A Multilevel Bayesian Markov Chain Monte Carlo Poisson Modelling of Factors Associated With Number of Components of Antenatal Care Offered Pregnant Women In Nigeria

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Abstract

Background: The most recent WHO guideline on antenatal care (ANC) utilization reaffirmed the necessary and compulsory care and services a pregnant woman should receive to maximize the importance and gains of ANC. While most studies focused on the time of initiation and number of ANC contacts, emphasis was rarely placed on the components of ANC offered women. This study assessed the number of components of ANC received by pregnant women as a proxy for the quality of ANC services offered in Nigeria. We also assessed the clustering of the components and within-country differentials and inequalities in the components of ANC received in Nigeria.

Methods: We used nationally representative cross-sectional data from the 2018 Nigeria Demographic Health Survey. We analysed data of 11867 women who had at least one ANC contacts during the most recent pregnancy within five years preceding the survey. The assessed components were tetanus injection, blood pressure, urine test, blood test, iron supplement, malaria intermittent preventive treatment in pregnancy (IPTp), and told about danger signs. Others are intestinal parasite drugs (IPD) intermittent and HIV/PMTCT counsel. Descriptive statistics, bivariable and multivariable multilevel Bayesian Monte Carlo Poisson model were used.

Results: In all, 94% had blood pressure measured, 91% received tetanus injection, had iron supplement-89%, blood test-87%, urine test-86%, IPTp-24%, danger signs-80%, HIV/PMTC-82% and IPD-22%. The overall prevalence of receiving all 9 components was 5% and highest in Ogun (24%) and lowest in Kebbi (0.1%). The earlier the initiation of ANC, the higher the number of contacts, and the higher the quality of ANC received. Respondents with higher education have 4% (adjusted incidence risk ratio (aIRR): 1.04, 95% credible interval (CrI): 1.01-1.09) higher risk of receiving more components of ANC relative to those with no education. The risk of receiving more ANC components were 5% (aIRRR: 1.05, 95% CI: 1.01-1.10) higher among pregnant women aged 40 to 49 years than those aged 15 to 19 years. Women who decide their healthcare utilization alone had 2% higher risk of getting more components than those whose spouses are the only decision taker of health care use. Other significant factors were household wealth status, spouse education, ethnicity, place of ANC, and skill of ANC provider. Pregnant women who had their blood pressure measured were very likely to have blood and urine tests, tetanus injection, iron supplement, and HIV talks.

Conclusions: Only one in every 20 pregnant women received all the 9 ANC components with wide disparities and inequalities across the background characteristics and the States of residence in Nigeria. There is a need to ensure that all pregnant women receive adequate components. Stakeholders should increase supplies, train, and create awareness among ANC providers and pregnant women in particular.

Introduction

Although improvements have been recorded in maternal and child health globally, most developing countries in sub-Saharan Africa (SSA) have continued to lag in the pace of this improvement [1]. Most

maternal and child health indicators put the Low and Middle-Income Countries (LMIC) including Nigeria at the lower end of the scale [1]. The Maternal and Child Health (MCH) situation in the SSA remained worrisome when compared to the advanced countries and some other developing countries. A childbearing woman in the developed countries has 1 in 5,400 chance of dying from pregnancy and childbirth-related complications compared with only 1 in 22 chances in SSA [1].

To facilitate the attainment of Sustainable Development Goals (SDGs) on improved health and wellbeing [2], in its Strategy for Health 2016 to 2030, the UNICEF envisioned “a world where no child dies from a preventable cause and all children reach their full potential in health and wellbeing” [3]. Efforts focused on achieving this vision birthed the goal to “end preventable maternal, newborn and child deaths” [3]. This underscores the need to ensure guaranteed maternal and child health without inequality at any level. Antenatal care (ANC) is recognised worldwide as the main approach to ensure safe maternal and infant health outcomes. Compliance with ANC protocol is important in the management of pregnancy conditions and is essential for safe delivery [4–7]. The standards in the existing ANC protocol were reviewed in 2016 to reinvigorate the ANC program to guarantee the realization of the relevant goal of the SDGs by 2030 [7]. The reviewed WHO guideline on ANC utilization established three main pillars that can help maximize the gains and importance of ANC utilization. They are (i) initiation of first ANC contact in the first trimester of gestation (ii) having a minimum of 8 ANC contacts and (iii) receiving all components of ANC during the contacts with ANC providers. Therefore, it is not just sufficient to initiate ANC early and have at least 8 ANC contacts, a pregnant woman must receive all the components of ANC services. WHO therefore prescribed the components of ANC to achieve effective results all over the world [7]. Thus, among other reviewed standards, several services were packaged to make up the minimum quality of ANC available to a pregnant woman. Emphasis was laid on the compulsory administration of specific components of ANC [7]. WHO identified and grouped the components to ensure standard quality of ANC into three (i) history taking, assessment, physical examination and laboratory tests, (ii) health promotion and education on nutrition, delivery, danger signs, child health and (iii) care provision such as tetanus toxoid immunization, and others [7–10]. The specifics of these components vary slightly across countries.

Although evidence supports that ANC coverage has increased in Nigeria [11–14], improvement in coverage alone cannot guarantee safe maternal and infant health outcomes [15, 16]. A Nigerian study showed evidence of an unacceptable quality of ANC with only about 1 in 8 pregnant women who had ANC contacts were provided with the minimum quality standard [15]. The study further emphasized that the poor quality of ANC among childbearing women might have contributed to the non-realisation of the defunct Millennium Development Goals (MDGs) on child and maternal health in Nigeria.

