Journal of NAMP 71, (2025) 73-84

The Nigerian Association of Mathematical Physics

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

SPATIAL DISTRIBUTION OF PREVALENCE OF ANEMIA AMONG NIGERIAN WOMEN.

Bodunwa, O. K

Department of Statistics, Federal University of Technology, Akure Nigeria

ARTICLE INFO

Article history:
Received xxxxx
Revised xxxxx
Accepted xxxxx
Available online xxxxx

Keywords:
Prevalence,
Anemia,
Spatial,
Binary,
Cumulative model

ABSTRACT

Anemia is a global health problem that excessively affects women in reproductive age in low-and medium income countries among like Nigeria. The prevalence of anemia among women based on household characteristics and the geographical variations of these variables were considered. Data from Nigeria Demographic and Health Survey 2018 for socio-economic status of the women was used from 15-49 years. The relationship between the covariates of different types and possible severity of anemia were modelled two models with spatial analysis. The results revealed that anaemia decreases with increasing education and increasing wealth index also reduces women with anemia. Women living in rural area are at higher risk of being anemic compare with those in urban area. Spatial analysis reveals states in Nigeria that are at highest risk of being anemic for both models. Improving living conditions as well as reducing poverty may contribute to improving the hemoglobin level of affected women.

1 INTRODUCTION

Anemia is a condition in which the number of red blood cells is not sufficient to meet the physiological need of the body. It is also a condition that is marked by low levels of hemoglobin in the blood. Anemia impairs the capacity of blood to transport oxygen around the body and is an indicator of poor nutrition and health [23]. Anemia is a world -wide problem, but disproportionately affecting low- and middle- income countries including Nigeria with young children, women of reproductive age and pregnant women as the most affected population groups [6]. It was estimated that 42% of children less than 5 years of age and 40% of pregnant women are anemic which in turn may contribute to maternal morbidity and mortality worldwide [23]. Causes of anemia include blood loss, iron deficiency, infections, acute and chronic diseases, micronutrient deficiencies, splenomegaly and haemoglobinopathies [4]. Among these, iron deficiency contributes to around 50% of the anemia problem [11]. Evidence has documented the association between anemia and postpartum hemorrhage, preterm labour, low birth weight, small-for-gestational age babies and perinatal death [15].

*Corresponding author: BODUNWA, O. K
E-mail address: okbodunwa@futa.edu.ng
https://doi.org/10.60787/jnamp.vol71no.609
1118-4388© 2025 JNAMP. All rights reserved

A complex interplay of political, ecological, social and biological factors determines the prevalence and distribution of anemia in a population [5].

[9] examined the prevalence of anemia among women of reproductive age in Nepal. It was found that women who were married at the time of the survey, decision making autonomy regarding health care and those who experienced intimate partner violence (IPV) were less likely to be anemic. Prevalence and determinants of anemia in pregnant women receiving antenatal care at a tertiary referral hospital in Northern Ghana was examined by Wemakor [22]. The study showed that there was a high prevalence of anemia that increases with pregnancy trimester in pregnant women attending the tertiary referral hospital.

Nigeria is one of the countries in Sub-Saharan Africa where anemia has remained a problem. The 2018 Nigeria Demographic and Health Survey reveals that, 68% of children aged 6-59 months and 58% of women aged 15 – 49 were anemic. Among the over half (58%) of women with some degree of anemia, about 28% were mildly or moderately anemic and 2% were severely anemic. A study of [13] on anemia prevalence in women of reproductive age in low- and middle -income countries between 2000 and 2018 reported that only three of the countries, exclude Nigeria have high chances of achieving the global nutritional target of a 50% reduction of anemia prevalence by 2030.

There are many literatures on the prevalence of anemia in Nigeria among children and women.
[10] examined the possible determinants and the spatial structure of anemia among under-five children in Nigeria. [21] studied the prevalence of anemia in pregnant women that attended antenatal clinics in Anambra state South East Nigeria. Of the 700 women examined, the study found that 525 had Hb level less than 11gm/dl indicating anemia prevalence of 75%. Similarly, [19] reviewed data on the records of antenatal clinic attendees between 2004 and 2013 to determine the prevalence of anemia in the Niger Delta region for the country. A total of 8,751 pregnant women out of 37,506 were found to be anemic in the nine-year period. The effects of maternal age, educational status, parity, gestational age, haemoglobin genotype and infections on the prevalence of anaemia were investigated Their findings revealed that the prevalence of anaemia at booking was 69.6%, most of whom had moderate anaemia. Anaemia was significantly prevalent in the 10–19-year age group, and in women with secondary education, in their 2nd trimester and with SS genotype. Recent study by [18] showed that the prevalence among all categories of women of reproductive age is high in Nigeria. Their findings anemia prevalence was 57.8%, 57.4%, and 61.1% for women of reproductive age, non-pregnant women and pregnant women, respectively. The prevalence of severe anaemia was 1.6%, 1.5%, and 2.3% for overall women of reproductive age, non-pregnant women, and pregnant women, correspondingly. The southern regions, rural residence, low education, unemployment, low wealth index, and non-use of modern contraceptives significantly increased the likelihood of anaemia and severe anaemia among women of reproductive age and non-pregnant women. It is known that some key social determinants, especially social and demographic factors such as the education status, wealth index, and family size, can affect various medical conditions. Studies that examine the prevalence and/or determinants of anaemia, at a national level in Nigeria most especially study that shows the severity of anemia have not been adequately undertaken. Moreover, no attempt has been made to unravel the spatial pattern of anaemic status of women of reproductive age. Available reports on the geographical distribution of anaemia across Nigeria are based on the six geopolitical regions and show the existence of geographical variation. This has been
found to be too coarse to allow for detailed discussions of spatial effects, as spatial effects of states within the same region can vary widely [16]. Therefore, this paper aims at modelling the prevalence of anemia among women of reproductive age in Nigeria with the view of examining

