Multilevel Analysis On The Determinants Of Birth Registration In Nigeria

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***Abstract*—Data on Birth registration often comes from complex sampling designs with hierarchical structure. The use of single level probit or logistic model which don't account for population structures such as grouping (by state) or clustering effect (within households) in the population often biases estimates obtained from such analysis. The study aimed at using a novel approach and expanded variables on the determinants of birth registration.**

This study used a multilevel logistic approach in determining predictors of birth registration. The systematic bias is accounted for by taking advantage of the multi stage sampling structure of the Demographic and Heath Survey (DHS), and employing a three-level (state, cluster and individual) random effect logistic model.

The results of the study showed that Birth registration in Nigeria is influenced primarily by the demographic characteristics of the parents, characteristics of the child and the socio and economic wellbeing of the household. Also, birth registration varies by 21.7% between two children within the same cluster, implying same state and 7.1% between two children who belong to different cluster, but within the same state.

Nigeria's population faces numerous limitations to birth registration amongst them being lack of accessibility of registration services and indirect costs associated to registration. This study recommends that the government urgently mitigates these by improving accessibility of registration services to its population.

The study explored a more robust methodology than considered the design structure of the data under study in the model building and permitted the estimation of effects related to the structure variables.

Keywords—Birth registration, Multilevel, Hierarchical, Clustering effect, Logistics, Complex Sampling Design, DHS

Introduction

Civil registration and vital statistics (CRVS) systems are concerned with the legal registration of the occurrence and characteristics of vital events, and the routine production of statistics on these events. Civil registration systems that are operating effectively compile information pertaining to vital events occurring in all areas of a country on a permanent and continuous basis. When analysed, this information provides a credible source of population data which can be used for multiple purposes, including to validate other population data sources such as Censuses. Vital events include births, deaths, marriages, divorces, foetal deaths, annulments, judicial separations and adoptions, and through the registration process these events are made legal and legitimate (World Health Organization (WHO), 2013).

Births and deaths are considered by the United Nations to be of higher priority as these are basic to the assessment of population growth as well as the health of the population (United Nations (UN), 2014)[1].

The Federal Government of Nigeria (FGN) established the National Population Commission (NPC) in 1988 with the responsibility to collect, analyze, and disseminate demographic data in the country. Two of its core roles are to carry out civil registration and to undertake population censuses. The Child Rights Act of 2003 mandates the compulsory registration of every child's birth within 60 days of birth (Isara and Atimati 2015). The commission set a target of 60% completeness[2] for 2010 with the aim of reaching universal registration (100%) by 2015.

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[1] https://unstats.un.org/unsd/demographic/standmeth/principles/M19Rev3en.pdf , page 81, para 291

[2] Completeness refers to the proportion of vital events that are registered within the civil registration system, as a proportion of the total number of events that are expected to have occurred. Completeness is used a measure of the status of performance of the civil registration system. Countries that have achieved more than 90% completeness of individual events are considered to have complete civil registration systems.

Propelled by the target, the NPC and partners, including United Nations Children's Fund (UNICEF), put in place various strategies intended to improve birth registration. These included relaxing the fine for late registration and encouraging the registration of births of all children under 5 years old. For a child's birth to be registered through this program, the parents had to visit a birth registration center or see an itinerant registrar during a community visit. Recently, the establishment of a RapidSMS channel for birth registration reporting by remote registrars was hailed as a good means of improving birth registration monitoring (UNICEF 2012)[3].

Data on birth registration are drawn from official registration figures (the civil registration system), censuses, and household surveys. However, the systematic recording of births in most countries remains a serious challenge and Nigeria is not an exception. In the absence of reliable administrative data, household surveys have become a key source of data to monitor levels and trends in birth registration. In most low- and middle-income countries, such surveys represent the only source of this information.

With the exception of a few nationally representative surveys like the Multiple Indicator Cluster Surveys (MICS) and the Demographic and Health Survey (DHS) of some countries, surveys and census rarely include questions on birth registration. Hence, these two sources have been used extensively by researchers interested in the determining factors that enhance or inhibit birth registration using linear and standard logistic or probit regression model. Research articles of Ana Corbacho Rene Osorio Rivas (2012), Joshua Amo-Adjei and Samuel K. Annim (2015), Ornella Comandini, Stefano Cabras, and Elisabetta Marini (2015) and Olusegun Ayodeji Makinde, Bolanle Olapeju, Osondu Ogbouji, and Stella Babalola (2016) are the most recent and very good examples. However, these methods do not account for population structures such as grouping (by state) or clustering effect (within households) in the population. As a result, the estimates obtained from such analysis are often be biased.

Md. Hasinur Rahaman Khan and J. Ewart H. Shaw (2011) in their paper titled "Multilevel Logistic Regression Analysis Applied to Binary Contraceptive Prevalence Data" reported the effect of failing to take into account the clustering within the divisions (level 3) and clusters (level 2). From their study, they compared the estimate of standard logistic model to that of the multilevel logistic model, and found that there was a significant difference between the standard logistic model and the multilevel logistic model estimate. Precisely, they reported that the standard logistic model overestimated the odd-ratio by 33% compared to the multilevel model when Penalized Quasi Likelihood of order two was used and under estimated the odd-ratio by 11% when Markov Chain Monte Carlo (MCMC) method was applied.

Furthermore, these studies fail to include important region level characteristics such as cultural or ethnic attributes that may affect birth registration. Therefore, the focus of this article is to evolve a novel framework in research articles seeking to model or figure out the determinants of birth registration using Nigeria's Demographic and Health Survey Data. In this study, we account for such systematic bias by taking advantage of the multi stage sampling structure of the survey, and employing a three-level (state, cluster and individual) random effect logistic model.

Consequently, the study will provide salient information on determinants of birth registration after controlling for grouping and clustering effect which is missing in this area of study till date. Also, variability due to population hierarchy will be determined. Summarily, the research questions that this study addressed are the following: What are the determinants of birth registration when grouping and clustering effect are controlled for? Which of the population hierarchy account for substantial amount of variability in birth registration?

1.1 Global and Local View of Birth Registration Scenarios

Universal Birth registration serves a statistical purpose and it is an essential part of a system of vital statistics, which tracks the major milestones in a person's life – from birth, marriage and death. Such data are essential for planning and implementing development policies and programmes, particularly in health, education, housing, water and sanitation, employment, agriculture and industrial production. As reported by the Pacific Community (SPC), Birth registration data and statistics is needed for the direct measurement and monitoring of at least 17 targets of the recently endorsed Sustainable development Goals[4] (SDGs). It is worth noting that close to all SDGs require population data for their measurement; this data can be reliably and cost-effectively provided by administrative records on birth. Birth registration further sets the platform for the realisation of fundamental rights and privileges including the right to a legal identity; which is also enlisted as one of the priority targets of the SDG agenda (See Target 16.9).