Early initiation of ANC, sufficient number of ANC contacts, attention by skilled health workers, living in urban areas, better education, short distance to health facilities, media exposure, and household wealth quintile have been associated with the quality of ANC received by pregnant women in Nigeria [15, 17–19]. Older pregnant women, higher parity, higher level of education, and higher household wealth status were identified as factors associated with receiving a good quality of ANC by a similar study in Nepal [18]. Also, a Kenyan study pointed out that level of women’s literacy, employment status, and receiving all ANC

services from a health facility had a relationship with having a good quality of ANC by pregnant women [20, 21]. Studies have identified that the commonest components of ANC services received by pregnant women were blood pressure measurement, iron supplement, urine test [15, 20]; while education on PMTCT was low in Nigeria as only 2 in 5 tested for HIV during ANC visit [15] and negligible proportion had an ultrasound performed.

While most studies focused on the time of initiation of ANC contacts and the minimum number of ANC contacts made, such emphasis was rarely placed on the components of ANC offered women during the ANC contacts. Whereas, up to date information on the components of ANC services could provide a good understanding of the level of compliance with the recommended components and standards of ANC in Nigeria and could provide relevant evidence-based information necessary to inform policy on the implementation of the WHO ANC guidelines. This study is also a response to the United Nations call for periodical monitoring and evaluation of how close countries of the world are to attaining the specific targets of the Sustainable Development Goals (SDG) [2]. The call also encouraged sub-country analysis. Our study shows how close Nigeria is to SDG-3 target 3.1: “By 2030, end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births” [2]. The services received during ANC contacts are of paramount importance to the attainment of SDG-3. Therefore, this study assessed the number of components of ANC received by pregnant women in Nigeria and its associated factors. We also assessed within-country differentials and inequalities in the quality of ANC care across the states in Nigeria and examined clustering of the ANC components (or its lack) to inform policy intervention and research translation. The study provided recommendations on the pathways for the improvement of maternal and child health outcomes in Nigeria.

Methodologies

Study Setting and Data Source

The study was retrospective and cross-sectional in design. Data were extracted from the nationally representative 2018 Nigeria Demographic Health Survey (NDHS) conducted by ICF Macro Calverton, Maryland, USA in conjunction with the Nigeria National Population Commission (NPC), Nigeria [13]. Administratively, Nigeria is divided into 36 states and the Federal Capital Territory (FCT). The states are further grouped into 6 regions as shown in Fig. 1. Although the regions have no administrative functions, people within each region are deemed to have similar characteristics, culture, ethnicity, vegetation etc. Each state is subdivided into local government areas (LGAs). Using the most recent 2006 Population Census, each LGA was subdivided into convenient areas called census enumeration areas (EAs).

Sampling Techniques

A two-stage probability sampling was adopted to select the respondents who were women of child-bearing age (15–49). The EAs were the primary sampling unit (PSU). In each state, depending on the population, about 38 EAs were selected with probability proportional to EA size making a total of 1,400

EAs in the first stage. Then a full list of households in all selected EAs in the first stage was drawn to serve as the sampling frame for household selection in the second stage. In the second stage, 30 households each were selected in every EAs using equal probability systematic sampling. All eligible women of reproductive age (15–49 years) in each selected household were interviewed. Due to the non-proportional allocation of sample sizes at the different states, LGAs and EAs, as well as the possible differences in response rates, sampling weights were applied in all the descriptive analysis. A total of 41,821 women aged 15–49 years were interviewed [13].

The Data

All respondents (women aged 15–49 years) were asked if they had any pregnancy or birth within 5 years preceding the survey (2013 to 2018). Those who had at least one birth were thereafter asked questions relating to conception, pregnancy-related care including ANC visits made, time ANC began, ANC care provider, etc of each birth delivery starting from the most recent. Our analysis is based on the information provided on the most recent deliveries and the associated pregnancy information. Among the 21,785 women who provided information about the ANC visits during their most recent pregnancy within the five years that preceded the survey, 16,448 (75.5%) made at least one ANC visit. We used all pregnancy history from 2013 to 2018 because the 2016 WGO guideline only reaffirmed the preceding guidelines in the 1990s, and 2006. Furthermore, of those that had at least one ANC contact, only 11867 (72.1%) provided the ANC components received during all ANC contacts for the most recent pregnancy. Our analysis was based on the components of ANC received by the 11867 women.

Variables

The outcome variable in this study is the quality of ANC services using the number of ANC components received as a proxy. The identified components were: receiving tetanus injection, intestinal parasite drugs (IPD), blood pressure, urine test, blood test, iron supplement, three or more doses of malaria intermittent preventive treatment in pregnancy (IPTp), told about danger signs, and counselled on HIV/PMTCT (either talked about HIV transmitted mother to child, things to do to prevent getting HIV, getting tested for HIV). These components have been recommended and recognized in the literature [7, 8, 15, 18, 20, 22].

Conceptual framework

Having ANC components could be influenced women and their household compositional factors as well as the contextual based on community and state of residence and the health system. These include women and their spouse background characteristics, their employment status, and household wealth status that could determine the type of facilities women patronize. Similarly, the birth order and preceding birth interval, as well as family mobility, could affect health care utilization. Due to the secondary nature of the data used, the health system factors considered in this study are having health insurance, the skill of the ANC provider and whether the ANC was received at a health facility or not. Having health insurance could dictate the type of health facility visited and by extension the skill of the ANC providers which are major influencers of giving ANC components to women. Of importance are the community factors (such

as poverty level, illiteracy, rural residence, poor media access) and societal factors such as religion and ethnicity as they could affect the uptake of components.