the possible relationship between the severity of anaemia with individual and household characteristics of women aged 15-49 years and the possible geographical variations at a disaggregated state level in Nigeria. A Bayesian modelling technique, which is a best approach that allows for joint modelling of fixed effects, nonlinear effects of metrical covariate and spatial effect, while at the same time controlling for the hierarchical nature of the data via random effects, was adopted.

METHODOLOGY

Data

The study uses data from the 2018 Nigeria Demographic and Health Survey (NDHS), which was implemented by the National Population Commission (NPC) in collaboration with the National Malaria Elimination Programme (NMEP) of the Ministry of Health, Nigeria. Data collection took place from 14th August to 29th December 2018. The sample for the 2018 NDHS was a stratified sample selected in two stages. Stratification was achieved by separating each of the 36 states and the Federal Capital Territory into urban and rural areas. In total, 74 sampling strata were identified. Samples were selected independently in every stratum via a two-stage selection. Due to the non-proportional allocation of the sample to the different states and the possible differences in response rates, sampling weights were calculated, added to the data file, and applied so that the results would be representative at the national level as well as the domain level. The survey included all women aged 15-49 in the sampled households. Those who were either permanent residents of the selected households or visitors who stayed in the households the night before the survey were interviewed. The survey includes the height and weight for women aged 15-49 and children aged 0-59 months, haemoglobin testing for women age 15-49 and children age 6-59 months were also done. This dataset is considered more appropriate because it contains detailed information about the prevalence of anemia from women of reproductive age (15 -49 years). The total number of women considered in this study were 14750. Blood samples for anaemia testing were obtained from a drop of blood taken from a finger prick. A drop of blood from the prick site was drawn into a microcuvette, and a haemoglobin analysis was carried out on-site with a battery-operated portable machine. Nonpregnant women and pregnant women were referred for follow-up care if their haemoglobin levels were below 8 g/dl and 7 g/dl, respectively [23]. Administratively, Nigeria is divided into six geopolitical zones with each comprising about six states (totaling 36 states) and a Federal Capital Territory (FCT), Abuja.

Measurement of variables

Dependent variable: anemia status at the time of the survey is the dependent variable. According to the WHO, for non-pregnant women aged ≥15 years, anemia was defined as blood hemoglobin level <12.0 g/ dL, which was further categorized as mild (11.0–11.9 g/dL), moderate (8.0–10.9 g/dL), and severe anemia (<8.0 g/dL); for pregnant women, any anemia was defined as blood haemoglobin level <11 g/dL, and further categorized as mild (10.0–10.9 g/dL), moderate (7.0–9.9 g/dL), and severe anemia (<7.0 g/dL)

Independent variables: predictors of anemia were chosen based on the array of literature pertaining to anemia study in a low- and middle-income countries. These include wealth index of the woman (poorest, poorer, middle, richer and richest), the type of place of residence (rural and urban), educational level of the woman (primary, secondary, high and others, which are those that do not complete primary or not attend at all), marital status (ever in union / not in union), possess mosquito net (yes / no), currently working (yes / no), source of water (unprotected / protected), ever had terminated pregnancy (yes / no), ethnicity categorized into Yoruba, Hausa-Fulani, Ibo and others, breastfeeding status, distance to a health facility, and age of the woman. The state of residence of the women was used as the spatial covariate.

Data analysis

In this study, two outcome variables were considered. The first was on a dichotomous variable that classifies the women into anemic (for any level) or not anemic. This was assumed to follows a binomial distribution whose dependence and effect on a predictor of interest is modelled through a Probit model. The second outcome variable considered a four-level ordered categorical variable that categorized the women according to the severity of anemia: severe, moderate, mild and not anemic (normal). This was modelled assuming a cumulative Probit model. The regression problem was considered with observations $(y_{ij}\ x_{ij}\ s_{ij}\ v_{ij})\ i = 1, \cdots, 14750;\ j = 1, 2$ with y_i being binary or ordered categorical; x_i the metrical covariate effect of a woman's age, $s \in (1, \cdots 37)$; the spatial covariate of the district (state) where the woman resided in Nigeria during the survey and a categorical covariate vector $v = (v_{i1}, \cdots, v_{ik})'$ whose effect was modelled parametrically.

