An Empirical Analysis of the Socioeconomic and Demographic characteristics influencing Birth Certification in Nigeria

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Research article

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An Empirical Analysis of the Socioeconomic and Demographic characteristics influencing Birth Certification in Nigeria

Uchechi Shirley Anaduaka^{1*}

Abstract

Background: Promoting birth certification is instrumental to achieving target 16.9 of the Sustainable Development Goals: legal identity for all by 2030. Currently, the birth certification rates are very low: on average, only 16.6% of children under-five years have their births certified.

Methods: Using the nationally representative Nigerian Demographic and Health Survey, this paper analyzes the socioeconomic and demographic factors associated with the birth certification of children under-five years. The relationship with these factors and birth certification were analyzed using robust econometric techniques – ordinary least squares and multilevel regression approaches.

Results: The study finds that access to health services, parental education and household wealth strongly influence birth certification. Conversely, distance to registration center, higher birth orders, longer birth intervals and father's working status are significant obstacles to birth certification. Finally, child age, maternal age at birth and father age have non-linear effects on birth certification among children under-five years in Nigeria. I find no significant effects of gender on birth certification.

Conclusions: Improving access to health services and anchoring birth certification on child-targeted conditional cash transfer programs could be significant policy instruments for increasing birth certification in Nigeria.

Keywords: Birth certification; Early Childhood; Multilevel modeling; DHS; Nigeria

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Background

Historically, children's rights were steered towards the attainment of human capital (health and education) outcomes, and policies were targeted towards the risk factors preventing improvement in the two outcomes. In the past decade, however, there has been a rise in the incorporation of child protection indicators such as birth registration into the development goals agenda [1]. The premise rests on the consideration that having children's births registered is the 'first right' and presupposes the human capital outcomes: utilization of health services, school enrolment, progression and completion [2], as it provides the child with the legal 'membership card' to participate in the society [3, 4]. Without being registered, a child will be born and die without any trace of their existence documented officially.

According to the United Nations Convention on the Rights of the Child (UNCRC), children have the legal right to be registered and target 16.9 of the Sustainable Development Goals (SDG) suggests a *legal identity for all*, by 2030. *Birth registration* is defined as "the continuous, permanent, and universal recording within the civil registry, of the occurrence and characteristics of births in accordance with the legal requirements of a country" [5]. Universal birth registration is also a public good that modern societies use to monitor progress towards set development goals (e.g. SDG), and is necessary for the functioning of the rule of law [6]. To prove completeness of the birth registration process, registered children are issued *birth certificates*, which documents their right to an identity, protects and ensures that their human rights are not overlooked when violated or abused [2, 7, 8]. The lack of this valid proof of age can cause long-term problems for children, given that they technically do not exist in any system in the world, and thus it may be difficult for them to claim rights and/or privileges in the future [9]. As one of the basic means of identification, children without birth certificates may also be denied access to fundamental activities such as formal labor market participation, civil marriage registration, bank account ownership, owning or inheriting land and housing facilities, accessing social welfare and safety-net programs (e.g. scholarships, food-

assistance, insurance and pensions), voting and obtaining a passport for international travel [10-12]. In some countries, birth certificates are required during primary and secondary education for enrollment, taking tests and examinations, scholarship applications and graduation from school [13].

In Nigeria, the births of more than 70% of children under-five years of age are not registered, 83% do not have certificates to prove their registration, and thus are at risk of statelessness [14]. This problem of non-documentation in Nigeria is one of the world's highest, and ranks higher than Sub-Saharan Africa (59%), and West and Central Africa (55%) [15]. This implies that the nation is one of the countries plagued by the so-called *scandal of invisibility* - the likelihood of being born and dying without leaving a trace in any legal documents or official statistics. In other words, the non-certified are unseen, uncountable, and hence uncounted [16-18]. Notable factors which exacerbate the problem of low birth registration and certification include large child population, high levels of household poverty, many uneducated parents, significant conflict and terrorist events.

A logical first step to addressing this 'scandal of invisibility' is to identify which factors drive the registration of a child's presence in the world. The knowledge of these factors is crucial to ensure that policies aimed at addressing the problem are well targeted. For example, some communities may suffer from poverty and poor parental education, and despite a high presence of birth registration centers, children in those communities will still not be registered. Analyzing these influential factors in the developing world is relatively new, with most of the empirical papers spanning the past decade, given the poor availability of data before then. With increasing access to data, empirical studies conducted identify some significant socioeconomic and demographic factors deemed important. Such factors identified include: *gender of the child* [19] (Nigeria)); *perinatal health services* [20] (Edo, Nigeria), [21] (Nusa Tenggara, Indonesia)); *mother's age at child's birth* – [22] (Ghana), [23] (Western Australia),

[24] (Bolivia, Brazil, Colombia, the Dominican Republic, Peru, and Nicaragua)); *maternal health-seeking behavior* [25] (Bauchi and Cross-River, Nigeria)); *parent's literacy and education* ([26] (Lombok, Indonesia), [27] (Ghana)); *wealth and parent's marital status* ([16] (Indonesia), [28] (Dominican Republic)); and *geographical location* ([29] (Bolivia, the Dominican Republic, and Peru)).

It is important to note that many of the studies exist in a different context than the one applied in this study. Given the low levels of birth certification in Nigeria, it is vital to investigate whether these broad range of factors are also positively associated with birth certification in a different context. The findings will prove important to programs targeted at improving these rates. Additionally, among the existing studies on Nigeria none analyze the socioeconomic and demographic characteristics using different waves of the Nigerian Demographic & Health Survey (NDHS) whilst simultaneously considering the hierarchical structure of the data. Also, the existent papers use birth registration instead of birth certification as the outcome. As the former is based on the parent/caregiver report, the outcome is open to bias. This paper thus utilizes birth certification as an indicator of completing the birth registration process.

The main objective of the study is to provide a better understanding of the underlying socioeconomic and demographic determinants of birth certification among children under-five years in Nigeria. The study has four main contributions to the literature. First, the study uses the Demographic & health survey (DHS) data, the largest nationally representative and mutually comparable repeated cross-sectional data samples available for 66,630 children born to 46,672 mothers in 3,127 communities in Nigeria for the period 2008-2018 [30]. The pooled NDHS sample provides substantial heterogeneity within and between communities to analyze the association between the socioeconomic and demographic factors, and birth certification. Second, the paper combines different robust econometric techniques (Ordinary

Least Squares (OLS) and multilevel binomial logistic regression) to analyze the factors associated with birth registration in Nigeria. The multilevel approach considering the hierarchical structure of the NDHS: 66630 Children (level-1) are nested within 3127 communities (level-2) and communities are nested within 37 states (level-3). The nested data structure corrects for bias on the parameter estimates, as each level represented by its own sub-model expresses the association between the explanatory variables employed in the model and birth certification. The approach also explicitly models and uncovers heterogeneity in covariates effects [31]. Third, the pooled data and empirical techniques permit going beyond the analyses of [32], who only employed multilevel techniques and only used the 2013 round of the NDHS data. The study also goes beyond the findings of [20, 25, 33], who carried out small-scale studies in Nigeria. Fourth, this study includes variables to measure geographical accessibility as one of the factors that can affect the child's birth certification status. According to [29], "accessibility to birth registration centers is influenced by the location and terrain, and infrastructure. The greater the distance to the registration center, the higher the financial and opportunity costs for the family, and the lower the likelihood of birth registration and certification."

Overall, this paper adds to the existing evidence on the determinants of birth certification in a developing country context. The estimates from the study suggest that indeed parental and household level factors (parental education, maternal age at birth, household wealth, access to health services) are significant drivers of birth certification. On the other hand, distance to registration centers, higher birth order, longer birth intervals and father's work status are significant obstacles to birth certification in Nigeria. These findings are in line with the works of 32, 34 and 35.

