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BAYESIAN ANALYSIS OF SEXUAL BEHAVIOURS AMONG NIGERIAN WOMEN USING GEOADDITIVE MULTINOMIAL LOGIT MODEL

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ABSTRACT

This study investigated the geographical variations in the sexual behaviours of Nigerian women aged 15-49 years, using geoadditive multinomial logit model. The dependent variable was sexual abstinence which was viewed within the context of "Recent sexual activity". This was categorized for analysis as "Active in the last 4 weeks, "Had postpartum abstinence" and "Not active in the last 4 weeks" and "Had postpartum abstinence" was made the reference category. Effects of all categorical covariates were assumed to be linear and hence estimated in the usual parametric form while the effect of age was assumed to be nonlinear. The geographical information at state level was also explored in the model to assess the impact of spatial distribution on sexual behaviours of the women. Inferences were based on Markov Chain Monte Carlo (MCMC) technique. Findings revealed some spatial variations in the sexual patterns among Nigerian women at less aggregated state level. The results of this study can provide insights to states that possibly need interventions on matters relating to the sexual risks among the Nigerian women, and this can reduce the spread of HIV and AIDS among the Nigerian women through controlled sexual activities.

Keywords: Multinomial Logit Model, Abstinence, Bayesian, Geoadditive, MCMC

INTRODUCTION

The key to sexual health is encouraging sexual abstinence practice, especially having the knowledge that as adolescents mature, they acquire the desire, skills to negotiate for sex (Masatu *et al.*, 2009). In line with this, the Action Health Incorporated (2003) describes sexuality education as a planned process of education that fosters the acquisition of factual information of positive attitudes, beliefs and values as well as the development of skills to cope with the biological, psychological, socio-cultural and spiritual needs of human sexuality. Abstinence programs encourage unmarried youth to abstain from sexual activity as the best and only certain way to protect themselves from exposure to HIV and other STIs. Studies in Uganda, Kenya, and Zimbabwe have provided evidence that an increase in abstinence behaviors tends to be associated with declining HIV acquisition among young people (Cheluget *et al*., 2006; Kamali *et al*., 2000; Mahomva *et al*., 2006; Chiao and Mishra, 2007).

Studies have examined early sexual activities largely as a potential risk factor for adverse outcomes rather than identifying the correlates of the timing of sexual debut (Harrison *et al*., 2005; Abiodun et al., 2014). Young women often express the need to avoid unwanted pregnancy because they may be too young to care for a baby, they may have to end or postpone their education or they may remain unmarried (Abiodun and Balogun, 2009).

Contextual gender relations are important in influencing sexual behaviours, which include multiple sexual partners, transactional sex, unprotected sex, etc (Wandera et al., 2010; Antai, 2011; 2003; Abiodun and Adeleke, 2016).

Young people are particularly vulnerable to HIV infection because of the physical, psychological, social and economic attributes of adolescent (Earl, 1995). Population Reference Bureau (2000) report that adolescent are at risk due to the high level of risky sexual behaviours, and expectations of the societies in which they grow up. Studies have shown that those who begins sexual activities early are likely to have sex with more partners who have been at risk of HIV infections (WHO, 2002). Abstinence from sexual intercourse after childbirth until the child is fully weaned from breastfeeding is a deeply rooted practice in cultures of different communities (Dada et al., 2002). Recent reports however, suggests that most women resumed sexual intercourse within 3-6 months of delivery (Sule-Odu et al., 2008; Abdool, et al., 2009), and this is a shift from the taboo against sexual intercourse after birth (Anzaku and Mikah, 2014). Pregnancy related health services are likely to expose women to various types of reproductive information and services including the practice of modern contraception (Anzaku and Mikah, 2014). Reports suggests that prenatal care has a strong influence on subsequent use of modern contraceptive methods. Despite the provision of information about contraceptive methods during prenatal and postnatal cares, most women resume sexual intercourse within 6 months postpartum without the use of modern contraceptive method in many countries (Borda et al., 2010; Nyengidiki and Eyinda, 2008).

Sexual abstinence is of a particular interest because a search of related literature brings to note that more emphasis is generally laid on the use of contraceptives and other preventive/protective methods rather than total abstinence. In an analysis of the early datasets of the Demographic and Health Surveys in West Africa, it was found that levels of contraceptive practice were much higher among never-married than among currently married women in Nigeria and Cameroon, and almost as high in Ghana (Adebayo *et al*., 2012).