The regression models for the analysis is represented as:

$y_i = \eta_i + \varepsilon_i$ where η_i is the predictor and ε_i is the random error term. The predictor can be linked to the available covariates as follows:

$$\eta_i = f(x_i) + f_{spat}(s_i) + v_i'\gamma \quad (1)$$

Where $f(x_i), f_{spat}(s_i)$ and γ represent the unknown nonlinear smoothing effects of metrical covariate x (woman's age), spatial effect and a vector of fixed effect parameters respectively [8]. The following two models were examined.

Model 1: A bivariate logistic regression analysis was considered for the binary variable created to represent the women as being anemic or not. According to WHO, pregnant women from age 15 are considered anemic if their Hb <11.0g/dl and <12.0g/dl for non-pregnant women. Thus, a binary response variable (y_{11}) was created as

$$(y_{11}) = \begin{cases} 1: \textit{if the woman is anemic} \\ 0: \quad \textit{otherwise} \end{cases}$$

Model 2: This was used to measure the severity of anemia in women when the anemia test was done. This can be classified as severe, moderate, mild and normal leading to four level ordered categories. The response variable (y_{12}) was constructed as;

$$(y_{12}) = \begin{cases} 1: \textit{no anemia} \\ 2: \textit{mild} \\ 3: \textit{moderate} \\ 4: \textit{severe} \end{cases}$$

Model 1 was influenced by covariates whose determinants were modelled through a binary model assuming a Probit link. Probit model results are qualitatively similar to logit estimates and these are having computational advantages on latent variables [7]. A cumulative Probit model was adopted in fitting the multi-categorical outcome.

Parameter estimation was considered through Bayesian framework such that all parameters and functions are assumed as random variables upon which appropriate priors are assigned. Diffuse priors were assumed for the fixed effect parameters γ while for the unknown (smooth) function, the Bayesian perspective of pernalised splines (P-splines) that for the estimation of the function as a linear combination of basis splines (B-splines), that is $p(z) = \sum_{j=1}^{j} \beta_j \, \beta_j(z)$ where $\beta_j(z)$ are B-splines and the coefficients β_j are further defined to follow a first or second order random walk prior. The spatial effect (s_i) was modelled by assuming the intrinsic conditional autoregressive prior which introduces a neighborhood structure for the area $s_i, s \in (1, 2, \cdots 37)$. This prior defines areas as neighbors if they share a common boundary and consequently proximate areas are assumed to have similar patterns and weight computed based on this. The analysis was performed using BayesX version 2.1

RESULT

Descriptive analysis

Table 1 presents the findings from the descriptive analysis of biosocial and demographic characteristics of the respondent. A total of 16,750 women were included in the study of which 1,525 (10.4%) were pregnant. The Table shows that 1.54% of the women had severe anemia while 29.1% had moderate anemia, 27.4% had mild and the remaining had no anemia. The wealth index of the women reveals that the prevalence of anemia among the surveyed women from poorest household was 2.1% compared with 0.98% for those from the richest household. Altogether, 58.8% of the respondents resided in rural areas while the rest lived in urban areas. The findings show that the prevalence of anemia among Nigeria women living in rural areas was higher compared with those in urban areas for all the levels of anemia.

The educational level of the surveyed respondent was another factor where severity of anemic was directly associated with the women with no education compared with those having higher education. Majority of the women who were mildly anemic attained higher education.

There seems no difference in other variables used in this study on the prevalence of anemia among Nigeria women except for the ethnicity which shows that Yoruba tribe are less severely anemic compared to those in other tribes.

The pregnancy status of the surveyed women was also presented. The total number of pregnant women were 10.3% which implies that majority of the respondents were not pregnant as at the time of the survey. The respondents residing area still shows that those in rural area are more prone to have anemia compared with living in urban area.