Study Context

Nigeria is the most populous country south of the Sahara and ranks 7th in the world. At present, it is structured into six geo-political regions (North-Central, North-East, North-West,

South-East, South-South and South-West), and 37 administrative states. The country is a viable study setting given the low prevalence of birth certification coupled with significant socioeconomic and demographic characteristics. It also has significant cultural differences with more than 300 ethnic and three main religious groups. However, three ethnic (Hausa/Fulani, Igbo and Yoruba) and two religious (Christianity and Islam) groups dominate the cultural sphere. The Hausa/Fulani occupy are primarily in the north, the Igbos in the southeastern part, and the Yoruba occupy the southwestern part of the country. Also, the north and south are divided across religious lines, with Islam occupying a large part of the north, and Christianity a large part of the south.

With these differences, it is crucial that an effective civil registration and vital statistics (CRVS) system is in place. The role of the system is to provide a credible source of information on vital events, especially births and deaths (including fetal deaths). In Nigeria, this responsibility falls on the National Population Commission (NPC) established in 1988 by the Federal Government of Nigeria. The NPC is charged with two core responsibilities: to carry out civil registration and undertake periodic enumeration of the population through sample surveys and censuses. Since 2003, following the introduction of the Child Rights Act, it became compulsory for every child's birth to be registered within 60 days of birth [20]. Consequently, the NPC aimed at achieving Universal Birth Registration (100%) by 2015. However as at 2018, this mandate has fallen below par as less than 43% of children have their births registered, and only 22% have their births certified [36]. Fig. 1 shows significant variation in the proportion of birth certification rates across the local government areas (LGAs) in Nigeria. At the regional level, the South-West ranks the highest (26.86%), while the North-West ranks the lowest (11.75%) in mean birth certification rates in Nigeria.

Fig. 2 presents the trends of registration and certification rates by geo-political regions and the child's year of birth. Overall, there is an increasing trend in birth certification rates across all the six regions. The South-West (SW) recorded the highest mean certification rates for children in the 2015_16 period (35.85%), whereas the North-West (NW) recorded the lowest mean certification rates for children born in the 2003_04 period (6.33%). Most of the growth recorded are in the South of the country and after the 2009_10 period.

Table 1 presents the state-level distribution of birth certification for children under-five years in Nigeria. It is not surprising that the Federal Capital Territory (FCT) (North-Central) (NC) ranks highest (36.24%), followed by Oyo state (34.43%) in the SW and Anambra state

(32.69%) in the South-East (SE). The remaining 7 best-performing states are: Lagos (SW, 30.98%), Ekiti (SW, 29.03%), Edo (South-South (SS), 28.27%), Osun (SW, 28.06%), Ondo (SW, 23.87%), Katsina (North-West (NW), 30.00%) and Nasarawa (NC, 24.25%) states, respectively. At the bottom of the trench, lies Zamfara state in the NW, wherein only 2.33% of children under-five years have their births certified. This represents a 33.91% gap between the state and the best-performer (the FCT). Among the 10 worst performing states, the North accounts for 90% of the states and the NW accounts for 50% of the states in the group. Following Zamfara state in order of rank is: Sokoto (NW, 3.12%), Kebbi (NW, 5.74%), Niger (NC, 7.72%), Bauchi (North-East (NE), 8.02%), Bayelsa (South-South (SS), 8.66%), Yobe (NE, 8.81%), Jigawa (NW, 9.28%), Plateau (NC, 10.07%) and Kano (NW, 12.66%). The North-South gap is not surprising as it has been documented in various studies on a wide range of development outcomes [37-39].

Insert Table 1 here

Methods

The data: The Nigerian Demographic & Health Survey

The variables used in the analysis are constructed using information for children under-five years of age from the Nigerian Demographic and Health Survey (NDHS) data. The data is a repeated cross-sectional standardized survey conducted in Nigeria by the Macro International Inc., Calverton, Maryland with cooperation with the USAID (U. S. Agency for International Development), the National Population Commission (NPC), and the Ministry of Health in Nigeria. The NDHS is a part of a project designed by the MEASURE-DHS to collect detailed information on women, men, children and households regarding demographic and health topics including: fertility/birth history, marital history, household and respondent characteristics, education, employment and decision-making power, nutrition, as well as

household durables and the quality of dwelling.² Given that the information on birth registration was first collected in 2008, the study will restrict its analysis to the three most recent waves - 2008, 2013 and 2018 of the NDHS data [30]. The surveys provide estimates for the six geo-political regions, and the 36 states plus the Federal Capital Territory, Abuja. Before the detailed interview, a household roster is taken, and within each sampled household eligible women (ages 15-49) are identified. The response rates for the household and women are high. For instance, in the 2008 round, the response rate was 98% percent for households and 97% for women.

NDHS Sample Design and Population

The eligible households are selected using a multi-stage stratified random cluster sampling technique for the administrative states and considerations of the urban/rural areas, based on the latest census. At the first stage, the clusters are drawn from an official list of the census enumeration areas, which usually correspond to small villages or blocks within larger villages or cities. At the second stage, the households are drawn randomly from a list in each identified cluster. Within each household, every eligible woman is interviewed and asked to provide a birth history. She provides information on her children including their birth date, gender, birth order, size at birth³, place of and attendant during delivery. Also, other demographic and socioeconomic characteristics such as religion, location, marital status, educational attainment, autonomy in household decision-making in the data. The information on the birth registration status was provided in the household member record.

² The 2008 wave randomly collected information from 34000 households. In all households, women aged 15-49 and men aged 15-59 were eligible to participate in the survey, however, for the latter only men from half of the sampled households were interviewed.

³ The size at birth is used as a proxy for the child's birth weight as the latter is not available for most of the children in the sample. This indicator is commonly used in the literature and reported as a good measure for the child's birth weight [41].

Sample size

The final sample for the study is restricted to single-birth children born to mothers in a union (married or cohabiting) and co-resident with both parents at the time of the survey. In addition to this, observations without GPS coordinates are dropped as it was not possible to compute distance variables to the registration center and roads for them. Furthermore, observations missing key socioeconomic and demographic information are dropped from the sample. Following the restrictions to the sample and excluding the unusable records, 66,630 children born in the five years period preceding the survey to 46,672 mothers from 3,127 communities and 37 states during 2008-2018 were suitable for the analysis.

Study variables

The theoretical framework classifying child, parent, household and community characteristics into socioeconomic and demographic factors, falls within that proposed by [40] to study child survival. The assumption is that these proximate determinants of child survival are most likely related to the underlying factors affect a child's probability of having their births registered and thus certified.

Outcome variable

In the data, there are two ways of assessing whether a child under 5 years is certified. First, it can be assessed based on the parent/caregiver's report that the child is registered. The second approach is based on whether the birth certificate, which is the proof of completing the registration process is available for the interviewer to see. This more robust definition is applied in this study. The outcome variable *birth certification* is defined as:

$$BC_i = \begin{cases} 1: & \text{if child } i \text{ is certified} \\ 0: & \text{otherwise} \end{cases} \quad (3.1)$$

In this study, 16.6% ($n = 11072$) of the children have their births certified. This implies that 83.4% who do not have their births certified are at risk of not being recognized by the legal system of Nigeria.

Explanatory variables

Table 2 summarizes the characteristics of the children, their families and community (proxied by the geographic ‘cluster’ of their household).

Child-level characteristics

Seven child-level characteristics of interest were examined: *i)* gender; *ii)* age-in-months and its squared; *iii)* birth order; *iv)* reported size-at-birth; *v)* birth interval; *vii)* skilled attendant at birth; and *viii)* the child’s vaccination status. Male children make-up 51% of the sample, and this is consistent regardless of their certification status. The children are on average, 27 months old and those certified are one month older than their counterparts who lacked a birth certificate at the time of the interview. In terms of the birth order, it is common knowledge that Nigerian women have more children ever born than the global average at 2.5 births [42]. This is evident, as children in the 4th or higher-order birth category make-up on average, 49% of the full and 51% non-certified sample, respectively.

