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DEPARTMENT OF SOCIOLOGY AND CRIMINOLOGY

# A SPATIAL ANALYSIS OF CHILD MORTALITY RATE ACROSS NIGERIA

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# ABSTRACT

Nigeria is a geographically and demographically diverse nation with over 500 different ethnicities, languages, and unique cultures; but the resources available to different people groups is markedly different according to where they are located. Spatial inequalities in social and economic resources may be influencing Nigeria's struggle to reduce child mortality rates across the country. In the face of demographic, economic, and political change, Nigeria's under-5 mortality rate remains high, inhibiting positive outcomes for Nigeria's children.

This paper seeks to understand how differing regional distributions of personal, household, and contextual variables influence child mortality rate. Through spatial analysis, this research paper examines distributions of in literacy, household wealth, health decision-making power, religion, and residence type across Nigeria, and interprets how the spatial distribution disproportionately affects certain ethnic groups. This paper also employs statistical analyses methods to identify the significant personal, household, and contextual determinants of under-5 mortality in Nigeria.

Distributions of social and economic resources are in fact distributed unequally in Nigeria, as supported by strong measures of positive spatial autocorrelation. Regional and state disparities in maternal education, wealth, decision-making power, and residence type disadvantage ethnic groups residing in the northern region of the country more so than people living in the south. Two methods of regression highlight the importance of maternal education, decision-making power, and residence type on child health outcomes in Nigeria, and spatial autocorrelation indicates the areas in need of more governmental resources to combat high levels of under-5 mortality.

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# Chapter 1

## Introduction

Nigeria is a nation of immense geographic diversity and cultural variety, but like many Sub-Saharan African countries, Africa's most populous country[1] is often portrayed simply as a struggling developing nation. However, Nigeria boasts its continent's largest economy. Even with Africa's second largest oil reserves, Nigeria's economy is not solely centered on oil, but diversified with agriculture, construction, trade, and business sectors.

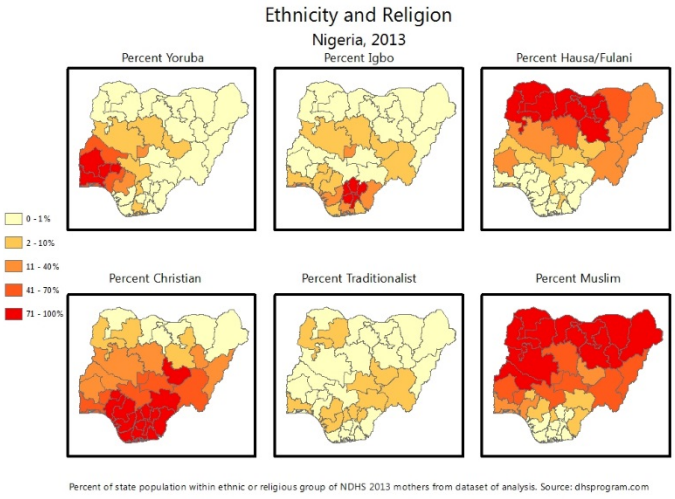



**Figure 1.1 Ethnicity and Religion in Nigeria**

Across Nigeria's 356,667 combined square miles of tropical jungle, desert highlands, delta oil fields, savannah plains, and urban landscape span more than different 500 ethnic groups. Each group has their own unique languages and customs, influenced by long histories tied to their location within Nigeria's political borders. There is a spatial pattern of ethnic distribution. The dispersion of ethnic group majorities influences patterns of cultural beliefs, values, and practices; for example, the visual

[1] Nigeria's 2006 Population Census reports 140,431,790 (2006 Population Housing and Housing Census, 2006). United Nations estimates 2015 population at 182,202,000 (UN World Population Prospects, 2015, p. 16).

pattern of majority religion in Nigeria mirrors the distribution of majority ethnic group as shown in figure 1.

In Nigeria, the federal government's geographic distribution of resources is markedly unequal. The inequality caused by spatial distortion of infrastructural development and social programs has resulted in a range of health outcomes across the nation. For some Nigerians, federal provisions effectively meet their household's health needs, but others are deplorably disadvantaged simply because of where they are located within the country.

Due to the imbalanced allocation of governmental educational and health services across the nation, regional divisions of demographic characteristics – ethnicity and religion – reflect regional divisions of important health indicators, such as maternal education and household wealth. Nigeria is split into six geo-political zones (see figure 1.2[2]) that adequately capture regional diversities. Within those zones, the 36 states and Federal Capital Territory (FCT) they contain, and even the urban-rural distinctions within the states, there is heterogeneity that is influencing health outcomes, particularly for children.


**Figure 1.2 Geopolitical Zones in Nigeria**

[2] Six geo-political zone boundaries were determined in NDHS 2003. See Appendix A to view maps of the evolution of NDHS geo-political boundaries between 1990 and 2013.

As Nigeria strives to improve their developmental status in accordance with their economic potential, understanding which factors are affecting the country's health outcomes will be an important part of helping the country move through the stages of demographic transition. Moreover, examining regional disparities in health outcomes and their predictors will allow an in-depth understanding of where certain policies and programs will be most beneficial for increasing positive health outcomes for Nigeria's children.

## Child Mortality

Child mortality is an important indicator of development. While Nigeria has the population and economy to surmount their status as a developing nation, young children in Nigeria face early mortality, often from preventable diseases. According to the United Nations Children's Fund (UNICEF), more than 70% of under-5 deaths in the developing world are caused by diarrhea, malaria, neonatal infection, pneumonia, preterm delivery, or lack of oxygen at birth ("Millennium Development Goals," n.d.).

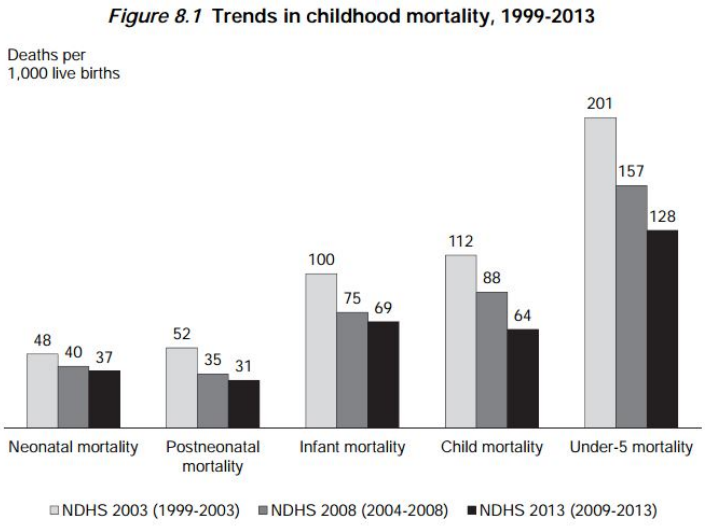



**Figure 1.3 Trends in Nigerian Childhood Mortality**

Nigeria has made strides to lower national child and infant mortality rates. The trends in figure 1.3 from the National Demographic Health Survey taken in Nigeria in 2013, (NDHS 2013) indicate that since 1999, rates of neonatal, post-neonatal, infant, child, and under-5 mortality have all

decreased (see Appendix B for DHS definitions of the different indicators of child mortality). National under-5 mortality has decreased from 185 children per 1,000 births to 128 per 1,000. Despite decreases, under-5 mortality in Nigeria remains very high, 12th in the world according to UNICEF. Moreover, a larger scale examination of under-5 mortality rate reveals regional disparities. Figure 1.4 contains a table with national and regional under-5 and child and infant mortality rates. In the South West region, under-5 mortality averages 90 deaths per 1,000 live births, but in the North West, it reaches 185 deaths per 1,000 live births.

Table 8.2 Early childhood mortality rates by socioeconomic characteristics

Neonatal, postneonatal, infant, child, and under-5 mortality rates for the 10-year period preceding the survey, by background characteristics, Nigeria 2013

| Background characteristic | Neonatal mortality (NN) | Postneonatal mortality (PNN)[1] | Infant mortality ($_1q_0$) | Child mortality ($_4q_1$) | Under-5 mortality ($_5q_0$) |
|---|---|---|---|---|---|
| **Residence** | | | | | |
| Urban | 34 | 26 | 60 | 42 | 100 |
| Rural | 44 | 42 | 86 | 89 | 167 |
| **Zone** | | | | | |
| North Central | 35 | 31 | 66 | 36 | 100 |
| North East | 43 | 33 | 77 | 90 | 160 |
| North West | 44 | 46 | 89 | 105 | 185 |
| South East | 37 | 45 | 82 | 54 | 131 |
| South South | 32 | 26 | 58 | 35 | 91 |
| South West | 39 | 21 | 61 | 31 | 90 |
| **Mother's education** | | | | | |
| No education | 44 | 45 | 89 | 100 | 180 |
| Primary | 42 | 33 | 74 | 57 | 128 |
| Secondary | 34 | 24 | 58 | 35 | 91 |
| More than secondary | 30 | 20 | 50 | 13 | 62 |
| **Wealth quintile** | | | | | |
| Lowest | 45 | 47 | 92 | 108 | 190 |
| Second | 45 | 49 | 94 | 103 | 187 |
| Middle | 39 | 31 | 71 | 61 | 127 |
| Fourth | 37 | 28 | 65 | 38 | 100 |
| Highest | 30 | 18 | 48 | 26 | 73 |

[1] Computed as the difference between the infant and neonatal mortality rates

**Figure 1.4 Childhood Mortality by Region, Maternal Education, and Household Wealth**

In addition to regional disparities of infant and child mortality indicators, figure 1.4 provides differentials in mortality by maternal education and wealth quintile. The trend shows that as maternal education and wealth quintile increase, all indicators of mortality decrease, most notably child mortality. The table connotes the differences in under-5 mortality by region, education, and household wealth, but what are not presented are the regional inequalities in the personal, household, and residential factors that may influence under-5 mortality. If a connection can be made between the

regional disparities in child health determinant indicators and the regional differences in child health outcomes, then hopefully Nigeria will be better able to implement policies that target areas of extremely high infant mortality rate, and address regional inequalities of social and health infrastructure problems.

I want to understand if there is statistical spatial significance to the connection between regional under-5 mortality disparity within Nigeria and the disparity in demographic, socioeconomic, and contextual indicators. This paper will provide a quantitative statistical analysis of individual-level under-5 child mortality and a spatial analysis of state-level under-5 mortality rate using data from the most recent National Demographic Health Survey conducted in Nigeria, NDHS 2013. I aim to understand which child health indicators are influential by examining a combination of personal level, household level, and contextual level variables. The personal indicators that I am interested in are maternal education and ethnicity. Furthermore, I want to know if household wealth, household religion, and the person who makes the health decisions in the home are statistically relevant indicators of child mortality. Lastly, I will explore the influence of urban-rural distinctions and if a person's regional context based on their location within one of Nigeria's six geo-political zones are significant to child health outcomes.

The motivation for this research is to understand not just which inherently sociological indicators have an impact on child health outcomes, but how the influence of these indicators differently impacts Nigerians because of where they are located. Parallel statistical and spatial analyses will allow for a more comprehensive understanding of the influence of personal, household, and contextual on child mortality. Two types of analyses will also contribute to understanding of the influence of geographic region on the sociological determinants, and on child mortality.

Through spatial analysis, I expect to observe distinct spatial patterns of ethnic, religious, educational, and household wealth distributions across Nigeria's regions and states. I expect to find higher levels of under-5 mortality, and lower levels of education and household wealth in the northern geo-political zones within Nigeria. Conversely, I expect lower mortality rates and higher levels of education and wealth in the southern zones.

On both the individual and state levels of analyses, I expect to observe a negative correlation between the independent variables of maternal education, household wealth and the dependent variable, child mortality. I also expect ethnicity, religion, and health-care decision making to be statistically significant indicators of child mortality.

## Chapter 2

## Literature Review

Nigeria's six geo-political zones can be generalized into three divisions: northern, central, and southern. The northern region is predominantly populated by partially nomadic Fulani and Hausa ethnic groups. Like most Nigerian ethnic groups, the Hausa and Fulani people used to primarily practice traditional religions before British colonialism. Now, these groups are predominantly Muslim. Conversely, the southern region of Nigeria is predominantly Christian and the largest ethnic groups are Yoruba and Igbo. Nigeria's central region is often considered the least developed region of the country, despite the fact that it is where the nation's capital is located. The central region is largely rural and is home to many of Nigeria's smaller ethnic group; this region contains the highest rates of people still practicing traditional religion, although that population is low throughout the entire country.

The connection between ethnicity and religion has deep implications in Nigeria because there is an undeniable link between politics and religion. Figure 2.1 displays the extent to which Islamic law, also called Sharia, applies to the judicial system in Nigeria. The map shows that Sharia fully applies in legal matters, including criminal law, in most of the northwest region and parts of the northcentral region; Sharia applies to matters of personal status (i.e. marriage) in areas of the northeast. In southern regions, however, there is little to no influence of Sharia on legal proceedings.