Table 1: Results of descriptive analysis for the characteristics of respondents

		Status		Anemia prevalence			
Variables	Overall	Pregnant	Not Pregnant	Severe	Moderate	Mild	Normal
Total	14, 750 (100)	1525 (10.4%)	13,225 (89.6%)	227	4286	4044	6193
Wealth index							
Poorest	2535 (17.2)	244	2191	52 (2.1)	901 (35.4)	704 (27.8)	878 (34.6)
Poorer	2848 (19.3)	360	2488	50 (1.8)	911(31.9)	788 (27.7)	1099 (38.6)
Middle	3276 (22.2)	338	2938	51 (1.6)	945 (28.9)	924 (28.2)	1356 (41.39)
Richer	3251 (22.0)	273	2978	46 (1.5)	904 (27.8)	868 (26.7)	1433 (44.1)
Richest	2840 (19.3)	210	2630	28 (0.98)	625 (22.0)	760 (26.8)	1427 (50.2)
Residence							
Rural	8,665 (58.8)	985	7681	160 (1.8)	2718 (31.4)	2410 (27.8)	3378 (38.9)
Urban	6084 (41.2)	540	5544	67 (1.2)	1568 (25.8)	1634 (26.9)	2815 (46.3)
Education							
No education	4,758 (32.3)	666	4092	97 (2.0)	1617 (33.9)	1321 (27.8)	1723 (36.2)

Primary Secondary High	2,358 (15.9) 6, 156 (41.8) 1,478 (10.0)	216 520 123	2142 5636 1355	42 (1.8) 75 (1.2) 13 (0.9)	669 (28.4) 1699 (27.6) 301 (20.4)	648 (27.5) 1681 (27.3) 394 (26.7)	999 (42.4) 2701 (43.9) 770 (52.1)
Marital status Never in Union Married	3,432 (23.3) 11,318 (76.7)	31 1494	3201 10,024	37 (1.1) 190 (1.7)	928 (27.0) 3358 (29.7)	979 (28.5) 3065 (27.1)	1488 (43.4) 4705 (41.6)
Mosquito net No Yes	4,971 (33.7) 9,779 (66.3)	457 1068	4514 8711	66 (1.3) 161 (1.6)	1428 (28.7) 2858 (29.2)	1399 (28.1) 2645 (27.0)	2078 (41.80 4115 (42.1)
Currently working No Yes	5,030 (34.1) 9,720 (65.9)	560 965	4470 8755	81 (1.6) 146 (1.5)	1533 (30.5) 2753 (28.3)	1439 (28.6) 2605 (26.8)	1977 (39.3) 4216 (43.4)
Source of water Unprotected Protected	6105 (41.4) 8645 (58.6)	714 811	5391 7834	86 (1.4) 141 (1.6)	1869 (30.6) 2417 (27.9)	1671 (27.4) 2373 (27.4)	2479 (40.6) 3714 (42.9)
Terminated-Pregnancy No Yes	12,912 (87.5) 1,838 (12.5)	1,270 255	11642 1583	200 (1.5) 27 (1.5)	3726 (28.9) 560 (30.5)	3559 (27.6) 485 (26.4)	5427 (42.0) 766 (41.7)
Ethnicity Others Yoruba Hausa-Fulani Ibo	5,798 (39.4) 2,053 (13.9) 4,424 (29.9) 2,475 (16.7)	547 154 619 205	5251 1899 3805 2270	79 (1.4) 14 (0.7) 87 (1.9) 47 (1.9)	1571 (27.1) 461 (22.5) 1439 (32.5) 818 (33.1)	1543 (26.6) 564 (27.5) 1213 (27.4 724 (29.3)	2624 (45.3) 994 (48.4) 1689 (38.2) 886 (35.8)
Currently Breast feeding No Yes	10,946 (74.2) 3,804 (25.8)	1466 59	9480 3745	160 (1.5) 67 (1.8)	3141 (28.7) 1145 (30.1)	3011 (27.5) 1033 (27.2)	4634 (42.3) 1559 (40.9)
Distance to health facility Big problem Not a big problem	4,048 (27.4) 10,702 (72.6)	472 1053	3576 9649	63 (1.6) 164 (1.5)	1298 (32.1) 2988 (27.9)	1104 (27.3) 2940 (27.5)	1583 (39.1) 4610 (43.1)

Results of the models

Results from the binary and cumulative probit models are presented in Table 2. From the binary model, the results show that as the household wealth increases, the likelihood of being anemic reduces as expected. Women from the richest households were significantly less likely to be anemic compared with those from the poorest households. Results for the poorest wealth quintile were not significant. The estimates also indicate that women who live in urban areas have significantly lower risks of being anemic when compared with those in the rural areas {mean: -0.111; CI: (-0.164, -0.056)}. Women who attained at least secondary level of education are less likely to be anemic compared to those with those that had primary or no education at all. Meanwhile, water source, terminated pregnancy, breastfeeding and distance to health facilities are not significant for women to have anemia. Women who possess mosquito net have lower risk of being anemic compared with those who do not have {mean: -0.052; CI: (-0.099, -0.003)}. Women who were working have significantly lower risks of having anemia compared with those working as at the time of collecting the data {mean: -0.075; CI: (-0.122, -0.0025)}. The results on ethnicity show that Ibo and Hausa-Fulani are more likely to be anemic compared with the other tribes and all are significant. Women who were in union during this survey were significantly more likely to be anemic than those who were not in any union.

