Journal of NAMP 70, (2025) 45-56

The Nigerian Association of Mathematical Physics

Journal homepage: https://nampjournals.org.ng

MODELLING GEOGRAPHICAL VARIATIONS OF PARITY LEVELS IN THE FACE OF FAMILY PLANNING METHODS IN NIGERIA

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ARTICLE INFO

Article history:
Received 10/4/2025
Revised 18/4/2025
Accepted 24/5/2025
Available online 17/7/2025

Keywords:
Geo-additive,
Trend,
Model,
Cohabiting,
Spatial Effect.

ABSTRACT

High parity is common in most sub-Saharan Africa countries and Nigeria is equally battling with the menace. Understanding the level, trend and geographical variations of high parity level of any country is important to proffering solution despite the availability of various family planning methods. This study assessed these characteristics in Nigeria using data from the 2018 Nigerian Demographic and Health Survey data set for women who started cohabiting with men before 18 years old. A Bayesian geo-additive procedure was used with Poisson regression model. Three models were developed of which Model M_3 had the smallest deviance information criterion (DIC). The findings discovered significant geographic variation in parity levels in Nigeria, with a north–south division. The use of any form of contraceptives was found to be significantly less likely to have impact on women with high parity in Nigeria. Policy makers must improve on awareness programs among productive women.

1. INTRODUCTION

Generally, most Sub African countries are characterized by high parity as the region has the highest fertility rate in the world [1]. Nigeria is the most populous country in the African region with a population of about 206 million, an annual population growth rate of 3.2%, and a total fertility rate of 5.5 per woman [1-3]. One of the major set-back of meeting the Millennium Development Goals in Nigeria and many other developing countries is the continuous rapid growth of the population [4]. Parity is defined as the number of birth in the life time of a woman and this had been grouped majorly into three by researchers as follows: primi-parity (one live birth), multi-parity (more than one but less than five live births), and grand multi-parity (more than five live births) [5-7]. One of the identified causes of high parity which is a public and universal health challenge found in Nigeria is the girl-child marriage below the age of 18 years This is also a developing challenge as it impacts the overall well-being and put restrictions on the input of young women to national socioeconomic growth. About 12 million girls got married or cohabit with men before the age of 18 years yearly throughout the globe.

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https://doi.org/10.60787/jnamp.vol69no2.537

Globally, there are more than 700 million women alive who married before the age of 18 years of which sub-Saharan Africa is among the regions with high prevalence [8-14]. Nigerian women usually attach a sense of dignity to having many children, it is seen as a gift and should not be rejected [3,7,15].

Government and other private organizations had been unrelenting in promoting the use of modern family planning (FP) methods. Nigeria is one of the countries with the least contraceptive prevalence rates (CPR), though with high knowledge of about 70% but with as low as less than 10% usage among women of reproductive age [4]. This showed that the 27% by 2020 target by the Federal Government of Nigeria, through the Federal Ministry of Health (FMOH) for a modern contraceptive prevalence rate (mCPR) was not achieved, though there was a little improvement in the 2018 Nigerian Demographic and Health Survey (NDHS) over the 2013 NDHS data. This low use of modern FP methods had been attributed to several factors and major among them are: desire to get pregnant and side effects/health concerns [16,17]. It has also been established in literature that several women in developing countries including those with more than 4 children do not use modern contraceptives [1,4,13, 18-21].

It has been discovered that geographical information is not enough to get information about the health conditions of any country, since there are spatial differences across regions and states [22-24]. This study therefore, assessed the social and demographic characteristics believed to be linked with high parity in Nigeria despite various family planning methods using data from the 2018 Nigerian Demographic and Health Survey data set for women who started cohabiting with men before 18 years old. 15,061 women were in this group. A Bayesian geo-additive procedure was used with Poisson regression model since the number of children ever born is categorized as count data, this provided flexible modelling of non-linear and spatial effects at the states level. Detecting spatial clusters and gaining insights into common demographic and health systems can inform mediations to increase uptake of family planning services, thereby improving the long-term health status of women and also adjusting steady for the Nigeria population.