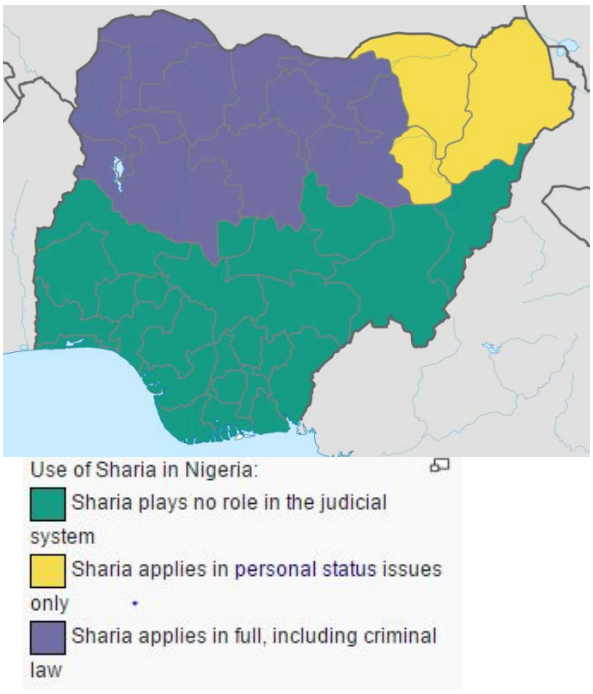



**Figure 2.1 Influence of Sharia Law in Nigeria**

Nigeria faced multiple military coups and violent conflicts after achieving independence from British control in 1960. Many of these conflicts were inter-religious and started because of differences in political ideology. Decades later, these types of violent conflicts still plague Nigeria's citizens. Boko Haram is an Islamic extremist group that has been conducting terrorist attacks in northern regions of Nigeria in opposition to Western education since 2009. The group's name itself translates to "Western education is forbidden," and they are responsible for over 1 million internally displaced persons, 56% of which are children (Report of the United Nations High Commissioner for Human Rights on violations and abuses committed by Boko Haram, 2015, p. 4).

Thousands of Northern Nigerian's have fled to the surrounding countries of Cameroon, Chad, and Niger – only to have the terrorist violence follow them into the surrounding nations.

Boko Haram's multitude of violent human rights violations have targeted innocent citizens at churches, mosques, prisons, hospitals, public markets, and schools. According to the Human Rights Council report on the impact of Boko Haram on human rights (2015), Nigeria and other countries affected by Boko Haram violence have made important strides in counter-terrorism to help protect citizens, but these steps have caused other types of economic and social disadvantages for the citizens they are meant to protect.

> "For girls, interruption in education has increased their exposure to child marriage, trafficking and other forms of gender-based violence. In Cameroon, the destruction and closure of schools resulted in more than 35,000 students staying out of school for the entire 2014-2015 academic year. In Nigeria, authorities reported that some 196 teachers were killed between 2012 and 2014.
>
> The already fragile economic situation in some parts of the affected areas has been exacerbated by security and counter-insurgency measures of respective Governments, such as limiting circulation of traffic, closure of borders, banning of motorbikes, curfews, suspension of fishing, and the seizure of truckloads of goods on the grounds that they may be intended for Boko Haram. Consequently, many people have been deprived of their means of subsistence" (p. 14).

The economic and social impact of spatially clustered religious conflict in Nigeria might be disproportionately impacting people of certain ethnic groups. Differences in political ideology, policy implementation, and governmental corruption are other factors that contribute to disparaging resource allocation throughout Nigeria and have economic and social repercussions that can impact health outcomes within the country.

There are repercussions to the disadvantage that many Nigerians face simply because of where they are located; and those disadvantages can manifest on a personal, household, or contextual level. A review of the literature on the social and economic determinants of child health will provide context for my research question; a connection between maternal education, wealth, decision-making, residence type and child health outcomes is important to understand before identifying clusters high and low indicator values within the population.

Cleland and Ginnekan (1988) established the relationship between maternal education and child survival in developing countries with their research across nations in Sub-Saharan Africa, Asia, Arab countries, and Latin America. Their cross-national research concluded that an average increase of one year in a mother's education could reduce her child's chance of mortality by 7 – 9 %. Their analyses of the maternal education and child survival compare health outcomes between children and infants; they found that the correlation between child survival and maternal education is particularly influential in childhood years as opposed to infancy. Balk et. al (2004) suggest that this is because infant deaths are more attributable to "endogenous factors" such as congenital malformations or low birth weight, while older children are more likely to experience morbidity risk due to preventable conditions (e.g. infectious disease or malnutrition).

Caldwell (1979) was one of the first researchers to study the empirical relationship between maternal education and child health. Previously, it was "assumed that maternal education is merely a reflection of the standard of living," (p. 396) and that the influence of maternal education on child health outcomes resulted as mechanism of household or contextual variables, particularly socioeconomic status and general economic development. Caldwell's research shed light on the individual statistical correlation between maternal education and child mortality outcomes. He utilized cross-national examples to support his findings that mothers'

education was a major social determinant of child health outcomes despite the influence varying social, economic, and regional factors.

Two of Caldwell's main studies used data specifically from Nigeria and closely examined the relationship between maternal education and child mortality. He found that "child mortality differentials by mother's education do not appear to be merely reflections of other even broader differentials. They are the largest socioeconomic differentials found, and are clearly important in their own right" (Caldwell, 1979, p. 402).

Caldwell's research highlighted significant regional disparities in Nigeria, indicating to the history of regional divisions within the country. His assessment attributed these differences to cultural variances in residence type that adequately separated the nation into urban and rural regions. Because Nigeria's ethnic groups are regionally dispersed, the health outcomes impacted by differences in social and economic practices are reflected spatially. Caldwell wrote, "Where other characteristics are held constant, the area of residence seems to be of greatest importance among the poorest or most traditional population where neither spouse works in a white-collar position and where the wave has received, at most, primary schooling" (Caldwell, 1979, p.407). However, the heterogeneity within the nation's regions was so notable that Caldwell had to mention the wide disparities "…demonstrated by the fact that different groups in a single city, Ibadan, exhibit child (and probably more general) mortality regimes characterizing populations with expectations of life at birth as far apart as 45 and 70 years" (p. 408). Differences in life expectancy were attributed to residential disparities within the state capital city that mirrored urban-rural distinctions, highlighting the importance of location and residence type for the health outcomes of children in Nigeria.

Caldwell and McDonald (1982) expanded further on Caldwell's original research. The 1982 study provided a variety of social explanations for the influence of maternal education on child mortality in Nigeria; many of them related to the autonomy that females gain with education. Increased female autonomy leads to a restructuring of the traditional balance of household relationships (Caldwell, 1979). Although there is great ethnic and cultural variation in Nigeria, traditional ideologies tend to emphasize a fatalistic attitude towards illness that can discourage parents from seeking medical care for themselves or for their children (Caldwell, 1979), or opt for traditional remedies instead. Additionally, certain ethnic groups in Nigeria assign healthcare decisions to patriarchal family members; Caldwell particularly noted Yoruba ethnic groups in the south-west part of the country that abide by strict patriarchal decisions. More female autonomy results in increased maternal decision making about childcare outcomes (Caldwell and McDonald, 1982). The influence of global culture – particularly western ideologies – could be a factor in the transition towards accepting attitudes about female autonomy.

Education introduces mothers to a global culture that weakens ties to traditional cultures that could inhibit social progress. "Schooling introduces parents to a global culture of largely Western origin and loosens their ties to traditional cultures. Age and sex differentiations in power, decision-making and benefits within the larger family are reduced when schooling brings about a new family in which women and children are allocated higher priorities" (Caldwell and McDonald, 1982, Abstract)." This "new family" established through more and better education prioritizes the health and nutritional needs of family members and relies less on tradition to make decisions related to health outcomes.

Caldwell and McDonald suggested that the "fact of [maternal] schooling" had a greater influence on child health outcomes than did the actual content of the education because of the social mechanisms learned through formal education. Basu and Stephenson's (2005) mixed methods research examined the mechanisms of maternal education on child mortality and morbidity in India. They posited that the social skills developed in low levels of education are impactful for improved child health outcomes.

> "The respect for authority, the obedience of authority figures, and the ability to follow a time table of routine—go a long way towards making the slightly educated woman more able to seek and follow the dictates of health-care providers in later life. When a child is ill, she turns to the authority of the doctor or nurse; and then she obeys the instructions on timed medication that this figure dispenses. When such obedience does indeed lead to the resolution of illness in the child, faith can only be fortified" (Basu and Stephenson, 2005, p. 2021).

With low levels of maternal education come other mechanisms that reduce child mortality rate. Mothers with at least a primary school education are less likely to expose their children to infection through environmental contamination related to traditional practices, as they pay more attention to hygiene and create sanitary spaces for their children. Mothers with at least a primary school education are also more likely get their children immunized depending on the aggresivity of the locally available immunization program (Basu and Stephenson, 2005).

However, both Caldwell and McDonald and Basu and Stephenson recognized the value of the actual content of education. Basu and Stephenson (2005) suggest that low levels of maternal education influences child mortality not only through increased decision-making, but through more informed decision-making. They wrote, "while schooling itself does not teach

child-rearing skills…It makes them good at understanding decontextualized information, information that is pro- vided by impersonal sources like the mass media and health workers" (p. 2020).

Perhaps this is why many researchers have found that the level of maternal education is particularly important for child health outcomes, depending on intervening socioeconomic factors and region. The content value of low levels of maternal education on child health outcomes is noted through the mechanisms of literacy and language skills that improve mothers' understanding of written and auditory instructions related to health and childcare (Smith-Greenaway, 2012). Smith-Greenaway examined the reading skills of Nigerian women, going beyond just educational level attainment. Her research suggests "mothers' reading skills—a subcomponent of literacy and language skills—significantly lower child mortality risk in Nigeria" particularly for low-income citizens (Smith-Greenaway, 2013, n.p.).

Many researchers have examined the connection between maternal education, child health, and other influence structural variables, particularly household income and wealth. There is a correlation between household wealth and child health that is statistically independent of maternal education (Cleland and van Ginnekan, 1988). As both variables influence child health outcomes, there are casual mechanisms that connect them, for example, maternal occupation (Caldwell, 1979). However, cross-national research has found that the influence of maternal education is more impactful on child mortality with increasing levels than is the influence of household wealth:

> "Comparable proportionate shares of higher education and higher wealth revealed a consistent reduction in the likelihood of infant death with higher education, with the education effect exceeding that of higher wealth for all but four of the countries

> examined...we observed a larger and more consistent tendency for the likelihood of infant death to decline with each increase in education level compared to increases in wealth quintile" (Fuchs et. al, 2010, p. 194).

Fuchs et. al examined not only household wealth and maternal education, but community and country levels of maternal education as well. Their finding that maternal education is more impactful was supported even in these extended definitions of wealth and education. However, household and community wealth were still relevant to infant mortality rate, more significantly so in certain regions. Interestingly, the mechanisms of community wealth – increased locally available material resources for health – functioned similarly to those of maternal education. Fuchs et. al observed an imitative effect where uneducated mothers in a community with educated women actually adjusted their child health attitudes and behaviors, by imitating educated women in their communities, thereby increasing the educational resources available to them. (Fuchs et. al, 2010).

# Chapter 3

# Data & Methods

## Sample & Sample Design

The Nigerian Demographic Health Survey 2013, (NDHS, 2013) was designed to collect information from a nationally representative sample of Nigeria's population and provide reliable reports about maternal and child health indicators on different spatial scales – 6 geopolitical zones, 37 states including the Federal Capital Territory (FCT-Abuja), and urban-rural distinction. The National Population

Commission in Nigeria executed NDHS 2013 as a more expansive follow-up to four previous NDHS surveys conducted in 1990, 1999, 2003, and 2008 (p. 5).

NDHS 2013 data were collected between February and May 2013[3], by teams of DHS field workers, one team for each state. Teams consisted of a field supervisor, field editor, four female interviewers, two male interviewers, and two drivers. Technical team members trained for fieldwork through reviews, mock interviews, exercises, presentations, and module tests according to standard DHS training procedures; field editors and field supervisors had additional special training (NDHS, 2013, pp. 7-9). Resource representatives from Intergovernmental organizations and NGOs such as USAID, UNICEF, UN Women, UN Population Fund (UNFPA), and National Primary Health Care Development Agency of Nigeria (NPHCDA) attended appropriate technical training sessions (p.8).

