Sensitivity of Hyperparameters to Prior distribution: Exploratory study of Discontinuity of Family planning in Uganda

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Abstract

Objective: To investigate the sensitivity of hyperparameters to prior distribution.
Methodology: Three choices of hyperparameters were used to investigate the sensitivity of the prior distribution to the inverse Gamma distribution using Uganda Demographic Health Survey data on Family Planning. The Bayesian framework based on Markov Chain Monte Carlo (MCMC) simulation techniques from full conditional of nonlinear, linear and random effects were used for estimation of the unknown posterior distribution.
Findings: The three choices of hyperparameters are less sensitive to variations. Similar results were obtained in the different choices except in private place of delivery where two variations in hyperparameters were insignificant while one was significant at 95% CI.

Keywords: Bayesian inference, family planning, inverse Gamma, hyperparameters, Uganda

1. Introduction

Bayesian inference has become an elegant tool in the twentieth century, which has been integrated into both the fabric of statistical thinking within the field of statistics and the methodology used in a broad array of applications [1]. The three important distributions are the prior distribution or information, the likelihood of the data and the posterior distribution. However, the treatment of prior information has been a major challenge in Bayesian inference [2]. In a given data vector Y with density $p(\alpha)$ for some unknown $\alpha \in \Theta$. The family of prior densities for any function is given as $\{vq, q \in Q\}$, where q is called the hyperparameter [3]. The Structured Additive Regression Model (STAR) has been widely used in broad arrays of real life situations to simultaneously handle different effects embedded therein. Appropriate priors are often assigned to different parameters of the fixed, nonlinear, spatial and random effects in the model. The effect of categorical covariates are often modelled using the diffuse prior, the nonlinear effect of continuous variables are modelled using the random walk or P-splines prior, the spatial effects follow 2-dimensional P-splines or Markov random field priors while the exchangeable normal priors were used for the random effect [4, 5, 6]. The vector of variance components which accounts for smoothness of the nonlinear and spatial function, over dispersion and heterogeneity are succinctly realized from the different effects of the parameters which can follow an inverse-gamma distribution which is a univariate specialization of the inverse-Wishart distribution [7, 8]. Different choices of hyperparameters *a* and *b* are chosen with the inverse- gamma distribution such that $\tau^2 \sim IG(a,b)$, where τ^2 is the variance component. This study is set to carry out sensitivity analysis by varying the hyperparameters to investigate the effect of using survey data of Uganda for the empirical model. The paper is organised as follows. In section 2 we describe family planning in Uganda while the model was discussed in section 3. Full details of the data and variables used are discussed in section 4. Section 5 is devoted to data analysis and discussion of results and summary and conclusion in section 6.

2. Family planning in Uganda

Uganda is a landlocked country that borders Kenya to the east, Tanzania to the south, Rwanda to the southwest, the Democratic Republic of Congo to the West and South Sudan to the north with a Total Fertility Rate of 6.2 [9].

Uganda and Zambia have the highest TFRs in the Eastern and Southern Africa with 6.2 live births per woman. Nearly half of the annual pregnancies occurring in Uganda are unwanted.

Family Planning (FP) has been described as a means to achieving all the Millennium Development Goals (MDGs) and a key part of any comprehensive development strategy [10, 11, 12]. Family planning does not only give couples the freedom to space and plan the number of children they wish, but also contribute to the health and overall quality of life of the population [13]. The two main metrics in use to measure FP success are Contraceptive Prevalence Rate (CPR) and unmet need [14]. Addressing the need for FP worldwide would prevent 53 million unintended pregnancies each year, protecting the health of women and their children [15]. Family Planning has been widely accepted as a way of reducing fertility trend and improving maternal and child health in the world at large [16]. Maternal deaths associated with unwanted pregnancies can be reduced by 40 percent with contraceptive use alone [16].

