Multilevel Modelling of Determinants of Maternal Health Care Utilization in Nigeria

Globally, more than 500,000 women die of complications due to pregnancy and child birth annually (Glasier et al, 2006), and about 99 percent (533,000) of these deaths occur in developing regions, with sub-Saharan Africa and Southern Asia accounting for 86 percent of maternal deaths (Kistiana, 2009). With an estimated 59,000 maternal deaths annually, Nigeria contributes about 10 percent of the world's maternal deaths. For most women in low resource countries, delivery is associated with suffering, morbidity and in most cases maternal mortality. Despite the call to improve access to maternal health services universally and reduce maternal mortality, there has not been any significant decline in maternal mortality levels especially in developing countries. Antenatal and delivery care services are among the major recommended interventions to reduce maternal and newborn deaths globally (Titaley et al., 2010). Antenatal care ensures optimal outcome for both mother and baby; and is important in monitoring pregnancy and reduction of morbidity and mortality (NPC & ICF Macro, 2009).

The antenatal care policy in Nigeria follows the newest World Health Organization approach (that is Focused Antenatal Care) which seeks to promote safe pregnancies. The updated approach recommends at least four antenatal care visits for women without complications and emphasises quality of care during each visit (NPC & ICF Macro, 2009). The number of antenatal care visits a woman attends during pregnancy is important in preventing complications and adverse maternal health outcomes (Ikamiri, 2004). Health facility delivery is also an important factor that can influence maternal and neonatal outcomes. For instance, health facility delivery attended to by trained medical personnel has been shown to be associated with maternal and newborn mortality and morbidity rates that are lower than home delivery (Stephenson et al., 2006). Despite the importance of these interventions the Nigeria Demographic and Health Survey (NDHS) 2008 report indicated that 55% of women in Nigeria had fewer than the four recommended antenatal care visits and only 38% delivered in a health facility. In view of the poor maternal health situation in Nigeria and other parts of the developing world, concerted efforts have been made by researchers to understand the factors driving the phenomenon.

Women's status has been identified as an important predictor of the use of maternal health care services in Pakistan (Shaikh et al., 2008). Similarly, Furuta and Salway (2006) noted significant associations between some indicators of women's household position and the utilization of antenatal and delivery care. The authors observed that employment, household economic status, cost of accessing health care and urban-rural residence were strongly associated with antenatal and delivery care. Further, studies have shown that the use of maternal health care is shaped by demographic factors such as parity, maternal age, (Magadi et al., 2000; Adamu, 2011), and marital status (Stekelenburg,et al., 2004) which may be shaped in turn by culture (Griffiths & Stephenson, 2001). Socioeconomic factors including husband's occupation distance to health facilities and financial difficulty have been found to influence maternal health care utilization both in Nigeria and elsewhere (Moore et al, 2010; Titaley et al., 2010; Dhakal et al., 2007).

Existing studies have identified important predictors of maternal health care utilization, but their focus is mainly on individual demographic and household socioeconomic determinants. However, little attention has been given to community characteristics that can influence women's decisions to use antenatal and delivery care. Understanding community level factors in the study of maternal health care is important because individuals are nested within households and households are embedded in communities hence individual decisions can also be influenced by the characteristics of the communities in which they live (Mackian, 2003). Writing on the utilization of primary health care services, Rahman (2000) demonstrated that a woman's decision to attend a particular health care facility is as a result of personal need, social factors and the location of services. More importantly, ecological perspectives suggest multiple levels of influence of physical and social environmental conditions on health behaviour (Stokols, 1996). However, most theoretical and empirical work that examine how community or environmental conditions influence individual behaviour have been developed in reference to conditions in the United States and some developing countries making it unclear whether existing and empirical evidence applies to other social contexts (Burgard & Lee-Rife, 2009) including Nigeria. Thus the purpose of this study specifically is to understand how antenatal and delivery care utilization in Nigeria are influenced by community conditions. In addition the study seeks to address an important research question: Do community factors have significant impact on maternal health care utilization in Nigeria?

Methods

The study draws data from a cross sectional data- the 2008 Nigerian Demographic and Health Survey (NDHS). The 2008 NDHS provided information on population and health indicators at the national and state levels. The primary sampling unit (PSU), which is referred to as the cluster was selected from the lists of Enumeration Areas (EAs). Sample for the survey was selected using a stratified two-stage cluster design, made up of 888 clusters; 286 in the urban and 602 in the rural areas (NPC and ICF, 2009). A weighted probability sample of 36,800 households was selected in the survey and a minimum of 950 interviews were completed for each state. For each cluster, a listing of household and mapping was done, and the lists of households were used as the sampling frame for the selection of households in the second stage. All private households were listed and an average of 41 households was selected in each cluster, by equal probability systematic sampling. All women aged 15-49 who were either permanent residents of the households or visitors present in the households on the night before the survey were interviewed. In all, a total sample of 33,385 women aged 15-49 years and 15,486 men aged 15-59 were interviewed. In this study, the sample consists of, 16005 women who attended antenatal care visits and 17542 who used delivery care services for their last birth in the five years preceding the survey.

Variables and definitions

The outcome variables are antenatal and delivery care. Antenatal care is defined as having antenatal care visits during pregnancy. The indicator of antenatal care visits examined in this study

is the number of antenatal care visits. Number of antenatal care visits is categorised into two groups consisting of those women who attended no antenatal care visit verses those who attended between 1 and 3 visits and those attending 4 or more visits; and coded as 1 if a woman had 4 or more antenatal care visits and 0 if she had no visits and less than four visits. Delivery care is a binary variable coded 1 if delivery took place in a health facility and 0 if a woman delivered at home. The individual level variables include maternal age at last birth, education, religion, ethnic origin, occupation, women's autonomy, parity and household wealth index. The community level variables considered in the study include place of residence (urban and rural), region of residence, community hospital delivery, community women's education, community mass media exposure, community poverty and ethnic diversity.

