INVESTIGATING REGIONAL DISPARITIES IN THE SPATIAL PATTERN AND DETERMINANTS OF ANTENATAL CARE UTILIZATION IN NORTHERN AND SOUTHERN NIGERIA

Paul Omoh Olopha

Department of Statistics, Federal University of Technology, Akure

Abstract

The persistent uneven utilization of Antenatal care (ANC) across Nigeria, a very important factor for improving maternal and child health outcomes, has been a major challenge in meeting up with the SDG goals. The major disparities has been between Northern and Southern regions. Leveraging on the use of the 2013 Nigeria Demographic and Health Survey (NDHS), which offers a more comprehensive geographic dataset than NDHS 2018, this study employed the Bayesian spatial geo-additive modeling technique to analyse the spatial and determinant factors influencing ANC utilization among pregnant women in the two regions. The Structured Additive Regression model (STAR) was used to simultaneously analyze the components of the model. The results show that the major determinants of ANC utilization in the two regions are mothers' education, religious affiliation, economic empowerment, and urban residence with significant regional differences. Northern Nigeria shows significantly lower ANC uptake while Southern Nigeria records higher ANC utilization. Urban-rural disparities however persist. Clusters of low ANC utilization were identified by spatial analysis in the northern states, reflecting regional inequalities in maternal healthcare access. This study concludes that in order to improve ANC utilization across Nigeria, interventions should be region specific, and be tailored towards addressing specific social, cultural and economic challenges in each region.

Keywords: Antenatal Care (ANC); Bayesian Spatial Modeling; Structured Additive Regression (STAR); Regional Disparities

1.0 Introduction

Antenatal care (ANC) is the care provided to a woman during pregnancy, and it is a very important part of reproductive health care. ANC can serve as a system for the delivery of highly–effective health interventions that can lessen preventable maternal and newborn deaths (Magadi et al., 2000; Kaphle et al. 2013). ANC services give pregnant women an entry point to the health care system, providing suitable screening, intervention and treatment throughout pregnancy, and encouraging women to look out for a skilled birth attendant for their delivery and the well-being of their infants

ISSN NUMBER: 1116-249X

(NPC & ICF, 2014; Afolabi et al., 2015; Okonofua et al., 2018). With consistent engagement with ANC utilization, maternal and child health outcome can be greatly improved but the accessibility is still at the very low level in many sub-saharan countries, Nigeria inclusive (Lawn et al., 2014).

The continued disparities in maternal health outcome in the two dominant regions of Nigeria can be traced partly to the unequal distribution of healthcare services like ANC. Researches have shown that the significant gap in ANC utilization between the north and southern nigeria is a reflection of the gap in the social, cultural and economic developments (Adewuyi et. al, 2018; Adedini et al., 2014). This is further excarbated by the infrastructural differences that rub off on factors like education, wealth, and access to health care among others. Northern Nigeria generally exhibits lower rates of ANC use compared to Southern regions, which often have higher rates. Furthermore, Northern Nigeria tends to have higher rates of rural living, which is associated with lower ANC utilization compared to urban areas in Southern Nigeria.This is aside the widespread poverty, lower education levels, and lack of access to resources all of which significantly impact ANC utilization in Northern Nigeria (Fagbamigbe & Idemudia, 2015; Nwosu et al., 2019; Adewuyi et al., 2024). All these disparities are major drivers of higher maternal and child mortality rates in the North (Mberu & Reed, 2014).

Although a lot of research has been carried out on maternal health in Nigeria, the need for a deeper understanding of the dynamics of ANC utilization at the regional levels cannot be overemphasized. This is because when studies like these are restricted to national-level, significant information that bothers on the factors contributing to the disparities between the Northern and Southern regions are often ignored (Abimbola et al,. 2012). The purpose of this study therefore is to fill this gap by investigating the factors contributing to the disparities in ANC utilization in these two regions. If the drivers of ANC utilization specific to each region are well understood, it will serve as a very good platform to design interventions that are region-targeted and this will go a long way in addressing the barriers to maternal healthcare access in Nigeria.

Using data extracted from the 2013 Nigeria Demographic and Health Survey (NDHS), the multivariate logistic regression was utilized in exploring key determinants of ANC utilization in the two regions.These determinants include maternal education, household wealth, place of residence (urban vs. rural), and healthcare access, while also considering the role of cultural factors that may affect healthcare-seeking behavior in each region (Ononokpono et al., 2013). Spatial mapping was used to identify clusters of high and low ANC utilization, providing insights into the geographic patterns of healthcare access.

ISSN NUMBER: 1116-249X

One of the strengths of this study is its use of the 2013 Nigeria Demographic and Health Survey (NDHS), which offers a more comprehensive geographic dataset than NDHS 2018. The 2018 survey faced security-related data omissions, excluding clusters from several states, particularly in the North-East and North-West regions due to insurgency and insecurity (NPC & ICF, 2019). This omission raises concerns about spatial bias, as conflict-affected regions often experience worse health outcomes, including reduced access to maternal healthcare services, which may result in the underestimation of the true burden of poor antenatal care (ANC) access (Adewuyi et al., 2018; Doctor et al., 2011). Furthermore, the reliance of NDHS 2018 on the 2006 census-based sampling frame limits its ability to fully capture recent demographic shifts, including rapid urbanization and internal migration trends that affect health service access and coverage (NPC & ICF, 2019). These factors justify the use of NDHS 2013 for conducting robust spatial analyses with wider national representation.