The DHS Program divides Nigeria's 37 states into 774 local government areas (LGAs). LGAs are subdivided into localities, and localities are further divided into enumeration areas (EAs) created during the 2006 census. Clusters (also referred to as primary sampling units in DHS) are defined based on the census (EAs); due to the varying size of the EAs defined by the census, clusters may include one or multiple EAs. As part of the stratified three-stage cluster design of NDHS, each cluster was given an urban or rural designation (NDHS, 2013, p. 378). A fixed sample of 45 households was selected for the survey through equal probability systematic sampling from each urban and rural cluster[4], totaling 40,680 households (pp. 6 – 10).

The samples from the Individual Questionnaire consisted of women age 15 – 49. In order to capture spatially pertinent information, the questionnaires themselves were appropriately adapted for Nigerian respondents. Before the survey was distributed, National Population Commission organized a panel of experts in the federal capital of Abuja, Nigeria, to analyze the questionnaire and contribute to the final version of questions. The goal of the panel was to ensure that the survey provided ample information

[3] Two teams completed fieldwork in June 2013 (NDHS, 2013, p.9).

[4] Due to political violence and instability in the Northeastern and Northwestern parts of the country caused by the presence of the radical terrorist group Boko Haram, a total of 8 clusters were not surveyed across the states of Borno, Yobe, Nassarawa, and Plateau (NDHS, 2013, pp. 9 -10).

pertinent to Nigeria's women, particularly about the topics of maternal and child health, HIV/AIDS, family planning, and domestic violence. Respondents were able to answer the survey in a variety of languages – Hausa, Igbo, Yoruba, Ibibio, Pidgin, Tiv, English, and other native languages (NDHS, 2013, p. 7).

The Household Questionnaire and Woman's Questionnaire collected information about the following topics:

- Background characteristics and demographics
- Education and literacy
- Employment
- Reproductive history and fertility preferences
- Child mortality and maternal mortality
- Use and source of family planning resources
- Antenatal and postnatal care
- Birth and delivery information
- Breastfeeding practices
- Child immunization and childhood illnesses
- Sexual activity
- Husband's background characteristics
- Malaria prevention and treatment
- Women's decision making
- Awareness of AIDS and other sexually transmitted infections
- Domestic violence (NDHS, 2013, p.8)

# Methods

## Statistical Analyses

For bivariate and multivariate statistical analysis, a dataset containing individual level data was created from the full NDHS 2013 sample. The full NDHS 2013 sample contains 38,938 individual cases. In order to gain an understanding of the impact of the personal, household, and contextual factors on child survival in Nigeria, I chose to examine only mothers. The dataset of analysis comprised individual cases of mothers who had had at least one child between the years of 2009 and 2013; it contains 19,306 individual cases. The dataset was created from the NDHS Individual Survey Recode using SPSS statistical software, which was also used for bivariate and multivariate analyses.

### *Child Mortality*

My individual-level dependent variable is a categorical indicator of under-5 child mortality. The outcome variable that I used for analysis is different from the standard DHS measure of under-5 mortality, as it only includes the child from the last birth event. The variable expresses whether the child of the respondent's last birth event passed away before their $5^{th}$ year. I coded available DHS variables concerning the child's birth year, whether the child is alive, and the age of death of the child. Respondents whose last child was born between 2009 and 2013 and had passed away before their $5^{th}$ year were coded 0; all other respondents were coded 1. This is the primary dependent variable used in the bivariate and multivariate analyses; its level of measurement is nominal.

***Personal Level Variables***

Nigeria's large population encompasses hundreds of different ethnic groups, each with unique cultures and customs. NDHS 2013 labors to capture that diversity by offering over 250 ethnicity options for ethnicity from respondents to choose[5]. For the purposes of this research's analyses, ethnicity was coded into four variables. The largest ethnic groups in Nigeria – Hausa/Fulani, Igbo, and Yoruba – compose the first three groups, all other values comprise the category of "other."

**Table 3.1 Respondent Education Correlation Matrix**

**Respondent Education Correlaion Matrix**

| | Educational Attainment | Education Level | Education in Single Years | Literacy |
|---|---|---|---|---|
| Educational Attainment | 1 | 0.981*** | 0.994*** | 0.906** |
| Education Level | | 1 | 0.979*** | 0.904*** |
| Education in Single Years | | | 1 | 0.903*** |
| Literacy | | | | 1 |

The DHS individual questionnaire contains many questions pertaining to the respondent's education. Together, the different indicators provide a comprehensive understanding of each respondent's educational attainment, the number of years of schooling, school completion, and literacy. Table 3.1 is a correlation matrix of the variables available in the DHS that indicate the respondent's education. Due to the high levels of significant correlation between all of the education variables, only one is used for bivariate and multivariate analyses.

I chose literacy to represent an indicator of maternal education; it is measured as an ordinal level variable. It is useful as comparative measure of education because it captures education information for young mothers who may not have yet completed their educational attainment. In the NDHS (2013), respondents with a secondary education or higher were automatically coded as literate and those with primary schooling or less were assessed on their ability to read a provided sentence (p. 35).

[5] See Appendix C for a frequency table of the total NDHS 2013 sample with all ethnicities provided in the questionnaire.

***Household Level Variables***

Wealth is an important household level ordinal variable and is often correlated with other indicators of a household's resources. An independent samples T-test between a household's wealth index score and presence of electricity is statistically relevant where F(19093, 17939.742) = 278.454, p = 0.000 (see table 3.2). Additionally, wealth can also be used as an indicator of the personal indicator of a child's parent. There is a significant positive correlation between wealth and the educational attainment of the NDHS 2013 survey respondent's educational attainment where is *r* (18615) = 0.583, p < 0.001 (see Appendix D for Pearson's r correlation matrix SPSS output).

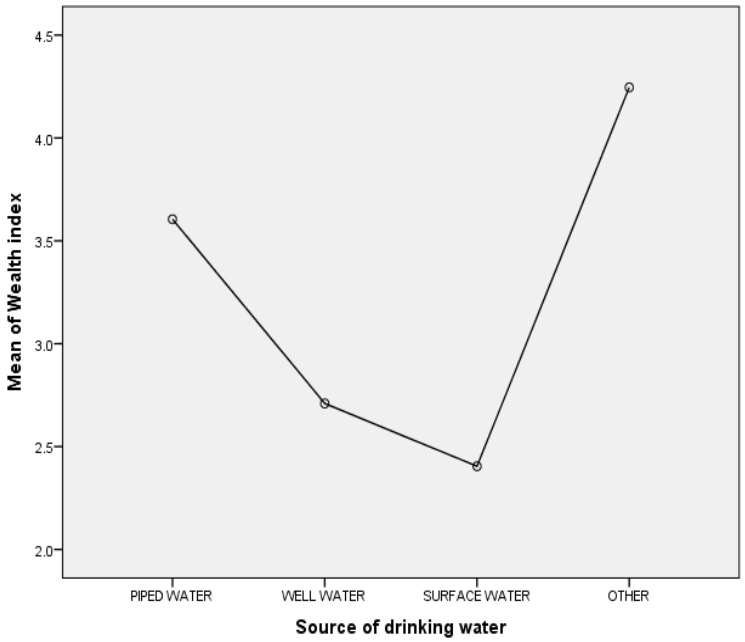



**Figure 3.1 Drinking Water and Wealth One-Way ANOVA Mean Mean Plots Graph**

Another indicator of household resources is the source of drinking water for the home. Drinking water sources were coded into four categories[6]. The graph in figure 3.1 shows the variation in average household wealth by sources of drinking water. A one-way ANOVA of the two variables yields an F-statistic of F(3, 19302) = 933.811, p= 0.000; this connotes support that a household's average wealth index score significant differs by the source of a household's drinking water (See Appendix D for one-way ANOVA SPSS output table). Respondents who used piped and other water sources also reported higher levels of household wealth, and those using well water and surface water had lower levels of wealth as shown in the graph in figure 3.1

[6] NDHS 2013 provides specificity about drinking water source in order to compare improved water sources to non-improved sources as described by Millennium Development Goal 7 (NDHS, 2013, p. 11).

Due to the statistical relationships in the bivariate analyses of the household wealth index score indicator, I am using wealth as the primary independent variable to measure household resources.

The secondary household indicator pertains to the household religion. I coded the NDHS 2013 nominal-level religion variable from an original five categories into three: Christian/Catholic, Muslim, and Traditionalist/other.

**Table 3.2 Wealth and Electricity Independent Samples T-Test**

**Wealth and Electricity Independent Samples T-Test**

| | | N | Mean | SD | SE of Mean | F-Statistic | Sig. |
|---|---|---|---|---|---|---|---|
| Wealth Index | **Household has Electricity** | | | | | F(19093, 17939.742) = 278.454 | 0.000 |
| | Yes | 8998 | 3.83 | 1.092 | .012 | | |
| | No | 10097 | 1.95 | .949 | .009 | | |

***Contextual Variables***

Understanding the relevance of spatial distribution is an important part of the purpose of this research. The DHS Program divided Nigeria into 6 geo-political zones representative; the maps in figures 3.2 illustrate the distribution of the analysis dataset's population according to these zones and the administrative states. For my multivariate analyses, I chose the North West region as the category of comparison. This region of the country contains the most populous state, Kano, and the second most populous city in the county, also named Kano (2006 Population Housing and Housing Census, 2006). I will use Muslim and Hausa/Fulani as comparison groups for the personal and household level indicators; this relates nicely with the chosen region as the North West has high populations of respondents who are Hausa and live in Muslim households.


**Figure 3.2 Regions and States of Nigeria with DHS clusters**

### *Control Variables*

NDHS provides many indicators about the respondents' last birth event. I am adding control variables concerning the birth event to include relevant health information provided by DHS into my multivariate analyses with the hopes of resulting more comprehensive regression models.

I coded place of delivery into two categories; respondents were coded 0 if their last birth took place at home and 1 if the birth took place in either a private or public hospital or health clinic.

**Table 3.3 Delivery Place and Delivery Assistance Cross Tabulation**

| Delivery Place and Delivery Assistance Cross Tabulation | | | |
|---|---|---|---|
| | Place of Delivery | | |
| | Home | Hospital | Total |
| **Delivery Assistance** | | | |
| **Doctor** | | | |
| Yes | 68.60% | 31.40% | 100.00% |
| No | 3.80% | 96.20% | 100.00% |
| Total within doctor assistance | 61.90% | 38.10% | 100.00% |
| $\chi^2$= 3152.679*** | N= 19220 | | |
| **Delivery Assistance** | | | |
| **Nurse/Midwife** | | | |
| Yes | 88.30% | 11.70% | 100.00% |
| No | 7.30% | 92.70% | 100.00% |
| Total within XXXX | 61.90% | 38.10% | 100.00% |
| $\chi^2$= 11755.829*** | N= 19220 | | |
| **Deliver Assistance** | | | |
| **Relative** | | | |
| Yes | 98.90% | 1.10% | 100.00% |
| No | 50.30% | 49.70% | 100.00% |
| Total within XXXX | 61.90% | 38.10% | 100.00% |
| $\chi^2$= 3509.489*** | N= 19220 | | |
| **Delivery Assistance** | | | |
| **TBA** | | | |
| Yes | 99.00% | 1.00% | 100.00% |
| No | 50.90% | 49.10% | 100.00% |
| Total within XXXX | 61.90% | 38.10% | 100.00% |
| $\chi^2$= 3317.732*** | N= 19220 | | |
| **Delivery Assistance** | | | |
| **No one** | | | |
| Some Assistance | 56.80% | 43.20% | 100.00% |
| No Assistance | 99.40% | 0.60% | 100.00% |
| Total within XXXX | 61.90% | 38.10% | 100.00% |
| $\chi^2$= 1569.509*** | N= 19220 | | |

NDHS 2013 offers information about the person who gave the respondent delivery assistance. The questionnaire asks respondents if their last delivery was assisted by a doctor, nurse/midwife, traditional birth attendant (TBA), a relative, or if no one assisted their last birth. As the cross tabulation in table 3.3 shows, the five Pearson Chi Square values are all statistically significant where $p > 0.001$. The location of the respondent's most recent birth is statistically dependent with the person who assisted in the delivery of the child. As would be expected, high percentages of respondents who reported giving birth in a hospital also reported assistance from a doctor or nurse. Higher percentages of respondents who delivered at home also reported receiving assistance from a relative, traditional birth attendant or receiving no delivery assistance at all. Therefore, only place of delivery is used in the multivariate analyses.

**Spatial Analyses**

State-level data for spatial analyses was aggregated from the same dataset of analysis from NDHS 2013 used for statistical analysis. The under-5 mortality rate of respondents' last birth is used in analyses as a continuous outcome variable and expressed as a rate per 1,000.

The spatial analysis methods used are Local Moran's I Spatial Autocorrelation and Spatial Lag Regression. Both methods of analyses employ spatial lag variables; this is defined by GeoDa as "a variable that essentially averages the neighboring values of a location (the value of each neighboring location is multiplied by the spatial weight and then the products are summed). It can be used to compare the neighboring values with those of the location itself" (geodacenter.asu.edu).

