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Determinants of anaemia prevalence in women of reproductive age in Nigeria: A cross-sectional study using secondary data from Nigeria Demographic and Health Survey 2018

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Abstract

Background: Anaemia disproportionately affects women of reproductive age in sub-Saharan Africa including Nigeria. Yet, community-based studies on the prevalence and determinants of anaemia among women of reproductive age are scarce in Nigeria.

Design: A cross-sectional community-based survey using a nationally representative sample.

Objectives: This study described anaemia prevalence and its associated factors among women of reproductive age, pregnant women, and non-pregnant women in Nigeria.

Methods: We analysed data from the 2018 Nigeria Demographic and Health Survey. Pregnant women with a haemoglobin level less than 11 g/dL and non-pregnant women with a haemoglobin level less than 12 g/dL were considered anaemic. Anaemia was also categorized as mild, moderate, and severe. Pearson's chi-square test was used to evaluate the association between anaemia status and independent variables. All variables with $\rho \leqslant 0.25$ in bivariate analyses were further analysed using complex sample logistic regression.

Results: Anaemia 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. The likelihood of being anaemic was significantly increased by large family size among women of reproductive age and by being underweight among non-pregnant women. The South-East region, rural residence, low education, and unemployment were significantly associated with anaemia among pregnant women. The South-South region and unemployment increased the likelihood of severe anaemia among pregnant women. Short stature significantly reduced the odds of being anaemic and severely anaemic among pregnant women.

Conclusions: Anaemia prevalence among all categories of women of reproductive age is high in Nigeria. Predictors of anaemia prevalence and severity should be considered in policies intended to reduce anaemia among women of reproductive age in Nigeria.

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Introduction

Anaemia is a condition in which the number of healthy red blood cells is decreased, and haemoglobin (Hb), the primary oxygen-carrying molecule in red blood cells, is insufficient to meet the body's physiological needs for oxygen delivery to vital tissues.[1] Anaemia is highly prevalent in low- and middle-income countries (LMICs) and disproportionately affects women of reproductive age (WRA), especially in sub-Saharan Africa.[2,3] In Nigeria, anaemia prevalence among pregnant and non-pregnant women is high.[4,5] Nigeria has also a high prevalence of micronutrient deficiencies.[6] Despite policies and programmes to reduce the anaemia burden among WRA in LMICs, the decrease in anaemia prevalence has been marginal.[2] Only three LMICs, excluding Nigeria, have a high probability of achieving the global nutritional target of a 50% reduction of anaemia prevalence by 2030.[3]

The health and socio-economic impacts of anaemia are huge. Anaemia in pregnant WRA increases the risk of preterm birth, stillbirth, perinatal morbidity, low birth weight, and susceptibility to infection.[2] The risk of maternal death is twice as high in pregnant women with severe anaemia compared with those without severe anaemia.[7] Anaemia is a major direct and indirect cause of maternal mortality and is associated with high foetal wastage in Nigeria.[8] Anaemia among pregnant and non-pregnant WRA results in impaired cognitive functioning, academic and workplace underperformance, and loss of productivity from reduced work capacity.[9,10] Loss of productivity from anaemia, in turn, results in personal income and substantial national economic losses.[9]

Previous community-based studies from sub-Saharan Africa, which included pregnant and non-pregnant women, found three classes of risk factors for being anaemic. The first category, individual maternal risk factors, included current pregnancy status,[11–16] increasing age,[11,13] younger age,[12,14] marital status,[14,17,18] large household size,[17] female-headed households,[14,19] underweight,[11,17,18] high parity,[12–14,19,20] ever had a terminated pregnancy,[14] non-use of modern contraceptives,[12,14,17,18] currently breastfeeding,[13,15] being HIV positive,[13,15,16] and tobacco use.[17] Household and socio-economic risk factors are the second set of factors and included region or province of residence,[4,17,18,20] rural residence,[4,11,13,15,21] urban residence,[14] low education,[4,12–14,16,19] low literacy,[17] being poor,[4,11–14,16–19,21,22] unemployment,[11,14,20] unimproved toilet facilities,[13,14,17] unimproved water source,[4,14,17] and non-use of mosquito bed nets.[17,18] The third group of factors are health service–related factors comprising perceiving distance as a big problem,[14] low intake of iron-folic acid,[15,19] home deliveries,[19] and malaria infection.[16,22] Furthermore, non-use of modern contraceptive,[23,24] rural residence,[24] being married,[24] increasing parity,[24] being poor,[24] unemployment,[24] poor malaria knowledge,[4] malaria infection, and living camp[22] were specific factors associated with being anaemic among non-pregnant women.

Few community-based studies in Africa specifically examined the risk factors among pregnant WRA.[22,25–32] Among pregnant women, the individual risk factors were being unmarried,[33] monogamous families, and high parity.[25,26] The household and socio-economic risk factors comprised being poor,[25,26,31] low education,[19,31] low dietary diversity,[26] unemployment,[27] rural residence,[28,31,32] region of residence,[30,31] and non-use of mosquito bed nets.[28,29] The health service–related risk factors for being anaemic included low intake of iron-folic acid,[19,25–27] pregnancy trimester,[25,26,30] number of antenatal care,[27,30] malaria infection,[22,28,29] and worm infestation.[26,28]

Community-based, Nigerian studies investigating the determinants of anaemia among WRA are scarce. Three existing studies have methodological limitations. One study with a subnational pregnant women sample from one district in Northern Nigeria lacked a predictive model.[27] The two studies, using nationally representative data, did not account for the different risk factors for pregnant women and non-pregnant women.[4,31] These studies also included a narrow set of risk factors for anaemia among the two categories of WRA.[4,31] This article aims to update the evidence about the prevalence and determinants of anaemia and its severity among WRA, and pregnant and non-pregnant women in Nigeria using a logistic predictive model that includes a wider range of individual, household/socio-economic, and health service–related factors.

Methods

Study setting

Nigeria had an estimated population of 195,874,683 **people** and annual population growth of 2.62% in 2018.[34] Nigeria comprises six geopolitical regions, 36 states, and one Federal Capital territory. Each state consists of local government areas (LGAs). Each LGA is composed of wards. Approximately 50.3% of the 2018 population was urban. WRA constituted around 46% of the population.[34]

Study design

This study used a quantitative, cross-sectional design by analysing data from the Nigeria Demographic and Health Survey (NDHS) 2018.

Sampling strategy

The sampling frame consisted of households listed in Nigeria's 2006 Population and Housing Census (NPHC). The primary sampling unit (PSU) consisted of a distinct group of enumeration areas (EAs) from the sampling frame referred to as a cluster. An EA is usually a clearly defined geographic area which groups several households together for population and housing census. A two-stage stratified sampling technique was used to select the households. Each of the 36 states and the Federal Capital Territory was stratified into urban and rural areas, creating 74 sampling strata. In the first stage, 1400 (580 urban and 820 rural) EAs were selected from the sampling strata with probability proportional to EA size. In the second stage selection, 30 households were selected from every cluster through equal probability systematic sampling, resulting in a total sample size of about 42,000 households (Figure 1). One-third of the total sample size of households (14,000) were selected for anaemia testing. Using an estimated proportion of WRA that are anaemic (P = 0.578), design effect (Deft = 1.434), relative standard error ($\alpha = 0.01$), individual response rate ($R_i = 97\%$), household gross response rate ($R_h = 95\%$), and the number of eligible individuals per household (d = 1.032),[35] the sample size in terms of the number of households (n) was calculated using the formula[36]

$$n = Deft^2 \times \frac{(1/P - 1)}{\frac{\alpha^2}{R_i \times R_h \times d}}$$

Data collection

The survey was successfully carried out in 1389 clusters in 36 states and Federal Capital Territory comprising 747 LGAs from August to December 2018. Eleven clusters, with deteriorating law-and-order situations, were dropped during the fieldwork. To prevent bias, no replacements and no changes to the pre-selected households were allowed in the implementing stages. Anaemia testing was conducted for WRA in one-third of sampled households selected through equal probability systematic sampling from the total sample size of 42,000 households. The inclusion criteria were all WRA, either permanent residents or visitors who stayed in the sampled household the night before the survey. Women who did not agree to provide consent and women outside the age of 15–49 years were excluded. A blood sample from a finger prick site was drawn into a microcuvette, and a haemoglobin analysis was carried out on-site with a battery-operated portable HemoCue analyser (HemoCue Hb 301 system, Sweden).

Variables

Dependent variable. Anaemia status at the time of the survey is the dependent variable. Pregnant women with a haemoglobin level less than 11 g/dL and non-pregnant women with a haemoglobin level less than 12 g/dL were considered anaemic.[35,37] Anaemia was categorized as mild (haemoglobin (Hb) of 10.0–10.9 g/dL for pregnant women and 11.0–11.9 g/dL for non-pregnant women), moderate (Hb of 7.0–9.9 g/dL for pregnant women and 8.0–10.9 g/dL for non-pregnant women), and severe (Hb < 7.0 g/dL for pregnant women and <8.0 g/dL for non-pregnant women). The anaemia status of respondents was also recoded into a binary variable as anaemia (mild, moderate, and severe) and no anaemia.

Haemoglobin levels were adjusted for cigarette smoking and for the altitude in EAs that are above 1000 metres.[38] The adjustment was made with the following formula: 'adjust = $-0.032 \times alt + 0.022 \times alt^2$' and 'adjHb = Hb – adjust (for adjust > 0)' where 'adjust' is the amount of the adjustment, 'alt' is the altitude in 1000 feet (converted from metres by dividing by 1000 and multiplying by 3.3), 'adjHb' is the adjusted haemoglobin level, and 'Hb' is the measured haemoglobin level in grammes per decilitre. Regarding smoking adjustment, no adjustment for women who smoked less than 10 sticks per day, while the haemoglobin of women who smoked 10–19, 20–39, and 40 or more sticks of cigarette per day were adjusted by –0.3, –0.5, and –0.7 g/dL, correspondingly.

Independent variables. The variables were grouped into individual maternal characteristics, socio-economic and household characteristics, and health service–related factors based on the conceptual framework for maternal anaemia determinants.[2] The individual characteristics included the age of the respondent, marital status (never in a union, married/living with a partner, and divorced/separated/widowed), family size (<5 and ⩾5), sex of household head (female and male), ever had a termination of pregnancy (yes and no), breastfeeding status (yes and no), body mass index (BMI) (underweight, normal, overweight, and obese), and modern contraceptive use (yes and no). The total children ever born (0, 1, 2–4, and ⩾5) were regrouped into four categories of parity (nulliparity, primiparity, multiparity, and grand multiparity), correspondingly.[39] BMI was converted from a numeric to a categorical variable based on the World Health Organization (WHO) BMI.[35] As BMI is not appropriate for pregnant women, we used stature (height) for all categories of WRA categorized as short stature (<145 cm) and normal (⩾145 cm).[35] The socio-economic and household characteristics included

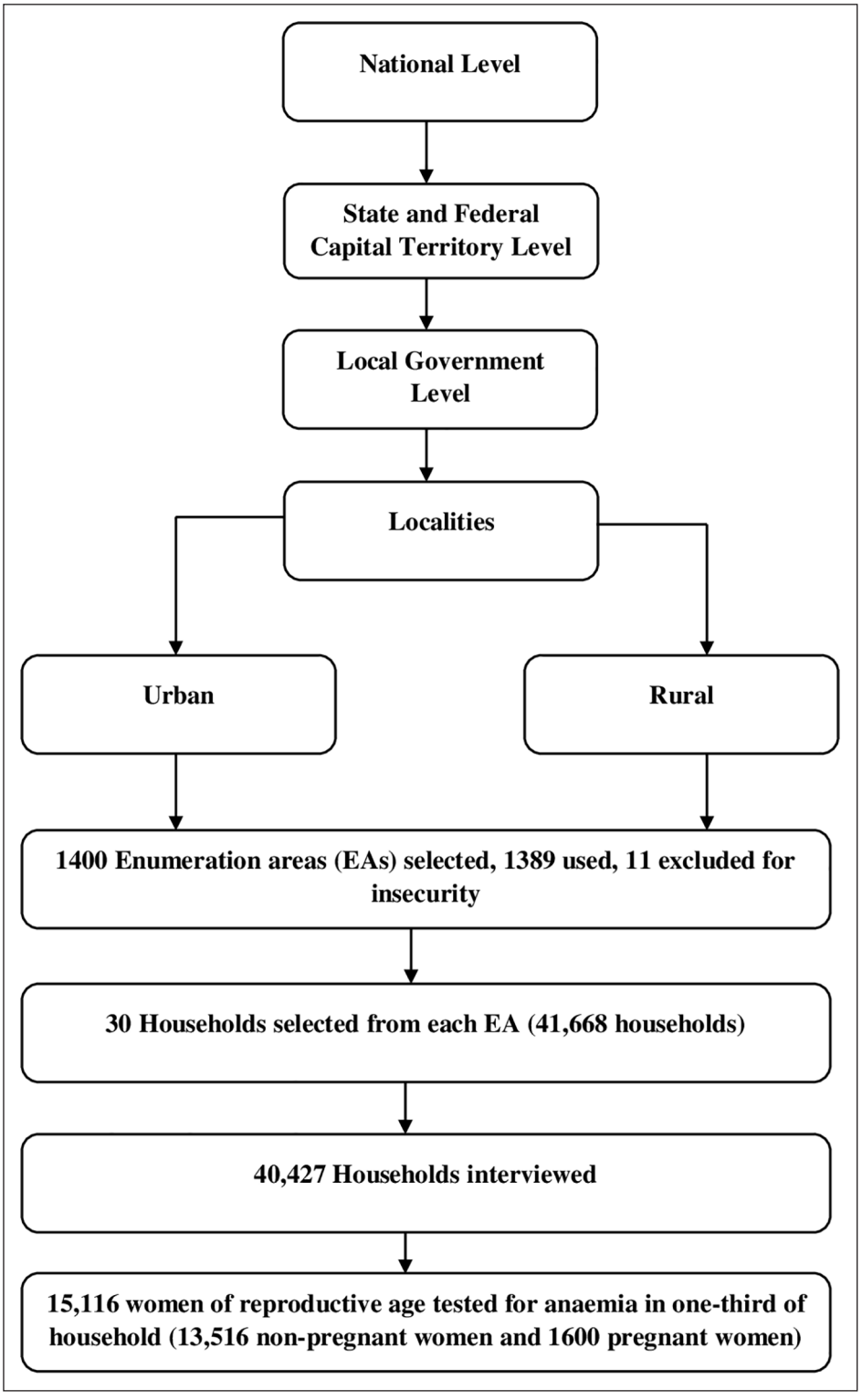

Figure 1. Flowchart for the sampling procedure.

region (North-Central, North-East, North-West, South-East, South-South, and South-West), type of residence (urban and rural), highest education (no education, primary, secondary, and higher), employment (unemployed and employed), wealth index (poorest, poor, moderate, rich, richest), access to sanitation (unimproved and improved), the main source of drinking water (unimproved and improved), ownership of a mosquito bed net for

sleeping (yes and no), respondent having slept under a mosquito bed net the night before the survey (yes and no), and media exposure (none and any form). Based on the consumption of 10 food groups in the 24 h preceding the survey, women were categorized into low (<5) and high diversity (⩾5) groups.[35] The health service–related factor is the extent to which respondents considered the distance to a health facility as a problem (not a problem, not a big problem).