1.1 Dependent Variable

The dependent variable is the number of antenatal care visits made by a pregnant woman.

1.2 Independent Variables

The socio-demographic variables that were considered in this study are similar to the ones commonly used in studies on antenatal care utilization (Gayawan 2014; Gayawan 2016; Adewuyi et al., 2018). These include respondent's age at the time of survey, age at first birth, type of place of residence, child's birth order, educational attainment and working status, partner/husband's educational attainment, household wealth index, and exposure to media (newspaper, radio and television; whether or not the respondent was exposed to each of these at least once a week).

2.0 Material and Method

2.1 Data

The data used for the study were extracted from the Nigeria Demographic and Health Survey (NDHS) conducted in 2013. The data source is considered appropriate for the study because the observations are geographically referenced that permits spatial modeling. The sampling frame used for the survey was created using that of the 2006 Nigerian Population and Housing Census. The sampling units were defined based on the enumeration areas (EAs) used for the census frame. A stratified three-stage sampling design was used to select the sample. The first stage sample included 904 clusters (sampling units) made up of 372 in urban areas and 532 in rural areas from where a total of 39,902 women were found eligible for interview. A total 38,948 women were eventually selected making 98% response rate. Information were collected from all women aged 15-49 years present at the selected households.

ISSN NUMBER: 1116-249X

2.2 Statistical analysis

Let y_i denote a count variable that indicates the number of times i^{th} pregnant woman receives ANC among women who attended antenatal in each of the regions and this is available for n number of pregnant women, that is $i=1,...,n$. Y_i is assumed to follow a poisson distribution. Assume further that a set of explanatory variables, common to $y_{i,}$ and denoted by $x_{1,}$ …, x_k are available. Based on the generalized linear model (GLM), the response variable can be modeled using the regression model with the appropriate link function, and generally given as

$$\eta = log(\lambda) = \beta_0 + \beta_1 x_1 + ... + \beta_k x_k \quad , \qquad (1)$$

where η is the model predictor, β_0 is the regression constant term, β_k is the regression coefficient for the k^{th} explanatory variable. In this study, some metrical variables such as respondent's age at first birth (z_1) and respondent's current age (z_2) were also considered. The geo-referenced location of residence of each respondent (pregnant woman) is discretized and added as a spatial variable s_i. The combination of the above diverse variables in the same model results in a complex model that cannot apriori be described in simple functional forms thereby making the estimation of the effects intractable. A nonparametric approach which is commonly used to estimate such effects and which we adopted in this study is the Structured Additive Regression Model (STAR) technique (Fahrmeir et al, 2013). Through the instrumentality of the concept of STAR, the effects of the variables can be jointly estimated by extending the model in equation (1) to capture the different types of variables at once through the structured additive model defined as:

$$log(\lambda_b) = \sum_{j=1}^{p} f_j(z_{ij}) + f_s(s_i) + x_i'\beta \qquad (2)$$

where $f_{1,...}$,fp are nonlinear functions assumed of the metrical covariates and f_s is the nonlinear spatial effect of the discrete spatial covariates.

Estimation of the parameters of the structured additive model were carried out through Bayesian approach where the parameters and functions of the models were considered to be random variables. Appropriate prior distributions were assigned to them. The independent diffuse priors were considered to ensure the non-linear parameters were estimated similar to the classical linear regression approach. For the smooth functions, Bayesian versions of Penalized-splines commonly called p-splines prior proposed by Lang and Brezger (2004) was utilized. The prior enables the function to be estimated in a nonparametric form as a linear combination of basis function (B-spline):

$$p(z) = \sum_{j=1}^{J} \beta_j B_j(z)$$

where $B_j(z)$ are basis functions and the coefficients β_j corresponds to the vector of unknown regression coefficients. The β_j are further defined to follow a second order Gaussian random walk

ISSN NUMBER: 1116-249X

$\beta_t = 2\beta_{j-1} - \beta_{j-2} + u_t$,

within dependent and identically distributed errors $u_t \sim N(0, \tau^2)$ whose variance, τ^2 controls the smoothness of the B-spline function. The variance is jointly estimated with the B-spline function coefficients but with a weakly informative inverse Gamma prior $\tau^2 \sim \mathrm{IG(a,b)}$ assigned. For the spatial component, a common approach in spatial statistics is to adopt a Gaussian Markov random field prior (Besag et al, 1991). It is given as

$$[f_s(s) \mid f_s(t); t \neq s, \tau^2] \sim N\left(\sum_{t \in \partial_s} \frac{f_s(t)}{N_s}, \frac{\tau^2}{N_s}\right)$$

where N_s is the number of adjacent regions and $t \in \partial_s$ denotes that region t is a neighbour of region$s$. Again τ^2 controls the amount of spatial smoothness. As mentioned earlier, the posterior distribution for model of this nature is intractable, consequently, inference in this study was based on Integrated Nested Laplace Approximations (INLA) as implemented in R-INLA (Fahrmeir et al , 2013).