Furthermore, 15% of the full sample of children were reported to be of small size-at-birth . By certification status, 12% and 16% were reported small at birth for the certified and non-certified children, respectively. This variable is included in the analysis due to the suggestions in the literature that parental investments can be responsive to the initial child health endowments [43]. Finally, having a skilled attendant at birth (SBA) and being vaccinated were included to capture other parental investments into the child’s development. A large proportion of children (63%) had at least one of the recommended vaccinations on record, however, only 35% of the children had access to an SBA. In terms of their certification status, 61% of the certified compared to only 30% of the non-certified children had an SBA. Additionally, 74% of the certified compared to 61% of the non-certified children had at least one of the recommended vaccinations (Table 2).

Insert Table 2 here

Parent-level Characteristics

At the mother- and father-level, eleven indicators were examined. The first eight variables correspond to the *mother* and the remainder the *father*: *i*) age at birth and its squared (in years); *ii*) education (in years); *iii*) attendance at prenatal visits; *iv*) polygynous family structure; *v*) work status; *vi*) decision-making; *vii*) access to mass media; *viii*) child mortality; *ix*) age (in years); *x*) education (in years); *xi*) work status.⁴ Table 3 presents the descriptive statistics.

The mean age at birth for all the mothers in the sample is 28 years, and the mean age of the fathers is 40 years, regardless of their certification status. For parental education, the analysis utilizes a stock measure - the number of years of schooling reported for the child's mother and father separately. Education is very low with the mean of five and six years of education for the mothers and fathers, respectively. Given that complete primary education in Nigeria is six years, this implies that most of the mothers in the sample have incomplete primary education, while the fathers just get by completing their primary education. There are also significant variations noted across certification status. For instance, mothers whose children are not certified have a mean of four years compared to eight years for the certified. This variation is also noted at the father-level with a mean education of six years for the non-certified and 10 years for the certified, suggesting an education gap of four years. In schooling numbers, this implies that the former just get by with completed primary schooling (six years) whereas the latter have incomplete secondary schooling (<12 years). Furthermore, the differences noted between the parental educational attainment for non-certified and certified children is consistent with the human capital literature that more educated parents

⁴ Including the squares of child's age, mother's age at birth and the father's age allows the possibility of a nonlinear relationship between birth certification and these time variables.

are more likely to choose better options for their children, to enhance economic and social mobility in the future [44].

According to the WHO's four-visit focused ANC (FANC), women should have at least four prenatal/antenatal visits at: 1) 8-12 weeks of pregnancy 2) 24-26 weeks 3) 32 weeks, and 4) 36-38 weeks [45]. The variable enters the analysis as an indicator for mother's contact with skilled health personnel. It is assumed that the mothers who have such contact are likely to receive information on the birth registration process, and thus likely to start and/or complete the process. Within the sample, on average 1 in every 2 mothers had at least the 4 recommended visits (53%). However, for the certified children 76% of their mothers had at least 4 visits, compared to 48% among the non-certified (Table 3).

In terms of the family structure, 33% of the non-certified children compared to 22% of the certified live in polygynous households. In terms of decision-making, 69% of the mothers of the certified compared to 55% of the non-certified contribute to the decision-making over their health and other aspects of their household (large purchases and social visits to family and friends). A large proportion of the certified mothers (76%) also had access to mass-media (TV/Radio/Newspaper), compared to 54% of the non-certified mothers. On average, 77% of the mothers of the certified children had lost none of their children, compared to 65% of the non-certified children. Additionally, 1 in 3 mothers within the sample had lost at least one of their children (Table 3).

In terms of working status among mothers and fathers, very few are engaged in the high-skilled sector (professional, technical or managerial). For instance, four percent of the mothers and 10% of the fathers are engaged in this sector. A large proportion of the mothers (36%) are in the unclassified category (Not working, unknown, and other), compared to the fathers (two percent). This is expected given the low years of maternal schooling in Nigeria. Additionally, the statistics suggest that women (50%) are more likely than men (39%) to be

engaged in the medium-skilled sector (clerical, sales, services and skilled manual). The highest employers of female labor in Nigeria is the medium-skilled sector, as 50% of the mothers in the sample work in this sector. Conversely, the highest employers of male labor is the low-skilled sector (agricultural laborers, farmers and unskilled manual workers), as it accounts for 48% of total male employment (Table 3). Significant differences also exist between the parental employment and child certification status. For instance, eight percent of the mothers of certified children work in the high-skilled sector, compared to three percent among the non-certified children. Additionally, 18% of the fathers of certified children work in the high-skilled sector, compared to nine percent for the non-certified children.

Insert Table 3 here

Household- and Community-level Characteristics

As discussed above, the unit of analysis for the community-level characteristics is the geographic "cluster" or the *primary sampling unit*. In this paper, there are 3127 clusters in which all the children and their mothers had lived. At the household- and community-levels, 13 variables were examined: *i*) household head has a bank account; *ii*) wealth index, grouped as: poor, middle, and rich; *iii*) religion, classified as: Islamic, Christian, and other religion; *iv*) ethnicity, grouped as: Hausa/Fulani⁵, Igbo, Yoruba, other ethnicity; *v*) place of residence (rural vs. urban); *vi*) distance to registration center; *vii*) distance to the nearest road; *viii*) altitude (in meters above sea level); *ix*) community average of maternal education; *x*) community average of paternal education; *xi*) proportion of poor households in the community; *xii*) proportion of children who have died in the community; *xiii*) region of residence. In addition to the place of residence (rural or urban) and the poverty status of the child, I capture other characteristics within the community, as presented in Table 4. First, I

⁵ These ethnicities are grouped on the basis that they speak a common language or dialect, share a common sense of identity, cohesion and history; or have a single set of customs and behavioral norms e.g. marriage, clothing, diet, and taboos [47].

measure accessibility of the household proxied by the distance to the nearest registration center and road, and the altitude (meters above sea level). The distance variables were converted into 3-group categorical variables: 1) Live within a 5km radius; 2) Live between a 5 and <10km radius; and 3) Live 10 or more kms from the nearest center or road. A large proportion (69%) of the certified live within a 5km radius, even though they live very far (10km+) from the nearest road (64%). The altitude variable was also grouped into 3-levels: 1) low (<323 meters); 2) Middle (323-449 meters); and 3) High (>449 meters). On average, one in every two children live less than 323 meters above sea level, with minimal variation between the certified (53%) and non-certified (49%). Next, I compute separately the mean values for parental education, proportion of poor households, and proportion of children who have died within each community. The descriptive statistics in Table 4 suggest that on average, female education ranges from four to seven years, and male education ranges from six to nine years. The statistics also suggest 22% of the certified and 53% live in poor communities. Approximately half of the children within the sample live in communities in which at least 53.8% of their children born to the mothers have died. Finally, the North-west region accounts for 31% of the children within the sample, and the South-East region accounts for nine percent of the sample. Table 4 presents the descriptive statistics for these variables.

A large proportion do not have access to a bank account (69%), which suggests poor access to formal institutions. Generally, to open a bank account, the individuals need adequate documentation including the birth certificate to prove their age and country of origin.

Between the certified and non-certified, a large gap also exists, with 58% of the former and 26% of the latter having one. Also included in the study are the religion and ethnicity of the child's family. Within the sample, more than half (61%) of the children are Muslims, and 42% are Hausa/Fulani. Half of the certified children are Muslims and 29% are of the

Hausa/Fulani tribe. On the other hand, 63% of the non-certified are Muslims and 44% are of the Hausa/Fulani tribe.