This research is aimed at modelling the sexual pattern among the Nigerian women and assesses the influence of certain factors which could possibly be associated with it. We have applied a geo-additive multinomial logit model to the study of sexual abstinence pattern among Nigerian women.

MATERIALS AND METHODS

The study data

The 2013 Nigerian Demographic and Health Survey (NDHS) data were used for this study. The survey was conducted by the National Population Commission (NPC) with technical support from ICF International and funds from other international bodies/agencies. Question regarding the recent sexual activity of women was asked and the response was recorded as "Never had intercourse", "Active in the last 4 weeks", "Not active in the last 4 weeks-postpartum abstinence" and "Not active in the last 4 weeks- not postpartum abstinence". For the purpose of this study, no respondent chose the first category (Never had intercourse), so it was dropped and "Not active in the last 4 weeks-postpartum abstinence" was simply named "Had postpartum abstinence" and was made the reference category. This enabled a clear contrast between those who were active in the last 4 weeks and those who were not active but not due to postpartum abstinence and this we simply called "Not active". Explanatory variables collected include: religion, educational attainment, place of residence, wealth index, work status, marital status, and type of union.

Multinomial Logit Model

Consider observations (Y_i, x_i), $i = 1, \ldots, n$, where Y_i is a categorical response variable which takes the value 1 if a respondent is active in the last 4 weeks, 2 if she had postpartum abstinence and 3 if she is not active in the last 4 weeks. We also have a vector $x = (x_1, \ldots x_p)'$ of covariates collected.

The recent sexual activity categorized above can then be viewed as a multinomial response with three outcomes.

Suppose there are *K* response categories, then the probability that the *i*-th respondent falls in the *k*-th response category can be given by

$$\pi_{ik} = \Pr\{Y_i = k\},\ k = 1,2,\ldots,K \qquad (1)$$

The most common approach to estimate multinomial probabilities is the logit model. Suppose we chose k' as the reference category, then the multinomial logit model assumes that the log-odds of each *k*-th response category can be given by

$$\log\left(\frac{\pi_{ik}}{\pi_{ik'}}\right) = \beta_{0j} + x_i'\beta_j \qquad (2)$$

where β_{0k} is a constant and β_k is a vector of regression coefficients, for $k = 1,2,\ldots, K\text{-}1$.

The *K*-1 multinomial logit equations contrast each of categories 1, 2,…,*K*-1 with the reference category k'.

In this study, 'had postpartum abstinence' is chosen as the reference category (i.e $k' = 1$) so that the logit for active in the last 4 weeks is given as

$$\log\left(\frac{\pi_{i2}}{\pi_{i1}}\right) = \beta_{02} + x_i'\beta_2 \qquad (3)$$

and for not active in the last 4 weeks is given as

$$\log\left(\frac{\pi_{i3}}{\pi_{i1}}\right) = \beta_{03} + x_i'\beta_3 \qquad (4)$$

We can write model (2) as

$$\log\left(\frac{\pi_{ik}}{\pi_{ik'}}\right) = \eta_{ik} \qquad (5)$$

where $\eta_{ik} = \beta_{0k} + x_i'\beta_k$

The multinomial logit model may also be written in terms of the original probabilities rather than the log-odds.

$$\Pr(Y_i = k|x,\beta) = \begin{cases} \dfrac{\exp(\eta_{ik})}{1+\sum_{h=1}^{K-1}\exp(\eta_{ih})} & k = 1,\cdots,K-1 \\ \dfrac{1}{1+\sum_{h=1}^{K-1}\exp(\eta_{ih})} & k = k' \end{cases} \qquad (6)$$

where $\beta = (\beta_{0k}, \beta_k)'$

The likelihood would take the form

$$L = \prod_{i=1}^{n}\prod_{k=1}^{K}[\Pr(Y_i = k|x,\beta)]^{y_{ik}}, \qquad (7)$$

with log-likelihood

$$\log L = \sum_{i=1}^{n}\sum_{k=1}^{K} y_{ik}[(\Pr(Y_i = k|x,\beta)] \qquad (8)$$

In this classical multinomial logit model, all covariates are assumed to be independent of the category while effects are category-specific.

