Novelty Journals

ISSN 2394-7330

International Journal of Novel Research in Healthcare and Nursing
Vol. 10, Issue 3, pp: (420-425), Month: September - December 2023, Available at: www.noveltyjournals.com

Investigating the Risk Factors Associated with Anemia among Women of Reproductive Age and Children in Northwestern Nigeria

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DOI: https://doi.org/10.5281/zenodo.10370842

Published Date: 13-December-2023

Abstract: **Anaemia is defined as a lower than normal level of hemoglobin in the blood. Normal levels of hemoglobin are different for pregnant women, non-pregnant women, men, child etc. The prevalence of anaemia based on the studies conducted from 1993 to 2005 was 24.8 percent and it affected 1.62 billion people worldwide. It is one of the global widespread public health and nutritional problems affecting both developing and developed countries, and occurs at all stages of life cycle but it is prominent in pregnant women, young and other women of reproductive age. According to the 2011 EDHS data the prevalence of anaemia is 17 percent among North-Western Nigerian women aged 15-49. The objective of this study was to identify determinants of anaemia levels among women of reproductive age (between 15 and 49) in North-Western Nigeria using the 2011 EDHS data. To achieve the objective of this study descriptive statistics, chi-square test of association and partial proportional odds model and related tests were used for data analysis using socio-ecsonomic, demographic and health related variables as explanatory variables and anaemia levels of reproductive age of women as the response variables. The result of the analysis revealed that the variables education level, region, parity, pregnancy status, body mass index, place of residence, contraceptive methods and marital status were found to be significant determinants of anaemia levels among women in the reproductive age group in North-Western Nigeria and from the result it also suggested that pregnant women were more likely to be moderate anaemic and severe anaemic than none pregnant women. Women who had a large number of children were found to be more likely of being mild anaemic than those who had no child. Rural resident women were more likely of being mild, moderate and severe anaemic than urban resident.**

Keywords: **Anaemia, logistic regression, Northwestern Nigeria and WHO.**

1. INTRODUCTION

1.1 Background of the Study

Anaemia remains a serious global public health problem, particularly affecting young children, pregnant women and other women of childbearing age of both developing and developed countries at all stages of life cycle (WHO, 2022a). Anaemia is a medical condition in which the blood lacks enough healthy red blood cells or has low level of haemoglobin resulting in reducing the oxygen flow to the body organs. The most common causes of anaemia are iron-deficiency and other common causes of anaemia include deficiencies in folate, vitamins B12 and A; haemoglobin apathies'; and infectious diseases, such as malaria, tuberculosis, HIV and parasitic infections (WHO, 2022b). The optimal haemoglobin concentration in human body needed to meet physiologic needs varies by altitude, smoking, age, sex, and pregnancy status. Similarly, in women of reproductive age for example, normal haemoglobin concentrations and their corresponding anaemia levels vary for pregnant (<11.0 g/dl) and non-pregnant (<12.0 g/dl). According to (WHO 2022), the prevalence of anaemia in the world based on a recent study conducted in 2019 was 24.8 percent and it affected 1.6 million people worldwide. The estimated prevalence was 41.8 percent women and 30 percent in non-pregnant women, in number, 56 million pregnant women 468 million non-pregnant women was affected (WHO, 2018) so also according to WHO the estimated prevalence of anaemia in developed

and developing countries in pregnant women is 14 percent and 51 percent, respectively. Recent finding suggests that there is a decline in the prevalence of iron deficiency anaemia among industrialized regions but the global prevalence of iron deficiency anaemia among to the expected decline rate (Number et al 2019). WHO estimated that worldwide 41 percent of women are anemic (Stoltzfus, 2020). The aim of this study is to Investigate the Risk Factors Associated with Anemia Among Women of Reproductive Age and Children in Northwestern Nigeria. Specific objectives of the study are: (i) To investigate the determinants of anaemia levels among women of reproductive age in North-Western Nigeria. (ii) To assess the association between background and socio-demographic characteristics and prevalence of anaemia among women of reproductive age in North-Western Nigeria. (iii) To compare the anaemia status in pregnant women and non-pregnant women of North-Western Nigeria.