Similar findings to the binary Probit model were obtained for cumulative Probit model. However, the results are same except for the women in possession of mosquito net, which has no significant having anemia. Estimates of the threshold parameters θ_1 and θ_2 are for either having anemia or mot as presented in Table 2 alongside the other fixed effects. For interpretation of the results of threshold parameters, higher (lower) values correspond to higher (less) likelihood of being anaemic. For instance, a negative sign of θ_1 signifies a shift on the latent scale to the right side, yielding a lower probability for those with anemia while a positive sign of θ_2 signifies a shift on the latent scale to the left side, yielding a higher probability of those with no anemia categories.

Table 2: Results of fixed effects for Binary and Cumulative Probit models

Variables	**Binomial Probit**		**Cumulative Probit**	
	Mean	95% credible Int.	Mean	95% Credible Int.
Constant	0.288	0.176, 0.401	0.255	0.154, 0.358
Wealth index				
Poorest (Ref)	0		0	
Poorer	-0.025	-0.099, 0.049	-0.019	-0.088, 0.045
Middle	-0.120	-0.202, -0.043	-0.120	-0.189, -0.044
Richer	-0.218	-0.304, -0.128	-0.194	-0.272, -0.120
Richest	-0.346	-0.444, -0.253	-0.331	-0.418, -0.242
Residence				
Rural (Ref)	0		0	
Urban	-0.111	-0.164, -0.056	-0.094	-0.143, -0.043
Education				
No education (Ref)	0		0	
Primary	-0.165	-0.264, -0.060	-0.104	-0.203, -0.011
Secondary	-0.002	-0.073, 0.066	-0.028	-0.089, 0.034
High	-0.053	-0.114, 0.009	-0.040	-0.095, 0.016
Marital status				
Never in Union (ref)	0		0	
Married	0.071	0.002, 0.145	0.085	0.019, 0.151
Possess mosquito net				
No	0			
Yes	-0.052	-0.099, -0.003	-0.041	-0.084, 0.001
Currently working				
No	0		0	
Yes	-0.075	-0.122, -0.025	-0.060	-0.107, -0.016
Source of water				
Unprotected	0		0	
Protected	0.007	-0.041, 0.058	-0.015	-0.058, 0.029
Terminated-Pregnancy				
No	0		0	
Yes	0.037	-0.027, 0.102	0.052	-0.009, 0.111
Ethnicity				
Others	0		0	
Yoruba	0.138	0.026, 0.247	0.131	0.026, 0.236
Hausa-Fulani	0.159	0.087, 0.229	0.166	0.094, 0.234
Ibo	0.166	0.052, 0.276	0.133	0.029, 0.239
Currently Breast feeding				
No	0		0	
Yes	-0.033	-0.085, 0.017	-0.034	-0.079, 0.016
Distance to health facility				
Big problem	0		0	
Not a problem	0.031	-0.022, 0.085	0.039	-0.006, 0.088
θ_1	NA	NA	-0.255	(-0.358, -0.154)
θ_2	NA	NA	0.493	(0.391, 0.593)

Results of nonlinear effects

The nonlinear effects of the women's age for the two models are shown in Figure 1. The nonlinear effects for binary model have a pattern that shows a higher likelihood of being anemic around women aged 15 years but the likelihood reduces to age 25 and thereabout before slightly increasing till age 33 years, and reduces as the women advances in age. The estimates for the cumulative probit model display similar pattern as what was obtained for the binomial model.