I will use GeoDa geographic software to analyze NDHS 2013 data that has been aggregated to the state level. In total, the dataset of analysis consists of 37 polygons – one representing each administrative state in Nigeria and the FCT. Data were aggregated using SPSS, and I linked the survey data to the geographic data provided by the DHS program using ArcMap software from Environmental Systems Research Institute (ESRI), using the operation "table join."

For spatial analyses, the state-level geocoded DHS dataset was exported in shapefile format from ArcMap and imported into GeoDa. For analyses I created two weights matrices for comparison, one k-nearest-neighbor matrix and one contiguity-based matrix. The k-nearest-neighbor matrix specified 6 neighbors; the contiguity-based matrix used queen's contiguity; results in the following section are based on the results of the queen's contiguity weights matrices.

In order to determine statistical significance for the spatial autocorrelation analyses, I report pseudo p-values that are calculated through GeoDa software. GeoDa uses permutations to determine the pseudo significance level; I used 999 permutations in order to gain as much understanding of significance as possible. From there I examined the results of the spatial autocorrelation and weighted regression results discussed in the next chapter. In spatial lag regression, coefficients produced by analyses cannot

be directly compared as in regular OLS regression, so results were interpreted by their significance and the R squared value of the spatial regression model.

# Chapter 4

## Results

Individual level data was analyzed using SPSS statistical software. To gain an understanding of bivariate relationships, particularly between spatial location – that is geopolitical zone, state, and urban-rural distinction – bivariate analyses consisted of cross tabulations, correlations, chi squares, and T-tests. The appropriate statistics were used depending on the level of measurement of the variable – nominal, ordinal, or interval/ratio.

**Table 4.1 Variables of Interest Univariate Statistics**

| UNIVARIATE STATISTICS - Dependent and Indepent Variables | | | | | |
|---|---|---|---|---|---|
| | Percentage | Mean | Median | SD | N |
| **Child is alive** | | | | | 19306 |
| Yes | 94.2 | | | | |
| No | 5.8 | | | | |
| | | | | | |
| **Ethnicity** | | | | | 19306 |
| Hausa/Fulani | 39 | | | | |
| Igbo | 10.4 | | | | |
| Yoruba | 11.8 | | | | |
| Other | 38.9 | | | | |
| | | | | | |
| **Literacy** | | | | | 19134 |
| (0) No literacy | 56.4 | | | | |
| (1) Some literacy | 6.9 | | | | |
| (2) Full literacy | 35.8 | | | | |
| | | | | | |
| **Health Decision Making** | | | | | 18156 |
| Respondent Alone | 5.1 | | | | |
| Respondent and Husband | 29.6 | | | | |
| Husband Alone | 59.4 | | | | |
| | | | | | |
| **Wealth** | | | 3 | | 19306 |
| (1) Poorest | 21.9 | | | | |
| (2) Poorer | 23.1 | | | | |
| (3) Middle | 20.2 | | | | |
| (4) Richer | 18.6 | | | | |
| (5) Richest | 16.2 | | | | |
| | | | | | |
| **Household religion** | | | | | 19213 |
| Christian | 40.7 | | | | |
| Muslim | 57.7 | | | | |
| Traditional/Other | 1.1 | | | | |
| | | | | | |
| **Residence type** | | | | | 19306 |
| Urban | 33.3 | | | | |
| Rural | 66.7 | | | | |
| | | | | | |
| **Region** | | | | | 19306 |
| North Central | 15.3 | | | | |
| North East | 20 | | | | |
| North West | 31.2 | | | | |
| South East | 8.5 | | | | |
| South South | 12.2 | | | | |
| South West | 12.9 | | | | |

# Individual Level Descriptive Statistics

## Child Mortality

The dataset of analysis consisted only of mothers who had had a child between 2009 and 2013. Within the chosen dataset, a total of 5.8% of mothers who had had a child between 2009 and 2013 reported that their child passed away before their 5$^{th}$ year.

## Variables of Interest

### *Ethnicity*

The largest ethnic group in the sample is Hausa/Fulani. Other ethnic groups comprise the second largest group, but the second and third largest single ethnic groups are Yoruba and Igbo respectively.

### *Literacy*

More than half of the respondents in the sample were unable to read any of the sentence provided for them to ready by the field interviewer, a total of 56% of mothers who had had a child between 2009 and 2013 were completely illiterate. About 36% of women were completely able to read the sentence, while about 7% of the women were partially literate.

### *Wealth*

The distribution of wealth across the sample is normal and fairly even; slightly more respondents reported living in “poorest” or “poorer” households than “richer” or “richest”. Household wealth is measured as a quintile indicator; the largest group is “poorer” while the smallest group is “richest.”

### *Religion*

Similar to the true distribution in Nigeria’s population, most respondents in the sample live in a Muslim household. The split between Muslim and Christian households in the sample is essentially 60% to 40%, which traditionalist households only comprising 1% of sample households.

### *Health Decision Making*

Approximately 60% of mothers in the sample are not involved in the decisions about health that are made in their home. Around 30% of respondents in the sample share decision-making power with their husbands, and 5% make health decisions on their own. This small percentage presumably includes many women who are not married, divorced, and widowed and are the head of their household.

### *Residence Type*

The majority of Nigerians live in rural areas as is reflected in the distribution of residence type in the sample. Two-thirds of respondents’ residence type is rural, the remaining third live in urban residences.

### *Region*

The distribution of the sample across Nigeria's six geopolitical zones is not even. The northwest region had the largest number of the sample's respondents, totaling 31%. The region with the least number of sample respondents is the South East area, containing 8%. This univariate descriptive statistic is not representative of Nigeria's actual population density across regions; the southeast region is a population dense area due to the presence of the Igbo ethnic group and urban centers that serve as important areas for the oil industry. See table 4.1 for the remaining regional distributions.

## Control Variables

The distribution of the control variables relating to the respondent's personal characteristics and details of the birth even are recorded in table 4.2. The control variables that will be used for multivariate analyses are age, marital status, employment, age at first birth, number of antenatal visits, presence of prenatal are, birth order, twin status, sex of the child, and place of delivery.

**Table 4.2 Control Variables Univariate Statistics**

| UNIVARIATE STATISTICS - Control Variables | | | | | |
|---|---|---|---|---|---|
| | Percentage | Mean | Median | SD | N |
| **Respondent Age** | | 29.3 | 29 | 7.2 | 19306 |
| | | | | | |
| **Marital Status** | | | | | 19306 |
| Married | 91.5 | | | | |
| Not Married | 8.5 | | | | |
| | | | | | |
| **Employment** | | | | | 19222 |
| Not Employed | 31.3 | | | | |
| | | | | | |
| **Age at First Birth** | | 19.44 | 19 | 4.3 | 19306 |
| | | | | | |
| **Number of Antenatal Visits** | | 5.22 | 6.07 | 6.065 | 18800 |
| | | | | | |
| **Prenatal Care** | | | | | 19250 |
| Some prenatal care | 66.8 | | | | |
| No prenatal care | 32.9 | | | | |
| | | | | | |
| **Birth Order** | | 4.07 | 4 | 2.65 | 19306 |
| | | | | | |
| **Child is a twin/triplet** | | | | | 19306 |
| Yes | 1.9 | | | | |
| | | | | | |
| **Sex of child** | | | | | 19306 |
| Male | 50.7 | | | | |
| Female | 49.3 | | | | |
| | | | | | |
| **Place of delivery** | | | | | 19306 |
| Home | 61.9 | | | | |
| Hospital | 38.1 | | | | |

## Individual Level Bivariate Analyses

Table 4.3 Ethnicity and Child Mortality Cross Tabulation

| Ethnicity and Child Mortality Cross Tabulation | | | |
|---|---|---|---|
| | Under 5 Death | | |
| | Yes | No | Total |
| **Ethnicity** | | | |
| Hausa/Fulani | 6.60% | 93.40% | 100.00% |
| Igbo | 6.20% | 93.80% | 100.00% |
| Yoruba | 3.90% | 96.10% | 100.00% |
| Other | 5.50% | 94.50% | 100.00% |
| Total within Ethnicity | 5.80% | 94.20% | 100.00% |
| $\chi^2$= 26.234*** | N= 19306 | | |

### Ethnicity and Child Mortality

The results of the cross tabulation between ethnicity and child mortality reveal that where 4% of Yoruba respondents reported that their last child born between the years of 2009 and 2013 passed away before the age of 5, higher percentages of Hausa/Fulani, Igbo, and mothers of other ethnicities reported their last child's death. About 7% of Hausa mothers experienced child death, 6% of Igbo mothers, and 5% of mother in other ethnic groups. The results of the chi square reveal that ethnicity and this measure of child mortality are statistically dependent to a significant level.

### Literacy and Child Mortality

The percentages of mothers who reported under-5 child death of their last child appears linear in table 4.4. Where almost 7% of mothers in the sample reported last child's death, only about 4% of mothers who were fully literate reported

Table 4.4 Literacy and Child Mortality Cross Tabulation

| Literacy and Child Mortality Cross Tabulation | | | |
|---|---|---|---|
| | Under 5 Death | | |
| | Yes | No | Total |
| **Literacy** | | | |
| No literacy | 6.80% | 93.20% | 100.00% |
| Some literacy | 5.60% | 94.40% | 100.00% |
| Full literacy | 4.30% | 95.70% | 100.00% |
| Total within Literacy | 5.80% | 94.20% | 100.00% |
| $\chi^2$= 48.136*** | N= 19134 | | |

last child's death; mothers with some literacy fell somewhere in between at 5.6%. Again, a Pearson Chi square revealed significant results connoting statistical dependence between literacy and report of under-5 death.

## Wealth and Child Mortality

Unlike expected, there is not a perfectly linear pattern to the reports of under-5 mortality by household wealth in this sample; however, the pattern still adheres to expectations – more mothers in poor households reported their last child's death than did mothers in richer households. Only 3.5% of mothers in the richest category reported their last child's death, less than half the percentage of mothers who reported child mortality that lived in "poorer" households.

**Table 4.5 Wealth and Child Mortality Cross Tabulation**

| Wealth and Child Mortality Cross Tabulation | | | |
|---|---|---|---|
| | Under 5 Death | | |
| | Yes | No | Total |
| **Wealth Index** | | | |
| Poorest | 6.80% | 93.20% | 100.00% |
| Poorer | 7.40% | 92.60% | 100.00% |
| Middle | 5.30% | 94.70% | 100.00% |
| Richer | 5.20% | 94.80% | 100.00% |
| Richest | 3.50% | 96.50% | 100.00% |
| Total within Wealth | 5.80% | 94.20% | 100.00% |
| $\chi^2$= 62.559*** | N= 19306 | | |

## Religion and Child Mortality

A Pearson Chi Square test between religion and my chosen indicator of child mortality did not yield significant results, meaning that there is not a statistical dependence between religion and under-5 mortality in this sample. Mothers in traditionalist

**Table 4.6 Religion and Child Mortality Cross Tabulation**

| Religion and Child Mortality Cross Tabulation | | | |
|---|---|---|---|
| | Under 5 Death | | |
| | Yes | No | Total |
| Religion | | | |
| Christian/Catholic | 5.40% | 94.60% | 100.00% |
| Muslim | 6.10% | 93.90% | 100.00% |
| Traditionalist/Other | 6.40% | 93.60% | 100.00% |
| Total within Religion | 5.80% | 94.20% | 100.00% |
| $\chi^2$= 3.835 | N= 19213 | | |

households comprised a very small part of the sample, but reported the highest incidences of under-5 last child death compared to Muslim and Christian households. Muslim respondents reported higher incidences of last child's death than sample average (5.8%), and about 5% of mothers in Christian households reported last child's death.

## Health Decision Making and Child Mortality

**Table 4.7 Health Decision Making and Child Mortality Cross Tabulation**

| Health Decision Making and Child Mortality Cross Tabulation | | | |
|---|---|---|---|
| | Under 5 Death | | |
| | Yes | No | Total |
| Makes Health Decisions | | | |
| Respondent Alone | 5.40% | 94.60% | 100.00% |
| Respondent and Husband | 4.70% | 95.30% | 100.00% |
| Husband Alone | 6.10% | 93.90% | 100.00% |
| Total within Decision Making | 5.80% | 94.20% | 100.00% |
| $\chi^2$= 13.445*** | N= 18156 | | |

There is a significant statistical dependence between health decision making and child mortality in this sample. About 6% of households where the husband alone holds the decision-making power related to health reported an under-5 death; that number reduces to 4.7% for households where the decision-making power is shared between the respondent and her husband. Mothers who make health decisions alone fall in between the other two categories with 5.4% reporting a child death.