1.2 Scope and Limitations of the study

The study focuses on analyzing and interpreting secondary data from the 2018 Nigeria Demographic and Health Survey, the 2018 National Nutrition and Health Survey, and the 2018 National Human Development Report. It aims to determine the prevalence and identify determinants of anaemia among women aged 15 to 49 in the North-West Geo-political Zone of Nigeria. The scope is limited to these data sources and relevant information from state ministries of health in the region due to constraints in time and resources.

2. LITERATURE REVIEW

Research conducted by Phillips et al. (2022) on children aged 6–59 months in Nigeria revealed a national anaemia prevalence of 68.1%, with Zamfara state having the highest (84.0%) and Kaduna the lowest (50.0%). The likelihood of anaemia decreased from 82.9% for ages 6–18 months to 60.6% for ages 43–59 months. Children of anaemic mothers had a 10.2% higher chance of anaemia, decreasing with maternal age. State deprivation level also influenced anaemia rates, with mildly deprived states at 67.2% and highly deprived at 79.0%. In pregnant women at Usman Danfodio University Teaching Hospital (UDUTH), Sokoto, Buhari et al. (2016) found a 39.2% anaemia prevalence. Age-specific prevalence varied, with the highest in those ≤ 19 years (50.0%) and ≤ 40 years (100%). Mild anaemia was prevalent (86.0%), attributed to proper antenatal care and good dietary habits. Nwizu et al.'s (2011) study in Kano identified predictors of anaemia in pregnancy, associating low educational attainment, single/divorced status, high parity, late booking, and short pregnancy intervals. A Niger Delta study (Ibrahim et al., 2012) found a 66.7% anaemia prevalence among pregnant women, with age and occupation influencing risk. Bolaji et al.'s (2021) research on children aged 6–59 months nationally reported a 67% anaemia prevalence, linking it to factors like male gender, higher birth order, malaria, diarrhea/fever, wasting, low maternal age/education/BMI, maternal anaemia, geopolitical zone, and low socio-economic status.

3. METHODOLOGY

3.1 Ordinal logistic regression

The model for ordinal logistic regression is often represented as follows:

$$logit\big(P(Y \leq j)\big) = \alpha j - \beta 1x1 - \beta 2x2 - \cdots - \beta pxp \qquad (3.1)$$

The model parameters, including the threshold parameters (αj) and coefficients $(\beta 1, \beta 2, \dots, \beta p)$, are estimated using maximum likelihood estimation.

3.2 Proportional odds model or ordered logit model (POM)

Proportional Odds Model is used for modeling the response variable that has more than two levels with K set of explanatory variables by defining the cumulative probabilities, cumulative odds and cumulative logit for the J-1 categories of the response, this model simultaneously uses all cumulative logits. Let $j = 1, 2, \dots J$ are the ordinal categories of the response variable Y, and the vector of explanatory variable X, and denoted by vector form $X = (x_1, x_2, \dots, x_k)'$. For Y, the response with the J ordinal categories given that of k explanatory variables the individual probabilities are defined as follow;

$$p(y = j/x) = p_j \ ,, for \ j = 1, 2, \dots J \qquad (3.2)$$

$$\pi_j\,(x) \ = \ p(y \ \leq \ j|x) \ = \ p_1 \ + \ p_2 \ + \ \cdots \ + \ p_j, for\, j \ = \ 1, \dots \ , J \ - \ 1$$

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$$odd[\pi_j(x)] = \left(\frac{\pi_j(x)}{1-\pi_j(x)}\right), for\ j\ =\ 1, \dots, J\ -\ 1$$

$$ln(odd[\pi_j(x)]) = ln\left(\frac{\pi_j(x)}{1-\pi_j(x)}\right), for\ j\ =\ 1, \dots, J\ -\ 1 \qquad (3.3)$$

3.3 Generalized ordered logit model (GOM)

The model can be expressed as proposed by Fu (1998) and Williams (2006) as follows:

$$logit[P(Y > X)] = ln\left[\frac{p(Y > j/X)}{p(Y \leq j/X)}\right] = a_j + \beta_{1j}X_1 + \beta_{2j}X_2 + \cdots + \beta_{kj}X_k \qquad (3.4)$$

$$j = 1, 2, \dots, J-1$$

where, a_j are the intercept or cut points and $\beta_{1j}, \beta_{2j}, \dots, \beta_{kj}$ are logit coefficients.