Consistent with the development literature is the finding that children whose births are not registered are more likely to be poor and living in rural areas. The level of poverty is based on the household's wealth index provided by the data, as the NDHS does not collect income or consumption data. This index is constructed as a linear combination using the principal component analysis (PCA) of a household's ownership of selected assets [46]. The computed weights using the are not useful, thus households are distributed into one of five bins, ranging from *one* for the poorest fifth and *five* for the wealthiest fifth.⁶ In addition to the place of residence (rural or urban) and the poverty status of the child, I capture other characteristics within the community, as presented in Table 4. First, I measure accessibility of the household proxied by the distance to the nearest registration center and road, and the altitude (meters above sea level). The distance variables were converted into 3-group categorical variables: 1) Live within a 5km radius; 2) Live between a 5 and <10km radius; and 3) Live 10 or more kms from the nearest center or road. A large proportion (69%) of the certified live within a 5km radius, even though they live very far (10km+) from the nearest road (64%). The altitude variable was also grouped into 3-levels: 1) low (<323 meters); 2) Middle (323-449 meters); and 3) High (>449 meters). On average, one in every two children live less than 323 meters above sea level, with minimal variation between the certified (53%) and non-certified (49%). Next, I compute separately the mean values for parental education, proportion of poor households, and proportion of children who have died within each community. The descriptive statistics in Table 4 suggest that on average, female education ranges from four to seven years, and male education ranges from six to nine years. The statistics also suggest 22%

⁶ For a detailed discussion on the use of asset indices to capture the wealth status of households, see [48]. For a more detailed description on how the wealth index is constructed, see [49].

of the certified and 53% live in poor communities. Approximately half of the children within the sample live in communities in which at least 53.8% of their children born to the mothers have died. Finally, the North-west region accounts for 31% of the children within the sample, and the South-East region accounts for nine percent of the sample.

Table 4 reports that 73% of non-certified children reside in rural areas and 53% of them come from poor households, compared to 45% and 19% percent among the certified respectively.

In addition to the place of residence (rural or urban) and the poverty status of the child, I capture other characteristics within the community, as presented in Table 4. First, I measure accessibility of the household proxied by the distance to the nearest registration center and road, and the altitude (meters above sea level). The distance variables were converted into 3-group categorical variables: 1) Live within a 5km radius; 2) Live between a 5 and <10km radius; and 3) Live 10 or more kms from the nearest center or road. A large proportion (69%) of the certified live within a 5km radius, even though they live very far (10km+) from the nearest road (64%). The altitude variable was also grouped into 3-levels: 1) low (<323 meters); 2) Middle (323-449 meters); and 3) High (>449 meters). On average, one in every two children live less than 323 meters above sea level, with minimal variation between the certified (53%) and non-certified (49%). Next, I compute separately the mean values for parental education, proportion of poor households, and proportion of children who have died within each community. The descriptive statistics in Table 4 suggest that on average, female education ranges from four to seven years, and male education ranges from six to nine years. The statistics also suggest 22% of the certified and 53% live in poor communities.

Approximately half of the children within the sample live in communities in which at least 53.8% of their children born to the mothers have died. Finally, the North-west region accounts for 31% of the children within the sample, and the South-East region accounts for nine percent of the sample.

Insert Table 4 here

Empirical Specification

This section describes the estimation strategy used to examine the factors associated with birth certification, and the cross-sectional nature implies that one observation per child is used. The data was analyzed using Stata 14 software package [50], and normalized sampling weights provided in the NDHS data were added into the model to adjust for non-responses and ensuring that the findings can be generalized to the general population [47].

OLS Specification

The main specification for the analysis is:

$$BC_{ijk} = \alpha_{jk} + \beta X_{ijk} + \varepsilon_{ijk} \quad (4.1)$$

Where BC_{ijk} is the probability of birth certification for child i living in community j within state k , α_{jk} and β are the intercept and the vector of coefficients for the variables (child-, mother-, father-, household-, and community-level variables) X_i included in the analysis.

Standard errors ε_{ijk} are clustered at the community (cluster) level. All models in the analysis include survey and child's birth year-and-month fixed effects. These fixed effects are included to account for the differences in lag lengths and potential observed and unobserved heterogeneity in trends across space and time [51]. A positive regression estimate indicates a positive association between the factors and outcome of interest, and vice versa.

Multilevel model Specification

Given the hierarchical structure of the data and the binary nature of the outcome variable, a multilevel logistic regression model (MLRM) was also employed. The different levels of measurement and its sources in the data inform the need to incorporate the multilevel regression technique. It will help prevent misleading conclusions about the relative importance of these different levels on the child's birth certification [52]. That said, a three-level MLRM with a binary response is employed, clustering children i within communities (clusters) j , and communities within states k .

Six models were fitted containing variables of interest: *Model 1 (null model)*: fitted without any explanatory variables to test the random effects in the intercept and estimate the intraclass correlation coefficient (ICC) for the community and state levels. The model is used as a justification to assess random effects at the specified area levels. The ICC measures the correlation between two observations within the same level e.g. community. The larger the ICC (i.e. the higher the correlation *within* the clusters), the lower the variability is *within* the clusters and consequently, the higher the variability is *between* the clusters [53]. *Model 2*: child-level characteristics were added; *Model 3*: mother-level characteristics were added; *Model 4*: father-level characteristics were added; *Model 5*: household-level characteristics were added. In *Model 6*: all the explanatory variables were controlled for including the community-level and state-level factors. Dummies to capture the year-and-month of interview and the child's birth were included in all the models (except the null model) to adjust for the differences in the survey and birth timing.

The specific form of the three-level MLRM is given by equations (4.2, 4.3, and 4.4):

$$\text{Logit}(BC_{ijk}) = \log \frac{BC_{ijk}}{1-BC_{ijk}} = \alpha_{jk} + \beta X_i + \epsilon_i ; \text{ for } i = 1, \dots, I \quad (4.2)$$

$$\alpha_{jk} = \gamma_0^j + \gamma_k + \epsilon_j ; \text{ for } j = 1, \dots, J, k = 1, \dots, K \quad (4.3)$$

$$\gamma_k = \lambda_0^k + \lambda_k S_k + \epsilon_k ; \text{ for } k = 1, \dots, K \quad (4.4)$$

Where BC_{ijk} is the probability of birth certification for child i living in community j within state k , α_{jk} and β are the intercept and the vector of coefficients for the child-level variables X_i .

γ_0^j and γ_k is the community-specific and state-level intercepts, each of which is a function of the state-level variables S_k , state-level coefficients λ_k , and the state-level intercept λ_0^k .

Finally, i, j and k are the error terms at the child-, community- and state-levels, respectively.

The random intercepts of γ_0^j (between communities) and λ_0^k (between states) variance is assumed to follow a normal distribution with mean zero and the covariance matrix for a three-level model.

The estimates contained in β are termed the fixed part of the MLRM and capture the overall average relationship (*measures of association*) between birth certification and the predictor variables in the average community. The estimates were expressed as odds ratios (ORs) with their 95% credible intervals. On the other hand, the intercepts and residual errors represent the random effects at the mother and community level. They imply how the relationships between the community and state levels differ from this overall average relationship (*measures of variation*). They are also assumed to be independent of the child, mother and community characteristics, as they pertain to the random part of the model. The results of the measures of association (*fixed effects*) between birth certification and the included predicted characteristics are presented as OR with 95% credible interval (CI). An OR greater than one implies a positive relationship between the variable and birth certification, and vice versa. The results of measures of variation (*random effects*) are interpreted using the ICC and PCV. From the estimates, the ICC, the proportional change in variance (PCV) and the median odds ratio (MOR) are computed. The ICC is expressed as $[ICC = V_a + V_b + \frac{\pi^2}{3}]$, where V_a is the variance of area level a (e.g. community level), and V_b is the variance of area level b (e.g. state level). In a multilevel logistic model, the individual (first) level has standard a logistic distribution with variance $\frac{\pi^2}{3}$ which approximates to 3.29.⁷ The ICC is calculated based on the widely adopted latent response formulation that assumes a latent continuous response underlies the observed binary response. It is used to evaluate whether which neighborhood context is more relevant in explaining the variation in the outcome variable [52, 53]. The PCV is calculated as $[PCV = \frac{V_e - V_m}{V_e}]$, where V_e is the variance in the null model and V_m is variance in the successive models. It indicates the additional effects of the included variables. Finally, the formula for the MOR is given as $[MOR = \exp(2\sigma_\mu^2 \phi^{-1}(0.75))]$, where ϕ^{-1} is the

⁷ π denotes the mathematical constant 3.1416 and not the probability.

inverse cumulative standard normal distribution function. It is a measure of heterogeneity, an alternative way of interpreting the magnitude of the neighborhood variance. In simple terms, the MOR can be interpreted as the median increased odds of being certified in this case, when a child moves from one community to another with a higher probability of certification. The higher the MOR, the larger the general contextual effect. If the MOR is equal to 1 (i.e. $\sigma_\mu^2 = 0$), it implies the absence of a neighborhood variation.