Uganda lags behind in comparison with other countries in the regions such as Kenya (39%), Rwanda (27%) and Tanzania (20%) of married women using modern contraceptive methods [17]. Uganda still grapples with low uptake and utilization of FP and high TFR. [18] reported that most sexually active Ugandan have never used contraceptives despite the policy that allows access to contraceptive services irrespective of age. It has been well-documented that the major factors associated with contraceptive use are women's age, education and socio-economic status [19]. In Uganda, the use of FP has consistently increased over the past decade, however forty-three percent of FP users discontinue use of any method within a year of starting its use. Tables 1 and 2 give a clear picture of the increasing rate of discontinuity after the initial start of usage of FP. In 2001, the number of women who were not using any method of FP increased from 55.5 percent to 77.3 percent within the same year while in 2006 this increased from 56.9 women percent to 81.2 percent within a year. The direct implication of this is that the percentage of women who were on any method of FP fell from 44.5 percent to 22.6 percent in 2001 and from 43 percent to 18.9 percent in 2006. In 2011 the percentage of women who were currently on any method of FP was 22.8 percent [9].

Considerable attention has been given to increase in FP usage however this study investigates the reason for discontinuity of FP using the Generalized Additived Mixed Model (GAMM) which simultaneously captures the nonlinear, linear and random effects of the explored variables.

3. Generalized additive mixed model

Consider geo-additive model specified as

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

Where

η_r is the generalized additive mixed model predictor

$f_{i,i=1,\ldots,k}$ is the nonlinear effect of metrical or continuous covariates x

u is the fixed effect of categorical variables γ

$b_g, g \in \{1,\ldots,G\}$ are uncorrelated (unstructured) random effects to model unobserved heterogeneity

For the continuous/metrical covariates, we assume Penalized Splines (P-spline) prior with second order random walk [5, 6].

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

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 $\tau_\varepsilon^2 \square IG(\varepsilon, \varepsilon)$

A suitable choice of diffuse prior is assumed for the fixed effect of categorical covariates given as

$$p(\gamma) \alpha \; const \quad (4)$$

The random effects b_g were modelled from exchangeable normal priors, $b_{ij} \sim N(0, \tau_b^2)$

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) [6, 20]. These values can be varied to examine the sensitivity of the choices of hyperparameters to the inverse Gamma distribution.

Letting α represent the nonlinear effect of f , 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

$$p(\alpha, \tau, \beta \mid y) \;\; \alpha \;\; p(y \mid \alpha, \beta, \tau) p(\alpha) p(\beta) p(\tau) \quad (5)$$

where

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

$p(\alpha) p(\beta) p(\tau)$ 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, fixed effects and smoothing parameters will be used for the posterior analysis. The Deviance Information Criterion (DIC) [21] is employed for comparison of the models. The DIC is defined as

$$DIC = \bar{D}(\theta) + pD \quad (6)$$

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 $\bar{D}$ and pD indicate a better and parsimonious model respectively. The model with the lowest DIC is the best.

4. Data

The data used for this study were drawn from the Uganda Demographic and Health Survey (UDHS) 2011, 2006 and 2001 which are the fifth, fourth and third surveys implemented by the Uganda Statistics Department of Ministry of Finance and Planning and later by Uganda Bureau of Statistics (www.measuredhs.com). Funding supports were from Government of Uganda, U.S Agency for International Development (USAID), the United Nations Population Fund (UNFPA), United Nations Children's Fund (UNICEF), World Health Organisation (WHO), United Kingdom Government and Irish Aid- the Government of Ireland. Technical support was provided by Ministry of Health, Makerere University of School of Public Health, Department of Biochemistry of Makerere University and ICF International. The 2011, 2006 and 2001 UDHS sample were selected using a two-stage stratified design consisting of 404, 321 and 298 Enumeration Areas in the first stage and 10,086, 9864 and 8792 households in the second stage. For UDHS 2011, in the 10086 households selected, 9033 households were interviewed; for UDHS 2006, in the 9864 households selected, 8870 were interviewed while in the 2001 UDHS, in the 8792 households selected, 7885 were interviewed. In the interviewed households for 2011 UDHS, 9247 women and 2573 men were found eligible for the interview but 8674 women and 2295 men were interviewed; for 2006 UDHS 9006 women and 2760 men were found eligible for interview but 8531 women and 2512 were interviewed while for 2001 UDHS 7717 women and 2306 men were found eligible but 7246 women and 1962 men were interviewed. This represents a response rate of 95% for households, 94% for women and 89% for men for 2011 UDHS; 98% for households, 95% for women and 991% for men for 2006 UDHS while 96% for households, 94% for women and 85% for men. This study is based on the survey data with all participant identifiers removed. Although, different covariates on population and health issues in Uganda were presented in the comprehensive and well detailed dataset, we focused on contraceptives use by women. Tables 1 and 2 present the different types of family planning methods available and the percentage usage in Uganda for the three surveys considered.