Globally, the births of nearly 230 million children under age five years have never been registered (nearly one fourth of children under the age of five). Asia is home to more than half these children (59 per cent); another 37 per cent live in sub-Saharan Africa; the remaining 4 per cent are from other regions (UNICEF, 2012). Nearly one in three unregistered children live in India. In 2012 alone, 57 million infants – four out of every ten babies delivered worldwide that year – were not registered with civil authorities. The same report by UNICEF in 2012 confirmed that

[3] https://blogs.unicef.org/innovation/nigeria-using-rapidsms-for-birth-registration/

[4] http://www.pacific-crvs.org/docs?view=download&format=raw&fileId=102

approximately two thirds (65 per cent) of the global population of children under five have been registered, although significant regional differences are found. The percentage of registered children is above 90 per cent in all industrialized countries and among some countries in Central and Eastern Europe and the Commonwealth of Independent States (CEE/CIS) and Latin America and the Caribbean. In contrast, fewer than one in five children have had their births recorded in some sub-Saharan African countries.

A similar report published in 2013 showed markedly larger differences among the regions analyzed. The difference found in the completeness of birth registration between the regions is shown in figure 1. Central and Eastern Europe and the Commonwealth of Independent States (CEE/CIS) have the highest level of birth registration, with 98 per cent of children under 5 registered. This is followed by Latin America and the Caribbean, at 92 per cent, and the Middle East and North Africa, at 87 per cent. The lowest levels of birth registration are found in sub-Saharan Africa (41 per cent). In Eastern and Southern Africa, only 36 per cent of children are registered by their fifth birthday, while the rate in West and Central Africa is slightly higher, at 45 per cent (UNICEF, 2013).

Evidently, the percentage of children under age five whose births have been registered in the African region (especially Sub-Sahara African) are still below average. This lack of formal recognition by the State usually means that a child is unable to obtain a birth certificate. As a result, he or she may be denied fundamental rights and benefits that would be established upon such registration, such as the rights to health care and education. Indeed, how is a decision maker able to make any decision about the population of his country without accurate estimates of the population size and dynamics; primarily birth and death? How can we conduct a program on the health of children less than 5 years if we do not have a permanent and accurate source of data on the number and characteristics of children born as well as their location by geography?

There are significant discrepancies in the globally reported estimates for birth registration completeness in Nigeria, which points weaknesses in the methodologies adopted for estimation of completeness by international agencies, and the need to standardise approaches, definitions and data sources. As observed in Fig. 2 and 3, while UNICEF[5] estimated birth registration completeness in Nigeria to be at 29.8 percent in year 2013, according to the United Nations Statistics Division[6] (estimates updated in 2014), birth registration completeness in Nigeria ranges between 75-89 percent. The National estimate (30 percent) which is derived from Nigeria's RapidSMS database, aligns to UNICEF's estimate.

It is appalling, that in some parts of Nigeria, birth registration is close non-existent. As shown in figure 4, the percentage of under 5 births registered in year 2015 is below 50% in all the states of the federation with national rate of 30 per cent. In the rural area where the phenomenon is more pronounced, many children don't exceed the primary level school, because after this level a birth certificate is mandatory for registration for official exams. These children are thus forced to abandon their schooling due to lack of birth certificate. The current practice contravenes the universal human right to education and also undermines the government's commitments and strategy, to promoting education for all, and improving the living conditions of populations.

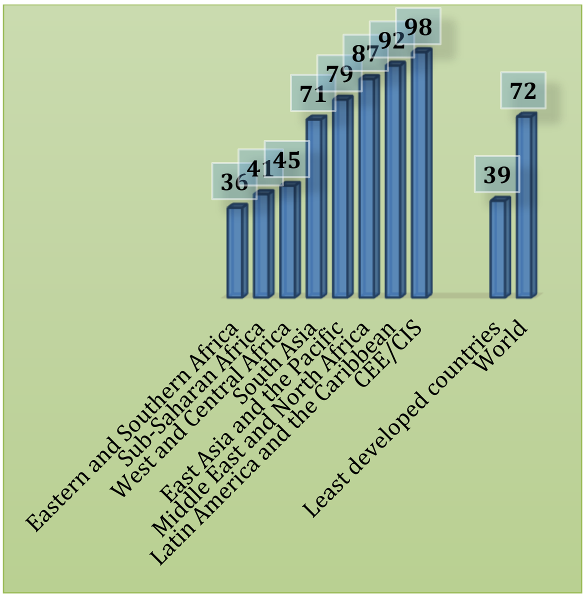

Fig. 1: Percentage of children under age five whose births are registered, by region

Source: UNICEF global databases, 2014. Based on DHS, MICS, other national household surveys, censuses and vital registration systems.

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[5] The World Bank http://data.worldbank.org/indicator/SP.REG.BRTH.ZS?view=map

[6] United Nations Statistics Division(UNSD) https://unstats.un.org/unsd/demographic/CRVS/CR_coverage.htm

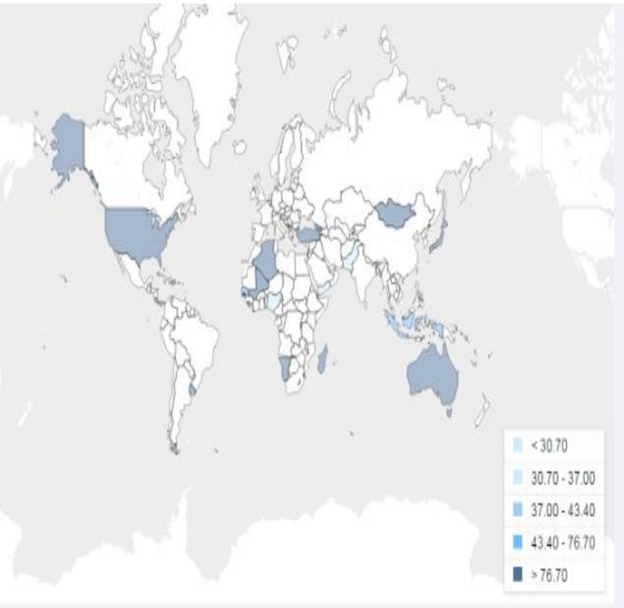

Fig. 2: Birth registration completeness in Nigeria, in comparison to other regions of the World

Source:http://data.worldbank.org/indicator/SP.REG.BRTH.ZS?end=2013&start=2013&view=map

Fig. 3: Birth registration completeness in Nigeria, in comparison to other regions of the World

Source:https://unstats.un.org/unsd/demographic/crvs/CR_coverage.htm

1.2 Significance and Determinants of Birth Registration

The significance of birth registration in global, regional and national development cannot be over-emphasized. A holistic look at the phenomenon suggests that there are certain factors that enhance or inhibit birth registration. The empirical literature finds that the maternal education levels, place of delivery, age of the child, household wealth index and urban location all affect birth registration status of a child in a given household (UNICEF, 2005; Duryea, Olgiati and Stone, 2006; Castro and Rud, 2011; Ana Corbacho and Rene Osorio Rivas, 2012).