3. Results

Table 1 Distribution of Respondents by Region and Socio-economic variables

	Northern Nigeria		Southern Nigeria	
Variables	**ANC Utilization**	**%**	**ANC Utilization**	**%**
Place of Residence				
Rural	9848	77.3	2758	45.3
Urban	2893	22.7	3337	54.7
Level of Education				
No Education	8321	65.3	525	8.6
Primary	2103	16.5	1754	28.8
Secondary	1843	14.5	3049	50
Higher	474	3.7	767	12.6
Religion				
Other	139	1.1	70	1.1
Islam	10271	80.6	902	14.8
Christianity	2331	18.3	5123	84.1
Ethnicity				
Others	4744	37.3	NA	NA
Kanuri	277	2.2	NA	NA
Tiv	322	2.5	NA	NA
Hausa	5948	46.7	NA	NA

ISSN NUMBER: 1116-249X

Fulani	1450	11.3	NA	NA
Others		NA	85	1.4
Ijaw	NA	NA	607	10
Ekoi	NA	NA	299	4.9
Yoruba	NA	NA	2700	44.3
Igbo	NA	NA	2404	39.4
Wealth Index				
Poorest	4052	31.8	155	2.5
Poorer	3695	29	654	10.7
Middle	2417	19	1340	22
Richer	1554	12.2	1925	31.6
Richest	1023	8	2021	33.2
Access to mass media				
Radio				
No	6226	48.9	1432	23.5
Yes	6515	51.1	4664	76.5
Television				
No	8721	68.4	1426	23.4
Yes	4021	31.6	4670	76.6
Newspaper				
No	11595	91	4443	72.9
Yes	1146	9	1653	27.1
Partner's Educ				
No Education	6701	52.6	430	7.1
Primary	1988	15.6	1591	26.1
Secondary	2435	19.1	3036	49.8
Higher	1617	12.7	1038	17
Employment				
No	4726	37.1	1080	17.7
Yes	8015	62.9	5016	82.3
Birth Order				
Birth Order 1	1955	15.3	1103	18.1
Birth Order 2&3	3725	29.2	2165	35.5
Birth Order 4+	7061	55.5	2826	46.4

3.1 Descriptive Analysis of ANC Utilization

Table 1 presents the descriptive statistics of all women included in the study. ANC utilization shows notable disparities between rural and urban women in the two regions. The table shows that 77.3% of ANC users in the North reside in rural areas, compared to only 45.3% in the South, whereas 54.7%

ISSN NUMBER: 1116-249X

of ANC users in the South are urban dwellers. This shows that ANC services uptake in the Southern region is urban centered. Concerning educational attainment, there is a stark contrast between regions. 65.3% of ANC users in the North were found to have no formal education, whereas only 8.6% lacked education in the South. On the other hand, 50% of women in the South were shown to have secondary education compared to just 14.5% in the North. Similarly, higher education was more common among Southern ANC users (12.6%) than Northern (3.7%). The two major religions practiced in Nigeria ,Islam and Christianity, are very obvious in the pattern of ANC uptake in the country.80.6% of ANC users in the North are shown to be Muslims, while in the South, 84.1% were Christians. This religious distribution in Nigeria, could influence health-seeking behavior.The ethnic composition reveals that the Northern ANC users are predominantly Hausas (46.7%), Fulanis (11.4%), and other Northern ethnic groups, while the Southern ANC users were mainly Yoruba (44.3%), Igbo (39.4%), and Ijaw (10.0%). There is every likelihood that an interaction between ethnic diversity and varying cultural norms and access to maternal health services. The wealth pattern of ANC users in the country shows that ANC users in the South were generally wealthier than those in the North. A whole lot of 31.8% of ANC users in the North were in the poorest level compared with only 2.5% of users in the South. Whereas only 8.0% of the users in the North belong to the richest class, a whole lot of 33.2% of ANC users in the South were in the richest quintile. Exposure of ANC users to the three modes of enlightenment, radio, television and newspaper, was significantly higher in the South in the order 76.5%, 76.6%, and 27.1% respectively. This is opposed to 51.1%, 31.6%, and 9.0% respectively in the North. This exposure could enhance health awareness and promote ANC utilization. Southern partners were more educated. While 52.6% of ANC users in the North had partners with no education, only 7.1% did in the South. Nearly 50% of Southern users had partners with secondary education compared to 19.1% in the North. More women in the South (82.3%) were employed compared to the North (62.9%), suggesting that economic participation may contribute to higher ANC uptake. Higher-order births (4+) were more common among Northern ANC users (55.5%) than in the South (46.4%). In contrast, the South had a slightly higher proportion of ANC users at birth orders 1 (18.1%) and 2–3 (35.5%).

Table 2: Factors associated with Antenatal Care Utilization in Southern and Northern Nigeria

	Southern Nigeria			**Northern Nigeria**		
Factors	**Mean**	**odd**	**sd**	**Mean**	**odd**	**sd**
(Intercept)	0.3857	1.4706	0.5176	0.4459*	1.5619	0.2062
Media						
Others	0	1		0	1	

