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Full Length Research Paper

Spatial Analysis on Breastfeeding in Nigeria

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Abstract

Several studies have been carried out on breastfeeeding as a major risk factor for infant and child mortality in Nigeria. However, over the years little attention is geared towards breastfeeding as a normal or default method of infant feeding and its spatial effect in region-state of Nigeria. In this paper we aim at examining high level of spatial variations not available with traditional semiparametric method and determinants of breastfeeding from Bayesian point of view in this country. We develop a Bayesian semi parametric Binomial logit Model (BLM), where the usual linear predictors are replaced by more flexible additive predictors allowing for simultaneous nonparametric estimation of such covariate (linear) effects and of spatial effects by consider Markov chain Monte Carlo Methods (MCMC) to estimate the parameters of breastfeeding under binomial logit model. The application is based on the 2008 Nigeria Demographic and Health Survey. The result shows that education, occupation, wealth index and smoking are negatively contributing while bednet, child gender, residence and marital status are positively contributing to breastfeeding. Also, the age of mother at early stage of child bearing increases breastfeeding but its impact at old stage decreases it. Some states in regions of Nigeria are less or high likely significant for breastfeeding.

Key words: Binomial logit, spatial effect

Introduction

Breastfeeding is normal or default method of infant feeding. It is as old as existence of man which lately becomes a natural event that draws researchers' attention to the risk associated to its avoidance like, diarrhea, fever, pneumonia and neonatal sepsis. This feeding practice played a significant role in child development. Poor breastfeeding practice impacts the health and nutritional status of infant and child which in turn has direct consequence for their mental and physical development. The risk factors for infant and child mortality included not being breastfed reported as a major risk factor for infantile mortality (Annette and Lisa, 2007). Thomas et al reported that suboptimal breastfeeding was a leading childhood risk factor in all developing countries and consistently ranks higher than water and sanitation which confirmed that more than 7.7 million children died before their fifth birthday (Thomas, Emily and Emmanuela, 2013). Breastfeeding only reduced mortality risk in the early months of life and its impact beyond 4 months of birth was either negligible or increases the risk of child mortality beyond 4 months (Adebayo, 2002). After 4 months, a child required adequate complementary food for normal growth. Lack of appropriate complementary feeding may led to under nutrition and frequent illness,

Breastfeeding is cost effective measure to reduce infant and child mortality under five years of age in less developed countries such as Nigeria. Boniface confirmed it to have statistically significant reduction impact on infant and child mortality rates and that longer breastfeeding

duration had about 34 percent increasing effect on infant and child mortality compared with shorter breastfeeding duration (Boniface, 2014). Duration and intensity of breastfeeding also affected a mother's period of postpartum infertility, the length of the birth interval and fertility levels.in addition, early sensitivity among breastfeeding mothers was an independent predictor of

the duration of any and exclusive breastfeeding during the first year, in which mothers who chose to breastfeed displayed greater sensitivity in dyadic interactions with their infants 3 months post-natally than those who chose to bottle feed, and intended breastfeeding duration prenatally correlated with sensitivity 3 months post-partum (Britton, Britton and Gronwaldt, 2006). It was argued that poverty actually threatened breastfeeding, both directly and indirectly. Women could not breastfeed their children less than five years because of job pleasure and financial reasons. They were no paid guaranteed maternity leave, making choice of returning to work soon after childbirth more necessary; in consequence leave their infants to be breast fed with commonly diluted sweetened condensed milk. Women with low income were often financially compelled to quickly return to the workforce. This socio economic inequality among women determined whether they would exclusively breastfeed their children for six month. It is important to know that overall goal of breastfeeding is just to improve infant survival but to also prevent various serious infection.