Qualitative studies have shown that children without identity documents have more difficulty accessing public services, including health services. Bracamonte and Ordonez (2006) covered the effects of the lack of a birth certificate in Chile, Colombia, Honduras, Ecuador, Nicaragua, and Peru on access to education, health services, and conditional cash transfers. Harbitz and Tamargo (2009) explore the factors that contribute to under-registration of births and lack of legal identity. Harbitz and Boekle-Giuffrida (2009) document the diverse challenges faced by those lacking legal identity documents. Cody C. (2009) finds that birth registration is a prerequisite for accessing health services in many developing regions. In addition, distance from households to registration facilities is widely perceived as one of the most important deterrents to registration.

The existence of limited studies, regional coverage, variable selection and methodology issues on works seeking determinants of birth registration are motivations for this study. Firstly, limited studies have been conducted in the African region and in particular, Nigeria on the determinants of birth registration. To date, the empirical studies on birth registration in the Africa region conducted by Joshua Amo-Adjei and Samuel Kobina Annim (2015), Stefano Cabras and Elisabetta Marini (2015) and Olusegun Ayodeji Makinde, Bolanle Olapeju, Osondu Ogbouji, and Stella Babalola (2016) found that Mother's education, age of the child, place of delivery and household wealth are positively associated with the likelihood of a child's birth being registered. In the context of structural factors, Joshua Amo-Adjei and Samuel Kobina Annim (2015) deduced that being a resident in the Eastern region of Ghana and rural areas were risk factors for children not being registered.

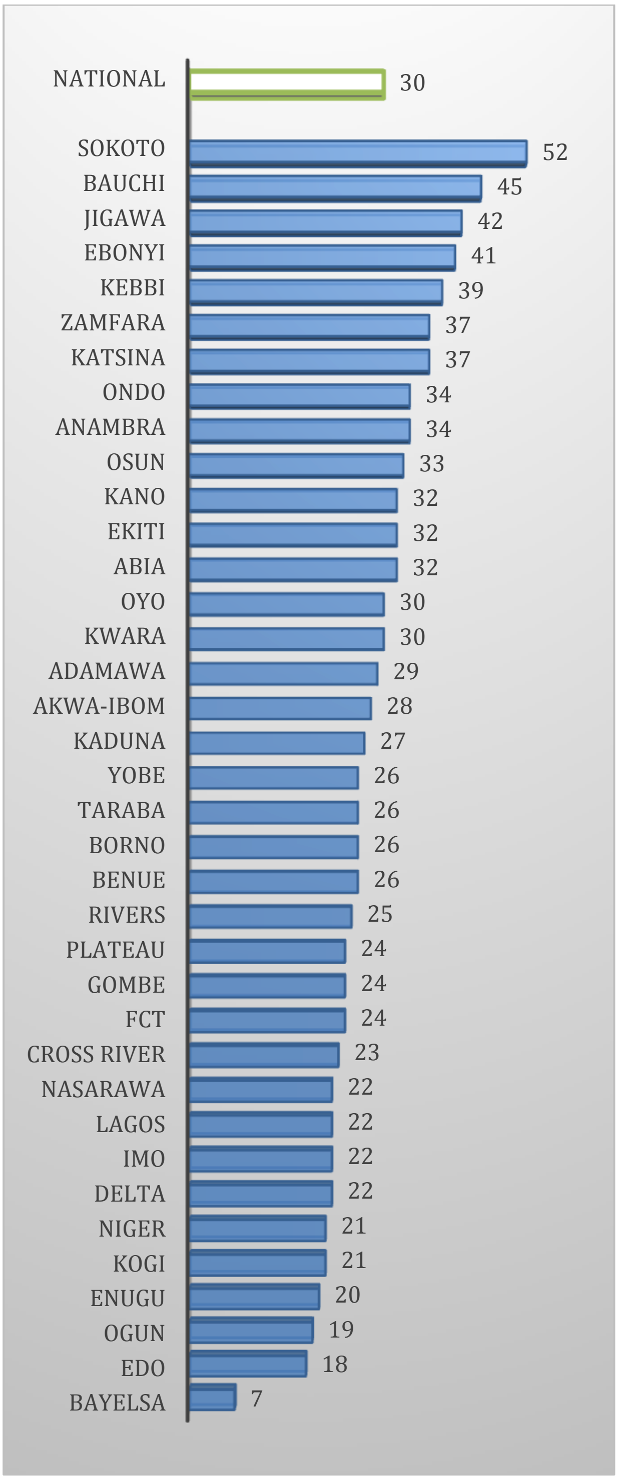

Fig. 4: Percentage of children under age five in Nigeria whose births were registered, by State

Source: http://br.rapidsmsnigeria.org/2015/12?cumulative=1

Besides, children who were resident in households where the head is affiliated to Traditional Religion were found to be at significant risk of having their births unregistered. However, these studies limited their choice of variables to only Socio-economic ones, leaving out household characteristics and utilities.

Despite the fact that these studies used data coming from complex survey design, these research works had adopted ordinary least square (OLS), PROBIT and Logistic methodology. The application of PROBIT and Logistic methodology might be justified because of the dichotomous nature of the dependent variable however incorporation of the hierarchical structure of the data is left out in the specification of the model. Ignoring the hierarchical structure of data can have serious implications, as the use of alternatives such as aggregation and disaggregation of information to another level can induce high collinearity among predictors and large or biased standard errors for the estimates. Discussions on the effects of these alternatives are contained in the work of Bryk and Raudenbush (1992), Longford (1987) and Rasbash (1993).

This study seeks to add onto existing knowledge on the determinants of birth registration. The study explores a more robust methodology; it is the first to model birth registration in the Africa region with expanded predictor variables, and incorporating the hierarchical nature of the data into the model specification. The latter hasn't been undertaken in any of the existing empirical studies undertaken in the African region on this subject.

1. Data and Methodology

2.1 Data Source and Sampling Design

The study used data from 2013 Nigeria Demographic and Health Survey (NDHS). The 2013 NDHS is the fifth and the most recent DHS in Nigeria, following those implemented in 1990, 1999, 2003, and 2008. The survey used multistage stratified sampling design; samples were selected independently in three stages from the sampling frame. Stratification was achieved by separating each state into urban and rural areas.

In the first stage, 893 localities were selected by applying the probability proportional to size and with independent selection in each sampling stratum. In the second stage, one EA was randomly selected from the 893 selected localities with an equal probability selection. In a few larger localities, more than one EA was selected. In total, 904 EAs were selected. After the selection of the EAs and before the main survey, a household listing operation was carried out in all of the selected EAs. The household listing consisted of visiting each of the 904 selected EAs, drawing a location map and a detailed sketch map, and recording on the household listing forms all occupied residential households found in the EA with the address and the name of the head of the household. If a selected EA included less than 80 households, a neighbouring EA from the selected locality was added to the cluster and listed completely. The resulting list of households served as the sampling frame for the selection of households in the third stage.