Table 1. Frequency of Women who ever used Family Planning in Uganda

	2011		2006		2001	
	Frequency	Percentage (%)	Frequency	Percentage (%)	Frequency	Percentage (%)
No method	NA	NA	4857	56.9	4019	55.5
Folkloric method	NA	NA	86	1.0	78	1.1
Traditional method	NA	NA	481	5.6	338	4.6
Modern method	NA	NA	3107	36.4	2814	38.8
Total	NA	NA	8531	100	7246	100

NA- Not Available

Table 2. Frequency of Women who are currently using Family Planning in Uganda

	2011		2006		2001	
	Frequency	Percentage (%)	Frequency	Percentage (%)	Frequency	Percentage (%)
No method	6690	77.1	6926	81.2	5601	77.3
Folkloric method	29	0.3	58	0.7	54	0.7
Traditional method	225	2.6	279	3.3	206	2.8
Modern method	1730	19.9	1268	14.9	1385	19.1
Total	8674	100	8531	100	7246	100

The variables considered were

$\mathcal{G}1$: year to determine the trend

$\mathcal{G}2$: category A (categorical variables): marital status, place of delivery, educational attainment, place of residence, region, religion; respondents have heard of FP on TV, radio and newspaper/magazine; whether respondents believe that FP affects the body, FP is inconvenient to use, FP is expensive, FP is not accessible or FP clinics are too far, respondents religion prohibits FP and breastfeeding mothers should not use FP.

$\mathcal{G}3$: category B (continuous variables): current age of respondent

5. Data analysis and discussion of results

5.1. 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:

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

Where

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

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

$$\eta_i = I_{2006} + I_{2011} + w'\gamma + f'x + b_i \quad (7)$$

where

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

I_{2006} is the dummy for the second survey

I_{2011} is the dummy for the third survey

$w'\gamma$ is the vector of fixed effect of the categorical covariates of ϑ_2

$f'x$ is the vector of unknown smooth functions for ϑ_3 that are continuous and nonlinear

b_i is the community effect

We considered this model to explore the variables responsible for discontinuity of FP using effect coding for all the categorical variables. The sensitivity analysis was carried out using three set of hyperparameters. The hyperparameters and summary of results are presented in Table 3.

Table 3. Summary of Results from the various Hyperparameters

Hyperparameters	$\bar{D}$	pD	DIC
Q1: a=1 and b=0.005	3181.3208	138.7144	3457.9497
Q2: a= 0.0005 and b=0.0005	3179.9271	138.7009	3457.3288
Q3: a= 0.001 and b=0.001	3188.2310	133.7509	3455.7329

$\bar{D}$ is the posterior mean of the deviance, pD is the effective number of parameters, DIC is the deviance information criterion

The model was implemented in BayesX version 2.1 [22]. We carried out 15000 iterations with the first 2000 considered as a burn-in sample. We thinned every 10th iteration of the remaining 13000 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 (which is close to Jeffrey's non-informative prior) [6, 20]. We report the results to know their sensitivity to the choices of the parameters.