Based on existing literature [15, 17, 20, 21, 23, 24], the independent variables are maternal age (15–19, 20–24, 25–29, 30–39, 40–49 years), education (no education, primary, secondary and higher), spouse education (no education, primary, secondary and higher), employment status (currently employed or not), spouse employment status (currently employed or not), access to media (at least one of radio, television, or newspaper), household wealth tertiles (lowest, middle, and highest), women's autonomy using “who decides respondents health care” (respondent alone, respondent/spouse, and spouse alone) as a proxy. Others are birth interval (firstborn, < 36 months, and ≥ 36 months), birth order (1, 2, 3, 4 and 5+), children ever born (none, 1–2, 3–4, 4+), current marital status (currently married or living together, divorced/separated/widowed, never married), place of residence (rural/urban), religion (Islam, Christian, others), and ethnicity (Hausa/Fulani, Igbo, Yoruba, and others). Family mobility (had stayed less than five years at residence or not), wanted child when became pregnant (then, later or not more), household headship (male or female), health insurance coverage (yes or no), place of ANC (health institution or not) and ANC caregiver (skilled or unskilled).

We also assessed four community-level factors in the descriptive analysis: poverty rate (high or low), unemployment rate (high or low), illiteracy rate (high or low), and media access rate (high or low). The communities are synonymous with the EAs. We computed the community socioeconomic (SES) disadvantage composite score using principal component analysis of the proportion of respondents within each community with no media access, who are illiterates, who are poor, and who are unemployed. The SES was categorized into three tertiles: lowest, middle, and highest. The only state-level characteristics considered was the proportion of the rural population in the states of residence. It was categorised as low rural proportion (0–33.3%); medium rural proportion (33.4–66.7%) and high rural proportion (66.8–100%).

Statistical Methods

Data were analysed using descriptive statistics, bivariable, and multivariable logistic regression using STATA version 16 (Stata Corp, Texas, USA). We invoked the “SVY” command in STATA to adjust for the study design and the sampling weights. Frequency tables showing percentages were used to describe the distribution of study respondents’ characteristics and the distribution of outcome variables by the respondents’ characteristics (Tables 1).

We fitted a multilevel Bayesian Markov Chain Monte Carlo (MCMC) Poisson-based Generalized Linear Model (GLMs) to the data, with women nested within EAs and the EAs nested within the states. The models have mixed outcomes consisting of the fixed and random parts as shown in Eq. (1).

$$\log(\gamma_{ijk}) = \underbrace{\beta_0 + \sum_{p=1}^t \beta_p X_{pijk}}_{Fixed} + \underbrace{U_{0jk} + V_{0k}}_{Random} \dots\dots\dots (1)$$

The “risk” that pregnant woman i of community j from state k will receive ANC component is denoted by Y_{ijk} . U_{ojk} is the random effect of mothers community j in state k and V_{ok} is the random effect of state k , e_{ijk} is the noise such that $e_{ijk} \sim N(0, \sigma_e^2)$, $U_{ojk} \sim N(0, \sigma_U^2)$ and $V_{ok} \sim N(0, \sigma_V^2)$ in a model with t covariates.

We reported the measure of the rates of receiving the components as incidence rate ratios (IRRs) with their 95% credible intervals (CrI). Measures of variations were explored using the intraclass correlation (ICC) and median incidence rate ratios (MIRR)[25, 26]. The ICCs, an equivalent of the variance partition coefficient (VPC), is the percentage of the total variance in the risk of a pregnant woman obtaining the components that is related to the community and state where they live (i.e. a measure of clustering of risk of child mortality in the same community and state). We also estimated the proportion of total variance which are accounted for at the community $[\sigma_U^2/(\sigma_U^2 + \sigma_V^2 + \sigma_e^2)]$ and the state $[\sigma_V^2/(\sigma_U^2 + \sigma_V^2 + \sigma_e^2)]$ levels. The MIRR is the estimate of the probability that a pregnant woman will receive additional components attributable to the community and state context. The Bayesian MCMC Multilevel Poisson model was implemented using MLwin v3.03 and implemented in Stata V16 with the following parameters: Burnin = 5000; Chain = 50000, Thinning = 50.

At the bivariable level, we first identified all variables that were significant at $p < 0.20$. The identified independent variables were then used as candidate variables in the multivariable model from where we identified the adjusted odds ratios of characteristics associated with the quality of ANC services. The “collin” command in Stata was used to identify collinear variables and the associated variance Inflation factor (VIF). Based on the VIF, the less important of a pair of collinear variables were dropped from the multiple regression. We used the principal component (PCA) and factor analysis procedure to explore clustering among the components. The PCA method maintains all theoretically relevant variables and avoids the negative influence of high inter-correlation among the variables [27, 28]. The “cluster single-linkage” and “loadingplot” commands in Stata were used to analyze the data and visualize the clustering respectively.

Ethics approval

This study was based on the analysis of existing survey data. The Institutional Review Board (IRB) of ICF Macro at Fairfax, Virginia in the USA reviewed and approved the MEASURE Demographic and Health Surveys Project Phase III. The 2010–2018 DHS’s are categorized under that approval. The IRB of ICF Macro complied with the United States Department of Health and Human Services requirements for the “Protection of Human Subjects” (45 CFR 46). Written informed consent was obtained from every study participant before participation and all information was collected without identifiers and kept confidentially. The full details of the ethical approvals can be found at <http://dhsprogram.com>.

Results

In all, 11867 women provided information about the ANC components received during ANC visits for their most recent pregnancy during the 5 years preceding the survey. During the last pregnancy, 94% had their

blood pressure measured, nine of every ten women (91%) received tetanus injection, 89% were given an iron supplement, 87% had a blood test, 86% had a urine test, 82% received counselling on HIV/PMTCT, 80% were told about danger signs while only 24% got IPTp and only 22% received IPD (Fig. 2).