## Residence Type and Child Mortality

As expected, there residence type is statistically dependent to under-5 death, as proven by a Pearson Chi Square test. Throughout the entire sample, an average of 5.8% of

**Table 4.8 Residence Type and Child Mortality Cross Tabulation**

| Residence Type and Child Mortality Cross Tabulation | | | |
|---|---|---|---|
| | Under 5 Death | | |
| | Yes | No | Total |
| **Residence Type** | | | |
| Urban | 4.30% | 95.70% | 100.00% |
| Rural | 6.60% | 93.40% | 100.00% |
| Total within Residency Type | 5.80% | 94.20% | 100.00% |
| $\chi^2$= 40.303*** | N= 19306 | | |

respondents reported an under-5 death. When considering residence type, 4.3% of urban respondents reported a death while 6.6% of rural respondents reported a death. The significance level of the Pearson Chi Square test indicated in table 4.8 demonstrates that the importance of residence type on this indicator of child health.

**Table 4.9 Region and Child Mortality Cross Tabulation**

| Region and Child Mortality Cross Tabulation | | | |
|---|---|---|---|
| | Under 5 Death | | |
| | Yes | No | Total |
| **Region** | | | |
| North Central | 4.70% | 95.30% | 100.00% |
| North East | 6.10% | 93.90% | 100.00% |
| North West | 6.90% | 93.10% | 100.00% |
| South East | 6.60% | 93.40% | 100.00% |
| South South | 5.20% | 94.80% | 100.00% |
| South West | 4.10% | 95.90% | 100.00% |
| Total within Region | 5.80% | 94.20% | 100.00% |
| $\chi^2$= 36.342*** | N= 19306 | | |

## Region and Child Mortality

My chosen indicator of under-5 mortality is statistically dependent with geopolitical region in Nigeria. In the southwest and northcentral regions, less than 5% of respondents reported last child's death and in the southeast and northwest regions, over 6.5% of respondents indicated under-5 mortality.

## Individual Level Multivariate Regression

This section contains the results of two binary logistic regression models conducted on the dataset of analysis where N= 19306. The first model analyzes the influence of the variables of interest on the binary outcome variable of under-5 mortality. The second model measures the influence of the variables of interest as well as control variables relating to the respondent's demographic and the birth event itself.

**Regression Model 1**

The first regression model included only the independent variables of interest – ethnicity, literacy, wealth, household religion, residence type, health decision making, and region. This logistic regression model yielded a low Nagelkerke R Square score, indicating that the chosen independent variables do not account for much of the variation within bi-categorical dependent variable. In this multivariate analysis, the variables of literacy and residence type were indicated as significant within the model, while ethnicity, wealth, religion, decision-making, and region were not. Although the coefficients resulted from logistic regression analyses cannot be directly compared as they could in an OLS regression analyses, the odds ratios given in table 4.10 can be interpreted; an odds ratio (OR) above 1 indicates higher odds of the outcome compared to the comparison category, and an OR below 1 indicates lower odds. In the case of

**Table 4.10 Binary Logistic Regression Model 1**

| Binary Logistic Regression Model 1 | | | | | |
|---|---|---|---|---|---|
| | B | SE | df | Sig. | Odds Ratio |
| **Ethnicity** | | | | | |
| Igbo | -.187 | .269 | 1 | .487 | .829 |
| Yoruba | -.085 | .206 | 1 | .679 | .918 |
| Other | .019 | .119 | 1 | .870 | 1.020 |
| **Literacy** | | | | | |
| Some literacy | .229 | .143 | 1 | .108 | 1.258 |
| Full literacy | .334 | .105 | 1 | **.001** | 1.397 |
| **Wealth** | | | | | |
| Poorer | -.104 | .089 | 1 | .243 | .901 |
| Middle | .138 | .112 | 1 | .220 | 1.147 |
| Richer | -.020 | .131 | 1 | .878 | .980 |
| Richest | .273 | .170 | 1 | .108 | 1.314 |
| **Household religion** | | | | | |
| Christian | -.163 | .118 | 1 | .168 | .850 |
| Traditional/Other | -.033 | .311 | 1 | .915 | .967 |
| **Urban Residence** | .243 | .096 | 1 | **.011** | 1.275 |
| **Health Decision Making** | | | | | |
| Respondent Alone | -.089 | .157 | 1 | .572 | .915 |
| Respondent and Husband | .088 | .083 | 1 | .289 | 1.092 |
| **Region** | | | | | |
| North Central | .256 | .143 | 1 | .074 | 1.291 |
| North East | .066 | .104 | 1 | .524 | 1.069 |
| South East | .031 | .284 | 1 | .913 | 1.031 |
| South South | .152 | .172 | 1 | .376 | 1.165 |
| South West | .267 | .198 | 1 | .178 | 1.305 |
| Nagelkerke R Square = .015 | | | | | |

this regression model, variables with an OR above 1 were more likely to experience child survival and those with an OR below 1 were less likely to experience their child passing away before their 5th year.

In that way, mothers who are fully literate are significantly less likely to experience last child's under-5 mortality than those who are illiterate, where $p$=0.05, which is an expected result from the regression. The other statistically significant finding within the regression is that mothers living in urban contexts are less likely to experience this measure of child morality outcomes than mothers living in rural residences.

**Regression Model 2**

The second regression model included all variables of interest at personal, household, and contextual levels as well as control variables concerning the birth event itself and other important control variables that have been considered in previous literature to influence child mortality such as respondent age, marital status, and employment. Although the Nagelkerke R Square value and coefficients cannot be compared between binary logistic regression models, the ORs for the variables of interest indicate similar likelihoods of child survival and mortality as the first regression model.

As in the previous model, respondents who are fully literate and partially literate are more likely to experience their last child's survival past the age of five than mothers who are illiterate. In this second model, both fully and partially literate indicators are statistically significant where $p$=0.05. Urban residence type is also statistically significant in this model as it is in the first model; even when considering the influence of control variables, residence type and maternal education still present as statistically important indicators of under-5 mortality. In addition, the indicator of North Central is statistically significant in the second multivariate analyses model, which implies the importance of region as an indicator of last child under-5 mortality in Nigeria. Again, mothers living in the five regions besides

the North West are more likely to experience their child's survival independent of other personal, household, contextual, and birth event variables.

The sex of the respondent's last child and their status as a twin or triplet were also identified in this model as statistically significant indicators of child mortality. Mothers who gave birth to female children were statistically more likely to experience their daughter's survival to age 5 than mothers who birthed sons. Status as a twin or triplet greatly disadvantaged children and mothers whose last child was a twin or triplet were more likely to experience under-5 mortality.

**Table 4.11 Binary Logistic Regression Model 2**

| Binary Logistic Regression Model 2 | | | | | |
|---|---|---|---|---|---|
| | B | SE | df | Sig. | Odds Ratio |
| **Ethnicity** | | | | | |
| Igbo | -.150 | .286 | 1 | .600 | .861 |
| Yoruba | -.049 | .219 | 1 | .824 | .952 |
| Other | .062 | .123 | 1 | .613 | 1.064 |
| **Literacy** | | | | | |
| Some literacy | .302 | .152 | 1 | **.047** | 1.353 |
| Full literacy | .312 | .113 | 1 | **.006** | 1.367 |
| **Wealth** | | | | | |
| Poorer | -.116 | .092 | 1 | .208 | .890 |
| Middle | .126 | .119 | 1 | .290 | 1.134 |
| Richer | -.060 | .140 | 1 | .666 | .941 |
| Richest | .159 | .182 | 1 | .382 | 1.172 |
| **Household religion** | | | | | |
| Christian | -.224 | .124 | 1 | .071 | .800 |
| Traditional/Other | .020 | .327 | 1 | .951 | 1.020 |
| **Urban Residence** | .288 | .101 | 1 | **.004** | 1.333 |
| **Health Decision Making** | | | | | |
| Respondent Alone | -.012 | .164 | 1 | .941 | .988 |
| Respondent and Husband | .151 | .088 | 1 | .085 | 1.163 |
| **Region** | | | | | |
| North Central | .300 | .151 | 1 | **.047** | 1.350 |
| North East | .035 | .108 | 1 | .745 | 1.036 |
| South East | .110 | .301 | 1 | .714 | 1.116 |
| South South | .285 | .184 | 1 | .122 | 1.329 |
| South West | .400 | .215 | 1 | .062 | 1.492 |
| **Respondent Age** | -.016 | .011 | 1 | .146 | .984 |
| **Age at first birth** | .016 | .013 | 1 | .231 | 1.016 |
| **Not Married** | -.089 | .220 | 1 | .685 | .915 |
| **Not Employed** | .062 | .078 | 1 | .424 | 1.064 |
| **Number of Antenatal Visits** | -.008 | .009 | 1 | .376 | .992 |
| **Some prenatal care** | .070 | .097 | 1 | .474 | 1.072 |
| **Delivered at Hospital** | -.001 | .098 | 1 | .992 | .999 |
| **Female Child** | .225 | .068 | 1 | **.001** | 1.252 |
| **Birth Order** | .004 | .029 | 1 | .881 | 1.004 |
| **Child is a twin/triplet** | -1.397 | .153 | 1 | **.000** | .247 |
| Nagelkerke R Square = .031 | | | | | |

# Spatial Analyses Results

## Spatial Autocorrelation

Table 4.12 Spatial Autocorrelation Results

| Univariate Moran's I Spatial Autocorrelation | | |
|---|---|---|
| | Moran's I | pseudo p-value |
| **Child Mortality Rate** | 0.118946 | 0.069 |
| **Ethnicity** | | |
| Hausa/Fulani | 0.793569 | 0.001 |
| Igbo | 0.513988 | 0.001 |
| Yoruba | 0.830005 | 0.001 |
| Other | 0.405416 | 0.001 |
| | | |
| **Literacy** | | |
| (0) No literacy | 0.788373 | 0.001 |
| (1) Some literacy | 0.29456 | 0.004 |
| (2) Full literacy | 0.766794 | 0.001 |
| | | |
| **Health Decision Making** | | |
| Respondent Alone | 0.402763 | 0.002 |
| Respondent and Husband | 0.564381 | 0.001 |
| Husband Alone | 0.633072 | 0.001 |
| | | |
| **Wealth** | | |
| (1) Poorest | 0.7782 | 0.001 |
| (2) Poorer | 0.616558 | 0.001 |
| (3) Middle | 0.261723 | 0.007 |
| (4) Richer | 0.650387 | 0.001 |
| (5) Richest | 0.444402 | 0.001 |
| | | |
| **Household religion** | | |
| Christian | 0.80465 | 0.001 |
| Muslim | 0.798767 | 0.001 |
| Traditional/Other | 0.146207 | 0.062 |
| | | |
| **Residence type** | | |
| Urban | 0.381588 | 0.001 |
| Rural | 0.381588 | 0.001 |

The following section contains the results of the spatial autocorrelation analyses conducted through GeoDa. The Moran's I values and pseudo-significance levels of all variables of interest are reported in table 4.12. Moran's I values between 0.1 -0.3 indicate weak spatial autocorrelation (clustering[7]). Values between 0.4 – 0.6 indicate moderate spatial autocorrelation, and values above 0.7 are considered strong Moran's I indicators of spatial autocorrelation. Significant spatial autocorrelations are illustrated through cluster maps which help

[7] Negative Moran's I values indicate dispersion rather than clustering.

visualize the patterns of clustering identified through the univariate spatial autocorrelation analyses. Areas of dark red signify states that contain high values and are also surrounded by states with high values. Light blue states indicate those with low values that are surrounded by high values; light red areas represent those containing high values but that are surrounded by states with low values.

### *Child Mortality*

The spatial analyses results for this measure of under-5 mortality yielded weak positive spatial autocorrelation results. Although the chosen measure is quite specific and relates to only the under-5 mortality rate of respondents' last birth, the spatial autocorrelation analysis still identified areas of significant clustering of high and low values of under-5 mortality rate.[8] Table 4.13 provides information about last child under-5 mortality rate by region and state; the South East state of Ebonyi has the highest rate of the chosen child mortality indicator. However, the state identified in the cluster map in figure 4.1 with a spatially dependent high value of this child health indicator is Sokoto, which is in the North West region. States with low

**Table 4.13 Under-5 Mortality by Region and State**

| | Last Child Under-5 Mortality Rate |
|---|---|
| **North Central** | **47.99** |
| Niger | 25.34 |
| FCT-Abuja | 43.34 |
| Kogi | 46.15 |
| Kwara | 49.66 |
| Plateau | 52.39 |
| Nasarawa | 56.07 |
| Benue | 62.97 |
| | |
| **North East** | **57.25** |
| Borno | 25.57 |
| Yobe | 40.37 |
| Adamawa | 56.38 |
| Taraba | 59.46 |
| Bauchi | 80.43 |
| Gombe | 81.28 |
| | |
| **North West** | **68.19** |
| Kaduna | 43.62 |
| Katsina | 48.42 |
| Sokoto | 65.16 |
| Kano | 66.62 |
| Zamfara | 84.44 |
| Kebbi | 84.45 |
| Jigawa | 84.61 |
| | |
| **South East** | **63.38** |
| Abia | 47.78 |
| Enugu | 54.91 |
| Anambra | 57.24 |
| Imo | 58.82 |
| Ebonyi | 98.13 |
| | |
| **South South** | **50.80** |
| Edo | 29.97 |
| Rivers | 45.98 |
| Cross River | 45.98 |
| Delta | 54.76 |
| Akwa Ibom | 60.27 |
| Bayelsa | 67.86 |
| | |
| **South West** | **40.18** |
| Osun | 19.07 |
| Oyo | 31.39 |
| Ogun | 38.46 |
| Ekiti | 44.64 |
| Lagos | 51.58 |
| Ondo | 55.96 |

[8] Additionally, some clusters were not sampled in the North West and North East regions, which contributes to comparative analyses results and interpretation.

values of this indicator are located primarily in the South West regions.