Bayesian Generalized Additive Model under Geoadditive Framework

Model (5) assumes a linear form for covariate effects on the response variable, and therefore modelled parametrically. In real life situations, for the continuous covariates such as age, the assumption of a strictly linear effect on the predictor may not be appropriate. Also, observations may be spatially correlated in which case complex interactions may be required to adequately model the joint effect of some of the covariates, and heterogeneity among individuals or units may be not sufficiently described by covariates (Adebayo and Fahrmeir, 2005).

The data under this study is of the form observations (Y_i , x_i , z_i, s_i ,), $i = 1, \ldots, n$, where Y_i and x_i are as earlier described. Also, $z_i = (z_{i1},\ldots z_{iq})'$ is vector of categorical variables and s_i = (1, . . . , 37) is the state (district) where respondent *i* lived during the survey.

The main focus of this paper is to investigate the factors associated sexual activities among Nigerian women as well as the influence of geographical heterogeneity taking advantage of spatial information at a highly disaggregated state level. Generalized Additive Models (Hastie & Tibshirani, 1990), model (5) can be extended to include spatial information as

$$\eta_i = \sum_{j=1}^{p} f_j(x_{ij}) + z'\gamma + f_{spat}(s_i), \qquad (9)$$

where

γ is a vector of the fixed effects of categorical covariates z_i,

f_j are nonlinear effects of continuous covariate x_i and

f_{spat} is a spatial effect of spatial covariate s_i

For Bayesian inference, priors need to be specified for unknown parameters and functions in (9). Independent diffuse priors are assumed on the parameters of fixed effects γ. Priors for functions f_j of continuous covariates are defined through Bayesian P-splines, based on Lang and Brezger (2004) and Brezger and Lang (2006).

To achieve smoothness of function f_j, a first or second order Gaussian random walk smoothness priors is assumed, which is given by

$$\beta_1 = \beta_{j-1} + u_1 \quad \text{or} \quad \beta_1 = 2\beta_{j-1} - \beta_{j-2} + u_1 \qquad (10)$$

with independently and identically errors $u_1 \sim N(0, t^2)$, where the variance t^2 controls the smoothness of f_j.

For the geographical effect $f_{spat}(s_i)$, Gaussian Markov Random Field (GMRF) prior is assumed.

Fully Bayesian inference is then based on the posterior distribution of the model of the unknown model parameters. Therefore, MCMC sampling from full conditionals for nonlinear effects, spatial effects, fixed effects and smoothing parameters was used for the posterior analysis. For nonlinear and spatial effects, Metropolis-Hastings algorithms based on conditional prior proposals (Knorr-Held, 2000) and iteratively weighted least squares (IWLS) proposals suggested by Brezger and Lang (2006) were applied.

RESULTS

Fixed effects

The results of the fixed effects are presented in Table 1. Shown are the posterior estimates of the fixed effects and the 95% credible intervals.

From the Table, it is observed that Christian women are 8% more likely to be sexually active in the last 4 weeks compared with their traditionalist counterparts, while Muslim women are 27% less likely to be active. However, religion has no significant effect on the likelihood of respondents to be sexually active in the last 4 weeks. Women who dwell in the rural areas are 11% less likely to be sexually active compared with their counterparts living in the rural areas (OR = 0.887, CI: 0.795, 0.992).

There exists a positive association between wealth index and the likelihood of being sexually active in the last 4 weeks. Compared with respondents in the poor income group, those in the average income group are 25% more likely to be sexually active (OR = 1.249, CI: 1.073, 1.450), whereas those in the rich income group are 36% more likely to be sexually active (OR = 1.362: 1.185, 1.573). It is also observed that marital status of respondents has a significant effect on the sexual activity of the respondents. Against expectation, the unmarried women are found to be more sexually active in the last 4 weeks than the married (OR=2.077, CI: 1.894, 2.288). This implies prenuptial relations, hence the need for more sexuality education and encouragement of abstinence culture among the unmarried.

Being in a polygamous union increases the likelihood of being sexually active in the last 4 weeks by 166% compared with those in the monogamous union.