Figure 3 shows that only 5% of the respondents received all the 9 components (Fig.3). The commonest (35%) number of components received was 7. About 61% and 90% received at least 7 and at least 5 components respectively.

Table 1 shows the distribution of the respondents by their background characteristics and the prevalence of receiving all the 9 studied components. The prevalence of having the 9 components was highest (6%) among women aged 30 to 39 years compared with 2% among those aged 15 to 19 years. Nearly a quarter (10%) of the pregnant women with higher education who had at least one ANC contact received all the 9 ANC components while less than 2% of those with no education did. The proportion of all the 9 ANC components was lowest among women whose spouse alone decide health care access (3%), no media exposure (2%), Hausa/Fulani (2%), from low wealth households (2%), North East (3%) North West (2%) and from rural areas (4%) as shown in Table 1. All the explanatory variables considered were significantly ($p < 0.001$) associated with receiving all the ANC components received except whether the pregnancy was wanted or not and the type of ANC facility attended. Also, all characteristics in Table 1 were associated with having all 9 components, except marital status, sex of household head, whether the pregnancy was wanted or not, health insurance, community media access. Having all the components was significantly higher among women from communities with low rates of illiteracy, poverty, and community socioeconomic disadvantage.

Table 1
Respondents' Characteristics and having all ANC components during the most recent pregnancy

Characteristics	n (%)	Received All 9	
		%	p-value
Age of mothers			0.004
15–19	705(6.0)	2.0	
20–24	2569(21.7)	4.1	
25–29	3314(27.9)	5.3	
30–39	4420(37.2)	6.0	
40–49	856(7.2)	5.4	
Highest educational level			0.000
No education	4057(34.2)	1.6	
Primary	1902(16.0)	5.2	
Secondary	4587(38.7)	6.9	
Higher	1320(11.1)	9.6	
Spouse's highest education			0.000
No education	2828(25.3)	1.1	
Primary	1631(14.6)	5.0	
Secondary	4494(40.2)	6.4	
Higher	2209(19.7)	7.3	
Who decides respondent's healthcare			0.000
Respondent alone	1176(10.5)	6.6	
Respondent and Spouse	3937(35.1)	7.0	
Spouse alone	6093(54.4)	3.4	
Media exposure			0.000
Unexposed to media	3519(29.7)	1.9	
Exposed to media	8348(70.3)	6.5	
Ethnicity			0.000
Hausa/Fulani	4668(39.3)	1.6	

Characteristics	n (%)	Received All 9
Yoruba	1680(14.2)	12.9
Igbo	2050(17.3)	8.5
Others	3468(29.2)	4.1
Religion		0.000
Islam	6750(56.9)	3.4
Other Christians	5064(42.6)	7.6
Others	53(0.5)	0.0
Marital Status		0.385
Never married	267(2.3)	10.4
Living with a spouse	11280(95.1)	5.0
Widowed/Divorced/Separated	320(2.7)	6.4
Household Wealth status		0.000
Lowest	2834(23.9)	1.7
Middle	3925(33.1)	4.0
Richest	5107(43.0)	9.0
Children ever-born		0.001
1 or 2 births	4260(38.9)	6.0
3 or 4 births	3424(28.9)	6.2
More than 4 births	3822(32.2)	3.2
Birth order		0.000
First	2315(19.5)	6.6
Second	2305(19.4)	5.4
Third	1903(16.0)	6.4
Fourth	1521(12.8)	5.9
Fifth or higher	3822(32.2)	3.2
Birth interval		0.001
First birth	2315(19.5)	6.6
< 36 months	5520(46.6)	4.1

Characteristics	n (%)	Received All 9
>=36 months	4013(33.9)	5.8
Current employment status		0.000
Employed	8346(70.3)	6.1
Unemployed	3521(29.7)	2.9
Spouse current employment statement		0.000
Employed	8846(74.5)	5.9
Unemployed	3021(25.5)	2.8
Household sex		0.110
Male	10716(90.3)	5.0
Female	1151(9.7)	6.3
Wanted Last child		0.738
Then	10338(87.1)	5.1
Later	1177(9.9)	5.4
Never	352(3.0)	4.1
Family Mobility		0.019
5 + yr	9561(80.6)	4.9
Less stable 0-4yr	2305(19.4)	6.3
Have health Insurance		0.223
No	11563(97.4)	5.1
Yes	304(2.6)	7.0
Place of antenatal care		0.026
Non-health facility	439(3.7)	1.9
Health facility	11428(96.3)	5.3
Provider of ANC assistance		0.000
Unskilled provider	1724(14.5)	1.5
Skilled provider	10143(85.5)	5.7
No of ANC Visits		0.000
1–3	2859(24.4)	2.0

Characteristics	n (%)	Received All 9
4–7	5960(51.0)	4.8
8+	2872(24.6)	7.6
First ANC Visit		0.000
Trimester 1	2805(23.7)	8.2
Trimester 2	7432(62.7)	4.6
Trimester 3	1611(13.6)	2.4
Region		0.000
North central	1420(12.0)	4.5
North East	2143(18.1)	3.1
North West	3770(31.8)	1.5
South East	1478(12.5)	8.3
South South	1112(9.4)	5.8
South West	1945(16.4)	12.2
Residence		0.000
Urban	5458(46.0)	6.6
Rural	6409(54.0)	3.9
Community Poverty Rate		0.001
High	4863(41.0)	3.7
Low	7004(59.0)	5.8
Community Illiteracy		0.000
High	4967(41.9)	3.3
Low	6900(58.1)	5.9
Community Unemployment		0.007
High	5226(44.0)	4.1
Low	6641(56.0)	5.8
Community Media barrier		0.167
High	5817(49.0)	4.6
Low	6049(51.0)	5.5