Statistical analysis

Data were analysed using SPSS 20 (IBM Corp., Armonk, NY). We adjusted the data for sampling weights, stratification, and multistage sampling before analysis to account for the non-proportional allocation of the sample to the different states and provide representative population estimates. The basic characteristics of the respondents were presented using frequencies, population estimates, and percentages (weighted). Pearson's chi-square test was used to evaluate the association between anaemia prevalence and independent variables. Multicollinearity was assessed using the variable inflation factor (VIF). The independent variables showed no multicollinearity (minimum VIF = 1.00, maximum VIF = 3.80). All variables with a p value ⩽ 0.25 in bivariate analyses were further analysed using multivariable complex samples logistic regression. In addition, we included age, stature, and parity in the model for pregnant women based on clinical significance. The results of regression analysis were presented by crude/unadjusted odds ratio (COR) and adjusted odds ratio (AOR) with 95% confidence intervals (CIs), F statistics, and p values. The McFadden test statistic for overall WRA, non-pregnant women, and pregnant women ranged from 0.02 to 0.04. Since values ranging from 0.2 to 0.4 indicate good model fit and values beyond 0.4 indicate excellent fit, our models might not be the best fit.[40] However, McFadden test, a log-likelihood-based pseudo-R^2 that represents the improvement in model likelihood over a null model, is influenced by sample size (the smaller the sample size, the higher the value), number of predictor variables, and number of categories of the dependent variable and its distribution asymmetry.[40] Statistical significance for the multivariable complex sample logistic regression analyses was set at $p < 0.05$.

Ethical consideration

The 2018 NDHS protocol was reviewed and approved by the National Health Research Ethics Committee of Nigeria (NHREC) and the ICF Institutional Review Board. Informed consent was obtained from participants before interviews or biomarker tests were conducted. Consequently, our study, being a secondary analysis, did not require further ethical approval.

Results

Characteristics of respondents

The proportion of non-pregnant women (NPW) and pregnant women (PW) included in the study were 89.4% and 10.6%, respectively. The basic characteristics of the respondents are shown in Table 1. About 53%, 52%, and 61% of WRA, NPW, and PW were from rural areas, respectively. Most WRA, NPW, and PW were married/living with a partner (72%, 69%, and 97%), and had a male head of household (83%, 82%, and 90%), correspondingly. About 66% of WRA and NPW each and 63% of PW were employed. Almost 11% of WRA and NPW each, and 8% of PW received higher education. Approximately 44% of WRA, 45% of NPW, and 38% of PW were rich. About 88% of WRA and 87% of NPW did not use modern contraceptives, while approximately 11% of WRA and 12% of NPW were underweight.

Prevalence of anaemia

Overall, about 57.8% (95% CI: 56.7–59.0) of WRA, 57.4% (95% CI: 56.7–58.7) of non-pregnant women, and 61.1% (95% CI: 57.9–64.2) of pregnant women were anaemic. Anaemia prevalence significantly differed with family size, sex of household head, parity, and current use of modern contraceptives among WRA. Among non-pregnant women, anaemia prevalence significantly varied with age, family size, sex of household head, parity, use of modern contraceptives, breastfeeding, and BMI (Table 2). Of all individual women characteristics, anaemia prevalence among pregnant women significantly differed with marital status only (Table 2).

Apart from the type of water source, ownership of a mosquito bed net, and sleeping under a mosquito bed net, anaemia prevalence among overall WRA and NPW significantly differed by other socio-economic and household factors (Table 3). In addition, anaemia prevalence was significantly associated with the region, type of place of residence, education, and access to sanitation among pregnant women (Table 3). Whereas distance to health facility showed no significant association with anaemia prevalence among pregnant women, anaemia prevalence significantly differed by 'distance to health facility' among overall WRA and non-pregnant women (Table 3).

Prevalence of severity of anaemia

The prevalence of mild, moderate, and severe anaemia among all WRA, non-pregnant women, and pregnant women are shown in Table 4. About 1.6%, 1.5%, and 2.3% WRA, NPW, and PW were severely anaemic, correspondingly. Apart from age, sex of household head, ever had a termination of pregnancy, stature, having bed net, slept under bed net, and water, all other variables were

Table 1. Basic characteristics of WRA in Nigeria, 2018.

Characteristics		Overall WRA (15,116)		Non-pregnant women (n = 13,516)		Pregnant women (n = 1600)	
		n	%	n	%	n	%
Region	North-Central	2130	14.1	1902	14.1	228	14.2
	North-East	2282	15.1	2000	14.8	282	17.6
	North-West	4082	27.0	3489	25.8	592	37.0
	South-East	1865	12.3	1706	12.6	159	9.9
	South-South	1889	12.5	1753	13.0	136	8.5
	South-West	2869	19.0	2666	19.7	203	12.7
Age group	15–19	2821	18.7	2648	19.6	173	10.8
	20–24	2378	15.7	2017	14.9	361	22.5
	25–29	2746	18.2	2276	16.8	470	29.4
	30–34	2385	15.8	2068	15.3	316	19.8
	35–39	2147	14.2	1951	14.4	196	12.2
	40–44	1351	8.9	1285	9.5	66	4.1
	45–49	1289	8.5	1270	9.4	18	1.1
Residence	Urban	7057	46.7	6432	47.6	625	39.0
	Rural	8059	53.3	7083	52.4	976	61.0
Marital status	Never in union	3457	22.9	3423	25.3	33	2.1
	Married/living with partner	10,894	72.1	9338	69.1	1556	97.2
	Widowed/divorced/separated	766	5.1	755	5.6	11	0.7
Highest education	No education	5030	33.3	4315	31.9	714	44.6
	Primary	2286	15.1	2076	15.4	210	13.1
	Secondary	6215	41.1	5663	41.9	552	34.5
	Higher	1586	10.5	1462	10.8	124	7.8
Employment	No	5159	34.1	4560	33.7	599	37.4
	Yes	9957	65.9	8955	66.3	1002	62.6
Family size	<5	4820	31.9	4147	30.7	672	42.0
	$\geqslant 5$	10,296	68.1	9368	69.3	928	58.0
Sex of household head	Male	12,544	83.0	11,101	82.1	1443	90.1
	Female	2572	17.0	2414	17.9	158	9.9
Wealth index	Poorest	2555	16.9	2244	16.6	311	19.4
	Poorer	2893	19.1	2544	18.8	350	21.8
	Middle	3021	20.0	2688	19.9	333	20.8
	Richer	3338	22.1	2979	22.0	359	22.4
	Richest	3308	21.9	3061	22.6	247	15.5
Parity	Nulliparity	3800	25.1	3570	26.4	230	14.4
	Primiparity	1812	12.0	1513	11.2	298	18.6
	Multiparity	5020	33.2	4329	32.0	691	43.2
	Grand multiparity	4484	29.7	4103	30.4	381	23.8
Ever had a terminated pregnancy	No	13,226	87.5	11,897	88.0	1329	83.1
	Yes	1890	12.5	1619	12.0	271	16.9
Current modern contraceptive use	No	13,345	88.3	11,744	86.9		
	Yes	1771	11.7	1771	13.1		
Currently breastfeeding	No	11,193	74.0	9664	71.5		
	Yes	3923	26.0	3851	28.5		
Body mass index	Underweight			1565	11.9		
	Normal			7921	60.1		
	Overweight			2389	18.1		
	Obese			1299	9.9		
Stature	Short stature	219	1.5	206	1.5	13	0.8
	Normal stature	14,516	96.0	12,974	96.0	1543	96.4
	Refused/not present/others	381	2.5	336	2.5	45	2.8

(Continued)

Table 1. (Continued)

Characteristics		Overall WRA (15,116)		Non-pregnant women (n = 13,516)		Pregnant women (n = 1600)	
		n	%	n	%	n	%
Water source	Unimproved	5058	33.9	4415	33.1	642	40.6
	Improved	9873	66.1	8931	66.9	942	59.4
Access to sanitation	Unimproved	6476	43.4	5683	42.6	793	50
	Improved	8455	56.6	7664	57.4	792	50
Have mosquito bed net	No	5132	34	4659	34.5	473	29.5
	Yes	9984	66	8856	65.5	1128	70.5
Respondent slept under mosquito bed net	No	7933	52.5	7267	53.8	666	41.6
	Yes	7183	47.5	6248	46.2	934	58.4
Distance to health facility	Big problem	3901	25.8	3439	25.4	463	28.9
	Not a big problem	11,214	74.2	10,077	74.6	1138	71.1
Media exposure	None	8163	54	7229	53.5	934	58.3
	Any form	6953	46	6286	46.5	667	41.7
Dietary diversity	Low	10,943	72.4	9752	72.2	1191	74.4
	High	4173	27.6	3764	27.8	409	25.6

WRA: women of reproductive age.

Table 2. Prevalence of anaemia among WRA in Nigeria disaggregated by maternal characteristics, 2018.

Maternal characteristics		Overall WRA			Non-pregnant women			Pregnant women		
		Prevalence (%)			Prevalence (%)			Prevalence (%)		
		(95% CI)	χ^2	p value	(95% CI)	χ^2	p value	(95% CI)	χ^2	p value
Age group	15–19	60.5 (58.2–62.7)	15.9	0.105	60.3 (57.9–62.6)	18.9	0.047*	63.8 (55.2–71.6)	5.9	0.683
	20–24	56.1 (53.5–58.7)			55.2 (52.4–58.0)			60.9 (54.6–67.0)		
	25–29	55.9 (53.3–58.5)			55.1 (52.5–57.8)			59.6 (53.0–65.9)		
	30–34	58.0 (55.4–60.5			56.9 (54.2–59.6)			65.2 (56.6–72.8)		
	35–39	58.9 (56.1–61.7)			58.8 (55.8–61.7)			60.1 (52.5–67.3)		
	40–44	57.4 (54.3–60.5)			57.7 (54.4–60.8)			52.6 (39.5–65.3)		
	45–49	57.5 (54.2–60.7)			57.6 (54.3–60.8)			49.6 (22.7–76.7)		
Marital status	Never in union	56.5 (54.2–58.8)	5.1	0.175	56.2 (53.9–58.5)	4.4	0.227	82.6 (65.2–92.4)	6.8	0.046*
	Married/ living with partner	58.4 (57.1–59.6)			58.0 (56.6–59.4)			60.6 (57.3–63.7)		
	Widowed/ divorced/ separated	55.7 (51.6–59.8)			55.4 (51.3–59.5)			74.1 (39.3–92.7)		
Family size	<5	54.9 (53.1–56.6)			54.4 (52.5–56.4)	21.3	<0.001*	57.6 (52.3–62.7)	5.9	0.053
	⩾5	59.2 (57.8–60.5)	24.4	<0.001*	58.7 (57.3–60.2)			63.7 (60.0–67.3)		
Sex of household head	Male	58.4 (57.2–59.7)		0.005*	58.1 (56.8–59.5)	12.5	0.003*	60.7 (57.3–63.9)	1.2	0.321
	Female	54.8 (52.5–57.1)			54.1 (51.7–56.6)			65.2 (56.4–73.1)		
Parity	Nulliparity	56.8 (54.7–58.9)	18.8	0.006*	56.4 (54.2–58.6)	24.5	0.001*	63.5 (55.9–70.5)	2.8	0.597
	Primiparity	57.7 (54.7–60.6)			57.8 (54.6–60.9)			57.3 (48.7–65.5)		
	Multiparity	56.2 (54.4–58.0)			55.3 (53.3–57.2)			62.4 (57.8–66.7)		
	Grand multiparity	60.4 (58.7–62.2)			60.4 (58.5–62.3)			60.5 (54.7–66.0)		
Ever had a terminated pregnancy	No	57.9 (56.7–59.1)	0.6	0.508	57.5 (56.2–58.7)	0.1	0.758	62.0 (58.6–65.3)	2.3	0.214
	Yes	57.0 (54.3–59.7)			57.0 (54.1–59.9)			56.9 (49.3–64.2)		

(Continued)

Table 2. (Continued)

Maternal characteristics		Overall WRA			Non-pregnant women			Pregnant women		
		Prevalence (%)			Prevalence (%)			Prevalence (%)		
		(95% CI)	χ^2	p value	(95% CI)	χ^2	p value	(95% CI)	χ^2	p value
Current modern contraceptive use	No	58.9 (57.7–60.1)	55.5	<0.001*	58.6 (57.3–59.9)	51.2	<0.001*			
	Yes	49.6 (46.5–52.6)			46.9 (42.5–52.6)					
Currently breastfeeding	No	57.2 (55.9–58.5)	5.5	0.051	56.5 (55.1–57.9)	10.8	0.006*			
	Yes	59.4 (57.5–61.3)			59.7 (57.7–61.6)					
Body mass index	Underweight				63.1 (59.9–66.2)	114.5	<0.001*			
	Normal				59.5 (57.9–61.1)					
	Overweight				52.2 (49.6–54.9)					
	Obese				47.5 (44.1–50.8)					
Stature	Short stature	60.0 (51.7–67.9)	0.5	0.588	61.7 (53.1–69.7)	1.6	0.310	32.5 (11.9–63.2)	4.4	0.051
	Normal	57.8 (56.6–58.9)			57.3 (56.1–58.6)			61.4 (58.2–64.5)		

WRA: women of reproductive age; CI: confidence interval.
Chi-square test.
*Significant at $p < 0.05$.