5.2. Discussion of Results

The summary of results of the various choices of hyperparameters was presented in Table 3 for the model in (7). The effective number of parameters and DIC of Q1 and Q2 are 138.7144, 3457.95 and 138.7009, 3457.33 respectively. Q3 gave a parsimonious model of 133.75 effective number of parameters and the best model based on least DIC of 3455.73. The hyperparameters with a = b = 0.001 gave the least DIC. The posterior odds within a 95% Credible Interval (CI) is given in Table 4. As earlier stated, this study is in two folds, to study the sensitivity of hyperparameters and to explore the reason why women discontinue the use of FP within twelve months of its use. The summary of the sensitivity of hyperparameters and the posterior odds why women discontinue FP are given in Table 4. In 2006, the discontinuance of FP slighty increased significantly [OR: 1.0020, CI: 1.0009, 1.2572] for hyperparameters a = b = 0.001. Similar results were observed in 2006, for hyperparameters a = b = 0.00005 [OR: 1.0606, CI: 1.0074, 2.66974] and a=1, b=0.005 [OR: 1.0454, CI: 1.0045, 1.9728]. In 2011, the odds of discontinuance of FP increased significantly for the three hyperparameters [OR: 11.1069, 12.5495, 21.1938] considered.

The risk of discontinuity of FP increased as the year progresses. The married/living together with partner insignificantly discontinued the use of FP than the never married [OR: 1.0192, CI: 0.8816, 1.1942], [OR: 1.0201, CI: 0.8681, 1.1766], [OR: 1.0233, CI: 0.8761, 1.1927] for hyperparameters a = b = 0.001, a = b = 0.00005 and a = 1, b = 0.005 respectively. The widowed/divorced are more likely to significantly discontinue the use of FP at 62%, 63% and 64% for the three hyperparameters respectively. Marital status is positively associated with discontinuity of FP. The choice of place of delivery showed that women who use public hospital [OR: 1.1537, CI: 0.9654, 1.3807] are 15% more likely to discontinue the use of FP than women who use homes/traditional centres with hyperparameters a = b = 0.001 while women who use private hospitals are 16% more likely to discontinue the use of FP than women who use traditional centres/homes. Similar results were obtained for the other two hyperparameters except hyperparameters a = 1, b = 0.005 for private hospital [OR: 1.1691, CI: 1.0404, 1.4199] which gave a significant result compared with other results on place of delivery which were insignificant. Place of delivery has no effect on discontinuity of FP. Women with primary education are 95% less likely to insignificantly discontinue the use of FP compared with women with no education for the different choices of hyperparameters. Women with secondary education are 52%, 52% and 51% significantly more likely to discontinue the use FP within a year than women with no education.

The women with higher education gave the highest odd ratio of discontinuity of FP [OR: 1.6226, CI: 1.0816, 2.3982], [OR: 1.8712, CI: 1.0899, 2.4488] and [OR: 1.6339, CI: 1.1359, 2.3986] for hyperparameters a = b = 0.001, a = b = 0.00005 and a = 1, b = 0.005 respectively compared with women with no education. Educated women tend to discontinue the use of FP more than women who are least educated. Women who reside in the urban areas are 57% more likely to discontinue the use of FP than women who reside in the rural areas for the three choices of hyperparameters. Women who stay in the Eastern and Western regions are less likely to discontinue the use of FP compared with women who stay in the Northern region. Women who stay in the Central region are 54% more likely to discontinue the use of FP compared with women who stay in the Northern region. The 95% CI gave significant results for the different choices of hyperparameters for all the regions. Region plays a significant role on discontinuance of FP. Christians/Protestants/Seventh Day Adventists (SDA) are 3% more likely to discontinue the use of FP; Muslim are 15% more likely to discontinue the use of FP. Results on religion were similar for the different choices of hyperparameters. This study examined the effect of media on discontinuity. Although, the effect of information on FP from television, radio and newspaper/magazine is insignificant, the results reveal that mass media do not necessarily decrease the rate of discontinuity of FP.

We also examined the reason why women discontinue the use of FP within twelve months after they started its use. The respondents are 82%, 83% and 84% more likely to discontinue FP because they believe FP affects the body for the three choices of hyperparameters respectively. Nine percent of the women discontinued the use of FP because they believe it's inconvenient to use. About 40% of women significantly discontinued the use of FP because FP is expensive; [OR: 1.3803, CI: 1.1172, 1.7376], [OR: 1.3992, CI: 1.1153, 1.7467] and [OR: 1.3972, CI: 1.1106, 1.7390] for hyperparameters a = b = 0.001, a = b = 0.00005 and a = 1, b = 0.005 respectively. From the results, the women discontinued the use of FP because it is not accessible, FP clinic is far and the use of FP affects one's health.