Data and Materials

The data analysed in this study were collected as part of the modified 2008 National Demographic Health Survey (NDHS) submitted in 2014. This dataset is considered appropriate for this study with a large number of observations on the response variable. It has geographical information that explains spatial modeling and is a nationally representatives sample. To collect information about breastfeeding and explanatory variables, the survey was designed to gather information on breastfeeding from woman of reproductive age. These are provided at national and regional levels, urban and rural, ethnicity, state/districts and regions. A total number of 8731 women of reproductive age were 15-49 years. Data used contained social-economic variables, sex, residence, wealth index, occupation, education, bednet, smoking, ethnicity, state (districts) and region

Information on breastfeeding is contained on pregnancy and postnatal section of the women questionnaire information which was collected among many others on states or districts and region where the respondents came from. Other social economic variables considered are maternal education attainment classified into no education, primary education, secondary education and higher education; occupation(working and not working); rural-urban residence; bednet (No and Yes); smoking(not smoking and smoking); religion (Christianity, Islam, Traditional); marital status(currently married and formerly married) and gender of the child (male and female). Assessing household income was rather difficult, this consequently makes wealth index (poorest, poorer, middle, richest and richer) appropriate by assigning values to the physical and monetary assets based on the market values.

Statistical Methods

In this work, binomial logit model within the framework of Bayesian approach was adopted to estimate all parameters. The standard measure of effect was the posterior estimates (Woldermicael, 2001; Yoannes, Streat-eld and Bost, 1992) and functions were assumed to be random variables with which appropriate priors were assigned. Diffused priors were assumed for fixed effect parameters. We considered the respondents age, the nonlinear effect parameter with P-splines priors which allowed a more parsimonious parameterization, which was a particular advantage in a Bayesian approach where inference is based on MCMC techniques. The basic assumption behind the P-splines approach was that the unknown smooth function *f* could be approximated by a spline of degree *l* defined on a set of equally spaced knots. The structured spatial effect of region and state or districts was modeled by Markov Random Field (MRF) priors. These priors reflected spatial neighbourhood relations.

Data Analysis

In the present study, however, the NDHS data contained geographical or spatial information, such as the state or district and region of individuals that cannot be assumed strictly linear because it could lead to spurious conclusion. The presence of non-linear effects for spatial information would facilitate spatial modeling. Modeling geographical patterns for breastfeeding, the impact of covariates, had not been given much attention in many studies. The geographical patterns of breastfeeding and nonlinear effects of other factors were therefore explored within a simultaneous, coherent regression framework based on a geo-additive (Kandala, Fahrmeir and Klasen, 2008). The general effects of the linear predictors were assumed to change according other parameters (additive effects) are independent.

A given a set of observation (y_i, w_i), i=1…n where y_i is a binary response such that y_i = 0 if a mother does not breastfeed child and y_i=1 a mother does breastfeed child; and w_i =(w_{i1}…w_{ip}) are covariates, we consider a binomial logit model to estimate the probability that mother does not breastfeed child versus the probability of mother breastfeed child. The breastfeeding is distributed as Bernoulli random variable such that model is defined as follows;

$$breastfeeding_i = \gamma_0 + \gamma_1 \text{education} + \gamma_2 \text{occupation} + \gamma_3 \text{religion} + \gamma_4 \text{wealth index} + \gamma_5 \text{bednet} + \gamma_6 \text{gender} + + \gamma_8 \text{marital} + \gamma_9 \text{residence} + f_1(\text{respondent age}) + e f^{str}(\text{state}) + f^{unstr}(\text{state}) + f^{str}(\text{region}) + f^{unstr}(\text{region})$$

where $p_i = p(y = 0)$ and $\eta_i = \text{logit}(p_i)$ is a canonical parameter linked to the linear predictors

$$\eta_i = w'_i \gamma \quad (1)$$

$$\eta_i = x'_\beta + w'_i \gamma \quad (2)$$

replaced with a logit link function with dynamic and spatial effect, Pr($y_i = 0,1$ and geo-additive semi parametric predictor $\mu_i = h(\eta_i)$