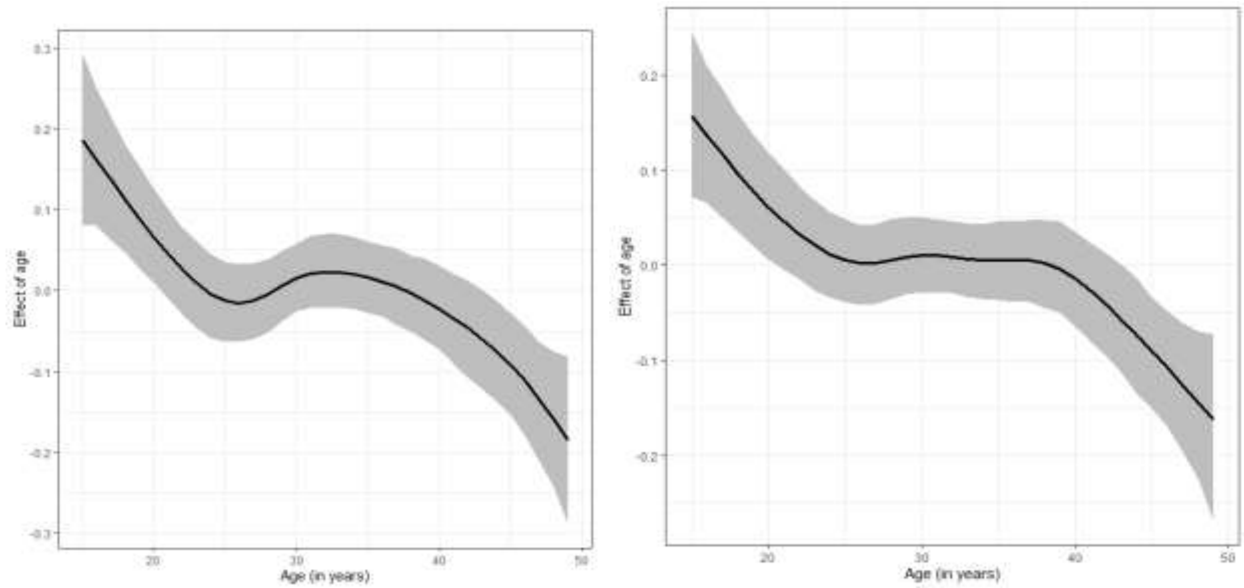
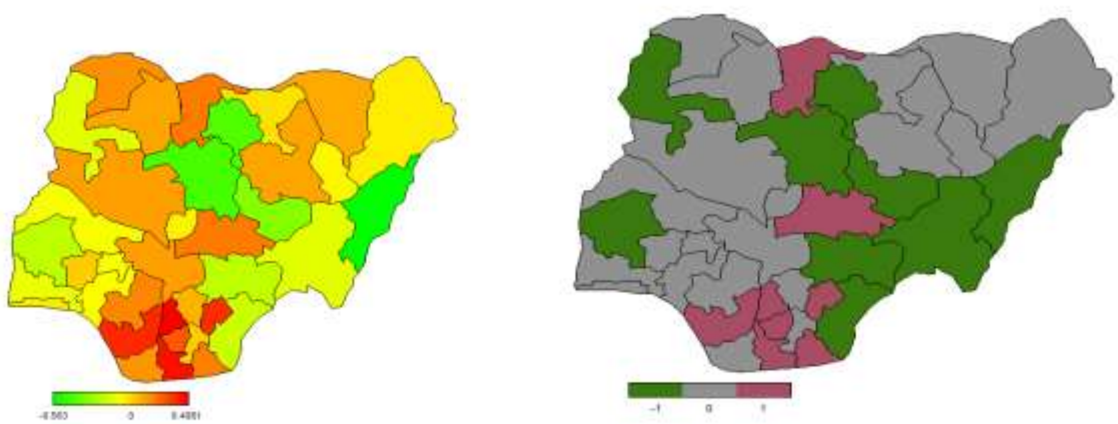
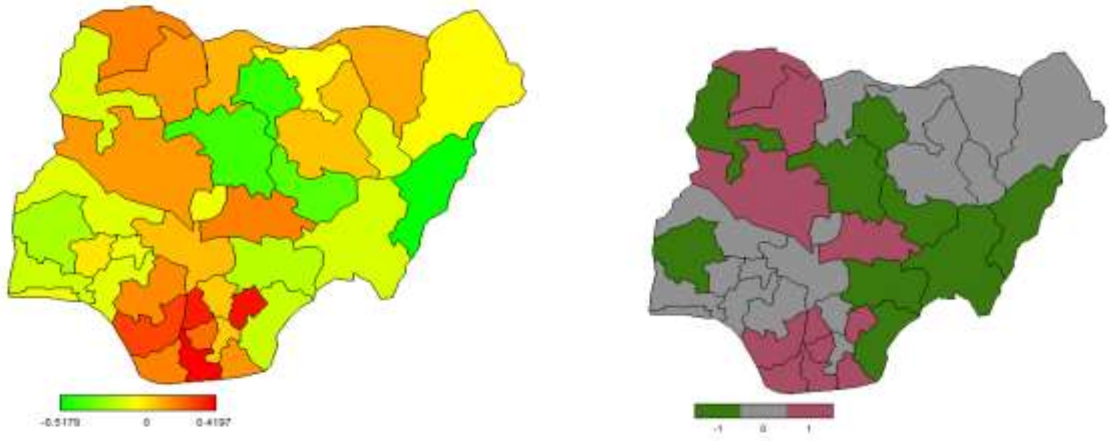


Figure 1: Nonlinear effect of women's age for binary and cumulative probit models

Results of spatial effect



(a) (b)



(c) (d)

Figure 2: Maps of Nigeria showing spatial effects of (a) binary model and (b) its 95% credible interval (c) cumulative model and (d) its 95% credible interval.

Results of the spatial effects for women with anemia are presented in Figure 2. Figures a and c are the maps for posterior means while b and d show the maps of the location of the 95% credible intervals, used in deciding the significance of the posterior mean estimates. From the maps of credible interval, state with pink (green) 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 gray colour (95% credible interval include 0).

Results from binary model showed that women from eight states namely Katsina, Nasarawa, Ebonyi, Akwa Ibom, Rivers, Delta, Imo and Anambra had a significantly higher likelihood of being anemic while those from Kebbi, Kano, Kaduna, Plateau, Adamawa, Taraba, Benue, Cross-River and Oyo were significantly associated lower likelihood.