The women did not discontinue FP because their religion prohibits it; [OR: 0.7394, CI: 0.4993, 1.0783], [OR: 0.7326, CI: 0.4827, 1.0724] and [OR: 0.7343, CI: 0.4856, 1.0895] for the three choices of hyperparameters. Religion supports the use of FP. Breastfeeding mothers are 18%, 17% and 9% significantly more likely to discontinue the use of FP for the different choices of hyperparameters used.

The nonlinear effect of age on discontinuity of FP is depicted for the hyperparameters in Figures. 1-3. Discontinuity of FP is positively associated with age, as the age is increasing so also is the rate at which women tend to discontinue the use of FP. Similar trend were displayed for the different choices of hyperparameters but for little variations noticed on the coefficients on y-axis

Figure 1. Nonlinear effect of Age on FP with hyperparameters a = b = 0.001

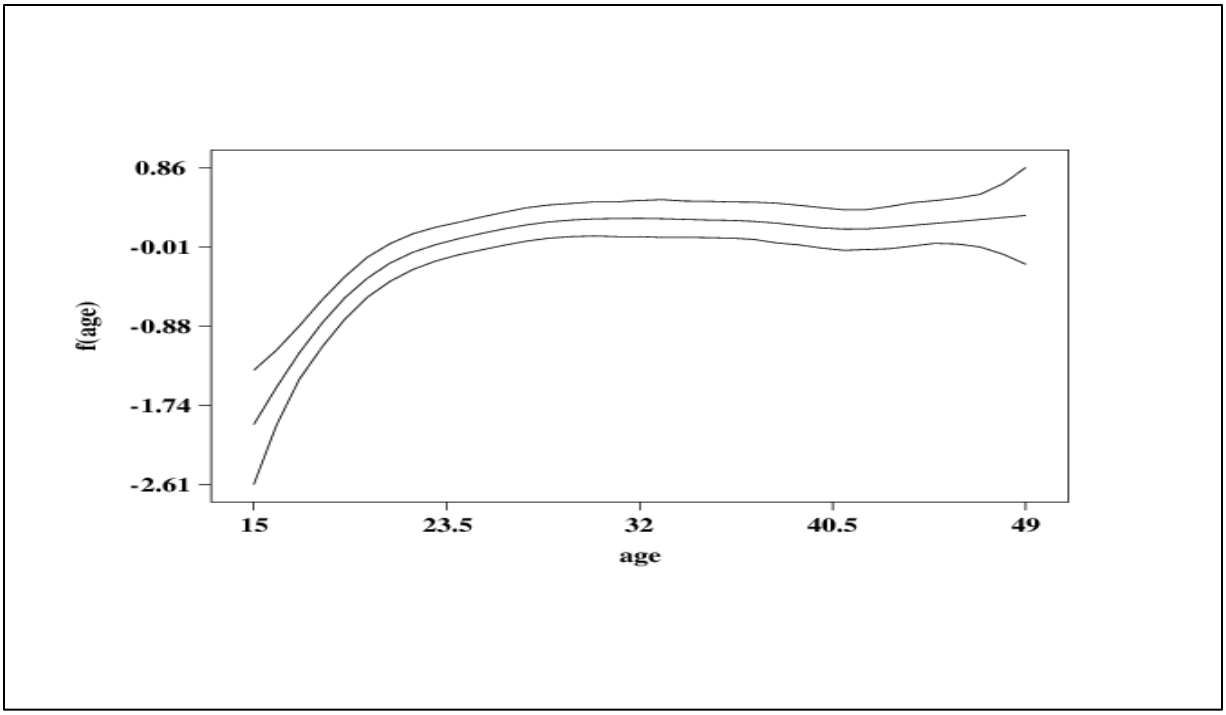

Figure 2. Nonlinear effect of Age on FP with hyperparameters a = b = 0.005

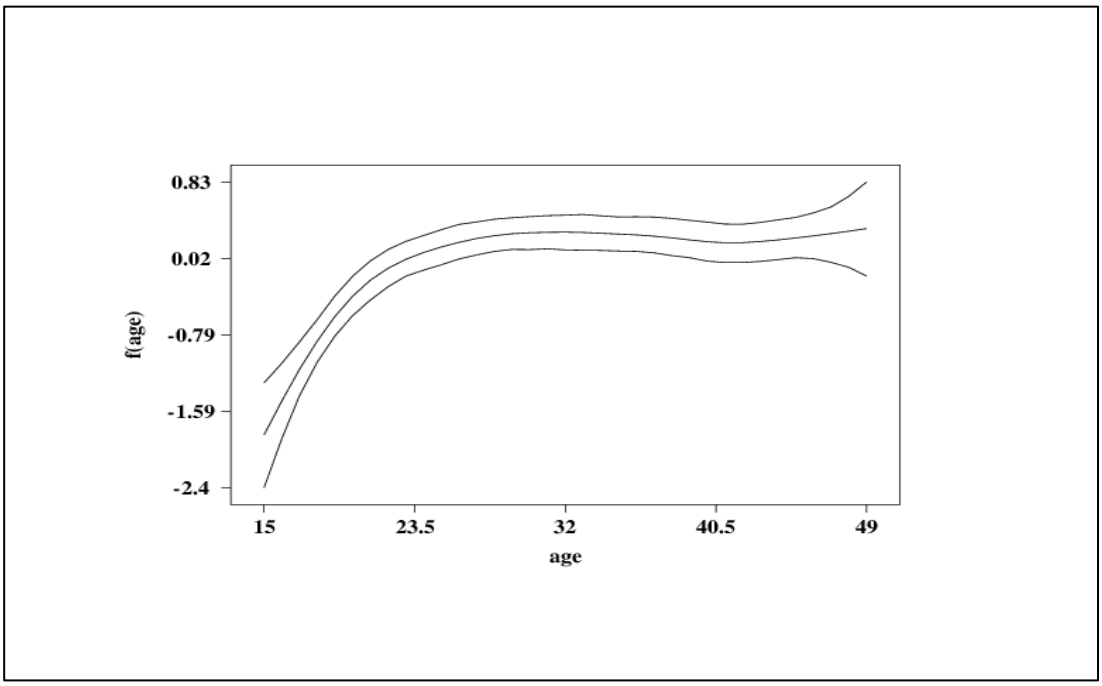

Figure 3. Nonlinear effect of Age on FP with hyperparameters a = 1, b = 0.005

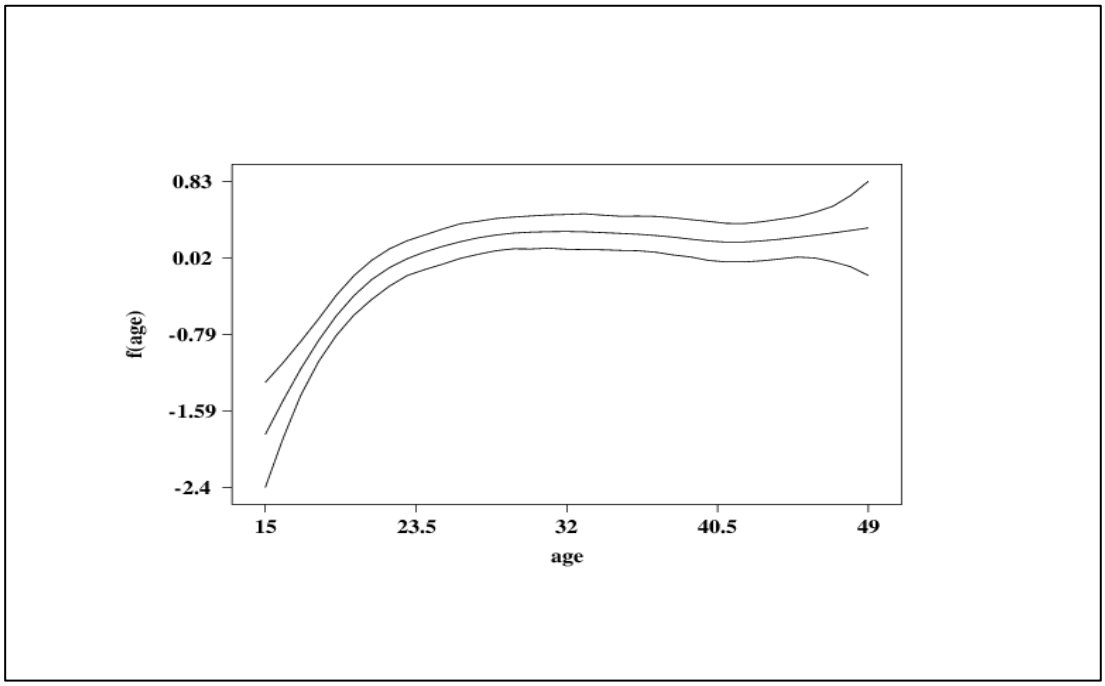

Table 4.Posterior estimates within 95% Credible Interval (CI)

	a = 0.001, b = 0.001		a = 0.00005, b = 0.00005		a= 1, b =0.005	
Variable	OR	95%CI	OR	95%CI	OR	95%CI
Constant	1969.27	(1.4749, 4053.17)	66.3206	(0.1498, 12452.79)	8.9174	(0.4277, 284.80)
Year						
2001(ref)	1.0000		1.0000		1.0000	
2006	1.0020	(1.0009, 1.2572)	1.0606	(1.0074, 2.6974)	1.0454	(1.0045, 1.9728)