3.4 Partial proportional odds model (PPOM)

The partial proportional odds model (Peterson and Harrell, 1990; Fu, 1998; Williams, 2006) is a natural extension of the proportional odds model, which allows β's to vary across logit equations. The model is given by:

$$logit[p(Y > j/X)] = a_j + \sum_{k=1}^{p_1} \beta_k X_{1k} + \sum_{r=1}^{p_2} \beta_{rj} X_{2r}\ , j = 1, 2, \dots, J-1 \qquad (3.5)$$

3.5 Odds Ratio

The odds ratio, denoted by OR, is defined as the ratio of the odds for Y= 1 to the odds for Y = 0, and is given by the equation

$$OR = \frac{\pi(1)/1-\pi(1)}{\pi(0)/1-\pi(0)} \qquad (3.6)$$

4. ANALYSIS AND RESULT

4.1 Estimation of Parameters

Table 4.1: PPOM model parameter estimates

		Non-anaemic		Mild		Moderate	
Predictors		Coef.	P>z	Coef.	P>z	Coef.	P>z
State	Jigawa	.790	0.000	.790	0.000	.790	0.000
	Kaduna	-.0563	0.636	-.412	0.017	-.440	0.254
	Kano	.052	0.652	.052	0.652	.052	0.652
	Katsina	1.181	0.000	1.606	0.000	2.054	0.000
	Kebbi	-.012	0.925	-.012	0.925	-.012	0.925
	Sokoto	-.564	0.000	-.564	0.000	-.564	0.000
	Zamfara	.110	0.388	.110	0.388	.110	0.388
Residence	Urban	-.448	0.000	-.671	0.000	-1.020	0.000
Education level	Primary	-.221	0.000	-.221	0.000	-.221	0.000
	Secondary and higher	-.204	0.095	-.204	0.095	-.204	0.095
Parity	1-2 children	.215	0.004	.001	0.993	.466	0.114
	3-5 children	.190	0.015	-.025	0.832	.325	0.266
	6 and above	.207	0.011	-.060	0.631	.014	0.965
Pregnancy	Yes (pregnant)	.312	0.000	1.047	0.000	.602	0.009
	Folkloric and	-.010	0.965	-.010	0.965	-.010	0.965

Contraceptive methods	Traditional						
	Modern Methods	-.571	0.000	-.571	0.000	-.571	0.000
BMI	Between 18.5 and24.9	-.178	0.000	-.178	0.000	-.178	0.000
	25.0and Above	-.456	0.000	-.456	0.000	-.456	0.000
Marital status	Married	.138	0.055	.421	0.000	.158	0.531
	Widowed	.320	0.009	.320	0.009	.321	0.009
	Divorced	.065	0.551	.065	0.551	.065	0.551
	Cons	-1.383	0.000	-3.104	0.000	-5.061	0.000

Results of the fitted PPOM are given above. The categories, urban residence, no education, no child, not pregnancy, no use of contraceptive method, marital status single and BMI less than 18.5 were used as reference categories. The table provides a variety of PPOM estimates (estimates, p-value, odds ratios, 95% CI for odds ratios).