Table 3. Prevalence of anaemia among WRA in Nigeria disaggregated by women's socio-economic, household environmental, and health service factors, 2018.

Household factors		Overall WRA			Non-pregnant WRA			Pregnant WRA		
		Prevalence (%)			Prevalence (%)			Prevalence (%)		
		(95% CI)	χ^2	p value	(95% CI)	χ^2	p value	(95% CI)	χ^2	p value
Region	North-Central	55.2 (52.5–57.8)	114.1	<0.001*	53.5 (50.7–56.2)	112.8	<0.001*	69.4 (63.0–75.2)	19.4	0.038*
	North-East	58.3 (55.4–61.1)			58.6 (55.5–61.7)			56.0 (49.2–62.5)		
	North-West	58.8 (56.3–61.3)			58.7 (55.8–61.5)			59.9 (54.6–65.1)		
	South-East	66.0 (63.2–68.7)			65.5 (62.7–68.2)			71.1 (62.4–78.6)		
	South-South	60.1 (56.9–63.3)			60.2 (56.8–63.4)			59.2 (47.5–70.0)		
	South-West	51.1 (48.3–53.8)			50.8 (47.8–53.7)			55.2 (43.9–66.0)		
Residence	Urban	53.6 (51.8–55.4)	92.7	<0.001*	53.4 (51.5–55.3)	78.6	<0.001*	55.7 (50.3–61.1)	11.8	0.008*
	Rural	61.5 (60.0–62.9)			61.0 (59.4–62.6)			64.5 (60.7–68.2)		
Highest education	No education	63.9 (62.0–65.8)	160.5	<0.001*	63.9 (61.7–66.0)	139.4	<0.001*	64.1 (60.0–67.9)	29.5	<0.001*
	Primary	58.6 (56.2–61.0)			57.4 (54.8–60.0)			70.2 (62.4–77.1)		
	Secondary	55.3 (53.5–57.1)			55.0 (53.3–56.8)			58.1 (52.1–63.8)		
	Higher	47.2 (43.9–50.6)			47.7 (44.1–51.2)			42.3 (32.7–52.4)		
Employment	No	60.7 (58.8–62.6)	26.5	<0.001*	60.2 (58.1–62.2)	20.9	<0.001*	64.9 (59.5–70.0)	5.5	0.062
	Yes	56.3 (55.0–57.6)			56.0 (54.6–57.5)			58.9 (55.1–62.6)		
Wealth index	Poorest	65.5 (63.1–67.9)	100.6	<0.001*	65.6 (63.0–68.2)	92.9	<0.001*	64.6 (58.4–70.4)	14.3	0.055
	Poorer	59.1 (56.7–61.5)			57.9 (55.2–60.5)			68.1 (61.9–73.6)		
	Middle	58.2 (55.8–60.6)			58.1 (55.6–60.6)			59.0 (52.6–65.1)		
	Richer	54.7 (52.3–57.1)			54.5 (52.0–56.9)			57.2 (49.0–65.0)		
	Richest	53.4 (51.0–55.9)			53.3 (50.7–55.8)			55.5 (47.9–62.7)		
Water source	Unimproved	59.0 (57.1–60.9)	4.5	0.128	58.6 (56.4–60.6)	3.6	0.185	62.0 (56.6–67.1)	0.4	0.634
	Improved	57.2 (55.7–58.6)			56.8 (55.3–58.3)			60.5 (56.6–64.2)		

(Continued)

Table 3. (Continued)

Household factors		Overall WRA			Non-pregnant WRA			Pregnant WRA		
		Prevalence (%)			Prevalence (%)			Prevalence (%)		
		(95% CI)	χ^2	p value	(95% CI)	χ^2	p value	(95% CI)	χ^2	p value
Access to sanitation	Unimproved	62.1 (60.5–63.7)	85.2	<0.001*	61.7 (59.9–63.5)	74.9	<0.001*	64.7 (60.3–68.8)	8.2	0.025*
	Improved	54.5 (52.9–56.1)			54.2 (52.4–55.9)			57.5 (52.8–62.0)		
Have mosquito bed net	No	57.6 (55.6–59.5)	0.2	0.736	57.4 (55.4–59.4)	0.0	0.966	59.2 (52.8–65.2)	1.0	0.440
	Yes	57.9 (56.6–59.3)			57.4 (55.9–58.9)			61.9 (58.3–65.4)		
Slept under mosquito bed net	No	57.3 (55.8–58.9)	1.6	0.340	57.2 (55.6–58.8)	0.2	0.713	58.3 (53.2–63.2)	3.6	0.140
	Yes	58.4 (56.8–59.9)			57.6 (55.9–59.4)			63.1 (59.1–67.0)		
Media exposure	None	60.8 (59.4–62.2)	64.7	<0.001*	60.6 (59.1–62.1)	63.5	<0.001*	62.5 (58.2–66.6)	1.7	0.304
	Any form	54.3 (52.7–55.8)			53.7 (52.0–55.4)			59.2 (54.4–63.8)		
Dietary diversity	Low	58.7 (57.4–60.0)	11.7	0.004	58.3 (56.9–59.7)	11.5	0.006*	61.5 (57.7–65.1)	0.3	0.635
	High	55.6 (53.7–57.4)			55.1 (53.0–57.1)			60.0 (54.6–65.2)		
Distance to health facility	Big problem	61.1 (59.0–63.1)	22.5	<0.001*	60.5 (58.2–62.7)	17.6	0.002*	65.3 (59.1–71.0)	4.5	0.106
	Not a big problem	56.7 (55.4–58.0			56.4 (55.0–57.8)			59.4 (55.7–63.0)		

WRA: women of reproductive age; CI: confidence interval.
Chi-square test.
*Significant at $p < 0.05$.

significantly associated with severity of anaemia among overall WRA. Similarly, ever had a terminated pregnancy, having bed net, slept under bed net, and water were not significantly associated with severity of anaemia among non-pregnant WRA. Regarding pregnant women, only marital status, region, place of residence, education, and employment showed significant association with anaemia severity.

Determinants of anaemia among WRA

Family size (AOR = 1.13, 95% CI: 1.03–1.23, ρ = 0.007), non-use of modern contraceptive (AOR = 1.27, 95% CI: 1.11–1.44, ρ = 0.001), residing in the South-East (AOR = 1.67, 95% CI: 1.42–1.97, ρ < 0.001) or South-South region (AOR = 1.30, 95% CI: 1.09–1.55, ρ = 0.004), rural residence (AOR = 1.35, 95% CI: 1.21–1.50, ρ < 0.001), no education (AOR = 1.67, 95% CI: 1.39–2.13, ρ < 0.001), primary education (AOR = 1.31, 95% CI: 1.10–1.57, ρ = 0.003), secondary education (AOR = 1.18, 95% CI: 1.00–1.38, ρ = 0.044), unemployment (AOR = 1.20, 95% CI: 1.09–1.31, ρ = 0.002), poorest quintile (AOR = 1.55, 95% CI: 1.32–1.82, ρ < 0.001), poorer quintile (AOR = 1.23, 95% CI: 1.06–1.44, ρ = 0.007), middle quintile (AOR = 1.23, 95% CI: 1.06–1.42, ρ = 0.006) significantly increased the odds of being anaemic among overall WRA. In contrast, residing in North-Central (AOR = 0.85, 95% CI: 0.72–0.99, ρ = 0.037), North-East (AOR = 0.76, 95% CI: 0.64–0.90, ρ = 0.002), and North-West (AOR = 0.77, 95% CI: 0.65–0.91, ρ = 0.002) regions significantly reduced the likelihood of being anaemic among WRA (Table 5).

Determinants of anaemia among non-pregnant women

Non-use of modern contraceptive (AOR = 1.20, 95% CI: 1.05–1.37, ρ = 0.006), underweight (AOR = 1.15, 95% CI: 0.99–1.34, ρ < 0.001), residing in the South-East (AOR = 1.76, 95% CI: 1.48–2.08, ρ < 0.001) or South-South region (AOR = 1.38, 95% CI: 1.15–1.66, ρ = 0.001), rural residence (AOR = 1.26, 95% CI: 1.13–1.41, ρ < 0.001), no education (AOR = 1.67, 95% CI: 1.37–2.03, ρ < 0.001), primary education (AOR = 1.25, 95% CI: 1.03–1.51, ρ = 0.023), unemployment (AOR = 1.14, 95% CI: 1.03–1.26, ρ = 0.013), poorest quintile (AOR = 1.43, 95% CI: 1.20–1.70, ρ < 0.001), middle quintile (AOR = 1.18, 95% CI: 1.01–1.37, ρ = 0.033), and richer quintile (AOR = 1.04, 95% CI: 0.91–1.20, ρ = 0.001) significantly increased the odds of being anaemic among overall WRA. In contrast, residing in North-Central (AOR = 0.82, 95% CI: 0.70–0.97, ρ = 0.019), North-East (AOR = 0.79, 95% CI: 0.66–0.95, ρ = 0.013), North-West (AOR = 0.78, 95% CI: 0.65–0.95, ρ = 0.011) regions and being overweight (AOR = 0.79, 95% CI: 0.70–0.90, ρ < 0.001) significantly reduced the likelihood of being anaemic among WRA (Table 5).

Table 4. Prevalence of severity of anaemia among women of reproductive age in Nigeria, 2018.