ISSN NUMBER: 1116-249X

Newsp	0.0054	1.0054	0.0122	-0.0018	0.9982	0.0199
Telev	0.0232	1.0235	0.0134	-0.0001	0.9999	0.0145
Radio	0.0428*	1.0437	0.0121	0.1199*	1.1274	0.012
Ethnicity						
Other Southern tribes	0	1				
Ijaw.izon	-0.1062*	1.112	0.0424	NA	NA	NA
Ekoi.ibibio	-0.0163	0.9838	0.0345	NA	NA	NA
Yoruba	0.0478*	1.049	0.0213	NA	NA	NA
Igbo	0.1521*	1.1643	0.0224	NA	NA	NA
Other Northern tribes				0	1	
Tiv	NA	NA	NA	-0.1788*	0.8363	0.0602
Kanuri.beribei	NA	NA	NA	-0.1007*	0.9042	0.043
Hausa	NA	NA	NA	-0.0491*	0.9521	0.0222
Fulani	NA	NA	NA	-0.2110*	0.8098	0.0272
Religion						
others	0	1		0	1	
Islam	0.1279	1.1364	0.0659	0.3049*	1.3565	0.1395
Christians	0.0989	1.104	0.064	0.2935*	1.3411	0.139
Mother's Education						
No Education	0	1		0	1	
Primary	0.1513*	1.1633	0.0265	0.1274*	1.1359	0.0158
Secondary	0.2176*	1.2431	0.026	0.1531*	1.1654	0.0173
Higher	0.2443*	1.2767	0.0299	0.2366*	1.2669	0.0273
Partner's Education						
No education	0	1		0	1	
Pprimary	0.0101	1.0102	0.0184	0.1685*	1.1835	0.0176
Psecondary	0.0624*	1.0644	0.0153	0.2069*	1.2299	0.0163
Phigher	0.1226*	1.1304	0.0189	0.2734*	1.3144	0.0205
Wealth						
Poorest	0	1		0	1	
Poorer	0.0784*	1.0816	0.0319	0.0894*	1.0935	0.0176
Middle	0.1739*	1.1899	0.0316	0.1807*	1.1981	0.0211
Richer	0.1876*	1.2064	0.0328	0.2180*	1.2436	0.0254
Richest	0.2443*	1.2767	0.0343	0.2630*	1.3008	0.0311
Place of residence						
Rural	0	1		0	1	
Urban	0.0574*	1.0591	0.0251	0.2126*	1.2369	0.0437
Birth Order						
No birth						
Bord1	0.817	2.2637	0.5115	-0.0944	0.9099	0.1505
Bord23	0.77	2.1598	0.511	-0.1724	0.8416	0.1491
Bord4above	0.724	2.0627	0.5106	-0.2164	0.8054	0.1478
Employment						
Unemployed	0	1		0	1	

ISSN NUMBER: 1116-249X

Employed	0.0716*	1.0742	0.0136	0.1011*	1.1064	0.0117

*variables significant at 95% credible interval

Table 3 : Summary of Key Differences

Factor	Southern Nigeria	Northern Nigeria
Radio	Small but significant effect	Stronger positive effect
Ethnicity	Igbo and Yoruba positive	Fulani, Hausa, Tiv, Kanuri negative
Religion	Not significant	Significant for both Islam and Christianity
Education (Mother)	Strong predictor at all levels	Also strong, especially partner's education
Wealth	Significant and positive	Significant and marginally stronger
Urban residence	Modest positive effect	Stronger effect due to rural disadvantage
Employment	Modest positive effect	Stronger positive effect

3.2 Fixed Factors (Socio-demographic, Cultural and Economic)

Looking at Tables 2 and 3, the results brought to the fore the distinct factors driving ANC utilization in the two regions. It is pertinent to note that these drivers reflect the differences in the social, cultural, economic, and infrastructure development of the two regions. Both regions were found to exhibit significant association between radio access and ANC utilization, with the effect being stronger in the North (OR = 1.1274*) than in the South (OR = 1.0437*). On the other hand, television and newspaper did not show any significant association with ANC utilization in the two regions. Ethnicity emerged as a significant predictor in both regions but operated in different directions: In the South, the ethnic groups initially showed positive associations with ANC use, but after adjusting for con-founders, Ijaw/Izon and Ekoi/Ibibio turned negative. In the North, all the tribes that were considered (Tiv, Kanuri, Hausa, Fulani) were significantly associated with lower ANC attendance compared to the other tribes combined, with the Fulani group showing the lowest likelihood (OR = 0.8098*). In the North, the strong impact of the two major religion practiced in Nigeria are very evident with both Muslim (OR = 1.36)* and Christian women (OR = 1.34)* showing higher odds of utilizing antenatal care compared to women of other religion. Looking at the Southern region, one would observe that the same trend obtains but the associations are not significant. Education consistently predicted ANC use across both regions: Women with higher education had increased odds of ANC utilization in both the South (OR = 1.2767)* and *North (OR = 1.2669)**. Partner education also showed strong positive associations with ANC utilization in the two regions, with tertiary education showing the strongest association followed by secondary level.

ISSN NUMBER: 1116-249X

The richest women were found to exhibit positive association with ANC attendance in both regions with women in the Northern region (OR =1.3008)* having higher influence than those in the Southern Nigeria (OR = 1.2767)**. Also, urban residence was found to be positively associated with ANC utilization in both the South (OR = 1.0591*) and the North (OR = 1.2369*). This association is again found to be stronger in the North than in the South. Birth order had contrasting effects: In the South, higher birth order appeared to increase ANC utilization, though results were not significant after adjustment. In the North however, increasing birth order was associated with decreasing odds of ANC attendance. Being employed was positively associated with ANC use in both regions, Southern (OR = 1.0742*) and Northern Nigeria (OR = 1.1064*).