4.2 Odds Ratio

Table 4.2: Odds ratio estimates of PPOM for the determinants of anaemia levels

		Non-anaemic		**Mild**		**Moderate**	
Predictors		Odds Ratio	95%CI	Odds Ratio	95%CI	Odds Ratio	**95%CI**
State	Jigawa	2.203	1.749-2.775	2.203	1.749-2.775	2.203	**1.749-2.775**
	Kaduna	.945	.748-1.194	.662	.472-.929	.644	**.302-1.371**
	Kano	1.054	.839-1.323	1.054	.839-1.323	1.054	**.839-1.323**
	Katsina	3.259	2.566-4.140	4.983	3.792-6.548	7.803	**4.969-12.254**
	Kebbi	.988	.771-1.266	.988	.771-1.266	.988	**.771-1.266**
	Sokoto	.569	.445-.728	.569	.445-.728	.569	**.445-.728**
	Zamfara	1.117	.869-1.434	1.117	.869-1.434	1.117	**.869-1.434**
Residence	Urban	.639	.561-.727	.511	.417-.626	.360	**.213-.611**
Education level	Primary	.801	.721-.891	.801	.721-.891	.801	**.721-.891**
	Secondary and Higher	.815	.641-1.036	.815	.641-1.036	.815	**.641-1.036**
Parity	1-2 children	1.240	1.070-1.436	1.001	.791-1.266	1.594	**.894-2.842**
	3-5 children	1.21	1.037-1.411	.975	.770-1.234	1.384	**.781-2.455**
	6 and above	1.230	1.048-1.443	.942	.737-1.203	1.014	**.549-1.873**
Pregnancy	Yes(pregnant)	1.366	1.184-1.577	2.849	2.365-3.431	1.825	**1.160-2.871**
Contraceptive methods	Folkloric and Traditional	.990	.629-1.558	.990	.629-1.558	.990	**.629-1.558**
	Modern Methods	.565	.492-.648	.565	.492-.648	.565	**.492-.648**
BMI	Between18.5 and 24.9	.837	.763-.918	.837	.763-.918	.837	**.763-.912**
	25.0 and above	.634	.523-.767	.634	.523-.767	.634	**.523-.767**
Marital status	Married	1.148	.997-1.322	1.523	1.225-1.894	1.171	**.715-1.920**
	Widowed	1.378	1.084-1.752	1.378	1.084-1.752	1.378	**1.084-1.752**
	Divorced	1.067	.863-1.319	1.067	.863-1.319	1.067	**.863-1.319**
	Cons	.251	.198-.318	.045	.034-.059	.006	**.004-.011**

Here we present the Odds ratio estimates of PPOM for the determinants of anaemia levels (estimates, p-value, odds ratios, 95% CI for odds ratios).

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ISSN 2394-7330

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4.3 Model Selecction

Table 4.3: AIC, BIC for POM, PPOM and GOM

Model	Obs	DF	AIC		BIC	
POM	15,351	27	18,491.86	18,346.76	18,698.11	18,690.52
PPOM						
GOM	15,351	45	18,378.52		18,951.44	
	15,351	75				

Among the three models POM has smallest number of parameters in the final model, and PPOM model also contains fewer parameters than GOM. A model with small AIC is preferred therefore; PPOM has the smallest AIC which is 18,346.76.

4.4 Likelihood ratio test and computed Pseudo R^2

Table 4.4: Likelihood ratio test and computed Pseudo R^2 for POM, PPOM and GOM

Model	Obs	LL (null)	LL (model)	DF	LR chi2	PROB > chi2	Pseudo R^2
POM	15,351	-9841.885	-9218.931	24	1,245.91	0.0000	0.0633
PPOM	15,351	9841.885	9128.382	42	1,427.01	0.0000	0.0725
GOM	15,351	9841.885	9114.26	72	1,455.25	0.0000	0.0739

The model fit statistics (AIC, likelihood ratio (LR) test and Pseudo R^2) for the three models POM, PPOM and GOM are given above.ss

5. CONCLUSIONS

The main objective of this study was to identify determinant of anaemia among women of the reproductive age group in North-Western Nigeria. The variables education level, District, parity (total number of children ever born), pregnancy status, body mass index, place of residence, contraceptive methods and marital status were found to be the significant determinants anaemia. Women from Sokoto State, Zamfara State and Katsina State were at higher risk of being mild, moderate and severe anaemic. Rural residence, low body mass index and widowed women were found to be at higher risk of mild, moderate and severe anaemic. Those who did not use of any contraceptive method were more likely to be mild and moderate anaemic. Women with a larger number of children and had no education were at higher risk of mild anaemic. Pregnancy was found to be a risk factor for women to have moderate and severe anaemic.

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