It is important to note at this point the non-numerical based categorical variables - gender, size-at-birth, religion, ethnicity, and place of residence - are *effect-coded* for the regressions. This is especially important for the multilevel regression.

When compared to dummy-coded variables, effect-coded variables have greater speed of convergence and the mixing of sampled parameters in the Markov Chain Monte Carlo (MCMC) based Bayesian estimation of the multilevel models [31]. In this case, variables are coded to yield a sum to zero constraint [55]: in the case of two distinct values (e.g. gender) this will have values 1 and -1. For each model, a burn-in length of 5,000 iterations and a monitoring chain length of 10,000 iterations.

Finally, the goodness-of-fit of the model approach relies on the Bayesian Deviance Information Criterion (DIC) introduced by [56]. With an interpretation like the Akaike Information Criterion (AIC), the Bayesian DIC suggests a trade-off between the complexity and deviance of the model. Models with smaller DIC are preferred to models with higher DIC, and a difference of 5 or more considered substantial. The MLRM with Binomial, Penalized Quasi Likelihood (PQL) of order-2 and MCMC estimation methods [57] were applied using the *runmlwin* command available in Stata 14 which allows researchers to combine the best features of Stata for Windows (Stata Corporation Inc., College Station, TX, USA) and MLwiN version 3.04 software [58].

Results

OLS Regression

Table 5 shows the OLS results from the study's main specification 4.1. Column one provides the estimates for the effects of individual characteristics on birth certification. As Table 5 shows, access to health services were significantly associated with birth certification ($p < 0.001$). Children with an SBA was 16.1 percentage points more likely to have their births certified compared to those who did not have an SBA. Also, children with at least one vaccination on their record were 6.7 percentage points more likely to have their births certified than those without.

Conversely, birth order and birth intervals were significant deterrents to birth certification.

Being at birth order four or higher increases a child's likelihood of certification by 2.2 percentage points. Also, an additional year between births increases the likelihood of certification by 0.2 percentage points. In Column five, when all the socioeconomic and demographic characteristics had been added, the positive effects of access to health services declined significantly but remained consistent. Having an SBA and at least one vaccination increased the likelihood of birth certification by 4.6 and 2.9 percentage points, respectively.

In this case, being of birth order three and four or higher reduced the likelihood of birth certification by 1.8 and 2.1 percentage points ($p < 0.001$). Additionally, an extra year between births reduces the child's chances of birth certification by 0.3 percentage points. Though, the current age of the child was positive and insignificant, its squared values were negatively and statistically significant (Table 5, Column 5).

In Column two, maternal characteristics were added. Her age at birth, education levels, prenatal visits and access to mass-media significantly influenced birth certification. An additional year at the child's birth (non-linear effects of maternal age at birth were also noted for birth certification), an additional schooling year and having access to mass media increased the likelihood of birth certification by 0.1, 1.0 and 2.7 percentage points,

respectively. Also, having 1-3 and 4+ prenatal visits increased the likelihood of birth certification by 2.6 and 5.1 percentage points, respectively. On the other hand, the number of the mother's children who had died reduces the likelihood that the child's birth is certified. In fact, having one or two plus dead children lowers the likelihood of birth certification by 1.2 and 2.2 percentage points, respectively (Table 5). Controlling for all the characteristics of the child, their family and community nullified the positive effects of having 1-3 prenatal visits and access to mass media, and negative effects of having one dead child. Women's involvement in household decision-making was positive and significantly associated with birth certification, albeit after controlling for the household- and community-level characteristics (Table 5, Column 5).

The effects of father's age and education were positive and significant, while being employed in a non-professional/technical job was negative and significant. In fact, adding one year to the father's age increases the likelihood of birth certification by 0.4 percentage points, however the positive effects reduce over time (father's age squared is negatively and statistically significant at 1% level of significance). In Column 5, after the inclusion of all the variables, while the signs of the father-level remain consistent, the magnitudes are generally moderated. For instance, controlling for all the variables nullifies the effect of father's education as it becomes statistically insignificant.

In Column 4 of Table 5 shows the effects of *household characteristics* on birth certification. The likelihood of birth certification increases by bank account ownership and the wealth status of the household. First, moving the child from a poor- to a middle-income and from a poor- to a rich household increases the chances of their births being certified by 4.7 and 9.8 percentage points, respectively. Controlling for the community characteristics reduces the effects of wealth and bank account ownership, however the latter only slightly. In the final model, living in a middle-income or rich household increases the likelihood of birth

certification by 2.1 and 5.3 percentage points, respectively. Generally, the results suggest that the effects of religion and ethnicity are not statistically significant.

Finally, Column 5 notes the results of birth certification by community-level characteristics. It is not surprising that the problem of distance to the nearest registration center proved an obstacle to birth certification: Living between 5 and <10kms, and 10kms+ lowers the chances of birth certification by 1.9 and 4.4 percentage points. However, the effects of the former are only significant at the 10% level of significance. In a surprising turn of events, those living with 5 and <10kms, and 10kms+ of a major road increases the chances of birth certification by 2.4 and 3.9 percentage points. Additionally, those living on higher altitudes was positively associated with birth certification; living between 323 and 449 meters above sea level was positive and significantly associated with birth certification ($p < 0.001$). Being surrounded by highly educated mothers increases the likelihood of certification, but no effects were noted for higher levels of father's education within the community. However, as expected living in a poor community lowers the chances of birth certification but living in one with at a higher proportion of the children dead increases the likelihood of birth certification (Table 5, Column 5).

Insert Table 5 here

Multilevel Logistic Regression

Table 6 presents the results of the MLRM examining the effects of the socioeconomic and demographic characteristics on birth certification of children under-five years old. The null model showed that there was a statistically significant variability in the odds of birth certification across communities ($\tau=2.34$, $p=0.000$) and states ($\tau=1.08$, $p=0.000$). The ICC indicated that, differences between communities and states accounted for 34.9% and 16.5%, respectively of the total variance in birth certification. From the null model, it was estimated if a child moved to another community with a higher probability of certification, the median

increase in his/her odds of certification would be four-fold ($MOR = 4.3$). On the other hand, moving a child from one state to another with a higher probability of birth certification, implies a three-fold median increase in their odds of birth certification.

In Model 2, child-level characteristics were added and the variation in birth certification remained significant across communities ($\tau=1.81, \rho=0.000$) and states ($\tau=0.68, \rho=0.000$).

31.4% and 11.9% of variability in the odds of birth certification is due to differences between communities and states, respectively. As shown by the PCV, 10% of the variance in birth certification across communities; 27.9% of the variance in birth certification across states, was explained by the child-level characteristics. On average, the community-level MOR remains 4 whereas, the MOR at the state-level declines to a two-fold median increase in the odds of birth certification.

With the introduction of mother-level characteristics in Model 3, the community- ($\tau=1.48, \rho=0.000$) and state-level ($\tau=0.43, \rho=0.000$) variability in the odds of birth certification remained significant. The ICC implied that differences between communities and differences between states account for 28.5% and 8.3% of the variation in birth certification.

Furthermore, the PCV indicated that 18.3% and 49.7% of the variation in birth certification between communities and states was explained by mother-level characteristics. Model 4 included the father's characteristics, and the variation remained statistically significant both at the community- ($\tau=1.39, \rho=0.000$) and the state-level ($\tau=0.43, \rho=0.000$), respectively. The ICC at the community-level declined to 27.3%, while the ICC at the state-level increased marginally to 8.4%. The PCV implied that 21.8% and 49.1% of the variation in birth certification between communities and states was explained by the father-level characteristics.