2.0 Data and Methods

2.1 Data

One of the most comprehensive sources of national household data on women is the Demographic and Health Survey (DHS). The data in this study is a cross-sectional analysis of a population-based study from the 2018 DHS. The DHS programme has provided technical support to surveys in several developing countries over the years through which health and population growth are studied. It has established standard techniques, approaches and instruction manual to guide the survey processes across countries. The sampling frames used for the surveys were centered on the population and housing censuses conducted in the countries while the primary sampling units were demarcated on the basis of the enumeration areas (EAs) from the Census frames. The selection of samples is through two-stage stratified design, firstly, through clusters from the EAs, and secondly, through the selection of households. For the 2018 survey, 24,281 women aged 15 to 49 present at the selected households participated in the survey. From this number, 15,061 women of reproductive age, who started cohabiting with men before age 18 years, who had complete information on contraceptive use and age at first sex were used in the study. We considered a woman to be using a FP method if she was using any of the following during the period of the survey: female sterilization, pill, intrauterine contraceptive device (IUD), injectables, implants, condom, diaphragm, contraceptive foam, lactational amenorrhea, and standard days method. The following covariates were also included in the study: mother's age at birth, parity, region, type of

place of residence, educational attainment, ethnicity, wealth index, access to health facility, whether or not the woman reads newspapers, watches television and listens to radio at least once a week. Nigeria is divided into 36 states and a Federal Capital Territory (FCT) with six regions. The dataset is available for download via https://dhsprogram.com/data/available-datasets.cfm.

2.2 Data Analysis

The number of children ever born by a woman is assumed as count data with non-negative integer valued random variable which can be modelled using the basic count data model, Poisson model [24,25]. Suppose we have a set of regression observations (y_{ijkl}, x_{ijkl}) where y_{ijkl} is the number of children by the lth woman belonging to the kth household, in the jth community, and in the ith state, and x_{ijkl} is the corresponding vector of covariates. The regression model is considered on the count variable y_{ijkl}, which can be modelled by means of the Poisson regression model [24],

$$y_{ijkl}|\gamma, u_{ijk}, v_{ij}, s_i \sim Poission(\mu_{ijkl}) \quad (1)$$

$$\log\left(\mu_{ijkl}\right) = \eta_{ijkl} = x'ijkl\gamma + u_{ijk} + v_{ij} + s_i \quad (2)$$

where μ_{ijkl} is the mean number of children per woman and γ is the vector of fixed effect of regression coefficients. The household, community and state latent variables are denoted by u_{ijk}, v_{ij} and s_i respectively. However, if there are covariates that are metrical, it is better not to specify their relationship form in the model [24,26]. Equation (2) can be extended to semiparametric structure additive predictor [27].

$$\eta_{ijkl} = x'ijkl\gamma + f_{ijkl}(x_{ijkl}) + u_{ijk} + v_{ij} + s_i \quad (3)$$

where f_{ijkl} are unidentified smooth functions for some covariates that are continuous and non-linear. Bayesian approach was assumed for estimating all parameters and functions. In the Bayesian framework, all parameters and functions are measured as random variables and have to be complemented with suitable prior assumptions. Independent diffuse priors, $p(\gamma) \propto const$, are assumed for the fixed effects parameters. For the unknown (smooth) functions, the Bayesian perception of penalised spline (P-spline) projected by Fahrmeir and Lang [27] and Lang and Brezger [28] was used. The P-spline permits for non-parametric estimation of f as a linear combination of basis function (B-spline), that is, $p(z) = \Sigma_{j=1}^{J}\beta_j\beta_j(z)$, where $\beta_j(z)$ are B-spline. The coefficients, β_j, are further defined to follow a first-order or second-order random walk smoothness prior. In this study, we adopted a second-order random walk, that is, $\beta_j = 2\beta_{j-1} - \beta_{j-2} + \varepsilon_i$ with Gaussian error $\varepsilon_i \tilde{} N(0, \tau_i^2)$. The variance τ_i^2 controls for the smoothness of f. When there is a weakly informative inverse gamma prior, it is estimated jointly with the basis function coefficients. The household and community random effects were modelled by assuming exchangeable normal priors, $u_{ijk} \tilde{} N(0, \tau_b^2)$, where τ_b^2 is a variance component that incorporates over-dispersion and heterogeneity for which an inverse gamma hyper-prior was assigned. The spatial effect component s_i was modelled by assuming intrinsic conditional autoregressive prior [24], which presents a neighbourhood structure for the areas $s_i, s \in \{1, \ldots, 37\}$. The prior describes areas as neighbours if they share a common boundary. Neighbouring areas are presumed to have similar patterns, such that the mean of area i is expected to be an average of neighbouring areas, with variance as a function of neighbours and spatial variance. The spatial effect can be further