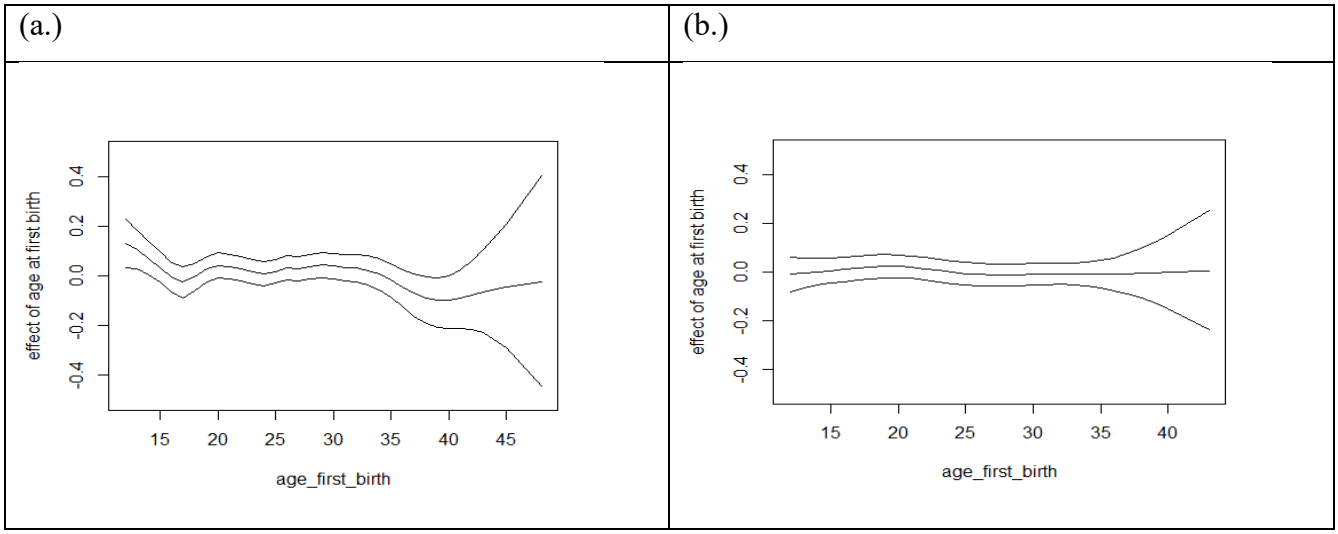

Figure 1: Non-linear Effects of mother's age at first birth on ANC utilization in (a) Southern Nigeria and (b) Northern Nigeria

3.3 Metric Factors (Age at First Birth and ANC Utilization)

Figure 1 reveals that in southern Nigeria, age at first birth shows a notable effect on ANC attendance. High ANC use is found among women who gave birth at a younger age, declining up to age 18. This slightly increased between ages 18–20, became stable between 20–35, and thereafter followed by a gradual decline. In contrast to Southern Nigeria, the effect of age at first birth on ANC utilization is found not to be significant, thus suggesting that this factor does not influence ANC attendance in the North.

ISSN NUMBER: 1116-249X

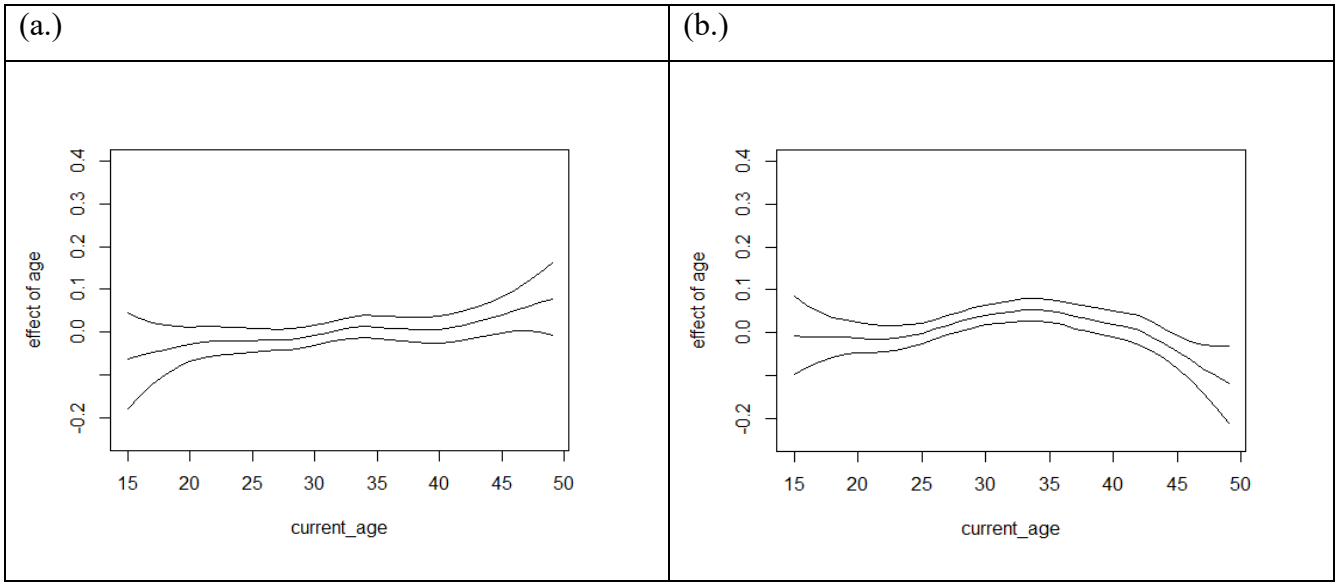

Figure 2 : Non-linear Effects of mother's current age on ANC utilization in (a) Southern Nigeria and (b) Northern Nigeria

3.4 Metric Factors (Mother's current age and ANC Utilization)

Figure 2 reveals that a positive direct relationship exists between current age of mother and ANC utilization in Southern Nigeria, as the older women showed consistent ANC utilization than the younger women. This disposition is in contrast to what obtained in the Northern region where current age of women did not show any effect on ANC utilization among the younger women (up to age 23) . A gradual increase is however revealed to follow, peaking at around early to mid-30s where it started declining steadily as the women get older.

