Underlying and State-level Contextual Determinants of Early Childhood Mortality in Nigeria

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Abstract

Early childhood mortality has remained stubbornly high in Nigeria, even compared with other sub-Saharan African countries. Tragically, one in every eight children in Nigeria die before their fifth birthday and more than half of those deaths are from preventable causes. Nigeria's high under-five mortality is indicative of the poor quality of health for the average Nigerian. Sub-national under-five mortality is even more worrisome given the vast differences in survivorship, ranging from a high of 252 deaths per 1,000 live births in Kebbi state (North West) to a low of 30 deaths per 1,000 live births in Ogun state (South West). These sub-national disparities highlight the importance of accounting for the hitherto unexplored impacts of community level background characteristics.

This study conducted an in-depth analysis of the determinants of under-five mortality in Nigeria from 2008 to 2018, focusing on the direct and indirect impacts of community context and socio-economic change. This approach is novel as most studies of under-five mortality in Africa have focused on individual and household factors. Using data from the Nigeria Demographic and Health Survey (NDHS), I examined persistent inequalities in under five-mortality between states and within socio-economic groups. Analyses were carried out in three stages. Trends and patterns of under-five deaths in Nigeria, alongside individual/household level factors associated with it was done using 2008, 2013, and 2018 NDHS. Then data from 2018 NDHS was used to explore child survival function, incidence rates of death, and determinants of under-five mortality using Cox proportional hazards regression. While still focusing on the 2018 NDHS, the study was further extended to a multilevel analysis to investigate the community-level contextual factors associated with under-five mortality in Nigeria using mixed-effects logistics regression and Cox proportional hazards regression with random effects.

The results showed that under-five mortality in Nigeria was persistently high over the focal period. Generally, the hazard rate of death was highest at birth and in the first month of life. The study found that the composition of the community at the individual/household level, together with community level contextual factors were predisposing factors to under-five mortality. Hence, residence in different community context in Nigeria appear to significantly influence variations in under-five mortality between and across communities, geo-political zones, and states. More specifically, the proportion of hospital deliveries and proportion of children fully immunized in the community influenced early childhood survival. Child

survival estimates and incidence of death also confirmed that under-five children in the North East and North West had lower survival probabilities than their counterparts in other geo-political zones. The findings suggest that effective measures to improve early childhood survival should look further than individual and household-level interventions to also address pertinent community contextual factors.

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This thesis is dedicated to my dear mother, and the loving memory of my father.

You laid the right foundation, showed relentless love, and made countless sacrifices for me.

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CHAPTER ONE INTRODUCTION

1.1 Statement of the problem

Early childhood mortality, also referred to as under-five mortality, is a critical indicator of child health, socio-economic development, quality of life and the general health of a population group (National Population Commission Nigeria [NPC] & ICF International, 2019; Van Malderen et al., 2019; Wang et al., 2014). Under-five mortality is a focus of global action, including the Sustainable Development Goals (SGDs), because children face their highest risk of death during this period, particularly in infancy. Early childhood mortality is also linked to fertility and population growth (Preston, 2007), with Rosling (2006) arguing that improving child survivorship reduces fertility and population growth in the long run. Globally, early childhood mortality reduced by 77 percent between 1950 and 2015 (United Nations, 2017). While the European region had the most rapid decline in under-five mortality (93%), improvements have been more muted and patchier in Africa, where under-five mortality reduced by 71 percent, with noticeable variations between countries (United Nations, 2017).

The situation in Nigeria is particularly dire. While some of the least developed African countries have seen remarkable improvements in under-five mortality, Nigeria has worsened in recent years. It now has the world's second highest under-five mortality rate (UN-IGME, 2019). The state of child health in Nigeria cannot be attributed solely to economic factors. Countries such as Rwanda, Liberia, Mali, Sierra Leone, and Niger have less economic endowment and recent civil war experiences have worsened their economic and political situations, yet they fared better than Nigeria in early childhood survival outcomes. Nigeria has a more robust economy, yet early childhood mortality has remained stubbornly intractable over the last decade. Unfortunately, one in every eight children in Nigeria die before their fifth birthday and more than half of those deaths are attributed to conditions that could be prevented or treated with timely access to affordable interventions such as maternal and child health care, proper handling of pregnancy-related complications, childhood vaccination against infectious diseases, and availability of basic amenities (Ezeh, Agho, Dibley, Hall, & Page, 2015; NPC & ICF International, 2019; Ojewumi & Ojewumi, 2012).

Given the extensive research that has been carried out on maternal and child health in Nigeria, coupled with the adoption of the Millennium Development Goals (MDG) and SDGs to meet set targets,[1] one would expect early childhood mortality in Nigeria to have reduced appreciatively in recent decades. However, the 2018 Nigeria Demographic and Health Survey (NDHS) showed that early childhood mortality in the five years preceding the survey increased to 132 deaths per 1,000 live births, up from the 2013 NDHS figure of 128 deaths per 1,000 live births (NPC & ICF International, 2019). This increase is a reversal of previous gains, where under-five mortality in Nigeria reduced from 201 to 157 deaths per 1,000 live births between 2003 and 2008 (NPC & ICF International, 2004, 2009; UNICEF, 2018). The state of child health sub-nationally is even more worrisome given the vast differences in early childhood mortality. In the ten years preceding 2018 NDHS, rates in the six geo-political zones ranged from a low of 62 deaths per 1,000 live births in the South West, to a high of 187 deaths per 1,000 live births in the North West (NPC & ICF International, 2019). Further disaggregation provides an even more granular view of sub-national inequities in childhood survival rates across the 37 states, with a high of 252 deaths per 1,000 live births in Kebbi (North West) to a low of 30 deaths per 1,000 live births in Ogun (South West) (see Figure 1.1).

These marked sub-national disparities in early childhood mortality might hold a clue to better understanding Nigeria's dire situation when it comes to under-five mortality. However, in Nigeria, few studies have systematically examined the impacts of community context on under-five mortality as most studies concentrate on the proximate determinants of early childhood mortality and individual level interventions. But sub-national variation points to the importance of accounting for the impacts of community level characteristics. These include ecological factors such as rainfall, temperature, topography and geographic location, levels of wealth and educational attainment, the availability of social and health services, predominant religious and cultural beliefs within a community, and the influence of social networks. One of the unique features of this study is that it undertakes complex multilevel

[1] MDG 4 was targeted to reduce by two thirds, between 1990 and 2015, under-five mortality rate while SDG 3.2 targets to end preventable deaths of new-borns and children under -five years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-five mortality to at least as low as 25 per 1,000 live births by 2030.

analysis to untangle the separate and joint effects of community and individual/household level factors on early childhood mortality in Nigeria.

An underlying assumption motivating this research work is that community context has direct or indirect implications for individual health outcomes (Adedini, 2014; Antai, 2011b; Galster, 2012; Sastry, 1996). For instance, studies have shown that both individual and community level factors influenced low child immunisation in Nigeria (Adedokun, Uthman, Adekanmbi, & Wiysonge, 2017; Antai, 2009). Antai (2009) found that a major determinant of full child immunisation was the proportion of women in the community that had hospital deliveries, an indication of timely access to health care and quality of care. It also underlines how the socio-economic level of the community affects individual health results. In Brazil, it has been shown that maternal educational level -both individually and by community proportion- determines to a large extent the child's level of access to medical and social services, ultimately impacting survival possibilities (Sastry, 1996). Such findings also reinforce the need for women empowerment and more representation in leadership positions (Macmillan, Shofia, & Sigle, 2018).

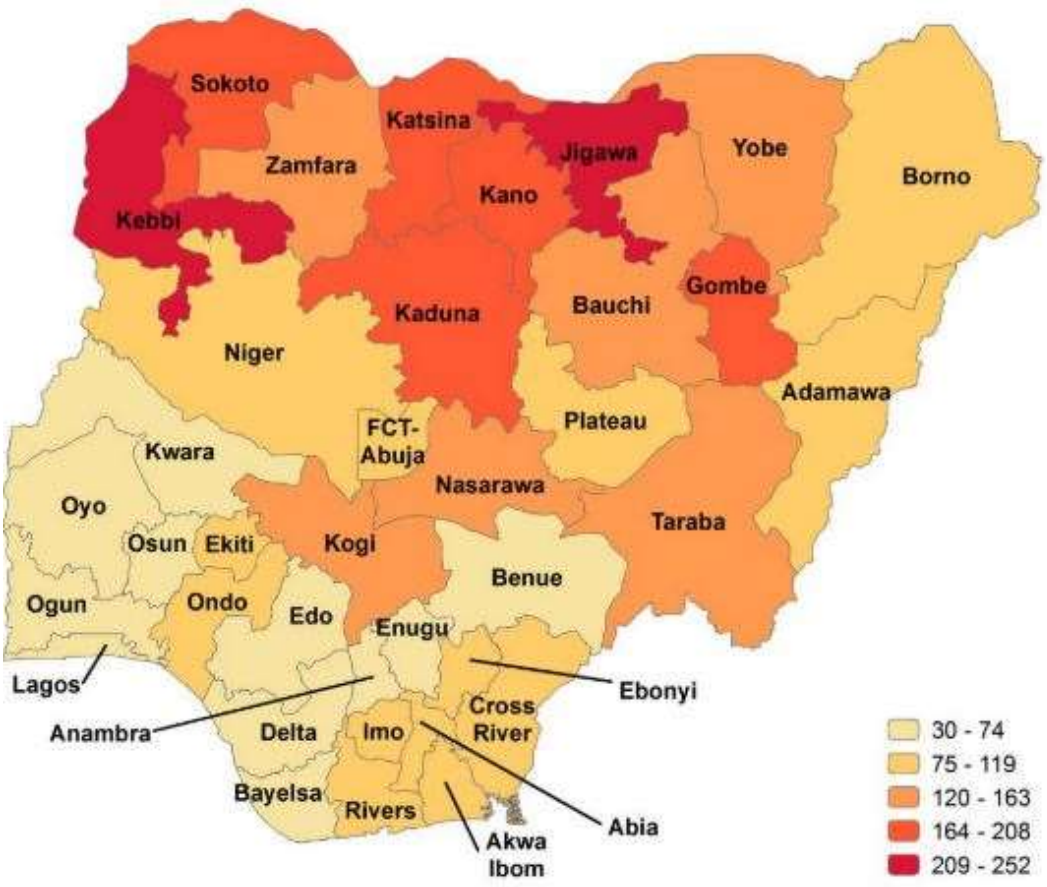

Figure 1.1: Under-five mortality by State for the 10-year period preceding 2018 NDHS
Source: NPC and ICF International, (2019)

This study thus offers an important contribution to the field, as it broadens the scope considerably beyond individual/household level factors to examine the direct and indirect impact of community context on under-five mortality. Existing knowledge on individual/household level drivers of childhood survival is necessary but not sufficient to tackle the societal challenge of rising child mortality adequately. Given the ethnic and cultural diversity in Nigeria, there is a need to understand the interplay between endogenous (internal factors within the household such as maternal education, housing amenities, etc.) and exogenous (external factors outside the household such as access to health care facilities, social services, etc.) factors within the child's immediate environment and the attendant exposures to risk, which lies at the core of my research. This study will use multilevel analysis to account for granular patterns of under-five mortality across Nigeria's 37 states. A multilevel analysis operates on the premise that individuals are nested within the households, and households within the communities, enabling it to account for the broad social ecology

that the child lives in (Griffiths, Madise, Whitworth, & Matthews, 2004). To provide context, the following sections summarize the literature on child mortality in Nigeria, identify key trends and findings, and describe the knowledge gaps addressed in the study.

1.2 Rationale for Study

Nigeria's high childhood mortality is indicative of the poor quality of health for the average Nigerian. The 2017 United Nations Development Programme (UNDP) Human Development Report (HDR) ranked Nigeria among the countries with the lowest levels of human development in the world with a Human Development Index rank of 157 out of 189 countries. As of 2015, only two-thirds of Nigerians had access to safe drinking and cooking water, while about one-third used improved sanitation facilities, and 41 percent of the rural population had access to electricity (UNDP, 2019).

Standard of living underscores the survivorship of a people. Without an enabling environment, including access to basic health facilities and social amenities, individual health outcomes are greatly impaired, especially for children under the age of five -who are a vulnerable group. The evidence suggests that provision of affordable and accessible health coverage for maternal women and children, by the government and other health programmes implementers, will be a major step in reducing health inequality and helping Nigeria to meet SDG target 3.2 by 2030 (Ojewumi & Ojewumi, 2012; Rutherford, Mulholland, & Hill, 2010). In Rwanda, which had a very similar level of under-five mortality to Nigeria in 2000, adequate coverage of maternal and child health from the government helped it achieve a 70 percent reduction in under-five mortality between 2000 and 2011 (Amoroso et al., 2018). Figure 1.2 shows trends in the different components of early childhood mortality rates – neonatal, infant, and under-five mortality- in Nigeria over the years, from 1990 to 2018.

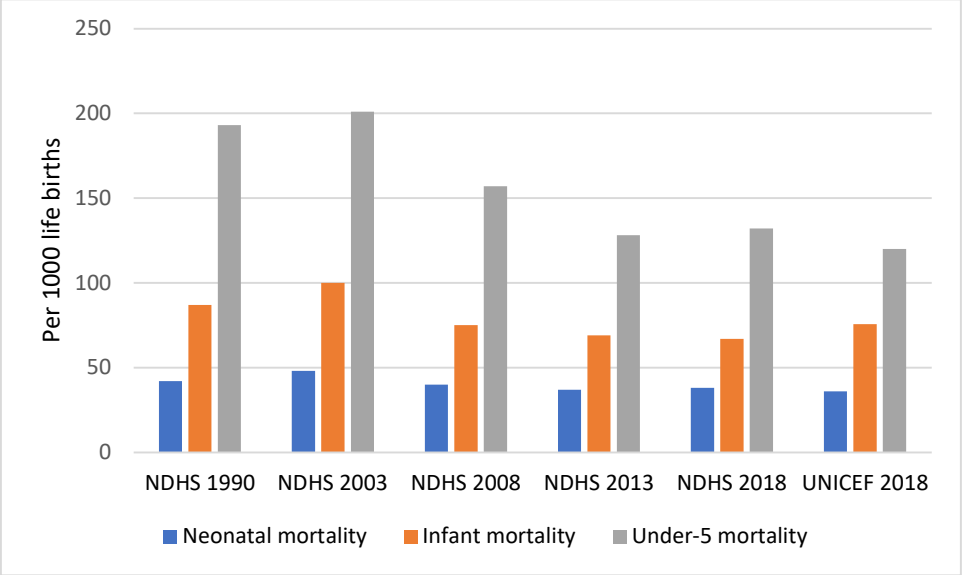

Figure 1.2: Trends in early childhood mortality rates in Nigeria
Source: NPC and ICF International, (2019)

Between 1990 and 2015 world under-five mortality reduced at an impressive rate of almost three percent per year. From 2010 to 2015, under-five mortality rates declined to just over half of what they were between 1990 and 1995, representing a drop from 91 to 50 deaths per 1,000 live births. It further declined to 39 deaths per 1,000 live births in 2017. However, this improvement in child survivorship was highly variable across the UN's regions, with child deaths still relatively high in sub-Saharan Africa and Southern Asia (UNICEF, 2018; United Nations, 2017). According to the 2015 World Mortality Report illustrated in Figure 1.3, the least developed countries had the highest level of under-five mortality of 86 deaths per 1,000 live births. The probability of under-five mortality in less developed countries was 54 deaths per 1,000 live births, which was more than nine times the rate in more developed countries, of only six deaths per 1,000 (Adedini, 2014; Kinney et al., 2010; United Nations, 2017).

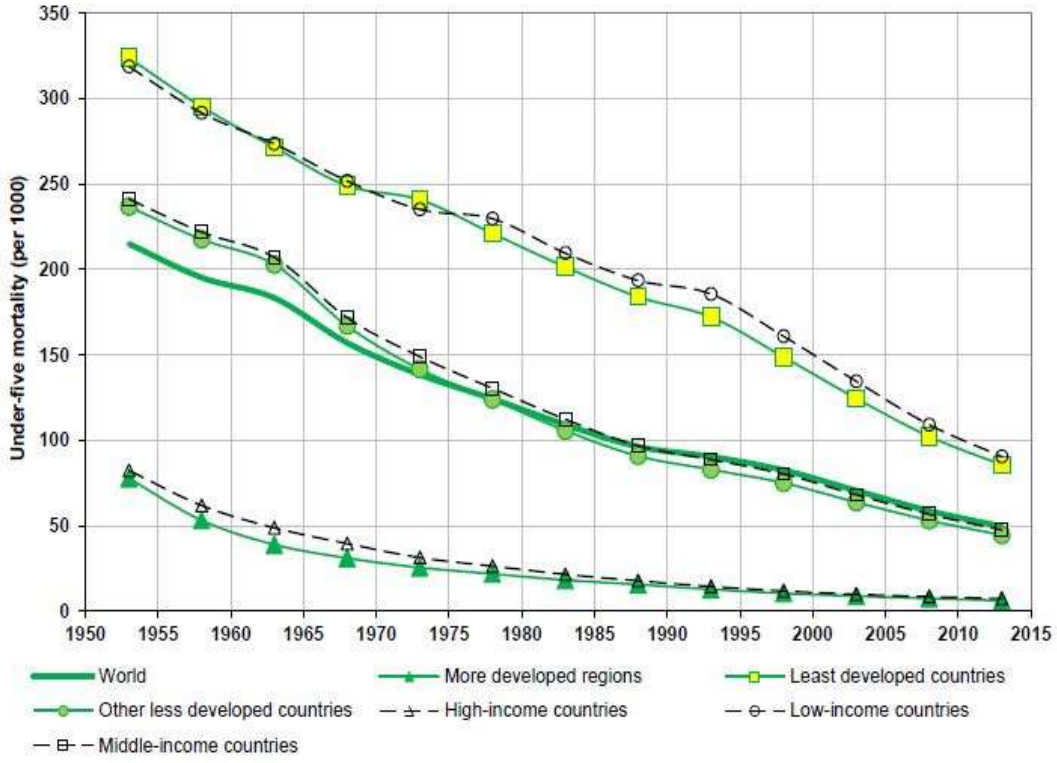

Figure 1.3: Under-five Mortality by development group, 1950-2015
Source: United Nations World Mortality Report, (2015)

If the inequities in child survival between and within countries are not given sufficient urgency, the global progress made in reducing under-five mortality could well be undermined. This would make attaining the SDG target 3.2 -which aims to end avoidable deaths of new-borns and children less than five years of age, with all countries working to lower neonatal mortality to 12 deaths per 1,000 live births and under-five mortality to 25 deaths per 1,000 live births by 2030- difficult, if not impossible (UN-SDG, 2019). Although the preceding MDG target 4 was not attained on a global scale, it contributed immensely to reducing early childhood mortality (UN-MDG, 2015; United Nations, 2017). In 2012 (Ojewumi & Ojewumi) called for prioritisation of child health in Nigeria and for urgent action to be undertaken through improvement in the treatment of vaccine preventable diseases, development of an integrated strategy to child health, institutionalisation of Primary Health Centres (PHC) nationwide, enhancement of women empowerment programmes, and building stronger partnerships among countries, donors, and development agencies. I could not agree more with this call. Under-five health reflects the effectiveness (or otherwise) of health and developmental policies of the government. More broadly, child health

programmes in Nigeria and sub-Saharan Africa are not consistent programmes conducted year-round but are executed as seasonal campaigns. Likewise, PHCs with skilled health personnel, which are the first point of call for maternal women, are unavailable in every locality, especially in the rural areas. It has been highlighted that most avoidable maternal and child mortality cases stem from unavailable and poor state of PHCs (Ram & Singh, 2006; Rutherford et al., 2010). Table 1.1 illustrates under-five mortality by major world regions.

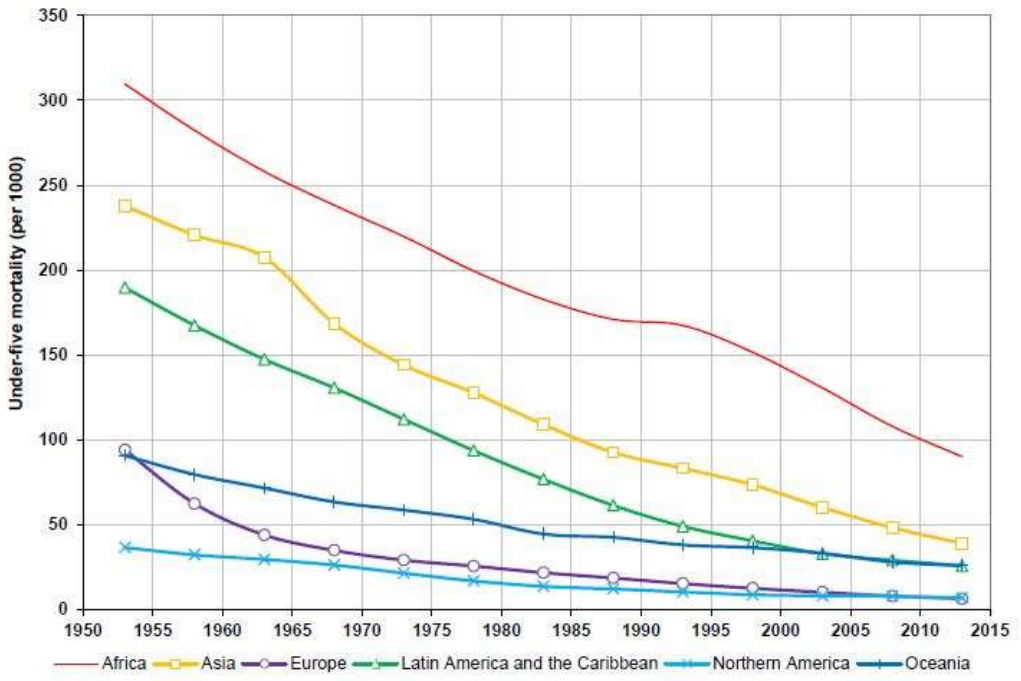

Figure 1.4: Under-five mortality by major area, 1950-2015
Source: United Nations World Mortality Report, (2015)

A closer look at under-five mortality rates in Figures 1.2 and 1.4 demonstrates that Nigeria is doing poorly when compared with the regional African rate. Figure 1.2 shows that 1990 and 2013 Nigeria Demographic and Health Surveys reported 193 and 128 deaths per 1,000 live births for Nigeria respectively while Figure 1.4 reveals early childhood rates of 167 and 90 deaths per 1,000 live births for Africa in the same period. Nigeria must do more to improve the life outcomes of her children. Data from the UN Inter-agency Group for Child Mortality Estimation (UN IGME) in Table 1.1 illustrates that Nigeria was consistently among the 10 countries with the highest under-five mortality rates between 2000 and 2018. Indeed, in 2018 the under-five mortality rate in Nigeria was second only to Somalia. These sobering statistics highlight the import and timeliness of this study. From Table 1.1 it can also be seen that over

the years, sub-Saharan African countries made up a larger majority of countries in the world with highest early childhood mortality rates. Notwithstanding the trends across sub-Saharan Africa, Rwanda recorded great improvement in under-five mortality with about 70 percent reduction in early childhood mortality rates from 2000 to 2011, making it one of the few developing countries to meet MDG 4 by 2015. This remarkable feat was achieved through providing integrated management of childhood illnesses, about 93 percent childhood immunisation coverage, training of community health workers, and a wide coverage of health insurance scheme with removal of user fees for some health services (Amoroso et al., 2018). Despite being the largest economy in Africa,[2] it is pertinent to understand why Nigeria is not making progress in tackling under-five mortality when compared with other countries in the region. Providing a robust understanding of early childhood survival in Nigeria is the rationale of this thesis.

Information on predisposing factors in early childhood mortality at the community level will provide relevant interpretations to sub-national disparities in under-five mortality in Nigeria. Thus, providing a contextual lens for the study, which will fill empirical knowledge gap, particularly at the state level. These results help to provide evidence-based spatial information, thereby improving actions and policies geared towards reducing under-five mortality across the country. A strong emphasis is placed on contextual issues in this study because without proper understanding of factors influencing sub-national inequities in under-five mortality in Nigeria, efforts channeled towards reducing early childhood mortality might be unproductive.

[2] Nigeria became the largest economy in Africa in 2013 after taking the top spot from South Africa. According to the World Bank, Nigeria's GDP in 2018 was valued at $397 billion while South Africa had a GDP of $366 billion. https://www.worldbank.org/ https://www.weforum.org/agenda/2019/08/nigeria-africa-economy/ https://www.bbc.com/news/business-26913497

Table 1.1: Comparison of under-five mortality by countries with the highest rates in 2000, 2010, and 2018[3]

Ranking	Country	2000 U5M	Country	2010 U5M	Country	2018 U5M
1	Sierra Leone	234	Haiti	209	Somalia	122
2	Niger	226	Sierra Leone	163	**Nigeria**	120
3	Angola	206	Somalia	157	Chad	119
4	Mali	188	Central African Republic	150	Central African Republic	116
5	Liberia	187	Chad	150	Sierra Leone	105
6	Chad	186	**Nigeria**	135	Guinea	101
7	**Nigeria**	185	Mali	131	South Sudan	99
8	South Sudan	183	Niger	123	Mali	98
9	Rwanda	183	Angola	120	Benin	93
10	Burkina Faso	179	Guinea	117	Democratic Republic of the Congo	88
11	Guinea-Bissau	175	Democratic Republic of the Congo	115	Equatorial Guinea	85
12	Malawi	173	Burkina Faso	114	Niger	84
13	Somalia	172	Guinea-Bissau	114	Guinea-Bissau	81
14	Central African Republic	172	Equatorial Guinea	112	Lesotho	81
15	Mozambique	171	Benin	111	Cote d'Ivoire	81
16	Guinea	166	South Sudan	109	Angola	77
17	Zambia	162	Cote d'Ivoire	107	Burkina Faso	76
18	Democratic Republic of the Congo	161	Cameroon	107	Cameroon	76
19	Equatorial Guinea	157	Mozambique	105	Mauritania	76
20	Burundi	156	Lesotho	100	Mozambique	73
21	Cameroon	149	Mauritania	97	Liberia	71
22	Uganda	148	Liberia	97	Togo	70
23	Cote d'Ivoire	145	Burundi	91	Pakistan	69
24	Ethiopia	142	Togo	90	Comoros	67
25	Benin	139	Eswatini	89	Haiti	65
26	Senegal	131	Malawi	88	Afghanistan	62
27	United Republic of Tanzania	130	Afghanistan	88	Sudan	60
28	Afghanistan	129	Pakistan	88	Djibouti	59
29	Eswatini	126	Comoros	87	Burundi	58

[3] Global estimates generated by the UN Inter-agency Group for Child Mortality Estimation (UN IGME) in 2019. Downloaded from http://www.childmortality.org. Last update: 19 September 2019.

1.3 Research Goal and Objectives

The goal of this study is to conduct an in-depth analysis of the underlying determinants of under-five mortality in Nigeria, with particular attention to the impacts of community contextual factors and socio-economic change. The aim is to examine the persistent inequities between states and within socio-economic groups, with a particular focus on exploring the extent to which persistently high levels of under-five mortality can be explained by community level factors above and beyond the individual/household level. Another aim is to provide evidence-based results that will aid the government and health policymakers in implementing programmes that can address the underlying drivers of under-five mortality. My study will not only provide more knowledge about community context but will also study trends and patterns of early childhood deaths in Nigeria from 2008 to 2018 at the national and sub-national levels. Salient factors such as health insurance, and how cost of health care predicts maternal health seeking behaviours will be highlighted. The importance of child health to a nation cannot be overemphasized.

In achieving the goal, this study will lean on the theories on understanding the proximate and socio-economic determinants of child survival in developing countries, community effects, and health care access (Aday & Andersen, 1974; Galster, 2012; Mosley & Chen, 1984).
The specific objectives are to:

1. examine changes in under-five mortality in Nigeria from 2008 to 2018, and provide a fine-grained spatial analysis of under-five mortality over time;
2. explore child survival between birth and age five by providing information on critical time points during the childhood period, and spatial variations of these risks across the country, thereby enhancing awareness of inequities in early childhood survival in Nigeria;
3. explore individual/household level factors associated with under-five mortality in Nigeria. This will further provide an understanding of the disparities in under-five mortality between and within geo-political zones, as well as different population sub-groups; and

4. determine the extent to which community factors explain state inequalities in early childhood mortality in the country by examining community contexts. This explains the impact of structural and social mechanisms on health outcomes.

1.4 Research Questions

The proposed study is motivated by one overarching research question and several related ones:

To what extent can the persistently high level of under-five mortality in Nigeria be explained by community level dynamics above and beyond those explained at the individual/household level?

The sub-questions below will help in explaining the various aspects of the main research question above:

1. What are the trends and patterns of under-five deaths in Nigeria?
2. What is the survival pattern of under-five children in Nigeria?
3. What are the determinants of under-five mortality at the individual/household level across various geo-political zones and states in Nigeria?
4. To what extent can community-level factors in the country influence child survival over and above individual/household-level factors?

These questions are important as they will fill a gap in knowledge and provide evidence-based information for further research and programmes in improving early childhood survival. Providing contextual information is key to effectively addressing wide disparities in sub-national under-five mortality in Nigeria.

1.5 Significance of the Study

This study will provide comprehensive analysis of inequities in under-five mortality across Nigeria's 37 states, which is unique as most studies focus on the determinants of under-five mortality at the zonal level. This more granular spatial analysis will provide policy makers and programmes implementers with knowledge of state-specific problems to achieve better results in maternal and child health programming. Providing state-level analysis is essential as prior analysis has shown that under-five mortality varies across the country and is highest in the north. Despite the marked difference in north-south ethnic and religious composition,

with the north predominantly Muslims and the south Christians, the government has been slow to adopt state-specific strategies rather than a one-size-fits-all approach. In addition, state-specific strategies help to effectively maximize the use of limited resources (Uthman, Aiyedun, & Yahaya, 2011). Knowledge on changes in child survivorship over the first five years of life will also be provided using survival analysis. This will help identify high risk mortality periods during the early childhood stage.

This research will also add to the very few studies on under-five mortality in Nigeria that have undertaken multilevel analysis. Such analysis is powerful because it identifies the interplay between individual/household and community level factors. This study thus seeks to address the lacuna of research on how contextual characteristics within states potentially impact child survivorship.

Although the government provides free immunisation programmes for children below the age of five, the percentage of children with basic immunisation coverage in Nigeria is still about 31 percent. My research will endeavor to bring awareness to some of the socio-economic characteristics that create barriers to immunisation. Proper immunisation coverage plays a significant role in reducing under-five mortality. Furthermore, given the poor health insurance coverage in the country, this study will also elaborate on how access to healthcare, measured by cost and distance to health facility, impacts maternal women's health seeking behaviours.

Finally, considering the importance of antenatal care, this study would fill gap on health provider knowledge and professionalism by assessing quality of care maternal women receive during ANC. There is limited knowledge on whether key examinations such as blood pressure, urine and blood tests are done during ANC to detect symptoms leading to the management of neonatal tetanus, malaria, and maternal anemia which are currently the leading causes of under-five mortality in Nigeria.

1.6 Structure of the Thesis

This thesis consists of eight chapters. Chapter One, which is the current chapter, sets the stage for this study by addressing the context of the research and rationale behind the study. It also makes clear the research goal and objectives, research questions, professional significance of the study, and outlines the structure of the thesis. Chapter Two provides a broad review and critical assessment of existing literatures on maternal and child health in Nigeria and other countries. In understanding under-five mortality, both theoretical and empirical, it contextualizes this research within broader literature.

Chapter Three presents the study setting, background knowledge, and conceptual framework for the study. It provides an overview of Nigeria dating back to the pre-colonial era, along with its economic development, and health system. The chapter further explores the use of under-five mortality index as a tool to measure development in Nigeria and highlights the population structure, demographic transition, and epidemiological transition. Finally, the chapter presents the conceptual and analytical frameworks for the study and introduces the study variables.

Chapter Four discusses the Nigeria Demographic and Health Survey (NDHS) data used in the subsequent empirical chapters and provides summary statistics of the study variables. It details the data source, questionnaire and sampling design, limitations of the data, analytical strategy and statistical methods used in this study. It presents the distribution of under-five children by background characteristics as well as detailed summary statistics of the study variables throughout the study period across Nigeria.

Chapter Five uses NDHS data to examine trends, patterns, differentials, and determinants of under-five deaths in Nigeria from 2008 to 2018. In addition, this chapter explores the individual/household level factors associated with under-five mortality in Nigeria using logistic regression. Separate analyses for infant and child mortality are presented, with detailed sub-national analysis to the state level. A key focus is explaining the inequalities in early childhood survival across the country.

Chapter Six focuses on the 2018 NDHS to further probe the individual/household level factors associated with under-five deaths in Nigeria using survival analysis that accounts for censored data. Cox proportional hazards regression is used to explore the risk factors of early

childhood survival in the country. To ensure the quality of analysis, parallel consistency checks of findings with those of Chapter Five are also done. In addition, the chapter provides sub-national estimates for child survival function and incidence rates of under-five mortality across Nigeria.

Chapter Seven undertakes multilevel analysis to determine the extent to which community contextual factors explain under-five deaths in Nigeria. It provides an understanding of how dynamics in the community explain individual behaviours and child survival, beyond the scope of the individual and household level. In doing so, the chapter also focuses on the 2018 NDHS and adopts two multilevel statistical methods; mixed-effects logistic regression and Cox proportional hazards regression with random effects.

Finally, Chapter Eight summarizes the study and discusses implications for policy and further research. It also highlights the key findings, study limitations and major contributions of this thesis within existing scholarship.

CHAPTER TWO PREVIOUS RESEARCH ON UNDER-FIVE MORTALITY

2.1 Introduction

This chapter provides a broad review and critical assessment of the literature on maternal and child health. It identifies relevant studies that have been carried out on the topic and their key contributions, along with some critique of the gaps and limitations that this study aims to address. While a significant number of studies have examined poor child survival outcomes in Nigeria, they are mainly focused on broad geo-political zones with little attention paid to states. As such, there is a lack of understanding about how state-level factors might be associated with under-five mortality.

This chapter shows that most of the literature has focused on the individual level proximate determinants of early childhood mortality. The broader structural determinants are far less studied. To critically review the literature in a way that is logically and theoretically informed, this chapter is separated into four broad sections. The first section provides an overview of under-five mortality in Nigeria; the second presents the determinants of under-five mortality, while the two successive sections discuss in detail the proximate and socio-economic/structural determinants, as well as community-level factors.

2.2 Overview of under-five mortality in Nigeria

There is a clear north-south divide in under-five mortality rates in Nigeria, with the northern regions not only having higher rates than the south, but also higher intra-zonal variation. This clearly suggests that we need to look beyond the individual and household level factors already known from the literature (see for example (Adedini, 2013; Antai, 2011b) to examine the state and community-level factors and processes also at work. In the 2018 NDHS (Table 2.1), under-five mortality over a ten-year period in Nigeria exceeded 100 deaths per 1,000 live births in the North West and North East (187 and 134 respectively) but was below 100 in the southern regions (75, 73, and 63 deaths per 1,000 in South East, South South and South West respectively). Table 2.1 also shows further gaps in under-five mortality amongst Nigeria's 37 states, with intra-zonal state variation, showing that even within the same geo-political zone, some states have substantially better or worse under-five mortality rates than

the zonal average. To illustrate, Bayelsa recorded only 31 deaths per 1,000 live births which is considerably below the South South total of 73 deaths per 1,000 live births, while Akwa Ibom recorded 98 deaths. In the North West, Kebbi had the highest rate of 252 deaths, while Zamfara recorded 130 deaths. This highlights a major limitation in only undertaking analysis at the national or zonal level.

The major causes of neonatal and under-five mortality in Nigeria are neonatal tetanus, malaria, and maternal anaemia, while diarrhoea and acute respiratory infections contribute to increased mortality rates during childhood (National Population Commission Nigeria [NPC] & ICF International, 2019; WHO, 2020). A study carried out in South East Asia and Africa found that malnutrition and micronutrients deficiencies drive a high proportion of malaria morbidity and mortality in children under five years (Caulfield, Richard, & Black, 2004). To tackle these health challenges, Nigeria antenatal care aims to provide anti-tetanus injections, anti-malaria drugs and insecticide treated mosquito nets (ITN), and iron supplements to pregnant women. Malaria remains endemic in Nigeria, with year-round transmission due to its tropical location and public health issues. Over 80 percent of the global malaria burden is still borne by Africa, with Nigeria accounting for about 25 percent (NPC & ICF International, 2009, 2014, 2019).

As stated earlier, Nigeria has experienced slow reductions in under-five mortality from 1950 to date, with an early rate of 335 deaths per 1000 live births in 1950, to 200 in 1990, 142 in 2010, 128 in 2013, 132 in 2018, with latest 2020 figure being 102 deaths per 1000 live births. Under-five mortality in Nigeria is still higher than both the sub-Saharan and West African rates, which are currently at 78 and 91 deaths per 1000 live births respectively (NPC & ICF International, 2019; UN-DESA, 2019a). The poor child survival outcomes in Nigeria also affects life expectancies at birth. In Nigeria a new-born boy can expect to live, on average, just 53 years and a new-born girl 55 years. This is more than 10 years below the global averages of 70 and 75 years for males and females, and lower than sub-Saharan Africa (59 and 62 years) and West Africa (56 and 58 years) (UN-DESA, 2019a). The poor life expectancy in Nigeria is a result of persistently low child and maternal survival rates, coupled with increasing violence and conflict (UN-DESA, 2019a).

To design programmes that will effectively address sub-national disparities in under-five mortality, there is a need to understand the underlying drivers in the various states. A key goal of this dissertation is to shed light on the extent to which individual and household level predictors of under-five mortality is being driven by state-level determinants (Sastry, 1996).

Table 2.1: Distribution of under-five mortality rate for Nigeria by State of residence, Geo-political zones, and National total

Characteristic	2008 NDHS	2013 NDHS	2018 NDHS
National Total (five years preceding the survey)	**157**	**128**	**132**
National Total (ten years preceding the survey)	**171**	**144**	**129**
North Central	**135**	**100**	**95**
FCT Abuja		76	75
Benue		127	59
Kogi		72	148
Kwara		63	74
Nasarawa		119	120
Niger		86	98
Plateau		130	106
North East	**222**	**160**	**134**
Adamawa		174	104
Bauchi		228	147
Borno		79	86
Gombe		186	189
Taraba		152	129
Yobe		143	152
North West	**217**	**185**	**187**
Jigawa		218	213
Kaduna		73	187
Kano		158	164
Katsina		220	188
Kebbi		194	252
Sokoto		210	197
Zamfara		256	130
South East	**153**	**131**	**75**
Abia		132	86
Anambra		87	58
Ebonyi		179	91
Enugu		111	61
Imo		133	87
South South	**138**	**91**	**73**
Akwa Ibom		79	98
Bayelsa		91	31
Cross River		104	80

Delta		93	53
Edo		71	71
Rivers		98	79
South West	**89**	**90**	**62**
Ekiti		105	95
Lagos		96	59
Ogun		93	30
Ondo		119	79
Osun		61	70
Oyo		76	64

2.3 Determinants of under-five mortality

Identifying all the determinants of under-five mortality is daunting given the complexity of the situation. Biological, economic, social, and environmental factors at the individual, household and community levels play different roles, either directly or indirectly, on the chances of survival of a new-born (Adebowale, Morakinyo, & Ana, 2017; Antai, 2011b; Koffi et al., 2017; Sastry, 1996).

In their framework for the study of child survival in developing countries, Mosley and Chen (1984) argued for a distinction between direct and indirect determinants of child wellbeing. While factors such as health care during pregnancy and delivery, maternal behaviours, and feeding practices have direct impacts on the child's health, factors such as household wealth, maternal education, and place of residence contribute indirectly to a child's survival outcomes. Earls and Carlton (2001) while exploring the social ecology of child health mentioned that an interplay of different factors at the home, school, and community, which are a make-up of a child's social ecology, affect their total health and survival chances. In short, a child belongs to different social groups at the same time. Since effective health care delivery cuts across different socio-economic and biological factors, it is pertinent to design health care programmes that consider the ecological environment of the child. Understanding the interplay of these factors and how they operate is important for reducing under-five mortality.

Mosley and Chen (1984) framework identify the proximate and socio-economic determinants that directly or indirectly impact child mortality. The direct proximate determinants are summarized as:

1. maternal factors during childbearing years (age at birth of child, parity, and preceding birth interval);
2. nutrition which comprises the quality of food eaten, with adequate supply of nutrients and micronutrients to the fetus and child;
3. personal illness practices, which is an indicator of preventive care given to the child to avert illness and medical care provided -both traditional and modern- in the event of illness;
4. environmental contamination from the air, food, water, human body, soil, objects, and disease-causing insects; and
5. injury (both intentional and unintentional).

In the framework, individual, household and community level factors form structures that shape maternal decisions and subsequent child survival outcomes. The more remote socio-economic factors operate on these different levels through the proximate factors. These socio-economic factors are:

1. individual level (parents' education, economic productivity, and traditions/norms); paternal and maternal education, occupation and beliefs affect their availability for the child and the type of care the child is provided with;
2. household level (household income); household wealth quintile determines to a large extent the food, water, clothing, housing type and amenities, fuel consumption, means of transportation, information, hygienic and sickness care the child has access to; and
3. community level (ecology, government, and health system); geographic location, political policies, and provision of social infrastructures by the government, together with quality and equitable health care system determines the health outcomes of the child and population at large (Mosley & Chen, 1984).