Maternal age is defined as the age of the woman at the birth of the last child in the five years preceding the survey. This is calculated by subtracting the century month code (CMC) of the date of birth of the child from the century month code of the date of birth reported by the respondent. Maternal age is further classified into: 15-24, 25-34 and 35-49 years. Education is defined as the highest level of education attended by the respondent and categorised as: no education, primary, and secondary or higher.

Religion is measured as the religious affiliation of the respondent, while ethnic affiliation is categorised as Hausa (a merger of Hausa, Fulani and Kanuri), Igbo, Yoruba and Northern/Southern (a merger of all the minority ethnic groups). Occupation is measured as the respondents occupation and re-grouped into formal employment (a merger of all professional and none professional white collar jobs) agricultural employment and manual workers. Women's autonomy is measured as decision making on a woman's own health care. Parity is measured as the number of children ever born and categorised as 1-2, 3-4, 5 or more. Household wealth index is the DHS wealth index measured as a standardized composite variable made up of quintiles. This is determined through Principal Component Analysis (from Factor Analysis) and based on household assets (e.g., type of flooring, water supply, electricity, radio, television, refrigerator, type of vehicle). Each quintile represents a relative measure of a household's socioeconomic status (Rutstein and Johnson, 2004).

Region of residence is defined as geopolitical zones with administrative boundaries and categorised as: North central, North east, North- west, South east, South-south and South west. Community hospital delivery is the proportion of delivery in a health facility in the primary sampling unit (PSU). This measure was divided into three quantiles and categorised as low, medium and high. Community women's education is the proportion of women's education (secondary and higher) in the primary sampling unit and categorised as Low, medium and high. Community mass media exposure is the proportion of women exposed to mass media in the PSU. The proportion was divided into three quantiles and categorised as Low, medium and high. Community poverty is measured as the proportion of women from the poor and poorest wealth quintiles and the measure was divided into three quantiles and categorised as low, medium and high. While ethnic diversity is defined as the proportion of women from different ethnic groups (Hausa, Igbo, Yoruba, and other minority ethnic groups) in the PSU (Uthman, 2010). The measure is divided into three quantiles and categorised as Low, medium and high.

Statistical methods

The distribution of respondents by key variables was assessed and expressed as percentages. At the bivariate level, frequencies and cross-tabulations were used to identify the distributions of the outcome variables by selected background characteristics. The chi square test of association was used to test the statistical significance of these bivariate distributions. Sample weights provided in the DHS data were applied for the univariate and bivariate analyses in order to adjust for non-response and over sampling of some areas. For all analyses, Stata 11.1 software package was used. Multilevel logistic regression was utilized to assess the impact of measured individual and community level factors. Multilevel analysis was considered appropriate in order to account for the hierarchical nature of the DHS data (Antai, 2009) and to be able to estimate community level effects on the outcome variable. A two-level multilevel logistic regression model was applied in the study and this consists of two sub models at level 1 and level 2. This implies that individuals (level 1) were nested within communities (level 2). The level 1 model represents the relationships among the individual level variables[1], while the level 2 model examines the influence of community level factors.

A two-level multilevel model for a dichotomous outcome uses a binomial sampling and a logit link (Vu, 2005). In level 1 model, the outcome variable Y_{ij} for individual i living in community j is written as follows:

Probability ($Y_{ij} = 1|B$) = Φ_{ij}
Level 1 variance = [Φ_{ij} (1 - Φ_{ij}]*
Predicted log odds η_{ij} = log [Φ_{ij} / (1- Φ_{ij})]

$$\eta_{ij} = \beta_{0j} + \sum_{q=1} \beta_{qj} X_{qij} \qquad (1)$$

Where

Φ_{ij} is the probability that the ith individual in the jth community take value "1" ("1" indicates that the event will occur)
β_{0j} is the level 1 intercept

β_{qj} is level 1 coefficients

[1] Both individual and household characteristics are considered as individual level variables in the study. The reason for this is because, the analysis is based on two levels and the average number of women in a household as contained in the dataset is small (1.7) and thus the household cannot be considered as a level of analysis in this case.

X_{qij} is level 1 predictor q for ith individual within jth community

In level 2 model, each of the level 1 coefficients, β_{qj} defined in the level 1 model becomes an outcome (Vu, 2005) and can be expressed as follows:

$$\beta_{qj} = \gamma_{q0} + \gamma_{q1}W_{1j} + \gamma_{q2}W_{2j} + \ldots\ldots\ldots\ldots + \gamma_{q}s_{q}Ws_{qj} + u_{qj}$$

$$= \gamma_{q0} + \sum_{s=1}^{S_q} \gamma_{q}sW_{sj} + u_{qj} \qquad (2)$$

Where

γ_{qs} (q = 0,1,.....S_q) are level 2 coefficients

Wsj are level 2 predictors and u_{qj} is level 2 random effects

All the level 2 random effects are assumed to have normal distribution with mean of 0 (zero) and variance of τ_{qq} (Vu, 2005). A comparison of the variance component (τ_{qq}) of the intercept (β_0) with its standard error gives an indication whether there are variations among communities in terms of antenatal and delivery care utilization.