Similar findings were obtained for the cumulative Probit model. The results showed that women from Sokoto, Zamfara, Niger, Nasarawa, Ebonyi, Akwa Ibom, Rivers, Bayelsa, Delta, Imo and Anambra were significantly associated with a higher likelihood of being anemic while Kebbi, Oyo, Kaduna, Kano, Plateau, Adamawa, Taraba, Benue and Cross-River were significantly associated with non-anemic (normal)

DISCUSSION

Anemia among women is a worldwide health problem. This study measured the prevalence of anemia with the socio-economic status of household where the women resided during the survey. The study also aimed at showing the spatial distribution of the severity of anemia among Nigeria women and therefore offers some insights into the disparity in the prevalence of anemia among Nigeria women. Exploring possible geographical variations in anemia status can helps policy-makers with tools to urgently roll out some guidelines for healthy living among women. From the study, women from Nasarawa, Ebonyi, Akwa Ibom, Rivers, Delta, Imo and Anambra states were significantly associated with higher chances of being anemia which should raise apprehensions of policy-maker in those states. Similarly, behavior maintenance intervention is needed in those states where lower likelihood of being anemic were recorded like Kebbi, Kano, Kaduna, Plateau, Adamawa, Taraba, Benue, Cross-River and Oyo state. Generally, findings on the spatial effects have shown that neighboring states at different geo-political zones of the country shared similar patterns. This may be partly explained by communal cultural norms that affect women, general healthcare practices and belief as well as other residual spatial variations influenced by unexplained state-specific trials. In some Nigerian state, ignorance and nonchalant attitude towards the healthcare even during pregnancy influence the health status [2]. A good understanding of possible causes and geographical distribution of anemia among women in Nigeria is needed in designing appropriate intervention approaches to reverse and turn the tide of all anemia related occurrence in this target group [10].

The socio-economic status of the women was significantly associated with the severity of anemic status. Place of residence reveals that women dwelling in the rural area were significantly associated with a higher likelihood of being anemic. The finding is similar to what had been confirmed from other studies ([18]; [17]). This might be due to the fact that having a low income would mean having less money to buy nutritious foods or have a balanced diet which, in turn, leads to inadequate nutrient intake and nutritional status [14]

Likewise, it was found in this study that there is variation of the anemia rate in terms of education status of the women. A higher proportion of anemia cases were observed among women who did not have formal education had high significant of being anemic than those with higher education. This is consistent with other studies conducted in some countries ([3]; [1]; [12]). A higher proportion of anemic cases were observed among women in the poorest wealth quantile. The lowest wealth quantile compared with highest quantile was associated with a higher risk of anemia. Results of this study show that women who were in the poorest wealth quantile were more likely significant too be anemic compared with those that belong richest quantile. This is in line with the results of [18].

The non-linear effect of the women's age indicates a higher likelihood of being anemic around age 15 years, the likelihood reduces to age 25 and thereabout, later increases till age 33 years and reduces as the women advances in age for both models used in this study. Women aged 40-49 years had a lower likelihood of being anemic compared with women aged between 15-19 years, these findings are in line with other studies. This could be due to the fact that low fertility rates occurred in this age group [20]. This study did not provide evidence of an association between the marital status, working status, terminated pregnancy with women being likelihood of anaemic. Sources of water has no effect on women being anemic. This is unlike the report of [18]. This may be due to different data used in carrying out the study.
The results from the two models shows that that the output for the binomial and cumulative probit models are consistent for the fixed, non-linear and spatial effects. The results from the fixed effect shows that the women from poorest family are at higher risk of being anemic for both models. Women with high education are less likely to be anemic. The results from nonlinear effect, it was found that from age 30 the likelihood of being anemic reduces as the woman advances in age. From the spatial effect, women from south-south are at higher risk of being anemic with some state in the North.

CONCLUSION

The prevalence of anemia among Nigeria women constituted a severe public health problem. The socio-economic status increased the likelihood of being anemic among women in the low- and middle- income countries especially Nigeria [19] confirmed this from their findings. The major findings different from the recent work on the prevalence of anemia in Nigeria among women is the study of spatial effects which shows from this study the trend in each state of the country the severity of anemia among women. The control of anemia is often overlooked, Nigeria health authority needs to consider subnational level variations and give priority to the people most in need when designing interventions and allocating resources. Improving living conditions as well as reducing poverty may contribute to improving the hemoglobin level of affected women.

REFERENCES

[1] Alaofe, H., Burney , J., & Naylor, R. (2017). Prevalence of anemia, deficiencies of iron and vitamin A and thier determinanats in rural women and young children: a cross-sectional study in Kalale of Northern Benin. *Public Health Nutr*, 1203-13.