Although the clustering of under-5mortality rate has a weak statistical significance, table 4.13 displays the numerical disparities in the collected under-5 mortality rate from the dataset of analysis. The North West has the highest last child under-5 mortality rate of 68 deaths per 1,000 live births; the region with the lowest last child under-5 mortality rate is the South West with a rate of 40 deaths per 1,000 live births.

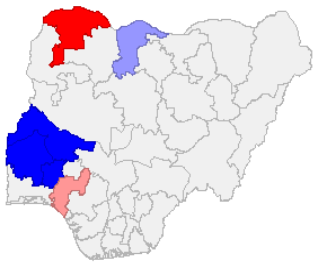


**Figure 4.1 Child Mortality Spatial Autocorrelation Map**

***Personal Indicator Maps***

The spatial autocorrelation maps of the three largest ethnic groups – Hausa/Fulani, Igbo, and Yoruba – indicate patterns of ethnic distribution in this sample that are representative of the true distribution of these groups in Nigeria. Table 4.12 displays the Moran's I values of the spatial autocorrelation analyses; all personal indicators yielded positive spatial autocorrelation results. The personal level indicators analyzed through spatial autocorrelation also resulted significant pseudo p-values, indicating that the spatial patterns are statistically significant.

The indicators of Hausa/Fulani, Yoruba, no literacy, and full literacy resulted very strong positive Moran's I values all above 0.7. Moderate positive spatial autocorrelation, with Moran's I values between 0.3 – 0.7, was identified in the personal variables of Igbo, and other ethnic group; and the indicator of some literacy resulted weak positive spatial autocorrelation. Although there is a range of weak to strong spatial autocorrelation among these personal level indicators of child health, the statistical results indicate that in Nigeria, states and their associated population percentages of ethnicity and literacy are clustered in space.

States represented as blue represent areas with low values surrounded by other states with low values. Significant clusters of large Hausa/Fulani populations reside in the northeastern region and parts of the northwest region, whereas states with low percentages of Hausa and Fulani women are located in parts of the southwestern region and most of the Southeast and South South regions. Conversely, states with high populations of Igbo respondents were located in the Southeastern geopolitical zone, which is also comparable with this group's actual distribution within Nigeria. Clusters of states with significantly low percentages of Igbo respondents were found in the northeastern states. States with low percentages of Yoruba mothers were also located in the northeastern region and a small part of the South South zone. States with high levels of Yoruba respondents were found in the southwestern region.

Spatial autocorrelation cluster maps concerning literacy highlight the regional differences. States that reported high percentages of illiterate respondents and are surrounded by states with high percentages of illiteracy are located in the northern regions. Oppositely, states with low percentages of illiterate respondents are located in the southwestern, southeastern, and South South regions, and parts of the northcentral geopolitical region. Areas with high percentages of literate respondents were located in these same states.

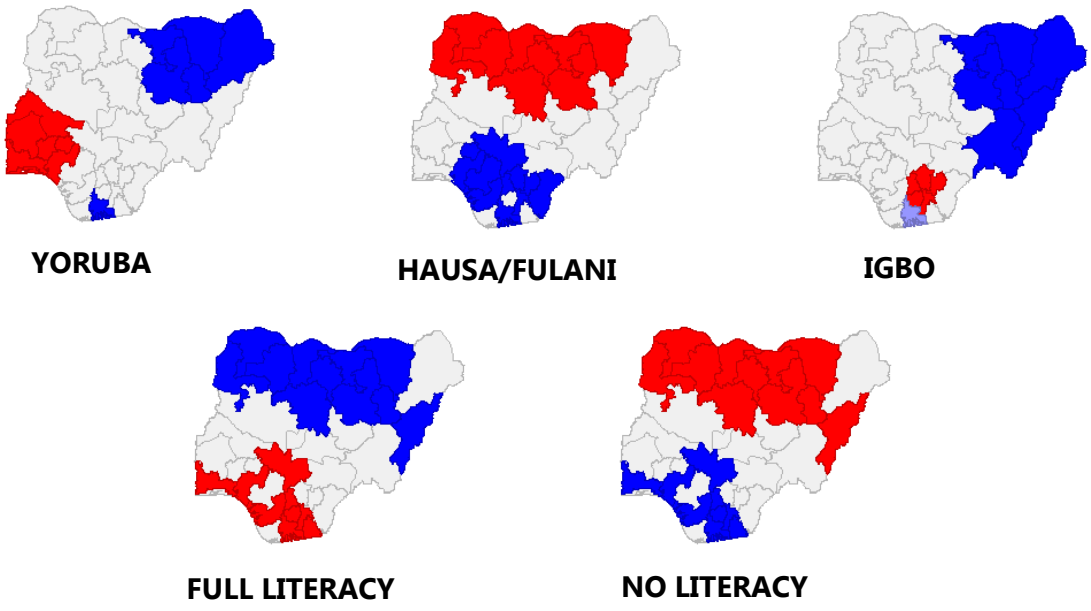



**Figure 4.2 Personal Indicator Spatial Autocorrelation Maps**

***Household and Contextual Indicator Maps***

The spatial autocorrelation maps relating to wealth demonstrate opposite distributions of poverty and wealth in Nigeria. Where the North West and North East regions contain high values of poor states, those states with clusters of the richest households are located in the southern regions, although there are only three states that yielded significant high-high value results. The Moran's I values relating to wealth were all significant where $p = 0.05$; the lowest category of wealth produced the highest positive Moran's I value of 0.78, followed by the "richer" category with 0.65. These high values of spatial autocorrelation connote that the distribution of household wealth in Nigeria is clustered.

Similarly, the cluster maps and Moran's I values of health decision-making indicate the moderate positive spatial autocorrelation associated with these values within the aggregated dataset. Husband alone health-decision making resulted a Moran's I of 0.63, the highest value within the variable. The maps show that state clusters of more husband-decision making power are located in northeastern and northwestern states and states with low values are located across the three southern regions.

Although the indicator of traditional religion resulted the only non-significant Moran's I value within the household level variables, the other two values concerning religion – Christian and Muslim – are very high. Spatial autocorrelation analyses for both religions yielded values above 0.79. As with ethnicity, the pattern identified in the cluster maps are representative of the historic demographic spatial distribution of religion in Nigeria. Large state clusters of Muslims reside in the north and are absent in the south; and the converse it true for Christians. State clusters of Christian households are located in the South East, South South, and parts of the South West geopolitical zones and absent in the northern regions.

The only contextual variable I analyzed through spatial autocorrelation was residence type. Measures of spatial autocorrelation for residence type indicated a moderate spatial autocorrelation Moran's I value of 0.38 for both urban and rural indicators. Unlike the other personal and household variables, the pattern in the maps displaying state-level residence type clusters is not split by north and south division. Rather, the areas where clusters are identified are the North Central region and the South West. Clusters of rural residences were found in the central states and clusters of urban residences identified in the South West.

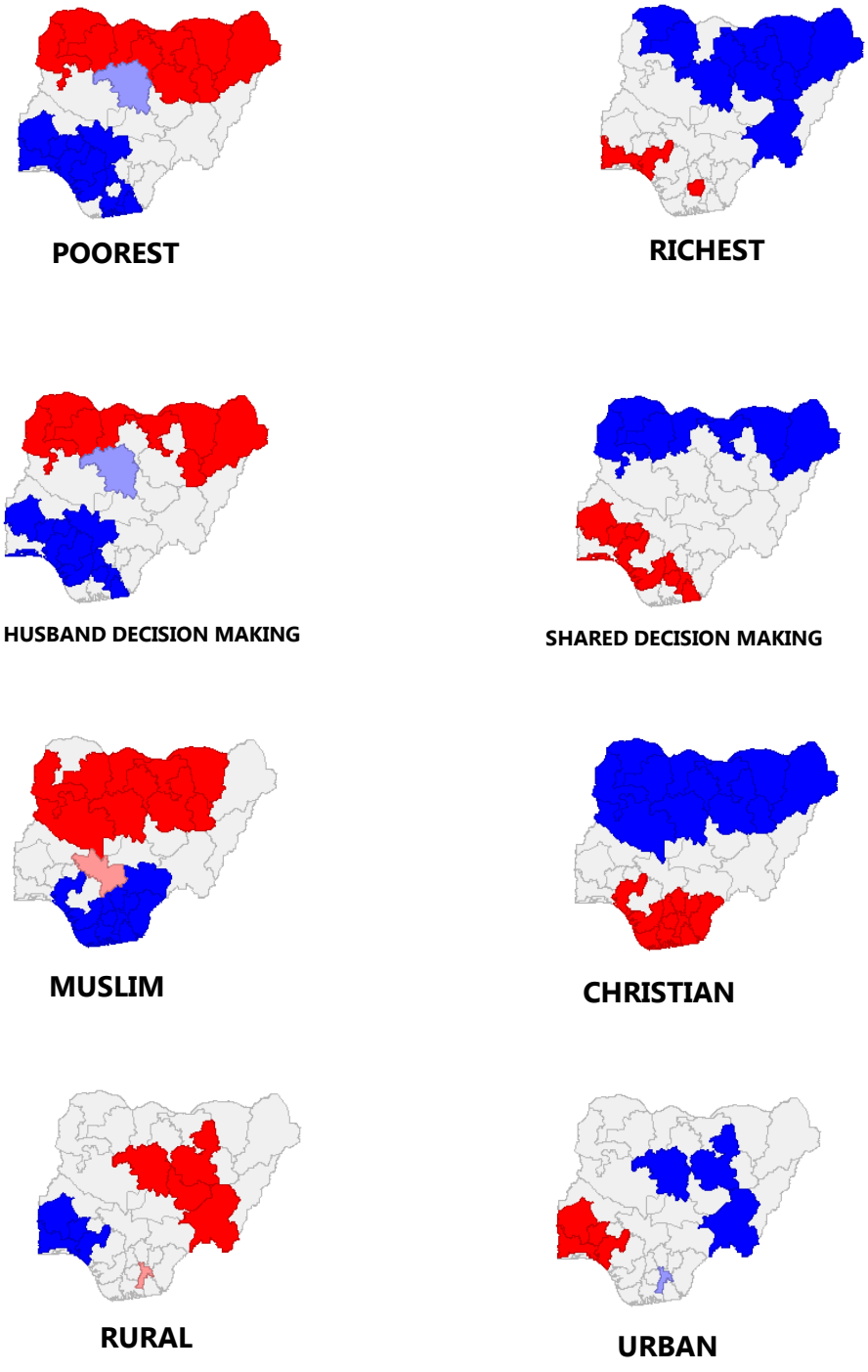



Figure 4.3 Household and Contextual Indicator Spatial Autocorrelation Maps

## Spatial Lag Regression

The previous section proves that both the dependent variable and independent variables that I am analyzing are spatially autocorrelated. The moderate to strong levels of spatial dependence indicated through Moran's I values undermine the assumption of independent distribution that is associated with normal OLS regression. Therefore, a regression analyses conducted with a spatial lag variable provides coefficients for the independent variables that can be interpreted more appropriately than in a regular statistical OLS regression.

As with the statistical analyses of the individual level data, two models of spatial lag regression were used to analyze the state-level data. The first model includes only the indicators of interest, and totals 16 variables when including the spatial dependence variable and constant. The second model is included for parallelism between statistical and spatial analyses, but it should be noted that the addition of 10 variables can influence resulting coefficients and significant values, particularly for this sample which has an N of 37.

### *Spatial Lag Regression Model 1*

Table 4.14 reports the results of the first model of spatial lag regression performed at the state level. The average last child under-5 mortality rate by state for this NDHS 2013 subset is 54.58 deaths per 1,000 live births. The $R^2$ value indicates a high goodness-of-fit for this model; the chosen independent variables account for 70% of the variation in the outcome variable of last child under-5 mortality.

