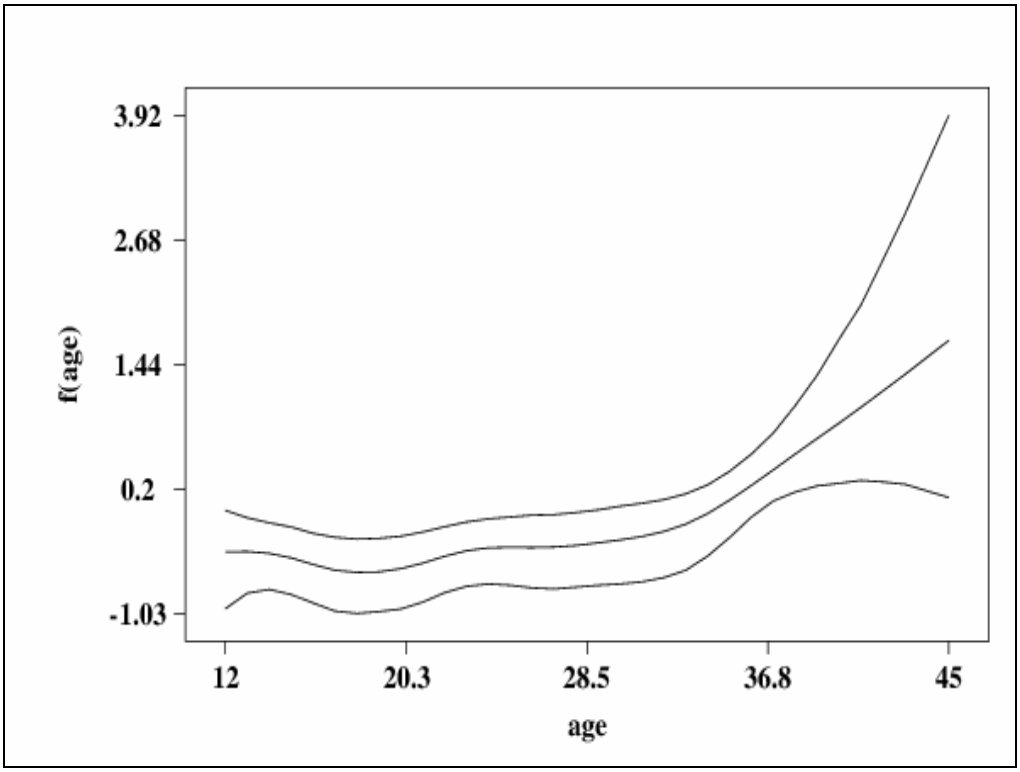

Fig 1: Effect of Age on Unmet Need of FP at 95% CI

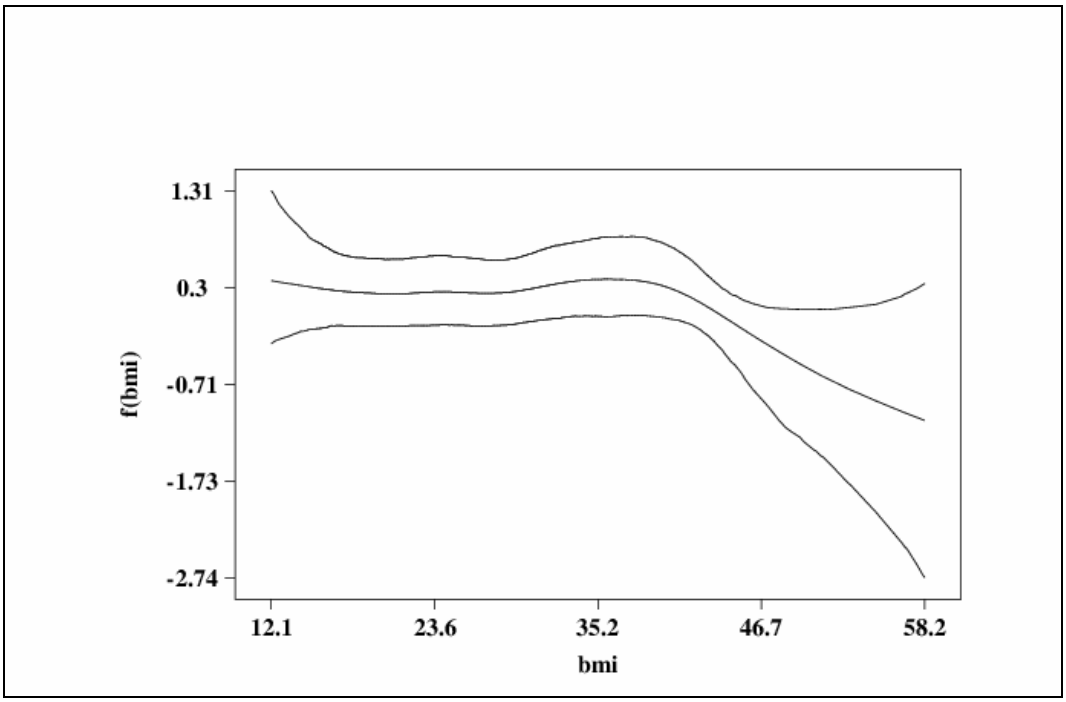

Fig 2: Effect of BMI on Unmet need of FP at 95% CI

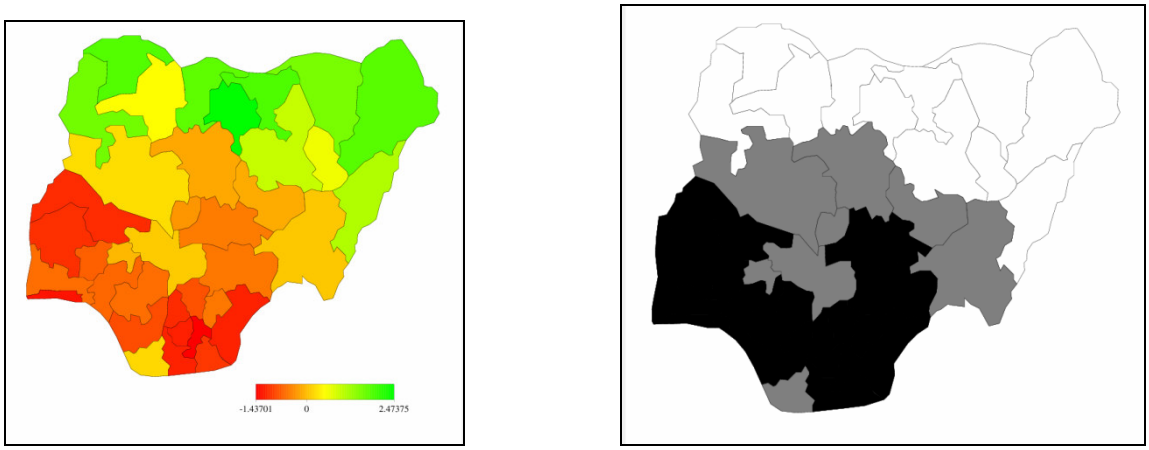

Fig 3: Posterior estimate of spatial pattern of unmet need of FP in Nigeria at 95 % CI.

White denotes states with strictly positive CI (significant high risks), black denotes states with strictly negative CI (significant low risks) and grey denotes states with insignificant risk of unmet need of FP

Fig 4: Labelled map of Nigeria [21]

5.0 Conclusion

We found that continuity of FP is positively related with modernisation and urbanisation [22]. Education is a factor that is linked to the general wellbeing of a woman. Education affects her knowledge about the usefulness of contraceptives, education as suggested by this study is a life transforming factor [22, 23]. Women who are not empowered financially tend to discontinue FP which corroborated our findings on women who are working [24, 25]. The reason is not far-fetched; affordability and dependence on partner for money. Religion also plays a significant role on the decision of whether to discontinue FP. Muslim women discontinued FP more than Christian women. Muslim religion supports polygamy which encouraged women to discontinue FP after a while [26, 27]. Mass media and social networks play important roles in disseminating

contraceptive knowledge which positively influence women decision on contraceptives [28].

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