Model 5 included the household's characteristics, and the variation remained statistically significant both at the community- ($\tau=1.30, \rho=0.000$) and the state-level ($\tau=0.39, \rho=0.000$),

respectively. Additionally, 26.1% and 7.9% of the variance among the communities and states were due to the household-level characteristics. Similarly, the PCV indicated that 25.2% and 52.1% of the variance in the likelihood of birth certification across communities and states were explained by the mother-level characteristics found in model 5.

Finally, Model 6 included all the socioeconomic and demographic characteristics. Random parts of Model 6 suggested that the variability in the odds of birth certification remained significant at the community- ($\tau=1.28, \rho=0.000$) and state-level ($\tau=0.41, \rho=0.000$).

Furthermore, 25.9% and 8.1% of the variance among the communities and states were due to the community-level characteristics. Similarly, the PCV indicated that 25.8% and 50.9% of the variance in the likelihood of birth certification across communities and states were explained by the mother-level characteristics found in model 6. With the inclusion of all the variables, the MOR at the community and state levels were 2.94 and 1.83, respectively. They imply that if a child moves from one community (state) to another community (state), the median increase in their odds of birth certification would be three-fold (two-fold). Overall, the odds ratio is high, which suggests that the heterogeneity evident in birth certification is substantial.

After adjusting for all the variables, those children who were large at birth had 3% [OR= 1.03, 95% CI: 0.99-1.07] higher likelihood of having their births certified as compared to those who were small at birth. Children with a skilled attendant at birth had 26% [OR= 1.26, 95% CI: 1.18-1.34] higher likelihood of having their births certified as compared to those without. Children with at least one vaccination on record had 53% [OR= 1.53, 95% CI: 1.41-1.66] higher odds of having their births certified as compared to those with no vaccinations on record. In contrary to this, when the child's birth order or the birth interval increases the chance of the child's birth being certified declines. For instance, the odds that a child whose birth order is 3 is certified is 0.86 [OR=0.86; 95% CI: 0.78-0.93] lower than the

corresponding odds for a first-born child. Also, a child whose birth order is 4 or higher is certified is 0.83 [OR=0.83; 95% CI: 0.76-0.91] lower than the corresponding odds for a first-born child. Additionally, for each additional year between births, the odds of birth certification decrease by 0.98 [OR=0.98; 95% CI: 0.97-0.99].

As the number of maternal prenatal visits increase, the odds of birth certification also increase. For example, a child whose mother had at least 4 prenatal visits is 1.54 times [OR=1.54; 95% CI: 1.39-1.69] more likely to have their births certified than those without. Maternal exposure to mass media also increases the likelihood that the child's birth will be certified [OR=1.07; 95% CI: 1.00-1.15]. Having 2 or more dead siblings reduces the odds of birth certification by 19 percentage points [OR=0.81; 95% CI: 0.74-0.89]. In contrast to the insignificant effects of maternal employment, the results suggest that having a father employed in a low-skilled job decreases, while having a father in a medium-skilled or high-skilled job increases the odds of birth certification. Children whose fathers are employed in a high-skilled (professional, technical or managerial) job is 1.05 times [OR=1.05, 95% CI: 0.97-1.13] more likely to having their births certified compared to those whose fathers are unemployed or unclassified.

Model 6 suggests that all the included household characteristics are statistically significant. I find that having a bank account, being a child in a middle-income or rich family, being adherent to the Christian faith, or being from the Igbo or Yoruba tribe improves a child's chances of having their births certified. Whereas being of a minority religion or ethnicity reduces this likelihood. Specifically, being born into a banked family increases the likelihood of birth certification by 24% [OR=1.24, 95% CI: 1.16-1.32]. Being from a middle-income or rich family increases the odds of birth certification by 27% [OR=1.27, 95% CI: 1.15-1.39] and 58% [OR=1.58, 95% CI: 1.38-1.77], respectively. Households who report that they are adherent to the Christian faith had 20% [OR=1.20, 95% CI: 1.09-1.31] higher odds of birth

certification compared to Muslim households. Households who are Igbo or Yoruba had 14% [OR=1.14, 95% CI:1.02-1.27] or 12% [OR=1.12, 95% CI:1.01-1.23] higher odds of birth certification compared to the Hausa/Fulani households.

In the final model, three variables were included to measure accessibility: distance to the nearest registration center, distance to the nearest major road and the altitude of the household's cluster. Contrary to expectation, the distance to the nearest major road and altitude increased the likelihood of birth certification. Conversely as expected, distance to the nearest registration center lowered the chances of birth certification. For example, living 10kms or more from a registration center reduced the likelihood of birth certification by 0.65 times [OR=0.65, 95% CI:0.53-0.77]. Also expected was the negative effect of living among poor people on birth certification [OR=0.38, 95% CI:0.29-0.49]. Being resident in the North-East increases the likelihood of birth certification by 1.64 times [OR=1.64, 95% CI:0.89-2.95], whereas being resident in the South-East reduces the likelihood of birth certification by 0.61 times [OR=0.61, 95% CI:0.31-0.88], as compared to residents of the North-West region. Finally, there was a successive decline in the Bayesian DIC between Model 1 and Model 6 as presented in Table 6. The decline in the DIC indicates the goodness-of-fit of the MLRM used in the analysis.

Insert Table 6 here

Sensitivity Analyses

To ensure the results are robust, I performed several sensitivity checks. First, I restricted the sample further to child who have at least one sibling (i.e. mother has at least two children). Second, I estimated the final model without Lagos and Abuja (the former and current federal capital territories). Third, I dropped the states with the highest and lowest population (Kano and Enugu states). Fourth, I dropped the states with the highest and lowest birth certification

rates (Oyo and Zamfara states). These four sensitivity checks presented in Table 7 showed that the results presented above are robust.

Insert Table 7 here

Discussion

This study utilized data based on the 2008, 2013 and 2018 rounds of the Demographic and Health Survey conducted in Nigeria and employed multiple empirical approaches [30].

According to the data, only 16.6% of the children under-five years have their births certified. This suggests that the nation is miles away from ensuring children's births are registered and certified, and acts as an obstacle to achieving SDG target 16.9 "to provide legal identity for all, including birth registration, by 2030". The setting of Nigeria is particularly important for a study of this nature, as the country ranks high in child population, coupled with the high prevalence of poverty and low parental education (key measures of socioeconomic status). In addition to this, the inequality in land size across the nation also has interesting effects on the access to public facilities, which in turn has significant implications to the utilization of the public service

To help improve the certification rates, this study analyzed which socioeconomic and demographic characteristics influence birth certification. The results identified several of those characteristics. Both the OLS and MLRM results showed that health access proxied by the prenatal visits (mother-level), having skilled attendants at birth and being vaccinated (child-level) had significant influence on the child's birth certification status. The positive effects of health access on birth certification has been noted by [27] and [28]. This finding may be due to being closer to health services and skilled personnel increases the chances of receiving information about the need and the process of birth certification.

Evidence of a strong statistical association between childhood birth certification and parental education. According to the results of this study, children whose parents who had higher years of education were more likely to be certified. This finding is in line with

previous studies conducted in Nigeria and elsewhere [19] and [28]. The arguments rest on the premise that more educated parents are more likely to better process information regarding the birth certification.

Exposure to mass media was also a significant predictor of birth certification. When compared to children whose mothers reported lack of exposure to mass media (newspaper, TV or radio at least once a week), those children whose mothers had exposure to the mass media had higher chances of having their births certified. The positive effects of mass media on birth certification is new and not noted elsewhere. However, maternal access to mass media has been seen to reduce the odds of a child not being fully immunized [59].

The premise of the argument rests on effective dissemination of information through these means, which in turn can facilitate behavioral changes that improve child outcomes.

An interesting find of this paper is the significant influence of bank account ownership on birth certification. This finding has not been noted anywhere else. In addition, being from a middle income or rich household increases the likelihood of birth certification for the children. This finding is supported by a few studies including [2] and [24]. This could be due to the fact that richer parents may be more aware of the importance of birth certification on the child's future mobility (for example, university education, participation in the formal job market and legal migration abroad). Higher wealth status and higher education has also been linked to better decision-making as they are in a better position to earn money and afford the registration services.