Overall, four models containing variables of interest were fitted for each of the maternal health care indicators or outcome variables. The first model which is usually called the "empty" or "null model" was fitted without explanatory variables. In other words, it contained no covariates, but decomposes the total variance into individual and community components. The empty model was used to determine whether the overall difference between communities and individuals in terms of antenatal and delivery care was significant. The second model referred to as the "individual model" included individual characteristics. This is to allow the assessment of the association between the outcome variable and individual characteristics. The model containing the individual level variables was used to determine whether the variation across communities could be explained by the characteristics of the individuals residing within that community or not.

A third model was also fitted and this contains only the community characteristics to allow the assessment of the impact of the community variables on the outcome variable.

Lastly a fourth model was generated which is called the "final model". This included explanatory variables at both the individual and community levels. The final model was used to test for the independent effect of community contextual variables above and over the individual variables.

In the multilevel models, fixed effects refer to the individual and community covariates and were expressed as odds ratio (OR) and 95% confidence interval. The random effects are the measures of variation in maternal health care (antenatal and delivery care) across communities. The ratio of the

variance at the community level to the total variance is referred to as the intra-class correlation coefficient. The precision was measured by the standard error (SE) of the independent variables (Antai, 2009). The results of random effects (which are the measures of variation) are expressed as Variance Partition Coefficient (VPC) (which in this study is equal to intra-class correlation (ICC)), and proportional change in variance (PCV). As a result of the dichotomous nature of the outcome variables in the study, the VPC was calculated based on the linear threshold model method which converts the individual level variance from the probability scale to the logistic scale, on which the community level variance is expressed (Merlo et al., 2006). In other words, by using the linear threshold model, the unobserved individual outcome variable follows a logistic distribution with individual level variance σ^2_e equal to $\pi^2/3$ (equal to 3.29). In this case, the VPC corresponds to the intra-class correlation coefficient (ICC), which is a measure of general clustering of the individual outcome of interest in the communities.
The intraclass correlation is calculated as:

$$\rho = (\sigma^2_\mu / (\sigma^2_\mu + \pi^2/3)) \qquad (3)$$

Where

ρ is the intraclass correlation (ICC). σ^2_μ is the variance at the community level. $\pi^2/3 = 3.29$ and represents the fixed individual variance (Snijders & Bosker, 1999).

Community differences in antenatal and delivery care may be attributable to contextual influences or differences in individual composition of communities (including unobserved individual characteristics) (Merlo et al, 2004). In view of this, while adjusting for the individual characteristics in the multilevel models, some part of the compositional differences were taken into consideration to explain some of the community differences observed in the empty model. Thus the equation for the proportional change in community variance is:

$$PCV_1 = (V_{N-1} - V_{N-2})/ V_{N-1} \qquad (4)$$

Where
V_{N-1} is the community variance in the empty model and V_{N-2} is the community variance in the models including individual characteristics or community characteristics.

Statistical Tests

The maximum likelihood was evaluated by integrating out the random effects using the adaptive Gaussian quadrature (AGQ) (Gutierrez, 2007) available in Stata (version 11.1). While the likelihood ratio (LR) statistics was used to test the null hypothesis that the community level variance is equal to zero. Regression diagnostics AIC (Akaike information criterion) and the BIC (Bayesian information criterion) were used to determine the goodness of fit of the model. The AIC is appropriate for comparing non-nested models such as those estimates used in the analysis and is calculated as -2 (log-likelihood of fitted model) +2p, where p is number of parameters in the model (Boco, 2010). The AIC and BIC values for each model are compared and the model with the lowest value is considered to be a better explanatory model (Uthman & Kongnyuy, 2008).

Descriptive results

Table 1 indicates that the highest proportion of women (45%) belonged to age group 25-34 years. A significant proportion of women (41%) had given birth to one or more children. The study population is made up of a significant percentage of women with no education (45%). However, the sample also indicates some level of literacy with 26% and 23% of women having attained secondary and primary education respectively. The lower proportion of women (6%) with higher education is consistent with the observation that sub-Saharan Africa is among the world regions where the percentage of tertiary education enrolments have dramatically declined in recent years (NCRIM, 2005. For the entire sample, 54% were Muslims, 44% were Christians, while others were traditional religionists. A significant proportion (30%) of the women was unemployed and among those employed, more were in the formal than in the agriculture employment. Ethnic origin of women reflects the dominance of the three major ethnic groups in Nigeria; Hausa 40%, Igbo 12% and Yoruba 15%. The minority ethnic groups from Northern and southern Nigeria make up 34% of the sample. More than half of the women reported that their husbands or other people have a final say over their own health. Most of the women (45%) were in the two poorest wealth quintiles, while the lowest proportion was in the richest wealth quintile.

One third of the women resided in the North West region, while about 14% and 16% lived in north central and north eastern regions respectively. In the study population, the lowest proportion of women lived in the south eastern region. A significant 43% of the study sample lived in communities with low proportion of educated women, while 40.3% resided in communities with low proportion of women that delivered in a health facility. Women who lived in communities with high proportion of women from poor households and high proportion of those exposed to mass media account for 40.1% and 34.7% of the study population respectively. A significant 41.1% of the study sample resided in communities with low proportion of women from different ethnic groups.

Bivariate results

The bivariate results in table 1 showed that middle aged women (25-34) were more likely to have four or more antenatal care visits than older women (35-49). This is probably because younger women are at the peak of their child bearing age and are likely to have greater exposure and knowledge to modern maternal health care services. Education is significantly related to antenatal care visits. Having four or more antenatal care visits was more likely among women with higher and secondary education compared to those who had no education. Women who were in formal employment were more likely to have four or more antenatal care visits relative to the unemployed. Religion is significantly associated with antenatal care visits with Muslims exhibiting lowest levels of attending four or more antenatal care visits compared to Christians.