fragmented into two: structured and unstructured spatial effects considering that spatial data has spatial heterogeneity and correlation due to unobserved varying covariates.

That is $f_{geo}(s) = f_{str}(s) + f_{unstr}(s)$.

This representation of spatial effects enables us to distinguish between two kinds of unobserved independent variables, namely, those which are available locally, and those which display a strong spatial structure [29]. To evaluate the smoothing parameters for non-linear and spatial effects concurrently, highly dispersed but proper hyper-priors are allocated to them. Hence, for all variance components, an inverse gamma distribution with hyper-parameter a and b were selected. The standard of hyper-parameters are $a = 1$ and $b = 0{,}005$ or $a = b = 0.001$.

Parameter estimation was through integrated nested Laplace approximation in R-INLA package of R programming language and maps were plotted for visualization.

2.3 Model Building

Three different models were compared for the data set used, starting with the simplest to a more multifaceted one. As a primary model (M1), we considered only the spatial component for the regions of Nigeria without adjusting for any covariates. The categorical covariates were added to the first model with the continuous variables as linear effects to form the second model (M2). While, the third model (M3), the continuous variables were treated as nonlinear effects. These were done to examine model performances based on subsets of the entire different:

Model 1 (M1): η = spatial structured effects + unstructured random effects

Model 2 (M2): η = M1 + categorical covariates + linear effects

Model 3 (M3): η = M2 + non-linear effects

3.0 Results

Table 1 presents the findings from the descriptive statistics of the demographic characteristics of the respondent. A total of 15,061 women who had at least one (1) child were involved in the survey of which 13,547 (89.9%) had used family planning at one time or the other and 97.8% were married. The highest population was from the North West 6,334 (42.1%), while the least was from South East 668 (4.4%). The educational level of the respondent showed that majority had no education 9,641 (64.0%), while primary, secondary and higher education were 17.4%, 16.9% and 1.7% respectively. Majority of the respondents lives in the rural area 11,390 (75.6%) while 67.0% did not see the distance to health facility as a big problem. 63.7% of them are currently working, while 32.4% were from the poorest level on the wealth index. 95.3% of the respondents reads newspapers, 56.6% listened to radio while 71.6% watched television at least once in a week. The study showed that 58.0% of the women are from Hausa/Fulani ethnicity while 32.4% did not fall into any of the three main ethnicity groups in Nigeria.

Table 1 Descriptive statistics based on the categories of the socio-demographic variables included in the study

Variables	**No of Women (%)**
Total	15061 (100)
Region	
North Central	2389 (15.9)

North East	4011 (26.6)
North West	6334 (42.1)
South East	668 (4.4)
South South	883 (5.9)
South West	776 (5.2)
Place of Residence	
Rural	11390 (75.6)
Urban	3671 (24.4)
Level of Education	
No Education	9641 (64.0)
Primary	2619 (17.4)
Secondary	2549 (16.9)
Higher	252 (1.7)
Marital Status	
Yes	14727 (97.8)
No	334 (2.2)
Ethnicity	
Others	4887 (32.4)
Yoruba	687 (4.6)
Hausa/Fulani	8729 (58.0)
Ibo	758 (5.0)
Wealth Index	
Poorest	4875 (32.4)
Poorer	4220 (28.0)
Middle	3009 (20.0)
Richer	2062 (13.7)
Richest	895 (5.9)
Distance to Health Facility	
Big Problem	4969 (33.0)
Not a Big Problem	10092 (67.0)
Currently Working	
No	5473 (36.3)
Yes	9588 (63.7)
Newspaper (at least once a week)	
Yes	14353 (95.3)
No	708 (4.7)
Radio (at least once a week)	
Yes	8522 (56.6)
No	6539 (43.4)
Television (at least once a week)	
Yes	10779 (71.6)
No	4282 (28.4)
Contraceptive	
Yes	13547 (89.9)
No	1514 (10.1)