2.4 Proximate Determinants of under-five mortality

The impacts of proximate determinants of under-five mortality, as proposed by Mosley and Chen (1984), are well established in literature. Indeed, studies have found that old maternal age (over 40 years) during childbirth and teenage pregnancy are associated with high fetal loss (Andersen, Wohlfahrt, Christens, Olsen, & Melbye, 2000; Chen et al., 2007; Magadi, Agwanda, Obare, & Taffa, 2018; Titilayo, Obiyan, Agunbiade, & Fasina, 2009). Birth spacing, determined by the preceding birth interval, (Hong & Hor, 2013; Kozuki & Walker, 2013; Kumar & File, 2010; Norton, 2005; Ronsmans, 1996; Rutstein, 2005, 2008; van Soest & Saha, 2012), and parity (Kozuki et al., 2013; Umesi, 2018; USAID-HC3, 2016) have direct effects on under-five mortality. In Addition, factors which are not limited to physiological and cellular changes associated with maternal age bring about complications during childbirth (Ganchimeg et al., 2014; Nichols, 2017), such as under-utilisation of antenatal care by teenage mothers (Magadi et al., 2018), pressure on the maternal reproductive system (Rutstein, 2005), competition for maternal attention and resources (Rutstein, 2008), as well as religion and cultural beliefs (USAID-HC3, 2016). According to Legrand and Barbieri (2002), later marriages and first births are associated with lower levels of child mortality.

However, some findings are contested. Bayrampour, Heaman, Duncan, and Tough (2012) argue that the presumed risks associated with old maternal age births are overestimated, and that poor eating habits, poor health, and bad relationships pose more pregnancy risks than age. Others suggest that the linkage between adverse outcomes and high parity are not entirely biological, but rather due to underlying confounders such as environmental and socioeconomic factors highly correlated with high parity (Kozuki et al., 2013; Mor-Yosef, Seidman, Samueloff, & Schenker, 1990; Seidman, Dollberg, Stevenson, & Gale, 1991; Seidman, Gale, Slater, Ever-Hadani, & Harlap, 1987). Studies also show that economic stability or access to proper medical care reduces the risks associated with grand-multiparity (Hughes & Morrison, 1994; Kumari & Badrinath, 2002).

Other proximate determinants found to impact directly on under-five mortality are antenatal and delivery care (Greenwell & Winner, 2014; Ram & Singh, 2006; Starrs, 1997). Winter et al. (2013) found that improvement in neonatal mortality rate in Rwanda was largely due to increased coverage of maternal and delivery care services in rural areas. Breastfeeding,

nutrition, and personal illness practices help to combat morbidity and mortality in both mother and child (Brabin, Premji, & Verhoeff, 2001; Gwavuya, Murendo, Wekwete, Takavarasha, & Madzingira, 2014; Odusanya, Alufohai, Meurice, & Ahonkhai, 2008; Summer et al., 2007; WHO, 2018b). Adequate breastfeeding and nutrition provide the child with essential nutrients for healthy growth and the ability to fight diseases (Caulfield et al., 2004; Ezeh et al., 2017; Lilford et al., 2017; NPC & ICF International, 2019). Malnutrition is clearly an underlying cause of childhood mortality (Ibe, 2002).

Child factors such as sex of the child (Kayode, Adekanmbi, & Uthman, 2012; Negera, Abelti, Bogale, Gebreselassie, & Pearson, 2013) and birth weight (Lawn, Cousens, & Zupan, 2005; Rutstein, Ayad, Ren, & Hong, 2009) have also been found to be proximate determinants of under-five mortality. Likewise, immunisation coverage and timely treatment of early childhood illness such as malaria, diarrhoea, acute respiratory infection (pneumonia), and sickle cell disease increase a child's chances of survival (Ibe, 2002; Lawn et al., 2005; Rutstein et al., 2009). As this study also seeks to explore reasons behind the low rate of child immunisation and provide more information on maternal health seeking behaviours and home-care knowledge of childhood illness, the following section explores these areas further.

2.4.1 Immunisation against childhood preventable illnesses and personal illness practices

The Government of Nigeria has sought to improve immunisation coverage of children through the introduction of the Expanded Programme on Immunisation (EPI). This entails receiving three DPT vaccines against diphtheria, pertussis, and tetanus, with at least three doses of polio vaccine, and one dose of measles by 12 months (Olorunsaiye & Degge, 2016). However, efforts by the government are being hampered by education, early maternal age (due to poor education and lack of adequate information), low socio-economic status, lack of access to media, place of residence that creates accessibility barriers to health care centres, fear of side effects, place of delivery, ethnicity and cultural belief (Adedokun et al., 2017; Adeyinka, Oladimeji, Adeyinka, & Aimakhu, 2009; Oluwatosin, 2012; Chidiebere, Uchenna, & Kenechi, 2014; Tagbo et al., 2014). These factors have resulted in the persistently low uptake of vaccinations in the country. Reports of the 2008, 2013 and 2018 NDHS show little improvement in coverage, with 23, 25 and 31 percent of children, respectively, considered to

be adequately immunised (NPC & ICF International, 2009, 2014, 2019). These figures underscore the need for further studies that will help to break some of the barriers to child immunisation, to give the Nigerian child the needed protection over common childhood diseases.

Among children between 12 to 23 months who have received all basic immunisations, Nigeria lags in comparison with other sub-Saharan African countries, as reported in their current demographic and health survey reports. Table 2.2 presents basic vaccination coverage for children between one to two years in different countries in sub-Saharan Africa. As revealed in the table, several sub-Saharan countries have more than 50 percent coverage.

Table 2.2: Child immunisation coverage in selected sub-Saharan African countries

Country	Coverage (%)[4]
Nigeria	**31**
Ghana	77
Sierra Leone	68
The Gambia	76
Liberia	55
Zambia	68
Ethiopia	44
Tanzania	75
Namibia	68
Kenya	79
South Africa	61
Rwanda	93

[4]Results sourced from country reports: (Central Statistical Office (CSO) [Zambia], Ministry of Health (MOH) [Zambia], & International, 2014; Ghana Statistical Service (GSS), Ghana Health Service (GHS), & International, 2015; Kenya National Bureau of Statistics et al., 2015; Liberia Institute of Statistics and Geo-Information Services (LISGIS), Ministry of Health and Social Welfare [Liberia], National AIDS Control Program [Liberia], & International, 2014; Ministry of Health, National Bureau of Statistics (NBS), Office of the Chief Government Statistician (OCGS), & ICF, 2016; National Department of Health (NDoH), Statistics South Africa (Stats SA), South African Medical Research Council (SAMRC), & ICF, 2019; National Institute of Statistics of Rwanda (NISR) [Rwanda], Ministry of Health (MOH) [Rwanda], & International, 2015; Statistics Sierra Leone (SSL) & International., 2014; The Gambia Bureau of Statistics (GBOS) & International, 2014; The Nambia Ministry of Health and Social Services (MoHSS) & International, 2014; Ministry of Health Community Development Gender Elderly and Children (MoHCDGEC) [Tanzania Mainland], Ministry of Health (MoH) [Zanzibar], National Bureau of Statistics (NBS), Office of the Chief Government Statistician (OCGS), & ICF, 2016; Ethiopian Public Health Institute (EPHI) [Ethiopia] & ICF, 2021)

In support of the urgency for basic immunisation coverage, the WHO and UNICEF reported in 2020 that more than one in 10 children missed out on being immunised against diseases such as tetanus, diphtheria, and measles (WHO & UNICEF, 2019b). Even though about 113 million infants (83 percent) globally received three doses of DPT vaccine, with 129 countries meeting at least 90 percent coverage of the vaccine, 23 million children globally still missed out on vaccination. About 60 percent of these children live in these 10 countries with Nigeria inclusive: Angola, Brazil, DR Congo, Ethiopia, India, Indonesia, Pakistan, Philippines, Vietnam, and Nigeria (WHO & UNICEF, 2019b). The Director-General of WHO Dr Tedros Adhanom Ghebreyesus stressed the need for better vaccination coverage to prevent epidemic outbreaks. He highlighted that most of those who are persistently missed are the poorest and most marginalised, as well as those affected by conflicts (WHO & UNICEF, 2019a). In Nigeria alone, about four million children miss out on vaccination each year, with high inequality across states, from 76 percent basic coverage in Anambra to a low of only about five percent in Sokoto (NPC & ICF International, 2019; UNICEF, 2019). By focusing on state-level determinants, this study may contribute useful knowledge to assist health care administrators take appropriate steps to ensure children are not left out in immunisation campaigns.

Regarding maternal health seeking knowledge in Nigeria, Koffi et al. (2017) discovered that an average of two days passed before help was sought for sick children by caregivers, which could lead to severity of illness and further increase exposure to risk of death. The study also found that the main barriers to access to health facilities, as reported by women, were cost of health care, means of transportation, and distance to the health facilities. In as much as it is pertinent to throw more light on factors that impact on the child's chances of survival just like Koffi et al. (2017) did, the authors only carried out regional analysis between the north (North Central, North East and North West) and the south (South East, South South and South West). Thereby muting variations at the micro level. Even though there are similarities across geo-political zones, it will add more value to have results by states, which is what this study aims to achieve, as there are hidden peculiarities amongst states which will not be noticeable when categorised by geo-political zones. Intra-zonal variations in under-five mortality shown in Table 2.1 reinforce that there are differences below the regional level. It

is misleading to assume that if a geo-political zone is doing well on some indicators, then all the states within that zone are also doing well.

A study by Kayode et al. (2012) on under-five mortality in Nigeria also found that health seeking behaviour influences the likelihood of under-five mortality. In their analysis of health seeking behaviour, they used principal component analysis to combine five variables: possession of health care card, ANC attendance, delivery in a health facility, knowledge of oral rehydration salts (ORS), and intake of tetanus toxoid injection. The analysis, however, omitted a key behaviour – the duration taken to seek medical help when a child is sick. This factor is important as studies have shown that several caregivers do not seek help immediately due to various reasons which exacerbate the condition of the child (Koffi et al., 2017). Delayed care seeking is prevalent and can be attributed to the fact that most caregivers fail to appreciate the need to seek urgent healthcare (Koffi et al., 2017). Timely healthcare seeking is also hampered by economic, cultural, and educational factors. In several cases, economic factors may pose financial challenges while cultural and educational factors can reduce the potential for caregivers to recognise illness and take relevant timely action (Koffi et al., 2017). Enhanced maternal knowledge to recognise sickness in a child and take appropriate timely action can save lives. Social health policies could mitigate against barriers to accessing health care such as cost, transportation, and poor accessibility of health centres (Adeyanju, Tubeuf, & Ensor, 2017; Rutherford et al., 2010), especially in the southern parts of the country (Koffi et al., 2017).

The foregoing proximate determinants have received much attention in the literature. What has been less studied are the broader socio-economic structural determinants operating through the proximate ones, especially community level determinants over and above those at the individual/household level. In the following sub-section, these socio-economic and structural factors will be focused on, while drawing on relevant literature to shape the approach of this study on under-five mortality in Nigeria.

2.5 Socio-economic/structural determinants of under-five mortality

Individual, household, and community level factors form structures that shape maternal decisions and chances of child survival (Mosley & Chen, 1984). Indeed, this is the main

approach that this dissertation is pursuing and below I will draw on some of the literature that has studied under-five child mortality across these different levels of analyses while paying particular attention to those structural determinants at the community level. However, some factors such as government influence, cultural practices, and maternal mortality that impact on under-five mortality are recognised but cannot be measured using the Nigeria Demographic and Health Survey (NDHS) data.

2.5.1 Individual/household level factors

The role of individual/household socio-economic status on child health outcomes cannot be overemphasized. Studies have identified several individual/household background characteristics that act as indirect determinants of under-five mortality, including maternal education, wealth, and availability of basic amenities like improved toilet facility, quality drinking water and electricity (Akinyemi, Bamgboye, & Ayeni, 2015; Ettarh & Kimani, 2012; Kayode et al., 2012; Koffi et al., 2017; Rutherford et al., 2010; Rutstein et al., 2009; Yaya et al., 2017). Factors in the communities, beyond the individuals and households, also form external structures that operate through these determinants. For instance, if women have the right information and can access quality health care, some pregnancy and childbirth related anomalies and death can be prevented. Studies published in *The Lancet* showed that access to improved health care, quality drinking water and improved toilet facilities are essential in improving child survival, especially for those in areas with increased exposure to infection due to their household's socio-economic status (Ezeh et al., 2017; Lilford et al., 2017). Children below the age of five have lower immunity and providing optimum conditions at this stage are crucial for enhancing their survival outcomes.

Child health cannot be separated from maternal characteristics as they are so interwoven. A study has identified low socio-economic status, weak health care system, socio-cultural barriers to care utilisation, and insecurity in northern Nigeria as jointly associated with high maternal and child mortality in Nigeria (Olusegun, Ibe, & Michael, 2012; Olarewaju, 2021). Blackstone, Nwaozuru, and Iwelunmor (2017) emphasize the necessity of understanding maternal social determinants that influence child mortality, so that child health interventions can be properly planned to address the maternal factors as well. Their insightful study explored different structural and intermediary factors associated with child mortality, not only for first births (which is the norm), but up to three births. Blackstone et al. (2017)

acknowledged the need for further studies on how maternal education and place of residence influence child mortality. Given that longitudinal data on demographic health is lacking in Nigeria, their study would have been more informative if they had used different survey waves of the NDHS to present a clear trend in individual/household characteristics and child mortality over time. This current research seeks to overcome some of those limitations by using 2008, 2013, and 2018 NDHS data to identify recurring patterns and suggest associations.

Environmental contamination through poor water supply and sanitation in the household is a public health problem in developing countries, Nigeria included. Diarrhoea as one of the leading causes of childhood deaths is spread through unimproved water and sanitation (Kayode et al., 2012), and unimproved water and poor sanitation facilities increase risks of childhood mortality (Kayode et al., 2012). Improving household water and sanitation services can help to reduce child deaths (Ezeh, Agho, Dibley, Hall, & Page, 2014b). A study in Bangladesh found that sanitation improvement, which included proper disposal of child excreta, provided positive health outcomes by reducing cases of diarrhoea (Buttenheim (2008). In Nigeria, a study found that homes with unimproved toilet facilities increased chances of under-five mortality by 77 percent compared to those with improved toilet facilities (Kayode et al., 2012). Improved household water and toilet facilities are part of SDG 6 which is to ensure universal access to safe and affordable drinking water, as well as equitable sanitation and hygiene.

The wealth index of a household determines the resources available to a child, the type of house a child is raised in, and access to health care, thereby indirectly influencing under-five mortality (Blackstone et al., 2017; Ezeh et al., 2015; Rutherford et al., 2010). The household wealth quintile measures impact on the health of the child through a measure of the scale of social class differences in a society. Likewise, inequalities in wealth distribution and educational attainment in the household create social class separation which impacts on access to health care services (Wilkinson & Pickett, 2006). Link and Phelan in 1995 developed the fundamental cause theory to explain how social-economic conditions determine health inequalities. The theory is that socio-economic status is a fundamental cause that influences health outcomes through risk factors associated with the availability of resources (Phelan, Link, & Tehranifar, 2010). The link between the fundamental cause and

health is further reproduced through the replacement of intervening factors such as poor sanitation, smoking, exercise, diet, and cardiovascular disease (Phelan et al., 2010). In supporting the fundamental cause theory, Phelan et al. (2010) are of the view that health inequalities created by social conditions can be reduced by breaking or diminishing the connection between socio-economic status and health care access. That is, the extent to which socio-economic resources buy a health advantage should be minimized. The theory leads to implications about preventative interventions and the level at which they are best designed.

In Nigeria, wealth inequalities clearly create accessibility barriers to health care services in ways that impact negatively on early childhood survival outcomes (Koffi et al., 2017; Ojewumi & Ojewumi, 2012). The Federal Government of Nigeria initiated a National Health Insurance Scheme (NHIS)-MDG programme in 2005 to provide free maternal and child health (MCH) care through an exemption scheme to tackle the poor maternal and child health in the country. The programme was implemented in 12 states in two phases: the first phase included Bayelsa, Gombe, Imo, Niger, Oyo and Sokoto, while the second included Bauchi, Cross River, Jigawa, Katsina, Ondo, and Yobe. The initiative was targeted at providing primary health care services to maternal women and children under the age of five, including referrals to the secondary level for maternal women in public health care facilities (Onwujekwe, Obi, & Uzochukwu, 2016; Onwujekwe et al., 2018). However, the free MCH project could not be sustained and was stopped in 2015 due to several reasons highlighted by Onwujekwe et al. (2016). These included: a lack of commitment by the state governments to provide counterpart funding in partnership with the federal government; use of political appointees instead of health care professionals to manage the programme; and low involvement of the communities in the programme. Given that more than 90 percent of maternal women are without NHIS coverage (National Population Commission (NPC) Nigeria & ICF International, 2019), there is a need to provide universal health coverage for maternal women and under-five children. Studies have shown that during the period the NHIS-MDG programme was implemented, there were increased utilisation of health care services in the participating states by maternal women and children below five years, which brought about more provision of services, improvement in infrastructure of health care facilities, as well as quality of service delivery (Onwujekwe et al., 2016; Onwujekwe et al., 2018).

To further address socio-economic limitations to health care access at the individual/household level, the National Health Act was passed in 2014. The Act includes the establishment of a Basic Health Care Provision Fund (BHCPF), with the BHCPF being at least one percent Nigeria's Consolidated Revenue Fund (CFR) (Onwujekwe et al., 2018). In as much as the BHCPF is a step in the right direction, it is evident that the fund allocation is inadequate to achieve its purpose. Onwujekwe et al. (2018) carried out a feasibility study of what would be needed to achieve universal coverage for basic MCH care (antenatal care, delivery, postnatal care, family planning, treatment of malaria, pneumonia, diarrhoea, and routine immunisation) in Nigeria and found that at least four percent CRF is needed to meet the needs of the target group if 50 percent of BHCPF is allocated to NHIS. Moreover, for the National Health Act to be a success in improving the health of the citizens, especially maternal women and under-five children, issues around effective implementation needs to be tackled.

In contrast to Nigeria, Ghana is doing better at using its National Health Insurance Scheme (NHIS) as a tool for reducing inequity in health care access. Even though expenditure on health care seems to be about five percent of GDP in both countries, in 2010, public expenditure was 60 percent in Ghana compared to 38 percent in Nigeria (Odeyemi & Nixon, 2013). Also, since the introduction of NHIS in Ghana in 2004, private out-of-pocket expenditure fell from 80 percent in 2000 to 66 percent by 2010. In contrast, in Nigeria private out-of-pocket expenditure rather increased from 93 percent in 2002 to 95 percent by 2010, even after full implementation of NHIS in Nigeria in 2005. This has negative effects on those of low socio-economic status (Odeyemi & Nixon, 2013). Major factors that contributed to the success of Ghana are that the government ensured equity in access and provision, by making the same benefit package available to all members, and by earmarking exemption groups funded from general taxation. This strong commitment by the Ghanaian government to equity in health care access was reflected in the increased public expenditure since the introduction of the NHIS from 35 percent to 60 percent, while during the same period that of Nigeria only increased marginally from 32 percent to 38 percent (Odeyemi & Nixon, 2013).

2.5.2 Community level factors

At a high level, community context -including inequality- matters for all kinds of population health outcomes. Low social status and quality of the environment have been found to adversely affect health outcomes of residents (Bécares, Cormack, & Harris, 2013; Buttenheim, 2008; Wilkinson & Pickett, 2006, 2007). Roux et al. (2001) also added that disadvantaged communities are linked with higher incidence of coronary heart disease through the interplay of physical and social features of the place of residence. Although a very different context, a study of neighborhood social capital and wellbeing in New Zealand has shown how community social capital (network ties, amenities, physical disintegration, membership in communal organizations, and residential stability) impacts positively on adolescent well-being (Aminzadeh et al., 2013).

Studies elsewhere and a few in Nigeria have shown how community factors influence child survival outcomes due to differences in socio-economic characteristics of the geographic location/community, and availability of basic infrastructures such as clean water supply, good sanitation, electricity, and accessible health care facilities (Adedini, Odimegwu, Imasiku, Ononokpono, & Ibisomi, 2015; Antai, 2011b; Harttgen & Misselhorn, 2006; Odusanya et al., 2008; Olufunke & Obafemi, 2011; Sastry, 1997). In addition, Sastry (1997) found that the significantly lower rates of child mortality in urban areas of Brazil were largely due to the operation of community factors through individual/household socio-economic status, especially maternal education. This buttresses that individual/household factors moderate the impact of community level factors by facilitating or obstructing access to available services in the community. Even though availability of social and health services in the community are essential to reducing child mortality, Sastry argued their impact occurred through interactions with individual/household activities. In exploring the influence of individual/household level factors, they focused on maternal education and household wealth, and found that education arms the woman with relevant knowledge and skills to properly raise the child while wealth complements community structures in providing needed goods and services to improve child survival outcome.

In Nigeria, few studies have explicitly examined the complex relationships between community level indicators and under-five mortality. Several studies on childhood mortality

in Nigeria have found that maternal and other socio-economic factors at the individual/household level predict under-five mortality (Akinyemi, Bamgboye, & Ayeni, 2013; Antai, 2011a; Ezeh et al., 2014b; Yaya et al., 2017). But these studies are insufficient to explain the peculiar pattern of under-five mortality across different states, where there are great differences in mortality rates, as well as socio-economic and religious differences. Even though there is a clear-cut north-south divide with regards to religious and cultural beliefs, there are noticeable differences in under-five mortality rates between states within the same geo-political zone, that are otherwise very similar with regards to culture and religion. This suggests that underlying state-level factors might be contributing to the differences. For instance, from Table 2.1, under-five mortality rates reported from the Northwestern states in 2018 NDHS ranged from 252 in Kebbi to 130 in Zamfara, in the same vein South South states with similar cultural and economic pattern (riverine areas with large oil and gas deposits) also showed gaps from 31 in Bayelsa to 98 in Akwa Ibom. Although, as seen in the table, intra-zonal variation is more pronounced in the northern zones than in the south.

One feature of this study that is somewhat different from the literature that I have described thus far is that I focus on how structural factors at the community level potentially determine child survival outcomes over and above individual/household level factors. This level of analysis correctly distinguishes between individual/household and community level factors, thereby providing a more refined focus for effective programme planning (Antai & Moradi, 2010). There are a few studies that have examined how community level factors influences a child's chances of survival in Nigeria (Adedini, Odimegwu, Imasiku, Ononokpono, et al., 2015; Adedokun et al., 2017; Antai, 2009; Olorunsaiye & Degge, 2016), but these studies do not provide results to the state levels and are not based on a more recent dataset. Nevertheless, the results suggest that place of residence and geo-political zone significantly influence under-five mortality, as the characteristics of the area can improve or worsen the rate of exposure to risk for individuals living there (Adedini, 2013, 2014; Adedini, Odimegwu, Imasiku, Ononokpono, et al., 2015; Adedokun et al., 2017; Antai, 2009, 2011a, 2011b; Olorunsaiye & Degge, 2016). Also, while Kayode et al. (2012) supported that place of residence and geo-political zones exert significant effects on the child, they only did that in a multivariate analysis and did not explore multilevel analysis in measuring the strength of the impact.

Adedini (2014) argued that while certain characteristics in the South West of Nigeria mitigated under-five mortality in the region, peculiar characteristics in the North East and North West regions appeared to have contributed to the worsening of under-five mortality rates in those regions. He further argued that deprived residential areas had higher risks of under-five mortality compared to areas where people of higher economic status reside. A contributing reason could be because of the collective effort made by individuals at providing needed infrastructures in their area (in the absence of government commitment), thereby leaving communities largely occupied by people of lower economic status disadvantaged as they cannot afford to provide such for their communities.

In a study on global child health, Unger (2013) found that mortality rates of children residing in slums are higher when compared with those not residing in slums because of higher exposure to illness and communicable diseases. In addition, women in slums are less educated, with lower chances of receiving antenatal care and delivering in a health facility. These scenarios play out in Nigerian rural areas and rapidly increasing urban slums (Barrett, 2010).

Consistent with Earls and Carlton (2001), who argued that since a child can be nested in different units at the same time (family, school, and community), and that the social ecology of the child should be incorporated into health planning, Adedini, Odimegwu, Imasiku, Ononokpono, et al. (2015) found that community-level factors significantly influenced how individual/household factors predict under-five mortality. In effect, the community a child is raised in has as much effect on her well-being as the household she belongs to. Their study also found that children raised in households on the same wealth quintile, but different community level exposures, fared differently due to different socio-economic aspects of the communities affecting the availability of relevant infrastructures, social and health services. In addition, individual/household level factors were more important during infancy while community level factors played greater roles during childhood. Together these different dynamics largely explained regional variation in under-five mortality in Nigeria. While these studies (Adedini, 2014; Adedini, Odimegwu, Imasiku, Ononokpono, et al., 2015) were

limited to regional level analysis, this study drills down to the state-level and accounts for observed disparities in under-five mortality amongst states in the same geo-political zone.

Furthermore, as mentioned earlier, the few studies that looked at community-level factors in Nigeria did not provide sufficient information at the state-level, creating gaps that this study will specifically address. Adedokun et al., (2017) attempted to provide state-level socioeconomic factors that impact on immunisation coverage, where they grouped the states in Nigeria into three tertiles–from the least to the most disadvantaged- but did not provide information on specific states in the various groups, making it difficult for programming purposes. Similarly, while Olorunsaiye and Degge (2016) went down to the state-level, their study only focused on immunisation coverage using 2013 NDHS, which is a subset of what the present study will cover. They found that at the state-level, female literacy had no association with child immunisation, but that state-level health care access (availability of facilities personnel) played more vital roles. Identifying distance to health facility, lack of finance, and the need to get permission as major barriers to a child's basic immunisation coverage.

Several works by Diddy Antai, while recommending further community-level studies on under-five mortality in Nigeria, threw more light on the advantages of community-level analysis over only multivariate analysis at the individual/household-level. From Antai and Moradi (2010) it was gathered that urban area disadvantage was a strong determinant of under-five mortality, in addition to the need to focus on maternal and child health (MCH) care interventions at the communities (Antai, 2011b). Furthermore, there is evidence that majority of the differences in under-five mortality by ethnicity were influenced by the proportions of women in the community who received pre-natal care from doctors (Antai, 2011a). Hence the need for MCH services to be made available to the communities, including community-based actions targeted at maternal education. Antai (2009) echoed in support of other literatures that the percentage of women in a community that deliver in a health facility is positively associated with high child immunisation coverage in the community. In addition, Antai (2011a) further stated that maternal age and education mediated the effect of ethnicity on under-five mortality. For instance, most mothers from Hausa/Fulani/Kanuri were aged 18 years or younger at their first birth, and largely uneducated, which affected their low health-

seeking behaviour, contributing to the high under-five mortality reported in the region (Antai, 2011a; Yaya et al., 2017).

2.6 Conclusion

This chapter identified key arguments and evidence in the literature on under-five mortality, showing that while much attention has been given to proximate factors, there are still significant gaps regarding broader socio-economic structural factors. These studies highlight the need for more community-level approaches in tackling high rates of under-five mortality in Nigeria and underscore the gaps in the literature on state level contextual factors driving differences in child mortality. Addressing this is an important aim of this study. Using NDHS data, this thesis builds on studies that have explored community level contextual determinants in Nigeria, with a particular focus on rural/urban and state level differentials. In so doing, it aims to aid in a better understanding of the persistently high-under-five mortality and spatial inequality in Nigeria.

CHAPTER THREE BACKGROUND OF COUNTRY CONTEXT

3.1 Introduction

This chapter situates under-five mortality in Nigeria in its wider historical, political, and social context. Tracing the colonial history of Nigeria, and the effects on the government, economy, and health system, is important for understanding the deep drivers of under-five mortality. Corruption and mismanagement of resources by government agencies pose key structural challenges to state development and limits a state's capacity to fund projects, but they cannot be incorporated into statistical analysis using NDHS data. These political dynamics adversely affect access to health facilities, availability of social infrastructure, and wealth distribution, invariably leading to health and income inequities at different levels of spatial aggregation. This chapter will further conceptualize a framework that will serve as a roadmap for this paper in exploring the underlying and state-level contextual determinants of under-five mortality in Nigeria. It will also highlight the interconnection between development and early childhood mortality, while discussing the demographic changes in the country over time.

3.2 Overview of Nigeria

Nigeria has great geographical diversity, with its topography characterized by two main landforms: lowlands and highlands. The uplands stretch from 600 to 1,300 meters above sea level in the North Central and the east highlands, with lowlands of less than 20 meters above sea levels in the coastal areas. The lowlands extend from the Sokoto plains to the Borno plains in the north, the coastal lowlands of western Nigeria, and the Cross River basin in the south. The highland areas include the Jos Plateau and the Adamawa Highlands in the north, extending to the Obudu Plateau and the Oban Hills in the South East. Other topographic features include the Niger-Benue Trough and the Chad Basin (Ajayi, Udo, Kirk-Greene, & Falola, 2023; National Population Commission Nigeria [NPC] & ICF International, 2014). Figure 3.1 below shows Nigeria's map with geographical boundaries.

Figure 3.1: Nigerian map, boundaries, and location
Source: By courtesy of Encyclopædia Britannica, Inc., copyright 2002; used with permission.

Furthermore, Nigeria has a tropical climate with wet and dry seasons associated with the movement of the intertropical convergence zone north and south of the equator. Its climate is influenced by the rain-bearing south-westerly winds and the cold, dry, and dusty north-easterly winds, commonly referred to as harmattan. The dry season occurs from October to March with a spell of cool, dry, and dusty harmattan wind felt mostly in the north in December and January, while the wet season occurs from April to September (NPC & ICF International, 2014). This climatic variation brings about seasonal food shortages, drought, and famine especially around the Sahel grassland areas in the northern parts of the country with less rainfall (Ittmann, Cordell, & Maddox, 2010).

The 2006[5] Population and Housing Census reported Nigeria's population to be 140,431,790, with a national growth rate estimated at 3.2 percent per annum. Nigeria is the most populous nation in Africa, and the seventh most populous in the world (NPC & ICF International, 2014). Currently, it has an estimated population of about 200 million people, and a life expectancy at birth of 53.7 years for males and 55.8 for females (NPC, 2019). The growth rate of 3.2 percent annually has policy makers concerned about an impending population 'explosion', especially given the youthful age structure and median age of 18 years (World Population Review, 2022), thus large cohorts moving into reproductive ages. Furthermore, Nigeria has an uneven population distributed across the country. The Chad Basin, the middle Niger Valley, and the grassland plains, for example, are sparsely populated while the southern parts are more densely populated. As of 2006, the average population density for the country was estimated at 150 people per square kilometer with substantial subnational variation. In the south the most densely populated states were Lagos (2,607 people per square kilometer), Anambra (868 people per square kilometer), and Imo (758 people per square kilometer). Kano, with an average density of 442 people per square kilometer, was the most densely populated state in the north (NPC & ICF International, 2014).

3.2.1 Colonial history, Government, and politics

The Nigerian pre-colonial and colonial eras established institutions that set the foundations for the development of the current government system, and by extension the developmental pattern across the country. It is imperative to understand this history to situate under-five mortality in Nigeria in its proper context. There is, for example, a well-documented imbalance in power sharing in which the north has dominated the government since independence in 1960. This has its genesis in strong alliances built between the British and the region during the colonial era through the indirect rule system (Josephson, 2017). It is also believed that, through an alliance of British and northern Nigerian power brokers, the 1953 Nigerian census results were inflated in favour of the north to ensure the region dominated the country once independent (Caldwell, Addo, Gaisie, Igun, & Olusanya, 1975; Manning, 2010).

[5] The 2006 Population and Housing Census is the last census conducted in Nigeria; subsequent population figures are projected.

Cultural differences and contact with Europeans in the pre-colonial era had huge impacts on western education in Nigeria. The southern regions had far earlier exposure to education due to their proximity to the Atlantic coast which were points of entry for the Europeans (Davis & Kalu-Nwiwu, 2001). Furthermore, the control of education by Christian missionaries instigated strict opposition to education by the Muslim dominant north, which led to the banning of missionary activities in the north by the British colonial government who were allies of the Muslim leaders. This resulted in the region being cut out from western education throughout the period it was run by the missionaries (Davis & Kalu-Nwiwu, 2001). Likewise, the decentralized government amongst the Igbos in the South East made them more receptive to new practices being introduced by the Europeans at the time, unlike the rigid traditional pattern of the Hausa-Fulani in the North East where leadership is more centralized and controlled by the caliphate (Davis & Kalu-Nwiwu, 2001). Moreover, religious, and cultural beliefs played key roles in the acceptance and rejection of western education by different regions during the colonial era since education was managed by Christian missionaries. To some extent religious and cultural beliefs continue to influence reproductive and health behaviours in Nigeria. Table 3.1 gives a brief chronological history of Nigeria, pre, during, and post-colonial era. A more detailed version can be found in Table A.1 of Appendix A.

Table 3.1: Chronological history of Nigeria

Period	Event
1100–1400 CE	Introduction of Islam into savanna and Sahelian states of Northern Nigeria.
1450–1850	Contacts with Europeans on the coast brought about monumental changes to the political, economic, and social institutions of Southern Nigerian states. The trade in slaves dominated relations between Nigerians and Europeans at the time, changing forever the histories of four continents as goods and people engaged in a growing transatlantic trade.
1804	Beginning of Islamic revolution that results in the creation of the Sokoto Caliphate in Northern Nigeria. The Sokoto Caliphate expands the frontiers of Islam and spread the religion beyond the ruling classes to common people to a greater extent than existed previously.
1841	The Niger Expedition marked the first attempt by Europeans and African Christians to spread Christianity into the interior of Nigeria. In 1846 Church Missionary Society (CMS) missionaries established a mission at Abeokuta; from that point Christianity spread rapidly in Southern Nigeria for the first time. A new elite emerged in the South, educated in European

	mission schools, and sharing many European cultural attributes. Christianity and Islam have since become the two dominant religions in Nigeria.
1861	British annexed Lagos as a Crown Colony.
1893	Establishment of a British protectorate over Yoruba territories in the South West.
1900	Creation of the Protectorate of Northern Nigeria. Extension of the Northern protectorate was concluded in 1903, when British forces conquered the Sokoto Caliphate and killed the Sultan.
1902–3	The Aro Expedition, part of the British effort to ‘‘pacify’’ the hinterlands of Eastern Nigeria.
1914	Amalgamation of Northern and Southern protectorates. Before this time, there were over 350 cultural, ethnic, and linguistic groups that lived in kingdoms and emirates with sophisticated systems of governance, such as the Oyo, Benin, Nupe, Jukun, Kanem-Bornu, Hausa-Fulani empires, Igbos, Ibibios, Ijaws, and Tivs amongst others, who still claimed their own separate language, heritage, and culture even after being called a nation-state.
1923	Establishment of the Clifford Constitution, which allowed for elected representation in the governance of Nigeria for the first time.
1929	Aba women riot, a major protest against British indirect rule in South Eastern Nigeria took place.
1944	Nnamdi Azikiwe founded the NCNC, the National Council of Nigeria and the Cameroons (later Nigerian Citizens), which immediately became an influential political party that pushed for the independence of Nigeria from British colonial rule. In the same year Mrs. Olufunmilayo Ransome-Kuti founded the Abeokuta Ladies’ Club, later renamed the Abeokuta Women’s Union (AWU), to lobby against the injustices of colonial indirect rule.
1946	The Richards Constitution was enacted, it provided a central legislature and divided Nigeria into three regions: North, West, and East. This is the first set of constitutional reforms that led to independence for Nigeria.
1948	First university in Nigeria established in Ibadan.
1956	Petroleum discovered in the Niger delta region.
1957	Regional self-government attained in the East and West.
1959	Regional self-government attained in the North.
1960	Nigeria becomes independent from the United Kingdom on October 1.
1963	Nigeria becomes a republic, replacing the queen with an indigenous president as the symbolic head of state.
1967	Emeka Ojukwu declared independence of Eastern region as the Sovereign Republic of Biafra on May 30. In the same year Gowon created twelve states out of the existing three regions. From this point, there was constant clamour for the creation of more states. Since 2000 Nigeria has been made up of thirty-six states and a Federal Capital Territory (FCT) at Abuja,

	with 774 Local Government Areas divided into North Central, North East, North West, South East, South South, and South West geo-political zones.
1967–70	Civil war between the forces of the Federal Military Government (FMG) and Biafran separatists. War ended with the surrender of Biafra on January 12, 1970, and the reincorporation of Biafra into Nigeria.
1973	Rising price of oil resulted in a booming economy for Nigeria. Since this time Nigeria has been heavily dependent on its oil exports to supply government revenues.
1985	General Ibrahim Badamasi Babangida overthrew the Buhari regime on August 27. Under Babangida the Nigerian economy continued its decline and saw the implementation of Structural Adjustment Programme (SAP).
1991	The Federal Capital Territory was moved from Lagos to Abuja.
1995	Ken Saro-Wiwa and other members of the 'Ogoni Nine' were executed. The executions became a symbol of the tyranny of the Abacha regime and resulted in international protest and condemnation.
1999	The Fourth Republic commenced with a democratic civilian rule under the leadership of President Olusegun Obasanjo.
2006	National Population and Housing Census was conducted, with Nigeria's population recorded at over 140 million.

Source: Davis & Kalu-Nwiwu, 2001; Falola & Heaton, 2008; Josephson, (2017)

Despite obvious women's active participation in economic and political activities at the time, especially in the south, the colonial regime ran a patriarchal administration (Korieh, 2010). British officers only involved men in local administrative roles as messengers, interpreters, policemen, army recruits, and warrant chiefs (Korieh, 2010). This triggered significant gender problems and was one of the reasons underlying the women's riot of 1929 in Aba South East Nigeria.[6] The missionaries were used by the colonial officers to train women in domestic science and homemaking (cooking, craft, weaving etc.) to achieve their perceived rightful roles in a Christian home (Korieh, 2010). This created a gender divide where women were seen as less economically productive than men, with the more lucrative jobs reserved for the men while women were relegated to jobs with less economic value. The neglect of

[6] The Aba Women's riot of 1929, which was the first major revolt by women in West Africa, protested the British indirect rule system through the imposition of direct taxation and the introduction of warrant chiefs and new local courts. The riot which comprised of thousands of women from six ethnic groups (Igbo, Efik, Ibibio, Andoni, Ogoni, and Ijaw) also accused the warrant chiefs of restricting the role of women in the government. The aftermath of the riot brought about reforms that led to the abolishment of the warrant chieftains by the colonial government, and appointment of women to the native court system in 1930.

women by the British colonial officers also advanced gender inequality in education, because men were educated to fill local administrative roles while women were given vocational training, particularly on how to take care of the home (Korieh, 2010). Consequently, this pattern was further deepened during the implementation of the structural adjustment programme (SAP) in Nigeria where female education was discouraged when fees were introduced by the government, as educating male children was seen as more important (Marphatia, 2010; Obasi, 1997).

3.2.2 Economic development and natural resources

To understand the Nigerian economy, it is pertinent to note that it is mainly driven by a foreign-oriented trade structure put in place by the British government and its allies during the colonial regime. The trade pattern can be said to be detrimental to the development of Nigeria as it has continued to serve the interest of the British economy (David, Asuelime, & Onapajo, 2015). Subsequently, this also influenced oil exploration in Nigeria, which is largely controlled by foreign multinational companies, where crude oil is being exported from the country at a low price and finished products imported back to the country at high prices, to the loss of Nigerians and the development of oil refineries in the country (David et al., 2015; Obi, 2010; Ogene, 1988; Olaitan, 1995; Omoweh, 1995). Before the commercialization of oil in the 1970s, agriculture was the mainstay of Nigeria's economy, so much so that 85 percent of the nation's total export was from agriculture. Nigeria was the world's leading producer of groundnut as well as a major exporter of cocoa, cotton, hides, and rubber (David et al., 2015; Walker, 2000). The country had depended largely on agricultural production for food, and agro-industrial raw materials for foreign exchange earnings through the commodity trade. At the time of independence in 1960, agriculture provided gainful employment and a satisfactory livelihood to more than 90 percent of the population (David et al., 2015; NPC & ICF International, 2014). Over the years, the dominant role of agriculture in the economy, especially in terms of the country's foreign exchange earnings, gave way to petroleum exports. Today the country's political economy is largely dependent on crude oil production (David et al., 2015; Walker, 2000).

The discovery of large quantities of crude oil in Oloibiri, Bayelsa State in 1956, and subsequently in other locations in the Niger Delta,[7] made the region a significant player in Nigeria's political economy since oil is currently the mainstay of the economy. Export earnings due to crude oil production rose from one percent in 1958 to about 98 percent in the 1990s (Oluwaniyi, 2011). However, with the exploration of oil by the Nigerian Government through the Nigerian National Petroleum Corporation (NNPC) in joint ventures with transnational oil companies such as Shell, Agip (Eni), Texaco, Total, Chevron, and ExxonMobil came other problems for the Niger Delta region. These problems include increased transfer and control of oil revenues by the federal government, environmental impacts of oil exploration activities in the region, oil spillage, and mismanagement of resources (Obi, 2010). Worthy of note is the pollution of Ughelli area of Delta state, with subsequent negative impact on population health due to continuous gas flaring activities by Shell (Omoweh, 1995).

The neglect of the Niger Delta by the Nigerian government is also evident by the continuous downward review of their share in the derivation principle of oil allocation, which went from 50 percent in 1966 to only three percent in the 1980s, and then upwardly to 13 percent in 1999 (Obi, 2010; Oluwaniyi, 2011). Oil exploration led to the pollution of the waterways, soil, and forest of the Niger Delta region, with huge negative impacts on the agricultural activities of the region leaving them in abject poverty. These acts of neglect, deprivation, and impoverishment of the ethnic minority people of the Niger Delta region by the government and oil companies gave rise to different conflicts and the formation of local militancy groups to fight for the control of oil revenues. Subsequently, in its bid to address the lack of development and economic deficit in the region, the federal government established various commissions including the Petroleum (Special) Trust Fund (PTF) in 1995, and the Niger Delta Development Commission (NDDC) in 2000 (Obi, 2010; Oluwaniyi, 2011).

Due to the country's large dependence on oil, coupled with mismanagement of resources, and widespread government corruption, the oil crisis that started in 1973 had major adverse impacts on the economy. To meet budgetary needs, the country resorted to borrowing from

[7] States in the oil-producing Niger Delta region are Abia, Akwa Ibom, Bayelsa, Cross River, Delta, Edo, Imo, Ondo, and Rivers States located in the South East, South South and South Western geo-political zones of Nigeria.

the IMF and World Bank which consequently led to the introduction of the structural adjustment programme (SAP) in 1986 (Ahmed, 2007). The SAP was imposed on Nigeria by IMF and World Bank due to its high level of indebtedness to them. It required that Nigeria devalue her currency, liberalize her economy through deregulation of trade, privatize services and state-owned companies, reduce funding of social services, and retrench the work force. SAP ensured that huge funds were transferred from Nigeria to advanced countries, and this was the same pattern for other indebted developing nations, which was detrimental to their economic growth (Ahmed, 2007).