In the third stage of selection, a fixed number of 45 households were selected in every urban and rural cluster through equal probability systematic sampling based on the newly updated household listing. Details relevant to the complex sampling design are available in the NDHS, 2013 Final Report. Summarily, the total number of households sampled was 40,680, 16,740 from urban areas and 23,940 from rural areas. Equally, the number of Women 14-49 years in the survey was 37,928, 15,611 from urban areas and 22,317 from rural areas. Similarly, Children under age 5 years covered in the survey were 30,108 with 10,870 and 19,238 from urban rural areas respectively.

The sampling design as indicated above suggests that the population structure from which the data was obtained is hierarchical. The hierarchical structure of the data for this study follows individual as level 1 who are nested or grouped within clusters or EAs as level 2 and nested within states as level 3. It is important to incorporate hierarchical structures of the data collection design into models when they arise. This enables the research to demonstrate differences in the response variable under study by the higher level clusters. Naively fitting two-level models to three-level data results into misattributing response variation to the two included levels (G. van Landeghem, B. De Fraine and J. Van Damme., 2005; Moerbeek, 2004; Wim Van den Noortgate, Marie-Christine Opdenakker and Patrick Onghena, 2005; Tranmer and Steele, 2001). Generally, when clustering occurs in the population and they are ignored in the analysis the results may lead to misleading conclusions about the relative importance of different sources of influence on the response variable.

In this study we employ a multilevel modelling technique that takes advantage of the hierarchical structure in the data. In this technique, the design structure of the data under study is considered in the model building and analysis and this permits estimation of effects related to the structure variables. Unlike the traditional single level regression models which assumes that the relationship of covariates to outcome variable are the same across entities in the survey design, multilevel modelling has both fixed and random components. Random effects are useful in survey and longitudinal data, for modelling intra-cluster correlation; that is, correlation between observations in the same cluster because they share common cluster-level random effects. Hence, multilevel logistic modeling techniques allow us to assess the variations that could possibly occur at several levels of birth registration. Take for instance in this case; we can assess the probability of current birth registration of i^{th} children who is nested in j^{th} cluster of k^{th} state simultaneously at a time.

2.2 Model Specification and Accompanying Issues

The data under study consists of k^{th} states and each states consists of j^{th} clusters with i^{th} children within each cluster. Accordingly, a three level random intercept model is specified as;

$$y_{ijk} = \beta_0 + \beta_i \sum_{i=1}^{N} x_{ijk} + \beta_j \sum_{j=1}^{J} x_{jk} + \beta_k \sum_{k=1}^{K} x_k + v_k + u_{jk} + \varepsilon_{ijk} \quad (1)$$

y_{ijk} , is the response for child i in cluster j in state k, β_0 is the mean response across all states. In this specification, x_{ijk}, x_{jk}, x_k are the explanatory variables at the level of child, cluster and state while β_i, β_j and β_k are respectively the fixed effect parameters associated with these levels. v_k is the effect of state k , u_{jk} is the effect of locality j within the state and ε_{ijk} is the residual error term. The random effects and residual errors are assumed independent of one another and normally distributed with zero means and constant variances of σ_v^2, σ_u^2 and σ_e^2.

Equation (1) can be expressed in a standard linear multilevel model specification as: $y_{ijk} = X'_{ijk}\beta + z'_{2,ijk}u_{2,jk} + z'_{3,ijk}u_{3,k} + \varepsilon_{ijk}$ (2)

where y_{ijk} is the response of the i^{th} child in the i^{th} cluster in the k^{th} state, X_{ijk} is a vector of covariates having fixed effects β, $z_{2,ijk}$ is a vector of covariates having random effects $u_{2,jk}$ at the cluster level, $z_{3,ijk}$ is a vector of covariates having random effects $u_{3,k}$ at the state level and ε_{ijk} is the error term with mean 0 and variance σ^2. This also assumed that the random effects are mutually independent with mean 0 and variances Ω_2 and Ω_3 at cluster and state level respectively.

Equation (2) can as well be written as a special case of the general linear mixed model as:

$$Y = X\beta + Zu + \epsilon \quad (3)$$

Where y is $N \times 1$ vector of responses and X is an $N \times P$ model matrix for the fixed effects. u is a vector of random effects, Z is an $N \times Q$ model matrix for the random effects and ϵ is $N \times 1$ vector of error terms.

The situation in the present study is such that Y is a vector of binary responses; hence a nonlinear [7]multilevel model specification is expected. Following Goldstein (1991) a Multilevel Nonlinear Model consists of a nonlinear components and a linear component, both of which may contain fixed and random effects as,

$$Y = f(X\beta + Zu) + G\eta + H\delta \quad (4)$$

Where X, Z, β and u have the same definition as above and G, H, η and δ have the similar structure to X, Z, β and u. Since the response here is a vector of proportions, there is no linear component and the link function f is logit. Hence, the multilevel logit model is of the form,

$$logit(\mu) = \eta = X\beta + Zu \quad (5)$$

[7] For multilevel probit model μ_i is replace by $\phi(\eta_i)$ where η_i is the linear predictor for individual i.

Where $\mu_i = \Pr(Y_i = 1|\beta, \Omega, X, Z)$; for $i = 1,.,N$ *and* η is a conditional linear predictor. Since Y is binary and Bernoulli distributed with μ the contribution of all individual to the likelihood is the probability density function given as

$$f(y_i|X, Z, \beta, u) = \mu_i^{y_i}(1-\mu_i)^{1-y_i} \quad (6)$$

From here we assumed that the elements of Ω_i are unknown and there exist a known matrix$W$. Further, it is assumed that ϵ has a multivariate normal distribution and that the interest is to obtain Maximum Likelihood Estimation (MLE) of the parameters. Under this assumption the conditional likelihood function for a multilevel model is

$$L(\beta|u) = \prod_{i=1}^{N} \mu_i^{y_i}(1-\mu_i)^{1-y_i} \quad (7)$$

The likelihood function given by equation (8) is denoted by $L(\beta|u)$ because its value is conditional on the value of the random effect u and this is the reason it is referred to as the conditional likelihood. It is desirable to work with the unconditional or marginal distribution which does not involve u since u is unobserved. The marginal likelihood is obtained by averaging over the random effects which in mathematical term implies integrating over the random effects distribution:

$$L(\beta, \Omega) = \int_u L(\beta|u)g(u)du \quad (8)$$

Where g is the density function of the vector u.If we assume that u is normally distributed (Breslow and Clayton, 1993) then,

$$L(\beta, \Omega) = \int_{RQ} L(\beta|u)\phi(u)du \quad (9)$$

Unfortunately, the right hand side of (9) cannot be evaluated analytically. One way to proceed is to use numerical integration, which essentially replaces the integration in equation (9) with a summation. This involves approximating the normal distribution for the random effects by a discrete distribution with *q* points. The most commonly used methods of numerical integration are Gauss-Hermite numerical quadrature and adaptive quadrature. A large number of quadrature points *q* may be required to approximate the normal distribution, which can lead to lengthy estimation times for large datasets. Numerical integration is also computationally intensive when there are multiple random effects, for example in models for more complex population structures or random coefficient models.