Characteristics	n (%)	Received All 9
Community SES Disadvantage		0.000
Lowest	4807(40.5)	9.7
Middle	4296(36.2)	4.0
Highest	2764(23.3)	1.3
Total	11867	5.1
Significance at χ^2, 0.05		

Figure 4 shows the map of Nigeria with the geographical distribution of the percentage of ANC attendees that received all the nine components across the states. The highest prevalence of receiving all the 9 studied components was highest in Abia (32%), none (0%) in Zamfara, Borno (0.1%) and Kebbi (0.3%). Benue (8.3%), Kwara (8.6%) and Adamawa (9.3%) are the only states in the North with at least 5% women receiving all the 9 components. The only five states with 10% or higher were from the southern part of Nigeria. The distribution of having all ANC component received during the most recent pregnancy by States and regions in Nigeria is shown in Supplementary Table A.

Relationship between the number of ANC contacts, the timing of first ANC contact, and receiving all 9 ANC components received in Nigeria

The number of ANC contacts made during the last pregnancy and the timing of the first ANC contact were both significantly associated with the adequacy of ANC components received (Table 1 and Fig. 5). Figure 5 shows that a linear association exists between the number of ANC contacts made, the timing of the first ANC contacts, and the adequacy of ANC care received. Pregnant women who had first ANC contact during the first trimester had a higher (8%) prevalence of having all 9 components than those who started in the third trimester (2%). Similarly, pregnant women who had 8 or more ANC contact had a higher (8%) prevalence of having all 9 components than those who had less than 4 contacts (2%).

Factors associated with the number of ANC Components Received

Table 2 shows the crude and adjusted risk of receiving additional components of ANC among the respondents from the multilevel Bayesian MCMC Poisson model. The five-way MCMC graphical diagnostics of model 5 at the community and state levels are presented in Figs. 6 and 7 respectively. Respondents with higher education have 4% (adjusted incidence risk ratio (aIRR): 1.04, 95 % confidence interval (CI): 1.01–1.09) higher risk of receiving more components of ANC relative to those with no education (Table 2). The risk of receiving more ANC components were 5% (aIRR: 1.05, 95% CI: 1.01–1.10) higher among pregnant women aged 40 to 49 years than those aged 15 to 19 years. Women who decide their healthcare utilization alone had 2% higher risk of getting more components than those whose spouses are the only decision taker of health care use. Pregnant women from in South East were 6% more likely to receive a higher number of components of ANC relative to those in the North West. Also,

respondents from the households in the richest wealth quartile were 3% more likely to receive a higher number of components of ANC relative to those from households in the low wealth category. The risk of having a higher number of components was 4% higher in communities with the lowest SES disadvantaged than those with the highest disadvantage. Other significant variables with having a higher number of components of ANC are spouse education, ethnicity, religion, respondent's current employment status, family mobility, having health insurance, place of ANC, and skill of ANC provider, the proportion of the rural population in the states of residence.

Table 2
Crude and Adjusted correlates of number of ANC components received during the most recent pregnancy
(NDHS 2018)

Characteristics	IRR(95% CI)	significance	aIRR(95% CI)	significance
Fixed Effects				
Age of mothers				
15–19	Reference			
20–24	1.05(1.02–1.09)	0.003	1.03(0.98–1.07)	0.096
25–29	1.09(1.05–1.13)	0.000	1.04(0.99–1.09)	0.045
30–39	1.09(1.06–1.13)	0.000	1.04(1.01–1.09)	0.038
40–49	1.08(1.03–1.12)	0.001	1.05(1.01–1.10)	0.045
Highest educational level				
No education	Reference			
Primary	1.06(1.04–1.09)	0.000	1.01(0.98–1.04)	0.300
Secondary	1.14(1.12–1.16)	0.000	1.04(1.01–1.07)	0.010
Higher	1.20(1.17–1.23)	0.000	1.04(1.01–1.09)	0.024
Spouse's highest education				
No education	Reference			
Primary	1.08(1.05–1.11)	0.000	1.03(1.01–1.05)	0.049
Secondary	1.15(1.12–1.17)	0.000	1.05(1.02–1.08)	0.000
Higher	1.18(1.15–1.21)	0.000	1.05(1.02–1.08)	0.000
Who decides respondent's healthcare				
Respondent alone	1.05(1.02–1.07)	0.001	1.02(1.01–1.03)	0.048
Respondent and Spouse	1.06(1.04–1.08)	0.000	1.00(0.98–1.02)	0.454

Characteristics	IRR(95% CI)	significance	aIRR(95% CI)	significance
Spouse alone	Reference			
Media exposure				
Exposed to media	1.13(1.11–1.15)	0.000	1.03(1.01–1.05)	0.002
Ethnicity				
Hausa/Fulani	Reference			
Yoruba	1.13(1.10–1.16)	0.000	1.03(1.01–1.07)	0.315
Igbo	1.15(1.13–1.18)	0.000	1.05(1.01–1.11)	0.032
Others	1.09(1.04–1.15)	0.001	1.01(0.98–1.04)	0.038
Religion				
Islam	Reference			
Christians	1.08(1.07–1.10)	0.000	0.99(0.96–1.02)	0.254
Others	1.03(0.93–1.14)	0.554	0.95(0.84–1.07)	0.201
Marital Status				
Never married	1.01(0.94–1.07)	0.864	+	
Living with a spouse	1.01(0.97–1.06)	0.549		
Widowed/Divorced/Separated	Reference			
Household Wealth status				
Low	Reference			
Middle	1.09(1.07–1.11)	0.000	1.02(1.00–1.04)	0.026
Richest	1.17(1.15–1.19)	0.000	1.03(1.01–1.06)	0.034
Children ever-born				
1 or 2 births	1.04(1.02–1.06)	0.000	1.01(0.98–1.04)	0.204