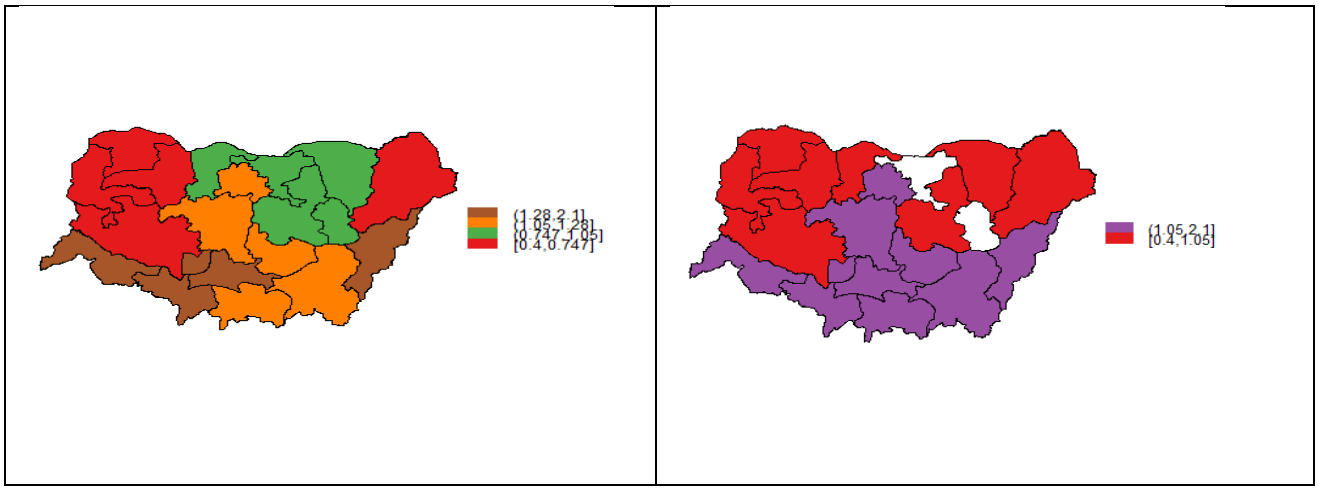

Figure 3: Spatial effects of ANC Utilization (a) adjusted for covariates (b) 95% credible interval in Northern Nigeria

ISSN NUMBER: 1116-249X

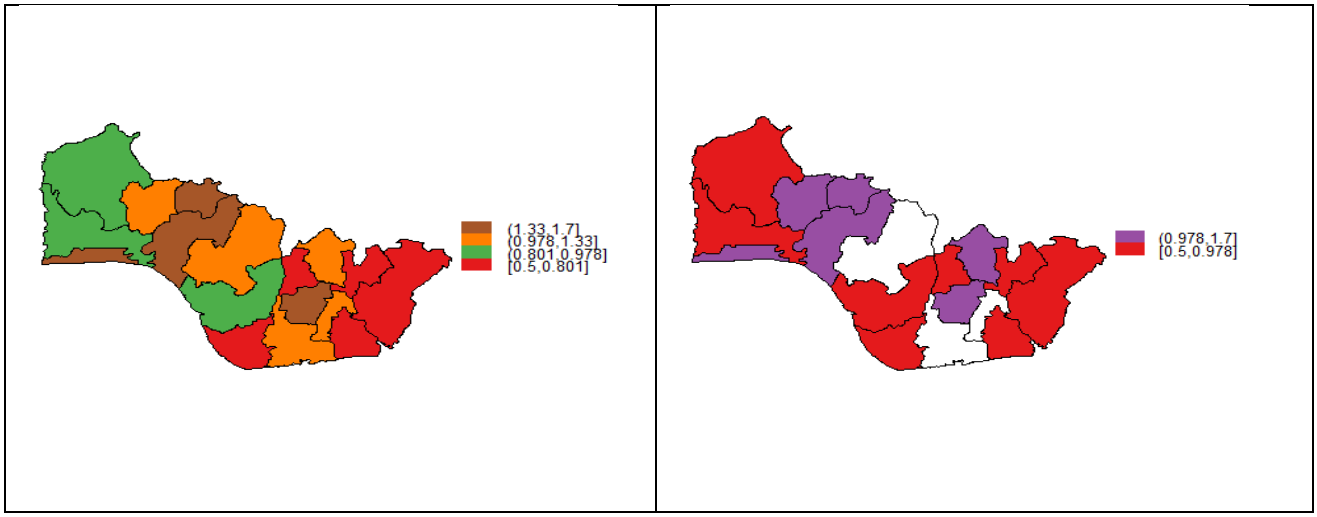

Figure 4: Spatial effects of ANC Utilization (a) adjusted for covariates (b) 95% credible interval in Southern Nigeria

3.5 Spatial Factor

Figures 3 and 4 revealed a distinct disparity in the spatial distribution of ANC utilization between and within the southern and Northern regions. The results reveal a distinct inequality in the spatial pattern of ANC utilization in the southern region. This is particularly obvious between the southwest and southeast where only four states in the South-West (Osun, Ekiti, Ondo, and Lagos) exhibited significantly higher odds of ANC utilization compared to the Southern regional average. Similarly, only two out of the other nine states, Anambra and Imo, showed significantly higher odds. All other states showed significantly lower ANC utilization except Edo, Rivers and Enugu, that showed no significant association. All these clusters reveal potential pockets of under-utilization even within the generally better-performing South.