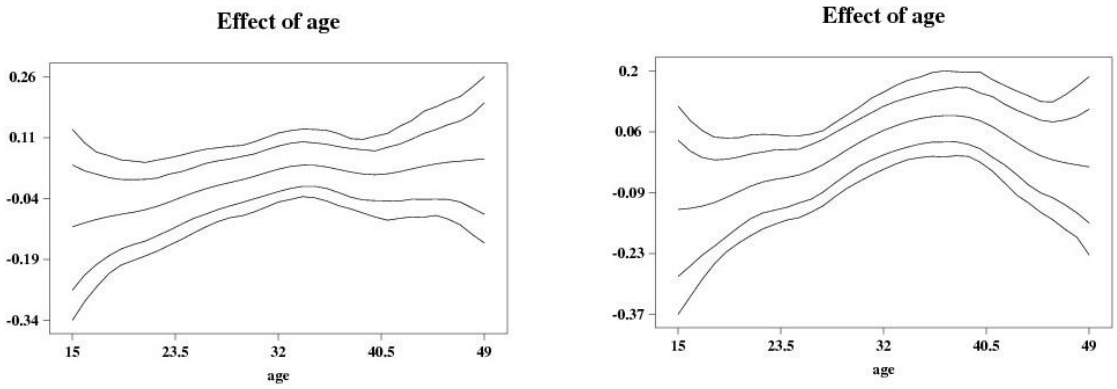
On sexual inactiveness, from Table 1, it is found that respondents with higher education are 2.391 times more likely not to be sexually active in the last 4 weeks than those with no education. The results also show that the odds of not being sexually active by respondents in the rich income category significantly increases by 36% compared with their counterparts in the poor income category (OR = 2.362, CI: 1.086, 1.455). Also, respondents who are not married are 2.077 times more likely not to be sexually active in the last 4 weeks.

Table 1: Results of fixed effects showing odds ratio and the 95% credible intervals (CI) for the sexually active and not sexually active women

	ACTIVE			NOT ACTIVE		
Variable	**Odds Ratio (OR)**	**Lower 95% CI**	**Upper 95% CI**	**Odds Ratio (OR)**	**Lower 95% CI**	**Upper 95% CI**
Constant	0.509	0.233	0.974	0.988	0.364	1.301
Relgion						
Traditionalist (ref)	1.000					
Christian	1.083	0.670	1.777	1.404	0.781	2.544
Islam	0.730	0.445	1.198	0.730	0.423	1.335
Educational Attainment						
None (ref)	1.000					
Primary	0.972	0.786	1.207	0.862	0.697	1.066
Secondary	0.291	0.248	0.344	0.312	0.262	0.371
Higher	2.391	1.897	3.043	2.031	1.573	2.605
Place of Residence						
Rural (ref)	1.000					
Urban	0.887	0.795	0.992	0.888	0.790	0.998
Wealth Index						
Poor (ref)	1.000					
Average	1.249	1.073	1.450	1.157	0.984	1.356
Rich	1.362	1.185	1.573	1.266	1.086	1.455
Work Status						
Not working (ref)	1.000					
Working	0.929	0.824	1.041	0.955	0.845	1.076
Marital Status						
Married (ref)	1.000					
Not married	2.077	1.894	2.288	1.371	1.233	1.516
Type of Union						
Polygamy (ref)	1.000					
Monogamy	2.658	2.404	2.985	0.965	0.857	1.094

Non-linear effect

The relationship between respondent's age and sexual activity among the women are presented in **Figure 1.** As observed, effect of age appears to be nonlinear. Being sexually active in the last 4 weeks (Figure 1a) increases as age increases up to the mid-30s and remains almost linear through age 49 years. For the category of not being sexually active in the last 4 weeks (1b), the effect of age is observed to have an inverse 'U' shape.



(a) Sexually active (b) Not sexually active

Figure 1: Non-linear Effect of age with 95% Credible Intervals

Spatial effect

The spatial effects of the fitted models are shown in Figures 2 and 3. Shown are the posterior means with the corresponding 95% credible interval, which is used to assess the significance of the spatial effect. It can be observed that there exists a considerable amount of residual geographical variability at state level on the recent sexual activity of the Nigerian women.

States with white colour are associated with positively significant spatial effect. For the active category (Figure 2), this means that such states are associated with high level of being sexually active in the last 4 weeks (the 95% credible interval lies on the positive side). States with black colour are significantly associated with low level of sexual activeness (the 95% credible interval lies in the negative side), while sexual activeness in the last 4 weeks is not significant in states with grey colour (the 95% credible interval include zero '0'). Therefore from Figure 2, Kwara, Benue, Taraba, Adamawa, Gombe, Bauchi, Kaduna, Imo States and FCT are significantly associated with high level of being sexually active in the last 4 weeks, while Sokoto, Kebbi, Zamfara, Katsina, Yobe and Jigawa states are significantly associated with low level.