Coefficients resulted by this method of spatial analyses indicate the direction of relationships between the independent variables and the dependent variable, conditioning on the spatial dependence variable created through queens first order contiguity-based weight matrix.. The coefficient values cannot be interpreted in the same way as regular OLS regression because of the influence of the spatial lag variable; however, the direction of the coefficients indicates the direction of the relationship between the

independent and outcome variables. The variables of interest with positive coefficients are: some literacy, Christian household, traditionalist religion household, and respondent alone health decision-making power. Therefore, as the percentages of these populations increase, so does the rate of this indicator of under-5 mortality. Variables with negative coefficients are Igbo, Yoruba, other ethnicity, full literacy, middle wealth, Christian household, urban residence type, and lastly respondent and husband health decision-making power. As the percentages of women within these categories increases, under-5 mortality decreases.

Through the use of a spatial weights matrix employing queen's contiguity, the analyses indicates which variables are statistically significant indicators of child mortality when accounting for spatial

**Table 4.14 Spatial Lag Regression Model 1**

| Spatial Lag Regression Model 1 | | | |
|---|---|---|---|
| | Coefficient | SE | *p* |
| **Spatial Lag Variable** | -0.711 | 0.200 | **0.000** |
| **Constant** | 129.379 | 24.163 | 0.000 |
| **Ethnicity** | | | |
| Igbo | -0.092 | 0.162 | 0.571 |
| Yoruba | -0.365 | 0.156 | **0.019** |
| Other | -0.232 | 0.116 | **0.045** |
| **Literacy** | | | |
| Some literacy | 0.700 | 0.675 | 0.299 |
| Full literacy | -0.020 | 0.351 | 0.954 |
| **Wealth** | | | |
| Poorer | -0.096 | 0.468 | 0.838 |
| Middle | -0.321 | 0.289 | 0.267 |
| Richer | -0.560 | 0.424 | 0.187 |
| Richest | -0.316 | 0.366 | 0.388 |
| **Household religion** | | | |
| Christian | 0.221 | 0.169 | 0.192 |
| Traditional/Other | 0.893 | 1.798 | 0.619 |
| **Urban Residence** | -0.043 | 0.145 | 0.765 |
| **Health Decision Making** | | | |
| Respondent Alone | 0.776 | 0.522 | 0.137 |
| Respondent and Husband | -0.327 | 0.140 | **0.019** |
| R Squared = 0.706 | | | |
| Spatial Weight: Queen's Continguity | | | |
| Mean dependent variable: 54.58 | | | |
| SD dependent variable: 17.86 | | | |

dependence. The model identifies the spatial lag variable and ethnicity as statistically significant indicators of last birth under-5 mortality in Nigeria, where $p$= 0.05.

### *Spatial Lag Regression Model 2*

My second spatial lag regression model includes the control variables also used for the individual-level analyses. As indicated above, the addition of control variables to the first spatial regression model is included for general interest to parallel the statistical analyses. The results of this model are expected to be weaker than the first spatial model because of the low N (37) and the high number of variables (26). For those reasons, the results of the first spatial regression are interpreted in the discussion section rather than this one.

The addition of 10 variables impacts the significance of the indicators, most notably the spatial lag variable that measures spatial dependence between the states. In the

**Table 4.15 Spatial Lag Regression Model 2**

| Spatial Lag Regression Model 2 | | | |
|---|---|---|---|
| | Coefficient | SE | *p* |
| **Spatial Lag Variable** | -0.254 | 0.216 | 0.240 |
| **Constant** | 282.294 | 109.305 | 0.009 |
| **Ethnicity** | | | |
| Igbo | -0.019 | 0.199 | 0.926 |
| Yoruba | -0.224 | 0.177 | 0.205 |
| Other | -0.111 | 0.151 | 0.460 |
| **Literacy** | | | |
| Some literacy | 1.986 | 0.854 | **0.020** |
| Full literacy | -0.035 | 0.502 | 0.945 |
| **Wealth** | | | |
| Poorer | 0.665 | 0.613 | 0.278 |
| Middle | -0.236 | 0.351 | 0.502 |
| Richer | 0.465 | 0.519 | 0.371 |
| Richest | 0.733 | 0.434 | 0.091 |
| **Household religion** | | | |
| Christian | -0.111 | 0.242 | 0.646 |
| Traditional/Other | 4.510 | 2.388 | 0.059 |
| **Urban Residence** | -0.033 | 0.128 | 0.796 |
| **Health Decision Making** | | | |
| Respondent Alone | 1.648 | 0.630 | **0.009** |
| Respondent and Husband | -0.033 | 0.165 | 0.051 |
| **Respondent Age** | -15.481 | 4.446 | **0.001** |
| **Age at first birth** | 4.413 | 4.452 | 0.322 |
| **Not Married** | -1.025 | 0.428 | **0.017** |
| **Not Employed** | 0.025 | 0.240 | 0.917 |
| **Number of Antenatal Visits** | 1.290 | 1.458 | 0.376 |
| **Some prenatal care** | 0.014 | 0.257 | 0.958 |
| **Delivered at Hospital** | 0.170 | 0.294 | 0.563 |
| **Female Child** | 0.966 | 1.598 | 0.546 |
| **Birth Order** | 36.266 | 10.680 | **0.001** |
| **Child is a twin/triplet** | -1.691 | 3.418 | 0.621 |
| R Squared = 0.802 | | | |
| Spatial Weight: Queen's Continguity | | | |
| Mean dependent variable: 54.58 | | | |
| SD dependent variable: 17.86 | | | |

second model, the spatial lag variable is no longer significant. The addition of the control variables also affects the direction of the relationship between wealth and this indicator of child mortality. In the first model, all categories within the wealth index have negative coefficients, but in the second model, only the middle category yielded a negative coefficient. These results indicate a non-linear relationship between wealth and under-5 mortality which is not expected, but aligns with the binary logistic regression results of the individual-level data.

A part from the categories of wealth, the variables of interest in this model with positive coefficients are: some literacy, respondent health decision-making power, and traditionalist household. This denotes that as the percentage of partial literacy, respondent alone health-decision making, and traditionalist households increases at a state level, so does the under-5 mortality rate within that state. All categories of ethnicity, full literacy, urban residence type, Christian household, and shared health decision-making power all yielded negative coefficients indicating a negative correlation between these variables and child mortality.

# Chapter 5

# Discussion

## Individual Level Results

For the individual-level results, bivariate analyses provided useful information about the distribution of personal, household, and contextual variables across Nigeria. Except for religion, all of the other variables of interest – literacy, ethnicity, household wealth, and residence type – were significantly dependent on the chosen indicator of child mortality.

Multivariate analyses of the individual-level data revealed information useful for understanding the distribution of child mortality disparities in Nigeria. Compared to the largest ethnic group in the

country – the Hausa/Fulani, who live primarily in northern regions as proven by spatial analyses– mothers who are Igbo and Yoruba are less likely to experience child mortality than Hausa mothers, and mothers who belong to the multitude of other ethnicities in the country are more likely to experience child mortality. The fact that Hausa mothers are more likely to experience child mortality aligns with findings associated with other variables, such as religion. Most Hausa/Fulani mothers live in a Muslim household, and the regression indicates that Muslim mothers are more likely to experience child mortality than both Christian and traditionalist mothers. Although neither ethnicity nor religion resulted significant coefficients within the individual-level regression models, the similarities between their ORs is most likely connected to the similarity in distribution between religion and ethnicity in Nigeria. Like ethnicity and religion, health decision making did not significantly contribute to the multivariate analyses. That being said, compared to mothers who do not have decision-making power related to healthcare, mothers who share health decision-making power are less likely to experience child mortality. Decision making power related to health is an important indicator of female autonomy within the household. As the literature suggests, autonomous mothers have better outcomes for their children. However, this research found that mothers who make healthcare decisions alone are statistically more likely to experience their child's death than are mothers not involved in decision-making. It is more likely that women who make health-related decisions solely are the head of their household because they are unwed, divorced, or widowed; female-headed households face social and economic disadvantage, especially in a developing nation like Nigeria. It is possible that the results of my analyses are picking up the effects of mediating variables, for example household wealth.

In the bivariate analyses between wealth and the chosen indicator of child mortality, the distribution of wealth does not present as linearly as would be expected. Still, the regression models revealed that mothers in the richest households and those in the "middle" category of wealth were more likely to experience their child's survival than mothers in the poorest category. Strangely, the results indicated that mothers in the "poorer" and "richer" category are actually more likely to experience child

mortality than mothers in the poorest category. It is not clear why the relationship between wealth and this indicator of child mortality is not linear, but the fact that mothers with more wealth generally experience better child health outcomes is still supported by these results.

The findings relating to contextual indicators of child health are connected to the personal and household level indicators. Mothers in all five geopolitical regions were less likely to experience under-5 mortality than mothers in the northwest, significantly so when compared to the North Central region. This aligns with the results that indicate Hausa/Fulani and Muslim mothers experience higher rates of child mortality because Hausa and Fulani women predominantly populate the northwest region.

Both individual-level regression models indicate that children with mothers in urban residences are significantly less likely to experience under-5 mortality than those with rural mothers. This finding, which is supported by the literature, is particularly important because urban and rural distinctions are not just regional or even state-level indicators, rather they are relevant at district and city levels of analysis. The finding that urban mothers are less likely to experience child mortality could be because mothers in urban areas have more access to health infrastructure resources as well as social indicators of child health such as education and employment. In Nigeria, areas of high education and high wealth are concentrated in urban areas. As suggested by the literature, even if mothers have status in categories that increase their likelihood of experiencing under-5 mortality, the influence of being around women who are educated and wealthy can have a positive effect on their children's health outcomes. On the individual level, the impact of urban residence on child mortality outcomes is more significant than the indicators of ethnicity, wealth, religion, decision-making, and region, but it is not more significant than the influence of literacy.

Mothers who are partially or fully literate have higher odds off child survival than do mothers who are completely illiterate; and mothers who are fully literate have significantly higher odds of child survival an illiterate mothers. While this finding is not particularly surprising, it is substantial because of the high percentage of illiterate mothers in this sample, and in Nigeria. Nearly 60% of mothers in the

sample were illiterate, which disadvantages them and their children; in many regions in Nigeria, particularly the norths, levels of illiteracy nearly reach 100%.

The spatial analyses conducted offered visualization of clusters of personal, household, and contextual determinants of child health in Nigeria. Spatial autocorrelation and spatial lag regression provided statistical values that indicate significant clustering of negative child health indicators in the northern geopolitical zones and better distributions of positive indicators of child health in the southern regions.

The first spatial lag model included fewer variables, but points to the conclusion that under-5 mortality rate is spatially dependent on a state-level in Nigeria.

The inherent connections that I have made between the spatial distributions of ethnicity, religion, and wealth are important (and will be discussed further in the next section), but the regression models help identify which indicators are actually statistically significant in relation to this important measure of national health. As one of the most significant indicators in both multivariate analyses models of individual-level data, maternal education has proven itself as an important element of improving health outcomes for Nigeria's children. Residence type also stands out as particularly significant in multivariate analyses. Both of these finding align with analyses of child mortality in Nigeria that date back almost 40 years. Increasing the quantity and quality of female education and prioritizing rural development will

## Regional, State, and Cluster Level Results

The spatial autocorrelation maps in the previous chapter display the visual pattern of statistically significant spatial autocorrelation results. Patterns of ethnicity and household religion reflect national distributions as expected – significant clusters of high percentages of Hausa/Fulani and Muslim respondents in the northern regions and clusters of high percentages of Igbo and Yoruba mothers in the southern regions – and even the pattern of urban-rural distinctions are indicative of population patterns

within Nigeria. The central region contained the most states with significant clusters of high rural populations surrounding one another; as the central region is the least developed and most sparsely populated area of the country compared to the north and south, the results of the spatial autocorrelation appear sensible. The demographic patterns of the individual level analyses coupled with the state level data indicate that this sample is nationally representative of Nigerian mothers.

The interesting stories resulted from the spatial autocorrelation analyses are the patterns of literacy, health decision making, and wealth. Together, the maps show that mothers in northern regions are in general more disadvantaged in health outcomes than mothers in the southern region. States within the central region of the country often yielded insignificant spatial autocorrelation results for personal and household indicators, perhaps attributable to a transition effect between the southern and regions.

The literacy cluster maps essentially show opposite patterns of literacy in the country and indicate that in Nigeria, mothers who live in northern states are disadvantaged and more likely to be illiterate than mothers living in southern regions. A similar pattern is repeated for the indicators of health decision-making power and wealth; positive determinants of child health – non-inclusive decision-making power and poverty – clustered in northern states with more clusters of the opposite positive determinants in southern regions. Strong to moderate positive Moran's I values of literacy, decision-making, and wealth connote the significance of spatial dependence on regional divisions, and the results of the spatial lag regression affirm the importance of these three variables in child health outcomes.