In an attempt to explore parity with the different family planning programmes in the country while controlling for other factors, models M1 to M3, as specified in the Model building section, were fitted. Table 2 presents information on the DIC and log-likelihood for model diagnostics for the data. The results show that model M3, which incorporates spatial, non-linear effect of mother's age at 1st sex, woman's age, partners' age and demographic indices is best based on the DIC for the data. Model diagnostics show that model performance becomes better with increased model complexity. Discussion of results is based on M3

Table 2. Model comparison based on the deviance information criterion (DIC)

Model	DIC	log-likelihood
M1	78743.58	-39380.84
M2	62210.49	-31251.42
M3	59507.26	-29918.10

Results of fixed effects

Table 2 presents the results of the fixed effects from Poisson model fitted to the parity level of the women. Presented are the posterior modes, standard deviations and 95% credible intervals. Results show that parity level of women living in the urban areas was not significantly different from that of women who reside in rural areas. Similarly, there was no evidence of significant difference in the parity level of women based on their working and marital status. With regard to the level of education, parity level was not significant for women with only primary education, while it was significantly lower for women with higher education. Regarding ethnicity, Yoruba women have significantly lower parity level, Hausa/Fulani have significantly higher parity while, it was not significant among Ibo women. With regard to where a woman reads newspaper, listens to radio or watches television at least once in a week was not significant to their parity level. The wealth index showed that women in the richest households have significantly lower parity level while it was not significant for those in the poorer, middle and richer households. Distance to health facility was not significant to the parity level of the women who participated in the survey. While contraceptive use was significantly lower for parity level among the women.

Table 2: Results of Fixed Effects Modelled for Poisson Model

Variables	Post mode	SD	95% credible interval
Constant	1.676	0.030	1.558, 1.676
Place of Residence			
Rural (ref)	0		
Urban	0.013	0.010	-0.006, 0.032
Level of Education			
No Education (ref)	0		
Primary	0.011	0.010	-0.009, 0.032
Higher	-0.034	0.013	-0.060, -0.008
Marital Status			
No (ref)	0		
Yes	-0.024	0.028	-0.079, 0.030
Ethnicity			
Others (ref)	0		
Yoruba	-0.113	0.024	-0.159, -0.065
Hausa/Fulani	0.043	0.011	0.021, 0.065
Ibo	-0.007	0.026	-0.059, 0.045
Wealth Index			
Poorest (ref)	0		
Poorer	-0.004	0.009	-0.023, 0.014
Middle	-0.005	0.011	-0.027, 0.018
Richer	-0.022	0.014	-0.050, 0.006
Richest	-0.070	0.020	-0.109, -0.031
Distance to Health Facility			
Big Problem (ref)	0		

Not a Big Problem	0.007	0.008	-0.009, 0.023
Currently Working			
No (ref)	0		
Yes	-0.024	0.028	-0.079, 0.030
Newspaper (at least once a week)			
No (ref)	0		
Yes	-0.012	0.019	-0.048, 0.025
Radio (at least once a week)			
No (ref)	0		
Yes	0.003	0.008	-0.013, 0.019
Television (at least once a week)			
No (ref)	0		
Yes	-0.019	0.010	-0.039, 0.001
Contraceptive			
No (ref)	0		
Yes	-0.070	0.012	-0.093, -0.046

Results of nonlinear and spatial effects

The nonlinear effects of mother's age, mother's age at 1st sex and partner's age are shown in Figure 2 (a-c), demonstrating the posterior modes and 95% credible intervals. Findings from Poisson model display that for mother's age, parity level experienced a steep rise to age 27 years, then a gradual but slow increase to age 37 years. A stable position was noticed to age 45 years, thereafter, there was a steady rise in the parity level again. For mother's age at 1st sex, parity level has an inverse "U" shape that started declining at about age 12 years gradually to age 25 years. Thereafter, there was a steady rise to around age 35 years and this was followed by a very slow rise in the parity level of women in this category for the rest of their lives. That is there is a likelihood of reduced parity between age 12 years and 25 years. For partner's age, there is a likelihood of reduced parity level for women whose partners are below 25 years, thereafter, there is a steady but slow rise in parity level to around age 40 years. However, from age 40 years, women experience a steady and continuous decline in parity level which started to fluctuate again from around age 70 years.