Reduction of spending on social services in Nigeria, in line with SAP stipulations, led to the introduction of user-fees for services provided by the government such as health clinics, schools, and clean water supply (Ahmed, 2007; Skosireva & Holaday, 2010). In the 1980s, introduction of user-fees was done through the drug revolving fund schemes (DRF), which was non-existent in the 1970's during the oil boom. As a result of this, the use of health services by the poor populace reduced (Ahmed, 2007). It has been argued that the impacts of these reforms through the years led to the current socio-economic challenges such as unemployment, a high inflation rate, poor health services, income inequity, lack of social infrastructures, and poor quality of living being faced by many Nigerians, irrespective of social class and region (David et al., 2015; Jega, 2000; Olukoshi, 1984). According to Momoh (1995) SAP ended up creating a "rich lazy class." The rural majority who were the 'target' group saw few benefits. A key reason was the improper implementation of the programme. Amongst other actions, public enterprises were sold at absurdly low prices, back to the same people who had mismanaged them (Momoh, 1995).

Despite Nigeria's abundant human and natural resources, the 2019 Human Development Reports (HDR) of the United Nations Development Programme (UNDP) ranked Nigeria 158 in Human Development Index (HDI) out of 188 countries and reported that about 53 percent of the populace live below the income poverty line of $1.90 (using price purchasing power (PPP)) a day (UNDP, 2019). Nigeria has high income inequality with huge gaps between the rich and the poor, where Gini coefficient worsened from 0.35 in 2004 to 0.41 in 2013 and improved slightly to 0.39 in 2016 (NBS, 2018). Similarly, there was an increase in the population living in rural areas, from 56.3 percent in 2003-04 to 63.8 percent in 2009-10 (NBS, 2010). Income inequity is also evident between and within states. As can be seen from

Table 3.2, Oyo state had the lowest poverty rate in the country as at 2003-04, with 38 percent living in poverty, while in 2009-10 Osun state recorded the lowest rate of 37.5 percent, whereas Jigawa state had the highest number of people living in poverty at both times, at 95.3 percent in 2003-04 and 88.5 percent in 2009-10.

Lagos achieved a 29 percent reduction in poverty between the surveys, making it the state with the highest reduction in poverty (NBS, 2010). As pointed out by previous studies, the link between poverty and under-five mortality is reinforced by the poverty rate in different states in Nigeria (Ahmed, 2007; Fotso, 2006; Hong, Banta, & Betancourt, 2006; Sanders & Carver, 1985). The northern zones with higher poverty rates also have higher under-five mortality rates when compared with the southern zones. In addition, states with lesser income have lower capacity to finance social services at the macro level.

Table 3.2: Headcount per capita poverty measure (%) for Nigeria by national, residence, and state.

	2003-04	2009-10
National	**64.2**	**62.6**
Rural	73.4	69.0
Urban	52.2	51.2
North Central		
Benue	64.7	73.6
FCT (Abuja)	53.3	45.5
Kogi	91.8	67.4
Kwara	87.8	72.1
Nasarawa	66.1	78.4
Niger	64.4	51.0
Plateau	68.5	72.4
North East		
Adamawa	76.6	77.8
Bauchi	87.8	84.0
Borno	59.8	60.6
Gombe	73.1	81.6
Taraba	60.5	68.3
Yobe	88.0	81.7
North West		
Jigawa	95.3	88.5
Kaduna	54.2	64.0
Kano	59.4	70.4
Katsina	72.9	77.6
Kebbi	90.8	72.5
Sokoto	75.2	86.1

Zamfara	84.0	67.5
South East		
Abia	40.9	50.2
Anambra	41.4	53.7
Ebonyi	63.2	82.9
Enugu	50.2	60.6
Imo	46.7	39.4
South South		
Akwa Ibom	56.8	51.0
Bayelsa	40.0	44.0
Cross River	67.0	60.4
Delta	70.6	53.8
Edo	53.6	64.1
Rivers	56.7	47.2
South West		
Ekiti	60.4	55.9
Lagos	69.4	40.3
Ogun	49.9	57.6
Ondo	62.8	57.7
Osun	44.6	37.5
Oyo	38.0	50.8

Source: NBS, (2010)

Umar, Ismail, and Abdul-Hakim (2013) used the Thiel index to measure educational inequality across geo-political zones and reported higher levels of inequality in the north. The highest index was in the North West at 0.49 compared to the lowest of 0.16 in the South South (the northern regions had indices of 0.30 and above while the southern regions were less than 0.20). Furthermore, using household assets data collected from the 2012 National HIV/AIDS and Reproductive Health Survey (NARHS Plus 2), Fagbamigbe et al., (2015) constructed a wealth quintile for households across states and geopolitical zones in Nigeria, which gives a better picture of the inequity index within states. Table 3.3 shows that poverty inequality is higher in the north, particularly North East and North West, than in the south.

Table 3.3: Distribution of wealth quintiles by geo-political zones and states

State	Lowest	Lower	Middle	Higher	Highest	Population
North Central	**16.0**	**21.8**	**21.3**	**19.0**	**21.9**	**5,635**
Benue	27.1	23.8	19.0	16.9	13.3	728
FCT (Abuja)	0.7	4.8	14.1	25.3	55.1	724
Kogi	4.2	15.0	30.3	27.2	23.3	838
Kwara	12.3	10.2	18.8	31.1	27.5	861
Nasarawa	23.4	37.0	25.8	8.2	5.6	765
Niger	21.3	27.7	21.4	15.4	14.2	855
Plateau	22.9	33.0	19.1	8.6	16.4	864
North East	**41.7**	**29.3**	**13.8**	**8.5**	**6.8**	**4,673**
Adamawa	23.7	32.2	18.2	13.2	12.8	721
Bauchi	34.6	26.9	18.9	11.9	7.6	866
Borno	49.3	34.2	11.2	4.2	1.2	816
Gombe	36.7	27.9	15.6	11.2	8.6	795
Taraba	45.9	28.6	12.0	6.2	7.3	936
Yobe	65.9	24.9	3.9	3.2	2.2	539
North West	**40.9**	**27.7**	**14.6**	**8.9**	**7.9**	**6,179**
Jigawa	46.8	31.2	12.6	6.4	3.0	897
Kaduna	10.4	29.0	24.7	17.7	18.1	938
Kano	31.3	23.2	18.3	12.5	14.7	672
Katsina	40.8	30.8	16.3	7.0	5.2	892
Kebbi	48.8	26.5	11.0	6.8	6.8	952
Sokoto	49.9	20.8	12.7	9.4	7.1	897
Zamfara	56.3	31.0	7.4	3.3	1.9	931
South East	**6.9**	**13.3**	**26.2**	**27.6**	**26.0**	**4,301**
Abia	0.8	6.9	26.7	31.6	34.2	919
Anambra	1.6	7.1	23.5	33.1	34.6	910
Ebonyi	28.2	34.7	24.1	8.1	5.0	877
Enugu	3.3	16.4	29.9	22.7	27.7	669
Imo	0.4	3.5	27.6	40.5	28.0	926
South South	**5.6**	**13.3**	**26.0**	**27.5**	**27.8**	**4,994**
Akwa Ibom	6.0	16.0	30.8	26.7	20.6	938
Bayelsa	8.4	19.5	26.2	25.1	20.8	821
Cross River	7.8	19.2	29.7	22.2	21.1	871
Delta	4.0	7.4	24.2	28.0	36.3	900
Edo	1.3	7.7	23.0	34.6	33.5	819
Rivers	5.9	8.7	19.7	29.0	36.7	645
South West	**4.4**	**12.3**	**19.8**	**31.5**	**32.1**	**5,073**
Ekiti	3.5	17.6	25.4	29.1	24.3	879

Lagos	0.0	1.6	10.0	30.3	58.1	852
Ogun	3.8	14.6	21.4	32.8	27.5	899
Ondo	5.8	16.8	22.6	27.9	26.8	619
Osun	2.4	4.3	21.2	42.1	30.0	921
Oyo	11.1	19.7	18.8	25.1	25.2	903

Source: Fagbamigbe et al., (2015)

In many developed and developing nations, an increase in GDP is usually followed by investment in education, healthcare, and social services, resulting in improved child survival (Rosling, 2006). This is not the case in Nigeria. Instead, the country has experienced persistently high under-five mortality rates despite a steady rise in GDP from the 1990s as shown in Figure 3.2. Although other regions such as Europe, North America, and Eastern Asia are experiencing a declining fertility leading to structural ageing, increase in life expectancy and a decline in the percentage of the population at the working ages, Nigeria is experiencing a growth in its workforce due to high fertility (UN-DESA, 2019b). With more than half of its population aged 15 to 65 years, Nigeria has the potential to witness accelerated economic growth and capitalise on its 'demographic dividend' (Bloom & Canning, 2003). However, this requires that the government make investments in education and heath a priority, while providing an enabling environment for continuous economic growth (UN-DESA, 2019b). This can be done through provision of quality and affordable education up to secondary level, creation of more job opportunities and support for private enterprise, as well as provision of health services and basic social infrastructure.

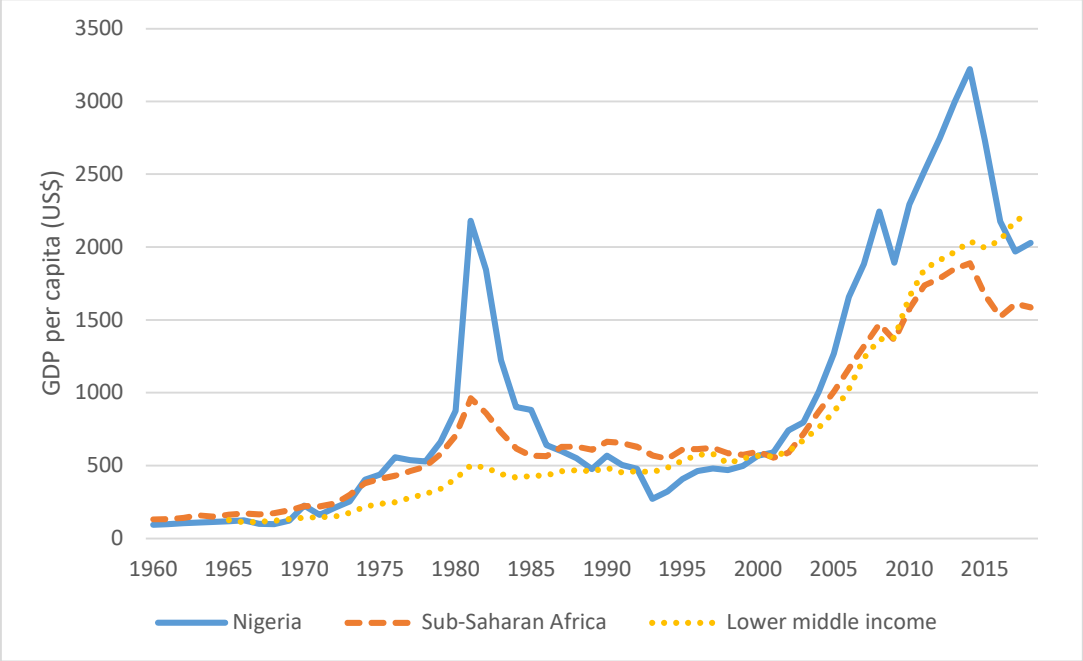

Figure 3.2: Nigeria's GDP per capita with aggregates
Source: World Bank, (2019)

3.2.3 Health system and structure

As a result of colonial capitalism, health services were initially located in areas such as Lagos, Jos, Kano, and Kaduna where high profit was expected (Ityavyar, 1988). Post-independence health establishments followed the same pattern which has given rise to regional and urban-rural inequalities in the development of health care services. This is more so the case with private medical practice that is highly driven by demand and income (Ityavyar, 1988). These inequalities in the location of health facilities have contributed to unequal access to health care, thereby permeating state-level differences in under-five mortality. Ityavyar (1988) argued that the concentration of missionaries in the southern regions over a long period could also be an early factor in the development of the north-south patterning of health inequalities. Nigerian health care delivery has gone through series of reforms from when the first hospital was built by the Roman Catholic Mission in 1885 (Scott-Emuakpor, 2010) to having more than 34, 000 public and private owned health facilities offering different levels of care (FMOH Nigeria, 2018). After the civil war, and subsequent division of the nation into more states, health care became the state's responsibility with each planning, maintaining, and staffing its own projects (Pearce, 1980). The health system is thus highly fragmented, and there are major challenges in trying to implement federal government reforms.

The Nigerian health care system is fashioned after the British health system (Mcdikkoh, 2010), with public and private sectors providing modern and traditional care. More than 60 percent of Nigeria's health care delivery is provided by the private sector, with the rest provided by the public sector under the purview of the three tiers of government (FMOH Nigeria, 2018). As shown in Figure 3.3, local government areas (LGA) are responsible for providing primary health care (PHC) services, state governments provide secondary level care, and the federal government delivers care at the tertiary level. This three-tier system further creates state-level differences in the provision of health care at the primary and secondary health care levels as there are different administrators in the states. In addition to tertiary health care provision, the federal government through the Federal Ministry of Health (FMOH) leads the development and implementation of specific public health programmes, such as the National AIDS and STDs Control Programme (NASCP), National Malaria Elimination Programme (NMEP), and National Tuberculosis and Leprosy Control Programme (NTLCP). The federal and state health ministries, departments, and agencies (MDAs) manage the implementation of these programmes at all levels of government (FMOH Nigeria, 2018).

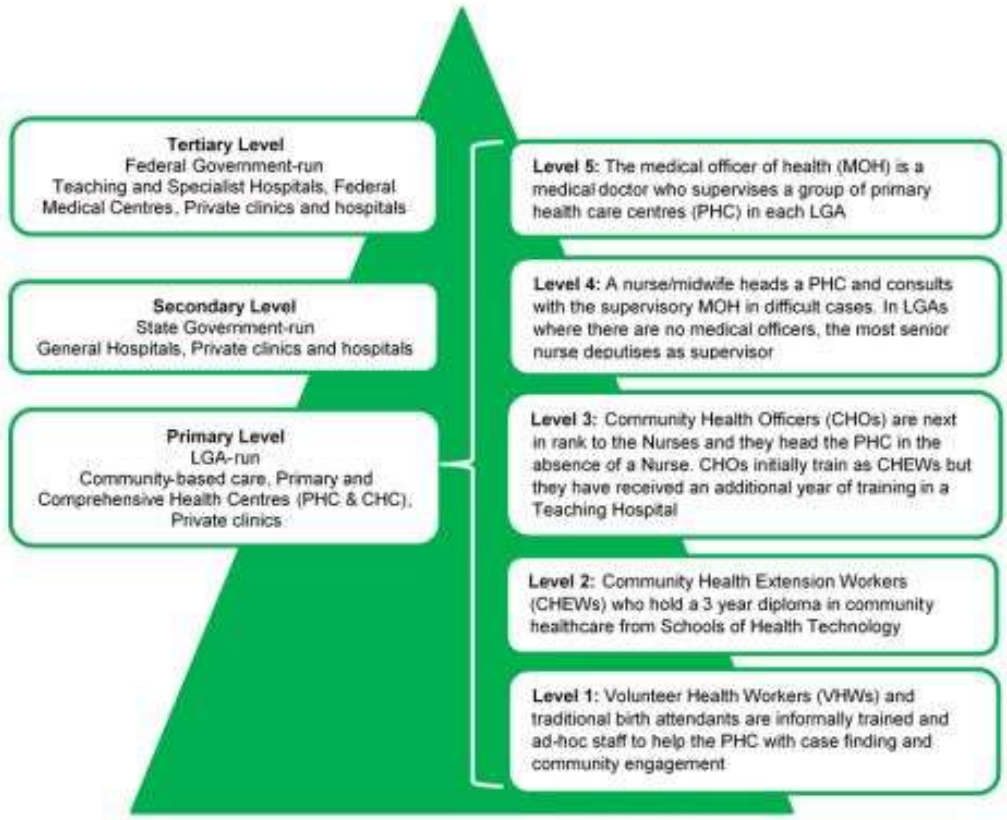

Figure 3.3: Nigeria's health care system
Source: FMOH Nigeria, (2018)

As noted earlier, the implementation of SAP contributed negatively to health care delivery and child health in Nigeria and other sub-Saharan African countries as the introduction of user fees by government health centres resulted in a decline in access to health care. For instance, after the imposition of user fees, the University of Jos Teaching Hospital recorded a massive drop in average monthly deliveries from 800 births to 160 births (Hong, 2000; Owoh, 1996; Skosireva & Holaday, 2010). The number of healthcare providers in the public sector also declined due to wage cuts and job loss. In addition, since SAP increased poverty income inequities and reduced access to healthcare, there was an increased women's participation in the labour force which resulted in a noticeable decrease in breastfeeding time, and an increase in early weaning (Lugalla, 1995; Skosireva & Holaday, 2010).

Negligent and corrupt practices by public officeholders in Nigeria have contributed to a failing health system which impacts under-five mortality. Little wonder that Nigeria is

consistently ranked low in the Transparency International's corruption perceptions index (CPI), ranking 146 out of 180 countries in the measure of public sector corruption from the 2019 CPI report (Transparency International, 2019). The literature suggests that government allocates limited resources to education, health, and infrastructural development while spending huge sums on military, and other coercive state institutions. What little is allocated to health care does not achieve much because of misappropriation (David et al., 2015; Yaqub, Ojapinwa, & Yussuff, 2012). This is important because studies have shown that the share of GDP spent on public health care is positively associated with a lower infant mortality rate (Przeworski, Alvarez, Alvarez, Cheibub, & Limongi, 2000), although others have found this only to be the case for countries with good governance (Rajkumar & Swaroop, 2008). Poor governance is a major problem in effectively implementing programmes in Nigeria, as persistent corruption results in a wastage of limited resources and enrichment of the ruling class (David et al., 2015; Dike, 2005). McGuire (2006) argues that, in developing countries, improved maternal and infant health services steadily lower levels of under-five mortality more than overall increased health care spending does.

As at 2017, the government health spending was $11 billion, only about 3.7 percent of GDP, while out-of-pocket spending on health was about $60 billion, and an upgrade in the Universal Health Coverage (UHC)[8] effective coverage index of Nigeria from 31.6 in 2010 to 38.3 in 2019 (IHME, 2017; NBS, 2016). According to the Institute of Health Metrics and Evaluation (IHME) the three major determinants of premature death in Nigeria are neonatal disorders, malaria, and diarrhoeal diseases (IHME, 2017). Unfortunately, the system has not effectively tackled these health challenges. The poor outcomes in health policy and intervention programmes can also be traced to the complex nature of Nigeria's health system. Because of the size of the country and its decentralized health system, health policies or programmes are executed in a phased manner starting from the Ministry of Health at the top and then gradually adopted at the state and local levels. This leads to differentials in the speed and intensity of adoption, resulting in wide variations in implementation and health outcomes among states and local areas, sometimes taking years before interventions reach all states (Wollum, Burstein, Fullman, Dwyer-Lindgren, & Gakidou, 2015). However, as a way of

[8] The Universal health Coverage (UHC) effective coverage index aims to represent service coverage across population needs and how much these services could contribute to improved health. In other words, it measures how well a country or territory is providing effective, essential health services.

increasing access to health care across the states, some state governments have taken the initiative of launching intervention programmes within their states. For instance, Enugu state government started the free maternal and child healthcare pogramme in 2007, which saw the elimination of user fees at the point of service delivery for pregnant women and under-five children based on a minimum service package (Ogbuabor & Onwujekwe, 2018).

In 1988, Nigeria formulated a national health policy to deliver quality health, with the policy further reviewed due to emerging issues in healthcare delivery. The Revised National Health Policy launched in September 2004 aimed to provide satisfactory access to primary, secondary, and tertiary health care services for the entire country using a functional referral system (NPC & ICF International, 2014). The primary principles and values of the policy are as follows:

1. Social justice, equity, and the ideals of freedom and opportunity affirmed in the 1999 Constitution of the Federal Republic of Nigeria are basic rights.
2. Health and access to quality and affordable health care are human rights.
3. Pursue equity in health care for all Nigerians as a goal.
4. Primary health care (PHC) remains the basic philosophy and strategy for national health development.
5. Assure good-quality health care through cost-effective interventions targeted at priority health problems.
6. Maintain a high level of efficiency and accountability in the development and management of the national health system.
7. Pursue effective partnerships and collaborations between various health sectors while safeguarding the identity of each (NPC & ICF International, 2014).

In the recent past, Nigeria has experienced both progress and challenges in providing safe, accessible, and affordable health care in a country where 80 percent of health facilities are dysfunctional (FMOH Nigeria, 2018). In tackling health care challenges, the federal government proposed to provide at least one functional PHC per ward, linked to a functional secondary health facility with qualified personnel in each LGA. As well as upgrade specialist and tertiary hospitals to meet local needs including the establishment of a comprehensive and efficient referral system (FMOH Nigeria, 2018). In line with strengthening primary health care, the National Primary Health Care Development Agency (NPHCDA) was set up as a

FMOH agency to function in partnership with states and LGAs, with active involvement at the grassroots to develop community-based systems and functional infrastructure. This included ensuring that women deliver their babies in safe conditions, and that infants receive full immunisation against vaccine-preventable diseases. In collaboration with states, they also implemented the national campaign against polio and measles (FMOH Nigeria, 2018; Timothy et al., 2014). Other health agencies such as the National AIDS Control Agency (NACA) and the National Malaria Control Programme (NMCP) are responsible for the development and implementation of policies, and programmes that directly affect the survival and health outcomes of women and children (Timothy et al., 2014).

3.2.4 Conceptual Framework

Most studies on early childhood mortality have focused on some set of variables within the individual and household levels. As mentioned in Chapter Two, few have also attempted to investigate a wider range of factors on a multilevel scale (Adedini, 2013; Antai, 2009; Ononokpono, Odimegwu, Imasiku, & Adedini, 2014). Based on the purpose of the study, some studies have found significant associations between under-five mortality and specific factors, while some have found no association, even amongst those within Nigeria. Though there are different ways to conceptualize a study on under-five mortality, this thesis draws on prior research and the setting of Nigeria to develop a conceptual framework focused on social determinants of under-five mortality, summarized in Figure 3.4. The arrows in Figure 3.4 show the direction of influence and highlight the paths through which the different indicators at different levels can influence each other to produce variations in early childhood mortality.

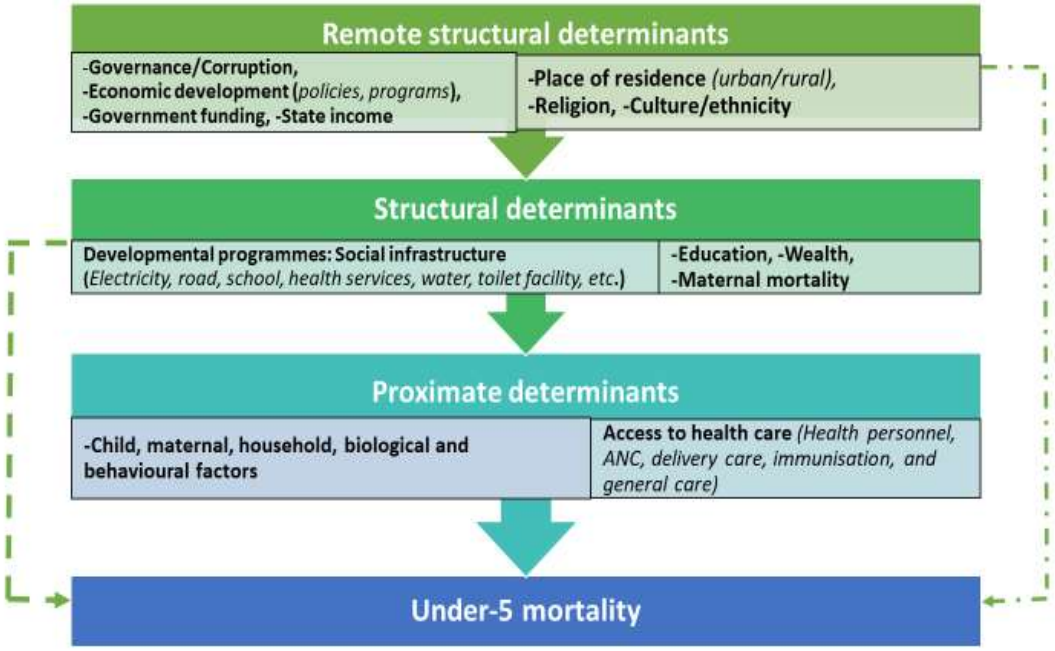

Figure 3.4: Conceptual framework of structural and proximate determinants of inequity in under-five mortality in Nigeria

The conceptual framework used in this study is in three levels, grouped into proximate and structural determinants. The proximate determinates are the factors that directly impact on a child's exposure to mortality risks. These include child factors, maternal biological and behavioural factors during reproductive years, household factors such as nutrition and environmental contamination, and access to quality health care. The structural factors, however, comprise a broader range of factors connected to communal context and the subsequent socio-economic status of individuals, households, and communities. These structural determinants are further divided into two levels: remote and intermediate. The remote level comprises the factors associated with the political, socio-economic, religious, and cultural context. This level includes governance, laws and policies, economic developmental programmes, and social norms and values. These factors, though difficult to assess, are the central elements of society that play key roles in the distribution of power and resources to different population groups in society. The intermediate level addresses the factors associated with the direct socio-economic status of individuals, households, and communities such as education, wealth quintile, and social infrastructures, as well as the impact of maternal deaths on the surviving children. The remote structural factors determine

access to social services and opportunities, hence leading to disparities and inequalities in the socio-economic status of individuals and households at national and sub-national levels.

As primary caregivers, there is a knowledge gap on the important interaction between maternal mortality and early childhood survival in Nigeria. However, studies in similar developing countries show the survival trajectory of the children to be far worse than those of mothers who do not die postpartum, and with far-reaching effects (Finlay et al., 2015; Moucheraud et al., 2015). Another study on the association between child's death and mothers' deaths from breast or cervical cancer in low- and middle-income countries showed that children of women who died before they reached ten years had increased risk of death from all causes (Mailhot Vega et al., 2019).

The conceptual framework is derived from the underlying premise that the remote structural determinants strongly influence variations in under-five mortality. This influence occurs indirectly. Social variations in community socio-economic status are generated, which in turn affects inequality in the socio-economic status of individuals and households. Variations in individual and household socio-economic status play a central role in forming the proximate determinants of mortality amongst children under five. Clearly, inequalities in place of residence (rural, urban), and between and within states, is associated with child survival outcomes in Nigeria. Possible explanations are poor socioeconomic factors within the community and inability of households with low income to pay for health services in the absence of universal health care, especially for maternal women and children below the age of five. The disproportionate establishment of health facilities that make it difficult for rural residents to easily access healthcare has also been traced to the capitalist nature of the colonial regime where location of facilities was driven by profit. Proper understanding of these structures within states, and their effects on under-five mortality as captured in Figure 3.4, will help provide answers to the research questions and proffer additional knowledge on improving survival outcomes of children in Nigeria.

3.3 Early childhood mortality as a measure of development in Nigeria

Early childhood mortality is a powerful indicator of a country's level of development. In a general sense, development can be defined as a practice that brings about positive transformation (Stiglitz, 2008), be it an improvement in physical, economic, political, demographic, social, and environmental components of a society or institute. Development transcends all aspects of human life and has a close association with population change (McNicoll, 2003), with its presence or absence evident in the wellbeing of the people. Economically, it entails advancement from a subsistent to an urban-industrialised economy, with sustained increase in productivity and income. Political development refers to structures to ensure that the values and institutions of a state are efficient (McNicoll, 2003). Sen (2001) argues that development is a means of expanding the freedom enjoyed by all people.

There are many ways to measure development as a process and a status. The UNDP carries out cross-national comparison with the Human Development Index using life expectancy, education and GNI per capita as indicators to estimate quality of life (UNDP, 2019). Population studies view development from the lens of improvement in living standards, health, and child survival. These indicators are seen as important aspects of human development, since they are largely driven by development policies (NPC & ICF International, 2019; United Nations, 2017; Wilmoth, 2003). Given that this study focuses on early childhood mortality, it provides an important window into Nigeria's state of development. Child survival outcomes speak volumes about a country's level of inequity, education, healthcare delivery, and socio-cultural development. These factors operate at the macro, meso, and micro levels to impact on childhood survival. I now turn to an overview of the demographic changes in Nigeria to further elucidate development in Nigeria.

3.3.1 Population growth and pattern

Nigeria has experienced steady population growth, with a pre-independence population of about 38 million in 1950, increasing to 95 million in 1990, and just over 206 million in 2020 (UN-DESA, 2019a). By 2050, Nigeria is projected to be the third largest country after India and China, with approximately 401 million people. Its fertility rate of around five children per woman has barely changed in 60 years (NPC & ICF International, 2019; UN-DESA, 2019b). There is an ongoing debate on whether rapid population growth affects development

and technological advancement (McNicoll, 2003). Labour is a major factor of production supplied by the population. A large youthful population provides possibilities for economic growth, but the dilemma lies in the quality of the input, which hinges on human capital development.

Nigeria's age structure, which is a broad-based pyramid, has not changed much over a long period. The population under age 15 increased slightly from 42 percent in 1950 to 44 percent in 2020, while those aged 65 and above have remained at three percent from 1950 to date. Currently, Nigeria has a high total dependency ratio of 190.9 per 100 persons in the working age of 25-65 years, which puts some strain on the working population, potentially leading to chronic stress and its attendant adverse social and health conditions (UN-DESA, 2019a). The current age structure of Nigeria shown in Figure 3.5 portends an ongoing momentum for growth -on average 54 percent of the population have been in the economically active ages of 15-64 years since 1950 (UN-DESA, 2019a). This demographic dividend window, where more people have the potential to be productive and contribute to the development of the economy, offers Nigeria a timebound opportunity to gain labour, savings, and human capital (Bloom, Canning, & Sevilla, 2003; Pool, 2007).

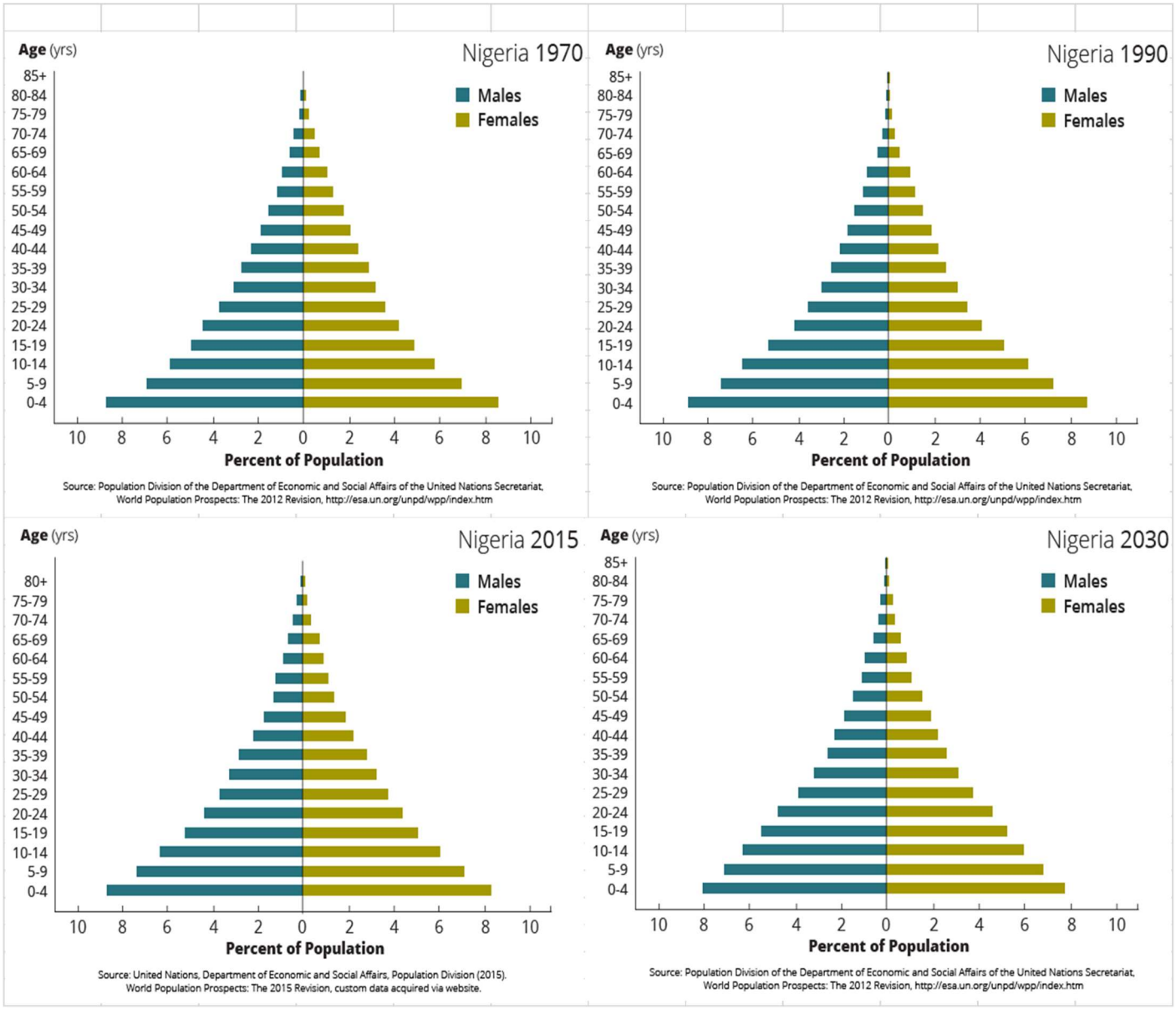

Figure 3.5: Nigeria's population pyramid showing age structures in 1970, 1990, 2015, and 2030

Source : http://www.demographicdividend.org/country_highlights/nigeria/

3.3.2 Demographic transition

Demographic transition refers to reductions in mortality and fertility from the high rates typical of a premodern and low-income societies to the low rates associated with modern and high-income societies, a reflection of the income and development stage of the society (Casterline, 2003). It is the process by which countries move from high fertility and mortality and stable population in contexts with low technology (pre-industrial) to low fertility and mortality and stable or declining population. So, there is an assumed relationship between

demographic behaviour and development. Notestein (1945) provided the original formulation of the demographic transition based on his observations of population change in Europe. He predicted that changes to the demographic balance of populations of different European regions would peak around 1950 followed by a subsequent decline. The transition occurred in three stages: pre-transition stage which is characterised by high mortality and high fertility; transition stage characterised by declining mortality and fertility, leading to population growth since reductions in mortality precede decline in fertility; and post-transition stage characterised by low mortality and low fertility. A major criticism of demographic transition theory is that it assumes that countries always progress through the various (three to five) stages as they 'modernize', and that mortality decline always precedes fertility decline (Kirk, 1996). Nevertheless, the demographic transition theory is still widely accepted among social scientists, and scholars have attributed mortality decline to factors associated with 'modernisation' such as economic development, political stability, improvement in standards of living, improved healthcare, and personal hygiene (Casterline, 2003; Preston, 2007).

Preston (2007) argued that in less developed countries, political stability and good governance complemented the effects of economic change by providing improved access to food and public sanitation resulting in mortality decline. However, fertility reduces in response to forces of mortality, economic, and technological changes. With declines in child mortality comes the associated challenge of child upkeep, making it more difficult to support large families, while economic growth followed by increasing standards of living and urbanization also drive declining fertility (Casterline, 2003; Notestein, 1945). In outlining the relationship between mortality and fertility, Cleland (2003) argued that early death of a child ends breastfeeding, shortens protection from lactation, and in most cases reduces interval to next birth because of the need to replace the dead child. Conversely, improved child survival reduces the tendency to replace dead children, increases birth intervals, and raises the cost of childbearing, where population growth becomes a threat to living standards (Cleland, 2003). In other words, high child mortality is a causal factor for high fertility, while improved child survival is associated with reductions in fertility.

Nigeria is in the second stage of demographic transition with decreasing mortality and high fertility rates, resulting in accelerated population growth due to natural increase (Casterline,

2003; Pool, 2007). Research has shown that there are differentials in mortality and fertility decline across the country, with states and individuals belonging to higher socio-economic status having fewer deaths and births than those of lower status, even though fertility is not reducing at the same pace as mortality in Nigeria. Like global trends, the timing, pace, and order with which sub-national mortality transition in each population can happen depends on geographical variations, gender differentials, and socio-economic inequalities (Vallin & Meslé, 2004).

Unlike mortality change, there has not been much decline in fertility in Nigeria. It remained at an average of six live births per woman from 1950 to 2010, reduced to 5.7 in 2015, and only slightly to 5.4 live births per woman in 2020. This is characteristic of the pattern observed in sub-Saharan and West Africa, although women in sub-Saharan and Western Africa have on the average 4.7 and five live births respectively during their reproductive years (UN-DESA, 2019a). High fertility has delayed Nigeria's demographic transition. If it persists, high fertility coupled with large family size will make it challenging to improve population-level living standards, health, and education (Bloom et al., 2003). Demographic changes suggest that mortality and fertility decline support development. Population growth at the onset of the transition due to mortality decline provides increased labour for economic productivity, then sustained economic growth would lead to fertility decline because of increase in survival outcomes and cost of living, eventually helping the country attain the post-transition demographic stage.

3.3.3 Epidemiological transition and health

The epidemiological transition describes changing patterns of health and disease over time as they interact with socio-economic and demographic factors (Omran, 1971). Epidemiological transition theory assumes that mortality is a basic factor in population change, followed by a shift in cause of death from communicable to non-communicable diseases. The most profound changes in health and disease patterns occur among children and young women, and epidemiologic changes are closely associated with demographic and socio-economic transitions. Different countries follow peculiar patterns or timing, leading to three main stages of the epidemiological transition -the 'age of pestilence and famine', the 'age of receding pandemics' and the 'age of degenerative and man-made diseases' (Omran, 1971).

As with the demographic transition, Nigeria is in the second stage of the epidemiological transition known as the age of receding pandemics, characterised by progressive decline in mortality, less frequent epidemic cases, increasing life expectancy to 50 years, and sustained population growth (Omran, 1971). Nigeria's progression out of this stage was stalled by AIDS epidemics of the 1980s, as was the case in other African countries such as Botswana, Zambia, and Zimbabwe (Omran, 1971; Robine, 2003). Shkolnikov (2003) argued the interactions of epidemiological, socio-economic, cultural, and behavioural factors can cause mortality reversals leading to unprecedented premature deaths, akin to AIDS related mortality of the 1980s in sub-Saharan Africa, and 1994 genocide and civil war in Rwanda. In those instances, life expectancy declined due to mass death arising from war and AIDS infection across the region.

Progression to the third stage of degenerative and man-made diseases is determined by factors such as: ecological environment; government, socio-economic, and cultural factors that determine quality of life, health care behaviour, personal hygiene, and nutrition; and medical and public health factors that provide preventive and curative care such as immunisation and public sanitation (Omran, 1971). According to Omran (1971), sustained survivorship associated with declining pandemics is most beneficial to children, female adolescents, and women in their reproductive years as these groups are more susceptible to infectious diseases. Having entered the demographic transition in the mid-twentieth century with other sub-Saharan African countries, and considerably later than other regions, Nigeria experienced most of its mortality decline from reductions in diarrhoea, cholera, tuberculosis, measles, malaria, HIV/AIDS, and other infectious and parasitic diseases (Dyson, 2013). Vallin and Meslé (2004) stressed that for sub-Saharan African countries to achieve their epidemiological transition, there must be improvement and adequate funding for health policies.

Most of the successes made by Nigeria in lowering early childhood mortality can be attributed to foreign medical aid programmes, suggesting the need for more national development programmes if the country is to consolidate on the progress made and progress epidemiologically (Omran, 1971). Studies have shown that mortality decline, especially in sub-Saharan Africa, can be largely sustained through improvement in standards of living, and public health measures such as clean drinking water, sanitation, and public health

education (Wilmoth, 2003). Despite the economic growth Nigeria has attained, it is still not socially developed. Until relevant structures are put in place to bring about social development as indicated in the conceptual framework (Figure 3.4), especially at the grassroots, under-five mortality will continue to be unacceptably high.

3.3.4 The nexus of development and early childhood mortality in Nigeria

Having looked at the history, economic, and demographic changes in the country, it is understandable that inequities in under-five mortality in Nigeria is mostly determined by development policies. These policies are evident in the levels of educational attainment, differences in income distribution, availability of jobs for the growing workforce, accessibility of healthcare systems, and public health expenditures (Preston, 2007). Sen (2001) further expounded that GNP was a narrow view of development, and that development should be assessed by the county's ability to provide freedom from poverty, poor economic opportunities, social and health deprivations to most of the population.

While illustrating that increase in a country's GDP is usually associated with improved child survival and increased life expectancy, Rosling (2006) cautioned that improved health outcomes do not happen automatically, but rather are products of governmental development policies in social, educational, and health services. Countries such as South Korea and United Arab Emirates (UAE) gained improved child survival (to more than 90 percent) because they invested in social development programmes to improve standards of living, healthcare, and training of medical personnel, alongside advancement in levels of public health knowledge (Rosling, 2006). Even though Nigeria and UAE have different colonial histories, it is useful to draw a comparison between the two countries on the grounds that their economies are largely dependent on crude oil, which was discovered about the same time. UAE gives a clear picture of what can happen when a government appropriately channels its economic resources into development programmes. The government's focus has been on re-investing in human capital and social development programmes. Similarly, if other sub-Saharan African countries such as Kenya and Rwanda with less GDP and similar colonial histories, including the inheritance of corrupt institutions, can achieve higher child survivals, then Nigeria with higher GDP can (and must) also do better.