Characteristics		Overall women of reproductive age				Non-pregnant women				Pregnant women			
		Prevalence (%) (95% confidence interval)				Prevalence (%) (95% confidence interval)				Prevalence (%) (95% confidence interval)			
		Severe	Moderate	Mild	Sig. / ρ value	Severe	Moderate	Mild	Sig. /ρ value	Severe	Moderate	Mild	Sig. / ρ value
Age group	15–19	1.3 (0.9–1.9)	28.6 (26.4–30.9)	30.5 (28.3–32.9)		0.9 (0.6–1.4)	28.2 (25.9–30.5)	31.2 (28.9–33.6)		7.6 (3.9–14.2)	35.8 (28.1–44.3)	20.4 (14.2–28.4)	
	20–24	1.3 (0.9–2.0)	28.1 (26.0–30.3)	26.7 (24.5–29.0)	$\chi^2=40.7$	1.1 (0.7–1.8)	27.4 (25.2–29.7)	26.7 (24.4–29.2)	$\chi^2=55.1$	2.4 (1.1–4.9)	31.9 (26.4–38.1)	26.6 (21.5–32.5)	$\chi^2=38.3$
	25–29	1.3 (0.8–1.9)	28.8 (26.6–31.1)	25.8 (23.9–27.8)	0.076	1.3 (0.8–2.0)	27.7 (25.4–30.0)	26.2 (24.1–28.4)	0.006*	1.3 (0.4–3.6)	34.5 (29.0–40.4)	23.9 (19.2–29.3)	0.077
	30–34	2.5 (1.7–3.5)	28.4 (26.2–30.7)	27.2 (24.9–29.5)		2.6 (1.8–3.8)	27.5 (25.1–30.0)	26.8 (24.4–29.2)		1.4 (0.6–3.2)	34.0 (27.7–40.9)	29.8 (24.0–36.3)	
	35–39	1.6 (1.1–2.3)	29.4 (27.1–31.7)	28.0 (25.6–30.5)		1.7 (1.1–2.5)	29.2 (26.8–31.7)	28.0 (25.5–30.6)		0.8 (0.2–2.9)	31.2 (24.0–38.4)	28.1 (21.8–35.4)	
	40–44	1.5 (0.9–2.5)	28.1 (25.4–31.0)	27.8 (25.0–30.9)		1.3 (0.8–2.2)	28.3 (25.5–31.4)	28.0 (25.1–31.1)		4.7 (0.7–26.6)	23.6 (14.1–36.5)	24.3 (15.8–35.3)	
	45–49	1.8 (1.2–2.8)	26.6 (23.7–29.8)	29.19 (25.8–32.5)		1.8 (1.2–2.8)	26.6 (23.6–29.8)	29.2 (26.0–32.7)		0.00 (0.00–0.00)	31.6 (12.7–59.4)	18.0 (5.6–45.1)	
Current marital status	Never in union	0.9 (0.6–1.3)	25.9 (23.9–28.0)	29.7 (27.8–31.7)	$\chi^2=36.0$	0.8 (0.5–1.2)	25.6 (23.6–27.7)	29.8 (27.8–31.8)	$\chi^2=34.3$	6.4 (1.9–19.0)	56.6 (37.5–74.0)	19.6 (8.7–38.6)	$\chi^2=14.6$
	Married/living with partner	1.7 (1.5–2.1)	29.2 (28.2–30.3)	27.4 (26.4–28.5)	<0.001*	1.7 (1.4–2.0)	28.7 (27.5–29.8)	27.7 (26.5–28.9)	0.001*	2.2 (1.4–3.5)	32.6 (30.0–35.4)	25.7 (23.1–28.6)	0.019*
	Widowed/ divorced/separated	2.5 (1.4–4.4)	28.1 (24.6–32.0)	25.1 (21.9–28.6)		2.5 (1.3–4.4)	28.2 (24.6–32.1)	24.8 (21.5–28.3)		2.1 (0.3–14.5)	23.3 (6.6–56.6)	48.7 (20.8–77.4)	
Family size	<5	1.2 (0.9–1.7)	27.5 (25.9–29.1)	26.2 (24.7–27.7)	$\chi^2=28.2$	1.1 (0.8–1.5)	27.0 (25.3–28.7)	26.4 (24.8–28.1)	$\chi^2=26.8$	2.3 (1.2–4.3)	30.7 (26.6–35.0)	24.6 (20.6–29.1)	$\chi^2=6.0$
	⩾5	1.7 (1.4–2.1)	28.9 (27.7–30.1)	28.6 (27.5–29.7)	<0.001*	1.7 (1.4–2.1)	28.3 (27.0–29.6)	28.8 (27.6–29.9)	<0.001*	2.3 (1.3–4.2)	34.7 (31.3–38.4)	26.6 (23.4–30.1)	0.272
Sex of household head	Male	1.6 (1.3–1.9)	28.7 (27.6–29.8)	28.1 (27.1–29.2)	$\chi^2=11.0$	1.6 (1.3–1.9)	28.2 (27.0–29.3)	28.4 (27.3–29.5)	$\chi^2=13.5$	1.9 (1.2–2.9)	32.6 (29.9–35.4)	26.2 (23.4–29.2)	$\chi^2=12.5$
	Female	1.5 (1.0–2.3)	27.2 (25.2–29.2)	26.2 (24.3–28.1)	0.060	1.2 (0.8–1.9)	26.5 (24.5–28.6)	26.4 (24.5–28.5)	0.018*	6.0 (2.0–16.9)	37.1 (29.6–45.2)	22.2 (15.7–30.3)	0.062
Parity	Nulliparous	1.2 (0.9–1.7)	26.6 (24.6–28.6)	29.1 (27.3–30.9)	$\chi^2=32.0$	1.0 (0.7–1.4)	24.1 (24.1–28.2)	29.4 (27.5–31.3)	$\chi^2=44.3$	5.0 (2.4–9.9)	34.5 (27.6–42.2)	24.0 (18.1–31.2)	$\chi^2=16.7$
	Primiparous	1.6 (1.1–2.4)	28.4 (26.0–31.0)	27.6 (25.2–30.2)	0.008*	1.5 (0.9–2.4)	28.4 (25.8–31.2)	27.9 (25.1–30.8)	<0.001*	2.2 (1.0–4.5)	28.6 (22.8–35.2)	26.5 (20.5–33.6)	0.155
	Multiparous	1.6 (1.2–2.2)	28.2 (26.8–29.8)	26.4 (24.9–28.0)		1.5 (1.0–2.10	27.2 (25.7–28.8)	26.6 (25.0–28.3)		2.4 (1.3–4.6)	34.8 (30.8–38.9)	25.2 (21.3–29.5)	
	Grand multiparous	1.9 (1.5–2.4)	30.2 (28.6–31.7)	28.4 (26.9–29.9)		2.0 (1.6–2.6)	29.9 (28.3–31.6)	28.5 (26.9–30.1)		0.5 (0.1–1.8)	32.6 (27.8–37.9)	27.3 (23.032.2)	
Ever had a terminated pregnancy	No	1.6 (1.3–1.9)	28.3 (27.2–29.4)	6.0 (27.1–29.1)	$\chi^2=4.9$	1.5 (1.2–18)	27.7 (26.6–28.9)	28.3 (27.2–29.4)	$\chi^2=3.2$	2.1 (1.3–3.4)	23.4 (30.5–36.4)	26.5 (23.5–29.7)	$\chi^2=4.4$
	Yes	1.8 (1.1–2.8)	29.5 (27.2–31.9)	25.8 (23.6–28.1)	0.342	1.5 (0.9–2.5)	29.2 (26.7–31.8)	26.3 (23.9–28.9)	0.525	3.3 (1.3–7.9)	31.2 (25.4–37.8)	22.4 (17.4–28.4)	0.386
Current modern contraceptive use	No	1.7 (1.4–2.0)	29.3 (28.3–30.4)	27.9 (26.9–28.8	$\chi^2=75.1$	1.6 (1.4–2.0)	28.8 (27.7–30.0)	28.2 (27.1–29.2)	$\chi^2=67.6$				
	Yes	0.7 (0.3–1.3)	21.6 (19.3–24.1)	27.3 (24.6–30.1)	<0.001*	0.7 (0.3–1.3)	21.6 (19.3–24.1)	27.3 (24.6–30.1)	<0.001*				
Currently breastfeeding	No	1.4 (1.2–1.7)	27.9 (26.8–29.1)	27.9 (26.9–28.9)	$\chi^2=13.3$	1.3 (1.0–1.6)	27.0 (25.8–28.3)	28.2 (27.1–29.3)	$\chi^2=26.1$				
	Yes	2.0 (1.5–2.7)	29.8 (28.1–31.6)	27.6 (25.9–29.3)	0.030*	2.1 (1.5–2.8)	30.0 (28.2–31–7)	27 (26.0–29.4)	<0.001*				
Body mass index	Underweight					3.0 (2.2–4.2)	33.0 (30.4–35.8)	27.1 (24.1–30.2)	$\chi^2=169.1$				
	Normal					1.5 (1.2–1.9)	29.0 (27.7–30.3)	29.0 (27.8–30.3)	<0.001*				
	Overweight					0.9 (0.6–1.5)	25.5 (23.5–27.9)	25.7 (23.5–28.0)					
	Obese					0.6 (0.3–1.4)	19.1 (16.8–21.6)	27.8 (24.7–31.1)					
Stature	Short stature	1.7 (0.5–5.8)	37.5 (29.6–46.1)	20.8 (15.4–27.5)	$\chi^2=10.7$	1.8 (0.5–6.3)	38.3 (30.3–47.0)	21.6 (16.0–28.6)	$\chi^2=12.4$	0.0 (0.0–0.0)	24.8 (7.6–56.8)	7.7 (1.0–40.1)	$\chi^2=4.8$
	Normal Stature	1.6 (1.3–1.9)	28.3 (27.3–29.3)	27.9 (27.0–28.9)	0.069	1.5 (1.3–1.8)	27.7 (26.6–28.8)	28.2 (27.1–29.2)	0.042*	2.3 (1.5–3.6)	33.1 (30.5–35.9)	26.0 (23.3–28.8)	0.263
Region	North-Central	1.2 (0.8–1.7)	27.5 (25.1–30.1)	26.5 (24.8–28.3)		1.1 (0.7–1.7)	26.8 (24.3–29.4)	25.6 (23.8–27.5)		1.9 (0.8–4.4)	33.5 (27.4–40.3)	34.0 (27.2–41.5)	
	North-East	1.6 (1.0–2.5)	29.5 (27.3–31.8)	27.1 (25.1–29.3)	$\chi^2=216.0$	1.5 (0.9–2.5)	29.6 (27.2–32.2)	27.5 (25.3–29.8)	$\chi^2=212.7$	2.2 (0.9–4.9)	28.9 (23.5–35.0)	24.9 (19.9–30.7)	$\chi^2=43.0$
	North-West	2.3 (1.7–3.0)	29.4 (27.4–31.6)	27.1 (25.3–29.1)	<0.001*	2.3 (1.7–3.1)	28.6 (26.3–30.9)	27.8 (25.8–29.9)	<0.001*	2.3 (0.9–5.5)	34.6 (30.1–39.4)	23.1 (19.0–27.7)	0.010*
	South-East	1.8 (1.3–2.5)	34.3 (31.4–37.3)	29.9 (27.6–32.3)		1.8 (1.3–2.5)	33.3 (30.4–36.6	30.4 (28.0–32.9)		1.7 (0.6–5.3)	44.5.5 (36.4–52.9)	24.9 (18.2–33.1)	
	South-South	2.0 (1.4–2.9)	32.4 (29.6–35.3)	25.7 (23.7–27.8)		1.6 (1.1–2.5)	32.8 (29.9–35.9)	25.7 (23.6–28.0)		6.5 (2.6–15.5)	27.5 (19.7–37.0)	25.2 (17.8–34.4)	
	South-West	0.5 (0.3–0.9)	20.3 (18.3–22.4)	30.3 (27.7–33.0)		0.5 (0.3–1.0)	19.7 (17.8–21.7)	30.5 (27.6–33.6)		0.5 (0.1–2.1)	28.2 (20.8–37.1)	26.5 (18.2–36.8)	
Residence	Urban	1.2 (0.9–1.5)	24.8 (23.3–26.4)	27.6 (26.1–29.1)	$\chi^2=125.0$	1.1 (0.9–1.5)	24.4 (22.8–26.0)	27.9 (26.3–29.6	$\chi^2=108.0$	1.7 (0.7–3.8)	29.4 (25.3–33.9)	24.6 (20.0–29.9)	$\chi^2=13.2$
	Rural	1.9 (1.6–2.4)	31.5 (30.2–32.9)	28.0 (26.9–29.1)	<0.001*	1.8 (1.5–2.3)	31.0 (29.6–32.5)	28.2 (27.0–29.4)	<0.001*	2.7 (1.6–4.5)	35.3 (32.0–38.8)	26.5 (23.5–29.8)	0.046*

(Continued)

Table 4. (Continued)

Characteristics		Overall women of reproductive age				Non-pregnant women				Pregnant women			
		Prevalence (%) (95% confidence interval)				Prevalence (%) (95% confidence interval)				Prevalence (%) (95% confidence interval)			
		Severe	Moderate	Mild	Sig. / ρ value	Severe	Moderate	Mild	Sig. /ρ value	Severe	Moderate	Mild	Sig. / ρ value
Highest education	No education	2.4 (1.8–3.0)	33.5 (31.8–35.2)	28.1 (26.5–29.7)		2.4 (1.8–3.1)	32.8 (30.9–34.7)	28.7 (27.0–30.5)		2.3 (1.3–4.0)	37.7 (33.9–41.7)	24.1 (20.7–27.9)	
	Primary	1.7 (1.2–2.4)	28.6 (26.5–30.8)	28.3 (26.0–30.8	$\chi^2=218.8$	1.5 (1.0–2.2)	27.8 (25.6–30.1)	28.1 (25.7–30.7)	$\chi^2=189.3$	3.2 (1.2–8.0)	36.8 (29.9–44.3)	30.2 (23.4–38.0)	$\chi^2=38.8$
	Secondary	1.2 (0.9–1.5)	26.5 (25.0–28.0)	27.7 (26.3–29.0)	<0.001*	1.1 (0.8–1.4)	26.2 (24.6–27.8)	27.8 (26.4–29.9)	<0.001*	2.2 (1.0–4.5)	29.4 (25.0–34.4)	26.5 (21.9–31.7)	0.001*
	Higher	0.7 (0.4–1.2)	19.8 (17.3–22.4)	26.8 (23.9–29.9)		0.6 (0.3–1.2)	20.0 (17.5–22.9)	27.0 (23.9–30.3)		1.2 (0.3–5.6)	16.6 (10.8–24.6)	24.4 (16.5–34.6)	
Employment	No	2.0 (1.5–2.6)	30.1 (28.4–31.8)	28.7 (27.1–30.3)	$\chi^2=31.5$	1.7 (1.3–2.3)	29.7 (27.9–31.4)	28.8 (27.1–30.6)	$\chi^2=22.8$	3.9 (2.1–7.3)	33.4 (29.1–38.0)	27.6 (23.6–32.1)	$\chi^2=14.9$
	Yes	1.4 (1.1–1.7)	27.6 (26.4–28.8)	27.4 (26.3–28.4)	<0.001*	1.4 (1.1–1.7)	27.0 (25.8–28.3)	27.6 (26.5–28.8)	0.003*	1.3 (0.8–2.3)	32.8 (27.7–36.2)	24.7 (21.4–28.3)	0.016*
Wealth index	Poorest	2.4 (1.8–3.2)	34.3 (32.0–36.6)	28.8 (26.9–30.8)		2.5 (1.8–3.4)	33.8 (31.3–36.4)	29.4 (27.4–31.4)		1.8 (0.8–4.1)	37.9 (32.2–44.0)	24.9 (20.2–30.3)	
	Poorer	1.2 (0.8–1.8)	30.1 (28.2–32.1)	27.8 (25.6–30.1)	$\chi^2=138.3$	1.1 (0.7–1.7)	29.2 (27.1–31.4)	27.6 (25.3–30.0)	$\chi^2=133.1$	2.2 (1.1–4.3)	36.5 (30.9–42.4)	29.4 (24.3–35.0)	$\chi^2=24.3$
	Middle	1.4 (0.9–2.0)	29.6 (27.6–31.8)	27.2 (25.1–29.4)	<0.001*	1.1 (0.8–1.7)	29.3 (27.1–31.5)	27.7 (25.5–30.1)	<0.001*	3.3 (1.2–9.0)	22.8 (27.0–39.2)	22.9 (18.2–28.4)	0.172
	Richer	1.7 (1.2–2.4)	24.8 (22.8–26.9)	28.2 (26.5–30.1)		1.7 (1.2–2.5)	24.0 (22.0–26.1)	28.8 (26.9–30.7)		1.8 (0.7–4.3)	31.7 (25.8–38.2)	23.7 (18.0–30.5)	
	Richest	1.4 (0.9–2.1)	24.9 (22.9–27.0)	27.2 (25.4–29.0)		1.3 (0.8–2.0)	24.9 (22.9–27.1)	27.0 (25.2–29.0)		2.5 (0.8–7.7)	24.3 (18.9–30.5)	28.7 (22.3–36.2)	
Water source	Unimproved	1.5 (1.1–1.9)	29.3 (27.6–31.0)	28.3 (26.8–29.8)	$\chi^2=6.2$	1.2 (0.9–1.6)	28.9 (27.1–30.7)	28.5 (26.8–30.2)	$\chi^2=8.8$	3.1 (1.6–6.1)	32.0 (28.0–36.3)	26.9 (22/8–31.4)	$\chi^2=3.8$
	Improved	1.7 (1.4–2.0)	27.9 (26.6–29.1)	27.6 (26.5–28.8)	0.284	1.7 (1.3–2.1)	27.3 (26.0–28.6)	27.9 (26.7–29.1)	0.141	1.8 (1.0–2.9)	33.4 (30.1–36.9)	25.3 (22.1–28.8)	0.462
Access to sanitation	Unimproved	1.8 (1.4–2.2)	31.4 (30.0–32.8)	28.9 (27.6–30.4)	$\chi^2=93.0$	1.7 (1.4–2.2)	30.8 (29.3–32.3)	29.2 (27.7–30.8)	$\chi^2=81.4$	2.2 (1.3–3.5)	35.7 (32.0–39.6)	26.8 (23.4–30.4)	$\chi^2=9.4$
	Improved	1.5 (1.1–1.9)	26.0 (24.6–27.4)	27.0 (25.8–28.3)	<0.001*	1.3 (1.0–1.8)	25.6 (24.2–27.0)	27.2 (25.9–28.6)	<0.001*	2.5 (1.2–5.0)	29.9 (26.2–33.9)	25.1 (21.2–29.5)	0.114
Have mosquito bed net	No	27.4 (25.6–29.4)	27.4 (25.6–29.4)	27.4 (25.6–29.4)	$\chi^2=9.7$	1.2 (0.9–1.6)	27.1 (25.3–29.0)	29.1 (27.4–30.8)	$\chi^2=8.4$	2.1 (0.9–5.0)	31.0 (26.0–36.4)	26.1 (21.5–31.4)	$\chi^2=1.6$
	Yes	1.7 (1.4–2.1)	28.9 (27.8–30.1)	27.3 (26.2–28.4)	0.120	1.7 (1.4–2.0)	28.3 (27.1–29.5)	27.5 (26.4–28.7)	0.152	2.4 (1.4–3.9)	33.9 (30.7–37.2)	25.7 (22.6–29.0)	0.809
Respondent slept under mosquito bed net	No	1.3 (1.0–1.7)	27.7 (26.3–29.2)	28.2 (27.0–29.5)	$\chi^2=10.6$	1.2 (0.9–1.6)	27.4 (26.0–28.9)	28.6 (27.2–30.0)	$\chi^2=10.1$	2.5 (1.4–4.5)	31.5 (27.5–35.8)	24.3 (20.6–28.5)	$\chi^2=4.0$
	Yes	1.8 (1.5–2.3)	29.2 (27.8–30.6)	27.3 (26.1–28.7)	0.095	1.8 (1.5–2.2)	28.4 (27.0–29.9)	27.4 (26.0–28.8)	0.100	2.1 (1.1–4.0)	34.1 (30.6–37.8)	26.8 (23.4–30.6)	0.463
Media exposure	None	1.7 (1.4–2.1)	31.9 (30.6–33.2)	27.2 (26.1–28.4)	$\chi^2=114.2$	1.6 (1.3–2.1)	31.4 (30.0–32.8)	27.6 (26.3–28.9)	$\chi^2=107.2$	2.0 (1.3–3.1)	35.8 (32.1–39.7)	24.6 (21.6–27.9)	$\chi^2=7.9$
	Any form	1.5 (1.2–1.9)	24.3 (23.0–25.7)	28.5 (27.1–29.9)	<0.001*	1.3 (1.0–1.7)	23.8 (22.5–25.2)	28.6 (27.1–30.1)	<0.001*	2.7 (1.2–5.8)	29.1 (25.2–33.4)	27.4 (23.0–32.3)	0.196
Dietary diversity	Low diversity	1.7 (1.4–2.1)	29.0 (27.7–30.2)	28.0 (26.8–29.1)	$\chi^2=17.2$	1.7 (1.4–2.1)	28.4 (27.2–29.7)	28.2 (27.0–29.5)	$\chi^2=18.8$	2.2 (1.2–3.8)	33.4 (30.3–36.6)	26.0 (23.1–29.1)	$\chi^2=0.6$
	High diversity	1.2 (0.9–1.6)	27.0 (25.5–28.6)	27.4 (25.8–28.9)	0.006	1.0 (0.7–1.4)	26.5 (24.8–28.2)	27.6 (26.0–29.3)	0.005*	2.6 (1.4–5.0)	32.1 (27.2–37.4)	25.3 (20.6–30.7)	0.924
Distance to health facility	Big problem	1.6 (1.2–2.2)	32.6 (29.8–33.5)	27.9 (26.2–29.6)	$\chi^2=31.4$	1.4 (1.0–1.9)	31.2 (29.3–33.2)	27.9 (26.1–29.8)	$\chi^2=29.1$	3.2 (1.3–7.3)	34.3 (29.5–39.6)	27.7 (23.5–32.5)	$\chi^2=6.2$
	Not a big problem	1.6 (1.3–1.9)	27.3 (26.2–28.5)	27.8 (26.7–28.9)	<0.001*	1.5 (1.3–1.9)	26.7 (25.6–27.9)	28.1 (26.9–29.3)	<0.001*	1.9 (1.2–3.1)	32.5 (29.4–35.8)	25.0 (21.8–28.4)	0.299
Total		1.6 (1.3–1.9)	28.4 (27.4–29.5)	27.8 (26.9–28.7)		1.5 (1.3–1.8)	27.9 (26.8–29.0)	28.0 (27.0–29.1)		2.3 (1.5–3.5)	33.0 (30.4–35.8)	25.8 (23.2–28.6)	