Spatial effects for the model is presented in Figure 3 (d, e). The map for posterior modes and the map of the location of the 95% credible intervals, used in deciding the significance of the estimates. From the maps of credible interval, states with white (black) colours are associated with significantly high (low) estimate (95% credible intervals lie in the positive (negative) side) while the estimates are not significant for states with grey colour (95% credible interval include 0). There was an evidence of a North-South divide in the parity level of the women in the country. Findings from the Poisson model indicated that women from the states in the Northern regions, in particular, those from most states in the North West region and half of states in North East region were associated with significantly higher parity level, while those from the Southern regions, particularly half of the states in the South South and only Benue state in the North Central were associated with significantly lower parity level. But, the credible intervals of parity level of women from other states in the North Central, all the states in the South West regions, some states in the South South, North East and North West include zero.

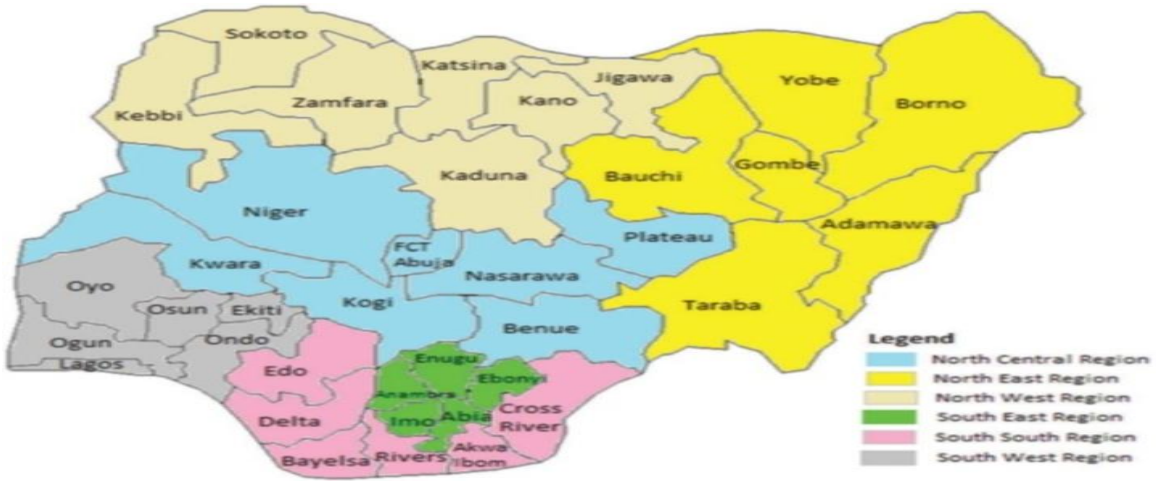

Figure 1: Map of Nigeria showing the six geopolitical zones [24]