2011	11.1069	(7.2507, 48.8737)	12.5495	(0.0598, 38.8809)	21.1938	(0.5505, 29.9963)
Marital Status						
Never Married (ref)	1.0000		1.0000		1.0000	
Married/Living Together	1.0192	(0.8816, 1.1942)	1.0201	(0.8681, 1.1766)	1.0223	(0.8761, 1.1927)
Widowed/Divorced	1.6252	(1.2858, 2.0865)	1.6320	(1.3050, 2.0743)	1.6443	(1.2869, 2.0674)
Place of Delivery						
Homes (ref)	1.0000		1.0000		1.0000	
Public Hospital	1.1537	(0.9654, 1.3807)	1.1455	(0.9735, 1.3415)	1.1530	(0.9677, 1.3825)
Private Hospital	1.1633	(0.9400, 1.4175)	1.1741	(0.9735, 1.4363)	1.1691	(1.0404, 1.4199)
Educational Attainment						
No education (ref)	1.0000		1.0000		1.0000	
Primary	0.9533	(0.7881, 1.1674)	0.9572	(0.7963, 1.1563)	0.9546	(0.7996, 1.1346)
Secondary	1.5162	(1.2340, 1.8883)	1.5209	(1.2242, 1.8712)	1.5100	(1.2297, 1.8772)
Higher	1.6226	(1.0816, 2.3982)	1.8712	(1.0899, 2.4488)	1.6339	(1.1359, 2.3986)
Place of Residence						
Rural (ref)	1.0000		1.0000		1.0000	
Urban	1.5732	(1.3814, 1.8216)	1.5749	(1.3791, 1.8013)	1.5680	(1.3827, 1.7875)
Region						
Northern (ref)	1.0000		1.0000		1.0000	
Central	1.5308	(1.2861, 1.8380)	1.5390	(1.2867, 1.8399)	1.5389	(1.3073, 1.8465)
Eastern	0.7504	(0.6087, 0.9074)	0.7471	(0.6241, 0.8969)	0.7482	(0.6233, 0.8995)
Western	0.6623	(0.5501, 0.7937)	0.6599	(0.5441, 0.7915)	0.6573	(0.5445, 0.7884)
Religion						
Others (ref)	1.0000		1.0000		1.0000	
Christianity/Protestant/SDA	1.0285	(0.8786, 1.2056)	1.0303	(0.8890, 1.1882)	1.0327	(0.8883, 1.2072)
Muslim	1.1476	(0.9337, 1.4179)	1.1472	(0.9472, 1.3961)	1.1491	(0.9404, 1.4114)