Chi-square test.
*Significant at $p < 0.05$.

Table 5. Risk factors for being anaemic among WRA in Nigeria, 2018.

Parameters		Overall WRA				Non-pregnant women				Pregnant women			
		OR (95% CI)	ρ value	AOR (95% CI)	ρ value	OR (95% CI)	ρ value	AOR (95% CI)	ρ value	OR (95% CI)	p value	AOR (95% CI)	p value
Age groups	15–19	1.28 (1.01–1.61)	0.039			1.14 (0.89–1.46)	0.299			1.31 (0.33–5.29)	0.703		
	20–24	1.08 (0.87–1.34)	0.493			0.94 (0.75–1.19)	0.628			1.38 (0.38–5.01)	0.621		
	25–29	1.06 (0.87–1.30)	0.541			0.96 (0.78–1.18)	0.677			1.42 (0.40–5.00)	0.583		
	30–34	1.16 (0.97–1.39)	0.105			1.04 (0.86–1.25)	0.684			2.25 (0.65–7.81)	0.203		
	35–39	1.18 (0.99–1.41)	0.067			1.13 (0.94–1.37)	0.191			1.85 (0.52–6.55)	0.340		
	40–44	1.07 (0.88–1.29)	0.517			1.04 (0.85–1.28)	0.677			1.08 (0.29–3.98)	0.910		
	45–49	1.00				1.00				1.00			
Current marital status	Married/living with partner	1.05 (0.88–1.26)	0.964			1.06 (0.87–1.29)	0.770			0.36 (0.12–1.07)	0.563		
	Widowed/divorced/ separated	0.99 (0.77–1.28)	0.537			1.01 (0.78–1.31)				0.58 (0.09–3.69)	0.536		
	Never in union	1.00				1.00				1.00			
Family size	⩾5	1.11 (1.00–1.23)	0.044	1.13 (1.03–1.23)	0.007	1.08 (0.97–1.21)	0.155			1.18 (0.88–1.58)	0.261		
	<5	1.00		1.00		1.00				1.00			
Sex of household head	Female	0.91 (0.81–1.03)	0.130			0.90 (0.79–1.02)	0.089						
	Male	1.00				1.00							
Parity	Primiparous	1.10 (0.91–1.32)	0.634			1.14 (0.93–1.41)	0.360			0.90 (0.55–1.45)	0.172		
	Multiparous	1.02 (0.85–1.23)	0.620			1.04 (0.85–1.27)	0.778			0.91 (0.56–1.49)	0.297		
	Grand multiparous	1.05 (0.85–1.29)	0.655			1.11 (0.88–1.40)	0.306			0.64 (0.34–1.21)	0.092		
	Nulliparous	1.00				1.00				1.00			
Ever had a terminated pregnancy	Yes									0.93 (0.66–1.32)	0.685		
	No									1.00			
Modern contraceptive use	No	1.27 (1.11–1.46)	0.001	1.26 (1.11–1.44)	0.001	1.23 (1.07–1.41)	0.004	1.20 (1.05–1.37)	0.006				
	Yes	1.00				1.00							
Currently breastfeeding	Yes	0.99 (0.89–1.11)	0.928			1.03 (0.91–1.16)	0.635						
	No	1.00				1.00							
Body mass index	Underweight					1.14 (0.98–1.33)	<0.001	1.15 (0.99–1.34)	<0.001				
	Overweight					0.78 (0.68–0.89)	<0.001	0.79 (0.70–0.90)	<0.001				
	Obese					0.67 (0.56–0.79)	0.057	0.68 (0.58–0.80)	0.059				
	Normal					1.00							
Stature	Short stature	0.97 (0.69–1.38)	0.882			1.13 (0.79–1.63)	0.499			0.19 (0.05–0.71)	0.013	0.24 (0.07–0.88)	0.032
	Normal	1.00				1.00				1.00		1.00	
Region	North-Central	0.83 (0.71–0.98)	0.024	0.85 (0.72–0.99)	0.037	0.80 (0.68–0.95)	0.009	0.82 (0.70–0.97)	0.019	1.08 (0.60–1.96)	0.792	1.24 (0.68–2.29)	0.482
	North-East	0.74 (0.62–0.88)	0.001	0.76 (0.64–0.90)	0.002	0.77 (0.64–0.92)	0.005	0.79 (0.66–0.95)	0.013	0.44 (0.25–0.77)	0.004	0.55 (0.30–1.01)	0.054
	North-West	0.75 (0.63–0.89)	0.001	0.77 (0.65–0.91)	0.002	0.75 (0.62–0.91)	0.003	0.78 (0.65–0.95)	0.011	0.51 (0.29–0.90)	0.019	0.62 (0.34–1.12)	0.115
	South-East	1.65 (1.39–1.95)	0.000	1.67 (1.42–1.97)	0.000	1.71 (1.44–2.03)	<0.001	1.76 (1.48–2.08)	<0.001	1.56 (0.86–2.84)	0.143	1.95 (1.03–3.68)	0.039
	South-South	1.31 (1.10–1.57)	0.003	1.30 (1.09–1.55)	0.004	1.41 (1.18–1.68)	<0.001	1.38 (1.15–1.66)	0.001	0.84 (0.42–1.67)	0.617	0.96 (0.48–1.93)	0.909
	South-West	1.00		1.00		1.00		1.00		1.00		1.00	

(Continued)

Table 5. (Continued)

Parameters		Overall WRA				Non-pregnant women				Pregnant women			
		OR (95% CI)	ρ value	AOR (95% CI)	ρ value	OR (95% CI)	ρ value	AOR (95% CI)	ρ value	OR (95% CI)	p value	AOR (95% CI)	p value
Place of residence	Rural	1.31 (1.17–1.48)	<0.001	1.35 (1.21–1.50)	<0.001	1.22 (1.08–1.39)	0.002	1.26 (1.13–1.41)	<0.001	1.67 (1.17–2.40)	0.005	1.43 (1.07–1.91)	0.015
	Urban	1.00		1.00		1.00		1.00		1.00		1.00	
Highest educational level	No education	1.62 (1.32–1.99)	<0.001	1.67 (1.39–2.13)	<0.001	1.49 (1.19–1.85)	<0.001	1.67 (1.37–2.03)	<0.001	2.69 (1.43–5.07)	0.002	2.97 (1.79–4.92)	<0.001
	Primary	1.27 (1.05–1.55)	0.015	1.31 (1.10–1.57)	0.003	1.13 (0.92–1.40)	0.241	1.25 (1.03–1.51)	0.023	3.37 (1.74–6.51)	<0.001	3.46 (1.97–6.07)	<0.001
	Secondary	1.14 (0.96–1.35)	0.133	1.18 (1.00–1.38)	0.044	1.07 (0.90–1.28)	0.452	1.12 (0.95–1.33)	0.161	1.82 (1.06–3.11)	0.030	1.81 (1.13–2.90)	0.014
	Higher	1.00		1.00		1.00		1.00		1.00		1.00	
Employment status	No	1.17 (1.05–1.29)	0.003	1.20 (1.09–1.31)	<0.001	1.14 (1.02–1.27)	0.024	1.14 (1.03–1.26)	0.013	1.42 (1.06–1.90)	0.020	1.38 (1.03–1.86)	0.031
	Yes	1.00		1.00		1.00		1.00		1.00		1.00	
Wealth index	Poorest	1.50 (1.25–1.81)	<0.001	1.55 (1.32–1.82)	<0.001	1.38 (1.13–1.68)	0.001	1.43 (1.20–1.70)	<0.001	1.65 (0.95–2.87)	0.075		
	Poorer	1.23 (1.04–1.45)	0.016	1.23 (1.06–1.44)	0.007	1.11 (0.94–1.32)	0.224	1.12 (0.95–1.32)	0.177	1.71 (1.03–2.84)	0.037		
	Middle	1.21 (1.04–1.41)	0.012	1.23 (1.06–1.42)	0.006	1.17 (1.00–1.37)	0.051	1.18 (1.01–1.37)	0.033	1.15 (0.72–1.83)	0.570		
	Richer	1.07 (0.92–1.24)	0.365	1.07 (0.93–1.24)	0.314	1.04 (0.90–1.200	0.624	1.04 (0.91–1.20)	0.551	1.06 (0.68–1.67)	0.785		
	Richest	1.00		1.00		1.00		1.00		1.00			
Water	Unimproved	0.96 (0.87–1.06)	0.404			0.97 (0.87–1.08)	0.582						
	Improved	1.00				1.00							
Sanitation	Unimproved	1.05 (0.94–1.17)	0.408			1.06 (0.93–1.21)	0.357			0.86 (0.60–1.22)	0.390		
	Improved	1.00				1.00				1.00			
Access to media	None	1.05 (0.96–1.15)	0.289			1.07 (0.97–1.17)	0.172						
	Any form	1.00				1.00							
Dietary diversity	Low diversity	1.03 (0.94–1.13)	0.572			1.02 (0.92–1.13)	0.662						
	High diversity	1.00				1.00							
Respondent slept under mosquito bed net	No									0.76 (0.57–1.02)	0.066		
	Yes									1.00			
Distance to health facility	Big problem	0.97 (0.88–1.07)	0.605			0.96 (0.86–1.07)	0.421			1.01 (0.75–1.37)	0.943		
	Not a big problem	1.00				1.00				1.00			

WRA: women of reproductive age; OR: odds ratio; CI: confidence interval; AOR: adjusted odds ratio.
Significance at $p < 0.05$.