3.4 Theoretical and Analytical Frameworks

A theoretical framework introduces and describes the set of interconnected ideas or theories that helps us make sense of the problem under consideration (in this case, under-five mortality in Nigeria), and the processes at work. Theories help us to explain and understand phenomena, and the circumstances that contribute either positively or negatively. In this study, theory brings to light how the interactions of different factors – demographic, socio-economic, biological, and environmental -operate at different levels (individual, household, and community) to produce variation in under-five mortality. This study draws primarily on three theoretical frameworks that focus, respectively, on proximate and socioeconomic determinants (Mosley & Chen, 1984); community effects (Galster, 2012); and health care access (Aday & Andersen, 1974). As discussed in Chapter Two, Mosley and Chen (1984)'s framework focuses on the interplay of biological, socio-economic, and environmental factors. Furthermore, malnutrition and child mortality are accumulated outcomes of interaction of diseases at different stages, and not the result of a single isolated disease phase (Mosley & Chen, 1984). Their framework is relevant to this study because it fits the context of Nigeria. It has also been used extensively by researchers studying child mortality (Adedini, Odimegwu, Imasiku, & Ononokpono, 2015; Hill, 2003; Ruzicka, Wunsch, Kane, & Kikō, 1989; Sastry, 1996).

The framework by Galster (2012) provides insights into understanding the different pathways through which community characteristics influence individual behaviour and child survival. It helps explain how the social environment a child is raised in predicts his/her survival outcomes and how individual/household variables modify the impact of community factors. This can provide answers to inequalities in under-five mortality in Nigeria and the question of why there is still low immunisation coverage in Nigeria despite governments efforts at making it available for free (Adedokun et al., 2017; Antai, 2009; Olorunsaiye & Degge, 2016). Galster (2012)'s study, developed on the premise of scholarly works by social scientists and epidemiologists, formulated causal mechanisms via which community effects transpire. He stated that social-interactive mechanisms, which are social processes within the community such as relative deprivation, and parental mediation influence the people's way of life. Additionally, geographical mechanisms comprising of some community characteristics such as public services, mainly because of the community's physical location

relative to larger-scale political and economic forces, contribute to child survival outcomes. The work by Galster (2012) is relevant in this study because without an in-depth knowledge of how community attributes act alongside individual factors to affect health, the gap in scholarly knowledge will persist which will in turn impact negatively on programme planning.

The third framework used in this study focuses on health care access (Aday and Andersen (1974). Access to health care is an inter-connection of different variables from health policy measures, through to the health delivery system. That is, inputs bring about outcomes that can be measured by level of utilisation of health services and consumer satisfaction (Aday and Andersen (1974). There work is useful in this study because determinants of healthcare choices and accessibility issues surrounding healthcare delivery are important factors to account for.

The analytical framework in Figure 3.6 draws on these three frameworks (Aday & Andersen, 1974; Galster, 2012; Mosley & Chen, 1984), to empirically examine under-five mortality in Nigeria, and the impacts of proximate and structural factors at the individual/household and community levels.

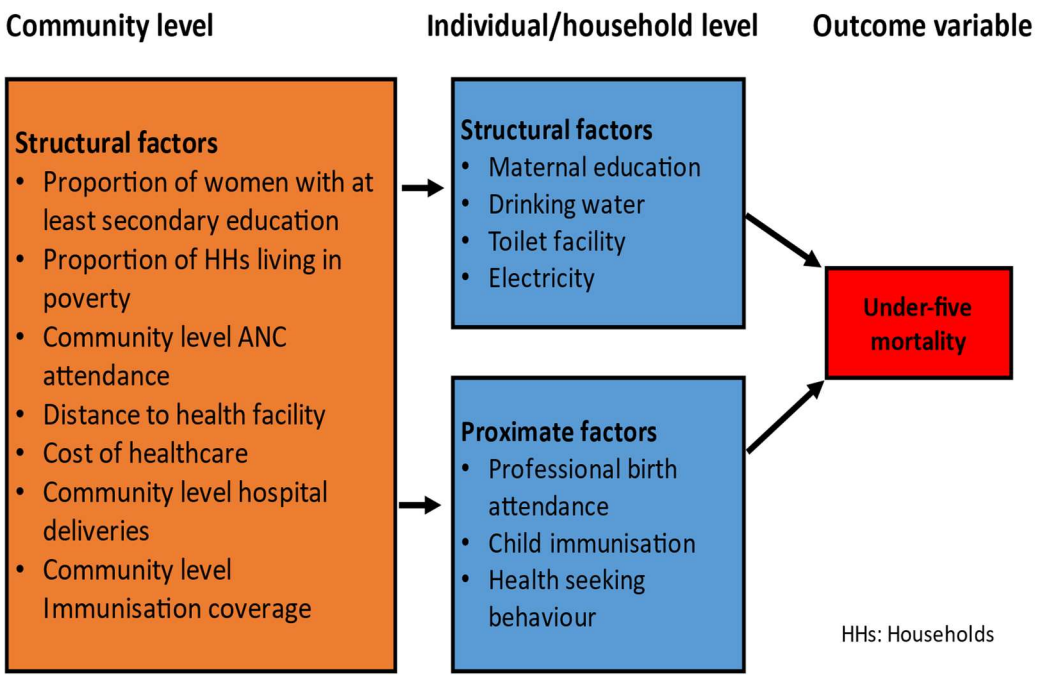

Figure 3.6: Analytical framework for the study of the underlying and proximate determinants of early childhood mortality in Nigeria

3.5 Study Variables

Drawing from indicators used in previous studies of early childhood mortality, and informed by the literature and analytical framework, I selected the following socio-economic and proximate variables from the Nigeria Demographic and Health Surveys (NDHS) to explore early childhood mortality in Nigeria.

3.5.1 Outcome variable:

Under-five mortality or early childhood mortality is the probability of a child dying between birth and fifth birthday if subject to age-specific mortality rates at the time of birth (Adedini, 2014; NPC & ICF International, 2019). Respondents were asked if they had children who were born alive but later died, and the age at death. Age at death is used to estimate early childhood mortality. For this thesis, mortality and death are used interchangeably in the analyses to explain number or proportion (percentage) or distribution of early childhood deaths and should not be misconstrued as showing mortality rates. As children die at different rates during the childhood period, with the highest mortality during the first year of life, the outcome variable is disaggregated into two stages of childhood.

1. Infant death: Number of deaths before the first birthday; and
2. Child death: Number of deaths between the first and fifth birthday.

3.5.2 Exposure variables:

To understand the disparities in under-five mortality across different geographical locations, the respondent's area of regular residence is used to delineate exposure to the socio-economic and intermediary factors that predict under-five mortality. They are:

1. **Place of residence:** categorised as urban and rural.
2. **State of residence:** This covers the 36 states of Nigeria plus the Federal Capital Territory (FCT) grouped into the six geo-political zones namely:
    i. ***North Central*** –Benue, FCT (Abuja), Kogi, Kwara, Nasarawa, Niger, and Plateau states.
    ii. ***North East*** –Adamawa, Bauchi, Borno, Gombe, Taraba, and Yobe states.
    iii. ***North West*** –Jigawa, Kaduna, Kano, Katsina, Kebbi, Sokoto, and Zamfara states.
    iv. ***South East*** –Abia, Anambra, Ebonyi, Enugu, and Imo states.
    v. ***South South*** –Akwa Ibom, Bayelsa, Cross River, Delta, Edo, and Rivers states.
    vi. ***South West*** –Ekiti, Lagos, Ogun, Ondo, Osun, and Oyo states.

3.5.3 Individual/household level variables:

At the individual/household level, the following variables have received less attention in the literature but are important for this study:

1. **Quality drinking water:** Information was gathered from respondents on their source of drinking water and time to get it, which was used to evaluate households' access to quality water. Improved sources of drinking water have been identified as pipe-borne water in the household or compound, public tap water supply, protected well or spring, rainwater, and bottled water (NPC & ICF International, 2014; WHO, 2018a).
2. **Improved toilet facility:** A household is said to have an improved toilet facility if the toilet is used by the household alone, and if it separates waste from human contact. Water cistern toilet is used in this study to measure a household's ownership of improved toilet facility (NPC & ICF International, 2014).

3. **Electricity:** A household's access to reliable electricity supply is remotely associated with reduced mortality, lower rates of disease and respiratory illness, increased immunisation, and access to health care, as well as improved access to information through the electronic media (radio, television, and internet) (Irwin, Hoxha, & Grépin, 2020).
4. **Professional birth attendance:** Respondents were asked whether their deliveries were assisted by a professional birth attendant such as a doctor, midwife, or nurse.
5. **Immunisation coverage:** Vaccination and timely response to childhood diseases are the most cost-effective means of preventing high under-five mortality and reducing the duration of severity of illnesses (NPC & ICF International, 2019). Information on the vaccinations received in the first year of life was sought for children from 12-23 months. Those with three doses of DPT, at least three for polio, and one for measles were said to have received basic immunisation coverage.
6. **Health seeking behaviour:** Respondents were asked if any child had diarrhoea or fever in the two weeks preceding the survey, if help was sought, where it was sought, and duration of time after the illness before help was sought. These questions are necessary because actions taken in times of illness goes a long way in predicting the survival outcome of the child (WHO, 2005).

3.5.4 Community-level variables:

At the community level, seven structural factors are aggregated at the level of primary sampling units (PSU) to measure the extent to which community level variables predict under-five mortality over and above individual and household level variables:

1. Proportion of women in the community with at least secondary education.
2. Proportion of households living in poverty.
3. Community level ANC attendance: The Nigerian antenatal care policy has adopted the recommendation of the WHO of not less than four ANC visits for women without complications during pregnancy, and more visits for those with complications or special need to promote safe pregnancies and deliveries. Women were asked the number of times they attended ANC for live births in the five years preceding the survey. Studies have shown that adequate ANC provides good cover for the mother and child through infancy (NPC & ICF International, 2019; Winter et al., 2013).

4. Community level hospital deliveries: The place of delivery determines to a large extent the hygienic environment the child is delivered in, the level of care that will be provided and availability of emergency obstetrics care in the event of complications (Greenwell & Winner, 2014; NPC & ICF International, 2019).
5. Proportion of children in the community with basic immunisation coverage.
6. Perception of distance to health facility: Respondents were asked their perception of distance from their homes to the nearest health facility. Information derived here, and perception on cost of healthcare will provide knowledge on access to health care and the structural barriers thereof. Also, it will help to identify prevalent challenges to accessing health care sub-nationally.
7. Perception of cost of health care: Respondents were asked if they considered it a problem getting the money needed for their treatment. As mentioned above, perception of cost of health care and distance to health facility will be used as proxy in this study to measure health care access. In the past, women have highlighted distance to health facility, obtaining money for treatment, and transportation as some of the many problems to accessing healthcare in the country (WHO, 2020).

3.6 Conclusion

This chapter dwelt extensively on the study setting and demographic structure of Nigeria to set the stage for statistical analysis. Current political and socio-economic structures in Nigeria are shaped by institutions established during the pre-colonial and colonial era. It is evident that these structures drive socio-economic inequality between and within geo-political zones in Nigeria. Also, the different stages of population change in Nigeria, described using population structure, demographic, and epidemiological transitions, provide critical insight into measuring the country's developmental growth. A good understanding of the study setting helps for a better interpretation of results within the context of the country.

The conceptual, theoretical, and analytical frameworks are also discussed, as well as the variables this study is focused on. The conceptual framework based on the social determinants of under-five mortality provides the roadmap for the study and explains the pathways through which the structural and proximate factors influence each other and

consequently under-five mortality. The following chapter focuses on the data and methods, alongside summary statistics of the study variables across the country.

CHAPTER FOUR DATA AND METHODS

4.1 Data Sources

The data used in this study is sourced from the 2008, 2013 and 2018 NDHS which are the three most recent ones carried out by the National Population Commission, Nigeria. ICF International provided technical assistance for the surveys through the DHS Program, with funding from United States Agency for International Development (USAID) (National Population Commission Nigeria [NPC] & ICF International, 2009, 2014, 2019). NDHS is a nationally representative household survey designed to provide population and health data from regular households at the national, geo-political, and state levels. I chose the NDHS data because it is a nationally representative population-based household survey, and it also provides the most comprehensive and reliable information on child health and outcomes, reproductive health behaviours, and socio-demographic characteristics of women in Nigeria.

4.1.1 Questionnaire Design

Three standard questionnaires –Household, Women's, and Men's- were used for the 2008, 2013, and 2018 NDHS, with an additional Biomarker questionnaire introduced in 2018 NDHS. The questionnaires were designed in line with standard questionnaires developed by the DHS program but modified for each country's requirements to reflect their specific issues and data needs such as maternal and child health, domestic violence, HIV/AIDS, and family planning. Information elicited from the questionnaires is intended to assist policymakers and programmes providers to measure health and plan effectively to meet the health needs of the population. The surveys also provide indicators in the following areas: zero hunger; good health and well-being; gender equality; affordable clean energy; decent work and economic growth; peace, justice, and strong institutions; and partnership for the goals important to the MDGs and SDGs for Nigeria. The questionnaires were produced in English, and translated into Nigeria's three major languages –Hausa, Igbo, and Yoruba. After they were pre-tested, they were revised and finalized (NPC & ICF International, 2009, 2014, 2019).

This study uses information from the women's questionnaire, which collected demographic and health data from de facto women of regular households aged 15 to 49 years. The women's questionnaire is the central part of DHS surveys and provides information on the topics: background information; reproductive history and health; maternal and childhood mortality;

family planning and fertility preferences; antenatal, delivery, and postnatal care; breastfeeding and child feeding practices; child immunisation and childhood illnesses; marriage and sexual activity; economic activities and women's decision making; domestic violence; knowledge of HIV/AIDS and other sexually transmitted diseases. The questionnaire also provides information on the full birth history of all women interviewed, from where characteristics of children under-five years, which is the focus of this study, are derived (NPC & ICF International, 2009, 2014, 2019).

4.1.2 Sampling Design

For administrative purposes, Nigeria is divided into 37 states (36 states plus the Federal Capital Territory), with the states further divided into 774 Local Government Areas (LGAs), and LGAs into localities. From the localities, smaller units called Census Enumeration Areas (EAs) were created during the 2006 Population and Housing Census. The 2008, 2013 and 2018 NDHS primary sampling units (PSUs), referred to as clusters, are defined based on the 2006 EA census frame. The sample selection for the surveys involved a two-stage stratified sample design, where the 37 states were separated into urban and rural (based on the 20,000-population threshold for urban area) making a total of 74 sampling strata, from where samples were selected using a two-stage selection per stratum. The number of households were distributed proportionately among urban and rural areas in each state during each survey, while interviews were completed from women aged 15-49 years who were either permanent residents or visitors who spent the night before the survey in the selected households in 2008, 2013 and 2018 NDHS respectively. In addition to the women interviews, the man's questionnaire was administered to all men aged 15-49 years in every second household sampled in the surveys. The different DHS questionnaires enabled the development of recode files, which are standardized files based on different units of analysis to facilitate cross-country analysis and the study of trends. The core DHS recode files are household recode, persons recode, individual (women's) recode, births recode, kids recode, men's recode, and couples recode. For my study, the kids recode file is used as the master dataset for analysis since it provides information on children below the age of five born to eligible women interviewed, while the individual (women's) recode is used as a supplementary dataset to get more information on the women for characteristics not contained in the kids recode file (NPC

& ICF International, 2009, 2014, 2019). Table 4.1 gives the detailed sample size selection for the surveys.

Table 4.1: Sample size selection for 2008, 2013 and 2018 NDHS

Sample size	2008 NDHS	2013 NDHS	2018 NDHS
Total clusters (PSUs)	888[9]	904	1,400[10]
Rural clusters	602	532	820
Urban clusters	286	372	580
Number of households	36,800	40,680	42,000
Total number of women interviewed	33,385	38,948	41,821
Response rate	96.5%	97.6%	99.3

4.1.3 Sampling Weights

Adjusted factors known as sampling weights are applied to analysis using DHS data to account for differences in the probability of selection and interview between different states due to the sample design, to ensure proper representation of results across the country, as well as correct differential response rates. Individual and cluster levels weight factors provided by Measure DHS are applied where necessary in analysing and managing the dataset. For instance, samples in the NDHS were selected non-proportionally to increase the number of cases for some population areas or subgroups for which information are needed, leading to a reduction in sample variability. Hence, weights are applied during statistical analysis to correct for over-sampling and under-sampling of such areas to achieve a proper representation of data at the national level. The individual weight for women which is derived from the inverse of the individual response rate for women in the stratum multiplied by the household weight is applied to each tabulation and analysis carried out in this study (Croft,

[9] 2008 NDHS final survey sample was 886 clusters instead of 888, because during fieldwork interviewing teams could not access one cluster due to flooding, and the second one because of inter-communal crises. (National Population Commission (NPC) Nigeria & ICF International, 2009) (2019-04-04).

[10] During 2018 NDHS household listing, 11 clusters found to be insecure or vacated because of insurgency were dropped. Hence, survey was successfully implemented in 1,389 clusters. The affected States are Borno (one cluster), Katsina (two clusters), Lagos (one cluster), Sokoto (three clusters), and Zamfara (four clusters). In addition to that, 11 LGAs in Borno State where about 39% of the state households reside were dropped due to high levels of insecurity. However, clusters selected from the dropped 11 LGAs were replaced with clusters from the remaining 16 LGAs of Borno State. Thus, provincial level results for Borno State are not representative for the dropped LGAs. (National Population Commission (NPC) Nigeria & ICF International, 2019) (2020-02-13).

Marshall, & Allen, 2018; NPC & ICF International, 2009, 2014, 2019). Cluster weights are equally applied where appropriate in the multilevel analysis.

Further information on questionnaire design, sample design, data collection, analysis, and other implementation strategies of the Nigeria Demographic and Health Survey can be found in the final reports (NPC & ICF International, 2009, 2014, 2019).

4.2 Limitations of Data

Even though NDHS provides reliable countrywide data for demographic and health measures, there is still a paucity of data, as direct causes of death for the population cannot be estimated and only associations can be inferred. The poor vital registration system in Nigeria also makes it difficult to account for specific causes of under-five mortality as most deaths are not registered and a lot of the information available on direct causes of death are limited to small study areas such as single cities and hospitals. Consequently, the country relies largely on estimates derived from statistical models, which has shown that most child deaths are caused by preventable or treatable diseases (Koffi et al., 2017). Also, NDHS data are susceptible to recall bias, but to limit this, pregnancy-related information was collected for births in the five years preceding a survey round. Despite the limitations, a major strength of using NDHS data is that the results can be used to make inference for the entire country.

4.3 Analytical Strategy and Statistical Methods

This research uses a range of statistical methods to analyse NDHS data. Trend analysis is conducted using the three datasets (2008, 2013, and 2018) while survival and multilevel analysis are undertaken using the most recent 2018 NDHS. Women aged 15-49 years with at least a live birth within the five years preceding each survey are included in the analysis, with the unit of analysis being children born in the five years preceding the surveys. The five-year reference period is necessary to limit recall bias to explore recent events and provide more accurate information. Also, the reference period only captures children under five years. The analytical sample adopted for this study is shown in Table 4.2.

Table 4.2: Analytical sample

Analytical sample	2008 NDHS	2013 NDHS	2018 NDHS
Total number of women interviewed	33,385	38,948	41,821
Women with births in the five years preceding the survey	18,028	20,192	29,992
Total number of children born within five years of the survey	28,647	31,482	33,924

4.3.1 Analytical strategy

The analytical strategy is driven by the analytical framework in Figure 4.1, a replica of Figure 3.6 but reproduced here because it is the bedrock of the analysis that follows. A key aim of this study is to explore the extent to which persistently high levels of under-five mortality can be explained by community level factors above and beyond those explained at the individual/household level. Hence, this study focuses on structural determinants at the individual/household and community levels that have received less attention in the literature. The key variables are selected in line with the conceptual framework, availability of data, and evidence from the literature. Well-known individual/household level predictors are also controlled for in the analysis. Univariate, bivariate, multivariate, and multilevel analysis are used to measure trends, correlations, and effects of the key independent variables on under-five mortality.

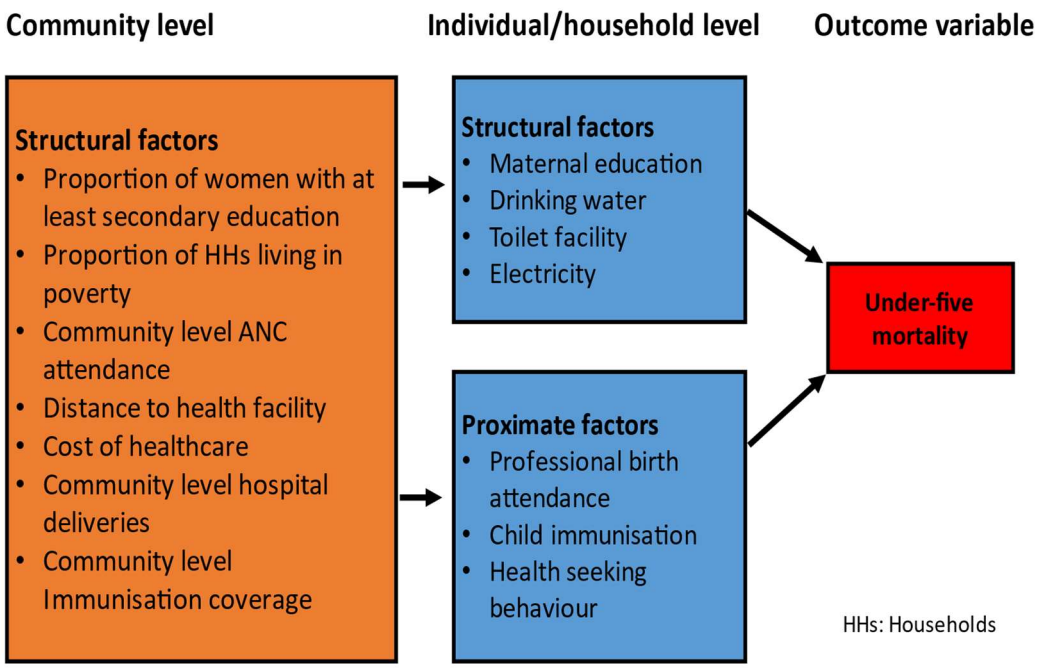

Figure 4.1: Analytical framework for the study of the underlying and proximate determinants of early childhood mortality in Nigeria

Survival analysis using Cox proportional hazards regression is the main analytical approach. This approach is appropriate because it:

1. measures the timing of an event (in this case under-five mortality) where the outcome is the length of time between being exposed to the risk of an event (birth) and event occurrence (death);
2. allows for variables that are both time-varying (age) and time-constant (gender);
3. can make comparisons between the survival of two or more groups in addition to measuring the association between explanatory variables and survival time; and
4. accounts for right-censored durations from individuals who have not yet experienced the event (under-five mortality) by the end of the observation period (the survey interview date) (Mills, 2010).

I also undertake multi-level analysis to account for the hierarchical structure of the data with individuals (children) nested within households, and households within communities (found in place of residence and states) (Kulu & Billari, 2004; Steele, 2011). The multilevel analysis uses two statistical methods: mixed-effects logistic regression method and Cox proportional

hazards regression with random effects method. Hence, in carrying out this study, three approaches are adopted:

1. First, I study trends and patterns of under-five mortality in Nigeria, alongside individual/household level factors associated with it using 2008, 2013, and 2018 NDHS. Comparative analysis is done across the years since all the cross-sectional data have similar sampling techniques and questionnaires, and they also provide state-level data for Nigeria.
2. Second, I focus on the 2018 NDHS to explore child survival function, incidence rates of death, and determinants of under-five mortality using Cox proportional hazards regression.
3. Finally, still focusing on the 2018 NDHS, I conduct a multilevel analysis to investigate the community-level contextual factors associated with under-five mortality in Nigeria.

4.3.2 Hypotheses

The foregoing analyses are used to test the following hypotheses:

1. Under-five deaths in Nigeria has changed both nationally and sub-nationally between 2008 and 2018.
2. The survival function for under-five children in Nigeria varies over the childhood stage.
3. Individual/household level socio-economic factors are significant predictors of under-five mortality across states and geo-political zones of Nigeria.
4. Community-level factors in the country significantly influence child survival over and above individual/household-level factors.

Table 4.3: Key study variables and their hypothesized associated effect on under-five mortality in Nigeria

S/No	Key study variables	Direction of effect on under-five mortality
	Individual/Household level	
1.	Quality drinking water	-
2.	Improved toilet facility	-
3.	Electricity	-
4.	Professional birth attendance	-
5.	Child immunisation	-
6.	Health seeking behaviour	-
	Community level	
7.	Proportion of women with at least secondary education	-
8.	Proportion of households living in poverty	+
9.	Community level ANC attendance	-
10.	Perception of distance to health facility	+
11.	Perception of cost of healthcare	+
12.	Community level hospital deliveries	-
13.	Community level immunisation coverage	-

4.4 Distribution of children born in the five years preceding the surveys by their background characteristics

Having explored the analytical strategy of this study, this section provides the summary statistics of early childhood mortality in Nigeria and the sub-national distribution of under-five children by various socio-economic and demographic background characteristics. The distribution of under-five children in Nigeria at the different survey rounds is shown by proximate and socio-economic factors at the individual, household, and community levels. These descriptive statistics highlight changes in the socio-economic make-up of the country over time, reflecting Nigeria's social and economic development. Recall, the link between development and early childhood mortality discussed in Chapter Three.

Summary statistics of early childhood mortality in Nigeria over the study period are shown in Table 4.4 and Figure 4.2. Results demonstrate that deaths in the neonatal period constituted a greater proportion of deaths during the infant stage, which led to a higher proportion of the children dying during infancy than in the childhood period. Infant deaths at each survey point made up more than 60 percent of total under-five deaths. Also, improvement in child survival

was delayed during the period under study, as under-five mortality barely reduced from 11 percent in 2008 to 10 percent in 2018.

Table 4.4: Summary statistics of early childhood mortality in the five years preceding each survey

	2008 NDHS		2013 NDHS		2018 NDHS	
Indicators	**Frequency**	**Percent**	**Frequency**	**Percent**	**Frequency**	**Percent**
Neonatal mortality	1,122	4.0	1,180	3.7	1,340	3.9
Post-neonatal mortality	877	3.1	847	2.7	861	2.5
Infant mortality	1,999	7.1	2,027	6.4	2,201	6.4
Child mortality	1,126	4.0	852	2.7	1,111	3.3
Under-five mortality	3,126	11.1	2,879	9.0	3,312	9.7
Number of under-five children alive	24,975	88.9	28,950	91.0	30,881	90.3
Total number of under-five children	**28,100**		**31,828**		**34,193**	

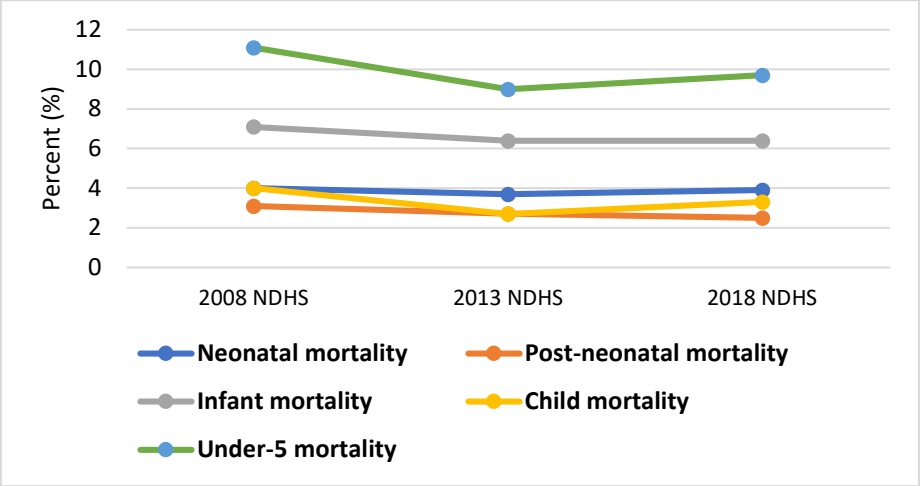

Figure 4.2: Early childhood mortality in Nigeria, 5 years preceding each survey

Distribution of the children by individual level background characteristics shown in Table 4.5 reveals that male births were slightly higher than female births in all periods, and that more than 20 percent of the births occurred less than 24 months after the mother's previous birth. The current high fertility rate in Nigeria is clearly represented in Table 4.5 with more than 30 percent of the children as fifth births and above across the survey points. Less than five percent of babies were born to teenage mothers. The poor educational status of Nigerian

women is evident in the table as well, with more than 40 percent of the births to women with no formal education. Less than 10 percent of births were to women with higher education. More than 90 percent of the children were born to married women.

Table 4.5: Distribution of children born in the five years preceding each survey by individual level background characteristics

	2008 NDHS		2013 NDHS		2018 NDHS	
Indicators	**Frequency**	**Percentage**	**Frequency**	**Percentage**	**Frequency**	**Percentage**
Sex of child						
Male	14,289	50.9	16,057	50.5	17,420	51.0
Female	13,811	49.2	15,771	49.6	16,773	49.1
Preceding birth interval						
8-23 months	5,395	23.8	5,935	23.2	6,850	24.9
24-60 months	15,294	67.4	17,365	68.0	18,324	66.6
61-120 months	1,812	8.0	2,037	8.0	2,080	7.6
121 months and above	187	0.8	205	0.8	244	0.9
Birth size						
large/very large	13,004	47.1	13,638	42.9	11,273	33.0
average	10,453	37.8	12,841	40.4	17,695	51.8
small/very small	3,974	14.8	4,750	14.9	4,693	13.7
don't know	207	0.8	136	0.4	532	1.6
missing	-	0.0	463	1.5	-	0.0
Birth order						
1st births	5,371	19.1	6,202	19.5	6,625	19.4
2nd births	4,970	17.7	5,482	17.2	6,256	18.3
3rd births	4,364	15.5	4,827	15.2	5,249	15.4
4th births	3,655	13.0	4,137	13.0	4,329	12.7
5th births	2,910	10.4	3,329	10.5	3,544	10.4
6th births	2,130	7.6	2,568	8.1	2,669	7.9
7th births and above	4,699	16.7	5,283	16.6	5,522	16.2
Mother's current age						
15-19	1,478	5.3	1,597	5.0	1,461	4.3
20-24	5,489	19.5	6,237	19.6	6,684	19.6
25-29	7,968	28.4	8,893	27.9	9,591	28.1
30-34	6,031	21.5	6,974	21.9	7,792	22.8
35-39	4,207	15.0	4,926	15.5	5,441	15.9

40-44	2,010	7.2	2,317	7.3	2,337	6.8
45-49	916	3.3	885	2.8	887	2.6
Maternal education						
No education	13,071	46.5	15,657	49.2	15,858	46.4
Less than primary	1,901	6.8	1,872	5.9	1,617	4.7
Primary	4,620	16.4	4,255	13.4	3,486	10.2
Less than secondary	3,163	11.3	3,424	10.8	3,631	10.6
Secondary	3,834	13.6	4,787	15.0	6,782	19.8
Higher education	1,511	5.4	1,834	5.8	2,818	8.2
Mother's marital status						
Never married	467	1.7	500	1.6	584	1.7
Married	26,400	94.0	29,709	93.3	31,673	92.6
Living together	489	1.7	783	2.5	933	2.7
Widowed	313	1.1	339	1.1	366	1.1
Divorced	201	0.7	275	0.9	361	1.1
Separated	229	0.8	223	0.7	276	0.8
Unweighted total	**28,647**		**31,482**		**33,924**	
Weighted total	**28,100**		**31,828**		**34,193**	

When distributed by household level characteristics, Table 4.6 shows that about 30 percent of children were from homes with five or more children as well as from polygamous homes. Of the two major religions in Nigeria -Christianity and Islam - a greater proportion of the children sampled were Muslims. Most of the mothers were into provision of sales/services and agricultural sector, with an increased participation in the labour market as shown in the drop in the proportion of women not working from 30 percent in 2008 to zero percent in 2018. The proportion of fathers out of a job increased by three percent from 2008 to 2018.

The socioeconomic status of the households reflected in the wealth quintile remained almost constant throughout the period, with more than 20 percent of the children from the poorest households. Furthermore, more than 39 percent of the children were from homes without improved sources of drinking water while only about one-fifth of the children had access to improved toilet facilities. Poor sanitation services are also highlighted in Table 4.6. Not only were more than half of the children from homes with non-improved toilet facilities, more than 20 percent of them had no toilet facility. In addition to these, more than 30 percent of

the children were from households that shared toilet facilities with another household. Generally, about half of the children lived in households without electricity.

Table 4.6: Distribution of children born in the five years preceding each survey by household level background characteristics

	2008 NDHS		2013 NDHS		2018 NDHS	
Indicators	**Frequency**	**Percentage**	**Frequency**	**Percentage**	**Frequency**	**Percentage**
Children ever born						
One child	3,053	10.9	3,670	11.5	3,758	11.0
Two children	4,883	17.4	5,494	17.3	6,347	18.6
Three children	4,809	17.11	5297	16.6	5781	16.9
Four children	4,041	14.4	4,503	14.2	4,738	13.9
Five children	3,263	11.6	3,645	11.5	3,943	11.5
Six children	2,454	8.7	2,928	9.2	3,044	8.9
Seven or more children	5,598	19.9	6,291	20.0	6,581	19.3
Family structure						
Monogamous	18,155	67.8	20,427	67.0	22,438	68.8
Two wives	6,929	25.9	8,044	26.4	8,189	25.1
Three wives	1,265	4.7	1,483	4.9	1,572	4.8
Four wives	273	1.0	290	1.0	297	0.9
Five or more wives	88	0.3	37	0.1	36	0.1
Don't know	57	0.2	70	0.2	74	0.2
missing	-	0.0	140	0.5	-	0.0
Religion						
Christian	12,017	43.0	11,647	36.6	12,304	36.0
Islam	15,441	55.3	19,689	61.9	21,706	63.5
Other	478	1.7	300	0.9	182	0.5
Missing	-	0.0	193	0.6	-	0.0
Mother's occupation						
Not working	8,491	30.4	9,324	29.3	-	0.0

Professional/ Technical/ Managerial/ Clerical	1,027	3.7	1,171	3.7	1,950	8.0
Sales/ Services	10,448	37.4	14,000	44.0	16,151	66.2
Agriculture	4,848	17.4	3,470	10.9	5,014	20.5
Manual work	3,134	11.2	3,725	11.7	1,251	5.1
Other	-	0.0	26	0.1	47	0.2
Don't know	1	0.0	-	0.0	-	0.0
Missing	-	0.0	112	0.4	-	0.0
Father's occupation						
Not working	-	0.0	237	0.8	1,037	3.2
Professional/ Technical/ Managerial/ Clerical	2,861	10.5	3,824	12.2	4,015	12.3
Sales/ Services	8,744	32.1	7,944	25.4	9,393	28.8
Agriculture	11,212	41.1	11,280	36.0	11,972	36.7
Manual work	4,455	16.3	7,848	25.1	6,006	18.4
Other	-	0.0	6	0.0	93	0.3
Don't know	2	0.0	-	0.0	90	0.3
Missing	-	0.0	189	0.6	-	0.0
Wealth index						
Lowest	6,525	23.2	7,496	23.6	7,572	22.2
Second	6,395	22.8	7,355	23.1	7,782	22.8
Middle	5,417	19.3	6,001	18.9	7,043	20.6
Fourth	5,003	17.8	5,656	17.8	6,254	18.3
Highest	4,760	16.9	5,320	16.7	5,541	16.2
Source of drinking water						
Improved source	14,595	52.0	17,876	56.2	20,240	59.2
Non-improved source	12,976	46.2	13,668	42.9	13,531	39.6
Other	317	1.1	18	0.1	46	0.1
Missing	202	0.7	266	0.8	376	1.1
Time to obtain drinking water						
Water on premises	7,097	25.4	6,515	20.5	10,960	32.1

0-30 minutes	16,716	59.9	19,884	62.5	20,447	59.8
31-60 minutes	2,676	9.6	3,575	11.2	1,767	5.2
More than 1-hour	909	3.3	1,313	4.1	618	1.8
Don't know	312	1.1	207	0.7	24	0.1
Missing	202	0.7	333	1.1	376	1.1
Toilet facility						
None	8,468	30.3	9,169	28.8	7,708	22.5
Non-improved facility	15,727	56.3	17,500	55.0	18,825	55.1
Improved facility	3,573	12.8	4,916	15.5	7,283	21.3
Missing	202	1.2	243	0.8	376	1.1
Share toilet with another household						
No	11,682	55.8	14,963	66.0	17,210	65.0
Yes	7,592	43.5	7,428	32.8	8,899	33.6
Missing	202	1.0	268	1.2	376	1.4
Electricity						
No	15,634	55.8	16,375	51.5	16,228	47.5
Yes	12,182	43.5	15,206	47.8	17,589	51.4
Missing	202	0.7	248	0.8	376	1.1
Unweighted total	**28,647**		**31,482**		**33,924**	
Weighted total	**28,100**		**31,828**		**34,193**	

To provide community context, Table 4.7 displays the distribution of children across the country. Results indicate that a greater majority of the children were resident in the rural areas, which underscores the need for accessible health and social infrastructures in those areas. The table also shows that the lowest cluster of the children were in the South South while the highest were in the North West. Aside from high fertility in the northern regions, one factor that could have led to the noticeable increase in the population of children in the North West from 2008 to 2013 would most likely be high mobility from the North Eastern states to North Western states due to insecurity and displacement of people because of the Boko Haram crisis in the North East from 2009. A close look at the states further highlights that there were higher births in the northern states than in the southern states during the focal

period. The highest proportion of children sampled were in Kano, Katsina and Kaduna, all in the North West. Anambra and Lagos states had the two highest populations of under-five children in the south, reflecting the high population density in the states due to the availability of economic opportunities.

Table 4.7: Distribution of children born in the five years preceding each survey by place of residence

	2008 NDHS		2013 NDHS		2018 NDHS	
Indicators	**Frequency**	**Percentage**	**Frequency**	**Percentage**	**Frequency**	**Percentage**
Residence						
Urban	8,359	29.8	11,126	35.0	13,170	38.5
Rural	19,741	70.3	20,702	65.0	21,023	61.5
Geo-political zone						
North Central	3,830	13.6	4,340	13.6	4,619	13.5
North East	4,575	16.3	5,578	17.5	6,213	18.2
North West	8,779	31.2	11,775	37.0	12,558	36.7
South East	2,730	9.7	2,840	8.9	3,428	10.0
South South	3,667	13.1	2,935	9.2	2,968	8.7
South West	4,519	16.1	4,360	13.7	4,407	12.9
State						
North Central						
Benue	832	3.0	967	3.0	949	2.8
FCT (Abuja)	254	0.9	209	0.7	225	0.7
Kogi	478	1.7	401	1.3	451	1.3
Kwara	412	1.5	405	1.3	533	1.6
Nasarawa	320	1.1	460	1.4	521	1.5
Niger	927	3.3	1,394	4.4	1,312	3.8
Plateau	607	2.2	505	1.6	628	1.8
North East						
Adamawa	729	2.6	732	2.3	786	2.3
Bauchi	1,172	4.2	1,431	4.5	1,469	4.3

Borno	1,049	3.7	1,118	3.5	1,219	3.6
Gombe	526	1.9	595	1.9	728	2.1
Taraba	482	1.7	764	2.4	758	2.2
Yobe	618	2.2	938	3.0	1,253	3.7
North West						
Jigawa	1,052	3.7	1,594	5.0	1,497	4.4
Kaduna	1,222	4.4	1,439	4.5	2,402	7.0
Kano	2,430	8.7	3,024	9.5	2,738	8.0
Katsina	1,569	5.6	1,703	5.4	2,428	7.1
Kebbi	708	2.5	1,247	3.9	1,228	3.6
Sokoto	983	3.5	1,151	3.6	978	2.9
Zamfara	815	2.9	1,618	5.1	1,287	3.8
South East						
Abia	472	1.7	326	1.0	426	1.3
Anambra	781	2.8	657	2.1	1,045	3.1
Ebonyi	432	1.5	748	2.4	814	2.4
Enugu	444	1.6	558	1.8	486	1.4
Imo	602	2.1	552	1.7	657	1.9
South South						
Akwa Ibom	590	2.1	473	1.5	522	1.5
Bayelsa	341	1.2	233	0.7	217	0.6
Cross River	549	2.0	532	1.7	318	0.9
Delta	682	2.4	561	1.8	595	1.7
Edo	568	2.0	405	1.3	411	1.2
Rivers	937	3.3	730	2.3	906	2.7
South West						
Ekiti	374	1.3	200	0.6	329	1.0
Lagos	1,454	5.2	1,303	4.1	1,545	4.5
Ogun	703	2.5	736	2.3	586	1.7
Ondo	528	1.9	568	1.8	423	1.2
Osun	484	1.7	445	1.4	549	1.6
Oyo	978	3.5	1,108	3.5	976	2.9
Unweighted total	**28,647**		**31,482**		**33,924**	
Weighted total	**28,100**		**31,828**		**34,193**	

Figure 4.3 show respondents' perceived distance from their homes to the nearest health facility, and their ability to pay for health care. Both are used in this study as proxies for healthcare access in the community. As evident from the figure, a decent proportion of women found it difficult to access healthcare, as more than 25 percent responded that the distance to a health facility posed a big problem, while more than 40 percent struggled with paying for their health needs across the focal period.