$$\eta_i = f_{non}(x_i) + f_{spat}(s_i) + w'_i \gamma \quad (3)$$

Where h is a known response function with f_{non}, a non-linear smoothed effect of the metrical covariate (respondents age) and f_{spat} is the varied effect smoothed over the ranges of state/districts and regions in Nigeria. Covariates in w'_i are unordered (gender, residence, smoking and bednet) and ordered categorical (education, occupation, religion and wealth index) variables. The model with predictors in Equation 2 above is referred to as geo-additive model. P-spline priors were assigned to the function f_{non} while a Markov random field prior was used for f_{spat} (Brezger, Kneib and Lang, 2005; Britton, Britton and Gronwaldt, 2006); Fahrmeir and Lang, 2001).

The analysis was carried out using version 2.1 of the BayesX software package (Brezger, Kneib and Lang, 2005)., which permits Bayesian inference based on Markov chain Monte Carlo (MCMC) simulation techniques with which multivariate analysis was used to investigate the posterior estimates determined for the fixed, non-linear effects and spatial effects.

Prediction analysis was not carried out but rather uses a useful and reliable model that describes breastfeeding in Nigeria. Thus, we do not embark on diagnostic tool to detect unusual observation, but to change the best model between a numbers of covariates. Performances were compared using model Deviance Information Criterion (DIC) which is the sum of model fit and complexity (Spiegelhalter, Best, Carlin and Van Der, 2002). The $\bar{\Omega}$ of the model is given by the P_D, term mean of Deviance(D) whereas the model complexity is given by effective number of parameter, P_D. The quantity P_D is defined as $P_D = D(\bar{\Omega})d$ where $D(\bar{\Omega})$ is the evaluated at the posterior expectation of the model parameter P_D. Thus, DIC=D + P_D and a model is better supported by the data.

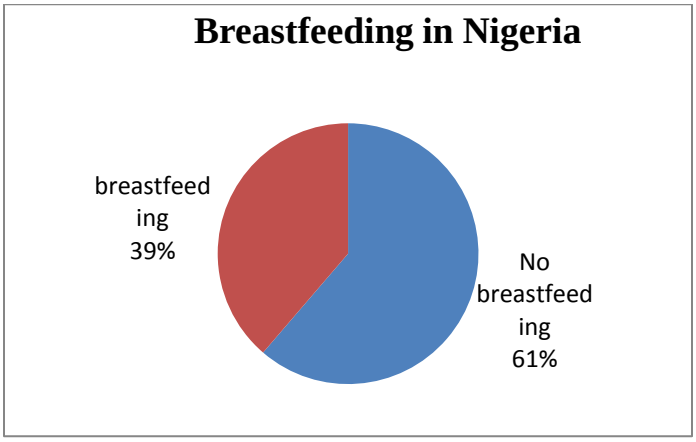

Figure 1: Breastfeeding in Nigeria

Figure 1 shows the percentage of breastfeeding in Nigeria. The percentage of no breastfeeding is more than that of breastfeeding. It is apparent that mothers do not breastfeed their children under five years of age which confirm many reports about significantly negative impact of breastfeeding to infant and child mortality.