The differences in educational, economic, and health are patterned, but the outcomes are distributed differently in southern regions than in the north. Where most states of the North East and North West have clustered values of education, wealth, and decision-making, the distributions of these variables does not repeatedly cluster in the same states. The South West geopolitical zone has more clusters of wealthy households than do the South South and South East zones, while clusters with high values fully literate mothers are distributed more evenly across the general southern area. The high Moran's I values – particularly for literacy and husband health-decision making – and the visual patterns

displayed in the cluster maps regarding these variables signify that women living in southern regions are prone to better health outcomes than mothers in the north. The advantages of literacy, decision-making power, and wealth are more beneficial on child health outcomes for Yoruba and Igbo mothers because they are located in the south.

State clusters with high percentages of mothers with no literacy, no decision-making power related the health, and of respondents living in the poorest category of households were all located in northern regions. The univariate spatial autocorrelation analyses identified the northeastern and northwestern states of Sokoto, Kebbi, Zamfara, Katsina, Jigawa, Yobe, and Gombe as areas with and surrounded by significant populations of all three negative determinants of child health – mothers who are illiterate, rely on their husband for health decision making, and live in very poor households. Mothers living in these states are more likely to be disadvantaged educationally and economically, which therefore disadvantages their children and increases their chances of experiencing a child death, very possibly due to a preventable disease. As these areas are predominantly populated by Hausa and Fulani mothers, these women are inherently disadvantaged simply because of where they are located within Nigeria's borders.

The individual-level statistical results of my research suggest that promoting maternal education and rural development will benefit Nigerian mothers and increase health outcomes, and the spatial regression results indicate that measure of female autonomy are also important. The literature pertaining to social determinants and health often connects female autonomy with maternal education. Therefore, in order to combat areas with very high levels of under-5 mortality, Nigeria should allocate resources to prioritizing female education across the country, but particularly in areas where rural development and female education is are low. The states where these issues need to be addressed most urgently are predominantly in northern regions. Doing so will particularly benefit Hausa/Fulani women and hopefully positively influence the disparaging child health outcomes across the country.

## Limitations and Suggestions for Future Research

Many of the NDHS 2013 variables that were chosen as controls relating to the birth event were only asked of the last birth; for that reason, my chosen indicator of child mortality only includes the respondent's last birth event and child mortality rates aggregated to the state level are lower than other estimates based on NDHS 2013. The specificity of the indicator to the last birth also impacted the measures of spatial autocorrelation; a univariate spatial autocorrelation measure of under-5 mortality as provided by NDHS 2013 full sample would most likely yield a higher and more significant positive Moran's I value.

In the future, this research could be expanded in a couple ways. A district-level spatial analysis would allow more insight into the influence of urban-rural distinctions on child health in Nigeria[9], and be useful to local governments for identifying areas to increase social, economic, or health services for mothers. A more in-depth spatial analysis using methods such as geographically weighted regression and spatial regimes models could identify differences between locally-weighted and globally-weighted regression coefficients and provide more detail about the function of spatial heterogeneity across Nigeria when evaluated against personal, household, contextual, and health variables. Additionally, because district-level analyses would have a much larger sample size than state-level, more variables of analysis or control variables could be analyzed appropriately. Because results concerning the "other" ethnicity group were not as easily interpretable on a national scale, an exploration of this research question that examines more than just the three main ethnic groups in Nigeria could also provide more detail for understanding which groups are disadvantaged because of their geographic region.

[9] As it is, the DHS program does not provide district level information that is able to be geocoded by researchers; this is to allow for the privacy of DHS survey respondents because district sizes vary across the many developing nations where DHS surveys are conducted and in certain areas a district level analyses might cause privacy concerns. However, district level information is available from other gazetteer services may be used to join DHS and GPS data for analysis.

# Chapter 6

## Conclusion

Spatial analyses revealed the distinct patterns of ethnic, religious, educational, and wealth distributions that I hoped to find and expected to observe. Bivariate analyses confirms their statistical dependence on child mortality, but two methods of multivariate regression identify only literacy, health decision making, and residence type as significant determinants of child mortality. While the pattern of last child under-5 mortality across Nigeria was not as statistically significant as I had expected, spatial autocorrelation measures still identified high and low value clusters for this specific measure of child health. As expected, negative correlations are associated with last child under-5 mortality and the independent variables of maternal education and wealth.

The aim of this research was to gain a large-scale understanding of regional disparities in child mortality, literacy, ethnicity, household wealth, household religion, health decision-making power, and residence type. I began by exploring national data and worked to understand these disparities by examining six regional zones then 37 states including FCT-Abuja. In the end however, the data revealed regional and state-level patterns of personal, household, contextual, and health variables that can best be described by three main divisions.

Mothers living in the southern, central, and northern regions of Nigeria report disparaging levels of education, wealth, and health decision-making power because access to the resources that affect child health outcomes is prominently unequal. The historical geographic division of the three largest ethnic groups in Nigeria coupled with the regional disparities disadvantage certain ethnic groups over others.

Bivariate analyses indicate that all indicator values of literacy, ethnicity, wealth, health-decision making, residence type, and region are all significantly statistically dependent on under-5 mortality; these personal, household, and contextual level indicators are influential in the lives of Nigerian mothers and children. Hausa and Fulani mothers living in northern zones face significant social and economic resource

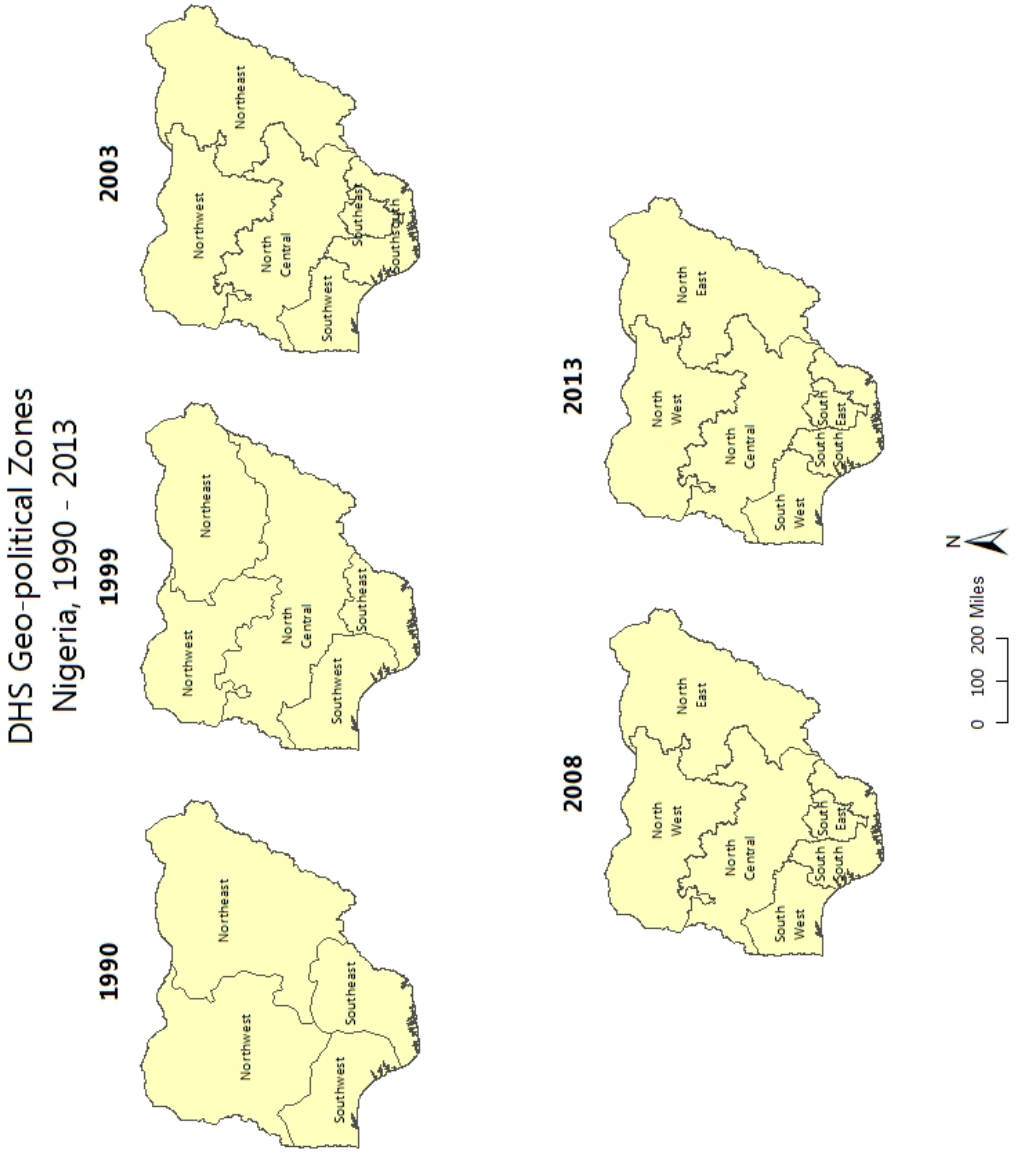
inequalities that can contribute to child mortality in Nigeria and disadvantage them in comparison to Yoruba and Igbo mothers living in the south. The significant inequalities highlighted by both statistical and spatial multivariate analyses are in maternal education, health decision-making power, and residence type. Mothers who are literate, share decision-making power with their spouse, and live in urban areas are less likely to experience child mortality; the implications of the spatial autocorrelation is that these mothers are also more likely to be located in the southern regions, reside in Christian households and be of Yoruba or Igbo ethnicity.

Identifying regions and states where children face disadvantage because of the personal, household, and contextual influences around them is a useful contribution to regional Nigerian demographics. This research contributes to the understanding of demographic patterns in Nigeria; not just the patterns of ethnicity and religion which have been tied to geographic region for centuries, but also the demographic patterns of inherently sociological indicators such as maternal education and female autonomy. The geographic patterns of these social determinants and the extent of their spatial dependence are imperative to understand because of their implications for child health outcomes.

As Nigeria endeavors to continue economic growth and development, this sub-Saharan African nation will need to address the important health issues that are negatively impacting the lives of Nigeria's families and inhibiting movement through the demographic stages of development. Nigeria has the potential to overcome the high levels of child mortality, and with a better understanding of child health determinants and their spatial distributions, the country can hopefully increase deficient social, economic, and health resources. The country's federal and state governments must prioritize female education and rural development, particularly in the North East and North West geopolitical zones, in order to create better health outcomes for future generations of Nigerian children.

# Appendix A

## Changes in NDHS Geopolitical Zone 1990 – 2013



## Appendix B

## Definitions of Infant and Child Mortality Indicators

"Infant and child mortality rates are also basic indicators of a country's socioeconomic situation and quality of life (UNDP, 2007). Estimates of childhood mortality are based on information collected in the birth history section of the questionnaire administered to individual women. The section begins with questions about the aggregate childbearing experience of respondents (i.e., the number of sons and daughters who live with their mother, the number who live elsewhere, and the number who have died). The rates are estimated directly from the birth history information on the child's birth date, survivorship status, and the age at death for children who died. This information is used to directly estimate the following five mortality rates:

Neonatal mortality: the probability of dying within the first month of life

Post-neonatal mortality: the difference between infant and neonatal mortality

Infant mortality: the probability of dying before the first birthday

Child mortality: the probability of dying between the first and fifth birthday

Under-5 mortality: the probability of dying between birth and the fifth birthday

All rates are expressed per 1,000 live births, except for child mortality, which is expressed per 1,000 children surviving to 12 months of age" (Nigeria Demographic and Health Survey, 2013, p. 18)

## Appendix C

## Total NDHS 2013 Sample Top 10 Ethnic Groups

The top 10 ethnic groups by frequency are listed in ascending count order from the smallest to largest. Counts and percentages represent the entire NDHS 2013 sample.

| Ethnicity | Count | Percent |
|---|---|---|
| Annang | 263 | 0.7 |
| Kanuri/Beriberi | 523 | 1.3 |
| Nupe | 533 | 1.4 |
| Urhobo | 582 | 1.5 |
| Tiv | 621 | 1.6 |
| Ibibio | 849 | 2.2 |
| Ijaw/Izon | 1590 | 4.1 |
| Igbo/Ibo | 5448 | 14 |
| Yoruba | 5606 | 14.4 |
| Hausa/Fulani | 11811 | 30.3 |
| Total | 38887 | 99.8 |

# Appendix D

## Bivariate Analyses Tables

**Wealth and Source of Drinking Water One-way ANOVA**

Wealth index

| | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Between Groups | 4688.773 | 3 | 1562.924 | 933.811 | 0.000 |
| Within Groups | 32305.856 | 19302 | 1.674 | | |
| Total | 36994.629 | 19305 | | | |

**Spouse's Educational Attainment and Wealth**

| | Educational Attainment | Husband's Education |
|---|---|---|
| Wealth | 1 | 0.583*** |
| Husband's Education | | 1 |

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