The results also suggested non-linear effects of child age, maternal age at birth and fathers' age on the likelihood of birth certification. This implies that the positive effects of the different age variables inflect at some point and the efforts to register the child's birth decreases. This finding has not been noted elsewhere for Nigerian children. Mixed results were also noted for the effect of culture (religion and ethnicity) on the likelihood of birth

certification. While Christian children higher, those of minority religious groups had lower likelihood of birth certification, as compared to Muslim children. What's more, children of Igbo and Yoruba ethnicities had higher chances of being certified compared to Hausa/Fulani children. This finding is in line with the study by [32]. On the other hand, children of minority ethnicities had lesser chances of birth certification, as compared to children of the Hausa/Fulani tribes.

Notable deterrents to birth certification include being of higher-order births and having longer birth intervals (child-level), mother having two or more dead children, the father working in a low skilled job, living far away from the registration center and having higher child mortality in the community (community-level). The further the child lives from a registration center, the lower the chances of birth certification. This finding has not been recorded for the factors associated with birth certification in Nigeria. However, the findings of [29] where children residing in communities further from the registration center had lower odds of having their births certified.

The findings from the random parts of the multilevel regression has shown a largely significant variance between communities and states even after adjusting for socioeconomic and demographic characteristics at the child, parent, household and community levels. It thus confirms the use of multilevel modeling techniques. This finding was consistent with the study conducted by [32], and justified by the existence of differences in coverage, social norms, cultural beliefs, geography, quality of health services and distribution of registration centers. One can thus conclude that 8.1% of the variation in birth certification is attributed to state differences and 25.9% to differences across communities nested within the states.

Strengths and Limitations

The study has numerous strengths. First, it utilized the three most recent, nationally representative and large sample of a population-based survey which covers all the regions and administrative states in Nigeria. Second, the DHS surveys are comparable across settings due to the standardized nature of the variables within the data set. Hence, these findings could be tested in and generalized to other developing countries for whom data is available. Third, the study utilized different empirical methods including the advanced statistical technique - multilevel modeling - which enabled an accommodation of the hierarchical nature of the NDHS data, which allows for the clustering effect of the outcome variable that is under examination. Fourth, the study included more robust variables unlike previous studies conducted using the DHS data. Fifth, due to the tendency of recall bias in such outcomes based on retrospective information, the study used the *birth certification* status as the outcome of interest, rather than relying on the parent/caregiver report of whether the child is registered.

Despite the strengths mentioned above, it is important to note some of the limitations of this study. First, as mentioned above, the NDHS data is cross-sectional and not longitudinal, which makes it difficult to track the children over time to confirm their certification status nor make causal inferences. To verify the validity of the observed associations within the study, the individual effects need to be unpacked by using longitudinal data or instrumental variable techniques.

Second, the data does not precisely state whether the children were born in the location where they were surveyed. This is the basis exploited for the geographical variation to study the factors associated with birth registration. Third, the data does not provide information on the exact timing of the registration. Hence, discussion on whether the child was registered on time is outside the scope of this study.

Furthermore, the spatial data used to construct the accessibility to registration centers are de-identified to ensure confidentiality of the respondents. To make causal claims on the associative factors of birth registration, future researchers can unpack the factors (e.g. child vs. parent vs. household), and test for the causal relationships between them and birth certification for children under-five years in Nigeria.

Conclusions

To the best of my knowledge, this paper counts among the first studies highlighting the determinants of birth registration for Nigerian children using a robust range of socioeconomic and demographic factors associated with the process. Previous attempts use a restricted range of factors or do not incorporate the supply-side constraints (e.g. distance to the nearest registration center) that may affect the probability of certification.

Despite the limitations discussed above, this study makes important contributions to the literature and corroborates some of the findings by earlier studies. The results highlight the crucial roles played by health service utilization, socioeconomic status and accessibility to registration services. This information is extremely important to the government (e.g. the NPC) and other local and multinational organizations interested in improving birth registration and certification rates for children in Nigeria.

The study findings suggest that children are more likely have their births registered and certified as the near school going age (6 years). This goes against the mandate of the 2003 Child Rights Act. I suggest the design and implementation of well targeted birth registration and health programs in order to ensure children are registered and certified on time. Ensuring this, will be valuable to achieving target of universal birth registration by 2030. Another suggestion is to ensure a national child policy, which will include all development factors - health, education and child protection that are necessary to ensure that children survive and thrive in adulthood. Furthermore, to include children of poor and

uneducated parents, conditional cash transfer (CCT) programs or free registration can be introduced to ensure that parents begin and complete the birth registration for the children, and on time too. Another way would be to incorporate training on civil registration (especially child births) into the educational curricula from as early as pre-primary school, so that parents are aware of the process and benefits.

Finally, for further study it is necessary to unpack these associations to identify the causal effects of the significant socioeconomic and demographic characteristics that affect the birth certification of children under-five years in Nigeria.

List of abbreviations

AIC: Akaike Information Criterion; ANC: Antenatal Care; BC: Birth Certification; CCT: Conditional Cash Transfer; CRVS: Civil Registration & Vital Statistics; DIC: Deviance Information Criterion; DHS: Demographic & Health Survey; FE: Fixed Effects; ICC: Intraclass Correlation Coefficient; MCMC: Markov Chain Monte Carlo; MLRM: Multilevel Logistic Regression Model; MOR: Median Odds Ratio; NC: North Central; NDHS: Nigerian Demographic & Health Survey; NE: North East; NPC: National Population Commission; NW: North West; OLS: Ordinary Least Squares; OR: Odds Ratio; PCA: Principal Component Analysis; PCV: Proportional Change in Variance; PQL: Penalized Quasi Likelihood; SBA: Skilled Birth Attendants; SDG: Sustainable Development Goals; SE: South East; SS: South South; SW: South West; UNICEF: United Nations Children's Fund; UNCRC: United Nations Convention on the Rights of the Child.

Declarations

Ethics approval and consent to participate

The author was granted approval from the DHS Review Board, ORC Macro Inc to obtain and use the collected data for analysis. All the respondent identifiers were removed prior to the author downloading and using the data.

Consent for publication

Not applicable

Availability of data and materials

The dataset analyzed during the current study are available in the DHS data repository, https://www.dhsprogram.com/data/dataset_admin/index.cfm.

Competing interests

The author declares no competing interests.

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Authors' contribution

USA analyzed and interpreted the data. USA also read and approved the final manuscript.

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Title of Figures

Fig. 1 Birth certification rates among children under-five years, across 774 local government areas (LGAs), Nigeria, pooled data, 2008-2018

Fig. 2 Prevalence of birth certification by region of residence and birth year, Nigeria, pooled data 2008-2018

Table 1: Mean birth certification rates by regions and states, Nigeria, 2008-2018