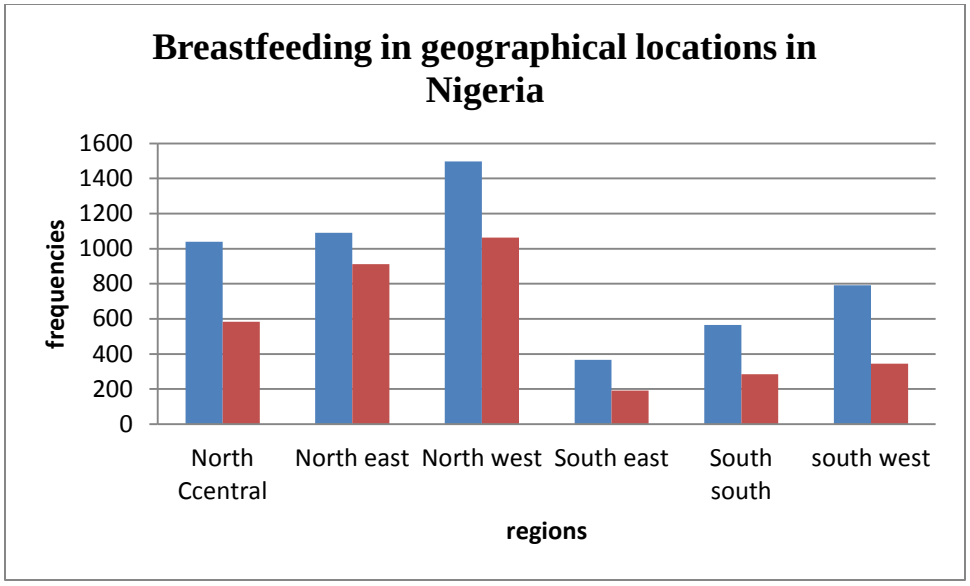

Figure 2: Breastfeeding in geographical locations in Nigeria

Figure 2 shows the total number of breastfeeding in the regions of Nigeria. Colour blue (brown) represents no breastfeeding (breastfeeding); this implies that North West of this country recorded high number of no breastfeeding and breastfeeding.

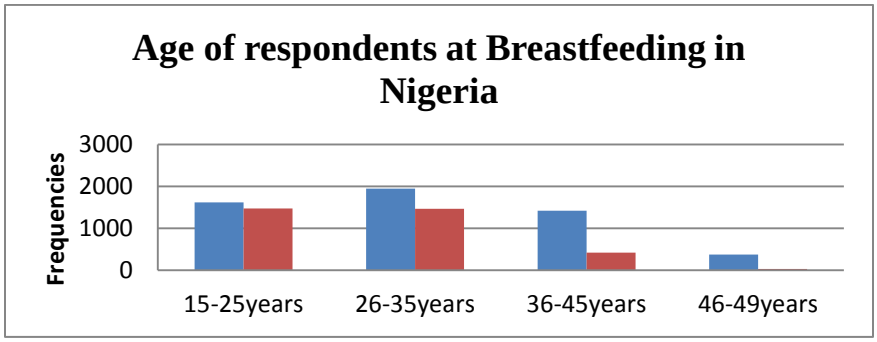

Figure 3: Age of respondents at Breastfeeding in Nigeria

Figure 3 shows that mothers at age 26-35years have the highest number of infant and child that were breastfed and not breastfed.

Results

As a step of analyzing data, the fitted models described in equation 1 and 2 to data on breastfeeding were shown in table 1 and 2. Model 1 referred to as fixed effect model, $\eta_i = w'_i \gamma$ and Model 2 as nonlinear effect model, $\eta_i = x'_\beta + w'_i \gamma$. The results of categorical covariates presented in table 3 and 4 showed the posterior estimates and 95% Credible Intervals (CI: 2.5% quantile=lower bound, 97.5% quantile=upper bound). It was showed that education; wealth index and smoking were negatively significant in model 1 and model 2. However, bednet, and gender of the child were positively significant in model 1 and model 2 for breastfeeding. The model 2 with DIC=10520.016 performed better than model 1 with DIC=11249.126. Model 2 took all relevant structure into account because of the effect of additivity. It was showed from both model 1 and model 2 that bednet and gender of child increased the probability of mother breastfeeding.