Heard of Family Planning on TV						
No (ref)	1.0000		1.0000		1.0000	
Yes	1.0167	(0.8896, 1.1696)	1.0163	(0.8842, 1.1646)	1.0173	(0.8901, 1.1606)
Heard of Family Planning on Radio						
No (ref)	1.0000		1.0000		1.0000	
Yes	1.0414	(0.9387, 1.1395)	1.0404	(0.9367, 1.1541)	1.0413	(0.9366, 1.1512)
Heard of Family Planning on Newspaper/Magazine						
No	1.0000		1.0000		1.0000	
Yes	1.0982	(0.9687, 1.2438)	1.0972	(0.9612, 1.2478)	1.0979	(0.9604, 1.2526)
Family Planning affects the body						
No (ref)	1.0000		1.0000		1.0000	
Yes	1.8194	(1.3102, 2.5465)	1.8292	(1.2945, 2.6140)	1.8373	(1.3090, 2.5312)
Family Planning is inconvenient to use						
No (ref)	1.0000		1.0000		1.0000	
Yes	1.0920	(0.6803, 1.7366)	1.0864	(0.6922, 1.6812)	1.0954	(0.6839, 1.7100)
Family Planning is expensive						
No (ref)	1.0000		1.0000		1.0000	
Yes	1.3803	(1.1172, 1.7376)	1.3992	(1.1153, 1.7467)	1.3972	(1.1106, 1.7390)
Family Planning is not accessible/too far						
Yes	1.0000		1.0000		1.0000	
No	1.2443	(0.9333, 1.7001)	1.2396	(0.9046, 1.6961)	1.2430	(0.8966, 1.6832)
Family Planning affects ones health						
No (ref)	1.0000		1.0000		1.0000	
Yes	1.3287	(1.1065, 1.5847)	1.6960	(1.0800, 1.5971)	1.3284	(1.1015, 1.5738)
My religion prohibits Family Planning						
No (ref)	1.0000		1.0000		1.0000	
Yes	0.7394	(0.4993, 1.0783)	0.7326	(0.4827, 1.0724)	0.7343	(0.4856, 1.0895)
I am breastfeeding so I cannot use Family Planning						
No (ref)	1.0000		1.0000		1.0000	
Yes	1.1826	(1.0243, 1.3813)	1.1746	(1.0185, 1.3666)	1.0895	(1.0163, 1.3742)