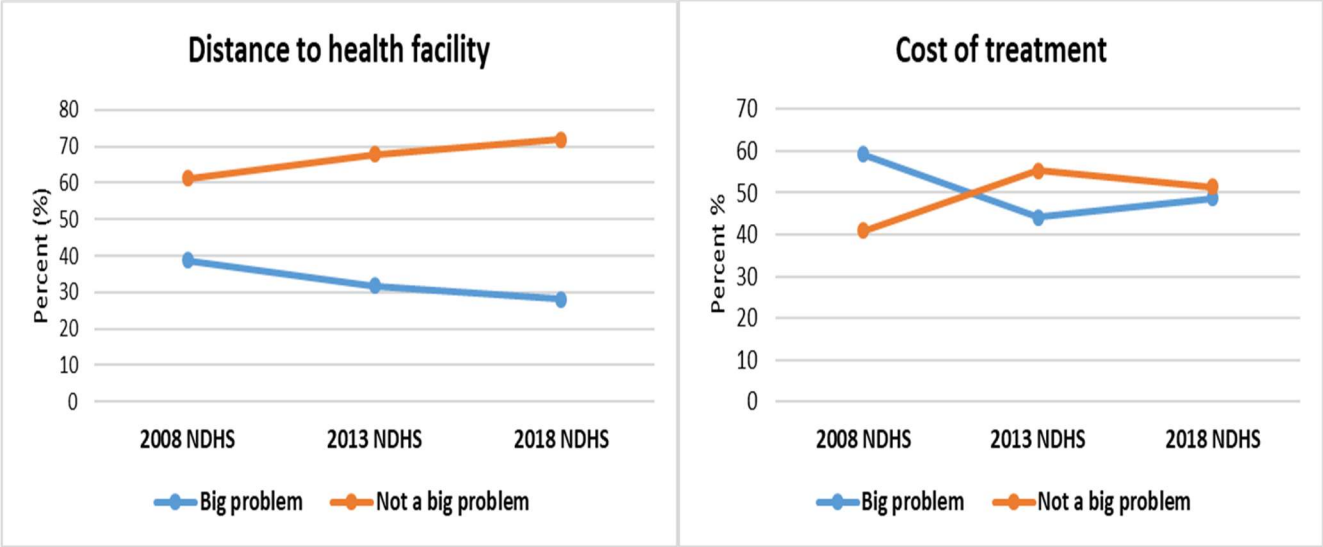

Figure 4.3: Access to health care

Table 4.8 indicates that there was an improvement in the recommended four or more antenatal care visits during pregnancy from 45 percent in 2013, to 57 percent in 2018. Although there was still a high percentage of non-attendance, there was a reduction from 37 to 24 percent across the period. Similarly, there was an improvement in the proportion of children born to women that had their blood pressure checked, as well as urine and blood samples taken during ANC, which were used in the NDHS to measure quality of ANC received during pregnancy. About 60 percent of the children were delivered at home, which also corresponded with the percentage of children that were not delivered by professional birth attendants such as doctors, midwives, or nurses. Despite campaigns to improve immunisation coverage amongst children, results from Table 4.8 indicate that more than 65 percent of children 12-23 months did not receive all basic vaccinations, namely BCG, measles, three doses each of DPT and polio vaccine (except for polio vaccine given at birth).

However, the proportion of children vaccinated increased marginally from 22.7 percent in 2008 to 31.5 percent in 2018.

Table 4.8: Distribution of children born in the five years preceding each survey by proximate determinants

Indicators	2008 NDHS		2013 NDHS		2018 NDHS	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
ANC attendance						
No visit	6,403	36.6	6,990	34.2	5,336	24.4
Less than 4 visits	1,699	9.7	2,474	12.1	3,761	17.2
4 or more visits	7,905	45.2	10,457	51.1	12,456	56.9
Don't know	1,474	8.4	420	2.1	358	1.6
Missing	-	0.0	126	0.6	-	0.0
Received quality ANC care (blood pressure, urine, and blood samples taken)						
No	3,556	16.4	3,060	12.3	3,044	10.5
Yes	18,141	83.6	21,778	87.7	25,813	89.5
Place of delivery						
Home	17,437	62.7	20,078	63.1	20,175	59.0
Govt. health facility	5,624	20.2	7,179	22.6	9,012	26.4
Private health facility	4,211	15.1	4,208	13.2	4,450	13.0
Other	542	2.0	38	0.1	556	1.6
Missing	-	0.0	326	1.0	-	0.0
Professional birth attendance						
No	16,766	60.5	19,241	60.5	19,399	56.7
Yes	10,939	39.5	12,141	38.2	14,794	43.3
Missing	-	0.0	446	1.4	-	0.0
Immunisation						
No	3,824	77.3	4,406	74.7	4,250	68.5
Yes	1,121	22.7	1,494	25.3	1,951	31.5

Health seeking behaviours for sick child						
Place first sought treatment for child's diarrhoea						
Govt. health facility	585	35.9	704	33.4	947	35.5
Private health facility	489	30.0	1,079	51.2	294	11.0
Chemist/shop	478	29.4	127	6.0	1,276	47.8
Other	77	4.8	194	9.2	152	5.7
Missing	-	0.0	4	0.2	-	0.0
Child received medical treatment for diarrhoea						
No	1,438	57.4	2,086	70.3	1,571	39.8
Yes	1,068	42.6	858	28.9	2,379	60.2
Missing	-	0.0	22	0.8	-	0.0
Unweighted total	**28,647**		**31,482**		**33,924**	
Weighted total	**28,100**		**31,828**		**34,193**	

Table 4.8 additionally shows the attitude of mothers or caregivers towards a sick child, highlighted in their health seeking behaviours. Government health facilities seemed to be the constant point of call, until there arose a preference for chemists/shop. The use of private health facilities dropped sharply from 51 percent in 2013 to 11 percent in 2018. Furthermore, in Nigeria, there still appear to be an unnerving proportion of children who did not receive medical treatment while sick with diarrhoea.

4.5 Summary of structural and proximate determinants of under-five mortality by geo-political zone and state across the three time periods

Having seen the background characteristics of our study's unit of analysis (under-five children) at the national level, this section will focus on the sub-national level, cutting across the six geo-political zones and 37 states of Nigeria. Sub-national distribution of the study measures, showing different dynamics across the country, and their changes over time from 2008 to 2018, provides an enhanced understanding of the trend and rate of socio-economic development across the country. This level of information would help programmes and research on the persistently high sub-national inequality in under-five mortality in Nigeria.

4.5.1 Summary of trends in maternal educational attainment

Results on mother's education amongst children born within five years of the surveys show higher rates of illiteracy amongst women in the northern region during the period under study. Figure 4.4 indicates a reduction in the proportion of children born to women with no formal education across all the regions with an attendant increase in secondary and higher levels educational attainment. But North West consistently had the highest levels of no education across the period at 78, 77, and 73 percent in 2008, 2013 and 2018 respectively while South East had the lowest at 3 percent in 2018. Most recent result in 2018 reveal that 20 percent of the children in the South West were born to women with higher education, which was the highest percentage of those with higher education, in contrast to only three percent in the North West.

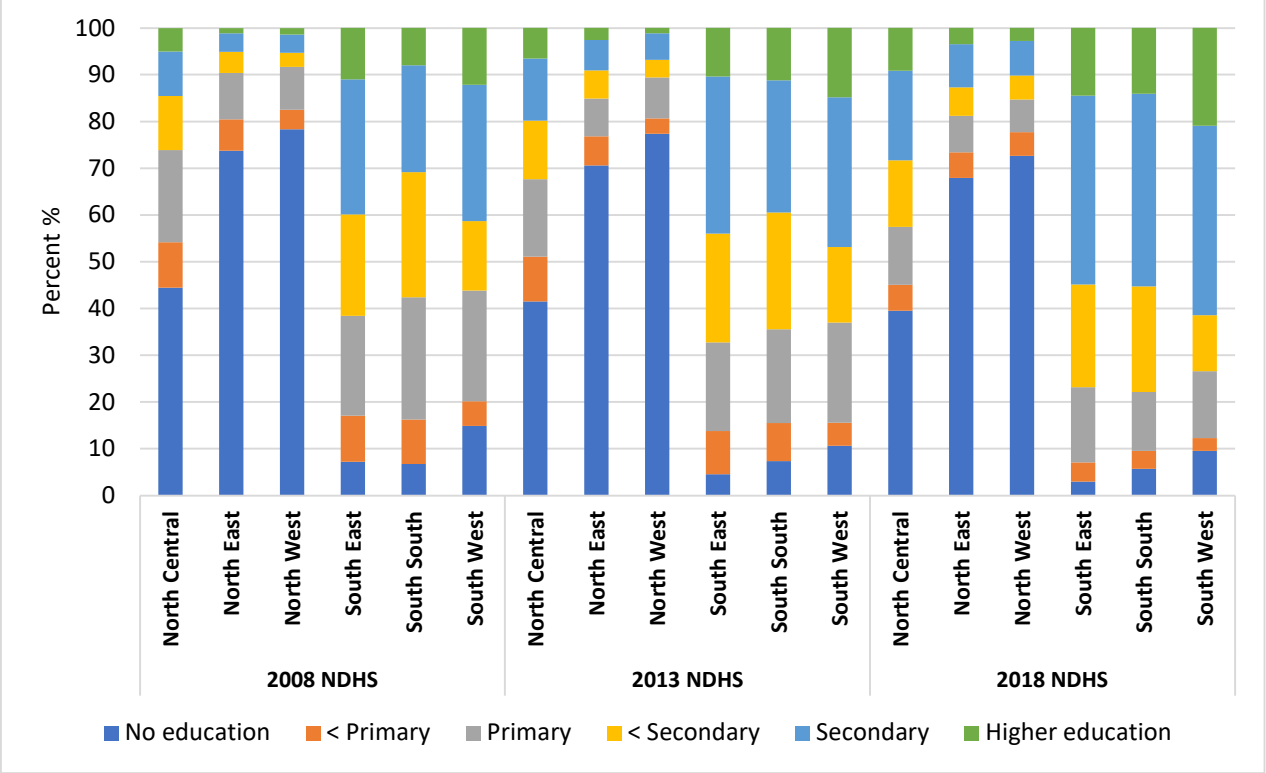

Figure 4.4: Distribution of children born in the five years preceding each survey by maternal educational attainment and geo-political zone, Nigeria 2008-2018

State analysis across the period as shown in Figures B.1-B.3 (Appendix B) further highlights the contributions of the different states to changes in educational attainment seen at the regional level. There was a high concentration of children born to women without formal education in the northern states. Sokoto state (North West) at 93 percent had the highest

proportion of children born to women with no education in 2018 while Imo state (South East) with less than one percent had the lowest. Generally, Lagos state (South West) with 30 percent had the highest proportion of children born to women with higher education. Improvements in educational attainment could be seen from the figures, as the proportion of children born to women with secondary or higher education improved across the board from 2008 to 2018.

4.5.2 Summary of trends in household wealth quintile

As displayed in Figure 4.5, the proportion of children born into households in the highest wealth quintile in the six geo-political zones increased over time, with an associated reduction in children born in households in the lowest quintile. The only exception was in South East, where there was a small one percent increase in the proportion of children in the poorest households from 2008 to 2018. Higher wealth inequality was evident in the North East and North West zones in 2018 - less than 20 percent of the children belonged to households in the two upper socio-economic status, in contrast with more than 70 percent in the South West. Similarly, less than 10 percent of the children in North East and North West were from households in the highest wealth group, as against 32 and 47 percent in South South and South West respectively.

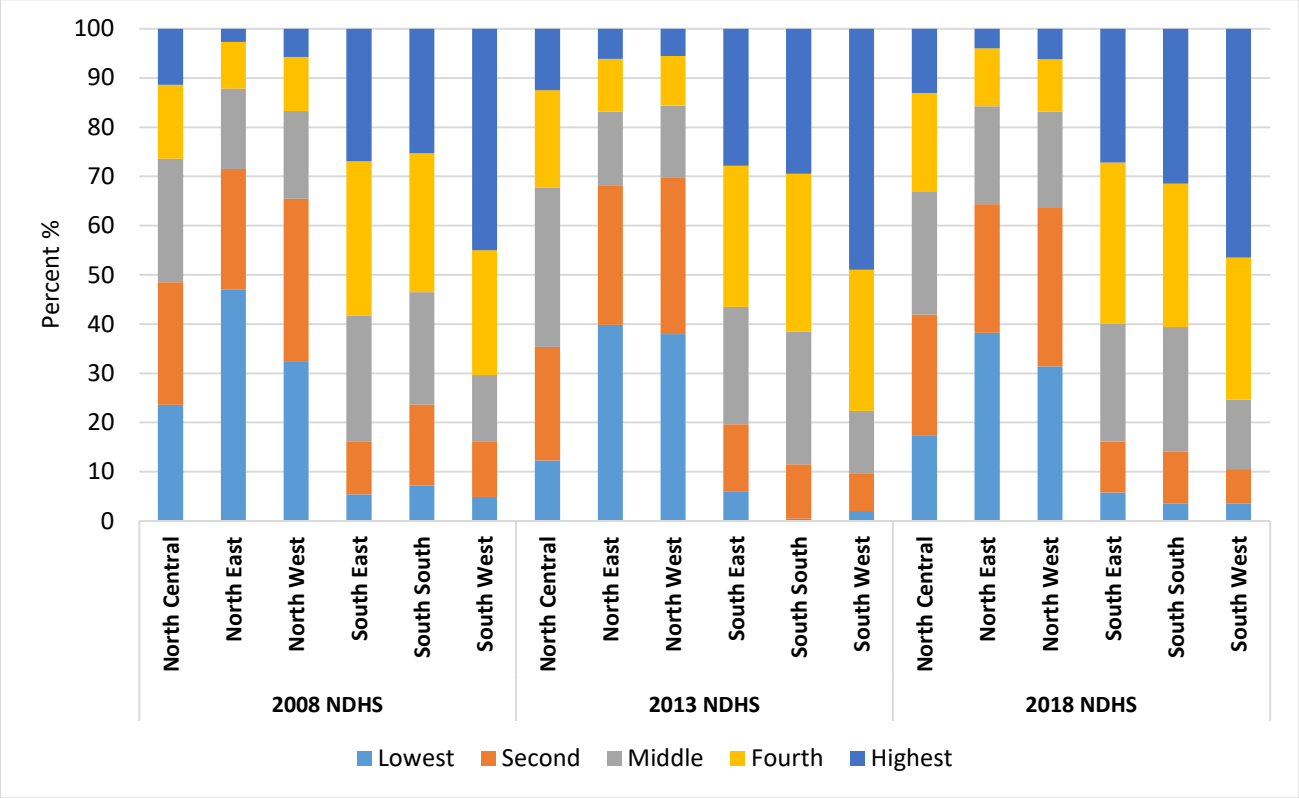

Figure 4.5: Distribution of children born in the five years preceding each survey by household wealth and geo-political zone, Nigeria 2008-2018

Analysis by state shown in Figures B.4-B.6 (Appendix B) illustrates that while more children in the southern states escaped poverty over time, a higher proportion of those in the northern states were still trapped in the poor class. Sadly, as of 2018, more than half of the children in Jigawa, Sokoto and Zamfara states, all in the North West where from households in the lowest socio-economic status, in sharp contrast to Abia (South East) and Lagos (South West) with 54 and 76 percent of their children respectively in the highest socio-economic status. Results also reveal a more even spread of wealth in the southern states than in the northern states. The FCT (Abuja) in the North Central recorded the highest proportion of children (39%) in the highest wealth quintile amongst the northern states, a reflection of its socio-economic pull because of its status as the country's seat of power. Similarly, Lagos being the commercial nerve-centre of Nigeria also trumped the rest of the southern states, and the country at large, with the highest proportion of children belonging to households in the highest wealth quintile.

4.5.3 Summary of trends in availability of basic amenities in households

This section presents results on basic living conditions of the children with respect to availability of quality drinking water, improved toilet facilities and electricity in their households. Description of household's source of drinking water as presented in Table 4.9, shows that only South West had a reduction in the proportion of children belonging to households with improved source of drinking water from 79 percent in 2008 to 65 percent in 2018. South East at 22 percent had the lowest proportion of children in households with non-improved water source, while North East at 47 percent had the highest. Analysis by state indicate that while states such as Nasarawa, Taraba, and Benue recorded marked improvements in their sources of drinking water, the reverse was the case for Kebbi state, where children in households with improved source of drinking water dropped from 72 percent in 2008 to 44 percent in 2018. Likewise, Lagos state reported a steep drop in the proportion of children born to households with improved sources of drinking water from 89 percent in 2008 to 48 percent in 2018. This decline in improved source of drinking water over time could be attributed to the deplorable state of public water supply and the widespread use of sachet water, especially in the cities, which has been classified as unimproved source due to unhygienic manufacturing conditions and unethical practices. Gombe and Sokoto states had the highest proportions of non-improved water source while Imo state had the least.

Table 4.9: Sub-national distribution of children born in the five years preceding each survey by household's source of drinking water, Nigeria 2008-2018

	2008 NDHS			2013 NDHS			2018 NDHS		
	Improved source	Non-improved source	Other/ Missing	Improved source	Non-improved source	Other/ Missing	Improved source	Non-improved source	Other/ Missing
Geo-political zone									
North Central	45.4	53.5	1.0	51.2	47.4	1.4	61.3	37.9	0.8
North East	31.7	66.6	1.7	45.7	53.6	0.7	51.5	47.5	1.1
North West	47.1	51.6	1.3	54.1	45.6	0.3	54.1	45.5	0.5
South East	66.9	30.9	2.2	66.5	32.2	1.3	73.9	22.3	3.9
South South	54.8	40.9	4.3	65.4	32.6	2.1	68.5	29.7	1.9
South West	76.0	22.2	1.8	67.2	31.7	1.1	64.8	33.6	1.6

State									
North Central									
Benue	44.56	55.31	0.1	36.1	62.1	1.8	71.2	28.5	0.2
FCT (Abuja)	69.39	24.85	5.8	77.8	21.7	0.6	51.6	46.6	1.7
Kogi	43.65	55.4	0.9	72.4	27.1	0.5	66.6	32.2	1.2
Kwara	58.44	40.83	0.7	78.5	19.2	2.3	58.4	40.1	1.6
Nasarawa	48.79	50.9	0.3	56.2	40.3	3.6	75.5	23.2	1.3
Niger	44.79	54.65	0.6	48.2	51.1	0.7	59.1	40.4	0.5
Plateau	28.39	69.96	1.6	34.2	65.2	0.7	41.1	57.8	1.1
North East									
Adamawa	20.6	78.26	1.1	57.8	40.5	1.7	51.4	48.5	0.1
Bauchi	35.43	63.91	0.7	34.6	64.9	0.5	57.4	41.7	0.8
Borno	35.47	60.04	4.5	58.5	40.6	0.9	56.4	43.3	0.3
Gombe	21.49	77.57	0.9	53.7	45.7	0.6	32.8	65.6	1.7
Taraba	18.84	80.4	0.8	32.3	66.9	0.8	37.3	60.3	2.4
Yobe	49.98	49.73	0.3	43.7	56.3	0.0	59.3	39.2	1.5
North West									
Jigawa	78.54	18.79	2.7	73.2	25.7	1.1	82.5	17.4	0.1
Kaduna	42.93	56.55	0.5	60.9	38.5	0.6	62.7	36.8	0.5
Kano	53.14	44.4	2.5	66.9	32.9	0.3	51.1	48.5	0.5
Katsina	34.96	64.89	0.1	48.4	51.7	0.0	46.7	53.2	0.1
Kebbi	72.16	27.84	0.0	20.0	79.9	0.1	43.8	56.2	0.0
Sokoto	23.27	76.55	0.2	62.7	37.1	0.2	31.5	65.7	2.8
Zamfara	25.6	73.48	0.9	31.6	68.4	0.0	52.2	47.7	0.1
South East									
Abia	81.83	16.82	1.4	67.9	31.7	0.4	81.7	10.8	7.5
Anambra	67.95	28.02	4.0	71.5	28.1	0.4	72.9	22.3	4.9
Ebonyi	52.58	45.15	2.3	67.4	32.3	0.3	72.6	25.1	2.3
Enugu	58.54	40.49	1.0	46.0	50.8	3.2	54.6	44.7	0.7
Imo	70.14	28.43	1.4	79.3	18.7	2.0	86.3	9.4	4.3
South South									
Akwa Ibom	59.32	35.3	5.4	68.3	29.0	2.7	73.2	25.0	1.7
Bayelsa	25.85	70.41	3.7	40.1	55.5	4.4	49.6	48.5	1.9
Cross River	20.21	77.02	2.8	63.9	35.6	0.5	52.0	47.5	0.5
Delta	66.17	28.09	5.7	63.3	34.6	2.2	73.3	24.2	2.5
Edo	62.53	33.43	4.0	70.9	27.0	2.1	65.0	29.4	5.6
Rivers	69.8	26.41	3.8	71.1	26.9	2.0	74.3	25.3	0.4
South West									
Ekiti	59.95	38.25	1.8	76.0	22.9	1.1	79.7	17.5	2.8
Lagos	88.97	10.09	0.9	61.5	37.5	1.1	47.6	50.8	1.6
Ogun	64.08	34.74	1.2	77.2	22.8	0.0	72.2	25.0	2.8
Ondo	60.85	38.02	1.1	49.9	48.3	1.7	61.3	36.6	2.0
Osun	80.02	17.75	2.2	81.3	17.6	1.2	83.9	15.8	0.3
Oyo	77.65	18.61	3.7	68.7	29.6	1.6	73.6	25.6	0.9

Further examination into household's source of drinking water, as shown in Figure 4.6, suggests that it still took households in Nigeria an average of 30 minutes to get drinking water. As of 2018, more than 60 percent of the children lived in households with no source of drinking water for their residents. Exposure to diarrhoea-causing agents is usually linked to the use of polluted water, poor hygiene during food preparation, and poor disposal of excreta (NPC & ICF International, 2014).

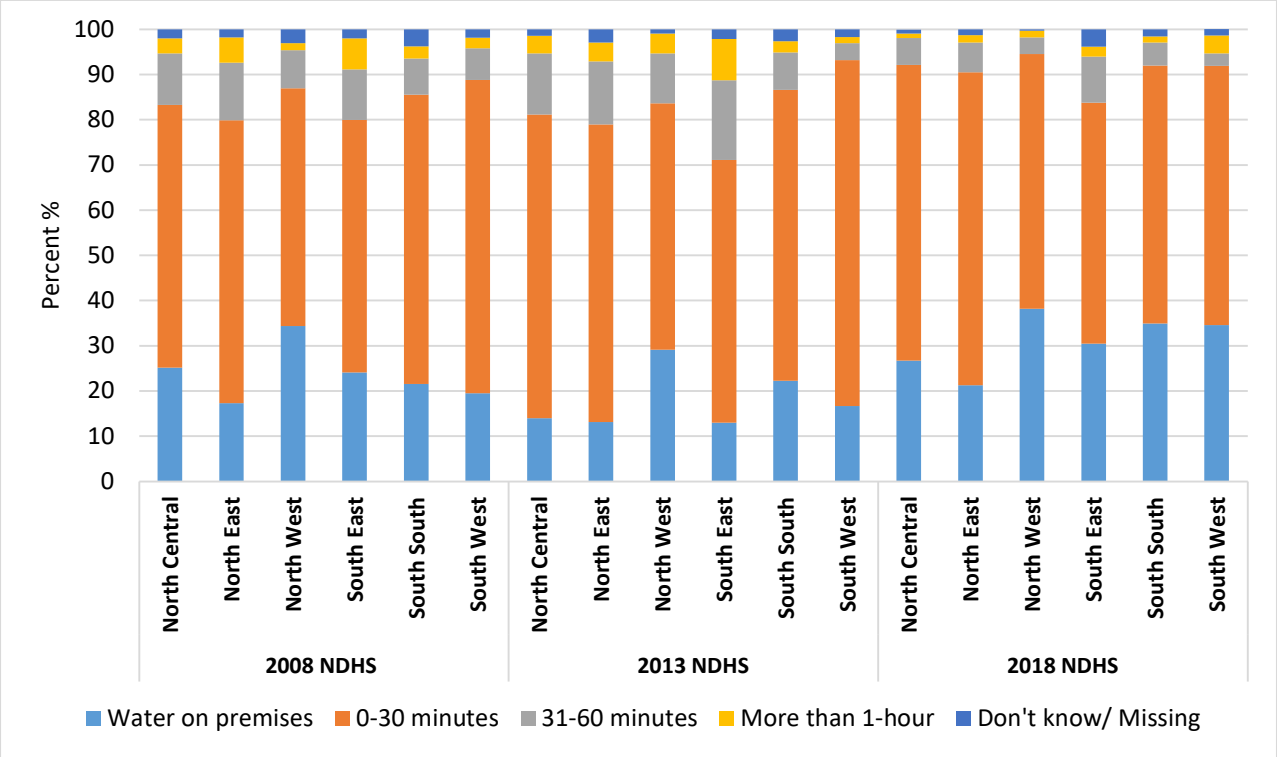

Figure 4.6: Distribution of children born in the five years preceding each survey by household's time to get drinking water and geo-political zone, Nigeria 2008-2018

Additional breakdown of the study population by the type of toilet facility in their households by geo-political zone is shown in Figure 4.7. The result implies that the North West had the lowest proportion of children in households without toilet facility across the focal period, while the highest was in the North Central. The North West with 80 percent in 2018, still had the highest proportion of children in households with non-improved toilet facilities, in contrast to the lowest of 25 percent in the South West. Almost half of the children in the

South West had improved toilet facility (flushed toilet) while only about six percent of those in the North East had same.

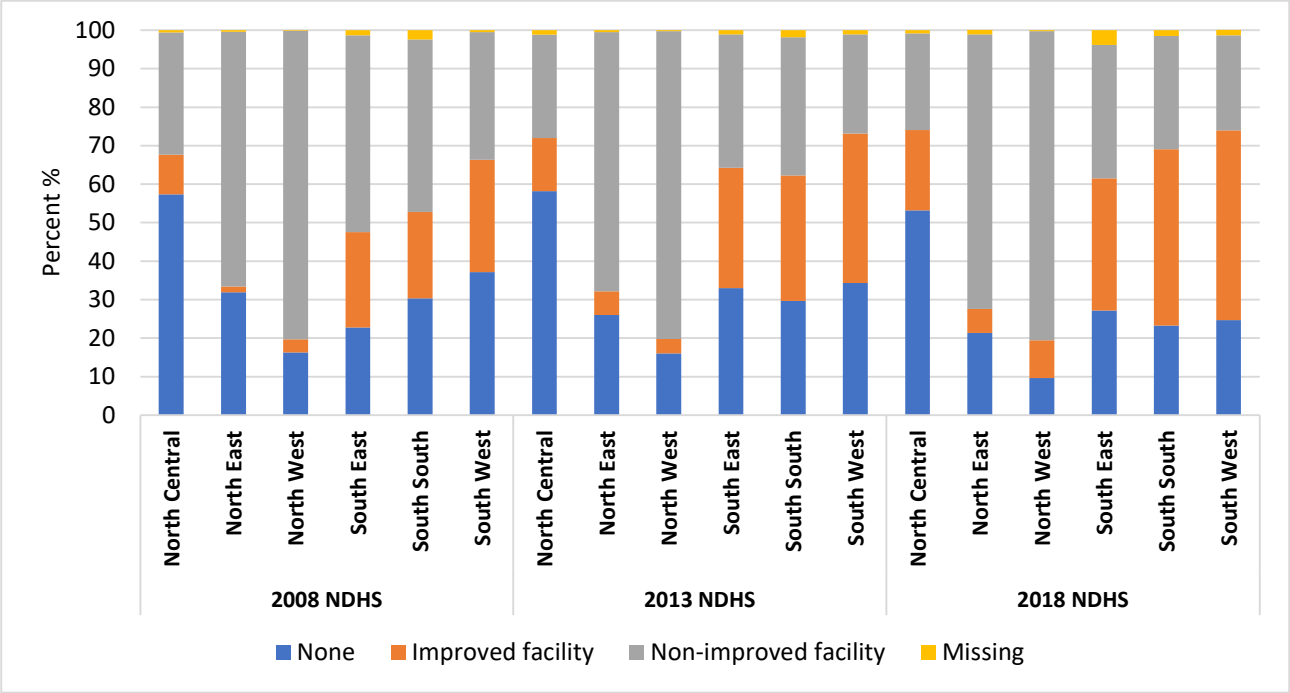

Figure 4.7: Distribution of children born in the five years preceding each survey by household's type of toilet facility and geo-political zone, Nigeria 2008-2018

More sub-national description by state in Figures B.7-B.9 (Appendix B) shows a noticeable improvement in the proportion of under-five children in households with improved toilet facility over the study period, even though a greater proportion of children in states in the North East and North West could only access non-improved facilities. For instance, from the 2018 results up to 80 percent of the children in Bauchi, Gombe, Kaduna, Katsina and Zamfara states lived in households with non-improved toilet facilities. Conversely, more than half of the children in Abia, Rivers, and Lagos states (southern zones) had access to improved toilet facilities.

Further investigation of use of toilet facilities by households presented in Table 4.10 suggests that in 2018, less than 10 percent of children in Gombe, Jigawa, Sokoto and Taraba belonged to households that shared toilet facilities with another household. More households in the South South and South West states shared toilet facilities with another household unlike in the North East states. The high proportion of households with shared toilet facilities in the

North Central and southern zones could be an indication of the high population density in those areas and rising urban slums because of influx of people to economically viable cities, especially FCT (Abuja) and Lagos (Ezeh et al., 2017).

Table 4.10: Sub-national distribution of children born in the five years preceding each survey by whether their household share toilet facility with another household, Nigeria 2008-2018

	2008 NDHS			2013 NDHS			2018 NDHS		
	No	**Yes**	**Missing**	**No**	**Yes**	**Missing**	**No**	**Yes**	**Missing**
Geo-political zone									
North Central	54.5	44.1	1.4	51.6	45.4	3.0	50.0	48.2	1.8
North East	80.4	19.0	0.6	85.7	13.6	0.7	81.6	17.1	1.3
North West	77.3	22.5	0.2	80.5	19.2	0.3	73.0	26.7	0.3
South East	53.1	45.2	1.7	52.2	45.6	2.2	66.3	28.4	5.2
South South	35.4	61.1	3.5	40.4	56.6	2.9	44.3	53.7	2.0
South West	23.1	76.1	0.8	24.5	73.7	1.8	36.1	62.1	1.8
State									
North Central									
Benue	50.6	49.0	0.4	54.9	41.8	3.4	69.1	30.5	0.4
FCT (Abuja)	51.0	46.1	2.9	55.7	43.9	0.4	54.6	43.7	1.7
Kogi	47.2	50.2	2.6	52.9	44.9	2.2	48.4	47.3	4.4
Kwara	29.2	69.8	1.1	35.6	59.9	4.4	31.7	64.6	3.8
Nasarawa	75.8	23.6	0.6	71.2	22.0	6.8	37.1	61.3	1.6
Niger	58.5	40.5	1.0	43.7	54.9	1.4	46.6	52.2	1.2
Plateau	57.6	40.1	2.4	53.4	44.5	2.1	55.8	40.6	3.6
North East									
Adamawa	90.6	9.1	0.3	91.7	6.2	2.2	71.0	28.8	0.2
Bauchi	82.1	17.1	0.9	85.8	14.0	0.2	89.1	10.0	0.9
Borno	77.6	22.0	0.5	86.1	13.4	0.5	75.2	24.5	0.3
Gombe	85.3	14.0	0.7	86.7	12.8	0.6	89.9	8.3	1.9
Taraba	75.8	22.9	1.4	87.6	11.2	1.2	78.0	19.0	3.0
Yobe	65.0	35.0	0.0	73.4	26.6	0.0	81.9	14.9	3.2
North West									
Jigawa	95.0	5.0	0.0	87.9	11.1	1.0	92.8	7.2	0.1
Kaduna	57.6	42.2	0.2	38.1	61.6	0.3	37.3	62.1	0.5
Kano	82.4	17.5	0.1	87.9	12.0	0.1	78.8	20.7	0.5
Katsina	73.9	25.9	0.2	84.1	15.5	0.4	86.3	13.6	0.1
Kebbi	93.2	6.8	0.0	90.1	9.9	0.0	45.1	54.9	0.1
Sokoto	88.0	11.9	0.1	78.9	20.9	0.2	90.9	8.5	0.7
Zamfara	55.5	43.8	0.7	85.9	13.7	0.4	90.8	9.1	0.1
South East									
Abia	44.0	55.5	0.5	63.5	36.3	0.1	58.8	33.6	7.6

Anambra	49.9	48.1	2.0	47.4	50.6	2.0	69.4	24.6	6.0
Ebonyi	54.9	42.6	2.5	46.3	53.3	0.4	52.1	43.3	4.7
Enugu	58.2	39.8	2.0	56.2	36.5	7.3	53.6	45.2	1.3
Imo	62.5	35.8	1.7	53.9	43.5	2.7	83.1	12.3	4.6
South South									
Akwa Ibom	57.7	37.1	5.2	58.4	39.1	2.5	48.1	50.1	1.8
Bayelsa	8.7	89.9	1.4	15.8	78.3	5.8	40.8	54.7	4.5
Cross River	24.5	70.1	5.4	23.2	76.2	0.6	35.1	64.3	0.5
Delta	27.9	66.7	5.4	35.2	60.8	4.1	51.8	47.0	1.3
Edo	35.1	62.8	2.1	37.9	59.0	3.1	42.5	49.5	8.0
Rivers	34.4	64.3	1.3	47.4	49.8	2.8	42.7	56.9	0.5
South West									
Ekiti	41.0	54.7	4.4	30.1	68.0	2.0	36.6	58.5	4.9
Lagos	26.1	74.0	0.0	30.3	68.5	1.2	41.0	57.9	1.2
Ogun	17.1	80.6	2.2	11.0	89.1	0.0	23.1	73.4	3.5
Ondo	20.6	79.1	0.4	29.8	67.1	3.1	32.4	63.9	3.7
Osun	25.0	72.5	2.5	20.9	77.1	2.1	37.0	62.6	0.5
Oyo	14.2	85.8	0.0	22.0	73.9	4.1	34.8	64.0	1.2

Still on access to basic amenities in the household. A closer look at availability of electricity in households across the country shown in Table 4.11 indicates that South West had the highest proportion of children in households with electricity within the period under review. Apart from the South East, there was visible improvement in the presence of electricity over the study period. State analysis also reveals that Taraba (North East) at 18 percent had the least percentage of children in households with electricity, while Lagos (South West) at 97 percent had the highest. However, going by the high rate of power outages in Nigeria, these results do not provide information on household use of electricity nor the duration of power supply in a household at any given time frame. Given the data available, we cannot measure the frequency of electricity supply in the households. It is one thing to be connected to the electricity grid, while it is another to have power supplied when needed. Nevertheless, these results provide additional insight into the developmental pattern of Nigeria with regards to the electrification of homes.

Table 4.11: Sub-national distribution of children born in the five years preceding each survey by availability of electricity in their household, Nigeria 2008-2018

	2008 NDHS			2013 NDHS			2018 NDHS		
	No	Yes	Missing	No	Yes	Missing	No	Yes	Missing
Geo-political zone									
North Central	72.3	27.1	0.6	56.7	42.2	1.2	48.9	50.2	0.8
North East	75.9	23.7	0.4	69.7	29.7	0.7	64.1	34.8	1.1
North West	63.6	36.2	0.1	60.6	39.2	0.1	56.5	43.2	0.3
South East	37.3	61.4	1.3	36.8	62.1	1.2	37.6	58.6	3.8
South South	42.8	54.8	2.4	31.7	66.1	2.1	28.6	69.9	1.5
South West	28	71.5	0.5	20.9	77.9	1.1	17.1	81.6	1.4
State									
North Central									
Benue	89.7	10.1	0.1	80.9	17.7	1.4	60.5	39.3	0.2
FCT (Abuja)	30.9	67.3	1.9	29.7	70.0	0.3	23.1	75.7	1.2
Kogi	49.9	49.1	0.9	35.4	64.2	0.5	40.6	58.2	1.2
Kwara	52.6	47.1	0.4	12.4	84.9	2.6	30.3	68.1	1.6
Nasarawa	75.3	24.4	0.3	71.3	25.0	3.7	38.2	60.5	1.3
Niger	75.7	23.8	0.6	51.2	48.5	0.3	52.6	46.9	0.5
Plateau	90.1	9.0	0.9	75.5	23.9	0.7	63.6	35.3	1.1
North East									
Adamawa	71.5	28.3	0.2	56.9	41.4	1.7	62.7	37.1	0.1
Bauchi	79.1	20.3	0.7	69.7	29.9	0.4	64.9	34.3	0.8
Borno	81.7	18.0	0.3	60.7	38.8	0.5	54.6	45.2	0.3
Gombe	63.6	35.9	0.5	52.3	47.2	0.5	57.5	40.8	1.7
Taraba	83.1	16.1	0.8	91.3	7.7	1.0	79.7	17.9	2.4
Yobe	70.1	29.9	0.0	83.7	16.1	0.1	67.9	30.7	1.5
North West									
Jigawa	77.8	22.2	0.0	70.3	29.4	0.3	74.4	25.6	0.1
Kaduna	46.4	53.4	0.2	54.9	44.6	0.5	39.5	60.0	0.5
Kano	50.8	49.1	0.1	50.3	49.7	0.0	49.7	49.8	0.5
Katsina	71.4	28.5	0.1	68.8	31.2	0.0	56.7	43.2	0.1
Kebbi	59.6	40.4	0.0	56.9	43.2	0.0	69.1	30.9	0.0
Sokoto	76.7	23.2	0.1	62.0	37.8	0.3	63.6	36.0	0.5
Zamfara	82.4	17.0	0.6	69.0	31.0	0.0	64.3	35.6	0.1
South East									
Abia	31.6	68.0	0.5	17.2	82.7	0.1	8.4	84.1	7.5
Anambra	14.3	84.0	1.7	16.2	83.4	0.4	14.7	80.4	4.9
Ebonyi	67.0	31.0	2.0	61.2	38.3	0.5	73.6	24.1	2.3
Enugu	56.2	43.1	0.7	42.8	54.7	2.5	34.7	64.6	0.7
Imo	36.0	62.6	1.4	33.8	64.2	2.0	50.3	45.7	4.0
South South									
Akwa Ibom	38.1	56.9	5.0	35.9	61.7	2.4	26.0	72.3	1.7

Bayelsa	48.1	51.1	0.8	51.8	43.6	4.5	49.2	48.9	1.9
Cross River	67.3	29.9	2.8	41.1	57.3	1.7	45.2	54.4	0.5
Delta	34.9	61.4	3.7	21.3	76.6	2.2	30.5	68.7	0.8
Edo	23.4	75.0	1.6	19.5	78.5	2.1	25.9	68.7	5.4
Rivers	46.8	52.4	0.8	30.6	67.8	1.6	19.3	80.3	0.4
South West									
Ekiti	37.7	60.5	1.8	4.9	94.0	1.1	38.2	59.3	2.6
Lagos	7.9	92.1	0.0	0.4	98.5	1.2	1.7	97.1	1.1
Ogun	33.6	65.2	1.2	25.2	74.8	0.0	8.3	88.9	2.8
Ondo	56.0	43.8	0.2	42.5	55.9	1.6	43.4	54.6	2.0
Osun	24.7	74.1	1.2	8.0	90.8	1.2	18.8	80.8	0.3
Oyo	36.6	63.4	0.0	39.3	59.1	1.6	27.1	72.2	0.7

4.5.4 Summary of trends in maternal care

This section presents results on components of maternal care leading up to pregnancy, with focus on antenatal care visits, quality of antenatal care (ANC) received, place of delivery, and access to a professional birth attendant during delivery. Results on ANC attendance during pregnancy showed clear variations across geo-political zones and states. Findings by geo-political zones in Figure 4.8 indicate that the South West with 84 percent in 2018 reported the highest proportion of children whose mothers attended ANC up to the recommended four visits during pregnancy while the North West with 42 percent reported the lowest. Generally, there were reductions in the proportion of children born to maternal women who did not attend ANC during pregnancy throughout the study period. Nevertheless, more than 25 percent of the children in the northern zones still had mothers who did not attend ANC.

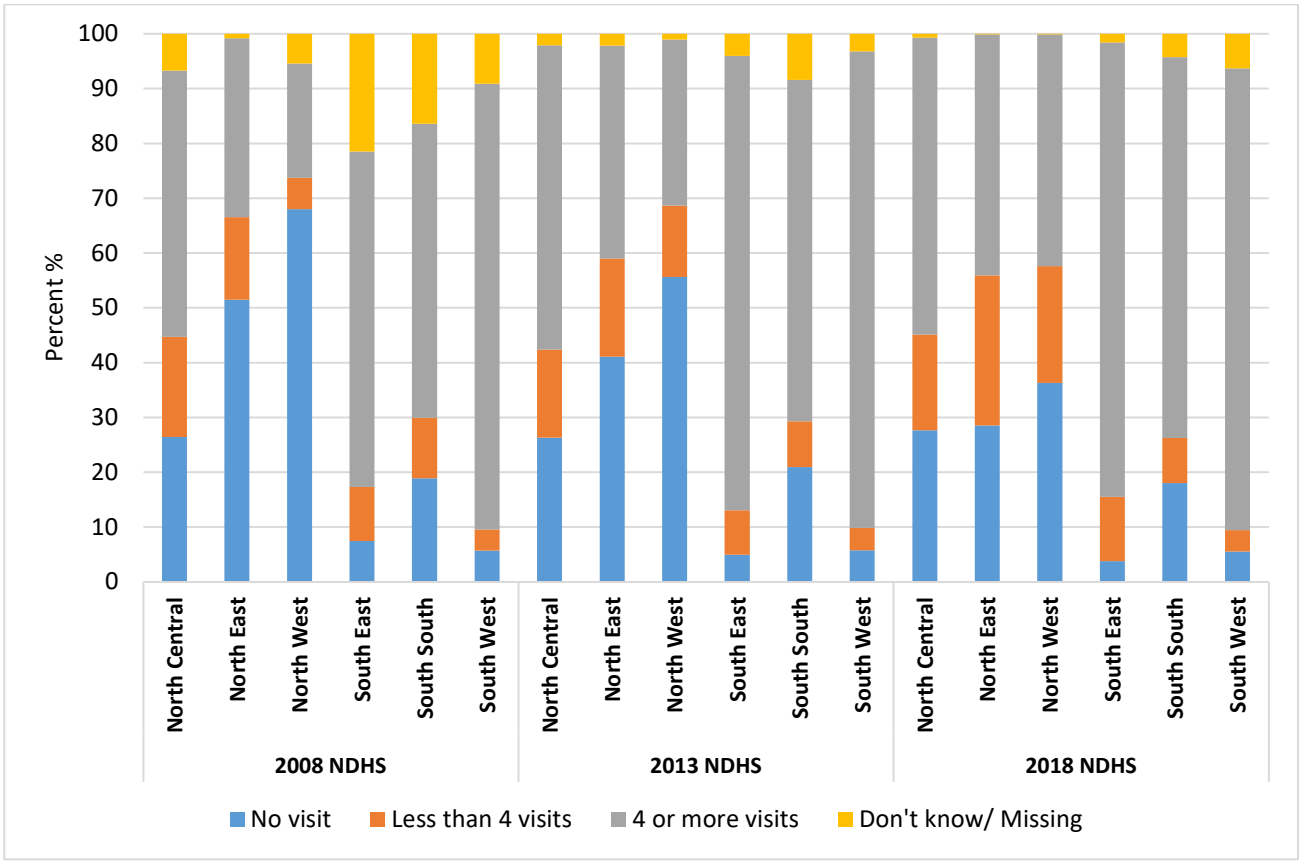

Figure 4.8: Distribution of children born in the five years preceding each survey by mother's ANC attendance and geo-political zone, Nigeria 2008-2018

State results in Figures B.10-B.12 (Appendix B) underscore what was shown at the zonal levels with regards to improvement in the proportion of children born to women who received at least four antenatal cares. However, there still exists a high proportion of children whose mothers did not receive antenatal care, with Zamfara and Sokoto (in the North West) as high as 64 and 53 percent respectively in 2018. Osun state (South West) at 96 percent had the highest proportion of children whose mothers attended ANC at least four times, while Kebbi (North West) with 27 percent had the lowest.