A profound outcome observed in the data is wide variation in antenatal care attendance for women from different ethnic groups. Attendance of four or more antenatal care visits was higher among women from Igbo, Yoruba and Northern/Southern minority ethnic groups compared to Hausa women. Women who reported taking decisions alone and jointly with their husband over their own health care had higher proportion of antenatal care attendance. Women of higher parity (3-5)

were less likely to attend four or more antenatal care visits relative to those who had 1 or two pregnancies. The distribution of number of antenatal care visits across economic status is consistent with conventional wisdom that women who are in the richest wealth quintile are more likely to have four or more antenatal care visits, relative to those in the poorest wealth quintile.

Regional variations in having four or more antenatal care visits were pronounced, with the lowest proportion observed among women in North west and North east compared to North Central; while women from South west, South south, and South east had the highest proportion. Women who lived in communities with high proportion of educated women; high proportion of those who had health facility delivery and high proportion of women who were exposed to mass media, had a higher propensity of attending four or more antenatal care visits. In contrast, the lowest proportion of antenatal care attendance was observed among women who lived in communities with high level of poverty.

Table 1 Percentage distribution of women by background characteristics and antenatal care visits, Nigeria 2008 DHS

Characteristics	**(%)**	**All women (n)**		**Antenatal care visits**	
			(P-value)	**≤ 3 visits** (%)	**4 or more visits** (%)
Maternal age at last birth					
15-24	36.9	6476		57.3	42.7
25-34	44.7	7847		43.9	56.1
35-49	18.4	3238	0.001	53.2	46.8
Educational attainment					
No education	45.4	7969		76.8	23.2
Primary	22.8	4004		40.1	59.9
Secondary	25.9	4542		20.1	79.9
Higher	5.9	1045	0.001	5.9	94.1
Occupation					
Unemployed	30.4	5312		61.6	38.4
Formal employment	41.4	7235		39.1	61.0
Agricultural employment	17.2	3005		58.6	41.4
Manual workers	10.9	1910	0.001	50.7	49.3
Religion					
Muslims	54.3	9482		65.3	34.7
Christians	44.0	7685		30.5	69.5
Traditional/Others	1.7	297	0.001	64.6	35.4
Ethnic origin					
Hausa	39.6	6924		76.7	23.3
Igbo	11.6	2033		19.7	80.3
Yoruba	15.0	2627		9.5	90.5
Northern/Southern minority	33.7	5887	0.001	46.0	54.0
Women's autonomy (decisions over own health)					
Wife alone	8.8	1450		31.2	68.8
Wife/husband	33.1	5477		35.5	64.5
Husband alone/Others	58.2	9634	0.001	62.2	37.8
Household wealth index					
Poorest	23.1	4059		83.8	16.2
Poor	22.2	3898		69.1	30.9
Middle	19.0	3332		46.1	53.9
Rich	18.2	3187		25.7	74.3
Richest	17.6	3084	0.001	7.6	92.4
Region of residence					
North Central	14.3	2516		47.9	52.1
North East	15.6	2745		67.1	32.9
North West	30.4	5337		78.0	22.0
South East	9.1	1599		22.0	78.0
South South	13.1	2303		35.8	64.2

South West	17.4	3061	0.001	10.5	89.5
Community women's education					
Low	42.6	7487		78.3	21.7
Medium	29.0	5097		37.6	62.4
High	28.3	4976	0.001	19.1	80.9
Community hospital delivery					
Low	40.3	7072		81.6	18.4
Medium	27.4	4807		39.2	60.8
High	32.4	5682	0.001	18.1	81.9
Community poverty					
Low	30.5	5356		13.5	86.5
Medium	29.4	5166		46.5	53.5
High	40.1	7039	0.001	78.3	21.7
Community mass media exposure					
Low	32.9	5779		74.5	25.6
Medium	32.4	5683		49.5	50.5
High	34.7	6098	0.001	28.2	71.8

Table 2 indicates that maternal age is significantly associated with place of delivery. Delivery in a health facility increases with maternal age; with women in age group 20-34 more likely to deliver in a health facility compared to those in age groups 15-19 and 35-49. The pattern follows a U-shaped with the peak among women aged 20-34 years. The relationship between place of delivery and education is highly significant. Result shows that women with higher education were more likely to deliver in a health facility relative to those with no schooling. The working status of women shows a positive and significant association with decisions to deliver in a health facility. Women in formal employment were more likely to deliver in a health facility than those who were unemployed. Result also indicates a significant association between religion and delivery care. A higher proportion of Christian women (61%) delivered in a health facility compared to their Muslim counterparts (21%). The percentage of health facility delivery varied among women from different ethnic groups with the Igbo and Yoruba more likely to deliver in a health facility than Hausa women.

Women's autonomy has a strong association with use of delivery care. The data revealed that women whose husbands have a final say on their own health care were less likely to deliver in a health facility compared to women who made decisions concerning their own health care alone. Parity had a significant inverse relationship with the utilization of delivery care services. This is indicated by the consistent decline in the proportion of women who delivered in a health facility with the increase in the number of children ever born. Women with less than three pregnancies were 43% more likely to deliver in a health facility than those of higher parity (five or more pregnancies). Household economic status is a significant predictor delivery care utilization. A

significant percentage (81%) of women in the richest wealth quintile delivered in a health facility, while the lowest proportion of health facility delivery was observed among women in the poorest wealth quintile. Women who resided in the rural areas exhibited lower levels of health facility delivery than those who resided in the urban areas.

A significant regional variation in place of delivery was observed. The proportion of health facility delivery was higher among women from the southern region, while it was lower among women from the northern region. Women from communities with high proportion of educated women, high proportion of those who had hospital delivery and high proportion of women from different ethnic groups were more likely to deliver in a health facility compared to those from disadvantaged communities.