An alternative to numerical quadrature, which is more computationally efficient when there are large numbers of random parameters, is simulated maximum likelihood (Ng ESW, Carpenter JR, Goldstein H, Rasbash J, 2006) which uses Monte Carlo integration to repeatedly evaluate the marginal likelihood at plausible values of (β, Ω). However, this method is also highly computationally intensive. However, our focus in this study will be Quasi-likelihood estimation provided in MLWin software.

2.3 Quasi-Likelihood Estimation

This method is an alternative to direct maximum likelihood and involve using approximation to replace (5) by a linear model. Standard procedures for continuous responses are then applied, e.g. iterative generalized least squares (IGLS). We begin the discussion with an outline of the IGLS algorithm and then described how equation (5) is linearized.

Consider a specification in equation (3) and given that Y is a continous response. In ordinary least squares (OLS) estimation of a single model for Y, we can derive a set of equations that expresses each parameter β *and* σ_ϵ^2, as a function of data (X, Y). The implication of this is that the parameters can all be estimated in a single step. The parameters (β, Ω) in a multilevel model depend solely on the data therefore it is not possible to derive expression for them. Take for instance, the expression for the fixed part parameters (says β_0 and β_1) depend only on the random part parameters (σ_v^2, σ_u^2 *and* σ_e^2). In a situation as this, the iterative procedure is applicable such that each iteration the estimate of a parameter is updated using the current values of the other parameters. The IGLS algorithm consists of the following steps:

i. Obtain the starting values $(\beta_i^{(0)}, \sigma_v^{2(0)}, \sigma_u^{2(0)}$ *and* $\sigma_e^{2(0)})$ for parameters(β, Ω). The betas and σ_e^2 are often set to the OLS estimates while $\sigma_v^2,$ *and* σ_u^2 are set to zeros (i.e. estimates from single-level model)

ii. Obtain improved estimates of β denoted by $\beta_i^{(m)}$. These will be based on $\sigma_v^{2(m-1)}, \sigma_u^{2(m-1)}$ *and* $\sigma_e^{2(m-1)}$.

iii. Obtain improved estimates of σ_v^2, σ_u^2 *and* σ_e^2 denoted by $\sigma_v^{2(m)}, \sigma_u^{2(m)}$ *and* $\sigma_e^{2(m)}$ based on $\beta_i^{(m)}$, $\sigma_v^{2(m-1)}, \sigma_u^{2(m-1)}$ *and* $\sigma_e^{2(m-1)}$.

Steps 1 and 2 are repeated, updating m by 1 each time, until an additional iteration of the procedure leads to only a 'small' relative change in the parameter estimates, at which point convergence is achieved. The convergence criterion is commonly referred to as the tolerance.

The two quasi-likelihood methods are Marginal and Penalised (or Predictive) Quasi-likelihood. Under these procedures, a Taylor expansion is used to approximate and linearize the inverse link function. In the Marginal Quasi-Likelihood procedure (MQL), only the fixed part is used for the Taylor expansion, while in the Penalized or Predictive Quasi-Likelihood procedure (PQL) the Level-2 residual estimates are added to the fixed part when forming the Taylor expansion (Breslow & Clayton, 1993; Goldstein & Rasbash, 1996). In general, the PQL procedure reduces the bias of both fixed and random parameters and therefore is to be preferred (Rodriguez & Goldman, 1995; Goldstein & Rasbash, 1996). The MLwiN software provides first and second order marginal quasi-likelihood (MQL1, MQL2) and first and second order penalized quasi-likelihood (PQL1, PQL2).

The literature has shown that all the four approaches are biased, particularly if sample sizes within level 2 units are small or the response proportion is extreme. However, PQL2 has been used extensively in the literature because it is most accurate. George Leckie and Chris Charlton, 2012 noted that even though PQL2 is the most accurate it is least stable while MQL1 is the least accurate but the most stable and fastest to converge. Thus, they suggested that the model should first be fitted using MQL1 and use these estimates as starting values for running additional iterations by PQL2. This however is not common in the literature but it will be adopted in the current study.

2.4 Variance Partitioning Coefficient (VPC) and Intra-Class Correlation Coefficient (ICCs)

Other important area of multilevel analysis is variance partition coefficient (VPC) which helps to report the proportion of the observed response variation that lies at each level of the model hierarchy. The total response variance for child i is defined as

$$var(y_{ijk}) = var(\beta_0 + v_k + u_{jk} + e_{ijk}) \quad (10)$$

$$var(y_{ijk}) = var(v_k) + var(u_{jk}) + var(e_{ijk}) \quad (11)$$

[8] $$var(y_{ijk}) = \sigma_v^2 + \sigma_u^2 + \sigma_e^2 \quad (13)$$

This implies that the total variance is simply the sum of the three separate variance components. From here, VPC for the state, cluster and child level are obtained as follows:

$$VPC_v = \sigma_v^2/\sigma_v^2 + \sigma_u^2 + \sigma_e^2 \quad (14)$$

$$VPC_u = \sigma_u^2/\sigma_v^2 + \sigma_u^2 + \sigma_e^2 \quad (15)$$

$$VPC_e = \sigma_e^2/\sigma_v^2 + \sigma_u^2 + \sigma_e^2 \quad (16)$$

Also, the relative magnitude variance components can be interpreted by evaluating the intraclass correlation coefficients (ICCs). ICC statistics measure the degree of resemblance between lower level units belonging to the same higher level unit. In essence, it accounts for the extent to which values of the dependent variable are similar for individuals belonging to the same group. The picture of ICC is as presented in Table 1 for four different possible pairings of children.

Pairing 1 gives the correlation between a child and themselves. This correlation is equal to one. Pairing 2 gives the correlation between two children within the same cluster (and therefore the same state). This correlation is referred to as the cluster level ICC. Pairing 3 gives the correlation between two children who belong to different cluster, but within the same state. This correlation is referred to as the state ICC. Note that the state ICC coincides with the state VPC. However, this equivalence will not hold in more complex models, such as those including random coefficients. Pairing 4 gives the correlation between two children who belong to different state (and therefore different cluster). These two children share no common sources of influence and are therefore assumed independent; they have an expected correlation of zero.