Results on the quality of care received by the women during antenatal shown in Table 4.12 indicate that amongst those who attended ANC, majority of them had their blood pressures checked, and their urine and blood samples taken. These three main practices are used to monitor and support healthy pregnancy. More than 70 percent of those that attended ANC received these measures of quality care. This is a commendable practice in maternal and child health care in Nigeria that should be sustained.

Table 4.12: Sub-national distribution of children born in the five years preceding each survey by quality of ANC received (blood pressure, urine, and blood samples taken) by their mothers, Nigeria 2008-2018

	2008 NDHS (%)	2013 NDHS (%)	2018 NDHS (%)
Geo-political zone			
North Central	80.3	93.2	93.3
North East	80.5	81.9	84.5
North West	85.6	87.1	90.4
South East	85.4	85.0	90.3
South South	80.0	88.3	85.6
South West	87.5	91.1	91.5
State			
North Central			
Benue	76.6	91.3	97.6
FCT (Abuja)	89.8	87.2	96.2
Kogi	84.1	93.7	91.5
Kwara	88.3	97.5	95.3
Nasarawa	74.5	91.9	96.4
Niger	73.4	96.8	91.0
Plateau	84.8	86.2	87.1
North East			
Adamawa	69.1	76.8	83.1
Bauchi	72.9	83.7	87.9
Borno	90.3	84.3	91.5
Gombe	83.4	77.0	88.6
Taraba	82.2	79.2	71.7
Yobe	92.0	89.2	80.8
North West			
Jigawa	91.8	85.0	94.3
Kaduna	79.2	86.9	83.7
Kano	78.3	85.1	90.3
Katsina	93.1	90.2	93.7
Kebbi	93.9	82.1	90.6
Sokoto	92.8	96.0	89.7
Zamfara	95.1	89.2	94.6
South East			
Abia	90.4	94.1	95.3
Anambra	90.1	93.2	96.7
Ebonyi	69.3	73.4	78.0
Enugu	75.4	77.9	94.7
Imo	93.0	92.6	88.8
South South			
Akwa Ibom	74.1	91.6	85.4
Bayelsa	68.8	95.4	96.0

Cross River	81.4	79.0	81.2
Delta	70.1	87.1	88.8
Edo	90.7	89.5	88.8
Rivers	87.2	91.8	81.8
South West			
Ekiti	80.2	90.6	88.7
Lagos	88.9	90.6	89.2
Ogun	88.1	93.2	90.4
Ondo	80.4	81.4	87.7
Osun	95.1	97.4	92.9
Oyo	87.4	92.6	98.1

Moving on to place of delivery. Results by geo-political zones shown in Figure 4.9, suggest that a high proportion of the children were still delivered at home. It is evident that home deliveries expose maternal women and infants to higher risks of mortality and should be discouraged (Greenwell & Winner, 2014). The North West had the highest rate of home deliveries throughout the study period from 91 to 84 percent, while South East and South West with 17 percent had lowest proportions of home deliveries. While other geo-political zones reported more deliveries at the government health facilities, the South East reported more deliveries at the private facilities.

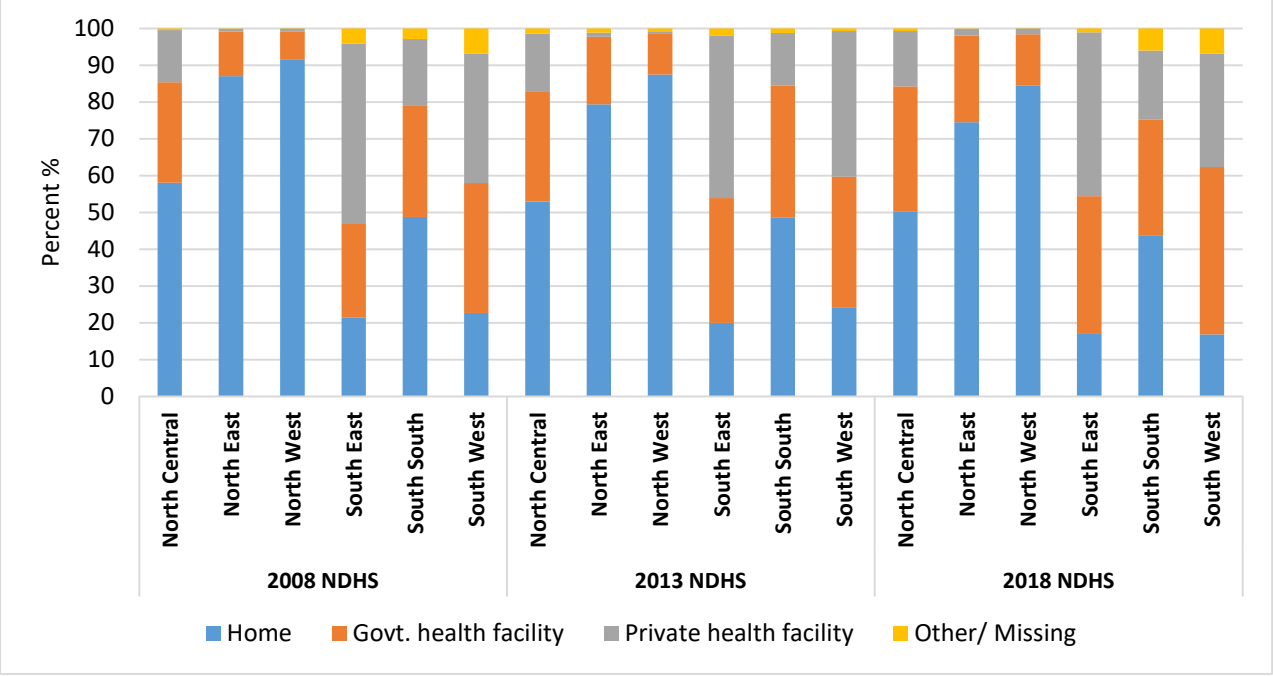

Figure 4.9: Distribution of children born in the five years preceding each survey by place of delivery and geo-political zone, Nigeria 2008-2018

State results in Figures B.13-B.15 (Appendix B) further accentuate what was seen at the regional level. The 2018 NDHS results suggest that more than 80 percent of the children in the North West states were delivered at home. The highest proportion of home deliveries was Sokoto's (North West) 92 percent, while Imo's (South East) five percent was the lowest proportion of home deliveries in 2018. Amongst the South East states, Ebonyi had a markedly high proportion of home deliveries. Remarkably, there is a growing demand for private health facilities, especially in the southern parts of the country, with Imo State (South East) reporting in 2018 that about three-quarters of its deliveries took place in private health facilities. Amongst the southern states, Bayelsa in the South South geo-political zone recorded a distinctively high percentage of home deliveries (76% in 2018). In retrospect, Bayelsa's delivery result is also like its ANC result, where proportions of children whose mothers did not attend ANC during pregnancy at 36, 52, and 47 percent in 2008, 2013, and 2018 respectively were the highest in the southern region (see Figures B.10-B.12 of Appendix B).

Further results on level of maternal care available in the country are shown in Table 4.13. It indicates that less than one-fifth of the children in the North West were attended to by a professional birth attendant during their delivey, unlike 85 percent of those in the South East and South West who received such care during delivery. State results further highlight the trend seen at the regional level. In the 2018 NDHS result, Kebbi and Sokoto in the North West had less than 10 percent assisted deliveries in stark contrast with more than 95 percent in Abia (South East), Imo (South East), and Osun (South West). Again, as seen earlier in results with ANC attendance and place of delivery, Bayelsa state also consistently had the lowest proportions of children whose births where assisted by a professional birth attendant amongst the southern states.

Table 4.13: Sub-national distribution of children born in the five years preceding each survey by professional birth attendance during delivery, Nigeria 2008-2018

	2008 NDHS	2013 NDHS	2018 NDHS
Geo-political zone			
North Central	43.4	46.5	51.0
North East	15.7	19.9	24.8
North West	10.0	12.3	18.2
South East	82.9	82.2	85.2
South South	56.2	55.4	64.8
South West	77.1	82.5	85.4
State			
North Central			
Benue	52.8	51.6	67.6
(FCT) Abuja	65.8	70.2	71.6
Kogi	76.1	70.9	73.4
Kwara	53.6	79.6	62.1
Nasarawa	34.0	40.8	57.3
Niger	17.9	28.6	24.7
Plateau	30.9	35.8	42.9
North East			
Adamawa	14.8	36.3	40.5
Bauchi	16.0	16.3	21.6
Borno	13.4	22.3	25.9
Gombe	18.8	26.6	18.8
Taraba	26.0	14.3	30.4
Yobe	9.4	10.2	17.8
North West			
Jigawa	5.1	7.6	20.9
Kaduna	22.4	35.5	26.5
Kano	12.9	13.7	21.5
Katsina	4.9	7.7	18.9
Kebbi	6.4	9.3	3.4
Sokoto	5.2	5.4	9.2
Zamfara	7.8	6.1	12.5
South East			
Abia	88.1	77.2	95.8
Anambra	96.8	87.6	94.7
Ebonyi	47.1	62.1	52.1
Enugu	66.8	91.5	93.0
Imo	98.3	96.5	98.2
South South			
Akwa Ibom	44.1	45.6	41.4
Bayelsa	21.6	32.1	27.0

Cross River	45.3	41.3	55.7
Delta	61.6	59.8	67.1
Edo	81.0	78.3	88.2
Rivers	63.7	63.4	78.3
South West			
Ekiti	82.0	84.7	87.1
Lagos	83.9	87.2	83.6
Ogun	72.1	84.8	79.9
Ondo	51.1	67.3	86.1
Osun	89.6	94.2	96.0
Oyo	76.5	78.3	84.6

4.5.5 Summary of trends in access to health care

Information was also gathered from respondents on their perception of distance to health facility and cost of treatment during times of illness. They were asked whether they perceived these indicators as big problems. As mentioned earlier, distance to a health facility and ability to pay for cost of medical care are used in this study to measure access to health care since these variables potentially create barriers to access to timely treatment during illness. Findings from Tables 4.14 and 4.15 suggest that access to health care was still a problem in Nigeria during the study period.

Table 4.14 further illustrates that by geo-political zones, more than 20 percent of children were born to mothers who saw distance to health facilities as big problems. Across the states from 2018 results, Ondo, and Osun (in the South West) with 0.5 and five percent respectively had the lowest proportions of children with mothers who reported that distance to health facility was a big problem. On the contrary, Delta (South South) with 61 percent and Oyo (South West) with 67 percent had the highest proportions of children whom their mothers perceived distance to health facilities as a challenge. Remarkably, in 2018, both the lowest and highest levels of perception of distance to a health facility in the country were reported from the South West.

Table 4.14: Sub-national distribution of children born in the five years preceding each survey by their mother's perception of distance to health facility, Nigeria 2008-2018

	Perceived as a big problem		
	2008 NDHS (%)	2013 NDHS (%)	2018 NDHS (%)
Geo-political zone			
North Central	44.6	31.1	39.0
North East	47.7	36.0	36.8
North West	37.5	37.5	22.5
South East	44.3	31.1	26.2
South South	36.8	28.5	26.5
South West	25.9	14.6	22.8
State			
North Central			
Benue	51.2	26.4	51.8
FCT (Abuja)	21.5	15.3	20.7
Kogi	32.2	11.9	36.9
Kwara	48.5	13.3	27.4
Nasarawa	23.1	26.5	8.4
Niger	55.8	43.4	49.2
Plateau	46.6	46.0	41.8
North East			
Adamawa	33.3	15.2	44.9
Bauchi	33.9	35.2	40.5
Borno	67.7	32.8	26.8
Gombe	46.2	18.3	45.8
Taraba	72.7	40.1	33.2
Yobe	38.4	65.0	34.3
North West			
Jigawa	38.5	29.2	29.1
Kaduna	44.0	31.5	14.0
Kano	45.9	41.8	21.3
Katsina	25.4	48.0	14.7
Kebbi	36.6	43.4	35.2
Sokoto	21.9	45.3	37.1
Zamfara	43.7	21.5	24.9
South East			
Abia	31.9	58.9	35.9
Anambra	33.9	21.7	11.1
Ebonyi	63.0	34.7	36.1
Enugu	72.5	37.1	28.2
Imo	33.7	14.8	30.2
South South			
Akwa Ibom	40.8	25.3	19.3

Bayelsa	59.7	53.6	33.4
Cross River	44.2	23.2	13.0
Delta	39.3	26.0	61.2
Edo	12.1	29.1	23.7
Rivers	34.8	28.2	12.1
South West			
Ekiti	23.5	11.7	16.4
Lagos	25.3	6.9	12.1
Ogun	30.5	3.1	12.3
Ondo	40.1	34.5	0.5
Osun	17.4	4.7	5.4
Oyo	21.0	25.4	67.5

Table 4.15 also shows that a high proportion of the children had mothers who perceived the cost of healthcare as a big problem. From the 2018 results, the highest proportion of those children were in the North East (63%), while the lowest were in the South West (35%). Like what was seen in Table 4.14, Osun state (South West) at eight percent also had the lowest proportion of children with mothers who perceived cost of treatment as a challenge, while Adamawa state (North East) with 93 percent had the highest proportion.

Table 4.15: Sub-national distribution of children born in the five years preceding each survey by their mother's perception of getting money needed for medical treatment, Nigeria 2008-2018

	Perceived as a big problem		
	2008 NDHS (%)	**2013 NDHS (%)**	**2018 NDHS (%)**
Geo-political zone			
North Central	68.7	52.5	55.5
North East	62.3	46.3	62.9
North West	58.5	42.5	43.2
South East	66.3	56.2	51.2
South South	56.2	49.3	48.9
South West	47.2	26.7	34.8
State			
North Central			
Benue	86.0	56.7	80.2
FCT (Abuja)	46.3	30.1	47.3
Kogi	54.4	35.1	67.0
Kwara	62.5	30.6	35.4

Nasarawa	51.7	44.8	11.7
Niger	70.8	59.6	66.2
Plateau	75.7	72.7	44.0
North East			
Adamawa	67.2	51.1	93.4
Bauchi	53.1	47.8	53.7
Borno	80.1	26.0	64.3
Gombe	46.3	38.0	64.6
Taraba	84.8	70.7	53.8
Yobe	39.3	50.0	57.7
North West			
Jigawa	61.0	42.4	72.0
Kaduna	61.3	38.4	55.5
Kano	53.0	38.0	37.3
Katsina	62.3	64.4	18.6
Kebbi	70.7	56.9	38.6
Sokoto	66.7	33.4	44.9
Zamfara	40.3	26.7	49.0
South East			
Abia	32.1	69.5	61.7
Anambra	59.9	46.2	35.1
Ebonyi	86.3	52.4	62.6
Enugu	78.2	65.1	58.0
Imo	78.5	56.4	50.7
South South			
Akwa Ibom	68.7	52.4	47.7
Bayelsa	74.8	54.3	41.1
Cross River	57.4	54.6	38.0
Delta	59.2	43.8	75.9
Edo	34.8	55.8	41.5
Rivers	51.9	42.5	40.9
South West			
Ekiti	33.1	29.7	22.9
Lagos	42.1	26.4	25.8
Ogun	62.1	10.9	40.8
Ondo	38.0	48.0	11.3
Osun	29.1	15.8	8.0
Oyo	63.3	30.5	74.9

4.6 Conclusion

This chapter has set the scene for the analysis of this study by explaining the data and methods in use. The study measures have also been extensively described from the national to the sub-national levels. Thereby providing a micro-level understanding of the clear inequality across the country, largely driven by government policies, socio-economic status, education, culture, and religion. The next chapter provides a detailed analysis of under-five deaths in Nigeria, temporal changes over the study period, and identifies determinants of under-five deaths at the individual/household level. A combined knowledge of information on the sub-national distribution of the study measures contained in this chapter, together with results on under-five deaths in the following chapter will aid sub-national research and programming in Nigeria with the intent of improving early childhood survival across the country.

CHAPTER FIVE TRENDS AND PATTERNS OF UNDER-FIVE DEATHS IN NIGERIA

5.1 Introduction

This chapter is the first of three empirical chapters, that presents results on trends and patterns of under-five deaths in Nigeria between 2008 and 2018. Understanding spatial and temporal changes in under-five deaths and the size of change is crucial for monitoring the effectiveness of policies and programmes and identifying key areas where future actions should be strengthened and/or expanded. For this study, under-five mortality is measured by deaths that occurred between birth and the fifth birthday, separated into infant and child deaths.

A series of bivariate analysis and regression models are developed to test the research questions and hypotheses. In so doing it seeks to answer the following questions: 1. ***What are the trends and patterns of under-five deaths in Nigeria?*** 2. ***What are the determinants of under-five mortality at the individual/household level across various geo-political zones and states in Nigeria?*** The second question is also further explored in the following chapter.

The next section focuses on trends and patterns of under-five deaths in Nigeria, paying particular attention to inter-zonal, intra-zonal, and inter-state variations. It then explores sub-national differences in immunisation coverage and access to medical treatment, as well as some socio-economic factors associated with variations in both. Separate attention is given to immunisation and access to medical treatment because they have been identified in the literature to be associated with early childhood survival. Since we do not have information on both indicators for all children ever born in the NDHS dataset but only on children alive, they must be analysed descriptively. Even though they cannot be directly analysed with under-five deaths due to this limitation, information on sub-national distribution of these factors provides more robust understanding to this research, while removing them entirely from the study will create a knowledge gap. Also, this chapter further explores bivariate and multivariate association between under-five deaths and the selected structural factors at the individual and household levels. Subsequently, there are discussion and conclusion sections where results shown are evaluated to see how best they provide answers to the research questions in line with this study's analytical approach and meet set objectives.

5.2 Trends and patterns of under-five deaths in Nigeria

The table of measures presented in Table 5.1 gives the definition and operationalisation of the indicators analysed in this chapter.

Table 5.1: Table of measures, definition, and operationalisation of variables

Measures	Definition	Operationalisation
Outcome variables: Indicators of under-five mortality		**Missing values were set to system missing**
Infant death	Died before first birthday	0 = none, 1 = yes
Child death	Died between the first and fifth birthday	0 = none, 1 = yes
Key independent variables Individual/Household level		
State	State of usual residence of the respondent	37 states of Nigeria
Geo-political zone	Region of usual residence of the respondent	Six geo-political zones of Nigeria (1 = North Central, 2 = North East, 3 = North Central, 4 = South East, 5 = South South, 6 = South West)
Maternal education	Respondent's highest level of educational attainment	0 = no education, 1 = incomplete primary, 2 = complete primary, 3 = incomplete secondary, 4 = complete secondary, 5 = higher education
Drinking water	Household's source of drinking water	0 = non-improved sources, 1 = improved sources. "Other" sources were categorised as non-improved facility.

Toilet facility	Type of toilet facility used by household	0 = none, 1 = non-improved type, 2 = improved type.
Electricity	Household has access to electricity	0 = none, 1 = yes
ANC attendance	Number of times respondent received ANC during pregnancy	0 = none, 1 = less than 4 visits, 2 = 4 or more visits, 3 = "do not know".
Professional birth attendance	Whether child delivery was handled by a doctor, midwife, or nurse	0 = none, 1 = yes
Child immunisation	Immunisation coverage for children 12-23 months	0 = none, 1 = yes
Health seeking behaviour		
Place mothers' first sought advice/treatment for child's diarrhoea	The first health provider child's mother consulted when the child was down with diarrhoea	1 = government facility, 2 = private facility, 3 = chemists/drug vendors, 4 = other sources such as traditional practitioners
Whether child received medical treatment for diarrhoea	Whether or not child received medical treatment for diarrhoea	0 = none, 1 = yes

Prior studies of early childhood mortality in Nigeria have shown that the risk of death is highest in the first year of life, largely due to high neonatal deaths in the first 27 days (Ekwochi et al., 2015; Fetuga, Ogunlesi, Adekanmbi, Olanrewaju, & Olowu, 2007). Consistent with these findings Figure 5.1 shows the risk of early childhood mortality in Nigeria is higher in infancy, both nationally and sub-nationally. Throughout the focal period, infant (0-11 months) mortality was almost double that of childhood mortality (12-59 months). As reported in NDHS 2013, 70 percent of under-five deaths occurred at infancy. Also, there was a marked increase in the proportion of deaths that occurred at infancy from 2008 to 2013, while deaths in childhood reduced in the same period. Infant deaths reduced marginally from 2013 to 2018, with a contrasting increase in child deaths in the same period. Remarkably, the distribution of death for these indicators remained almost static from 2008

to 2018 at the national level. Whatever improvement (in the case of childhood mortality) or loss (in the case of infant mortality) were made in 2013 became almost insignificant in 2018. Infant deaths increased from 64 percent at the onset of the study period in 2008 to 66 percent at the end of the period in 2018, while child deaths reduced from 36 percent in 2008 to 33 percent in 2018. Figure 5.1 clearly highlights the little progress made in improving child survival over more than a decade in Nigeria. Further breakdown of under-five deaths by year of life, shown in Appenidx C (Figure C.1), demonstrate that after infancy there is also a higher risk of death in the second year of life when compared to older years.

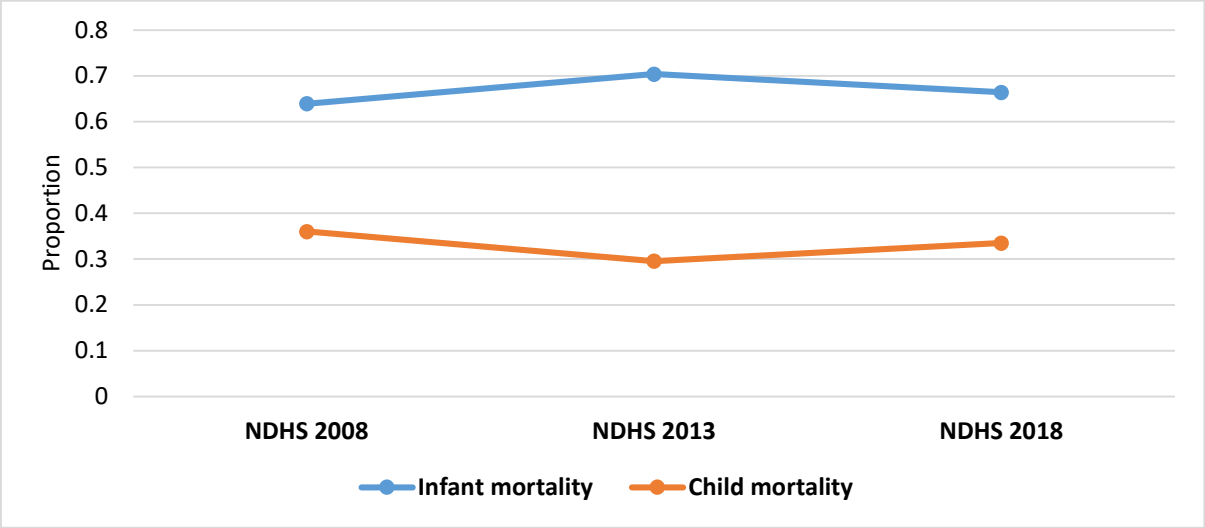

Figure 5.1: Proportion of infant and child deaths amongst under-five deaths in Nigeria from 2008-2018

The following sub-sections focus on vital aspects of this study: levels, trends, and differentials of infant and child deaths by geo-political zones and states. Findings on under-five mortality at the sub-national level are discussed in the light of the structural and proximate factors observed in different geo-political zones and states shown in Chapter Four. This level of analysis is important to raise awareness about the situation at the zonal and state levels and shed light on how they relate to sub-national disparities in early childhood survival.

5.2.1 Levels, trends, and differentials in under-five deaths by geo-political zones

As was stated in Chapter One, there exists vast differences in early childhood survival outcomes between and within the six geo-political zones that cannot be ignored. Exploring these zonal differences helps in identifying unique background characteristics within the zones that might be associated with under-five mortality, thus providing a more strategic view on under-five mortality. Inter-zonal differences in maternal education, religion and cultural practices have been identified in past studies as possible drivers of these differences (Adedini, Odimegwu, Imasiku, & Ononokpono, 2015; Adedini, Odimegwu, Imasiku, Ononokpono, et al., 2015). Disaggregation of infant and child deaths by geo-political zones as depicted in Figures 5.2 and 5.3 not only reveals inter-zonal differences but also a clear north-south divide. Consistent with other studies, under-five mortality rates are substantially higher in the northern geo-political zones than in the southern parts (Adebowale, Yusuf, & Fagbamigbe, 2012; Adedini, Odimegwu, Imasiku, Ononokpono, et al., 2015). The figures illustrate that the northern regions reported increased infant and child deaths from 2013 to 2018, except for child deaths in North East from 2013 to 2018 as shown in Figure 5.3. This is an indication that these regions contributed significantly to the increase in under-five mortality observed at the national level from 2013 to 2018. In contrast, early childhood deaths in the three southern regions declined steadily throughout the study period. Figures 5.2 and 5.3 also highlight relatively different results for North Central from the rest of the north, a reflection of the ethnic and religious diversity of the states there and the Federal Capital Territory (Abuja) in particular, making it serve as a mid-point between the north and south.

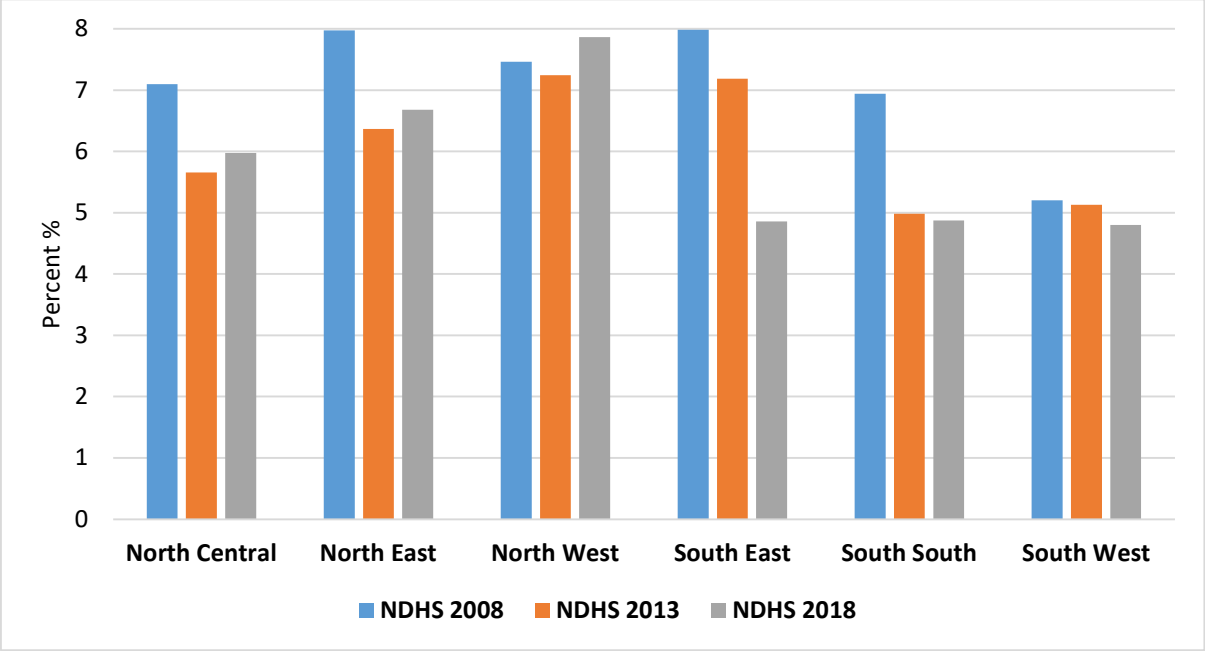

Figure 5.2: Percentage of infant (0-11 months) deaths by geo-political zones, Nigeria 2008-2018

Although under-five deaths were highest in the North West in all three survey points, the increase in 2018 is particularly noteworthy because under-five mortality had declined significantly in the previous period. A possible explanation for this reversal could be the increase in internal migration from the neighboring North East region, due to increasing insecurity in the region because of activities of the terrorist group: Boko Haram. These terrorists have killed thousands of people, displaced, or captured hundreds of thousands more, destroyed social and health infrastructures, and paralysed economic activities in the North East (Adamu, Okagbue, Akinwumi, & Idowu, 2021; Ager et al., 2015; Dunn, 2018). It is possible that the activities of the terrorist group may have created an existing health burden on the children, coupled with lack of health care and challenges with being displaced, thereby leading to their death on arrival at their new destinations.

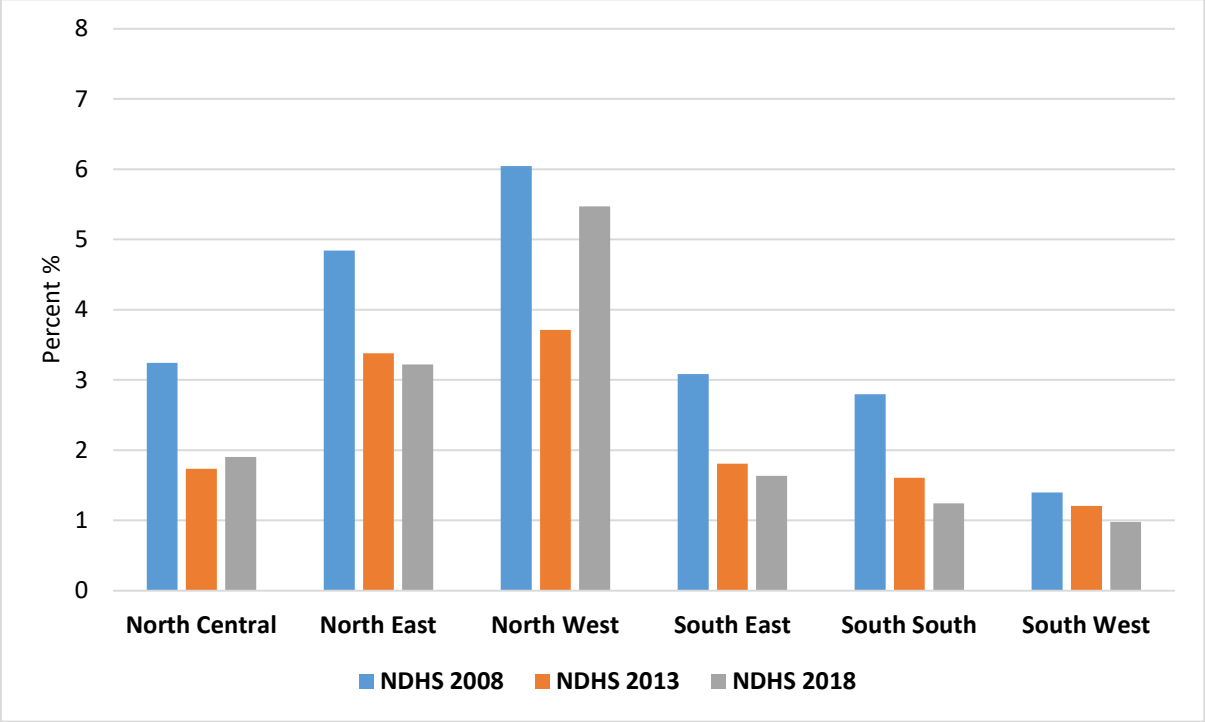

Figure 5.3: Percentage of child (12-59 months) deaths by geo-political zones, Nigeria 2008-2018

The geo-political zone comparisons also reveal notable progress in the South East. Infant deaths were almost at par with the North East in 2008, and higher than North Central in 2008 and 2013, but it declined slowly in the zone in 2013 and then sharply in 2018. However, South East still had the highest proportion of child deaths in the southern region at 1.9 percent. All zones made clear progress in reducing under-five deaths from 2008 to 2013, although the trend was more muted in the South West. The government's uptake of the MDGs goal 4 to reduce child mortality by two-thirds between 1990 and 2015 led to the initiation of different maternal and child health programmes which resulted in reductions in under-five mortality from 2008 to 2013 (Morakinyo & Fagbamigbe, 2017; Nwangwu, 2018). Unfortunately, the lack of sustained funding of some of these programmes in addition to the actions of Boko Haram from 2009 contributed to the lack of progress and to the deterioration of child survival outcomes in the northern regions (Ekhator-Mobayode & Abebe Asfaw, 2019; Iacoella & Tirivayi, 2020; Omole, Welye, & Abimbola, 2015)

Tables 5.2 and 5.3 present chi-square (chi-2) test results and percentage changes in under-five deaths by geo-political zones. The chi-2 test is useful in measuring test of dependence, thus establishing if there are significant relationships between two categorical variables, here being under-five mortality and geo-political zones. Chi-2 is evaluated by comparing observed values to expected values if no relationship exists between the variables. Equation 5.1 below is the mathematical representation.

$$\chi^2 = \Sigma \frac{(O_i - E_i)^2}{E_i} \quad \text{.....5.1}$$

Where:

O_i = Observed values

E_i = Expected values

The chi-2 tested results show significant relationships between under-five deaths and geo-political zones throughout the study period, suggesting that contextual factors within the geo-political zones are relevant in studying under-five mortality in Nigeria. In assessing the percentage change in early childhood mortality over time, Table 5.2 shows that the overall highest reduction in infant deaths was reported in the South East. In contrast, the North West had an increase of 5.4 percent between 2008 and 2018. Table 5.3 shows that South South made the most overall improvement with more than 50 percent decrease in child deaths, while North West made the least. Generally, there was more progress made in reducing childhood mortality than infant mortality.

Table 5.2: Trends and differentials in infant deaths by geo-political zones, Nigeria 2008-2018

Infant deaths	NDHS 2008 (%)	NDHS 2013 (%)	NDHS 2018 (%)	% Change (2008-2013)	% Change (2013-2018)	% Change (2008-2018)
Geo-political zone						
North Central	7.1	5.7	6.0	-20.4	5.7	-15.8
North East	8.0	6.4	6.7	-20.2	4.9	-16.2
North West	7.5	7.2	7.9	-2.9	8.6	5.4
South East	8.0	7.2	4.9	-10.1	-32.4	-39.2
South South	6.9	5.0	4.9	-28.2	-2.2	-29.8
South West	5.2	5.1	4.8	-1.5	-6.4	-7.8

Chi-2 tests are significant at *** $p < 0.001$

Table 5.3: Trends and differentials in child deaths by geo-political zones, Nigeria 2008-2018

Child deaths	NDHS 2008 (%)	NDHS 2013 (%)	NDHS 2018 (%)	% Change (2008-2013)	% Change (2013-2018)	% Change (2008-2018)
Geo-political zone						
North Central	3.2	1.7	1.9	-46.6	9.8	-41.4
North East	4.8	3.4	3.2	-30.2	-4.8	-33.6
North West	6.0	3.7	5.5	-38.6	47.5	-9.5
South East	3.1	1.8	1.6	-41.4	-9.6	-47.0
South South	2.8	1.6	1.2	-42.4	-22.7	-55.5
South West	1.4	1.2	1.0	-13.9	-18.8	-30.1

Chi-2 tests are significant at *** $p < 0.001$

Having observed inter-zonal variations in under-five deaths, it is pertinent to identify factors that might be driving under-five mortality in Nigeria, especially amongst the zones. To do this, analyses of structural and proximate factors at the individual and household levels in the preceding chapter are considered. Figure 4.4 in Chapter Four shows that the North West had the highest proportion of under-five children born to women with no formal education, with as high as 73 percent in 2018 in sharp contrast to three percent in the South East. Similarly, the northern regions had higher proportions of maternal women with no education, while the southern regions had higher proportions of maternal women with secondary or higher levels of educational attainment. Evidence shows that maternal education helps in controlling

fertility, preventing early marriage, and empowering women economically (Ezeh et al., 2015; Morakinyo & Fagbamigbe, 2017; Negera et al., 2013). Adebowale et al. (2012) added that, to a large extent, literacy cancels the effects of cultural and religious beliefs such as early marriage. As evident in the South West region, with a similar high proportion of Muslims to the north, the high level of female educational attainment reduces early marriage. Unlike in the northern regions with lower female educational attainment and high child marriage. The practice of early marriage further limits women's access to education and participation in economic activities (Adebowale et al., 2012).

In identifying more possible contextual factors associated with inter-zonal variations in under-five mortality using the structural and proximate analyses in Chapter Four, the North East and North West reported higher proportions of children in households in the lowest wealth quintile, as well as higher wealth inequality, an indication of higher poverty spread and concentration of wealth with a few individuals. In addition to this pattern, North East and North West reported the lowest proportions of households with access to improved sources of drinking water and electricity, while North Central had the highest cases of households without a toilet facility. The northern regions also reported higher proportions of children born to mothers who did not receive antenatal care, and those that were delivered at home. A high of 84 percent of the deliveries in North West from NDHS 2018 were at home, further exposing the mother and new-borns to birth complications and infections due to unhygienic environment and lack of professional care. Even though immunisation coverage is still low nationally, the northern regions still reported higher proportions of children without full immunisation coverage (see detailed results in Chapter Four).

5.2.2 Levels, trends, and differentials in under-five deaths by states

State-level variations and intra-zonal differences amongst states in the same geo-political zone are important to highlight. One of the key contributions of this research is not only to explore variations between zones, but also to highlight variations in under-five deaths amongst states in the same geo-political zone. As other scholars have shown, there are state level differences across a wide range of human development outcomes that do not map neatly onto geo-political zones (Adedokun et al., 2017; Ayoade, 2020; Olorunsaiye & Degge, 2016). Tables 5.4 and 5.5 present more granular spatial analysis of levels, trends and differentials in infant and child deaths in Nigeria. Percentage changes (temporal patterns) in under-five

deaths pinpoint critical lows and highs for each state across the period, by showing the size of change in under-five deaths.

Temporal patterns help in identifying states where current programmes need to be sustained, and those that require urgent attention. While analysis at the regional level provides some insight into the sub-national dynamics, a closer look inside regions shows noticeable differences in under-five mortality with visible peaks and troughs across states, emphasizing the need for sub-national analysis at the state-level. Evaluating progress at the state-level helps us explore these differences in under-five mortality while providing relevant information to policy makers and programmes implementers for effective decision making. Similarly, spatial analysis ensures accountability at the state levels, since provision of primary health care is largely managed by the state and local governments (Adedini, 2013; Ogbuoji & Yamey, 2019). Chi-2 tested results in Tables 5.4 and 5.5 indicate that structures at the state-level are significantly associated with under-five mortality in Nigeria.

When the states were ranked from the least to the highest percentage of infant deaths. Kaduna went from being the 21st state in 2008 to the state with the highest infant deaths in 2018 with 11 percent, even worse than Imo's figure (10.54%) in 2008, when it had the highest infant deaths. In contrast, Ogun progressed from being the 20th state in 2008, just one step ahead of Kaduna, to recording the lowest rate of 1.6 percent in 2018. This result highlights the vast disparity in infant deaths amongst states. Prominent overall changes can be seen in Table 5.4 in various states. Benue, Borno, Ebonyi, Bayelsa, Delta and Ogun had more than 50 percent reductions in infant deaths across the period, while Kwara, Gombe, Kaduna, Kebbi, and Osun had more than 50 percent increase in infant deaths. Throughout the study period, the figures for Plateau, Sokoto, and Ondo states remained unchanged.

In the North Central, Benue and the FCT made the most progress, while Kwara made the least. Results also show that Kogi went from 30 percent mid-point decrease to more than 100 percent increase in infant deaths from 2013 to 2018. Amongst the North East states, Adamawa and Borno recorded marked reductions in infant deaths from 2008 to 2013, which was visible at the regional level, while the other states in the region made no visible progress at the time. Nevertheless, Borno and two other states in the region recorded an increase in infant deaths from 2013. Overall, Adamawa and Borno reported the greatest reductions in infant deaths in the zone while Gombe had the greatest increase. The little progress that had

been made in the North West from 2008 to 2013 was cancelled out by increase in infant deaths from 2013 to 2018 in more than half of the North West states. To put this in context, Kaduna went from a 48 percent reduction in infant deaths from 2008 to 2013, to more than 200 percent increase between 2013 and 2018. Over the study period, Kebbi and Kaduna had the highest increases in infant deaths while Kano had the highest reduction in the zone.

Results from Adamawa and Borno seem to strengthen the argument made earlier of the effect of migration from the North East to other parts of the country, particularly the North West, which is the closest, due to Boko Haram activities. Insecurity in the region also caused the suspension of programmes needing external technical assistance (Ager et al., 2015; Sato, 2019). Considering that Borno state has been ravaged by insurgency since 2009, it is surprising to see the reported progress in infant mortality from 2013 to 2018. It is possible concerted effort was made towards improving infant mortality by the Borno state government, which is commendable, or there was misreporting of deaths. Due to the high level of insecurity in Borno during the 2018 NDHS household listing, one cluster plus 11 LGAs accounting for nearly 40 percent of state households were also dropped. Clusters previously selected from the dropped LGAs were replaced with clusters from the rest of the state. This could be why reported infant deaths seem to be unusually low, since data were not collected from a large section of the state. Hence, Borno state result should be used with caution as 2018 NDHS provincial level results are not representative for dropped LGAs. (National Population Commission Nigeria [NPC] & ICF International, 2019).