Table 2 Percentage distribution of women by background characteristics, controlling for Delivery Care, Nigeria 2008 DHS

Variable	Place of delivery		P-value
	Health facility (%)	Home (%)	
Maternal age at birth			
15-24	32.5	67.5	
25-34	44.4	55.6	
35-49	37.0	63.0	0.001
Educational attainment			
No education	10.9	89.0	
Primary	43.6	56.4	
Secondary	70.7	29.3	
Higher	91.4	8.6	0.001
Occupation			
Unemployed	28.1	71.9	
Formal employment	50.4	49.6	
Agricultural employment	31.9	68.1	
Manual workers	34.0	66.0	0.001
Religion			
Muslims	21.3	78.7	
Christians	60.9	39.1	
Traditional/Others	19.3	80.7	0.001
Ethnic origin			
Hausa	9.3	90.7	
Igbo	79.7	20.3	
Yoruba	79.3	20.4	
Northern/Southern minority	40.8	59.2	0.001
Women's autonomy (decisions over own health)			
Wife alone	59.3	40.7	
Wife/husband	53.6	46.4	
Husband alone/Others	26.3	73.7	0.001
Parity			
1-2	43.8	56.2	
3-4	39.3	60.7	
5 or more	30.1	69.9	0.001
Household wealth index			
Poorest	8.4	91.6	
Poor	17.5	82.5	
Middle	36.1	63.9	
Rich	61.9	39.1	
Richest	85.1	14.9	0.001
Type of place of residence			
Urban	65.3	34.7	
Rural	27.1	72.9	0.001
Region of residence			

North Central	43.2	56.9	
North East	14.0	86.0	
North West	9.3	90.7	
South East	77.8	22.2	
South South	51.8	48.2	
South West	77.7	22.3	0.001
Community women's education			
Low	9.3	90.7	
Medium	48.1	51.9	
High	73.2	26.8	0.001
Community hospital delivery			
Low	4.0	96.0	
Medium	41.0	59.0	
High	79.8	20.2	0.001
Ethnic diversity			
Low	19.1	80.9	
Medium	59.6	40.4	
High	45.5	54.5	0.001

Multilevel analysis

Results in Table 3 (Model 1) showed that there is variation in the likelihood of having four or more antenatal care visits across communities and this variation was significant ($\tau = 11.071$, $p = 0.001$). As shown by the variance partition coefficient, the intra-community correlation coefficient was estimated at 77%, which is variance that could be attributed to the community level. Model 2 showed the results of the effects of the individual level variables. Maternal age at last delivery was significantly associated with antenatal care visits with middle aged women (25-34) more likely to attend four or more antenatal care visits compared to those of younger age (15-24). Consistent with some earlier studies, educational level of the woman, ethnic origin, occupation, women's autonomy and household wealth index were significantly associated with antenatal care visits. Women with primary and secondary/higher education had significant odds of having four or more antenatal care visits that were 2.9 times and 5.8 times higher respectively compared to those with no education. Relative to Hausa, women from Igbo, Yoruba and Northern/Southern minority ethnic groups were 9.9 times, 32.9 times and 4.3 times respectively more likely to found to make four or more antenatal care visits. Women in formal employment and skilled manual workers were almost twice more likely to have four or more antenatal care visits compared to those with no employment. In line with expectation, the odds of having four or more antenatal care visits was higher for women from richest, richer and middle households relative to women from poorest households.

In comparison to the empty model, the variation in having four or more antenatal care visits was significant across communities ($\tau = 2.969$; $p<0.001$). The intra-community correlation was 47.4% indicating that the clustering of the outcome variable (antenatal care visits) across communities was as a result of the composition of the communities by individual level characteristics.

The results of the effects of community variables were presented in model 3. As indicated, all the community variables were positively and significantly associated with antenatal care visits. In line with expectation, the likelihood of having four or more antenatal care visits was higher among women who resided in South West and South East relative to those who resided in North Central region. Meanwhile living in North east and North West was associated with lower odds. Results further showed that women who lived in communities with high proportion of women with secondary and higher education, high proportion of women who delivered in a hospital, and high proportion of women who were exposed to mass media were 3.4 times, 5.8 times and 3.9 times respectively more likely to attend antenatal care at least four times relative to those living in disadvantaged communities. Community poverty was significantly associated with number of antenatal care visits. Living in communities with high proportion of women who were from poor households was associated with lower odds of attending four or more antenatal care visits. Compared to model 2 the variation in antenatal care visits across communities remained significant ($\tau = 2.550$, $p = 0.001$). The intra-community correlation was 43.6 %, indicating that the clustering of antenatal care visits between communities was as a result of the composition of the communities by community characteristics.

Model 4 was the final model for antenatal care visits and contained both the individual/household and community variables. Results showed that the inclusion of community variables had independent effects on antenatal care visits as well as moderating effects on the association between individual/household factors and antenatal care attendance. For instance with the introduction of community variables, the significance of maternal age at last birth as observed in model 2 disappeared. However, the effects of education, occupation, ethnic origin, women's autonomy and household wealth index remained significant but with slight reduction in odds for education, ethnic origin and household wealth index variable categories. The odds of having four or more antenatal care visits was 5.8 times higher for women with secondary/higher education, 2.9 times for those who belong to Igbo, 4.5 times for women of Yoruba ethnic origin and 2.5 times for those from Northern/Southern minority ethnic groups. Relative to women from poorest wealth quintiles those from the richest wealth quintiles were 15.5 times more likely to have four or more antenatal care visits. Women in formal employment, and those who made joint decision with husband on health care were 1.6 times and 2 times respectively more likely to attend antenatal care. Whereas the likelihood of having four or more antenatal care visits was 67% lower for women from North West and 39% lower for those from South south; the odds was higher for women from South East and South West (Odds ratio = 4.096; $p<0.001$) compared to North Central. The difference however was not statistically significant for South east.