Region	Mean (%)	Rank	State	Mean (%)	Rank	Position ⁸
North-Central	18.91	3	FCT ²	36.24	1	Higher
South-West	26.86	1	Oyo	34.43	2	Higher
South-East	17.42	4	Anambra	32.69	3	Higher
South-West	26.86	1	Lagos	30.98	4	Higher
North-West	11.75	6	Katsina	30.00	5	Higher
South-West	26.86	1	Ekiti	29.03	6	Higher
South-South	19.42	2	Edo	28.27	7	Higher
South-West	26.86	1	Osun	28.06	8	Higher
North-Central	18.91	3	Nasarawa	24.25	9	Higher
South-West	26.86	1	Ondo	23.87	10	Lower
South-South	19.42	2	Rivers	23.04	11	Higher
South-South	19.42	2	Delta	22.81	12	Higher
South-West	26.86	1	Ogun	22.23	13	Lower
North-East	14.01	5	Adamawa	22.09	14	Higher
South-South	19.42	2	Akwa-Ibom	21.69	15	Higher
South-East	17.42	4	Imo	21.25	16	Higher
North-Central	18.91	3	Kwara	20.49	17	Higher
South-East	17.42	4	Ebonyi	19.90	18	Higher
North-Central	18.91	3	Kogi	19.51	19	Higher
North-West	11.75	6	Kaduna	19.10	20	Higher
South-East	17.42	4	Abia	18.44	21	Higher
South-East	17.42	4	Enugu	15.57	22	Lower
North-East	14.01	5	Gombe	14.19	23	Higher
North-Central	18.91	3	Benue	14.06	24	Lower
South-South	19.42	2	Cross-River	14.05	25	Lower
North-East	14.01	5	Taraba	13.22	26	Lower
North-East	14.01	5	Borno	12.86	27	Lower
North-West	11.75	6	Kano	12.66	28	Higher
North-Central	18.91	3	Plateau	10.07	29	Lower
North-West	11.75	6	Jigawa	9.28	30	Lower
North-East	14.01	5	Yobe	8.81	31	Lower
South-South	19.42	2	Bayelsa	8.66	32	Lower
North-East	14.01	5	Bauchi	8.02	33	Lower
North-Central	18.91	3	Niger	7.72	34	Lower
North-West	11.75	6	Kebbi	5.74	35	Lower
North-West	11.75	6	Sokoto	3.12	36	Lower
North-West	11.75	6	Zamfara	2.33	37	Lower

Source: Author's computation from the Nigerian Demographic and Health survey (2008-2018).

¹ The table is ranked by mean birth certification rates by regions and states.

² FCT: Federal Capital Territory

⁸ Currently 5 waves (1990, 2003, 2008, 2013 and 2018) are publicly available on the DHS website:
[https:// www.dhsprogram.com/data/dataset_admin/index.cfm](https://www.dhsprogram.com/data/dataset_admin/index.cfm).

Table 2 Descriptive statistics of child-level variables employed in the study

Variables	All HHs (n=66,630)		Not Certified (n = 55,558)		Certified (n=11,072)	
	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev
Sex (male)	0.51	0.50	0.51	0.50	0.51	0.50
Age (months)	27.49	17.03	27.27	17.12	28.57	16.52
1st child	0.17	0.38	0.17	0.37	0.21	0.41
2nd child	0.18	0.38	0.17	0.38	0.21	0.41
3rd child	0.16	0.36	0.16	0.36	0.17	0.37
4th+ child	0.49	0.50	0.51	0.50	0.42	0.49
Small (at birth)	0.15	0.36	0.16	0.37	0.12	0.32
Birth Interval	2.84	1.77	2.85	1.75	2.77	1.86
SBA	0.35	0.48	0.30	0.46	0.61	0.49
Vaccination	0.63	0.48	0.61	0.49	0.74	0.44

Note: Author's computation from the NDHS 2008-2013 data.

Table 3 Descriptive statistics of parent-level variables employed in the study

Variables	All HHs (n=66,630)		Not Certified (n = 55,558)		Certified (n=11,072)	
	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev
<u>Maternal characteristics</u>						
Age-at-birth (years)	27.66	6.78	27.58	6.89	28.10	6.13
Education (years)	4.73	5.35	4.07	5.08	8.04	5.41
No Prenatal Visits	0.33	0.47	0.38	0.48	0.11	0.31
1-3 Prenatal Visits	0.14	0.35	0.14	0.35	0.13	0.33
4+ Prenatal Visits	0.53	0.50	0.48	0.50	0.76	0.43
Polygynous	0.31	0.46	0.33	0.47	0.22	0.42
Decision-maker	0.57	0.50	0.55	0.50	0.69	0.46
Access to mass media	0.58	0.49	0.54	0.50	0.76	0.42
Work (Unclassified)	0.36	0.48	0.38	0.49	0.29	0.45
Work (Low-skilled)	0.10	0.30	0.11	0.31	0.05	0.22
Work (Medium-skilled)	0.50	0.50	0.48	0.50	0.58	0.49
Work (High-skilled)	0.04	0.19	0.03	0.17	0.08	0.27
Child mortality (=0)	0.67	0.47	0.65	0.48	0.77	0.42
Child mortality (=1)	0.18	0.39	0.19	0.39	0.15	0.36
Child mortality (=2+)	0.15	0.35	0.16	0.37	0.08	0.28
<u>Paternal characteristics</u>						
Age (years)	39.81	9.76	39.86	9.94	39.56	8.78
Education (years)	6.37	5.84	5.68	5.71	9.81	5.26
Work (Unclassified)	0.02	0.15	0.02	0.15	0.02	0.15
Work (Low-skilled)	0.48	0.50	0.52	0.50	0.31	0.46
Work (Medium-skilled)	0.39	0.49	0.37	0.48	0.48	0.50
Work (High-skilled)	0.10	0.31	0.09	0.28	0.18	0.39

Note: Author's computation from the NDHS 2008-2013 data.

Table 4 Descriptive Statistics of the household- and community-level variables employed in the study

Variables	All HHs (n=66630)		Not Certified (n = 55558)		Certified (n=11072)	
	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev
<u>Household characteristics</u>						
Head has a bank account	0.31	0.46	0.26	0.44	0.58	0.49
Wealth- Poor	0.47	0.50	0.53	0.50	0.19	0.39
Wealth- Middle	0.19	0.39	0.19	0.39	0.19	0.40
Wealth- Rich	0.33	0.47	0.28	0.45	0.62	0.49
Religion- Muslim	0.61	0.49	0.63	0.48	0.50	0.50
Religion- Christian	0.37	0.48	0.35	0.48	0.50	0.50
Religion- Other	0.02	0.13	0.02	0.13	0.01	0.07
Ethnicity- Hausa/Fulani	0.42	0.49	0.44	0.50	0.29	0.45
Ethnicity- Igbo	0.11	0.31	0.10	0.30	0.16	0.37
Ethnicity- Yoruba	0.10	0.30	0.08	0.28	0.19	0.40
Ethnicity- Other	0.37	0.48	0.37	0.48	0.36	0.48
<u>Community characteristics</u>						
Rural	0.68	0.47	0.73	0.45	0.45	0.50
Dist. to Registration center (<5kms)	0.46	0.50	0.41	0.49	0.69	0.46
Dist. to Registration center (5-<10kms)	0.25	0.43	0.27	0.44	0.19	0.39
Dist. to Registration center (10kms+)	0.29	0.45	0.32	0.47	0.12	0.32
Dist. to road (<5kms)	0.16	0.37	0.16	0.36	0.19	0.40
Dist. to road (5-<10kms)	0.11	0.31	0.10	0.29	0.16	0.37
Dist. to road (10kms+)	0.73	0.44	0.75	0.43	0.64	0.48
Altitude (<323 meters)	0.50	0.50	0.49	0.50	0.53	0.40
Altitude (323-449 meters)	0.25	0.43	0.26	0.44	0.20	0.40
Altitude (>449 meters)	0.25	0.43	0.24	0.43	0.27	0.44
Mean female education	4.73	4.30	4.19	4.15	7.44	4.00
Mean male education	6.37	4.32	5.82	4.25	9.14	3.52
% of poor HHs	0.47	0.41	0.53	0.41	0.22	0.32
% of children who died	0.50	0.50	0.54	0.50	0.32	0.47
North-Central	0.17	0.37	0.17	0.37	0.18	0.39
North-East	0.22	0.41	0.23	0.42	0.16	0.37
North-West	0.31	0.46	0.33	0.47	0.23	0.42
South-East	0.09	0.28	0.08	0.27	0.11	0.31
South-South	0.10	0.30	0.10	0.29	0.12	0.33
South-West	0.11	0.32	0.10	0.30	0.20	0.40

Note: Author's computation from the NDHS 2008-2013 data.

Figures

Figure 1

Birth certification rates among children under-five years, across 774 local government areas (LGAs), Nigeria, pooled data, 2008-2018

Graphs by Geo-political region

Figure 2

Prevalence of birth certification by region of residence and birth year, Nigeria, pooled data 2008-2018

Supplementary Files

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