Characteristics	IRR(95% CI)	significance	aIRR(95% CI)	significance
3 or 4 births	1.04(1.02–1.06)	0.000	1.01(0.98–1.03)	0.378
More than 4 births	Reference			
Current employment status				
Employed	1.03(1.01–1.05)	0.001	0.97(0.93–1.01)	0.074
Spouse current employment status				
Employed	1.04(1.02–1.06)	0.000	1.04(1.01–1.09)	0.039
Residence				
Urban	1.09(1.07–1.11)	0.000	1.01(0.99–1.03)	0.154
Place of antenatal care				
Health facility	1.42(1.35–1.49)	0.000	1.37(1.29–1.44)	0.000
Provider of ANC assistance				
Skilled provider	1.19(1.16–1.22)	0.000	1.10(1.07–1.12)	0.000
Household head sex				
Male	1.03(1.01–1.05)	0.016	1.00(0.98–1.03)	0.390
Wanted Last child				
Then	1.03(0.98–1.07)	0.243	+	
Later	1.01(0.97–1.06)	0.576		
Never	Reference			
Family Mobility				
Less stable 0-4yr	1.04(1.03–1.06)	0.000	1.00(0.98–1.02)	0.472
Have health Insurance				
Yes	1.09(1.05–1.14)	0.000	1.01(0.96–1.06)	0.338

Characteristics	IRR(95% CI)	significance	aIRR(95% CI)	significance
Region				
North West	Reference			
North central	1.07(1.04–1.1)	0.000	1.00(0.93–1.07)	0.462
North East	1.00(0.98–1.02)	0.933	1.01(0.94–1.08)	0.399
South East	1.16(1.13–1.19)	0.000	1.06(1.01–1.12)	0.017
South South	1.05(1.02–1.08)	0.001	1.00(0.92–1.08)	0.493
South West	1.12(1.1–1.15)	0.000	1.06(0.96–1.15)	0.123
Random Effects				
Community Level				
Community SES Disadvantage				
Lowest	1.19(1.17–1.21)	0.000	1.04(1.01–1.07)	0.023
Middle	1.12(1.10–1.14)	0.000	1.01(0.98–1.05)	0.170
Highest	Reference			
Community Unemployment rate				
Low	1.00(0.99–1.02)	0.559	+	
Community media barrier rate				
Low	1.07(1.06–1.09)	0.000	1.01(0.99–1.03)	0.176
Community Illiteracy rate				
High	1.05(1.03–1.07)	0.000	1.03(1.01–1.04)	0.048
Community Poverty rate				
High	1.03(1.02–1.05)	0.000	1.01(0.99–1.04)	0.175
State Level				
Rural population proportion				

Characteristics	IRR(95% CI)	significance	aIRR(95% CI)	significance
Low	1.09(1.07–1.11)	0.000	1.03(1.01–1.06)	0.034
Middle	0.91(0.97–1.01)	0.160	0.95(0.91–1.00)	0.053
High	Reference			
Model Estimates				
State level: MIRR = 1.05 (1.04–1.08), VPC(ICC) = 0.09(0.05–0.17), % Explained variation = 56.2(29.9–77.3)				
Community Level: MIRR = 1.02 (1.01–1.07), VPC(ICC) = 0.10(0.05–0.33), % Explained variation = 49.0(28.6–75.4)				
IRR Incidence Rate Ratio, MIRR Median Incidence Rate Ratio; CrI Credible Interval; VPC variance partition coefficient, +dropped from adjusted model				

Clustering of ANC components received

Figure 8 shows clustering in of components of ANC received. It shows that pregnant women who received information on HIV, are likely to receive information on danger sign warning and get tetanus injection while having urine test, blood pressure and blood test formed a cluster and finally having IPD and IPTp formed another cluster. As shown, there are lower chances of having IPD and IPTp compared with the other components.

Discussions

This study was designed to assess the level of ANC components offered to pregnant women in Nigeria during ANC contacts in Nigeria and the associated factors. We found that only one in every twenty pregnant women received all the 9 ANC components available for this study. The ANC components are having blood pressure measured, receiving tetanus injection, had a urine test, had a blood test, given an iron supplement, reported taking three or more doses of IPTp, IPD, and told about danger signs and HIV/PMTCT. In comparison with the findings of Fagbamigbe *et al*, the proportion of women who received all ANC components offered remained low. The authors had assessed the quality of ANC in Nigeria using data collected in the same setting five years earlier, the authors found that only 12% of the respondents had the 7 critical components of ANC [15]. One would have expected a much higher tremendous improvement in the quality of ANC services following the rejuvenation of Nigeria's primary healthcare system in recent times through the World Bank sponsored “Nigerian State Health Investment Programme (NSHIP)” [29]. The low level is despite the well-known fact that the quality of ANC care significantly reduces mortality, morbidity, and disabilities and improves health maternal and child health outcomes [30–32]. Globally, ANC and its compliance remain the safest approach for safe motherhood [4–6].