Further, the results showed that living in communities with high proportion of women who had hospital delivery, and high proportion of women exposed to mass media was associated with higher likelihood of having four or more antenatal care visits. However living in communities with high proportion of women from poor households decreased the odds by 64%. The association between community women's education and number of antenatal care visits was not significant

Comparatively the variance at the community level in model 4 remained significant ($\tau = 2.149$; $p<0.001$). The intra-community correlation decreased to 39.5 percent indicating that the inclusion of community variables was important for obtaining a better explanatory model. The clustering of the likelihood of having four or more antenatal care visits at the community level is as a result of the composition of the communities by community characteristics. Further, it also indicates that part of the clustering in antenatal care visits between communities was due to the composition of communities by individual characteristics.

Table 3 Multilevel logistic regression odds ratio of the effects of individual and community factors on Antenatal care visits, Nigeria 2008 DHS

Variables	*Model 1 Empty model*	*Model 2 Individual variables*	*Model 3 Community variables*	*Model 4 Individual & community*
		Odds Ratio	Odds Ratio	Odds Ratio
Fixed effects				
Individual characteristics				
Maternal age at last birth				
15-24		1.000		1.000
25-34		1.216*		1.179
35-49		0 .978	-	0.923
Educational attainment				
No education		1.000		1.000
Primary		2.923***	-	2.572***
Secondary/Higher		5.881***		5.153***
Ethnic Origin				
Hausa		1.000	-	1.000
Igbo		9.606***		2.965**
Yoruba		32.992***		4.522***
North/South minority		4.300***		2.405***
Occupation				
Unemployed		1.000	-	1.000
Formal employment		1.579***		1.567***
Agric employment		0 .950		0.940
Skilled manual workers		1.639**		1.764***
Women's autonomy				
Wife alone		1.000	-	1.000
Wife/Husband		1.873**		2.043***
Husband alone/Others		1.169		1.409*
Household wealth index				
Poorest		1.000		1.000
Poorer		2.250***	-	1.915***
Middle		5.103***		3.123***
Richer		11.375***		4.899***
Richest		46.122***		15.547***
Region of residence				
North Central			1.000	1.000
North East			0.598**	1.229
North West			0.161***	0.331***
South East			1.933**	1.158
South South			0.792	0.614*
South West			7.808***	4.096***
Community women's education			1.000	1.000
Low			2.994***	1.316

Medium High			3.435*** 	0.863
Community hospital delivery[b] Low Medium High			 1.000 5.057*** 5.817***	 1.000 4.038*** 4.232***
Community poverty Low Medium High			 1.000 0.351*** 0.091***	 1.000 0.844 0.361***
Community mass media exposure Low Medium High			 1.000 2.618*** 3.937***	 1.000 2.332*** 3.159***
Random effects parameters	***Empty***	***Individual***	***Community***	***Individual/ Community***
Community level Variance (SE) VPC=ICC (%) (PCV) (%)	 11.071*** (3.903) 77 Reference	 2.969*** (1.024) 47.4 73.2	 2.550*** (0.719) 43.6 76.9	 2.149*** (0.662) 39.5 80.6
Log-likelihood	**-8155.0025**	**-6806.1056**	**-7591.7326**	**-6636.2953**
Model fit statistics ***AIC*** ***BIC***	 16316.0 16339.2	 13650.2 13795.6	 15215.5 15339.0	 13336.6 13581.4

The empty model contains no variables but partitions the variance into two component parts
SE = Standard error, VPC= Variance Partition Coefficient, PCV = Proportional change in variance, AIC=Akaike information criterion, BIC = Bayesian information criterion
Significance level ***p<0.001 **p<0.01 *p<0.5

With respect to delivery care, the total variance in having a health facility delivery at the community level was presented in the empty model (Table 4). The variation in the odds of a woman delivering a baby in a health facility between communities was significant ($\tau = 7.467$, $p = 0.001$). The variance partition coefficient or the intra-community correlation coefficient as shown by the estimated intercept component variance was 69.4%. This is the variability in the outcome variable attributed to the community level, while the remaining 31.6% could be attributed to the individual level.

Model 2 contained the individual level variables. Results showed that the odds of having a health facility delivery was significantly associated with maternal age at last delivery. The likelihood of having a health facility delivery was higher for older women (35-49) compared to younger women. This could be because older women may have more knowledge of maternal health care services. Women's autonomy was not significantly associated with delivery care. Consistent with literature, women's education, religion, ethnic origin, occupation household wealth index and

parity were strongly and significantly associated with health facility delivery. However occupation showed a rather weak association. Women with higher education and Christians were four fold and 1.2 times respectively more likely to deliver in a health facility compared to women with no schooling and Muslims.

With respect to ethnic origin, having a health facility delivery was more likely, among women from Igbo, Yoruba and those from Northern/Southern minority ethnic groups relative to Hausa women. Women that were in formal employment had odds of delivering in a health facility that were almost twice compared to those that were not employed. As expected, following the argument that high socio-economic status has the potential to improve health and wellbeing, the likelihood of having a health facility delivery was higher for women from richest, richer and middle households compared to those from poorest households. Consistent with literature, women of parity 3-4 and 5 or more were 32% and 35% respectively less likely to deliver in a health facility relative to those that have one or two children. Compared to the empty model, the variation in the odds of having a health facility delivery was significant across communities (τ = 1.933; $p<0.001$). The intra-community correlation was 37%, indicating the clustering of the outcome variable at the community level. The 74.1% proportional change in variance suggests that the clustering was explained by the individual characteristics of the women.