5. Summary and Conclusion

The generalized additive mixed model was used explored to identify some factors responsible for discontinuity of FP within twelve months of its use. We used a logit link model for the response variable of whether a woman is currently on any FP or not by using the 2001, 2006 and 2011 Uganda Demographic Health Survey (NDHS) data. The diffuse prior was used for the fixed effect of categorical variables, penalized spline with second random walk for the continuous variables while the exchangeable normal priors were used for the random effect of the community using the BayesX software. Three choices of hyperparameters were used to investigate the sensitivity of the prior distribution to the inverse Gamma distribution. The Bayesian framework based on Markov Chain Monte Carlo (MCMC) simulation techniques from full conditional of nonlinear, linear and random effects were used for estimation of the unknown posterior distribution. The trend showed that as the year progresses, women still tend to discontinue the use of FP. We found that women still tend to discontinue the use of FP despite the fact that they are married/living together with partner, widowed/divorced, use public or private hospital, have secondary/higher education, resides in urban area, stays in Central region of Uganda, Muslim/Christian and listen to television, radio or newspaper/magazine. Uganda women discontinue FP because they believe FP affects the body, its inconvenient to use, expensive, not accessible or too far, affects one's health and should not be used when one is breastfeeding. The three choices of hyperparameters are less sensitive to variations. Similar results were obtained in the different choices except in private place of delivery where two variations in hyperparameters were insignificant while one was significant at 95% CI.

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Competing Interests: None

Ethical Approval: Not required

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