Table 1: Geographical Locations of Breastfeeding in Nigeria

Region	N0	State/Districts	Breastfeeding		Total
			No	Yes	
North central		All	1039(64.02)	584(35.98)	1623
	1	Niger	192(60.76)	124(39.24)	316
	2	Abuja	152(69.41)	67(30.59)	219
	3	Nasarawa	153(68)	72(32)	225
	4	Plateau	144(57.83)	105(42.17)	249
	5	Benue	116(58.88)	81(41.12)	197
	6	Kogi	128(72.32)	49(27.68)	177
	7	Kwara	154(64.17)	86(35.83)	240
North east		All	1090(54.45)	912(45.55)	2002
	8	Yobe	186(53.45)	162(46.55)	348
	9	Borno	191(57.36)	142(42.64)	333
	10	Adamawa	170(61.15)	108(38.85)	278
	11	Bauchi	185(51.97)	171(48.03)	356
	12	Gombe	191(49.48)	195(50.52)	386
	13	Taraba	167(55.67)	133(44.33)	300
North west		All	1498(58.49)	1063(41.51)	2561
	14	Sokoto	148(50.69)	44(49.31)	292
	15	Zamfara	149(55.39)	120(44.61)	269
	16	Katsina	302(61.26)	191(38.74)	493
	17	Jigawa	197(56.61)	151(43.39)	348
	18	Kano	231(56.90)	175(43.10)	406
	19	Kaduna	214(58.95)	149(41.05)	363
	20	Kebbi	257(65.90)	133(34.10)	390
South east		All	367(65.77)	191(34.23)	558
	21	Anambra	69(61.61)	43(38.39)	112
	22	Enugu	51(66.23)	26(33.77)	77
	23	Ebonyi	95(62.09)	58(37.91)	153
	24	Abia	83(69.17)	37(30.83)	120
	25	Imo	69(71.88)	27(28.13)	96
South south		All	566(66.58)	284(33.41)	850
	26	Edo	104(68.42)	48(31.58)	152
	27	Cross River	94(70.68)	39(29.32)	133
	28	Akwa Ibom	104(74.29)	36(25.71)	140
	29	Rivers	79(63.71)	45(36.29)	124
	30	Bayelsa	107(63.69)	61(36.31)	168
	31	Delta	78(58.65)	55(41.35)	133
South west		All	792(69.66)	345(30.34)	1137
	32	Oyo	129(72.07)	50(27.93)	179
	33	Osun	145(69.05)	65(30.95)	210
	34	Ekiti	108(67.08)	53(32.92)	161
	35	Ondo	105(66.88)	52(33.12)	157
	36	Lagos	224(77.78)	64(22.22)	288
	37	Ogun	81(57.04)	61(42.96)	142

Table 1 shows the total and relative frequencies of breastfeeding that were observed in state-region.

Table 2: Descriptive Statistics of Socioeconomic Factors Used, NDHS, 2008

Variable Names	Breastfeeding		R. freq
	No	yes	
Education			
No education	2649	1899	1.3950
Primary	1131	723	1.5643
Secondary	1172	635	1.8457
higher	400	122	3.2786
residence			
rural	3832	2551	1.5022
urban	1520	828	1.8358
occupation			
not working	1867	1332	1.4017
working	3485	2047	1.7025
Child Gender			
male	2289	1679	1.3633
female	2257	1700	1.3277
missing	806	0	
Wealth Index			
poorest	1338	1030	1.2990
poorer	1182	836	1.4139
middle	1013	633	1.6003
richer	852	516	1.6512
richest	967	364	2.6566
Bednet			
NO	4761	2889	1.6480
YES	591	490	1.2061
Marital			
C. married	5262	3340	1.5755
F.married	90	39	2.3077
Smoking			
Don't smoking	4862	3061	1.5884
smoking	483	317	1.5237
missing	7	1	
Religion			
Christianity	2234	1127	1.9823
Islam	2967	2166	1.3698
Traditionalist	111	66	1.6818
Respondent age			
15-25 years	1619	1472	1.0999
26-35 years	1945	1462	1.3303
36-45 years	1417	415	3.4145
46-49 years	371	30	12.3667

Fixed Effects

The results of categorical data included in equation 1 are presented in table 3.The table presented posterior estimates of fixed effects. Findings revealed that education, occupation, wealth index and smoking reduced the chance of mother breastfeeding her child. However, bednet, gender of the child, religion, residence and marital status increased the chance of mother breastfeeding her child. Also the table showed he posterior mean (credible interval) of the selected variables.