Although at least 79% of the women received each of the 7 of the 9 components of ANC during the last pregnancy, only 24% and 22% each had IPTp and IPD respectively. Nigeria is a malaria-infested country, despite that the disease is preventable, treatable, and curable, with over 25% of the annual 25–30 million pregnant women in malaria-endemic areas in Africa [33], yet less than a quarter received the prescribed doses of IPTp. It is worrisome that only a quarter of pregnant women in Nigeria had IPTp during their last pregnancy and only 17% of women with a live birth in the 2 years preceding the survey reported having at least 3 doses of IPTp [13]. Malaria is one of the foremost public health problems in the country. Nigeria alone accounts for a quarter of the burden of malaria in Africa. This was why the Federal Ministry of Health recommended that all pregnant women should have at least three doses of IPTp in the course of each pregnancy. There is an urgent need to increase the uptake of IPTp in Nigeria. The low level of pregnant women offered IPD resonates with the little attention paid to the fight against intestinal parasites during pregnancy in Nigeria, the long clamour for its use to address this public health problem notwithstanding [34, 35]. Nigeria just like most Sub-Saharan Africa countries harbours the greatest proportion of global intestinal parasitic infections largely as a result of her socioeconomic and environmental challenges [36–38].

Socio-demographic and economic characteristics pose a significant influence on the number of ANC components offered to pregnant women. In this study, similar to the findings of other studies in LMIC, various characteristics including respondents' age, education, and economic class significantly influenced the having adequate quality of ANC components [18, 39–41]. In particular, pregnant women with higher educational attainment had a higher likelihood of receiving a higher number of components of ANC relative to those with no education. Similarly, there is a higher likelihood of receiving all components among pregnant women aged 40 to 49 years relative to those aged 15 to 19 years just as those from households in the wealthiest quintile had higher chances of receiving complete ANC components. Although education mediates in choice of place of ANC services [39, 42], and more educated women are more likely to belong to households in wealthier quintiles [27] and initiate ANC earlier [31, 43], it is not certain if different categories of women attending the same facility received different components based on their educational status. This will require further studies. Women with better-educated spouses also have significantly higher chances of receiving all the components.

Women who make decisions on their healthcare utilization alone or jointly with the spouse had significantly higher chances of getting more components than those whose spouses are the only decision-maker of the women's health care. Our finding is in agreement with existing literature [39, 42, 44]. This ease of decision making on women's healthcare utilization can greatly influence the timeliness of ANC service uptake, the number of ANC contacts made, and consequently, the quality of ANC services received.

Although insignificant in the multivariable model, the proportion that received all the components among the Christians nearly tripled the proportion among the Muslim women. This might be ascribed to the fact that Christians provide mission delivery and care and thereby provide the components better than others. Also, Christians may often receive double ANC service. Most times, Christian pregnant women receive

ANC services from both the mission houses as well as other government facilities[45, 46]. This could have increased the chances of better quality among Christian women than other women. Nonetheless, the differences between religious groups could be largely due to the states of residence of the respondent as most Muslim women reside in the northern states while Christian women are mostly from the southern states.

Another significant variable to the receipt of a higher number of ANC components is ethnicity. A higher number of components were commoner among the Igbo women than the Hausa/Fulani women but insignificantly different when compared with the Yoruba women[31, 43]. From this study, there were wide variations in the adequacy of components received by these background characteristics. Although insignificant in the adjusted model, receipt of higher numbers of the component was higher among pregnant women who have less mobility, did not experience violence and who has health insurance. Women with health insurance cover have a higher likelihood of having quality ANC services. This finding points to the fact that the components are mostly offered when the ANC services are covered by insurance than when they are provided free of charge.

We found that pregnant women from the same clusters and communities have a similar likelihood of receiving similar components. Those from the least disadvantaged social-economic status communities had a preponderance of receiving a higher number of ANC components than those from the most disadvantaged communities. Pregnant women from communities with a low proportion of illiterate women also had higher chances of receiving a higher number of components just as those from states with a low rural population received higher numbers of components. The skill and distance of ANC providers to a community can greatly influence the adequacy of ANC components offered [47].

There were wide variations in the completeness of components received by background characteristics and the state of origin of the women. There is a need to overturn the inadequacies and eliminate disparities and variations in receiving all the ANC components. These variations and disparities could contribute to poor pregnancy outcomes [20]. Of significance in this study, are the type of health facility where ANC services were sourced and the skill of the ANC service provider. Pregnant women who attended institutional health care services including public and private standard hospitals and those attended to by qualified nurses and doctors had a higher level of receiving a higher number of ANC components. Similar studies have associated these factors with the quality of ANC services [20, 23, 41, 48]. This association could be ascribed to better knowledge on the importance of the components among trained nurses, midwives, and doctors than the other unskilled providers who are usually found in non-institutional facilities[10].

We found that the number of ANC visits made during pregnancy and the timing of the first ANC visit were both significantly associated with the number of ANC components received. The earlier the initiation of ANC contacts, the higher the prevalence of having a higher number of ANC components. Fagbamigbe et al. had already suggested that early initiation of ANC contacts and having a sufficient number of contacts may increase the number of components of ANC received [49]. Also, the higher the number of

ANC contacts made, the higher the prevalence of having a higher number of ANC components. This is intuitive as initiating ANC contact early during the first trimester could increase the proportion of pregnant women making eight or more visits and the quality of ANC received will increase proportionately. Our finding is corroborated by findings of earlier studies that the high quality of ANC services is a direct consequence of early initiation and the sufficient number of ANC contacts [20, 23, 41, 48]. Literature is replete that ANC services significantly promote maternal and child health outcomes and by extension, reduction of maternal and child mortalities [20, 39, 50, 51].