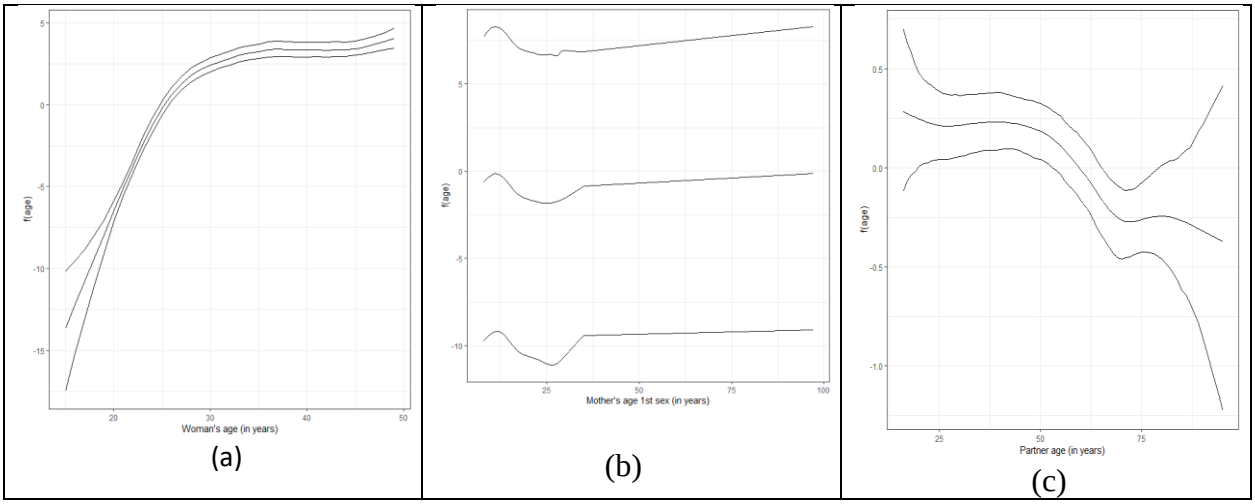

Figure 2 (a-c): Nonlinear effects of mother's age, mother's age at 1st sex and partner's age

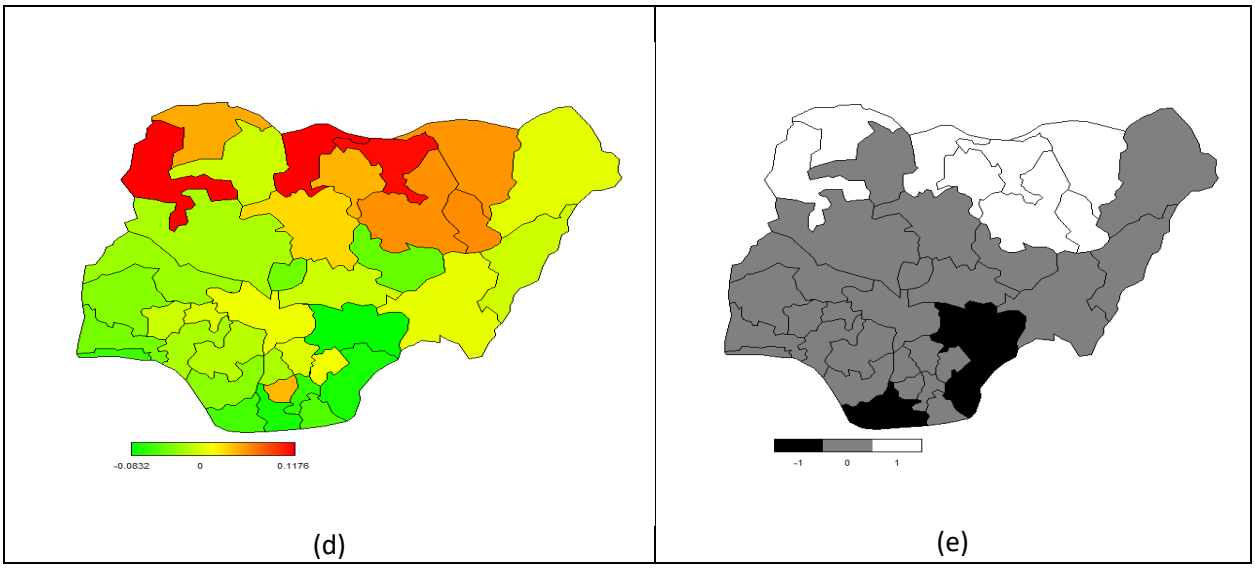

Figure 3 (d-e): Maps of Nigeria showing spatial effects of parity level for Poisson model and its 95% credible interval