Table 3: Posterior Estimates of fixed effects of Breastfeeding in Nigeria

Variables	post.mean	post.st err.	2.5%quant.	97.5quant.
Education	-0.0448	0.0349	-0.1098	0.0244
Occupation	-0.1730	0.0481	-0.2708	-0.0761
Wealth index	-0.1366	0.0238	-0.1872	-0.0902
Bednet	0.2888	0.0669	0.1533	0.4158
Child gender	0.6025	0.0369	0.5317	0.6781
Religion	0.0944	0.0390	0.0145	0.1711
residence	0.1140	0.0625	-0.2360	0.0058
marital status	0.0597	0.1393	-0.4345	0.3175
smoking	-0.0220	0.0608	-0.1443	0.0987

Table 4: Posterior Estimates of Non linear Effect in Breastfeeding in Nigeria

Variable	P.mean	P.std.dev	2.5% quant.	97.5% quant.
education	-0.1186	0.0360	-0.1885	-0.0524
occupation	0.0030	0.0535	-0.1018	0.1084
wealth index	-0.0942	0.0253	-0.1459	-0.0467
bednet	0.2431	0.0715	0.0934	0.3760
Child gender	0.6759	0.0404	0.5951	0.7574
religion	0.0439	0.0438	-0.0440	0.1269
residence	-0.1156	0.0650	-0.2478	0.0111
marital	-0.2661	0.2120	-0.7171	0.1455
smoking	- 0.0392	0.0627	-0.1651	0.0773

In this table 4, findings revealed that education, residence, marital status and smoking reduce the chance of mother breastfeeding her child. However, bednet, gender of child, occupation and religion increase the likelihood of mother breastfeeding her child.

Spatial effects

Estimated means of residual spatial district or state and region effects (botton) and 95% posterior probability map (top) of breastfeeding (NDHS, 2008). Figure 1 showed 95% for spatial effect and credible intervals of posterior probabilities for both region and state. 95% was used for credible interval of posterior probability for region and state, total spatial effect of breastfeeding for region and state. The residual spatial variations of breastfeeding in Nigeria after adjustment for other covariates as outlined in table 2 in addition to the unstructured spatial correlation was shown in region and state (Fig 1 c and d). The corresponding map of credible intervals used was to assess the significance of the spatial patterns. It showed that state with white(black) colour in the map were associated with significantly negative(positive) likelihood for breastfeeding while insignificant for state and region shaded with grey colour. This result showed a significant northern region where Zamfara, Katsina and Jigawa have low probability of breastfeeding and Nasarawa and Kwara with high probability of breastfeeding. Region where the likelihood of breastfeeding was insignificant in southern region.

The result showed that children under breastfeeding in Zamfara, Katsina, Jigawa, Nasarawa and Jigawa were significantly less likely to be breastfed. Contrary to those children that were insignificantly less likely to be breastfed in the remaining states in Nigeria.