It is striking that all the states in the Northern regions of Nigeria except Kwara and FCT had less than the national average that received all the 9 components of ANC. The average proportion who received all the 9 components in the North Central, Northeast, and North West were 5%, 3%, and 2% respectively. The prevalence in Kebbi State was 0.3% while Borno had 0.1%. Similar geographical variations in the quality of ANC has been documented[10]. States with the highest prevalence of ANC attendance had the highest prevalence of women receiving all components and vice versa. Although the prevalence is generally poor in Nigeria, the States with low ANC utilization and low prevalence of having all ANC component should take a cue from states such as Lagos, Ogun, Abia, and Anambra with better indicators. Additionally, we found clustering among having talks on HIV prevention and transmission, talk on danger signs and having tetanus injection while having urine test, blood pressure and blood test formed a cluster and finally having IPD and IPTp formed another cluster. There were distinct variabilities in the clustering of these ANC components.

Study Strength And Limitation

A major limitation of this study is the use of secondary data that prevented us from a detailed assessment of health system factors. Besides, we couldn't assess within-facility variations due to limited data. Also, our data was supplied by respondents without any way of considering facility-level data and facility-level factors occasioned by the secondary nature of the data used. The data were based mostly on respondents' ability to recall the number of ANC contacts during pregnancy, except few cases that were found on ANC cards. A recall bias is not unlikely. Caution should be exercised when interpreting our findings. The identified factors in this study are only associated with the number of ANC components received and should not be taken for causes of the number of ANC components received as the study was only cross-sectional in design. However, our findings are generalizable as the sample was nationally representative of the Nigerian population. More so, the data source has been reported to use rigorously tested collection tools, procedures, and trained personnel on questionnaire administration. The computationally intensive methods used for data analysis guarantees the accuracy and reliability of our estimates. This study is probably the first to explore the clustering of ANC components received by pregnant women in Nigeria.

Conclusions

The overall prevalence of receiving all the 9 components of ANC received during ANC contacts in Nigeria is poor. There is a need to ensure that all pregnant women receive an adequate and optimal number of ANC components. Different factors influenced the number of ANC components received. Notable among them is the institution and skill of the ANC provider, education, and social-economic status of the women. The study shows a strong relationship between timeliness of ANC initiation and having a minimum of 8 ANC contacts as they both increased the adequacy of ANC components received during the contacts. Although there are some states with high ANC utilization but inadequate ANC components. Our study suggested that early initiation of ANC during the first trimester, and having the recommended number of ANC contacts are critical to having all ANC components, which in turn ensures that a pregnant woman and her unborn child take optimal advantage of ANC services.

Recommendations

There is a need to ensure that all pregnant women receive all ANC components. Stakeholders should increase supplies, train, and create awareness among ANC providers and pregnant women. States such as Sokoto should understudy what works in states such as Abia, Anambra, Enugu, and Oyo with high ANC utilization and a high level of adequate ANC components received by pregnant women. We recommend a timely initiation of ANC services alongside the sufficient number of ANC contacts. There is a need to enhance the socio-economic status of women in terms of education and ensure women have autonomous decision-making power on their health care utilization.

Abbreviations

Adjusted Incidence Risk Ratio Ratio (aIRR),

Antenatal care (ANC),

Blood Pressure (BP),

Blood Test (BS),

Confidence Interval (CI),

Enumeration areas (EAs),

Federal Capital Territory (FCT),

Institutional Review Board (IRB),

Intestinal parasite drugs (IPD),

Intermittent preventive treatment in pregnancy (IPTp),

Iron Supplement (IRS)

Local government areas (LGAs),
Low and Middle-Income Countries (LMIC),
Nigeria Demographic Health Survey (NDHS),
Pregnancy-related maternal mortality (PRMM),
Primary sampling unit (PSU),
Socioeconomic (SES), and
Sub-Saharan Africa (SSA),
Sustainable development goals (SDG)
Tetanus Injection (TET),
United Nations Children's Fund (UNICEF),
United Nations Population Fund (UNFPA),
Urine Test (US)
World Health Organization (WHO),

Declarations

Ethics approval and consent to participate

Ethics approval was obtained from the ICF Institutional Review Board, United States (Number FWA000008450) by the ICF International, the owners of the population-based secondary DHS datasets. We were granted full access to use the data by ICF International with authorisation letter 144644. Duly signed informed consent to participate was obtained from all consenting participants before the interview started. Further information on the data and ethical considerations are available at dhsprogram.com.

All methods were carried out in accordance with relevant guidelines and regulations.

Consent for publication

Not applicable

Availability of data and materials

The anonymized data is available in the public domain. The data supporting this article is available on request at www.dhsprogram.com and contact Bridgette Wellington, the Data Archivist.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

AFF conceptualised the study, designed the study, AFF analysed the data, provided the visualization, and wrote the results. OSF contributed to interpretation and visualization of result. AFF, OSF, OGO, OOB, VS and JMN contributed to literature search, writing of introduction and discussion. All authors wrote the manuscript, read, and approved the manuscript.

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Figures

Figure 1

Map of Nigeria showing the 36 states and the federal capital territory (FCT), by the geopolitical regions/zones Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.

Figure 2

Distribution of ANC components received during the most recent pregnancy in Nigeria

Figure 3

Distribution of ANC components received during pregnancy

Figure 4

Distribution of the percentages of pregnant women offered all the 9 components of ANC during the most recent pregnancy by States in Nigeria Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.

Figure 5

Relationship between the number of ANC visits, the timing of the first ANC visit, and receiving the 9 ANC components during the most recent pregnancy in Nigeria

Figure 6

Five-way MCMC graphical diagnostics of the model at the community level

Figure 7

Five-way MCMC graphical diagnostics of the model at the state level

Supplementary Files

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- [SupplementaryTable1.docx](#)