Determinants of anaemia among pregnant women

Short stature (AOR = 0.24, 95% CI: 0.07–0.88, ρ = 0.032) significantly reduced the likelihood of being anaemic among pregnant women (Table 5). Conversely, living in the South-East (AOR = 1.95, 95% CI: 1.03–3.68, ρ = 0.039) regions, rural residence (AOR = 1.43, 95% CI: 1.07–1.91, ρ = 0.015), no education (AOR = 2.97, 95% CI: 1.79–4.92, ρ < 0.001), primary education (AOR = 3.46, 95% CI: 1.97–6.07, ρ < 0.001), and secondary education (AOR = 1.81, 95% CI: 1.13–2.90, ρ = 0.014), and no employment (AOR = 1.38, 95% CI: 1.03–1.86, ρ = 0.031) increased the odds of being anaemic among pregnant women (Table 5).

Determinants of anaemia severity among WRA

As shown in Table 6, the likelihood of severe anaemia among overall WRA increased with contraceptive use (AOR = 2.19, 95% CI: 1.10–4.33, ρ = 0.025); residing in North-West (AOR = 2.13, 95% CI: 1.06–4.28, ρ = 0.033), South-East (AOR = 4.51, 95% CI: 2.33–8.74, ρ < 0.001), and South-South (AOR = 4.07, 95% CI: 1.97–8.38, ρ < 0.001); no education (AOR = 5.12, 95% CI: 2.26–11.59, ρ < 0.001); primary education (AOR = 3.13, 95% CI: 1.46–6.73, ρ = 0.003); and unemployment (AOR = 1.43, 95% CI: 1.01–2.04, ρ = 0.046). Rural residence (AOR = 1.39, 95% CI: 1.22–1.59, ρ < 0.001); poorest (AOR = 1.63, 95% CI: 0.35–0.97, ρ < 0.001), poorer (AOR = 1.29, 95% CI: 1.08–1.54, ρ = 0.005), and richer quintile (AOR = 1.31, 95% CI: 1.10–1.55, ρ = 0.002); and lack of access to media (AOR = 1.18, 95% CI: 1.06–1.30, ρ = 0.002) increased the likelihood of being moderately anaemic.

Determinants of anaemia severity among non-pregnant women

As shown in Table 7, the likelihood of severe anaemia among non-pregnant increased with non-contraceptive use (AOR = 2.16, 95% CI: 1.08–4.34, ρ = 0.030); underweight (AOR = 2.38, 95% CI: 1.58–3.58, ρ < 0.001); residing in North-West (AOR = 2.51 95% CI: 1.16–5.41, ρ = 0.019); South-East (AOR = 5.10, 95% CI: 2.55–10.23, ρ < 0.001); South-South (AOR = 4.01, 95% CI: 1.87–8.59, ρ < 0.001); no education (AOR = 4.70, 95% CI: 1.88–11.72, ρ = 0.001); and primary education (AOR = 2.79, 95% CI: 1.18–6.61, ρ = 0.020). In contrast, the likelihood of severe anaemia among NPW is reduced by age 15–19 years (AOR = 0.42, 95% CI: 0.20–0.86, ρ = 0.018) and overweight (AOR = 0.50, 95% CI: 0.29–0.86, ρ = 0.006). Furthermore, the likelihood of moderate anaemia among non-pregnant women increased with age 35–39 years (AOR = 1.28, 95% CI: 1.03–1.60, ρ = 0.029); rural residence (AOR = 1.30, 95% CI: 1.12–1.50, ρ < 0.001); poorest (AOR = 1.47, 95% CI: 1.20–1.81, ρ < 0.001); middle quintile (AOR = 1.24, 95% CI: 1.04–1.48, ρ = 0.016), and lack of access to media (AOR = 1.20, 95% CI: 1.08–1.34, ρ = 0.001).

Determinants of anaemia severity among pregnant women

Residing in South-South (AOR = 9.27, 95% CI: 1.24–69.25, ρ < 0.030) and unemployment (AOR = 3.92, 95% CI: 1.51–10.15, ρ = 0.005) increased the odds of being severely anaemic among pregnant women as shown in Table 8. In contrast, short stature (AOR = 0.00, 95% CI: 0.00–0.00, ρ < 0.001) reduced the likelihood of severe anaemia among pregnant women (Table 8). Whereas residing in the North-East region reduces the likelihood of moderate anaemia, residing in the South-East region increases the risk of being moderately anaemic. Also, rural residence (AOR = 1.44, 95% CI: 1.04–1.98, ρ = 0.027), no education (AOR = 4.97, 95% CI: 2.68–9.19, ρ < 0.001), primary education (AOR = 4.82, 95% CI: 2.54–9.16, ρ < 0.001), and secondary education (AOR = 2.40, 95% CI: 1.35–4.28, ρ = 0.003) increased the likelihood of developing moderate anaemia.

Discussion

The high anaemia prevalence among pregnant women in our study is consistent with evidence from some community-based studies in sub-Saharan Africa,[25,28] but contrasts with the lower anaemia prevalence in other prior studies in Sudan and Ethiopia due to differences in dietary practices, iron supplementation, and malaria endemicity.[22,26,29] Similarly, the high anaemia prevalence among WRA and non-pregnant women in the current study compares to evidence of high prevalence from previous African studies.[11,12,16,31] In contrast, other African studies found low anaemia prevalence among WRA.[12,13,15,17–19] Since anaemia prevalence greater than 40% constitute a severe public health problem,[41] our findings indicate that anaemia among WRA is a grave public health problem in Nigeria. Consequently, increased maternal mortality, poor birth outcomes, and reduced productivity due to anaemia among reproductive-age women might persist in Nigeria.[9,10] To reduce anaemia prevalence, the Government of Nigeria introduced the national guidelines on micronutrient deficiency control in 2013.[42] The Government of Nigeria has implemented measures to reduce anaemia including universal iron and folate supplementation for adolescent girls and during pregnancy, deworming of pregnant women and adolescents, food fortification, promotion of dietary diversification, focused antenatal care, intermittent preventive treatment of malaria during pregnancy, health education, and promotion of personal hygiene.[6,42,43] Therefore, there is a need not only to sustain these interventions but also to

Table 6. Risk factors for severity of anaemia among overall women of reproductive age in Nigeria, 2018.

Parameters		Crude odd ratios						Adjusted odd ratios					
		Severe	ρ value	Moderate	ρ value	Mild	ρ value	Severe	ρ value	Moderate	ρ value	Mild	ρ value
Age groups	15–19	0.80 (0.33–1.95)	0.625	1.42 (1.09–1.86)	0.010	1.18 (0.88–1.60)	0.267						
	20–24	0.65 (0.29–1.46)	0.301	1.25 (0.98–1.59)	0.073	0.96 (0.72–1.29)	0.801						
	25–29	0.69 (0.33–1.42)	0.309	1.25 (1.00–1.56)	0.048	0.93 (0.71–1.21)	0.580						
	30–34	1.53 (0.85–2.77)	0.158	1.28 (1.03–1.60)	0.025	1.03 (0.81–1.30)	0.825						
	35–39	1.03 (0.55–1.94)	0.931	1.34 (1.08–1.66)	0.008	1.05 (0.85–1.30)	0.651						
	40–44	0.89 (0.43–1.83)	0.745	1.16 (0.93–1.45)	0.187	0.99 (0.77–1.26)	0.928						
	45–49	1.00		1.00		1.00							
Current marital status	Married/living with partner	2.60 (1.16–5.82)	0.004	1.13 (0.91–1.41)	0.593	0.94 (0.77–1.15)	0.270						
	Widowed/ divorced/ separated	3.53 (1.49–8.38)	0.412	1.08 (0.81–1.46)	0.705	0.85 (0.64–1.13)	0.392						
	Never in union	1.00		1.00		1.00							
Family size	⩾5	1.50 (0.98–2.30)	0.051	1.06 (0.94–1.19)	0.373	1.15 (1.02–1.30)	0.022						
	<5	1.00		1.00		1.00							
Sex of household head	Female	1.14 (0.62–2.07)	0.376	0.93 (0.80–1.07)	0.301	0.89 (0.78–1.02)	0.095						
	Male	1.00		1.00		1.00							
Parity	Primiparous	0.74 (0.37–1.48)	0.038	1.09 (0.88–1.35)	0.527	1.13 (0.90–1.43)	0.582						
	Multiparous	0.58 (0.30–1.12)	0.129	1.04 (0.83–1.31)	0.981	1.04 (0.83–1.30)	0.623						
	Grand multiparous	0.44 (0.21–0.96)	0.288	1.09 (0.84–1.40)	0.564	1.08 (0.83–1.39)	0.666						
	Nulliparous	1.00		1.00		1.00							
Modern contraceptive use	No	2.29 (1.15–4.59)	0.019	1.40 (1.19–1.64)	<0.001	1.15 (0.97–1.36)	0.112	2.19 (1.10–4.33)	0.025	1.37 (1.16–1.60)	<0.001	1.14 (0.98–1.34)	0.090
	Yes	1.00		1.00		1.00		1.00		1.00		1.00	
Currently breastfeeding	Yes	1.27 (0.83–1.93)	0.274	0.96 (0.85–1.08)	0.501	1.02 (0.89–1.17)	0.802						
	No	1.00		1.00		1.00							
Stature	Short stature	1.03 (0.31–3.44)	0.963	1.23 (0.82–1.84)	0.316	0.72 (0.47–1.09)	0.120						
	Normal	1.00		1.00		1.00							
Region	North-Central	1.48 (0.70–3.14)	0.303	0.96 (0.78–1.18)	0.675	0.75 (0.63–0.89)	0.001	1.53 (0.73–3.22)	0.263	0.97 (0.79–1.19)	0.775	0.76 (0.64–0.91)	0.002
	North-East	1.44 (0.64–3.23)	0.378	0.82 (0.66–1.02)	0.069	0.69 (0.56–0.84)	<0.001	1.56 (0.70–3.43)	0.274	0.86 (0.70–1.06)	0.148	0.71 (0.59–0.87)	0.001
	North-West	1.86 (0.86–4.03)	0.116	0.81 (0.66–1.00)	0.053	0.69 (0.56–0.84)	<0.001	2.13 (1.06–4.28)	0.033	0.85 (0.70–1.05)	0.127	0.71 (0.59–0.86)	0.001
	South-East	4.33 (2.22–8.45)	<0.001	2.09 (1.70–2.58)	<0.001	1.32 (1.10–1.60)	0.003	4.51 (2.33–8.74)	0.000	2.16 (1.75–2.66)	0.000	1.34 (1.11–1.60)	0.002
	South-South	4.04 (1.94–8.40)	<0.001	1.76 (1.42–2.19)	<0.001	0.97 (0.81–1.17)	0.765	4.07 (1.97–8.38)	0.000	1.73 (1.39–2.14)	0.000	0.96 (0.80–1.16)	0.692
	South-West	1.00		1.00		1.00		1.00		1.00		1.00	
Place of residence	Rural	1.35 (0.87–2.10)	0.176	1.38 (1.19–1.59)	<0.001	1.24 (1.09–1.41)	0.001	1.31 (0.86–2.00)	0.213	1.39 (1.22–1.59)	<0.001	1.27 (1.14–1.43)	<0.001
	Urban	1.00		1.00		1.00		1.00		1.00		1.00	

(Continued)

Table 6. (Continued)

Parameters		Crude odd ratios						Adjusted odd ratios					
		Severe	ρ value	Moderate	ρ value	Mild	ρ value	Severe	ρ value	Moderate	ρ value	Mild	ρ value
Highest educational level	No education	4.68 (1.95–11.19)	0.001	1.86 (1.45–2.39)	<0.001	1.36 (1.07–1.73)	0.012	5.12 (2.26–11.59)	<0.001	1.92 (1.53–2.42)	<0.001	1.43 (1.15–1.78)	0.001
	Primary	3.01 (1.32–6.84)	0.009	1.38 (1.10–1.75)	0.006	1.16 (0.91–1.47)	0.226	3.13 (1.46–6.73)	0.003	1.42 (1.15–1.76)	0.001	1.22 (0.97–1.52)	0.082
	Secondary	2.07 (0.99–4.33)	0.054	1.25 (1.02–1.54)	0.032	1.04 (0.85–1.27)	0.715	1.85 (0.92–3.71)	0.085	1.29 (1.06–1.56)	0.011	1.10 (0.91–1.33)	0.304
	Higher	1.00		1.00		1.00		1.00		1.00		1.00	
Employment status	No	1.55 (1.04–2.32)	0.032	1.16 (1.03–1.31)	0.015	1.15 (1.02–1.30)	0.022	1.43 (1.01–2.04)	0.046	1.18 (1.06–1.31)	0.003	1.20 (1.08–1.33)	0.001
	Yes	1.00		1.00		1.00		1.00		1.00		1.00	
Wealth index	Poorest	1.52 (0.77–3.02)	0.230	1.64 (1.32–2.04)	<0.001	1.36–1.10–1.67)	0.004	1.37 (0.64–2.92)	0.413	1.63 (1.35–1.97)	0.000	1.42 (1.18–1.70)	<0.001
	Poorer	0.74 (0.38–1.45)	0.381	1.32 (1.09–1.61)	0.005	1.16 (0.96–1.40)	0.115	0.67 (0.32–1.40)	0.288	1.29 (1.08–1.54)	0.005	1.18 (0.99–1.41)	0.070
	Middle	0.89 (0.46–1.75)	0.743	1.31 (1.10–1.58)	0.003	1.14 (0.096–1.35)	0.134	0.85 (0.42–1.72)	0.645	1.31 (1.10–1.55)	0.002	1.15 (0.97–1.35)	0.106
	Richer	1.17 (0.65–2.11)	0.598	1.05 (0.65–2.11)	0.629	1.08 (0.92–1.27)	0.328	1.14 (0.61–2.11)	0.688	1.04 (0.87–1.24)	0.694	1.10 (0.94–1.28)	0.244
	Richest	1.00		1.00		1.00		1.00		1.00		1.00	
Sanitation	Unimproved	0.99 (0.66–1.47)	0.946	0.99 (0.88–1.13)	0.939	1.10 (0.97–1.25)	0.149						
	Improved	1.00		1.00		1.00							
Have mosquito bed net for sleeping	No	0.93 (0.54–1.61)	0.803	0.97 (0.84–1.13)	0.727	1.07 (0.94–1.23)	0.310						
	Yes	1.00		1.000		1.00							
Respondent slept under mosquito bed net	No	0.96 (0.55–1.67)	0.871	1.00 (0.86–1.15)	0.950	0.96 (0.84–1.11)	0.606						
	Yes	1.00											
Access to media	None	0.77 (0.52–1.13)	0.180	1.18 (1.06–1.30)	0.002	0.95 (0.86–1.06)	0.362	0.79 (0.54–1.16)	0.230	1.18 (1.06–1.30)	0.002	0.97 (0.87–1.07)	0.513
	Any form	1.00		1.00		1.00		1.00		1.00		1.00	
Dietary diversity	Low diversity	1.39 (0.95–2.04)	0.086	1.00 (0.89–1.12)	0.991	1.04 (0.93–1.16)	0.488						
	High diversity	1.00		1.00		1.00							
Distance to health facility	Big problem	0.80 (0.53–1.22)	0.303	1.00 (0.89–1.12)	0.992	0.95 (0.85–1.07)	0.407						
	Not a big problem	1.00		1.00		1.00							

Significance at $p < 0.05$.