Moving on to the southern states. Infant mortality rates for all the states in the South East reduced between 2008 and 2018, reinforcing what was seen at the regional level, especially the progress reported in Imo, which had the highest infant mortality rate in 2008. Only Anambra reported an increase in infant deaths from 2008 to 2013, subsequently followed by a 50 percent reduction between 2013 and 2018. Overall, Ebonyi state recorded the greatest reduction in the zone. In the South South, improvements seen earlier at the zonal level from 2008 to 2013 can be attributed to the individual reductions in infant deaths seen in the states in Table 5.4, especially those of Bayelsa and Edo. However, Edo's progress was not sustained, as infant mortality deteriorated between 2013 and 2018. Overall, Bayelsa and Delta made the most progress in the zone, while Cross River made the least. Finally, in the South West, Ogun with more than 70 percent decrease recorded the most progress at reducing

infant deaths while Osun with more than 80 percent increase recorded the least. Intra-state dynamics across the study period culminated in the muted progress seen earlier at the South West zonal level.

Table 5.4: Trends and differentials in infant deaths by states, Nigeria 2008-2018

Infant deaths	NDHS 2008 (%)	NDHS 2013 (%)	NDHS 2018 (%)	% Change (2008-2013)	% Change (2013-2018)	% Change (2008-2018)
State						
North Central						
Benue	9.4	6.8	3.7	-27.2	-46.7	-61.2
FCT (Abuja)	6.3	5.2	4.3	-17.4	-18.6	-32.8
Kogi	5.5	3.8	8.2	-29.9	112.8	49.2
Kwara	3.3	5.3	5.8	63.1	9.9	79.2
Nasarawa	6.2	6.0	7.5	-2.9	25.3	21.7
Niger	7.9	4.9	6.0	-38.0	21.9	-24.4
Plateau	7.4	7.0	7.4	-5.1	4.8	-0.5
North East						
Adamawa	10.1	7.8	7.2	-22.3	-8.8	-29.1
Bauchi	7.9	8.1	6.5	2.1	-19.4	-17.7
Borno	8.8	2.7	4.5	-69.6	69.3	-48.6
Gombe	6.2	6.9	9.6	10.9	39.3	54.5
Taraba	7.9	7.4	6.0	-6.6	-18.6	-23.9
Yobe	5.7	5.9	7.4	2.6	26.3	29.6
North West						
Jigawa	5.5	8.6	7.9	56.7	-7.8	44.5
Kaduna	7.0	3.7	11.1	-48.0	202.3	57.1
Kano	9.3	6.8	6.2	-27.5	-8.2	-33.4
Katsina	6.6	5.0	5.7	-24.8	14.6	-13.8
Kebbi	6.2	8.8	10.4	42.4	18.1	68.1
Sokoto	8.4	7.8	8.4	-7.2	7.7	0.0
Zamfara	6.7	10.8	6.6	60.4	-38.8	-1.8
South East						
Abia	8.3	7.7	6.7	-6.6	-13.6	-19.3
Anambra	5.0	6.2	3.1	22.4	-50.4	-39.3
Ebonyi	9.3	8.4	4.6	-9.4	-45.2	-50.3
Enugu	8.2	6.4	5.2	-21.7	-18.2	-36.0
Imo	10.5	7.2	6.6	-31.5	-8.8	-37.6
South South						
Akwa Ibom	6.7	5.6	6.8	-15.8	21.0	1.9

Bayelsa	9.8	4.3	2.3	-55.9	-45.7	-76.0
Cross River	4.5	4.1	5.1	-8.9	25.3	14.2
Delta	8.3	5.9	3.5	-29.0	-40.3	-57.6
Edo	7.4	2.9	5.5	-60.3	87.9	-25.3
Rivers	6.2	5.8	4.8	-6.0	-17.1	-22.1
South West						
Ekiti	5.0	5.2	7.4	5.1	40.8	48.0
Lagos	5.1	5.8	5.7	12.9	-1.0	11.7
Ogun	7.0	5.3	1.6	-24.3	-70.0	-77.3
Ondo	4.3	6.4	4.3	49.2	-32.7	0.3
Osun	3.0	3.7	5.6	20.9	53.4	85.4
Oyo	5.7	4.2	4.2	-26.6	-0.6	-27.1

Chi-2 tests are significant at *** $p < 0.001$

Child mortality analysis by state in Table 5.5 consolidated the pattern seen in infant mortality results, where states in North East and North West reported the highest rates. When ranked from the least to the highest child deaths as well, Cross River went from being 6th in 2008 to the state with the least reported child deaths in 2018 at 0.4 percent, whereas Kebbi went from the 22nd position amongst 37 states in 2008 to reporting the highest rate of child death (7.7%) in 2018. However, across the board, Benue, Niger, Adamawa, Borno, Abia, Anambra, Akwa Ibom, Bayelsa, Cross River, Lagos, and Ogun recorded more than 50 percent progress in reducing child deaths while Kebbi with more than 100 percent increase in child deaths performed the worst. Overall, Jigawa remained unchanged throughout the study period.

In North Central, Benue and Niger made the most progress, while Kogi made the least. It can also be seen that Kogi, and Plateau had more than 100 percent increase in child deaths between 2013 and 2018. Only Taraba recorded an overall increase in child deaths amongst states in the North East, with Adamawa and Borno also recording the highest decrease. The rapid fall and rise in child deaths observed in the North West seen earlier in Figure 5.3, is clearer from intra-zonal and intra-state temporal patterns shown in Table 5.5. All the North Western states made progress between 2008 and 2013 but dropped from 2013 to 2018 except for Sokoto and Zamfara. At the end of the survey period, Zamfara recorded the greatest reductions in child deaths in the zone while Kebbi, with more than 100 percent increase made the least progress. The table further shows from 2008 results that the North West had such a poor childhood survival rate that even Zamfara with the lowest percentage in the zone was still higher than childhood survival results from the southern zones.

Child mortality rates for all the states in the South East reduced between 2008 and 2018. Abia with 81 percent reductions in deaths made the most progress in the zone while Imo with five percent reductions made the least. South South states also progressed substantially, with all the states recording overall reductions in child deaths. Akwa Ibom made the most progress while Edo, with a 20 percent reduction in child deaths, made the least. Going further to the South West, only Oyo state with a 29 percent increase in child deaths did not report reductions in child deaths throughout the focal period. Surprisingly, Ekiti went from reporting a 75 percent decrease in child deaths between 2008 to 2013 to more than 200 percent increase between 2013 and 2018.

Table 5.5: Trends and differentials in child deaths by states, Nigeria 2008-2018

				% Change		
Child deaths	**NDHS 2008 (%)**	**NDHS 2013 (%)**	**NDHS 2018 (%)**	**(2008-2013)**	**(2013-2018)**	**(2008-2018)**
State						
North Central						
Benue	2.0	2.3	0.6	15.4	-73.7	-69.7
FCT (Abuja)	1.8	1.0	1.6	-42.8	53.2	-12.4
Kogi	3.0	1.8	4.1	-40.7	130.8	36.8
Kwara	1.1	1.4	0.9	31.1	-34.9	-14.6
Nasarawa	2.2	2.3	2.1	4.3	-9.4	-5.5
Niger	6.7	1.6	2.0	-76.4	30.1	-69.3
Plateau	2.5	1.0	2.7	-59.6	170.0	9.0
North East						
Adamawa	5.0	1.9	2.0	-61.7	6.1	-59.4
Bauchi	5.7	5.1	3.9	-11.6	-22.9	-31.9
Borno	4.1	2.2	1.9	-46.9	-9.9	-52.1
Gombe	4.8	4.1	4.1	-14.3	-1.8	-15.8
Taraba	3.9	2.3	4.0	-39.8	70.4	2.6
Yobe	5.0	3.8	3.4	-24.8	-9.0	-31.6
North West						
Jigawa	6.8	4.8	6.8	-28.8	41.2	0.6
Kaduna	4.3	0.8	4.1	-81.1	395.6	-6.2
Kano	7.0	3.4	5.6	-51.4	64.1	-20.3
Katsina	6.1	4.1	6.1	-32.6	50.3	1.3
Kebbi	3.7	3.4	7.7	-9.8	128.4	106.0
Sokoto	7.5	4.8	4.5	-35.8	-7.8	-40.8
Zamfara	5.1	4.8	3.7	-4.5	-23.7	-27.1

South East						
Abia	3.1	1.0	0.6	-68.7	-38.5	-80.7
Anambra	4.2	1.2	1.3	-71.6	10.5	-68.6
Ebonyi	2.8	3.0	2.2	5.3	-26.0	-22.2
Enugu	2.0	1.5	1.2	-23.5	-22.2	-40.5
Imo	2.5	1.7	2.4	-33.2	41.5	-5.5
South South						
Akwa Ibom	4.6	1.6	1.2	-65.1	-24.5	-73.6
Bayelsa	2.9	1.4	0.6	-52.0	-57.4	-79.6
Cross River	1.7	2.1	0.4	19.2	-80.2	-76.4
Delta	2.2	1.4	1.2	-36.1	-15.0	-45.7
Edo	2.1	1.5	1.7	-30.6	13.9	-20.9
Rivers	3.1	1.6	1.5	-48.8	-2.2	-50.0
South West						
Ekiti	2.6	0.6	2.4	-75.2	279.0	-6.0
Lagos	1.2	0.6	0.5	-50.8	-12.4	-56.9
Ogun	1.2	1.1	0.5	-5.8	-51.1	-53.9
Ondo	2.5	2.2	2.2	-14.5	2.5	-12.4
Osun	1.2	0.4	0.6	-68.9	62.3	-49.5
Oyo	0.9	1.9	1.1	118.6	-41.1	28.7

Chi-2 tests were significant at *** $p < 0.001$

Overall analysis of under-five deaths in Nigeria indicates that in over a decade, most states in the country are still around the same place. These figures confirm that we have not progressed to the point where we can say as a country that we have made a shift in improving under-five mortality, that can be escalated to the state level. To this end, strategic actions are needed by government at all levels, if Nigeria is to make progress in improving early childhood survival. Graphical representation of the percentage distribution of under-five deaths by states can be found in Figures C.2 – C.7 of Appendix C.

Having described state variations in under-five deaths, it would be useful to try to interpret them using a structural lens by drawing from state level summary statistics of structural and proximate factors in Chapter Four. Like what was seen at the regional level, states in the North Central, North East and North West had the poorest outcome of factors being examined in this study in comparison with their southern counterparts. From the 2018 report, 80 percent of the children in Yobe (North East), Kebbi (North West), Sokoto (North West), and Zamfara (North West) were born to women with no formal education, and more than 50 percent belonged to households in the lowest wealth quintile. Similarly, more than 40 percent of the

children in Niger (North Central), Katsina (North West), Kebbi (North West), Sokoto (North West), Zamfara (North West) and Bayelsa (South South) were born to mothers who did not receive any antenatal care during pregnancy. In contrast, more than 70 percent of children in the FCT (North Central), Kogi (North Central), Delta (South South), Edo (South South), Rivers (South South) as well as all the South East and South West states were born to women who attended ANC more than four times.

In addition to these, Niger (North Central), Bayelsa (South South) as well as the states in the North East and North West reported more than 70 percent home deliveries in 2018. Studies have shown that poor maternal education is associated with poor ANC attendance, which also reduces the chances of hospital delivery (Doctor, Findley, Bairagi, & Dahiru, 2011; Ononokpono et al., 2014). Even though child immunisation is not at an optimal level in Nigeria, lowest immunisation rates are in the North Western states with Kebbi, Sokoto, and Zamfara recording six, 4.6, and 7.5 percent coverage respectively. As insurmountable as improving child survival in the country might seem, there are practical steps that need to be focused on to achieve sustainable progress. Fapohunda and Orobaton (2013) also suggest that programmes that aim to improve the independence of the woman and her ability to take strategic health decisions, such as education, income, and jobs, will most likely yield better results.

5.3 Sub-national trends and differentials in immunisation coverage and access to medical treatment

Moving on from the analysis of sub-national variation in under-five deaths, this section presents results on immunisation coverage, and access to medical treatment by evaluating maternal health-seeking choices when managing childhood sickness. Immunisation and proper management of childhood illness are key contributing factors to improved chances of survival beyond the childhood period (Fagbamigbe et al., 2015; Koffi et al., 2017; Okonko et al., 2009; Ophori, Tula, Azih, Okojie, & Ikpo, 2014). But as mentioned earlier, due to the methodology of the NDHS datasets it is not possible to use them in a regression model since the information collected on them is only on children still alive at the time of the interview. Thus, they are analysed descriptively across geo-political zones and states to show their levels and trends during the period under review. These factors also provide plausible

answers to under-five mortality results from the respective areas. The following sub-sections present sub-national levels and trends of these indicators.

5.3.1 Immunisation coverage

Poor immunisation coverage has been shown to be the greatest challenge to child health in sub-Saharan Africa (Antai, 2009; Oluwadare, 2009). It is a key indicator used to observe development towards reductions in child morbidity and mortality, given that it has been confirmed to be one of the most cost-effective public health measures (NPC & ICF International, 2019). Prior research shows that routine immunisation for infectious diseases has proven effective in eradicating small pox, as well as providing long term effective and efficient protection of children from measles, polio, chicken pox, tuberculosis, diphtheria, pertussis, and tetanus (Antai, 2009; NPC & ICF International, 2019; Okonko et al., 2009; Oleribe, Kumar, Awosika-Olumo, & Taylor-Robinson, 2017).

However, immunisation coverage in Nigeria was badly affected by the boycott of oral polio vaccines in the north between 2003 and 2007 because it was perceived as a western tool to control fertility (Kaufmann & Feldbaum, 2009; Ushie, Fayehun, & Ugal, 2014; Yahya, 2006). This boycott which led to a health crisis at the time, started when Islamic and political leaders in the northern zones banned polio immunisation campaigns being sponsored by the federal government in August 2003, in response to allegations that the vaccines were intentionally contaminated with anti-fertility agents and the HIV virus (Kaufmann & Feldbaum, 2009; Ushie et al., 2014; Yahya, 2006). They further alleged that the polio eradication programme in Nigeria was a decoy by the West to significantly reduce Muslim populations worldwide (Yahya, 2006). The ban, which was very effective in Kano state led to a global outbreak of polio, with the disease spreading into twenty countries in Africa, the Middle East, and Southeast Asia. The halt in vaccinations also gave rise to 80 percent of the world's cases of paralytic poliomyelitis (Kaufmann & Feldbaum, 2009). Another aspect of the anti-polio campaign in the north was the political angle. Vertical health interventions were seen as undermining primary health care, with residents suggesting that a collaborative community-based framework would be more acceptable (Ophori et al., 2014; Renne, 2006). In addition, ongoing armed conflicts in the North East have devastating effects on the immunisation of children born in the region (Sato, 2019).

Sub-national analysis of immunisation coverage for children aged between one and two years reveal a far more complex situation than the national figure and provides an important context for interpreting the sub-national inequalities in under-five mortality. As shown in Table 5.6, vaccination rates varied substantially, with coverage in the North West only one-third of that in the South East. In as much as North West and North East currently have lowest vaccination rates, they still made the most improvements over the period. In 2018, Sokoto (North West) at five percent reported the lowest proportion of children fully vaccinated while Anambra (South East) at 76 percent reported the highest. Also, recent results show that Kebbi, Sokoto and Zamfara, all in the North West, reported less than 10 percent immunisation coverage. This leaves about 90 percent of the children living in those states susceptible to infectious diseases, which might explain why the zone also had the highest under-five mortality rates. Comparable to the progress in these two geo-political zones, the uptake in child vaccination from 2008 to 2018 in Bauchi (North East), Borno (North East), Yobe (North East), Jigawa (North West), Kano (North West), and Katsina (North West) reflects the big picture at the zonal levels. In the South East, Imo reported a visible improvement in immunisation coverage from 40 percent in 2008 to 66 percent in 2018, which might be one of the contributing factors to taking it from being the state with the highest number of infant deaths in 2008 to the 23rd in 2018 as seen in earlier results.

Table 5.6: Sub-national distribution of children (12-23 months) born in the five years preceding each survey by full immunisation coverage, Nigeria 2008-2018

	2008 NDHS (%)	2013 NDHS (%)	2018 NDHS (%)
Geo-political zone			
North Central	25.9	26.9	30.4
North East	7.6	14.2	23.1
North West	6.0	9.6	20.1
South East	42.9	51.7	58.0
South South	36.1	52.0	41.8
South West	42.8	40.9	43.1
State			
North Central			
Benue	18.8	20.0	27.2
FCT (Abuja)	55.4	60.9	49.5
Kogi	39.4	35.6	24.3
Kwara	30.9	43.0	30.2
Nasarawa	16.1	20.1	38.8

Niger	12.3	23.1	23.6
Plateau	31.2	23.6	43.1
North East			
Adamawa	19.1	40.4	37.1
Bauchi	1.0	6.1	19.5
Borno	1.5	9.7	22.9
Gombe	15.5	22.4	18.4
Taraba	14.1	14.4	24.4
Yobe	4.0	6.9	20.4
North West			
Jigawa	0.0	3.6	24.3
Kaduna	21.4	35.3	22.0
Kano	5.5	13.2	34.7
Katsina	0.9	8.7	21.5
Kebbi	4.8	2.8	6.0
Sokoto	1.0	1.4	4.6
Zamfara	5.4	2.1	7.5
South East			
Abia	38.9	49.8	36.0
Anambra	51.9	51.6	76.1
Ebonyi	50.0	51.1	44.1
Enugu	28.4	45.0	40.8
Imo	40.3	62.4	65.7
South South			
Akwa Ibom	32.4	48.0	39.9
Bayelsa	20.4	51.5	18.8
Cross River	42.1	52.5	46.3
Delta	38.4	50.8	46.7
Edo	38.8	52.2	56.0
Rivers	36.6	55.5	37.9
South West			
Ekiti	57.7	49.4	41.8
Lagos	52.8	53.9	62.4
Ogun	23.1	24.4	25.5
Ondo	37.0	47.2	49.8
Osun	58.7	55.3	33.3
Oyo	30.6	25.8	23.3

Table 5.6 also suggests a more than 10 percent drop in vaccination coverage in Ekiti and Ondo states of the South West. It is a major concern that out of 37 states only six states had up to 50 percent coverage, with the FCT (Abuja) that enjoys a plethora of social and health services as the nation's capital barely making that threshold. According to Adeloye et al.

(2017), the main determinants of uptake of vaccines are the mother's community involvement such as social gatherings and events, as well as repeated stock-outs and unavailability of vaccines at the delivery points. The need to strengthen the quality and supply of immunisation services -availability of vaccines, health personnel and adequate cold chain equipment, especially to physically and socially marginalised areas have also been stressed in the literature (Oluwadare, 2009; Ophori et al., 2014). Other setbacks to immunisation coverage are concerns for vaccine safety and political problems (Adeloye et al., 2017; Ophori et al., 2014). For instance, misconceptions to cause sterility was a major concern that led to the rejection of vaccines in northern Nigeria as mentioned earlier.

Women with higher education are more likely to take up and complete their children's routine immunisation schedule unlike those with lower education, because education exposes maternal women with information and relevant knowledge of vaccines (Adeloye et al., 2017; Antai, 2010). Additionally, Antai (2010) pointed out that individual and community level factors such as health care utilisation, place of residence and proportion of women who had hospital delivery are important in explaining variations in immunisation among children in Nigeria. The north-south variation in child immunisation seen in Table 5.6 is supported by Ophori et al. (2014), who argued that religion is a great challenge to the acceptance of immunisation in northern Nigeria. Persistent variation in immunisation coverage between and within geo-political zones is more reinforced by poor socio-economic status, maternal age, absence of maternal education, poor management of primary health care services, and rural residence (Antai, 2010; Ezeh et al., 2015; Odusanya et al., 2008; Oleribe et al., 2017).

As stated in Chapter 1.5, one of the professional significances of this study is to provide knowledge on socio-economic factors that create barriers to immunisation coverage, despite being provided for free by the government. Basic socio-economic and health care access factors gleaned from past literature, and in line with key variables of this study are used to measure the determinants of immunisation uptake. Variables analysed in table 5.7 all have significant results for the three survey years when chi-2 tested, indicating significant relationship with immunisation. Children born to women less than 20 years had less coverage than those born to women above 20 years of age. The table further confirms an increase in vaccine uptake by mother's education, where more than 60 percent of the children born to mothers with higher education were vaccinated. Similarly, just as seen in previous literature,

household wealth quintile and place of residence predict child immunisation. Results in the table further imply that children born to maternal women who attended ANC, were delivered in a health facility, and whose births were assisted by professional birth attendants had a higher tendency of being fully immunised. In addition, women who did not have a problem with distance to a health facility or cost of health care were also more likely to fully vaccinate their children.

Table 5.7: Bivariate association between immunisation and socio-economic factors

	NDHS 2008 (%)	NDHS 2013 (%)	NDHS 2018 (%)
Maternal age			
15-19	7.64	14.15	15.9
20-29	22.66	25.13	30.22
30-39	25.96	28.8	36.22
40-49	22.28	21.38	28.29
Maternal education			
No education	6.5	6.9	14.9
Incomplete primary	17.2	24.7	23.8
Complete primary	25.5	27.0	36.7
Incomplete secondary	35.2	38.7	34.1
Complete secondary	46.9	52.2	47.3
Higher	61.2	64.1	64.1
Wealth quintile			
Lowest	4.8	3.6	14.3
Second	11.9	11.5	19.7
Middle	19.7	24.0	29.3
Fourth	33.4	39.3	40.4
Highest	52.7	57.8	59.9
Place of residence			
Urban	37.5	42.5	44.8
Rural	16.2	15.8	22.6
Religion			
Christian	38.8	46.4	45.4
Islam	10.0	12.4	22.8
Other	8.9	11.7	24.1
ANC attendance			
No visit	2.4	4.5	8.5
Less than 4 visits	19.0	18.9	24.2
4 or more visits	38.8	39.5	42.0
Do not know	30.2	35.3	36.6
Place of delivery			
Home	9.7	12.4	19.6

Government hospital	41.82	44.6	44.4
Private hospital	49.0	49.6	53.2
Other	43.9	15.6	29.1
Professional birth attendance			
No	9.0	11.1	18.4
Yes	43.5	46.2	46.8
Perceived distance to health facility			
Big problem	14.6	14.9	22.1
Not a big problem	27.9	30.0	35.1
Perceived cost of treatment			
Big problem	17.7	18.8	25.8
Not a big problem	29.9	30.4	36.9

5.3.2 Summary of trends in maternal health-seeking behaviours

Having explored sub-national differences in childhood immunisation coverage, this section focuses on spatial variation in maternal health seeking behaviours. Results here will increase awareness on health care choices of women with children by considering barriers to health care access and poor health insurance coverage in Nigeria. As also mentioned in Chapter 1.5 of this research, an attempt at understanding how health insurance impacts maternal health-seeking behaviours is explored, as this will ultimately improve knowledge and programmes addressing under-five mortality in Nigeria. We know from the literature that many preventable deaths in the first month of life are connected with late recognition of illness (poor knowledge of danger signs, delays in seeking care by care givers, and late intervention at health facilities (Ekwochi et al., 2015). As a result of the importance of seeking healthcare early, the World Health Organization developed the Integrated Management of Childhood Illness (IMCI) strategy to ensure that healthcare providers have relevant skills to handle childhood illness and are trained to educate mothers about danger signs and the need for prompt response (Koffi et al., 2017; WHO, 2005).

Diarrhoea is being focused on in this study because together with pneumonia and malaria, it is one of the leading causes of childhood death in sub-Saharan Africa (Winter, Akinlo, & Florey, 2016). The sub-national percentage distribution of children less than five years old, who were sick with diarrhoea within two weeks of the surveys are analysed by where mothers first sought for medical advice. The results are shown by geo-political zones in Figure 5.4 and states in Figures C.8-C.10 (Appendix C). The 2018 NDHS results reveal that the

preffered places for health needs were government health facilities and chemist shops, although from 2013 results private health facilities were previously most preffered. Notwithstanding, FCT(Abuja), Zamfara, Abia, Imo, Lagos and Oyo still reported higher utilisations of private health facilities in 2018. Bayelsa with 83 percent reported the highest use of government health facilities in 2018, while Imo at two percent reported the least utilisation of these facilities.

Furthermore, an increasing proportion of children with mothers who first sought treatment from chemists and shops instead of going to health centres or pharmacies can be seen. This is supported in the huge shift from utilisation of private health facilities to chemists and shops from 2013 to 2018 across the country. Possible reasons for the rise in preference for chemists and shops could be their proximity and ease of access to households, shortage of health workers in public hospitals, high cost of care in private hospitals, bad transportation system, health centres being regularly out of stock of essential drugs, and low motivation and inadequate supervison of health care workers amongst others (Adeyinka, Muhajarine, Petrucka, & Isaac, 2020; Oguntunde et al., 2018; Sumankuuro, Crockett, & Wang, 2018). Ajala, Sanni, and Adeyinka (2005) reiterated the need for governmnent to provide health care facilities, with focus on equitable distribution and ease of access, to improve development, especially in the rural areas.

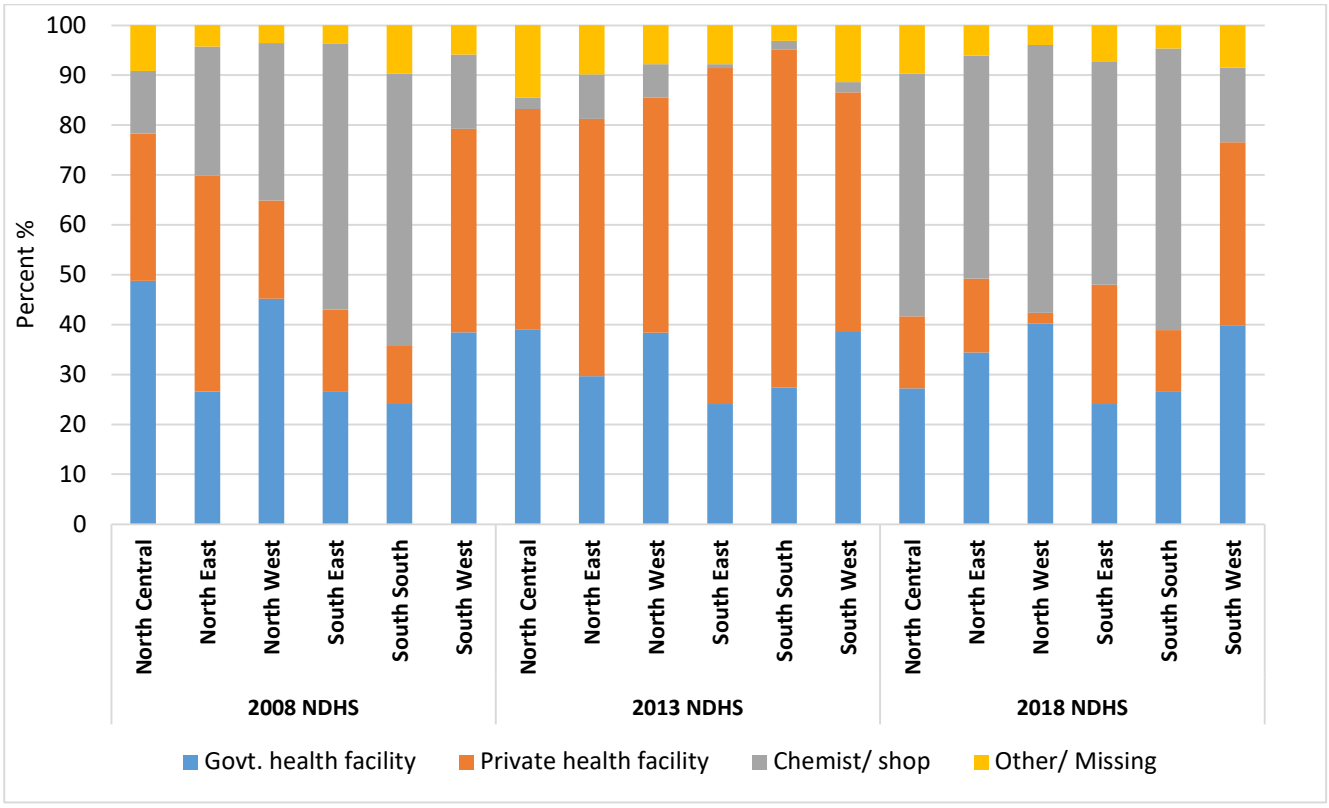

Figure 5.4: Percentage of children born in the five years preceding each survey by place their mothers' first sought advice/treatment for child's diarrhoea and geo-political zone, Nigeria 2008-2018

In order to provide more context to the results displayed above, further analysis was done to examine medical treatment patterns of children less than five years old in Nigeria, shown in Table 5.8. At the zonal level, more than 30 percent of the children that had diarrhoea two weeks before the 2018 survey received no medical treatment. By state analysis, the results show a remarkable improvement in the proportion of children who received medical treatment for diarrhoea amongst the northern states from 2008 to 2018. For example, Sokoto improved from 34 percent in 2008 to 73 percent in 2018. Results in the southern region varied, but the general trend indicate a sharp decline in the proportion of children who received medical treatment from 2008 to 2013, and then a subsequent improvement by 2018. For instance, Edo's figure fell from 71 percent in 2008 to nine percent in 2013 and then rose to 79 percent in 2018, while Imo dropped from 83 percent in 2008 to 25 in 2013, and picked up slightly to 37 percent in 2018.

Overall, Ogun reported in 2018 that 100 percent of children sick with diarrhoea received medical treatment, while Niger's 30 percent and Ekiti's 31 percented were the lowest nationwide. These results imply that a large proportion of sick children in Nigeria receive no medical treatment, which is associated with preventable deaths. Jinadu, Olusi, Agun, and Fabiyi (1991) argued that most deaths due to diarrhoea occur in the homes and health centres without being reported. They emphasized that social and envionmental factors such as education, drinking water, unhygienic handling of feeding bottles and utensils, as well as poor disposal of feaces and refuse from households are the determinants of diarrhoea. In comparison with results on access to health care in Chapter Four, it could be deduced that more than one-fifth of the repondents found distance and cost of medication as barriers to accessing health care (Adeyinka et al., 2020). These distance and cost barriers are also possbile explanations for the growing popularity of chemists and shops for medical advice as seen in earlier results.

Table 5.8: Sub-national distribution of children born in the five years preceding each survey by medical treatment for diarrhoea, Nigeria 2008-2018

	2008 NDHS (%)	2013 NDHS (%)[11]	2018 NDHS (%)
Geo-political zone			
North Central	45.4	42.0	49.6
North East	36.1	24.4	59.7
North West	39.2	28.7	65.3
South East	75.9	27.5	56.7
South South	61.8	31.3	66.0
South West	49.9	33.8	51.2
State			
North Central			
Benue	53.0	23.7	79.8
FCT (Abuja)	81.9	58.4	83.6
Kogi	28.5	43.7	32.9
Kwara	37.9	34.2	54.6
Nasarawa	52.4	57.3	83.0
Niger	37.3	52.6	29.7
Plateau	64.8	34.5	43.9
North East			
Adamawa	41.9	34.0	41.3
Bauchi	39.2	30.9	64.1
Borno	21.8	23.8	71.4

[11] Missing values for 2013 NDHS excluded from results. Highest value is Borno - 6.2%

Gombe	50.1	31.8	61.9
Taraba	56.4	21.9	31.4
Yobe	29.2	12.8	65.5
North West			
Jigawa	35.4	39.0	68.2
Kaduna	47.1	15.8	44.5
Kano	44.4	28.5	76.5
Katsina	33.2	42.5	63.4
Kebbi	54.3	17.7	62.0
Sokoto	33.8	39.2	72.8
Zamfara	26.7	26.4	47.4
South East			
Abia	88.9	43.9	86.0
Anambra	86.0	17.6	91.8
Ebonyi	63.8	19.9	51.8
Enugu	69.2	41.1	59.1
Imo	82.9	25.2	36.6
South South			
Akwa Ibom	73.0	18.4	53.8
Bayelsa	52.9	28.8	69.0
Cross River	61.0	34.1	88.1
Delta	64.7	44.9	61.4
Edo	71.3	9.3	78.7
Rivers	52.8	36.8	66.7
South West			
Ekiti	54.6	32.2	30.6
Lagos	40.8	30.6	55.8
Ogun	44.3	23.2	100.0
Ondo	49.2	37.8	42.3
Osun	73.8	81.5	35.9
Oyo	59.3	28.5	70.3

Major factors that determine whether or not a mother seeks medical help for a sick child, and how early she does that are accessibility (distance) to the facility, cost of health care and transportion. There is also the argument on quality of service, where mothers are reluctant to make payments at the health centres when they will only receive verbal instruction on how to administer oral rehydration salt (ORS) (Jinadu et al., 1991). Low income families are unable to obtain care from health facilities due to the cost of health care, especially from private owned facilities where services are readily available. Most times they resort to home remedial care and self-medication from chemists and shops, as clearly seen in the results with

the increase in preference for chemists during child illness. Winter et al. (2016) added that level of care seeking is lowest for children with uneducated mothers, rural resident, those in the poorest wealth quintile, and children residing in the North East.

In agreement with these works, it is logical for cost to also delay time before medical help is sought, as mothers -especially those without health insurance coverage and of poor socio-economic status- might be reluctant to spend limited resources at the first sign of illness, perhaps it turns out not to be serious. Rather, they would preffer to monitor a sick child while hoping symptoms will ease. This cost saving approach sometimes exposes children to more serious complications and even death. According to Jinadu et al. (1991) on their study in rural Nigeria, mothers confirmed that they were reluctant to take their sick children to government health facilities because of user fees and poor service delivery, being that a majority of the government owned primary and secondary health care facilities lack needed infrastructures. Findings in this section demonstrates that availability of free universal maternal and child health care in Nigeria would improve child survival outcomes. Presently, the National Health Insurance Scheme (NHIS) is still not as functional as it should be in the country. As illustrated in Table 5.9, 2018 report shows that less than 15 percent of the study population lived in households with NHIS coverage. Findings indicate that 100 percent of the study population in Zamfara had no NHIS coverage. Surprisingly during the study period, children living in the FCT with NHIS coverage fell from 17 to nine percent. Access to needed affordable health care has been mentioned in the literature as a difficult task for an average Nigerian household (Aregbeshola & Khan, 2018; Dror et al., 2016; Mohammed & Dong, 2012).

Table 5.9: Sub-national distribution of children born in the five years preceding each survey by maternal National Health Insurance Scheme (NHIS) coverage, Nigeria 2008-2018

	2008 NDHS (%)	2013 NDHS (%)[12]	2018 NDHS (%)
Geo-political zone			
North Central	2.2	2.3	1.8
North East	0.2	1.1	0.9
North West	0.4	0.4	2.4
South East	0.8	2.5	2.6
South South	2.8	3.4	2.4
South West	2.2	2.1	3.0
State			
North Central			
Benue	0.1	0.1	0.3
FCT (Abuja)	17.5	14.4	9.4
Kogi	1.9	0.9	2.2
Kwara	3.3	9.2	4.1
Nasarawa	0.0	0.9	0.8
Niger	1.5	1.0	1.0
Plateau	0.5	1.4	1.9
North East			
Adamawa	0.4	2.5	0.8
Bauchi	0.1	0.2	0.5
Borno	0.2	1.2	1.0
Gombe	0.4	0.3	0.6
Taraba	0.0	2.4	0.7
Yobe	0.1	0.6	1.5
North West			
Jigawa	0.0	0.2	0.2
Kaduna	1.9	2.1	2.3
Kano	0.5	0.1	3.8
Katsina	0.0	0.1	0.5
Kebbi	0.0	0.0	0.8
Sokoto	0.0	0.2	11.3
Zamfara	0.1	0.7	0.0
South East			
Abia	0.0	4.0	11.0
Anambra	0.0	4.5	1.5
Ebonyi	0.6	0.9	1.2
Enugu	0.5	1.1	0.4
Imo	2.6	3.0	2.4
South South			

[12] Missing values for 2013 NDHS excluded from results. Highest value is Katsina – 2.9%

Akwa Ibom	2.6	2.8	1.5
Bayelsa	2.0	1.0	1.9
Cross River	5.1	3.5	1.8
Delta	1.9	4.4	1.7
Edo	0.6	3.4	2.5
Rivers	3.8	3.8	3.7
South West			
Ekiti	1.6	4.2	1.2
Lagos	5.0	3.9	5.4
Ogun	0.6	0.6	3.2
Ondo	1.1	1.6	0.9
Osun	0.0	2.9	1.9
Oyo	1.1	0.4	1.2

5.4 Factors associated with under-five mortality in Nigeria at the individual and household levels

This section presents results on structural factors associated with under-five mortality in Nigeria using bivariate analysis, logistic regression, and predictive margins. Having extensively analysed trends and differentials of under-five mortality in Section 5.2, this section explores how the structural factors of interest in this research drive the changes seen in early childhood mortality in Nigeria over time. As mentioned in Chapter One, one of the objectives of this study is to identify factors at the individual and household levels associated with under-five mortality. The essence of identifying these factors is to fill knowledge gap and help to ensure that programmes towards addressing early childhood mortality in Nigeria are targeted appropriately. The results of the bivariate relationship between under-five mortality are presented in the first sub-section, logistic regression in the second sub-section, while predictive margins results are in the third sub-section.

5.4.1 Bivariate relationship between structural factors and under-five mortality in Nigeria

Results from Tables 5.10 and 5.11 explore the relationship between structural determinants and under-five deaths in Nigeria. Most of the structural factors are statistically significant. However, Table 5.10 also shows that ANC attendance in 2008 NDHS and drinking water in the household in 2018 NDHS were not significantly associated with infant deaths. As seen in Table 5.10, higher levels of mother's educational attainment were associated with reductions in infant deaths. It could also be seen that the gap between the impact of secondary

and higher education on infant deaths significantly blurred over the period, reinforcing the need for women to be educated to at least secondary level. Further consideration of mother's education and child deaths in Table 5.11 shows that as children survived beyond infancy, mother's education played a more prominent role. Almost all those whose mothers had tertiary education survived beyond age five, whereas five percent of those whose mothers had no education did not survive beyond childhood. Maternal education has been shown in various studies to play a protective role on the child due to how it influences the woman's level of economic empowerment, health, and reproductive behaviour (e.g., parity, birth spacing), health services utilisation (e.g., awareness) and home-care knowledge of childhood illness (e.g., proper sanitation, oral rehydration therapy) (Kanmiki et al., 2014; Mosley & Chen, 1984; Van Malderen et al., 2019).

Table 5.10: Bivariate association between structural factors and infant deaths, Nigeria 2008-2018

Infant deaths	NDHS 2008 (%)	NDHS 2013 (%)	NDHS 2018 (%)
Maternal education			
None	7.9	7.2	7.5
Incomplete primary	7.9	8.4	6.7
Complete primary	6.9	5.9	6.6
Incomplete secondary	7.1	5.7	5.5
Complete secondary	5.7	4.5	5.0
Higher	4.0	4.5	4.9
Drinking water			
Non-improved source	8.0	6.9	***6.9***
Improved source	6.3	5.9	***6.2***
Toilet facility			
None	7.3	6.7	6.1
Non-improved type	7.4	6.6	7.2
Improved type	5.2	4.6	5.0
Household has electricity			
No	7.9	7.1	7.0
Yes	6.1	5.5	5.9
ANC attendance			
No visit	***5.2***	5.0	5.6
Less than 4 visits	***4.4***	4.3	4.6
4 or more visits	***4.4***	3.9	3.8
Do not know	***5.3***	5.6	7.6

Professional birth attendance			
No	7.1	6.5	6.9
Yes	6.3	5.5	5.8

Results in bold italics are not significant.

Findings also indicate that children born in households with amenities such as quality drinking water, improved toilet facility and electricity were less likely to die before age five than those living in the absence of these amenities. Quality drinking water and improved toilet facilities, where wastes are separated from human contact reduces incidences of cholera, other water-borne infections, and diarrhoea (Kayode et al., 2012; NPC & ICF International, 2014). Also, electricity contributes to early childhood survival by improving preservation of food and drugs, increasing health care access, and enhancing transmission of information through the electronic media (Irwin et al., 2020).

The results further suggest that ANC attendance was associated with lower rates of infant and child deaths. It was reported in 2018 result of Table 5.10 that about 3.8 percent of the infants born to women who received ANC for at least four times died while about 5.6 percent of those whose mothers did not attend ANC died. Likewise, children delivered by professional birth attendants (doctors, midwives, and nurses) had significantly higher chances of surviving beyond the childhood stage when compared with those that were not. For instance, the proportion of child deaths (Table 5.11) for children who were not delivered by professional birth attendants was more than twice of those delivered by professional birth attendants.