Table 1: Implied covariances and correlations for the four different possible pairings of children

	Children	Clusters	States	Covariance	Correlation
1	$i = i'$	$j = j'$	$k = k'$	$\sigma_v^2 + \sigma_u^2 + \sigma_e^2$	1
2	$i \neq i'$	$j = j'$	$k = k'$	$\sigma_v^2 + \sigma_u^2$	$(\sigma_v^2 + \sigma_u^2)/(\sigma_v^2 + \sigma_u^2 + \sigma_e^2)$
3	$i \neq i'$	$j \neq j'$	$k = k'$	σ_v^2	$\sigma_v^2/\sigma_v^2 + \sigma_u^2 + \sigma_e^2$
4	$i \neq i'$	$j \neq j'$	$k \neq k'$		0

2.5 Statistical Analysis

MLwiN version 2.36 software is used in this study to analyse the multilevel data structure on birth registration as obtained from NDHS 2013.Variable merging was done between ***household members recode*** and ***children recode*** data files and empty cases on each variable was removed to ensure that the data is well filled and this reduced the sample size to 18701 (62.1 percent of the dataset).

Specifically, random intercept multilevel logistic is adopted because of the dichotomous nature of the response variable (birth registration). The levels of

[8] First level variance (σ_e^2) has a standard logistic distribution with variance $\pi^2/3$

hierarchy of the data are state ($n = 37$), cluster ($n = 885$) and child level ($n = 18701$). Two models were estimated. The first one contained only random term for each of the three levels. This model simply aimed to describe the components of the total variance in birth registration. The second model examines the effect parent characteristics, child characteristics, household characteristics and Utilities on birth registration. For estimation of the models, MLQ1 was first used to obtain starting values for final PQL2 estimation.

The contextual influences of the study was addressed by calculating VPC attributable to specific level and given the hierarchical structure of our data ICC was measured, which provides information about the correlation in likelihood of birth registration between two children randomly chosen from either the same state or from the same cluster.

1. Result Presentation and Interpretation

Birth registration of children under age 5 years by some socio-economic variables is presented in table 2.This table shows that approximately 31% of the children had their births officially registered. Almost equal proportion of male and female had their birth registered but children under 2 years were more likely than those between 2 to 4 years to register their birth.

The distribution of the sampled children by place of residence showed that children in the rural area were less likely to have their births officially registered as compared to their counterparts in the urban area. In the same vein, the poor were less likely to register births as compared to the rich. With regard to place of delivery, children delivered at ‘Government Health Facility’ had better chance of birth registration than those delivered at ‘Respondents Home’, ‘Private Health’ Facility and ‘Other Health Facility’ respectively.

In term of distribution of birth registration across the state, Zamfara had the lowest percentage of registered births (2.4 percent). In Yobe and Kebbi, the proportions were 5.7 percent and 8.0 percent, respectively. Whereas, the five topmost states in term of proportion of under-five birth registration were Katsina (35.4 percent), Lagos (29.1 percent), Adamawa (26.0 percent), Kwara (24.8 percent) and Edo (24.5 percent). Distribution of under 5 birth registration by region depicted in figure 5 showed that South West and North West were respectively above other regions.

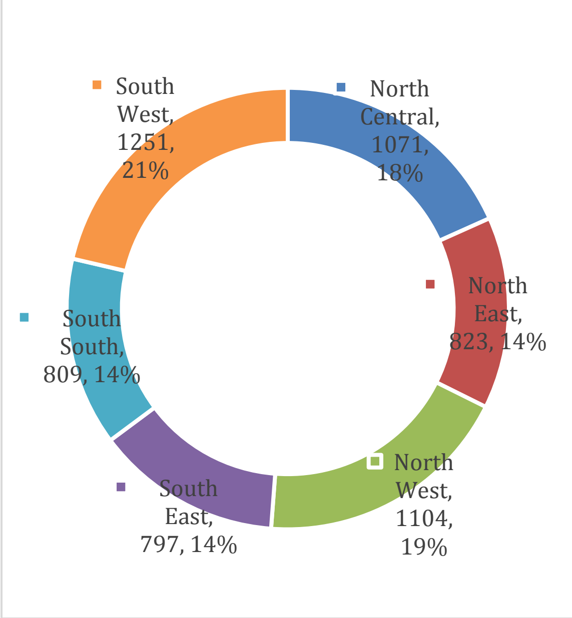

Fig.5:Distribution of under 5 birth registration by region.

Table 2: Birth registration of children under age 5

Does the child birth registered?			
	n=12846	n=5855	
	% Registered	% Not Registered	Total Number of Children
Age			
<2 years	53.5	56.8	10430
2-4 years	46.5	43.2	8271
Gender			
Male	50.7	50.5	9449
Female	49.3	49.5	9252
Place of Residence			
Urban	56.7	23.8	6376
Rural	43.3	49.5	12325
Native Language			
Hausa	21.3	40.3	6431
Igbo	18.1	6.6	1899
Yoruba	22.3	7.4	2253
Others	38.3	45.7	8118
Mother Highest Education			
No education	20.8	58.9	8782
Primary	21.8	19.4	3762
Secondary	41.5	18.9	4864
Higher	16.0	2.8	1293
Wealth quantile			
Poorest	5.2	29.7	4126
Poorer	12.0	27.2	4201
Middle	18.6	20.0	3657
Richer	27.8	14.6	3506
Richest	36.3	8.4	3211
Place of Delivery	34.8	73.3	11453

Respondent's Home Government Health Facility Private Health Facility Other Health Facility	41.4 23.1 0.7	17.8 17.8 0.8	4710 2392 146
Region/State North Central	**18.3**	**14.4**	**2926**
FCT-Abuja	21.8	5.9	344
Benue	10.6	14.1	376
Kogi	13.4	9.5	321
Kwara	24.8	9.6	444
Nasarawa	11.6	15.5	411
Niger	9.5	27.8	616
Plateau	8.3	17.6	414

Source: Authors' construct from the data

Table 2 continue.

	% Registered	% Not Registered	Total Number of Children
North East	**14.1**	**23.2**	**2802**
Adamawa	26.0	12.4	584
Bauchi	16.1	24.1	849
Borno	10.9	9.2	365
Gombe	20.4	16.7	666
Taraba	18.6	18.5	703
Yobe	8.0	19.1	635
North West	**18.9**	**37.5**	**5919**
Jigawa	10.1	14.4	805
Kaduna	12.1	9.9	611
Kano	23.9	22.3	1337
Katsina	35.4	9.3	838
Kebbi	5.7	13.2	699
Sokoto	10.2	14.3	800
Zamfara	2.4	16.7	829
South East	**13.6**	**5.4**	**1497**
Abia	21.2	14.9	273
Anambra	22.6	15.6	289
Ebonyi	15.9	32.8	357
Enugu	20.1	24.3	330
Imo	20.2	12.4	248
South South	**13.8**	**10.2**	**2119**
Akwa Ibom	19.8	12.3	321
Bayelsa	10.5	27.5	445
Cross River	9.4	15.8	284
Delta	20.1	19.1	413
Edo	24.5	12.4	360
Rivers	15.7	12.9	296
South West	**21.4**	**9.2**	**2438**
Ekiti	13.1	13.5	324
Lagos	29.1	18.4	582
Ogun	10.9	16.6	333
Ondo	12.7	19.6	392
Osun	18.7	11.7	373
Oyo	15.5	20.2	434
National	**31.3**	**68.7**	**18701**

Source: Authors' construct from the data

The empirical result for models 1 and 2 is presented in table 3. In the two models, the first concern is the goodness of fit and this is addressed by likelihood ratio test as this will help to judge the performance of the multilevel model to standard logistic regression model. As can be seen in the last panel of the two models, the likelihood ratio test is statistically significant indicating that the random effect model is better in comparison to standard logistic regression when it comes to explaining the variation of birth registration in the study area. Hence, the study proceed to interpret the result of the analysis.