[2] Babalola, S., & Fatusi, A. (2009). Determinants of use of maternal health services in Nigeria - looking beyond individual and household factors. *BMC Pregnancy and Childbirth*.

[3] Balarajan, Y., Fawzi, W., & Subramanian, S. (2013). Changing patterns of social inequalities in anemia among women in India; cross-sectional study using nationally representative data. *BMJ Open*.

[4] Bates, I., Mckew, S., & Sankinfada, F. (2007). Anaemia : a useful indicator of neglected disease burden and control. *PLoS Med* , 41285-90.

[5] Bslarajan, Y., Ramakrishman, U., Ozaltin, E., Shankar, A. H., & Subramanian, S. V. (2011). Anemia in low-income and middle- income countries. *The Lancet*, 2123-35.

[6] Elmardi, K. A., Adam, I., Malik, E. M., Abdelrahim, T. A., Elhag, M. S., Ibrahim, A. A., . . . Kremers, S. (2020). Prevalence and determinants of anemia in women of reproductive age in Sudan: analysis of a cross-sectional household survey. *BMC Public Health*.

[7] Fahmeir, L., & Tutz, G. (2001). Multivariate Statistical Modelling based on Generalised Linear Models . *Springer, New York*.

[8] Fahrmeir, L., & Lang, S. (2001). Bayesian semiparametric regression analysis of multicategorical time-space data. *Ann. Inst Stat Math*, 10-30.

[9] Gautam, S., Min, H., Kim, H., & Jeong, H. S. (2019). Determining factors for the prevalence of anemia in women of reproductive age in Nepal: Evidence from recent national survey dat. *PLos ONE*.

[10] Gayawan, E., Arogundade, E. D., & Adebayo, S. B. (2014). Possible determinants and spatial paterrns of aneamia among young children in Nigeria: A Bayesian semi-parametric modelling. *Int Health*, 35-45.

[11] Jin, L., Yeung, L. F., Cogswell, M. E., Berry, R. I., & Lui, J. (2010). Prevalence of anaemia among pregnant women in South-East China, 1993 - 2005. *Public Health Nutr*, 131511-8.

[12] Kibret, K., Chojenta, C., & D'Arcy, E. (2018). Spatial distribution and determinat factors of anemia among women of reproductive age in Ethiopia: a multilevel and spatial analysis. *BMJ Open*.

[13] Kinyoki, D., Osgood-Zimmerman, A. E., & Bhattacharjee, N. V. (2021). Anemia prevalence in women of reproductive age in low and middle-income countries between 2000 and 2018 . *Nat Med* , 1761 - 1782.

[14] Kuche, D., Singh, P., & Moges, D. (2015). Nutritional status and associated factors among pregnant women in Wondo genet district, Southern Ethiopian. *Journal of Food Science and Engineering*.

[15] Nair, M., Choudhury, M. K., Choudhury, S. S., Kakoty, S. D., Sarma, U. C., & Webster, P. (2016). Association between maternal anemia and pregnancy outcomes: a cohort study in Assam, India. *BMJ Glob Heal.*

[16] NPC, N. I. (2012). Nigeria Malaria Indicator Survey 2010. Abuja, Nigeia: National Population Commission [Nigeria] National Malaria Control Programme [Nigeria] and ICF International.

[17] Ogbuabor, D. C., Ogbuabor, A. O., & Ghasi, N. (2022). Determinants of anaemia prevalence in women of reproductive age in Nigeri: A cross-sectional study using secondary data from Nigeria Demographic and Health Survey 2018. *Women's Health*.

[18] Ogunsakin, R., Akinyemi, O., Babalola, B., & Adetoro, G. (2021). Spatial pattern and deteninants of anemia among women of childbearing age in Nigeria. *Spatial and Spatio-temporal Epidemiology*.

[19] Okoh, D. A., Iyalla, C., Omunakwe, H., Iwo-Anah, R. S., & Nwabuko, C. (2016). A retrospective study of the prevanlence of anaemia in pregnancy at booking in Niger Delta, Nigeria. *Journal of Obstetrics and Gynaecology*.

[20] Tay, S., Nani, E., & Walana, W. (2017). Parasitic infections and maternal anemia among expectant mothers in the Dangme East District of Ghana. *BMC Res Notes*.

[21] Ukibe, S. N., Ikeako, L. C., Mbanugo , J. I., Obi-Okaro, A. C., & Ukibe, N. R. (2013). Prevalence of Anemia in pregnant women attending antenatal clinics in Anambra State South-Eastern Nigeria. *International Journal of Advanced Research*, 65-69.

[22] Wemakor, A. (2019). Prevalence and determinants of anemia in pregnant women receiving antenatal care at a tertiary referral hospital in Nortern Ghana. *BMC Pregnancy and Childbirth*.

[23] WHO. (2015). *Global Prevalence of Anaemia in 2011.* World Health Organization .