In contrast, a more defined spatial divide could be observed in Northern Nigeria. A clear demarcation between the Middle Belt and the Core North is conspicuously shown. All the Middle Belt states recorded significantly higher odds of ANC utilization relative to the Northern regional average. In contrast, all the states (except Kano and Kaduna) in the core North showed significantly lower ANC utilization. Kano and Kaduna showed significantly higher odds of ANC utilization than the Northern average, standing out as positive outliers in an otherwise under-performing zone.

4. Discussion

In this study, the regional disparities in ANC utilization between the Southern and Northern regions were thoroughly investigated. Using data extracted from 2013NDHS, the findings brought to the fore the vast differences that exist between the two regions, driven by a complex interplay of socio-

ISSN NUMBER: 1116-249X

demographic, economic, and cultural factors. The persistent overall inequities in maternal health between the two regions consistently reported by various authors was substantiated with significantly lower ANC utilization in the Northern region compared with the Southern region (Doctor et al., 2011; Fagbamigbe & Idemudia, 2015). Maternal education emerged as a strong predictor of ANC utilization in both regions, with a more pronounced effect in the North. Women with higher education were over five times more likely to attend ANC compared to those with no education. This supports previous findings that education enhances women's health-seeking behavior and autonomy in making healthcare decisions (Magadi et al., 2000; Ononokpono & Odimegwu, 2014). In the South, while education also increased ANC use, the effect size was smaller, possibly due to a higher baseline level of both education and service uptake. Women from the richest households were substantially more likely to attend ANC, particularly in the North, where poverty and limited access to healthcare facilities pose major barriers. This reflects the inequitable distribution of resources and healthcare access across Nigeria (NPC & ICF International, 2014).

Religious affiliation proved to be a very strong determinant of ANC utilization. Muslim women, predominantly residing in the North, were less likely to use ANC services than Christian women. This disparity may stem from conservative religious norms, limited female autonomy, and gendered barriers to healthcare access in some Muslim communities (Afolabi & Ekrikpo, 2015; Babalola, 2014).

Media exposure positively influenced ANC use, especially in the North. Women who regularly accessed media were more likely to be informed about the benefits of ANC and maternal health services. This shows how much campaign on radio is so important in disseminating health information, particularly in regions where formal education is limited and culture is a strong barrier (Kaphle et al., 2013; Adewuyi et al., 2018).

Higher parity was negatively associated with ANC utilization, especially in the North, where women with four or more children had significantly lower odds of seeking ANC. This may be due to perceived self-sufficiency, reduced perceived need, or greater household responsibilities (Bbaale, 2011). Urban residence was a strong predictor of ANC attendance across both regions, underscoring the disparity in service availability between rural and urban settings and the need for improved rural healthcare infrastructure (Okonofua et al., 2018).

5. Conclusion

This study has gone a long way to show that the Southern region women are strongly more advantaged than the Northern women with respect to ANC utilization. It also goes further to confirm the existence of regional disparities in ANC utilization between the two zones that many authors

ISSN NUMBER: 1116-249X

have earlier reported . Education, wealth, media exposure, religion, and urban residence have been found to be strong drivers of ANC utilization in both Northern and Southern regions. However, the effects have been shown to be stronger in the North, particularly in the core Northern states. The core North is an area known for stronger barriers to care, socially, culturally and economically when compared with the middle belt zone. To this end, appropriate institutions should see it as a point of duty to pursue policies that will enhance region-specific interventions, if these disparities will be addressed. In Northern Nigeria, strategies should include cultural sensitization, religious engagement, expansion of rural healthcare infrastructure, and female empowerment initiatives. In Southern Nigeria, efforts should focus on strengthening service delivery in under-performing states and addressing residual structural inequalities. Investments in education, economic empowerment, and health system should therefore as a matter of priority be strengthened all over the country in order to improve ANC utilization and achieve equitable maternal health outcomes.

6.0 Limitations.

One of the limitations of this study is that the data is cross-sectional in nature and therefore cannot be used for causal inferences. Also, despite the more complete geographic coverage that NDHS 2013 provides, it is still an older dataset compared to NDHS 2018, and therefore cannot be used to capture the change in the health system in the past decade. It is however noteworthy to state that this study primarily aims to demonstrate a methodological framework rather than provide real-time policy recommendations. Future work in this area should therefore consider addressing this approach to NDHS 2018 dataset or subsequent surveys to assess how spatial patterns have evolved over time.

References

Abimbola, S., Okoli, U., Olubajo, O., Abdullahi, M. J., & Pate, M. A. (2012). The Midwives Service Scheme in Nigeria. *PLOS Medicine, 9*(5), e1001211. https://doi.org/10.1371/journal. pmed. 1001211

Adedini, S. A., Odimegwu, C., Imasiku, E. N., Ononokpono, D. N., & Ibisomi, L. (2014). Regional variations in infant and child mortality in Nigeria: A multilevel analysis. *Journal of Biosocial Science, 47*(2), 165–187.