Table 7. Risk factors for severity of anaemia among non-pregnant women in Nigeria, 2018.

Parameters		Crude odd ratios						Adjusted odd ratios					
		Severe	ρ value	Moderate	ρ value	Mild	ρ value	Severe	ρ value	Moderate	ρ value	Mild	ρ value
Age groups	15–19	0.32 (0.11–0.88)	0.028	1.20 (0.90–1.60)	0.214	1.16 (0.85–1.58)	0.361	0.42 (0.20–.89)	0.018	1.09 (0.88–1.35)	0.423	1.19 (0.96–1.46)	0.104
	20–24	0.38 (0.15–0.99)	0.047	1.05 (0.81–1.36)	0.737	0.89 (0.65–1.23)	0.487	0.59 (0.29–1.22)	0.153	1.01 (0.82–1.25)	0.895	0.91 (0.73–1.14)	0.421
	25–29	0.55 (0.24–1.23)	0.146	1.07 (0.85–1.35)	0.588	0.89 (0.68–1.16)	0.385	0.75 (0.40–1.43)	0.384	1.08 (0.88–1.33)	0.446	0.91 (0.74–1.11)	0.353
	30–34	1.32 (0.70–2.49)	0.385	1.12 (0.89–1.41)	0.327	0.95 (0.75–1.20)	0.650	1.63 (0.89–3.00)	0.115	1.14 (0.92–1.42)	0.234	0.96 (0.79–1.19)	0.733
	35–39	0.97 (0.49–1.91)	0.934	1.27 (1.01–1.60)	0.038	1.02 (0.82–1.28)	0.827	1.13 (0.60–2.12)	0.699	1.28 (1.03–1.60)	0.029	1.06 (0.86–1.30)	0.586
	40–44	0.74 (0.36–1.52)	0.412	1.14 (0.90–1.44)	0.269	0.97 (0.76–1.25)	0.844	0.78 (0.39–1.58)	0.494	1.15 (0.91–1.45)	0.245	1.00 (0.79–1.28)	0.995
	45–49	1.00		1.00		1.00		1.00		1.00		1.00	
Current marital status	Married/ living with partner	1.68 (0.74–3.80)	0.030	1.17 (0.92–1.51)	0.407	0.96 (0.77–1.20)	0.290						
	Widowed/ divorced/ separated	2.77 (1.10–6.96)	0.172	1.14 (0.83–1.57)	0.827	0.85 (0.63–1.15)	0.306						
	Never in union	1.00		1.00		1.00							
Family size	⩾5	1.38 (0.91–2.09)	0.130	1.02 (0.90–1.17)	0.703	1.12 (0.99–1.28)	0.081						
	<5	1.00		1.00		1.00							
Sex of household head	Female	0.87 (0.53–1.45)	0.599	0.91 (0.78–1.06)	0.203	0.89 (0.77–1.03)	0.118						
	Male	1.00		1.00		1.00							
Parity	Primiparous	0.90 (0.40–2.00)	0.131	1.14 (0.89–1.45)	0.366	1.17 (0.91–1.51)	0.391						
	Multiparous	0.61 (0.29–1.28)	0.171	1.04 (0.81–1.34)	0.988	1.07 (0.84–1.37)	0.780						
	Grand multiparous	0.54 (0.24–1.20)	0.650	1.14 (0.86–1.51)	0.236	1.13 (0.85–1.50)	0.507						
	Nulliparous	1.00		1.00		1.00							
Modern contraceptive use	No	2.09 (1.03–4.22)	0.040	1.34 (1.14–1.59)	0.001	1.12 (0.94–1.33)	0.197	2.16 (1.08–4.34)	0.030	1.32 (1.13–1.56)	0.001	1.09 (0.09–1.29)	0.274
	Yes	1.00		1.00		1.00		1.00		1.00		1.00	
Currently breastfeeding	Yes	1.46 (0.92–2.31)	0.106	1.01 (0.88–1.16)	0.839	1.03 (0.88–1.20)	0.704						
	No	1.00		1.00		1.00							
Body mass index	Underweight	2.41 (1.58–3.68)	<0.001	1.26 (1.07–1.48)	<0.001	0.99 (0.81–1.20)	0.063	2.38 (1.58–3.58)	<0.001	1.25 (1.07–1.47)	<0.001	0.99 (0.81–1.21)	0.054
	Overweight	0.51 (0.29–0.87)	0.006	0.80 (0.68–0.93)	<0.001	0.78 (0.67–0.91)	0.023	0.50 (0.29–0.86)	0.006	0.80 (0.69–0.93)	<0.001	0.79 (0.68–.91)	0.019
	Obese	0.29 (0.12–0.70)	0.253	0.56 (0.46–0.67)	0.001	0.79 (0.64–0.97)	0.907	0.29 (0.12–0.70)	0.263	0.57 (0.47–0.68)	0.001	0.78 (0.64–0.96)	0.961
	Normal	1.00		1.00		1.00		1.00		1.00		1.00	
Stature	Short stature	1.46 (0.41–5.13)	0.558	1.45 (0.96–2.19)	0.078	0.82 (0.53–1.27)	0.379						
	Normal	1.00		1.00		1.00							

(Continued)

Table 7. (Continued)

Parameters		Crude odd ratios						Adjusted odd ratios					
		Severe	ρ value	Moderate	ρ value	Mild	ρ value	Severe	ρ value	Moderate	ρ value	Mild	ρ value
Region	North-Central	1.38 (0.61–3.13)	0.446	0.96 (0.78–1.19)	0.743	0.70 (0.58–0.84)	<0.001	1.60 (0.71–3.60)	0.259	0.98 (0.79–1.20)	0.814	0.71 (0.59–0.86)	<0.001
	North-East	1.24 (0.52–2.96)	0.629	0.88 (0.70–1.10)	0.264	0.70 (0.57–0.87)	0.001	1.59 (0.67–3.75)	0.290	0.91 (0.73–1.13)	0.399	0.72 (0.59–0.90)	0.003
	North-West	1.81 (0.79–4.18)	0.166	0.83 (0.67–1.05)	0.130	0.71 (0.57–0.88)	0.002	2.51 (1.16–5.41)	0.019	0.89 (0.72–1.10)	0.280	0.74 (0.59–0.92)	0.006
	South-East	4.77 (2.37–9.60)	<0.001	2.19 (1.77–2.70)	<0.001	1.36 (1.12–1.66)	0.002	5.10 (2.55–10.23)	<0.001	2.26 (1.84–2.78)	<0.001	1.38 (1.14–1.68)	0.001
	South-South	3.83 (1.78–8.28)	0.001	1.97 (1.59–2.43)	<0.001	1.01 (0.83–1.23)	0.888	4.01 (1.87–8.59)	<0.001	1.92 (1.56–2.37)	<0.001	1.01 (0.83–1.23)	0.947
	South-West	1.00		1.00		1.00		1.00		1.00		1.00	
Place of residence	Rural	1.20 (0.74–1.96)	0.456	1.28 (1.10–1.50)	0.002	1.18 (1.02–1.36)	0.025	1.11 (0.70–1.75)	0.656	1.30 (1.12–1.50)	<0.001	1.21 (1.07–1.36)	0.003
	Urban	1.00		1.00		1.00		1.00		1.00		1.00	
Highest educational level	No education	4.16 (1.61–10.77)	0.003	1.62 (1.24–2.11)	0.000	1.32 (1.02–1.70)	0.034	4.70 (1.88–11.72)	0.001	1.78 (1.39–2.27)	<0.001	1.40 (1.11–1.78)	0.005
	Primary	2.45 (0.98–6.11)	0.054	1.19 (0.93–1.52)	0.171	1.07 (0.82–1.38)	0.618	2.79 (1.18–6.61)	0.020	1.28 (1.02–1.61)	0.034	1.11 (0.88–1.40)	0.391
	Secondary	1.93 (0.87–4.31)	0.107	1.16 (0.93–1.43)	0.184	0.99 (0.80–1.22)	0.905	2.09 (0.97–4.52)	0.061	1.21 (0.99–1.48)	0.067	1.02 (0.83–1.25)	0.834
	Higher	1.00		1.00		1.00		1.00		1.00		1.00	
Employment status	No	1.36 (0.90–2.06)	0.138	1.15 (1.01–1.32)	0.032	1.11 (0.98–1.26)	0.113						
	Yes	1.00		1.00		1.00							
Wealth index	Poorest	1.26 (0.58–2.72)	0.562	1.47 (1.16–1.87)	0.001	1.29 (1.04–1.62)	0.023	1.08 (0.47–2.49)	0.850	1.47 (1.20–1.81)	<0.001	1.34 (1.11–1.63)	0.003
	Poorer	0.55 (0.26–1.19)	0.129	1.19 (0.97–1.46)	0.101	1.08 (0.88–1.31)	0.461	0.50 (0.22–1.13)	0.098	1.17 (0.97–1.41)	0.110	1.10 (0.90–1.33)	0.347
	Middle	0.67 (0.33–1.36)	0.272	1.24 (1.03–1.50)	0.026	1.13 (0.95–1.36)	0.177	0.63 (0.30–1.33)	0.224	1.24 (1.04–1.48)	0.016	1.14 (0.96–1.36)	0.145
	Richer	1.08 (0.57–2.04)	0.819	0.98 (0.81–1.19)	0.852	1.09 (0.92–1.27)	0.314	1.05 (0.54–2.07)	0.884	0.97 (0.81–1.16)	0.755	1.10 (0.94–1.28)	0.233
	Richest	1.00		1.00		1.00		1.00		1.00		1.00	
Water	Unimproved	0.64 (0.43–0.96)	0.034	0.97 (0.85–1.10)	0.641	0.98 (0.87–1.11)	0.809						
	Improved	1.00		1.00		1.00							
Sanitation	Unimproved	1.10 (0.74–1.65)	0.633	1.01 (0.88–1.17)	0.858	1.12 (0.97–1.29)	0.129						
	Improved	1.00											
Access to media	None	0.81 (0.55–1.18)	0.268	1.19 (1.07–1.33)	0.002	0.97 (0.87–1.08)	0.602	0.84 (0.57–1.23)	0.366	1.20 (1.08–1.34)	0.001	0.99 (0.89–1.10)	0.787
	Any form	1.00		1.00		1.00		1.00		1.00		1.00	
Dietary diversity	Low diversity	1.51 (1.00–2.29)	0.050	0.99 (0.88–1.12)	0.861	1.04 (0.92–1.18)	0.557						
	High diversity	1.00		1.00		1.00							
Respondent slept under mosquito bed net	No	0.93 (0.51–1.71)	0.754	1.05 (0.91–1.22)	0.676	1.02 (0.88–1.18)	0.404						
	Yes	1.00		1.00		1.00							
Distance to health facility	Big problem	0.67 (0.44–1.02)	0.060	1.00 (0.88–1.13)	0.957	0.93 (0.82–1.06)	0.284						
	Not a big problem	1.00		1.00		1.00							

Significance at $p < 0.05$.

Table 8. Risk factors for severity of anaemia among pregnant women in Nigeria, 2018.