The effects of community contextual variables were examined in model 3, and results showed that all the community variables were significantly associated with delivery care. For instance, rural women were 31% less likely to have a health facility delivery compared to their urban counterparts. Interestingly, the odds of having a health facility delivery was 1.8 times higher for women from South west and 1.6 times for those from south east compared to those from North Central. Relative to women from North Central region, those from North east and North West were 62% and 72% respectively less likely to deliver in a health facility. Among women from communities with high proportion of educated women, the odds of having a health facility delivery was 4.9 times higher compared to that among women from communities with low proportion of educated women.

Similarly the odds of having a health facility delivery were 21.2 times higher among women from communities with high proportion of women who delivered in a hospital relative to those from communities with low proportion of hospital delivery. Surprisingly, women who lived in communities with high proportion of women from different ethnic groups were 64% less likely to have a health facility delivery compared to those who resided in communities with low proportion of women from different ethnic origin. Results also showed that there was an increase in the odds of having a health facility delivery for women from communities with high proportion of educated women and those who delivered in a hospital. In comparison to model 2, the variation in the odds of having a health facility delivery across communities was significant ($\tau = 0.504$, $p = 0.001$). The intra-community correlation estimate was 13.2 %. This indicates that the clustering in the odds of delivering a baby in a health facility was explained by community characteristics.

Controlling for individual/household and community variables in model 4, results indicated that the inclusion of community variables in this model moderated the effects of the individual/household variables on the outcome variable. The introduction of the community variables into the model attenuated the odds of having an institutional delivery for most individual level variables. However, the effects of maternal age, education, religion, occupation, ethnic origin, and household wealth index remained significant though there was sharp reduction in the odds, while increased odds was observed for women of higher parity (5 or more). Whereas higher education, belonging to richest households, Igbo, Yoruba and the minority ethnic groups were associated with higher odds of having a health facility delivery, such odds were lower for women affiliated to traditional religion and other religious groups and those of higher parity. Being a Christian was negatively and insignificantly associated with health facility delivery in this model indicating that the community variables moderated the effects of religion on the use of delivery care.

The association with community variables yielded interesting results. The odds of having a health facility delivery was significantly lower for women, from North east, North West and South south compared to North Central. Women from South western region had higher odds of having a health facility delivery, but the difference was not significant. Meanwhile, women from communities that have high proportion of educated women were 1.3 times more likely to deliver in a health facility relative to women from communities that have low proportion of educated women. Similarly,

women living in communities with high proportion and medium proportion of women who delivered in a health facility had higher odds of health facility delivery that were 17.3 times and 5.9 times respectively, compared to those living in communities where the proportion of women that had hospital delivery is low. Surprisingly and contrary to expectation women living in communities with high and medium proportion of women from different ethnic groups exhibited about 50% and 34% lower odds of health facility delivery respectively, relative to those from communities with low ethnic differences.

Compared to model 3, the variation in the odds of a woman having a baby in a health facility was significant across communities ($\tau = 0.356$; $p<0.001$). The intra-community correlation decreased to 9.8%. The 95.2% proportional change in variance of the odds of having a health facility delivery across communities was explained by community compositional factors indicating that part of the clustering in health facility delivery was due to the composition of communities by individual characteristics.

Table 4 Multilevel logistic regression odds ratio for the effects of individual and community factors on Delivery Care, Nigeria 2008 DHS

Characteristics	*Model 1 Empty model*	*Model 2 Individual variables*	*Model 3 Community variables*	*Model 4 Individual/ Community variables*
		Odds Ratio	Odds Ratio	Odds Ratio
Fixed effects				
Individual characteristics				
Maternal age at last birth				
15-24		1.000		1.000
25-34		1.142		1.096
35-49		1.394**	-	1.292**
Educational attainment				
No education		1.000		1.000
Primary		1.889***	-	1.473***
Secondary/Higher		4.133***		2.827***
Religion				
Muslims		1.000	-	1.000
Christians		1.243		0.974
Traditional/Others		0.445**		0.473***
Ethnic Origin				
Hausa		1.000	-	1.000
Igbo		21.091***		4.479***
Yoruba		13.588***		2.759***
Others		3.871***		2.153***
Occupation				
Unemployed		1.000	-	1.000
Formal employment		1.220*		1.179*
Agric employment		1.034		1.021
Manual workers		1.021		1.057
Women's autonomy				
Wife alone		1.000	-	1.000
Wife/Husband		1.230		1.204*
Husband alone/Others		0.948		1.039
Household wealth index				
Poorest		1.000		1.000
Poorer		1.829***	-	1.373***
Middle		3.548***		1.845***
Richer		8.558***		2.797***
Richest		23.897***		5.194***
Parity				
1-2		1.000	-	1.000
3-4		0.683***		0.732***
5+		0.646***		0.697***
Place of residence				
Urban		-	1.000	1.000