Also from Figure 3, Kwara, Adamawa, Taraba, Cross River, Akwa Ibom, Rivers, Imo and Anambra States are significantly associated with high level of not being sexually inactive in the last 4 weeks, while Sokoto, Zamfara, Katsina, Yobe, Borno and Bauchi States are significantly associated with low level of sexual inactiveness.

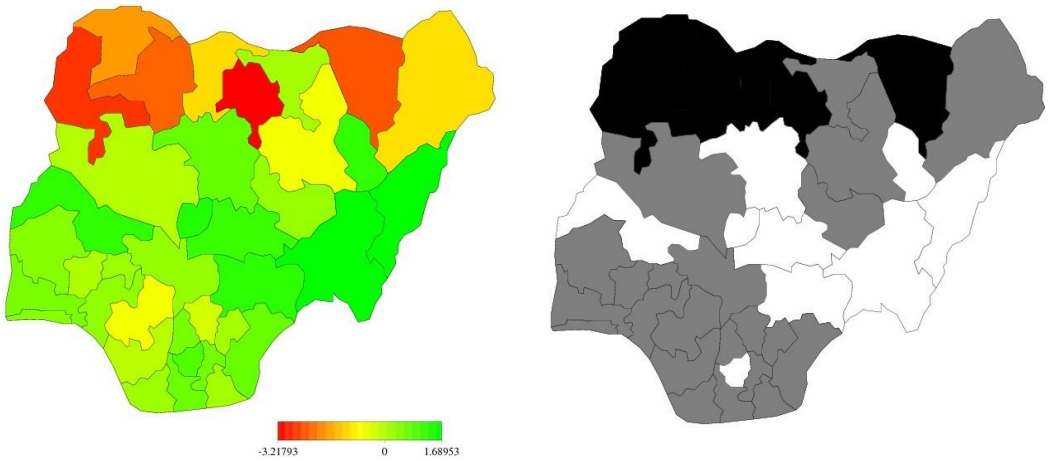


Figure 2: Spatial Effect of State for Active category.

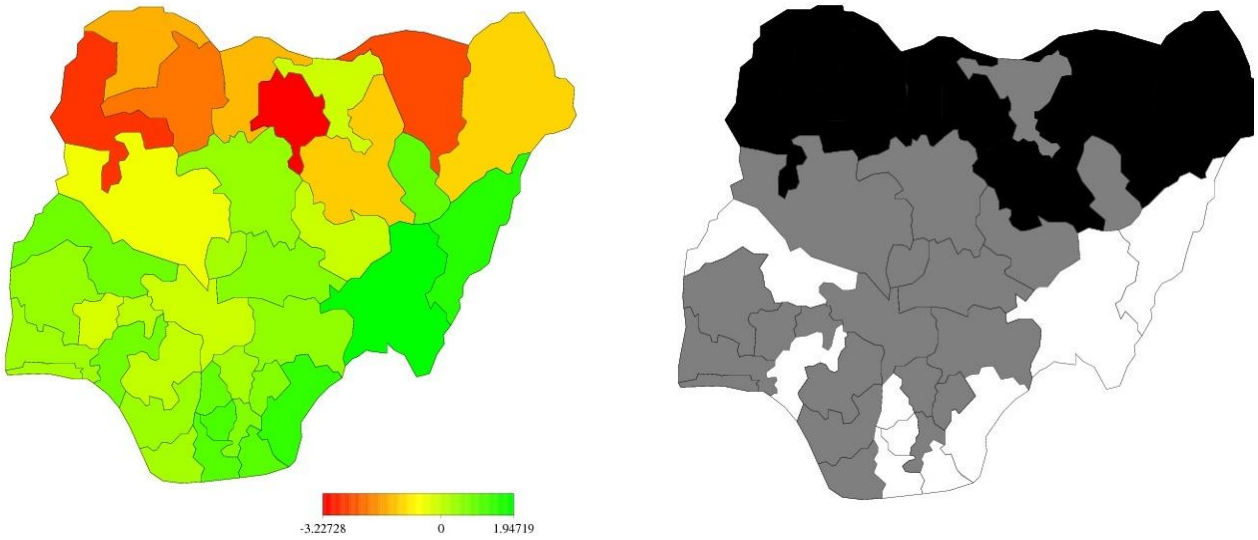


Figure 3: Spatial Effect of State for Not Active category.