The expected log-odds of birth registration from the intercept only multilevel model is given by the fixed effect term which is estimated to be -0.851 and this corresponds to odd ratio and predicted probability of

$\exp(-0.851) = 0.427\ and\ p_i = \exp(-0.851)/(1+\exp(-0.851)) = 0.299\ respectively.$ Assuming this log-odds denoted as β_{ojk}, which indicated the average of all states or all clusters of experience under five birth registration is normally distributed with mean $\hat{\beta}_{ojk} = -0.851$ and variance, $V(\beta_{ojk}) = V(\beta_o + u_{oj} + v_{ojk}) = 1.512 + 1.420 = 2.932$, the 95% confidence interval is given as, $CI = -0.851 \pm 1.96\sqrt{2.932} = (-4.207, 2.505)$. These log-odds when converted to predicted probabilities are found to be (0.015, 0.924). The explanation of this is that birth registration rate vary from 1.5% to 92.4% within the divisions when multilevel effects have been considered and no predictor has been included in the model.

Equally, model 2 examines the impact some predictor variables on birth registration. In this multilevel model, the random intercept estimates due to states and cluster are shown in the last panel of table 3. The parameter estimates of the fixed effect and the odd ratio associated with predictor variables are displaced in the result table. The multilevel analysis models the log odds of birth registration, but this study prefers to interpret the result of the model in terms of odds ratios as it has been done in the standard logistic model.

However, it is important to note that the odds ratio from standard logistic model cannot be compared directly with odds ratios from a multilevel model since odds ratios from a multilevel model are effects on the median odds of outcome variables whereas odds ratio estimated from a single-level has effect on the mean odds of outcome variable.

The research into variables associated with birth registration is the essence of model 2. Prior to the analysis, the selected variables are segmented into four. These are parents' characteristics, Child's characteristics, Household characteristics and Utilities (The details of variables under each segment are shown in table 3.). From the result, it is found that parents' characteristics like 'Parent native language' and 'Mother's highest education attainment' significantly determine likelihood of birth registration. In term of maternal native language, this study shows that those parent who speaks Yoruba and Igbo language are 1.451 and 1.589 (45.1% and 58.9%) more likely to engage in under 5 birth registration than those who speaks Hausa language. In the same vein, this study reveals that is an increased tendency to register birth with increase in the level of maternal education. That is, Mothers' with primary, secondary and Higher educational attainment are 1.619, 1.964 and 3.089 more likely to partake in birth registration than those with on education. Equally, those mother with higher education are approximately 2 time more likely to register birth than those with primary and secondary education. Others variables under parents' characteristics shows no significant relationship as regards birth registration, but it is important to note that teenage mothers and those not currently residing with their partners are 6% and 4% respectively less likely to register birth as compare to others in the reference group.

This study has also shown that increase probability of under 5 birth registration in Nigeria is significantly associated with child's characteristics such as age of child, the season of the birth and place of delivery of the child. The children age 2 years and below are 21.9% less likely to have their births registered as compare to children aged 2-4 years. Children born during the winter season are 7.4% less likely to have their births registered as compared to those children born during the summer. On the other hand, children delivered at government and private health facilities are 52.0% and 38.4% respectively more likely to have their births registered than those born in respondents' home. However, being a female child and involvement of a health professional in the child's delivery are not significant determinant of birth registration but they do increase chances of a child's being registered compared to their reference category outcomes.

Furthermore, the significance of household characteristics variables can be not be over-emphasized in determining the probability of a child's birth being registered. The most important variables in this category as regards birth registration are household wealth index, Number of household in a cluster, distance of household to place of medical attention and place of residence of the household. Specifically, the chance of birth registration increases as household wealth index changes from the poorest to the richest. The richest households are approximately twice as likely (OR= 4.145/1.781, OR=4.145/2.316) to register their children's births compared to those households in the poorer and middle wealth group. Equally, being in poorer, middle, richer and richest household wealth index group increases the chance of birth registration by 1.781, 2.316, 2.959 and 4.145, respectively compared to households in poorest wealth index category. Also, households in urban locations have better odds of birth registration compared to those in the rural areas. However, the possibility of birth registration decline where the number of household in the cluster are more and the distance constitute a big problem to these households in getting medical help.

As regards the utilities variables, the odds of birth registration are associated with presence of mass media (television and radio) and electricity in the household. When all these are in place, birth registration is enhanced by 11.5%, 20.2% and 38.8%, respectively. The intra correlation coefficient (ICC) at the state and cluster level were found to be 0.071 and 0.217 respectively. These measures indicate that the correlation of birth registration between two individuals in the same state and between two measurements on the same individual (in the same state).

Table 3: Multilevel logistic result showing determinant of birth registration

	Model 1		
Fixed Part	**Coefficient**	**z-score**	**Odd ratio**
Intercept	-0.851(0.202)	-4.216	
Random part State Cluster/Locality	1.420(0.349) 1.512(0.096)		
Likelihood ratio test	16.547***		
	Model 2		
Fixed Part	**Coefficient**	**z-score**	**Odd ratio**
Intercept	-2.747(0.331)	-8.312	