Rural			0 .684***	1.004
Region of residence				
North Central		-	1.000	1.000
North East			0.375 ***	0. 706**
North West			0.280 ***	0 .527***
South East			1.618***	0 .733
South South			0.880	0 .696**
South West			1.793***	1.157
Community women's education				
Low			1.000	1.000
Medium			2.339***	1.139
High			4.939***	1.392**
Community hospital delivery				
Low			1.000	1.000
Medium			7.115***	5.907***
High			21.327***	17.273***
Ethnic diversity				
Low			1.000	1.000
Medium			0.672***	0 .664***
High			0.466***	0.504***
Random effects	***Empty***	***Individual***	***Community***	***Individual/ Community***
Community level				
Variance (SE)	7.467*** (0.492)	1.933*** (0.774)	0.504*** (0.054)	0.356*** (0.047)
(VPC) =ICC (%)	69.4	37	13.2	9.8
(PCV) (%)	Reference	74.1	93.3	95.2
Log-likelihood	**-7376.9092**	**-5957.9257**	**-6621.2366**	**-5615.8334**
Model fit statistics				
AIC	14759.8	11961.9	13272.5	11301.7
BIC	14783.2	12139.4	13389.4	11571.8

The empty model contains no variables but partitions the variance into two component parts
SE = Standard error, VPC= Variance Partition Coefficient, PCV = Proportional Change in Variance
AIC=Akaike information criterion, BIC = Bayesian information criterion
Significance level *p<0.5

The smaller values of AIC and BIC observed at the end of Table 3 and 4 revealed that model 4 of the multilevel models for antenatal and delivery care respectively are better explanatory models. Thus the lower values indicate the goodness of fit of the multilevel models. This also suggests that the addition of the community compositional factors increased the ability of the multilevel model in explaining the variation in antenatal and delivery care between communities.

Discussion

Given our interest on the impact of community factors on the use of maternal health care, the findings have demonstrated that community level factors were important in explaining the variations in the use of antenatal and delivery care across communities. For instance models that included community contextual variables seemed to provide a better overall explanation for the variation in the use of antenatal and delivery care in Nigeria. Further results indicated that the addition of the community level variables in the final models moderated the effects of the association between individual level variables and antenatal and delivery care. A major important finding of this study is that even after controlling for the effects of individual and community level variables, substantial significant variations in the use of antenatal and delivery care across communities remained. Overall, the results suggest that residing in particular communities is an important determinant of the use of maternal health care. Specifically the finding that the likelihood of delivering a baby in a health facility was higher among women from communities with high proportion of women with secondary and higher education relative to those from communities with low proportion of educated women could represent communities with higher proportion of socioeconomically advantaged households (Stephenson et al., 2006; Gage 2007). This is consistent with empirical research that greater household wealth enables women to seek maternal health care; whereas for women in poor households, financial constraint is an important barrier to seeking care. In addition, it could also reflect greater awareness of care during childbirth as higher levels of education may create greater awareness of maternal health care services and the need for them (Stephenson et al., 2006).

Results showed that attending four or more antennal care visits and having a health facility delivery were more likely among women living in communities with high proportion of women who delivered in a health facility. This result could reflect the presence and availability of maternal health care services and health practices of others in the community which in turn may influence the use of maternal health care. In a community in which a high percentage of women are using maternal health services, the practice will be regarded as a norm, influencing individual health behaviour (Stephenson et al., 2006). Attending four or more antenatal care visits was found to be lower for women in communities with high level of poverty suggesting lack of resources, low financial autonomy and consequently lack of access to maternal health care services. Interestingly results showed that women from North eastern and North western regions were significantly less likely to attend four or more antenatal care visits and have a health facility delivery compared to those from North central and the southern regions of the country. Regional differences in the use of maternal health care could reflect disparities in socio-economic development, as well as effectiveness of maternal health care services campaigns across the various regions of Nigeria.

With respect to individual level variables, educational attainment, occupation, ethnic origin, household wealth index, parity, occupation and religion were significantly associated with antenatal and delivery care. These results were consistent with studies in Indonesia, Bangladesh, Palestine and Guatemala (Islam & Odland 2011; Kistiana, 2009; Dhaher et al., 2008; Pebley et al., 1996). The finding that women from Igbo, Yoruba, and Northern /Southern minority ethnic groups had a higher likelihood of using maternal health care compared to Hausa women, underscores the

complexity of forces in operation among the different ethnic groups in a culturally diverse society like Nigeria (Antai, 2009). The likelihood of having a health facility delivery decreased consistently as number of children ever born increased respectively. This could reflect lower income and supports the notion that higher parity suggests large family size and hence lower resources (both time and money) available to seek maternal health care (Kistiana, 2009).

This study however has some limitations that are noteworthy. One key limitation of the study is associated with the definition of relevant 'groups' which is a great challenge in multilevel analysis. The study used primary sampling units (PSU) as a proxy for the community. Community or neighbourhoods are defined in relation to geographical criteria, administrative boundaries or respondents' perceptions (Gage, 2007). As Boco (2010) noted using the DHS primary sampling unit as the community may bias results towards a functioning population as a result of endogeneity and selection effects. The 2008 Nigeria Demographic and Health Survey data was collected retrospectively. This however, may be associated with recall bias given that the events took place five years following the survey. For instance, women may forget or may not accurately recall during the interview the number of antenatal care visits attended. These limitations notwithstanding, the strength of the study remains significant. It is a large population based study with a national coverage. Its representativeness affords the researchers the opportunity to examine maternal health care utilization simultaneously among women in Nigeria's heterogeneous regions.

Conclusion

There are significant community variations in the outcome variables even after controlling for the effects of both individual and community characteristics indicating the presence of unobserved factors. Further research is needed to identify these factors. Findings indicate that community factors have significant influence on women's decisions to use maternal health care. This suggests that interventions to encourage the use of antenatal and delivery care should not only be implemented at the individual level but tailored to community context. Community interventions conceived without consideration for community context in which women live will have limited impact, unless they are informed by data that appreciates the important connection between community contextual factors and the use of maternal health care. To close the gap in the use of antenatal and delivery care, between communities, interventions should aim at empowering women economically, increasing women's education and hospital delivery in disadvantaged communities.