DISCUSSION

A multinomial logit geoadditive model was applied to data from the 2013 Nigeria Demographic and Health Survey (NDHS) on the recent sexual activity of Nigerian Women aged 15-49 years. The recent sexual activity by the women were categorized as "Active in the last 4 weeks", "Had postpartum abstinence" and "Not active in the last 4 weeks". Inference was fully Bayesian with Markov Chains Monte Carlo (MCMC) simulation technique, which allowed flexible modelling of small area district effect. Findings from the study revealed that Christian women were more likely to be sexually active in the last 4 weeks compared with their traditionalist counterparts while Muslim were less likely. Rural-urban differential was also seen to be evident on the sexual activities of the women, as rural dwellers were less sexually active in the last 4 weeks than their urban counterparts. Also, a positive association between wealth index and the likelihood of being sexually active in the last 4 weeks was observed. This was against expectation.

It was also observed that marital status had a significant effect on the sexual activity of the respondents. Though seemed unrealistic, unmarried women were found to be more sexually active in the last 4 weeks than the married. The findings also revealed that women in the polygamous union were more likely to be sexually active in the last 4 weeks compared with those in the monogamous union. On sexual inactiveness respondents with higher education are more likely not to be sexually active in the last 4 weeks.

It was observed that there existed a considerable amount of geographical variability at state level on the recent sexual activity of the Nigerian women.

Findings revealed that Kwara, Benue, Taraba, Adamawa, Gombe, Bauchi, Kaduna, Imo States and FCT were associated with high level of being sexually active in the last 4 weeks, while Sokoto, Kebbi, Zamfara, Katsina, Yobe and Jigawa states were associated with low level. It was also found that Kwara, Adamawa, Taraba, Cross River, Akwa Ibom, Rivers, Imo and Anambra States were associated with high level of not being sexually active in the last 4 weeks, while Sokoto, Zamfara, Katsina, Yobe, Borno and Bauchi states were significantly associated with low level of sexual activeness.

CONCLUSION

One major advantage of including spatial information in this analysis was that it revealed the sexual activity of Nigerian women at less aggregated state level rather than aggregating information only at the level of the six geopolitical zones. Spatial analysis such as in

this study will also guide the policy makers on the states where interventions are needed on matters relating to the sexual risks among the Nigerian women.

REFERENCES

Abiodun, A.A, Adeleke, K.A. (2016). Geoadditive Modelling of Adolescent Age of Sexual Initiation Among Nigerian Women. *Ife Journal of Science*. 8 (2): 521-529

Abiodun, A.A., Adebayo, S.B., Oyejola, B.A. and Anyanti J. (2014). A spatial Analysis of Age at Sexual Initiation among Nigerian Youth as a Tool for HIV Prevention: A Bayesian Approach. In: *Advanced Techniques for Modelling Maternal and Child Health in Africa*, The Springer series on Demographic Methods and Population Analysis 34, 279-302. DOI 10.1007/978-94-007-6778-2-14, Springer, New York London.

Abiodun, O.M. and Balogun, O.R. (2009). Sexual activity and contraceptive use among young female students of tertiary educational institution in Ilorin, Nigeria. *Contraception* 79(2): 146–149. doi:10.1016/j.contraception.2008.08.002.

Adebayo, S.B. and Fahrmeir, **L.** (2005). Analysing child mortality in Nigeria with geoadditive discrete-time survival models. *Statistics in Medicine*, 24(5): 709-728.

Adebayo, S.B., Gayawan, E., Ujuju, C. and Ankomah, A. (2012). Modelling Geographical Variations and Determinants of Use of Modern Family Planning Methods among Women of Reproductive Age in Nigeria. *J. Biosoc. Sci*. 00, 1–21. doi:10.1017/S0021932012000326

Action Health Inc, (2003): Comprehensive sexuality education. Trainers resource material: Lagos.

Antai, D. (2011). Regional inequalities in under-5 mortality in Nigeria: a population-based analysis of individual- and community-level determinants. *Population Health Metrics*, 9, 6. http://doi.org/10.1186/1478-7954-9-6.