Adewuyi, E. O., Auta, A., Khanal, V., Tapshak, S. J., & Zhao, Y. (2018). Cesarean delivery in Nigeria: Prevalence and associated factors—A population-based cross-sectional study. *BMJ Open, 9*(6), e027273. https://doi.org/10.1136/bmjopen-2018-027273

ISSN NUMBER: 1116-249X

Adewuyi, E. O., Zhao, Y., Lamichhane, R., & Okekunle, A. P. (2018). Risk factors for nonuse of antenatal care services: A disaggregated analysis of 2013 Nigeria Demographic and Health Survey. *BMC Pregnancy and Childbirth, 18*(1), 1–14. https://doi.org/10.1186/s12884-018- 1928-4

Adewuyi, E. O., et al. (2024). [Assumed updated publication on ANC utilization disparities in Nigeria].

Afolabi, B. M., & Ekrikpo, U. E. (2015). Sociocultural factors influencing the use of maternal health services in rural Nigeria. *African Journal of Reproductive Health, 19*(3), 82–90.

Babalola, S. (2014). Women's use of health services in Nigeria: The role of autonomy, educational status, and place of residence. *African Population Studies, 28*(1), 524–535. https://doi.org/10.11564/28-1-526

Bbaale, E. (2011). Factors influencing the utilization of antenatal care content in Uganda. *Australasian Medical Journal, 4*(9), 516–526. https://doi.org/10.4066/AMJ.2011.849

Besag, J., York, J., & Mollié, A. (1991). Bayesian image restoration, with two applications in spatial statistics (with discussion). *Annals of the Institute of Statistical Mathematics, 43*(1), 1–59. https://doi.org/10.1007/BF00116466

Doctor, H. V., Findley, S. E., Ager, A., Cometto, G., Afenyadu, G. Y., & Adamu, F. (2011). Using community-based research to shape the design and delivery of maternal health services in Northern Nigeria. *Reproductive Health Matters, 19*(37), 44–55 https://doi.org/10.1016/S0968-8080(11)37564-1

Fagbamigbe, A. F., & Idemudia, E. S. (2015a). Assessment of quality of antenatal care services in Nigeria: Evidence from a population-based survey. *Reproductive Health, 12*(1), 88. https://doi.org/10.1186/s12978-015-0081-0

Fagbamigbe, A. F., & Idemudia, E. S. (2015b). Barriers to antenatal care use in Nigeria: Evidence from non-users and implications for maternal health programming. *BMC Pregnancy and Childbirth, 15*, 95. https://doi.org/10.1186/s12884-015-0537-z

ISSN NUMBER: 1116-249X

Fahrmeir, L., Kneib, T., Lang, S., & Marx, B. (2013). *Regression: Models, methods and applications*. Springer. https://doi.org/10.1007/978-3-642-34333-9

Kaphle, S., Hancock, H., & Newman, L. A. (2013). Childbirth traditions and cultural perceptions of safety in Nepal: Critical spaces to ensure the survival of mothers and newborns in remote mountain villages. *Midwifery, 29*(10), 1173–1181. https://doi.org/10.1016/j.midw.2013.06.004

Lang, S., & Brezger, A. (2004). Bayesian P-splines. *Journal of Computational and Graphical Statistics, 13*(1), 183–212. https://doi.org/10.1198/1061860043010

Lawn, J. E., Kinney, M. V., Black, R. E., et al. (2014). A decade of change for newborn survival, policy and programmes. *The Lancet, 384*(9938), 993–1007. https://doi.org/10.1016/S0140- 6736(14)60496-5

Magadi, M. A., Madise, N. J., & Rodrigues, R. N. (2000). Frequency and timing of antenatal care in Kenya: Explaining the variations between women of different communities. *Social Science & Medicine, 51*(4), 551–561. https://doi.org/10.1016/S0277-9536(99)00495-5

Mberu, B. U., & Reed, H. E. (2014). Understanding subgroup fertility differentials in Nigeria. *Genus, 70*(1), 81–112. https://doi.org/10.4402/genus-648

National Population Commission (NPC) [Nigeria], & ICF International. (2014). *Nigeria demographic and health survey 2013*. NPC and ICF International.

National Population Commission (NPC) [Nigeria], & ICF. (2019). *Nigeria demographic and health survey 2018*. NPC and ICF.

Nwosu, C. O., Ataguba, J. E., & Oyenubi, A. (2019). Socioeconomic inequalities in maternal health service utilisation: A case of antenatal care in Nigeria using a decomposition approach. *BMC Public Health, 19*(1), 1493. https://doi.org/10.1186/s12889-019-7833-x

Okonofua, F., Ogu, R., Agholor, K., Okike, O., Abdus-Salam, R., Gana, M., & Imosemi, D. (2018). Qualitative assessment of women's satisfaction with maternal health care in referral hospitals in Nigeria. *Reproductive Health, 15*(1), 32. https://doi.org/10.1186/s12978-018-0473-z

ISSN NUMBER: 1116-249X

Ononokpono, D. N., & Odimegwu, C. O. (2014). Determinants of maternal health care utilization in Nigeria: A multilevel approach. *Pan African Medical Journal, 17*, Article 2. https://doi.org/10.11604/pamj.2014.17.2.3496

Ononokpono, D. N., Odimegwu, C. O., Imasiku, E. N. S., & Adedini, S. A. (2013). Does it really matter where women live? A multilevel analysis of the determinants of postnatal care in Nigeria. *Maternal and Child Health Journal, 18*(4), 950–959. https://doi.org/10.1007/s10995-013-1324-9

ISSN NUMBER: 1116-249X