Discussion

The presence/observation of high parity despite the availability of different modern family planning methods is an important health indicator that can provide vital information about a country. In Nigeria, the awareness of family planning methods is high, but its uptake is low despite the efforts of government and international agencies at increasing this fertility control mechanism [4, 30]. This study evaluated the social and demographic characteristics linked with high parity in Nigeria in the face of various family planning methods. Women who started co-habiting with men before 18 years of age and who had at least a child were considered for the study. Bayesian geo-additive technique was used since it is good at detecting spatial clusters that helped to gain insights into common demographic and health systems information. Nigeria has six geo-political regions, three from the North and three from the South. Findings show that majority of the women who took part in the survey were from the North regions, in particular, the North West region. This could be due to high population in the region and with higher rate of child marriage [31-32]. Findings from the study confirms that majority had used a method or the other of the family planning methods and the level of access to information by women is very high through the newspaper. Although, more than half of the total number of women who participated in the survey had no education and about one third were from the poorest level of the wealth index.

The place of residence of the women do not determine their parity since there was no significant difference between those living in the rural and the urban areas. Likewise, there was no significant difference in the parity level of women based on their working status, marital status, access to information and their distance to health facility. While, higher educational level, being a part of yoruba ethnic group, from the richest wealth index and who use any type of contraceptives indicate a lower parity level in this study. While these claims are consistent with researches in the literature [3, 33-36], it is at variance with the study at Indonesia where there was no significant relationship between education and parity [37]. Women from Hausa/Fulani ethnic group are more likely to be associated with high parity, while women from Ibo ethnic group are not significantly associated with parity level.

The likelihood of having high parity level with increase in mother's age is evident in this study. As the mother's age increases, the parity level increases until it became stable between ages 37 years and 45 years after which it began to rise again. This shows that women who co-habit with men at younger age are associated with high parity. The mother's age at 1st sex shows a likelihood of low parity until age 25 years old, thereafter, as the mother's age increases, the likelihood for high parity increases. This can be an evidence of forced marriage and a high probability that the reproductive system of the young girls is matured to carry babies. Also, women whose partners are below 25 years old have low likelihood to high parity. While their likelihood with high parity increases between age 25-40 years old and from 70 years old. This shows that women might be forced to have more children when their partners are in their prime years.

Significant geographical variation was found for parity level between the north and south regions of the country. The Northern regions were significantly more likely to be associated with high parity compared with the Southern regions. Findings show that five out of the seven states in the North West region have women who were significantly more like to have high parity, the two exempted states are Zamfara and Kaduna. In a similar way, three out of the six states in the North East region were significantly more likely to have high parity, these states include Yobe, Gombe and Bauchi states. Comparing this study with Adebayo *et al.*, (2012) [4] on the modelling geographical variations and determinants of use of modern family planning methods among women of reproductive age in Nigeria, shows that Kano and Yobe states had significantly low use of modern FP methods which is an indication of high likelihood for high parity level as seen in

this study. This is a call for government and policy makers to expedite necessary actions in the region. While in the North Central region, only Benue state was associated with significantly lower parity level, the remaining states including the FCT, Abuja were not significantly associated with parity level. For the Southern regions, three states from the South South region, which are Bayelsa, Rivers and Cross-Rivers states have women who were significantly less to have high parity. The remaining states in the South South region, South West and South East regions not significantly associated with parity level in this study. There is a need government and policy makers to call for attitudinal change in the North Central and the Southern regions of the country.

Conclusion

Nigeria is one of the countries with high parity in the world, having achieved a little improvement on the uptake of family planning programme which is a major process in cutting down high parity in the country, there still seems to be need for more advocacy on high parity. This study had evaluated the social and demographic characteristics associated with high parity in the six geopolitical regions in the country and the findings had assisted in ascertaining states with significantly high parity level. Thus, efforts must be made to savage the Northern regions from early marriage for both boys and girls and there should be more advocacy on the use of contraceptives. Funding of the health facilities are equally important to make available various family planning methods with well trained professionals at the centers to correct the indifference to information in the Southern regions.

Acknowledgement

The author acknowledged the Nigerian Demographic and Health Survey for making the data used in this research work available.

Conflict of Interest

The author confirms that there is no conflict of interest on this research work.

Funding

The author did not receive any funding for this work.

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