Anzaku, A.S. and Mikah, S. (2014). Postpartum Resumption of Sexual Activity, Sexual Morbidity and use of Modern Contraceptives Among Nigerian Women in Jos. 2014). *Annals of Medical and Health Sciences Research.* 4(2): 210-216.

Borda, M.R., Winfrey, W. and McKaig, C. (2010). Return to sexual activity and modern family Planning use in extended postpartum period: An analysis of findings from seventeen countries. *Afr. J. Repr. Health.* 14; 72-9.

Brezger, A. and Lang, S. (2006). GeneralizedStructured Additive Regression based on Bayesian P-splines. *Computational Statisticsand Data Analysis* 50, 967-991.

Cheluget, B., Baltazar, G., Orege, P. Ibrahim, M., Marum, L.H. and Stover, J. (2006). Evidence for population level declines in adult HIV prevalence in Kenya. *Sexually Transmitted Infections* 82 Suppl 1:i21-26.

Chiao, C. and Mishra,V. (2007). Trends in Primary and Secondary Abstinence among Kenyan youth. *DHS Working Paper* 36.

Dada, O.A., Akesode, F.A., Olanrewaju, D.M., Olowu, O.A., Sule-Odu, O., Fakoya, T.A., et al. (2002). Infant feeding and lactational amenorrhea in Sagamu, Nigeria. Afr. J. Repro. Health, 6: 39-50.

Earl, D. (1995). Re-examination of the paradigm of HIV risk reduction in Adolescents. Journal of the American Osteophatic Association, 95(12): 725-728.

Harrison A., Cleland J., Gouws E. And Frohlich J. (2005). Early sexual debut among young men in Rural South Africa: heightened vulnerability to sexual risk? *Sex Transm Infect*. 81:259–261

Hastie, T. & Tibshirani, R. (1990):

Generalized Additive Models. Monographs on Statistics & Applied Probability *Chapman and Hall London.*

Kamali, A., L.M. Carpenter, J.A. Whitworth, R. Pool, A. Ruberantwari, and A. Ojwiya. (2000). Seven-year trends in HIV-1 infection rates, and changes in sexual behaviour, among adults in rural Uganda. *AIDS* 14(4):427-434.

Knorr-Held, L. (2000). Bayesian modelling of inseparable space-time variation in disease risk. *Statistics in Medicine* 19 (17-18), 2555-67.

Lang, S. and Brezger, A. (2004): Bayesian P-Splines. *Journal of Computational and Graphical Statistics*, 13, 183-212.

Mahomva, A., S. Greby, S., Dube, O., Mugurungi, J., Hargrove, D., Rosen, K.L., Dehne, S., Gregson, M., St. Louis. and S. Hoder. (2006). HIV prevalence and trends from data in Zimbabwe, 1997-2004. *Sexually transmitted Infections* 82 Suppl 1:i42-47.

Masatu, M.C., Kazaura, M.R., Ndeki, S. and Mwampambe, R. (2009): Predictors of Risky Sexual Behaviour among Adolescents in Tanzania, AIDS Behaviour 13, 94-99.

Nyengidiki, K.T. and Eyinda, C.E. (2008). Contraceptive prevalence amongst women attending infant welfare clinic at the University of port Hacourt Teaching Hospital. Port Hacourt Med J.3: 42-48.

Population Reference Bureau. (2000). The World's Youth: Data Sheet. Washington, DC.

Sule-Odu, A.O., Fakoya, T.O., Oluwole, F. A., Ogundahunsi, O.A., Olowu, O.A., Olanrewaju, D.M, (2009). Postpartum sexual abstinence and breasfeeding pattern in Sagamu. Nigeria. Afr. J. repro. Health. 12: 96-100.

Wandera, S.O., Ntozi, J.P.M., and Kwagala, B. (2010). Spousal Sexual Violence, Sexual Behaviour and Sexually Transmitted Infections among Ever-Married Women in Uganda. *Journal of African Population Studies, Volume* 24 (1&2), 70-87

WHO: Young People and HIV/AIDS, Opportunity in Crisis. (2002). Uwalaka E, Matsuo H: Impact of knowledge, attitude, and beliefs about AIDS on sexual behavioral change among college students in Nigeria: the case of the University of Nigeria Nsukka. West Africa Review: 3,2 http://www.africaknowledgeproject.org/index.php/war/article/view/329.