Fig. 1 (a) 95 % posterior probabality for regions

Fig. 1 (b) 95 % posterior probability for states

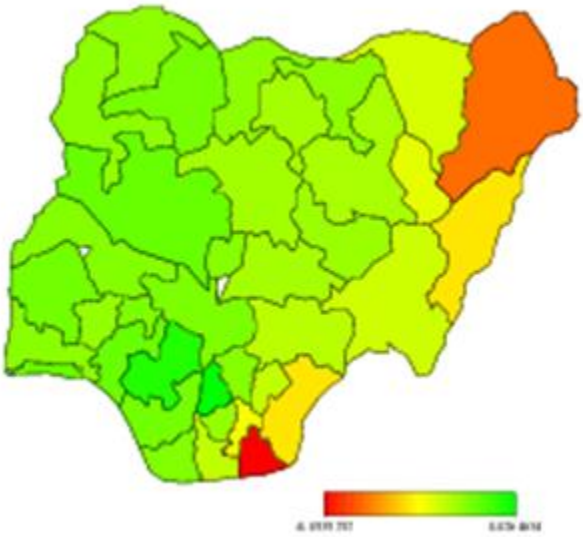

Fig. 1 (c) Total spatial effect of breastfeeding

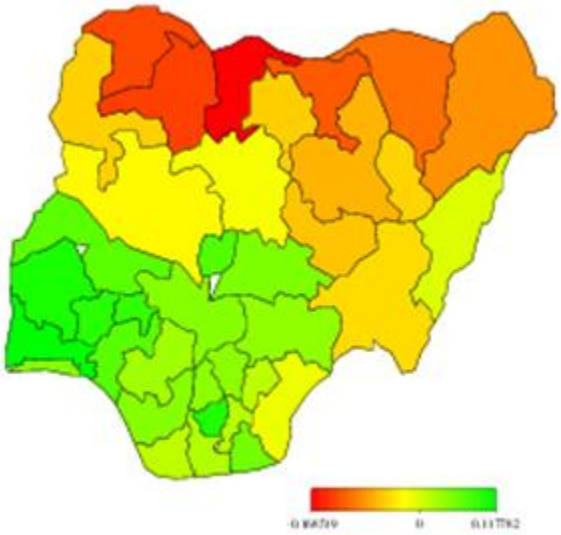

Fig. 1 (d) Total spatial effect of breastfeeding

Non linear effect

Estimated nonlinear (logits) effects of respondents age on breastfeeding. Shown is the posterior logits within the 95% credible intervals (NDHS, 2008). The relationship between respondents age (mothers age) and breastfeeding is non linear. This provides us with an insight into the functional pattern of respondent's ages in relation to breastfeeding.

With this, considering respondents age as a linear effect would have consequently resulted into spurious and unreliable conclusion. An approximately inverse U-shape feature is evident. This implies that at most the respondents (mothers) aged 20 years are with large chance before low chance of mortality with increase in respondent's age for breastfeeding their children.

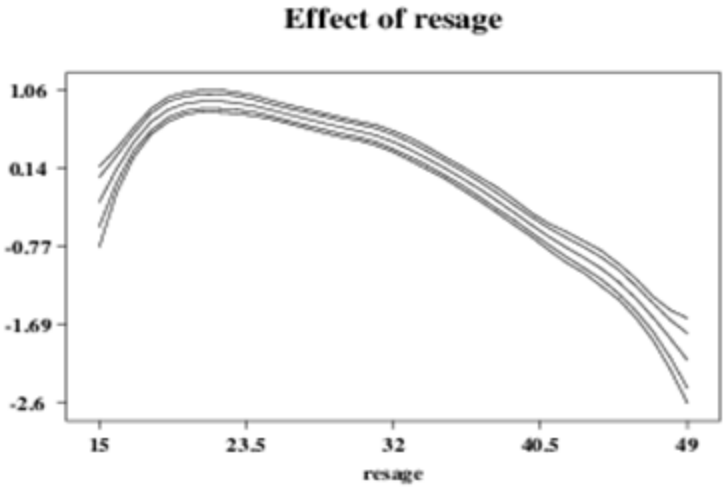

Fig. 2: Estimated nonlinear effect of respondents age with pointwise credible intervals