	PARENTS' CHARACTERISTICS		
Parent Native Language Hausa (Reference) Yoruba Igbo Others	0.372(0.143) 0.463(0.160) 0.038(0.098)	2.603 2.902 0.385	1.000 1.451*** 1.589*** 1.039
Mother's Highest Education Attainment No education (Reference) Primary Secondary Higher education	0.482(0.065) 0.675(0.070) 1.128(0.101)	7.448 9.687 11.152	1.000 1.619*** 1.964*** 3.089***
One of the parents is late	0.087(0.369)	0.235	1.091
The Mother is a teenager	-0.061(0.056)	-1.098	0.941
Not currently residing with partner	-0.043(0.084)	-0.517	0.958
	CHILD'S CHARACTERISTICS		
The child is a Female	0.006(0.040)	0.147	1.006
The child age is <2 years	-0.247(0.041)	-5.955	0.781***
The child is born during Winter	-0.077(0.040)	-1.903	0.926*
Child birth is attended by Health professional	0.116(0.078)	1.490	1.123
Place of delivery Respondent's Home (Reference) Government Health Facility Private Health Facility Other Health Facility	0.419(0.080) 0.325(0.091) -0.120(0.2)	5.220 3.595 -0.529	1.000 1.520*** 1.384*** 0.887
Child's birth order	-0.005(0.009)	-0.521	0.995
	HOUSEHOLD CHARACTERISTICS		
Household head is female	-0.048(0.086)	-0.561	0.953
Age of the household head	0.003(0.002)	1.609	1.003
Household Wealth index Poorest (Reference) Poorer Middle Richer Richest	0.577(0.095) 0.840(0.109) 1.085(0.131) 1.422(0.148)	6.080 7.717 8.309 9.584	1.000 1.781*** 2.316*** 2.959*** 4.145***
Number of household in a Cluster	-0.019(0.006)	-3.323	0.981***
Distance is a big problem to getting medical help	-0.120(0.053)	-2.254	0.887**
The child is born in Urban residence	0.364(0.088)	4.151	1.439***
Region North West (Reference) North Central North East South East South South South West	0.172(0.334) 0.236(0.333) 0.147(0.395) 0.019(0.363) -0.153(0.361)	0.515 0.710 0.373 0.052 -0.424	1.000 1.188 1.266 1.158 1.019 0.858
Cluster altitude (KM)	0.377(0.238)	1.586	1.458
	UTILITIES		
Household has car	0.111(0.068)	1.629	1.117
Household has television	0.109(0.065)	1.683	1.115*
Household has radio	0.184(0.052)	3.511	1.202***
Household has electricity	0.328(0.071)	4.617	1.388***
Random Part State Cluster/Locality	0.297(0.080) ICC/VPC= 0.071, 7.1% 0.614(0.050) ICC/VPC= 0.217, 21.7%		
Likelihood ratio test	13.833***		

Note: Standard error in parenthesis, *p < 0.10, **p < 0.05, ***p < 0.01

Source: Authors' computation from underlying data.

One can also conclude that 7.1% of the variation in birth registration is attributed to the state and 21.7% to the cluster nested within the state. Therefore, the addition of the state and cluster specific effects were not negligible and necessitated being accounted for in the model.

Conclusion and Recommendations

Determinants of birth registrations have been studied extensively in the literature. However, these authors appealed to fitting single level probit or logistic regression models which assumes that the relationship of covariates to outcome variable are the same across entities in the survey design. Ignoring the hierarchical structure of data can have serious implications because the use of alternatives such as aggregation and disaggregation of information to another level can induce high collinearity among predictors and large or biased standard errors for the estimates (Bryk and Raudenbush, 1992), Longford, 1987 and Rasbash, 1993). This study ensures that the proportion of variance in birth registration explained by these hierarchies can be factored out by using multilevel model modelling approach.

The level of under-five birth registration in Nigeria is still very low [$\simeq 31\, percent$] ; 7.1 percent of its variation is attributed to the state while 21.7 percent is attributed to the cluster nested within the state. This study identified salient demographic and socio-economic characteristics that known to influence whether or not a child's birth will be registered; some of which are discussed in this section in relation to their relevance for policy. This information is critical for the government (the National Population Commission) and other national stakeholders working in this field, as it would enable them to accurately target their birth registration incentives and can largely guide the crafting of programmatic response to under registration of births.

The findings of this study confirmed and are aligned to those of other authors such as [Alphonsus R. Isara, Antony O. Atimati, 2015; Olusesan Ayodeji Makinde, Bolanle Olapeju, Osondu Ogbuoji, Stella Babalola, 2016 who demonstrated that Birth registration in Nigeria is influenced primarily by the demographic characteristics of the parents (mainly the mother), characteristics of the child and the socio status and economic wellbeing of the household.

As would be expected, birth registration is positively skewed towards children whose parents reside in the Urban as compared to the rural areas (50.7% to 49.3 respectively). The differences in the two is however not disproportionally high. Often, urban dwellers are tagged with greater advantages such as better accessibility to registration facilities, as well as better knowledge and awareness about the need for registration. The findings reveal that birth registration improvement efforts should be intensified especially among rural dwellers.

The mother's level of educational attainment was found to influence whether or not her child would be registered. This finding is expected, as education would inherently provide individuals with a better understanding of the need for birth registration. Education is also often closely correlated with higher income levels, and hence the ability to afford any fees associated with registration. Ensuring universal birth registration among all persons with some level of education is one of the quick gains that a government can achieve. Such can be attained through inculcating training on civil registration into education curricula across all levels of learning.

Children aged below 2 years were 21.9% less likely to be have their births registered as compared to those aged between 2-4 years. In many countries, birth registration is often associated to school going age; children's births are more likely to be registered as the near school going age. While schools serve as an important incentive to ensuring improvements in registration, it is important to underline that birth registration is optimally undertaken within the first year of life from both a rights perspective and more importantly to ensure that the records are valid for computation of a country's annual vital statistics. In this regard it is critical for the government to focus on incentives that can encourage registration within the first year of life. Such can be achieved through integrating birth registration services with immunization and vaccination programmes among others. In general; every child that comes into contact with government services for whatever reason should have their births registered within that platform. This can be achieved through effective inter-departmental or inter-Ministry collaboration.

The findings also revealed that: (i) children born in the government and private health facilities are 52% and 38.4% respectively more likely to have their births registered as compared to those born at respondent's home; (ii) Birth registration increased with household wealth index from 1.781, to 2.316, to 2.959 among the poorer, middle, richest wealth group respectively; (iii) the odds of birth registration increased by 11.5%, 20.2% and 38.8% with the availability of television, radio and electricity in the household. These four findings could be closely linked to accessibility of birth registration services in terms of: (i) physical distance to registration facilities as well as (ii) the indirect costs associated with registration.

It is worth noting that a significant proportion of Nigeria's population (61.9%) live in absolute poverty[9]. This implies that access to daily means of sustenance (food, clothing or shelter) is a problem for many households. It is therefore important to recognize that any costs associated with registration of births are

[9] National Bureau of Statistics, Nigeria Poverty Profile, 2010
http://www.nigerianstat.gov.ng/pdfuploads/Nigeria%20Poverty%20Profile%202010.pdf. Page 21

evidently a unanimous burden for most households. In this regard it is recommended that the government enacts strategies to bring registration services closer to the people as possible, while eradicating any direct costs associated with registration. Recognizing that birth registration is a human right, the United Nations[10] recommends that registration services are offered free of charge.

In conclusion it is in the interest of this study to underline that while civil registration is a compulsory practice, it is against any country's development policies to deny a child education opportunities for failure to possess a birth certificate. Education is a fundamental human right which Nigeria recognizes, through its commitments to the United Nations Convention on the Rights of the Child and the Organization of African Unity (OAU) Charter on the Rights and Welfare of the Child among others. Birth registration is a basic responsibility of a government to its people. Penalties for registration are only reasonable when backed up by sufficient infrastructure to ensure that every member of the public has access to registration services. As observed above, Nigeria's population faces numerous limitations to birth registration amongst them being lack of accessibility of registration services and indirect costs associated to registration. This study recommends that the government urgently looks into ways of reversing this practice, and investing into improving accessibility of registration services to its population.

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