Parameters		Crude odd ratios						Adjusted odd ratios					
		Severe	ρ value	Moderate	ρ value	Mild	ρ value	Severe	ρ value	Moderate	ρ value	Mild	ρ value
Age groups	15–19	4.25E + 08 (4.25E + 08–4.25E + 08)		1.28 (0.27–6.08)	0.752	1.32 (0.24–7.14)	0.746						
	20–24	1.61E + 08 (1.61E + 08–1.61E + 08)		1.33 (0.32–5.47)	0.692	1.89 (0.38–9.32)	0.433						
	25–29	8.48E + 07 (8.48E + 07–8.48E + 07)		1.48 (0.37–5.84)	0.578	1.75 (0.36–8.45)	0.483						
	30–34	2.06E + 08 (2.06E + 08–2.06E + 08)		2.13 (0.55–8.29)	0.273	3.05 (0.64–14.50)	0.161						
	35–39	1.00E + 08 (1.00E + 08–1.00E + 08)		1.68 (0.42–6.68)	0.464	2.55 (0.53–12.33	0.243						
	40–44	5.65E + 08 (5.65E + 08–5.65E + 08)		0.82 (0.19–3.50)	0.783	1.47 (0.29–7.37)	0.638						
	45–49	1.00		1.00		1.00							
Current marital status	Married/ living with partner	0.47 (0.06–3.83)	0.529	0.24 (0.08–0.76)	0.188	0.54 (0.14–2.03)	0.864						
	Widowed/ divorced/ separated	0.32 (0.01–11.39)	0.798	0.23 (0.02–2.08)	0.946	1.19 (0.16–9.06)	0.344						
	Never in union	1.00		1.00		1.00							
Sex of household head	Female	3.08 (0.78–12.18)	0.108	1.20 (0.78–1.86)	0.408	0.81 (0.48–1.36)	0.430						
	Male	1.00		1.00		1.00							
Parity	Primiparous	0.86 (0.26–2.88)	0.217	0.84 (0.48–1.48)	0.274	1.00 (0.56–1.78)	0.633						
	Multiparous	1.43 (0.26–7.90)	0.207	0.99 (0.56–1.75)	0.502	0.92 (0.52–1.62)	0.632						
	Grand multiparous	0.21 (0.02–2.53)	0.032	0.68 (0.34–1.36	0.087	0.84 (0.41–1.73)	0.698						
	Nulliparous	1.00		1.00		1.00							
Stature	Short stature	1.028E-09 (3.503E-10–3.017E-09)	<0.001	0.25 (0.06–1.07)	0.062	0.13 (0.02–1.01)	0.051	7.251E-10 (2.499E-10–2.104E-09)	<0.001	0.32 (0.07–1.38)	0.126	0.15 (0.02–1.28)	0.083
	Normal	1.00		1.00		1.00		1.00		1.00		1.00	
Region	North-Central	3.87 (0.64–23.23)	0.139	1.03 (0.55–1.93)	0.918	1.33 (0.63–2.81)	0.459	2.78 (0.45–17.07)	0.268	1.09 (0.59–2.03)	0.781	1.39 (0.65–2.94)	0.395
	North-East	1.49 (0.24–9.16)	0.665	0.42 (0.22–.81)	0.010	0.54 (0.27–1.07)	0.076	1.59 (0.28–9.20)	0.603	0.49 (0.25–0.93)	0.030	0.61 (0.30–1.25)	0.180
	North-West	1.60 (0.26–10.00)	0.614	0.60 (0.33–1.10)	0.097	0.56 (0.28–1.14)	0.108	1.57 (0.27–9.32)	0.618	0.61 (0.30–1.25)	0.122	0.60 (0.29–1.22)	0.155
	South-East	5.62 (0.77–40.72)	0.088	2.12 (1.11–4.03)	0.022	1.21 (0.58–2.51)	0.614	4.87 (0.69–34.46)	0.113	2.46 (1.27–4.77)	0.008	1.41 (0.66–3.02)	0.381
	South-South	9.41 (1.35–65.79)	0.024	0.74 (0.35–1.57)	0.432	0.77 (0.35–1.69)	0.513	9.27 (1.24–69.25)	0.030	0.90 (0.42–1.93)	0.785	0.84 (0.38–1.89)	0.681
	South-West	1.00		1.00		1.00		1.00		1.00		1.00	
Place of residence	Rural	2.15 (0.64–7.19)	0.213	1.81 (1.21–2.70)	0.004	1.74 (1.13–2.68)	0.012	1.79 (0.66–4.89)	0.253	1.44 (1.04–1.98)	0.027	1.41 (0.99–2.03)	0.060
	Urban	1.00		1.00		1.00		1.00		1.00		1.00	

(Continued)

Table 8. (Continued)

Parameters		Crude odd ratios						Adjusted odd ratios					
		Severe	ρ value	Moderate	ρ value	Mild	ρ value	Severe	ρ value	Moderate	ρ value	Mild	ρ value
Highest educational level	No education	4.20 (0.54–32.64)	0.170	4.38 (2.10–9.13)	<0.001	1.72 (0.80–3.67)	0.163	3.52 (0.52–23.82)	0.196	4.97 (2.68–9.19)	<0.001	1.75 (0.95–3.24)	0.073
	Primary	4.07 (0.54–30.52)	0.172	4.52 (2.12–9.61)	<0.001	2.55 (1.17–5.57)	0.018	5.93 (0.89–39.69)	0.066	4.82 (2.54–9.16)	<0.001	2.50 (1.25–4.97)	0.009
	Secondary	1.60 (0.30–8.65)	0.584	2.22 (1.17–4.20)	0.015	1.49 (0.79–2.80)	0.215	2.16 (0.35–13.52)	0.409	2.40 (1.35–4.28)	0.003	1.41 (0.80–2.49)	0.236
	Higher	1.00		1.00		1.00		1.00		1.00		1.00	
Employment status	No	2.65 (0.92–7.69)	0.072	1.23 (0.89–1.69)	0.214	1.60 (1.12–2.27)	0.010	3.92 (1.51–10.15)	0.005	1.23 (0.89–1.70)	0.202	1.46 (1.03–2.08)	0.034
	Yes	1.00		1.00		1.00		1.00		1.00		1.00	
Wealth index	Poorest	1.44 (0.18–11.49)	0.728	2.15 (1.12–4.13)	0.022	1.48 (0.76–2.91)	0.252						
	Poorer	1.33 (0.23–7.60)	0.750	1.98 (1.09–3.60)	0.025	1.69 (0.91–3.15)	0.096						
	Middle	1.68 (0.30–9.34)	0.553	1.45 (0.83–2.52)	0.193	0.99 (0.55–1.78	0.982						
	Richer	0.89 (0.20–3.93)	0.876	1.38 (0.82–2.31)	0.222	0.92 (0.53–1.60)	0.764						
	Richest	1.00		1.00		1.00							
Sanitation	Unimproved	0.88 (0.33–2.36)	0.807	0.84 (0.57–1.22)	0.361	0.97 (0.65–1.45)	0.890						
	Improved	1.00		1.00		1.00							
Access to media	None	0.54 (0.17–1.67)	0.284	0.96 (0.65–1.40)	0.817	0.77 (0.52–1.14)	0.194						
	Any form	1.00		1.00		1.00							

*Significance at $p < 0.05$.

address the risk factors identified in this study in strategies to reduce anaemia prevalence in Nigeria.

Our findings of significant regional differences in anaemia prevalence and severity among WRA, pregnant women, and non-pregnant women are consistent with evidence that residing in specific regions or provinces increased the odds of being anaemic in other LMICs.[15,17,18,20,44] Our finding that the northern regions were largely protective is surprising given that households in South-East and South-South zones consumed more diverse diets than in other regions in Nigeria.[45] Contrary to our finding, anaemia prevalence among WRA was higher in the Northern regions than in Southern regions in a previous Nigerian study.[4] The reduction in anaemia in the Northern regions in the current study might stem from the use of different datasets and the timing of the studies. Our study used the 2018 NDHS dataset, but the prior study used the 2015 NDHS dataset.[4] It could be that variations in geographical and dietary-related factors could have a role in regional differences in anaemia prevalence as found in an earlier study.[14] The high consumption of meat and milk, which are rich in iron, may be one reason for the low prevalence of anaemia in the North. Between 2013 and 2017, there was improved access to a micronutrient, use of health facilities, nutritional counselling, and dietary diversity in Northern Nigeria resulting from increased donor-supported community-based maternal and child nutrition and food security interventions in Northern Nigeria.[46] Future qualitative studies to understand the geographical disparities in anaemia prevalence in Nigeria are warranted.

Our finding that rural residence predicted increased risk of anaemia and its severity is consistent with increased odds of being anaemic among pregnant women,[28,31,32] non-pregnant women,[24] and all WRA[4,11,13,15,21,44] in prior studies but differs from other studies where a rural residence is protective[14] or urban residence is a risk factor.[16] Low access to mass media in rural areas resulting in inequitable access to health information might contribute to the risk of being anaemic even though media exposure was only significant for moderate anaemia among all WRA and NPW in our model.[47] Second, Nigerian women residing in urban areas are more likely to be overweight/obese, while rural women are more likely to be either underweight or overweight.[48] Third, rural women are less likely to use modern contraceptives compared to urban women.[49] In our study, being underweight and non-use of contraceptives increased the odds of being anaemic among all WRA and NPW. To reduce the anaemia burden in rural areas, strategies addressing these rural disparities are needed.

Our findings that low education increased the odds of being anaemic and anaemia severity among all WRA, pregnant women, and non-pregnant WRA agreed with evidence from prior studies among pregnant women,[19,31] and all WRA,[4,13,16] whereas educational attainment was protective of being anaemic.[2,12,14] As stated elsewhere,[4,13] high education helps women to improve their nutrition and sanitary practices, hence reduce the risk of anaemia. Also, the more educated pregnant women complied with the uptake of iron-folate supplements to prevent anaemia during pregnancy.[31] Evidence shows that women who did not consume iron supplements during pregnancy had consistently higher odds of anaemia compared to women who did.[15]

Equally, this study's findings that being unemployed increased the odds of being anaemic among all WRA, pregnant women, and non-pregnant women are consistent with evidence from earlier studies.[11,14,20,27] Furthermore, unemployment increased the risk of severe anaemia among pregnant women and overall WRA in the current study. First, employment could enhance women's participation in household decision-making for their health care, hence improving health-seeking behaviours.[50] Second, employment increases women's economic empowerment, which means that women can effectively improve their food consumption preferences and hygienic practices.[50] Third, enhanced women's decision autonomy and economic empowerment increase the use of modern contraceptives, which in turn, decreases the likelihood of being anaemic.[23]

Our findings that household socio-economic status predicted anaemia prevalence and severity among all WRA and non-pregnant women highlight the protective role of wealth and predisposing role of poverty in being anaemic. These findings agreed with existing evidence that the rich quintile reduced the likelihood of being anaemic among non-pregnant women[24] and in all WRA,[2,11,12,14,18,44] while being poor increased the likelihood of anaemia among all WRA.[4,13,16,17,21,22,31] High socio-economic status improves women's access to improved sanitation, adequate dietary diversity, enhanced access to health care facilities as well as better media exposure, which contribute to the prevention of anaemia among WRA.[51]

The use of modern contraceptives reduced the risk of being anaemic and anaemia severity as was reported in several prior studies among non-pregnant women,[23,24] and all WRA.[2,14,17,18] Conversely, contraceptive use increased the likelihood of being anaemic.[12] Evidence from the literature indicates that the prevalence of anaemia declines with increasing duration of use of modern contraceptives in one of three ways.[23] First, spacing births reduces nutritional stress associated with successive pregnancies, preventing maternal iron depletion.[23] Second, some contraceptives modify the iron status, which lowers the risk of being anaemic.[23] Third, iron-containing contraceptives provide iron supplementation to prevent iron deficiency anaemia.[23] Further studies are needed to determine which of these factors play a greater role in predisposing to anaemia among WRA in Nigeria.

Similar to findings in Ethiopia, normal body weight reduced the likelihood of being anaemic among

non-pregnant women in our study.[24] Our findings also agreed with evidence that normal weight[11,17] and being overweight or obese[18] reduced the chances of anaemia, but underweight increased the risk of anaemia among all WRA.[11,16–18] Nevertheless, short stature was found to be a protective factor for being anaemic and developing severe anaemia among pregnant women in the current study. The protective influence of short stature might be because women with short stature were prioritized in micronutrient supplementation and food fortification interventions in Nigeria.[43] Anaemia, due to being underweight, might result from undernourishment, but poor dietary diversity was not predictive of being anaemic in this study. Further studies are required to determine the relationship between micronutrient-rich diets and BMI and anaemia among WRA and non-pregnant women in Nigeria.

Our finding that large household size increased the likelihood of developing anaemia is congruent with evidence from Ethiopia and Rwanda.[14,17] Low per capita income, commonly seen in large-sized households, results in food insecurity, reducing access to a diversity of sustainable healthy diets, and predisposing women to nutritional deficiency anaemia. On the contrary, our finding that lack of media exposure increased the likelihood of being moderately anaemic among non-pregnant and overall WRA is consistent with evidence from a preceding study.[52] Access to media is associated with awareness of the value and availability of health services,[47,53] information on diets and nutrition,[54] and increased likelihood of contraceptive use.[55,56] Furthermore, our finding that age 30 to 39 increased the odds of developing moderate anaemia among non-pregnant women contrasts evidence of reduced odds of anaemia among this age group in Ethiopia.[13] A possible explanation for the increased odds among women aged 30–39 years in Nigeria could be their high fertility rates.[13,35]

Our study provides generalizable evidence of determinants of anaemia among WRA in Nigeria. Second, we included both pregnant and non-pregnant WRA. Nevertheless, a cause-and-effect relationship cannot be established in a cross-sectional study such as ours. Also, pregnancy status relied on women's verbal responses and was not validated by any clinical test, which could bias the results. Moreover, this study did not account for chronic diseases such as blood disorders and metabolic diseases, which might affect anaemia status.

Conclusion

Anaemia prevalence among WRA, pregnant women, and non-pregnant women constituted a severe public health problem. The region, rural residence, low education, unemployment, low wealth index, and non-use of modern contraceptives increased the likelihood of being anaemic among all WRA and non-pregnant women. Lack of media exposure significantly increased the odds of developing severe anaemia among overall WRA and non-pregnant women. In addition, large family size significantly increased the likelihood of being anaemic among overall WRA. Among pregnant women, specific regions, unemployment, and low education also increased the likelihood of being anaemic and developing severe anaemia. Whereas underweight increased the likelihood of being anaemic in non-pregnant women, short stature reduced the odds of both anaemia and severe anaemia among pregnant women. Considering these factors in health and nutrition interventions and programmes would reduce anaemia prevalence and severity among WRA in Nigeria.

Declarations

Ethics approval and consent to participate

Since this study was a secondary analysis of the Nigeria Demographic and Health surveys (NDHS) data, which are publicly available, the study did not require any ethical approval. Only DHS programme authorization was requested to download the dataset.

Consent for publication

Not applicable.

Author contribution(s)

Daniel Chukwuemeka Ogbuabor: Conceptualization; Data curation; Formal analysis; Methodology; Project administration; Software; Supervision; Validation; Writing – original draft; Writing – review & editing.
Alphonsus Ogbonna Ogbuabor: Conceptualization; Data curation; Formal analysis; Methodology; Validation; Writing – review & editing.
Nwanneka Ghasi: Conceptualization; Data curation; Formal analysis; Methodology; Project administration; Writing – review & editing.

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Availability of data and materials

The data used for this study are from the 2018 Nigeria Demographic and Health surveys (NDHS) and are publicly available here: https://dhsprogram.com/data/available-datasets.cfm Data was accessed by the researchers upon registration.

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