Discussion of Result and Conclusion

The study was designed to investigate spatial pattern and determinants of breastfeeding in Nigeria. In this study we consider breastfeeding being a major risk factor of infant and child mortality and its determinants. Binomial regression model that incorporates individual characteristics and spatial distributed random effect was used to examine the chance of breastfeeding. South-east region with the highest (88.69%) compared North-east region with the lowest (45.45%) of no breastfeeding (table1). In this same table, North-east region has highest (45.55%) compared to South-east with the lowest (11.31%) of breastfeeding. Table 2 presented that the total number of male (n=2289) and female (n=2257) for child that were not actually breastfed while total number of male (n=1679 and female (=1700) were actually breastfed. There is reduction in in total number of no breastfeeding as mother continues to go further in education with mother at the bearing age that attained no education (n=2649) to primary education (n=1131) except secondary education (n=1172) to higher education(n=400). In the same manner, there is reduction in total number of breastfeeding as mothers at bearing age go further in education. Table 3 showed the posterior estimates of fixed effects with which education, occupation, wealth index and smoking reduced the chance of breastfeeding in some regions while bednet, child gender, religion residence and marital status increased the chance of breastfeeding. Table 4 showed posterior estimates of nonlinear effects which allow partial linear regression with which education, wealth index, residence, marital status and smoking reduce while occupation, bednet, religion and child gender increase the chance of breastfeeding.

Findings on the covariates shows that residence, occupation, education, religion, wealth index, gender of child, marital, bednet and smoking play significant role in shaping culture and belief of breastfeeding. In conclusion, this study helps in understanding spatial pattern and determinants of breastfeeding in Nigeria. The region and state where it is less significant to breastfeed are experiencing alternative method of breastfeeding. No doubt that this will assist in policy development and

planning, resource allocation, implementation, monitoring and evaluation. Campaign for breastfeeding at different locations copied with effort at religion centre, work places, and educational institutions as mothers increase in age from 15 years and above.

References

Adebayo, Fahrmeir (2002). Analyzing Child Mortality in Nigeria with Geoadditive Survival Models, Sonderforschungsbereich 386, Paper 303.

Annette Beasley and Lisa H Amir (2007). Infant feeding, poverty and human development, International Breastfeeding Journal, 2:14.

Boniface Omuga K'Oyugi (2014). Impact of Breastfeeding on Infant and Child Mortality with varying Levels of Immunization and HIV/AIDS: Evidence from 2008/09 Kenya Demographic and Health Survey, Social Sciences, Vol. 3, pp. 9-16.

Brezger, A., Kneib, T., & Lang, S. (2005). BayesX - Software for Bayesian Inference based on Markov Chain Monte Carlo simulation Techniques, Version 1.40.

Britton JR, Britton HL and Gronwaldt V. (2006). Breastfeeding, sensitivity, and attachment, Pediatrics. 118(5).

Fahrmeir, L. & Lang, S. (2001). Bayesian Inference for generalized additive mixed models on Markov random field priors, Applied Stat., 50(2):201-220.

Kandala, N.B., Fahrmeir L. and Klasen, S.J.(2008). Geoadditive models of childhood under nutrition in Sub Saharan African Countries. International Journal of Population Geography, 15:461-473.

National Population Commission, ICF Macro. Nigeria demographic and health survey, 2008. Abuja, Nigeria: National Population Commission and ICF Macro; 2009.
Spiegelhalter, D., Best, n., Carlin, B. and Van Der Linde, A.(2002). Bayesian Measures of Model Complexity and Fit. Journal of the Royal Statistical Society, B64:1-34.
Thomas J Roberts and Emily Carnahan and Emmanuela Gakidou (2013). Can breastfeeding promote child health equity? A comprehensive analysis of breastfeeding patterns across the developing world and what we can learn from them, BMC Med vol.11.254.
Woldermicael, G. (2001). Diarrhoea morbidity among young children in Eritrea: Environmental and socioeconomic determinants. Journal of Health Population and Nutrition, 19(2): 83-90
Yoannes, A G., Streat-eld, K., & Bost, L. (1992). Child morbidity patterns in Ethiopia. Journal of Biosocial Science, 24(2): 143-55.