Table 5.11: Bivariate association between structural factors and child deaths, Nigeria 2008-2018

Child deaths	NDHS 2008 (%)	NDHS 2013 (%)	NDHS 2018 (%)
Maternal education			
None	5.3	3.8	5.1
Incomplete primary	3.6	2.9	3.5
Complete primary	3.9	2.4	2.5
Incomplete secondary	2.7	1.5	2.1
Complete secondary	2.2	1.1	1.0
Higher	0.6	0.4	0.6
Drinking water			
Non-improved source	4.7	3.2	3.7
Improved source	3.3	2.3	3.0
Toilet facility			
None	3.5	2.8	2.8
Non-improved type	4.9	3.1	4.2
Improved type	1.1	0.9	1.2
Household has electricity			
No	4.8	3.4	4.4
Yes	3.0	1.9	2.2
ANC attendance			
No visit	3.2	2.0	2.6
Less than 4 visits	1.6	1.3	2.0
4 or more visits	1.3	1.1	1.3
Do not know	1.8	0.7	0.1
Professional birth attendance			
No	5.0	3.4	4.5
Yes	2.1	1.3	1.6

5.4.2 Multivariate logistic regression of under-five mortality in Nigeria

This section provides results of logistic regressions of under-five mortality and individual and household factors. Since the outcome variables (infant and child deaths) are non-categorical binary variables, binary logistic regression is useful as it assumes logistics standard error. Also, it applies a non-linear log transformation to the predicted odds ratio without requiring a linear relationship between the dependent and independent variables. Table 5.12 shows the results of models testing the association of individual/household level factors with infant mortality across the three survey-points, while Table 5.13 shows similar

results for child mortality. Even though from Tables 5.12-5.13 the structural factors do not seem to account much for variations in under-five mortality in Nigeria due to the size of some of the categories, the results are useful in understanding under-five mortality in Nigeria. Given the obvious spatial variations in under-five deaths and the bivariate association observed between the structural factors and under-five deaths in Nigeria, an investigation of these factors provides relevant insight into improving child survival. Logistic regression of structural determinants associated with infant and child deaths while controlling for other socio-economic and proximate factors such as place of residence, religion, maternal age, sex of child, preceding birth interval, child's birth size, number of children ever born, and marital status provides a more robust understanding of early childhood mortality in Nigeria. All the models accounted for the complex sampling design of the DHS and were tested for correct specification.

Results from Table 5.12 depict that urban-rural difference is prominent, as rural areas were associated with 24 and 27 percent increases in the odds of infant mortality in 2008 and 2013 respectively. These odds did not reduce between 2008 and 2013, which points to advantages associated with living in urban areas in terms of better access to health services and social amenities, as well as better economic opportunities for the households (Bocquier, Madise, & Zulu, 2011; Günther & Harttgen, 2012; Van Malderen et al., 2019; Wegbom, Wokoma, Nnoka, & Onyesom, 2016). The Table further highlights from the 2013 report that infants who lived in the North West zone were 1.46 times more likely to die in infancy when compared with those in the North Central. In contrast, the 2018 results suggest that children in the South East were 0.72 times less likely to die before their first birthday in comparison with those in the North Central.

Table 5.12: Logistic regression of infant (0-11 months) mortality by individual and household level determinants, Nigeria 2008-2018

	NDHS 2008	NDHS 2013	NDHS 2018
Infant deaths			
Maternal education			
No education	1	1	1
Incomplete primary	0.997	1.309	0.984
	(0.129)	(0.182)	(0.135)
Complete primary	0.944	0.843	1.006
	(0.100)	(0.106)	(0.126)
Incomplete secondary	1.072	0.778	0.867
	(0.140)	(0.120)	(0.113)
Complete secondary	0.812	0.693	1.031
	(0.121)	(0.135)	(0.143)
Higher	0.651	0.890	0.981
	(0.165)	(0.210)	(0.184)
Improved source of drinking water	0.873	1.010	0.970
	(0.065)	(0.080)	(0.070)
Toilet facility			
No facility	1	1	1
Non-improved type	1.018	0.959	0.986
	(0.080)	(0.081)	(0.093)
Improved type	1.070	0.860	0.899
	(0.176)	(0.136)	(0.114)
Has electricity	0.975	0.987	0.936
	(0.090)	(0.090)	(0.072)
Rural	1.269*	1.313**	1.100
	(0.124)	(0.129)	(0.085)
North Central	1	1	1
North East	1.089	1.117	1.004
	(0.124)	(0.165)	(0.137)
North West	1.037	1.458**	1.150
	(0.116)	(0.208)	(0.150)
South East	1.068	1.363	0.721*
	(0.147)	(0.232)	(0.117)
South South	1.051	0.914	0.794
	(0.140)	(0.146)	(0.135)
South West	1.147	1.377	0.812
	(0.168)	(0.236)	(0.136)

Professional birth attendance	1.241*	1.198	1.231*
	(0.112)	(0.137)	(0.111)
Religion			
Christian	1	1	1
Islam	0.864	0.860	0.956
	(0.089)	(0.105)	(0.152)
Other	1.026	0.777	0.934
	(0.202)	(0.229)	(0.354)
Maternal age			
15-19	1	1	1
20-24	0.632*	0.448**	0.426**
	(0.139)	(0.111)	(0.122)
25-29	0.374***	0.410***	0.368***
	(0.083)	(0.103)	(0.105)
30-34	0.346***	0.384***	0.324***
	(0.080)	(0.102)	(0.093)
35-39	0.385***	0.378***	0.340***
	(0.092)	(0.099)	(0.100)
40-44	0.417***	0.450**	0.338***
	(0.103)	(0.130)	(0.101)
45-49	0.530*	0.506*	0.450*
	(0.139)	(0.153)	(0.147)
Female	0.805***	0.821**	0.885
	(0.046)	(0.054)	(0.068)
Birth interval			
Less than 2 years	1	1	1
2-5 years	0.509***	0.545***	0.569***
	(0.034)	(0.038)	(0.039)
More than 5 years	0.328***	0.470***	0.443***
	(0.049)	(0.068)	(0.058)
Birth size			
large/very large	1	1	1
Average	1.140	1.144	1.136
	(0.082)	(0.090)	(0.075)
Small/very small	1.811***	1.852***	2.030***
	(0.157)	(0.164)	(0.189)
Children ever born			
1-2 children	1	1	1
3-4 children	1.675***	1.521**	1.697***
	(0.197)	(0.209)	(0.217)
5 or more children	2.551***	2.147***	2.747***
	(0.340)	(0.346)	(0.412)

Married/co-habiting	0.765	0.643**	0.715*
	(0.116)	(0.104)	(0.110)
Observations	**22192**	**24315**	**26680**

Exponentiated coefficients (odds ratios). Standard errors in parenthesis
*** p < 0.05, **** p < 0.01, ***** p < 0.001***

Surprisingly, Table 5.12 further suggests that babies delivered by professional birth attendants such as doctors, midwives and nurses had higher odds of dying at infancy when compared to those that were not. One possible explanation for this could be improper classification of health care workers by maternal women. There are maternal women, especially uneducated ones, or those in the rural areas, who cannot properly differentiate health care workers, leading to improper identification of community health extension workers (CHEWS) as professional birth attendants. CHEWS have minimal health training and are mostly at the primary health centres. This unusual result was also seen in the study by Adeyinka et al. (2020), where presence of professional health providers during delivery was associated with increased risk of neonatal mortality in Nigeria, even though its effect disappeared after the neonatal stage. Adeyinka et al. (2020) argued that the observed link between professional birth attendants and infant mortality might be a result of complications that arise due to late presentation of expectant mothers at health centres, which further enables childbirth complications and possible death of the new-born. Another possible explanation is the lack of relevant knowledge and skills of providers of maternal and child health care (Greenwell & Winner, 2014).

On hindsight, this finding might also be suggestive of the poor primary health care in Nigeria, where poor health seeking behaviour, cost, distance, and insufficient manpower have created barriers to access to health care, especially in the rural areas. These factors and more have been outlined by past studies as contributing factors to poor performance of health workers in low-and middle-income countries (Oguntunde et al., 2018; Sumankuuro et al., 2018; Yaya, Bishwajit, Uthman, & Amouzou, 2018). I agree with existing studies that health care providers should be supported adequately, as assisted deliveries by skilled healthcare providers, presently at 43 percent, is low in the country (Adeyinka et al., 2020; Ezeh, Agho, Dibley, Hall, & Page, 2014a; NPC & ICF International, 2019). Furthermore, with about 28 professional birth attendants per 10,000 population, Nigeria has yet to attain the United

Nation's recommended threshold of 44.5 professional birth attendants per 10,000 population needed to achieve SDG 3 targets on maternal and child health (WHO, 2016, 2017).

Table 5.12 also shows that higher maternal age was associated with reduced odds of infant mortality till age 34, and then the odds increased marginally afterwards. Maternal age, particularly the risks associated with early motherhood, has been shown in past studies as a determinant of under-five mortality (Akinyemi et al., 2015; Antai, 2011b; Kayode et al., 2012). In agreement with existing studies, female infants and babies with more than two years preceding birth interval had lower odds of dying at infancy when compared with males and babies with less than two years preceding their birth (Akinyemi et al., 2013; Ezeh et al., 2014a; Morakinyo & Fagbamigbe, 2017). Previous studies have explained that due to biological and genetic factors, new-born males have lesser chances of survival than females (Alonso, Fuster, & Luna, 2006; Bhuiya & Streatfield, 1991; Ezeh et al., 2015; Mekonnen, Tensou, Telake, Degefie, & Bekele, 2013; Morakinyo & Fagbamigbe, 2017). For instance, delay in the maturity of the lung during the first week of life among male children increase the incidence of respiratory infections (Morakinyo, Adebowale, & Oloruntoba, 2015).

It is also evident from Table 5.12 that a child's birth size is a predictor of infant mortality. Small sized babies had 59, 61, and 70 percent higher odds of dying at infancy across the three survey years when compared with large sized babies. Furthermore, having more than two children returned higher odds of death at infancy throughout the period with higher risks of death for five births and above (Akinyemi et al., 2015). The influence of high parity on child survival could be linked with socio-economic disadvantages within families leading to deprivation (Antai, 2011b). Also, children with mothers who were married or co-habiting with a partner had 44 and 33 percent lower odds of dying at infancy according to 2013 and 2018 results.

Having considered analysis of deaths during infancy, findings on child deaths for those that survived beyond age one in Table 5.13 reveals that maternal education plays more prominent roles on children aged 12-59 months than at infancy. Findings from 2018 illustrate that the odds of child death reduced with increase in mother's educational attainment. To put this in context, in comparison with children born to women with no education, children born to mothers with only primary level education had 33 percent lower odds of dying during childhood, while those born to women with tertiary education had more than 100 percent

lower odds of dying at childhood. From 2008 result, children living in households with improved toilet facility were 0.63 times less likely to die at childhood when compared with those in homes without improved toilet facility. Also, there appeared to be higher odds of child deaths in the rural areas than in urban areas.

Zonal analysis suggests increased odds of death for children living in the North West across the three survey years when compared with those in the North Central. From NDHS 2008 results, children in the South West had 41 percent less odds of dying before five years when compared with their counterparts in the North Central. While the South East had significantly higher odds of child mortality in 2013 in comparison with those in the North Central. It is argued in the literature that a possible reason for the association of South East with higher odds of child death could be the neglect of the southern more socio-economically advantaged states (Ayoade, 2020).

Findings additionally suggest that religion plays a significant role in child mortality. As reported in 2013, Muslim children had 39 percent increased odds of dying when compared with Christian children. In Nigeria, majority of the Muslims are found in the North East and North West, Christians in the South East and South South, while there is a mix of both religions in North Central and South West (Antai, 2011b). Remarkably, maternal age did not play as much significant role in childhood as it played during infancy, as only age group 45-49 in NDHS 2008 returned a significant result that suggest that maternal age of 45 and above was associated with increased odds of child mortality when compared to 15-19 age group. In addition, children with more than two years preceding birth interval were associated with lesser odds of dying before their firth birthday when compared with those with less than two years preceding birth interval. Table 5.13 results further shows that parity of more than two children was associated with increased odds of child death. Similarly, as seen with infant mortality, marriage/co-habitation was associated with lesser odds of child mortality.

Table 5.13: Logistic regression of child (12-59 months) mortality by individual and household level determinants, Nigeria 2008-2018

	NDHS 2008	NDHS 2013	NDHS 2018
Child mortality			
Maternal education			
No education	1	1	1
Incomplete primary	0.810	0.870	0.703
	(0.131)	(0.188)	(0.151)
Complete primary	1.149	0.842	0.716*
	(0.144)	(0.159)	(0.104)
Incomplete secondary	0.866	0.701	0.619**
	(0.158)	(0.168)	(0.111)
Complete secondary	0.998	0.743	0.464***
	(0.183)	(0.177)	(0.089)
Higher	0.384	0.160**	0.233***
	(0.206)	(0.097)	(0.084)
Improved source of drinking water	0.999	1.013	1.075
	(0.078)	(0.106)	(0.096)
Toilet facility			
No facility	1	1	1
Non-improved type	1.133	0.852	1.142
	(0.099)	(0.099)	(0.141)
Improved type	0.631*	0.657	0.976
	(0.146)	(0.164)	(0.201)
Has electricity	0.861	1.031	0.827
	(0.081)	(0.123)	(0.091)
Rural	1.321*	1.699***	1.295*
	(0.158)	(0.237)	(0.156)
Geo-political zones			
North Central	1	1	1
North East	1.226	1.309	1.169
	(0.186)	(0.237)	(0.212)
North West	1.650***	1.508*	1.870***
	(0.245)	(0.267)	(0.324)
South East	1.373	2.178**	1.443
	(0.246)	(0.607)	(0.351)
South South	1.063	1.505	1.006
	(0.183)	(0.377)	(0.295)
South West	0.663*	1.388	1.184
	(0.134)	(0.397)	(0.289)

Professional birth attendance	0.959	0.805	0.817
	(0.104)	(0.132)	(0.092)
Religion			
Christian	1	1	1
Islam	1.260	1.479*	0.987
	(0.169)	(0.287)	(0.161)
Other	0.553*	0.827	1.000
	(0.160)	(0.409)	(.)
Maternal age			
15-19	1	1	1
20-24	2.012	1.605	1.469
	(0.783)	(0.945)	(0.774)
25-29	1.729	1.334	1.246
	(0.671)	(0.770)	(0.681)
30-34	1.642	1.569	1.171
	(0.649)	(0.922)	(0.668)
35-39	1.792	1.493	1.000
	(0.713)	(0.866)	(0.565)
40-44	1.701	1.268	0.897
	(0.672)	(0.757)	(0.499)
45-49	2.298*	2.528	2.017
	(0.934)	(1.539)	(1.184)
Female	1.009	0.932	0.978
	(0.076)	(0.086)	(0.082)
Birth interval			
Less than 2 years	1	1	1
2-5 years	0.613***	0.563***	0.546***
	(0.050)	(0.058)	(0.050)
More than 5 years	0.443***	0.535**	0.294***
	(0.080)	(0.102)	(0.066)
Birth size			
Large/very large	1	1	1
Average	0.994	0.986	1.117
	(0.086)	(0.101)	(0.097)
Small/very small	1.034	1.151	0.938
	(0.109)	(0.152)	(0.114)
Children ever born			
1-2 children	1	1	1
3-4 children	1.654**	1.810**	1.756**
	(0.290)	(0.368)	(0.322)
5 or more children	2.318***	2.208***	2.541***
	(0.440)	(0.488)	(0.505)

Married/co-habiting	0.488***	0.856	0.508**
	(0.080)	(0.215)	(0.107)
Observations	**22192**	**24315**	**26469**

Exponentiated coefficients (odds ratios). Standard errors in parenthesis
*** p < 0.05, ** p < 0.01, *** p < 0.001***

Table 5.14 shows the results from models testing the temporal effects of factors associated with under-five mortality in Nigeria. Models 1-2 show how the structural factors explain temporal changes in infant and child deaths, while confounders are adjusted for in models 3-4. Amongst the key factors being explored in this study, maternal education, geo-political zones, and professional birth attendance were major determinants of under-five mortality from 2008-2018, followed by source of drinking water and toilet facility. The presence of electricity in the household did not return any significant result in all the models. Maternal education and toilet facility appeared to be more relevant during the childhood stage, although maternal education still played key roles during the infant stage. Model 1 shows lower odds of death for infants with mothers with up to secondary education. It can still be seen, however, that professional birth attendance was associated with higher odds of infant deaths which was cancelled out as the child survived beyond infancy.

Also, Table 5.14 suggests that in comparison with under-five mortality in the North Central zone, children in the North East, North West, and South East zones had higher odds of mortality. A closer examination of the result echoes the progress made in reducing under-five mortality from 2008 to 2013 in Nigeria, and which was not sustained to 2018. Marginal increase in child mortality from 2013 to 2018 is also reflected in the result. Model 4 clearly indicates from 2018 result that the odds of children surviving beyond age five reduced from 59 percent in 2013 to 47 percent in 2018. These results underscore what was seen in earlier graphs. Also, as already established in past studies, place of residence, religion, maternal age, sex of child, birth interval, birth size, parity, and marital status were associated with under-five mortality. See Table C.1 (Appendix C) for additional regression models run with interaction effect between geo-political zones and survey year.

Table 5.14: Temporal effects on under-five mortality in Nigeria, 2008-2018

	Infant mortality	Child mortality	Infant mortality	Child mortality
	(Model 1)	(Model 2)	(Model 3)	(Model 4)
Maternal education				
No education	1	1	1	1
Incomplete primary	1.052	.0.862	1.103	0.780*
	(0.072)	(0.084)	(0.086)	(0.087)
Complete primary	0.925	0.886	0.938	0.910
	(0.064)	(0.066)	(0.063)	(0.077)
Incomplete secondary	0.857*	0.670***	0.911	0.714**
	(0.055)	(0.067)	(0.072)	(0.080)
Complete secondary	0.735***	0.523***	0.851	0.675***
	(0.053)	(0.053)	(0.079)	(0.078)
Higher	0.710***	0.230***	0.844	0.259***
	(0.072)	(0.057)	(0.106)	(0.071)
Rural	1.219***	1.310***	1.211***	1.398***
	(0.062)	(0.089)	(0.063)	(0.104)
Improved source of drinking water	0.925*	1.001	0.945	1.022
	(0.035)	(0.048)	(0.041)	(0.053)
Toilet facility				
No facility	1	1	1	1
Non-improved type	1.050	1.110	0.985	1.048
	(0.048)	(0.063)	(0.049)	(0.066)
Improved type	0.955	0.780*	0.915	0.771*
	(0.070)	(0.094)	(0.077)	(0.101)
Has electricity	0.943	0.905	0.967	0.888
	(0.044)	(0.052)	(0.049)	(0.056)
Professional birth attendance	1.193**	0.791***	1.230***	0.865*
	(0.068)	(0.049)	(0.070)	(0.062)
Geo-political zones				
North Central	1	1	1	1
North East	1.095	1.352***	1.054	1.210*
	(0.071)	(0.115)	(0.081)	(0.117)
North West	1.200**	1.802***	1.198*	1.672***
	(0.077)	(0.147)	(0.090)	(0.158)
South East	1.200*	1.535***	1.018	1.580***
	(0.088)	(0.167)	(0.092)	(0.204)
South South	1.016	1.114	0.955	1.177

	(0.073)	(0.128)	(0.084)	(0.151)
South West	0.936	0.837	1.087	0.982
	(0.074)	(0.109)	(0.102)	(0.139)
Year of survey				
2008	1	1	1	1
2013	0.896*	0.639***	0.867**	0.613***
	(0.040)	(0.036)	(0.042)	(0.037)
2018	0.974	0.869**	0.935	0.823**
	(0.045)	(0.047)	(0.045)	(0.050)
Religion				
Christian			1	1
Islam			0.903	1.206*
			(0.069)	(0.113)
Other			0.957	0.476**
			(0.145)	(0.127)
Maternal age				
15-19			1	1
20-24			0.501***	1.713
			(0.073)	(0.497)
25-29			0.389***	1.451
			(0.056)	(0.426)
30-34			0.351***	1.449
			(0.053)	(0.439)
35-39			0.367***	1.383
			(0.056)	(0.416)
40-44			0.400***	1.264
			(0.064)	(0.380)
45-49			0.492***	2.222*
			(0.084)	(0.694)
Female			0.839***	0.975
			(0.033)	(0.047)
Birth interval				
Less than 2 years			1	1
2-5 years			0.542***	0.572***
			(0.022)	(0.030)
More than 5 years			0.408***	0.413***
			(0.033)	(0.047)
Birth size				
Large/very large			1	1
Average			1.143**	1.037
			(0.047)	(0.054)
Small/very small			1.904***	1.026
			(0.100)	(0.070)
Children ever born				
1-2 children			1.000	1.000

3-4 children			1.648***	1.734***
			(0.122)	(0.187)
5 or more children			2.521***	2.394***
			(0.217)	(0.279)
Married/co-habiting			0.707***	0.566***
			(0.064)	(0.067)
Observations	**91992**	**91992**	**73187**	**73187**

Exponentiated coefficients (odds ratios). Standard errors in parenthesis
*** p < 0.05, **** p < 0.01, ***** p < 0.001***

5.4.3 Predictive margins of structural factors on under-five mortality in Nigeria

Contrary to patterns seen earlier in the bivariate association between the structural factors and under-five mortality in Nigeria from Tables 5.10 and 5.11, logistic regression results in Tables 5.12 and 5.13 seemed like the structural factors in the presence of other confounders are not very useful in explaining under-five mortality in Nigeria. However, past studies on under-five mortality in Nigeria, as also confirmed from earlier results iterate that these structural factors are pre-disposing factors to under-five mortality. To add more clarity on the contributions of these structural variables, predictive margins are used. Predictive margins show the probability of an event occurring in the presence of other independent variables, especially when the natural metric is different from the modelled metric. It further explains the shape of the curve for each variable, and their roles on under-five mortality within each year, in the presence of other confounders (Graubard & Korn, 1999; Jann, 2013; Torres-Reyna, 2014). By using predictive margins, we can answer these questions better: *(1) What are the conditional probabilities of under-five death depending on different levels of the structural variables? (2) What are the marginal effects of these factors on the probability of under-five death?* Furthermore, to provide more information on temporal patterns of early childhood mortality in Nigeria, predictive margins are useful in indicating how the probabilities of under-five death changed over the years, thereby making the results more tangible.

Bivariate results seen earlier in Section 5.4.1 are supported by results in Figure 5.8. Associated marginal effects of these factors on under-five mortality over the focal period is also evident. The graphs clearly indicate that higher maternal education, urban residence, improved source of water supply, improved toilet facility, electricity, and ANC attendance all reduced the probability of under-five mortality in Nigeria. The graph for geo-political

zones indicates that North West, North East, and South East were associated with higher risks of under-five mortality than North Central, South South and South West. In addition, professional birth attendance during delivery showed increased probability of deaths for under-five children, which has been established to be linked with increased neonatal mortality. Results shown are on the combined under-five mortality output and are with 95 percent confidence intervals.

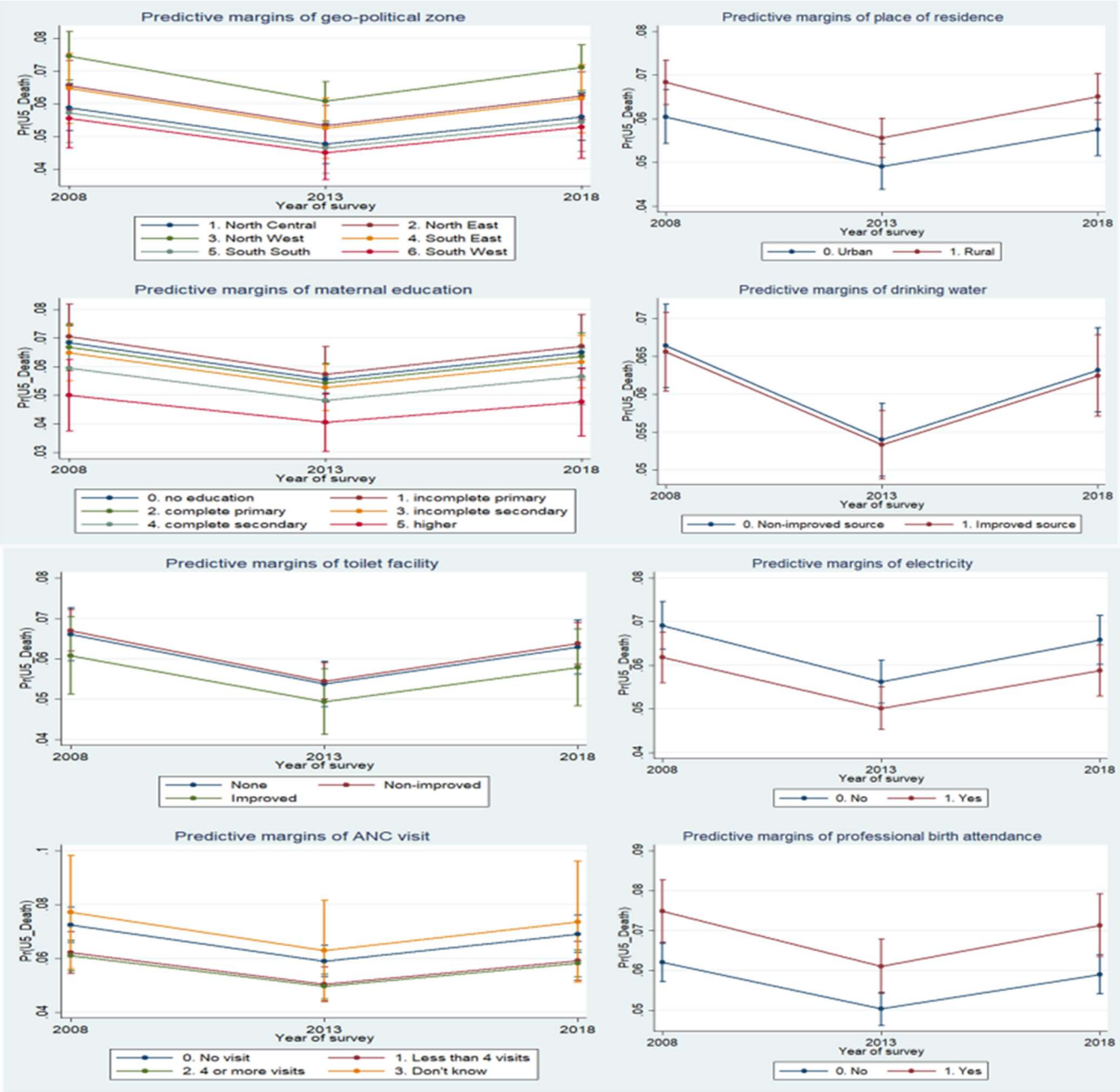

Figure 5.5: Predictive margins plots showing temporal effects of structural variables on under-five mortality in Nigeria, 2008 to 2018

5.5 Discussion

Using the three most recent datasets of the NDHS, this chapter explored spatial differences in under-five deaths, temporal changes within geo-political zones and states over more than a decade and identified the key structural and proximate factors associated with under-five mortality. The findings show that the risk of infant death was higher in the three northern regions than in the southern regions. However, beyond the infant stage, the South East had similar risk of child death as the North Central. Generally, the proportion of under-five deaths was lowest in the South West and highest in the North West. With regards to temporal changes, there were distinct patterns between states.

Although a direct analysis could not be done between under-five mortality and immunisation and access to medical treatment. It was evident from the patterns seen in the results, which is consistent with existing literature, that poor immunisation coverage was associated with poor child survival outcomes at the national level, and much more evident sub-nationally. The northern regions with lower immunisation coverage had higher under-five mortality rates (Akinyemi et al., 2013; Akinyemi & Morakinyo, 2018). Results further showed that socio-economic factors and health care access in different geo-political zones and states impacted on the uptake of vaccines. This confirms findings from other literature that the socio-economic status of individuals and communities influence childhood immunisation (Adedokun et al., 2017; Antai, 2009). Understanding behavioural processes linked with full immunisation uptake helps in the design of suitable programmes aimed at increasing full immunisation uptake among the geographically spread and culturally diverse Nigerian population (Antai, 2009). With regards to access to medical treatment, it was evident that costly health care and poor health insurance coverage were limiting factors to timely access to health care. Families were prone to calculate cost and distance when deciding whether to seek medical help or not. Lower wealth status has been shown to be associated with worse health outcomes (Barros et al., 2012; Boerma, Bryce, Kinfu, Axelson, & Victora, 2008).

Fetuga et al. (2007) added that socio-economic factors are associated with poor utilisation of health services. While those of lower socio-economic status and those resident in the rural areas are most affected by this, those of higher socio-economic status can afford private health care even though it is expensive, further widening inequalities in under-five mortality.

This strengthens the need for community-based interventions, with special target on children and women of low socio-economic status (Ezeh et al., 2015). Provision of universal health care for maternal women and children below five years will boost timely presentation to health facilities, discourage self-medication, and ensure services are easily accessible by rural dwellers. Information on immunisation and access to health care, which covers antenatal care, professional birth attendance, hospital delivery, and health seeking behaviour help in addressing gaps to health care access in Nigeria. Aday and Andersen (1974) in their framework on access to medical care cited in Chapter Three stated that access to health care was an interrelation of variables from health policy objectives to customer satisfaction.

This chapter also highlighted that the structural factors under review were associated with under-five mortality while predictive margins provided additional information on the roles of these factors on under-five mortality in the presence of other confounding variables. Findings show that maternal education had a higher impact in the childhood stage than infancy. Tsala Dimbuene et al. (2018) have shown that in Nigeria, maternal education is associated with uptake of maternal health services such as antenatal care visits with its timing and frequency, place of delivery and presence of a professional birth attendant. Maternal education, rural-urban difference, ethnicity, religion, region of residence, community level literacy, among others are associated with ANC visits (Bolarinwa et al., 2021). However, results on professional birth attendance highlights that it is associated with more infant death, but lower child death. In addition to the possible explanations of the unusual association between infant deaths and professional birth attendance mentioned earlier, further studies need to be carried out to explore the underlying drivers.

While sources of drinking water, toilet facility and electricity played some roles in reducing under-five mortality, their effects were not so significant in the regression models. Notwithstanding, poor source of drinking water and unimproved toilet facilities have been shown to be associated with diarrhoea in children and preventable child deaths, with an increased call to improve environmental and health practices as measures to improve child survival in the nation (Akinyemi et al., 2013; Ezeh et al., 2014b; Jinadu et al., 1991; Morakinyo et al., 2015). The case of electricity is difficult to measure with NDHS data, because given the poor power supply in Nigeria, availability of electricity in a household does not necessarily mean that electric power is available for usage when needed.

5.6 Conclusion

This chapter examined trends, differentials, and patterns of under-five deaths in Nigeria from 2008 to 2018 as well as provided empirical evidence that will aid the understanding of factors associated with child survival at the individual and household levels across geopolitical zones and states in the country. By so doing, answered the first research question of this study and threw more light on not only the persistently high under-five mortality, but also on the differences between and within zones. Generally, there were substantial between-zone, within-zone, and intra-state differences in levels of infant and child deaths across the three survey years. Results also indicate that there were higher deaths in infancy than in childhood. The country made progress in reducing under-five mortality to 2013 but could not sustain it to 2018.

Findings further suggest that under-five deaths were higher in the North East and North West zones. The most regional progress made over the period was in the South East and South South. Within-zone analysis also confirmed wide variations between states in the same geo-political zone, as well as varied temporal patterns between 2008 and 2018. This chapter likewise provided initial answers to the second research question aimed at identifying individual and household level factors associated with under-five mortality. In line with the analytical approach adopted in Chapter Three, results show that maternal education, geo-political zone of residence, and professional birth attendance accounted more for odds in under-five mortality than source of drinking water, toilet facility, and electricity. In essence, this chapter confirms the first and third hypotheses in Chapter Four, that there are trends and patterns to changes in under-five mortality over time in Nigeria. It further establishes that some factors at the individual and household levels influence early childhood survival outcomes. With the understanding gained from the findings in this chapter, further investigation of early childhood mortality in Nigeria using the structural factors at the individual/household level are carried out in the next chapter using survival analysis.

Unlike analysis done in this chapter, that studied trends and patterns of under-five deaths in Nigeria using 2008, 2013, and 2018 NDHS, the subsequent empirical chapters (Chapters 6 and 7) focus on the 2018 NDHS. This is enabling deep-dive analyses using the most recent NDHS, having understood the trends and patterns cross the three survey waves. In addition, focusing on the 2018 NDHS in carrying out key aspects of this research – child survival

function, incidence rates at death, and determinants of early childhood mortality in the individual/household, and community levels- provides the current information on the study variables which is most relevant for decision making.

CHAPTER SIX INDIVIDUAL AND HOUSEHOLD LEVEL DETERMINANTS OF UNDER-FIVE MORTALITY: A SURVIVAL ANALYSIS

6.1 Introduction

This empirical chapter presents results on child survival time and additional results on the individual and household level determinants of under-five deaths. Having identified the levels, trends, and patterns of under-five deaths in Nigeria in Chapter Five, this chapter uses survival analysis to undertake a more fine-grained study of the timing of early childhood mortality. Timing is important because the probability of experiencing early (and largely preventable) mortality varies over the early childhood period. In so doing I focus on the most recent 2018 iteration of the NDHS. Focusing on 2018 NDHS data ensures a more comprehensive analysis of early childhood survival in Nigeria. The use of survival analysis here overcomes some of the inherent limitations of the logistic regression models used in the preceding chapter, particularly, it addresses the problem of censoring. In the social sciences, censoring occurs when an observation has incomplete information. That is, it did not experience the event during the time it was part of the study (Adedini, 2013). In the case of our study, a child less than five years of age that is alive at the time of the interview is right censored. In addition to controlling for censoring, survival analysis differentiates survival probabilities between two or more groups, thereby providing a robust understanding of early childhood survival in Nigeria (Mills, 2010).

Over the past decades, initiatives to improve early childhood survival in Nigeria have not been particularly effective. This is evident in the country's persistently high under-five mortality rates over the years. Survival analysis identifies the high-risk periods within the first five-years of life (Adedini, 2013; Wegbom, Essi, & Kiri, 2019). This enables stakeholders to answer questions such as: 'if a child lives to two years, what is the risk that he/she will die in the following month?' These details cannot be achieved using the standard bivariate and logistic regression analysis in Chapter Five. Furthermore, since survival analysis considers the time to death of a child, it is possible to compare child survival between two or more groups such as geo-political zones and states, as well as measure the relationship between explanatory factors and survival time. These analyses address the research questions, 1. ***What is the survival pattern of under-five children in Nigeria?*** 2. ***What are***

the determinants of under-five mortality at the individual/household level across various geo-political zones and states in Nigeria?

The rest of the chapter is as follows. The next section focuses on the methods used in the analysis of this chapter. It then provides an overall sub-national description of the child survival function and incidence rates of under-five mortality across the country at the rural/urban, geo-political zone and state levels. This geographic dimension in early childhood survival outcome complements results from Chapter Five, helping to further grasp sub-national disparities in under-five mortality. Subsequently, this chapter examines the determinants of under-five mortality at the individual and household levels using the study variables highlighted in the conceptual framework. Finally, the discussion and the conclusion sections synthesize the findings and reflect on them in the context of the study objectives and research questions.

6.2 Methods

The use of survival analysis in this study ensures that the child is observed for the first five years of life from birth to death or to the time of survey for those that were still alive (censored), by measuring the probability of surviving beyond each time interval (month in this case). The outcome variable is the time between birth and death of a child under five years of age; or until censored. Three key things to remember about survival models are: 1) the outcome variable is the waiting time until the occurrence of a well-defined event (death in this case); 2) observations are censored; and 3) there are explanatory variables whose effect on the waiting time are assessed or controlled. The assumptions we make on how explanatory variables affect survival time determine the kinds of models we use.

The general survivor function expresses the probability that a survival time T is equal to or greater than some time t, which gives the probability that there is no failure event prior to t (Cleves, Gould, Gould, Gutierrez, & Marchenko, 2008; Mills, 2010). Assuming that T is a positive continuous random variable and F(t) is a cumulative density function. The survivor function is stated as:

$$\hat{S}(t) = 1 - F(t) = P_r(T \geq t) \qquad \text{.............................. (6.1)}$$

Considering the continuous nature of the NDHS outcome variable (time of death of child measured in months), non-parametric and semi-parametric tools of the survival analysis are deployed. The Kaplan Meier estimator being a non-parametric estimate of the survival function S(t) is used to estimate the probability that the survival time is greater than t or, alternatively, the probability of failing after time t (Cleves et al., 2008; Mills, 2010). The Kaplan Meier estimator makes no assumptions about the distribution of the hazard function or how covariates affect the shape of the survival function. Instead, it shows how covariates impact on the child's survival experience by stratifying data into groups. It is denoted by:

$$\hat{S}(t_{(j)}) = \hat{S}(t_{(j-1)}) \text{ X } P_r\left(T > t_{(j)} | T \geq t_{(j)}\right) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(6.2)}$$

The Kaplan Meier survival curve measures the probability of child survival past five years of age and compares the survival experiences for children in different categories of the study variables. The curve -defined as the probability of surviving beyond a given time- is used to consider survival time in many small intervals, while the log-rank test is used to measure the unadjusted effect of each variable on under-five mortality risk.

To examine the risks of death as well as the effect of multiple covariates on child survival, Cox proportional hazard regression is used. It is a semi-parametric estimate where the baseline hazard need not be specified and can hence take any form. Cox proportional hazard model shows how covariates affect the shape of the hazard function assuming that the hazard between groups over time is proportional (Mills, 2010). Just like the Kaplan Meier estimate, Cox proportional hazard regression does not make assumptions about the distribution of failure times. This is important because if such an assumption is wrong, it could produce misleading results about the coefficient. The probability of under-five mortality is known as the hazard. The hazard model for fixed covariates, which applies to the 2018 NDHS data, is denoted by:

$$h_i(t) = h_0(t)\{\exp(\beta_1 x_{i1} + \cdots + \beta_k x_{ik})\} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(6.3)}$$

Where $x_1 \ldots x_k$ consists of covariates and $h_0(t)$ is the baseline hazard at time t, which shows the hazard for a child with the value of zero (0) for all the covariates (Fox, 2008).

The hazard function (or rate) varies from zero (no risk at all) to infinity (the certainty of failure at that instantaneous time). It measures the instantaneous rate at which failures occur at any given time. Over the period of observation, the hazard function can increase, decrease, remain constant, or be curvy. There is a correlation between the probability of survival past a certain time and the amount of risk accumulated to that time, and the hazard function measures the rate at which risk is accumulated (Cleves et al., 2008). When equation 6.3 is expressed in terms of the log of the hazard ratios, it is denoted as:

$$\log\{\frac{h_i(t)}{h_0(t)}\} = \beta_1 x_{i1} + \cdots + \beta_k x_{ik} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (6.4)$$

Where $h_i(t)/h_0(t)$ is the hazard ratio and the Cox proportional hazards regression estimates the values for the coefficients $\beta_1 \ldots \beta_k$. Table 6.1 gives the variable definition of the factors used in this chapter to examine hazard prediction of child survival in Nigeria.

Cox regression technique models censor time-until-event data as an outcome variable with the assumption that the covariates have a multiplying effect on hazard rates (Adedini, 2013). Children reported to have died are treated as the cases while those who are still alive at the time of the interview are treated as right-censored observations. The children's survival status and the age of their death in months are also captured in the outcome variable.

Given that one of the main assumptions of the Cox proportional hazards model is proportionality, the models are tested to verify that they satisfy the proportionality assumption using the proportional hazards tests. The check on the validity of the proportional hazard assumption is done using log-log plots, which are graphs of the log of non-parametric estimates of the cumulative hazard against time for different covariate subgroups. When the graphs are plotted, a parallel movement of lines on the graph is a confirmation that the proportional hazard assumption is satisfied for the selected variables. In essence, the variables used in this chapter to predict risks of under-five mortality were tested accordingly and the results show that they did not violate the proportionality assumption. Results of the proportional hazards tests can be found in Appendix D (Figures D.1-D.4).

The variables defined in Table 6.1 are used for the analysis.

Table 6.1: Variable definition of hazard prediction of child survival in Nigeria

Measures	Definition	Operationalisation
Outcome variable: Indicator of under-five mortality		**Missing values were set to system missing**
Under-five death	Died between birth and death of a child under five years of age	0 = none, 1 = yes
Key independent variables Individual/Household level		
Place of residence	Urban, rural residence	1 = urban, 2 = rural
Geo-political zone	Region of usual residence of the respondent	Six geo-political zones of Nigeria (1 = North Central, 2 = North East, 3 = North Central, 4 = South East, 5 = South South, 6 = South West)
State	State of usual residence of the respondent	37 states of Nigeria
Maternal education	Respondent's highest level of educational attainment	0 = no education, 1 = incomplete primary, 2 = complete primary, 3 = incomplete secondary, 4 = complete secondary, 5 = higher education
Drinking water	Household's source of drinking water	0 = non-improved sources, 1 = improved sources. "Other" sources were categorised as non-improved facility.
Toilet facility	Type of toilet facility used by household	0 = none, 1 = non-improved type, 2 = improved type.
Electricity	Household has access to electricity	0 = none, 1 = yes

ANC attendance	Number of times respondent received ANC during pregnancy	0 = none, 1 = less than 4 visits, 2 = 4 or more visits, 3 = "do not know".
Professional birth attendance	Whether child delivery was handled by a doctor, midwife, or nurse	0 = none, 1 = yes

6.3 Sub-national variations in child survival function in Nigeria

This section builds on the previous chapter, by examining sub-national variation in the survival function of under-five children in Nigeria.

6.3.1 Under-five survival function at the national level

To begin, an overall description of under-five survival at the national level is shown in Table D.1 (Appendix D) and Figure 6.1. Table D.1 shows that the risk of early childhood mortality is highest during the neonatal stage, with 43 percent of children dying in their first month of life. Deaths in the first month also make up more than 60 percent of all deaths in infancy. Studies have shown that progress in child survival is worst in the neonatal period, with strong influence from antenatal, birth, and postnatal care factors such as the quality of ANC received, place of delivery, skilled birth attendance, and care of low-birth-weight infants (Adetola, Tongo, Orimadegun, & Osinusi, 2011; Akinyemi et al., 2015; Morakinyo & Fagbamigbe, 2017). Consistency with Chapter Five results, 67 percent of all under-five deaths occurred in the first year of life. Taken together, the key message is that concerted efforts aimed at improving child survival should be focused on the neonatal and infant stages.

The Kaplan-Meier survival curve in Figure 6.1 also illustrates that the probability of death at the early childhood stage reduces as age increase. In other words, the instantaneous rate of failure (hazard rate) at a given time appears to be greatest at birth, then steadily declined. The survival estimates had a relatively constant decline till the 24th month when the probability of survival dropped below 90 percent, after which the slope lagged as the probability of child death was zero at some time intervals. By way of comparison, the hazard rate after birth was more than three times higher than the hazard two years later. By the end of the study period, 88 percent of the children survived beyond age five.

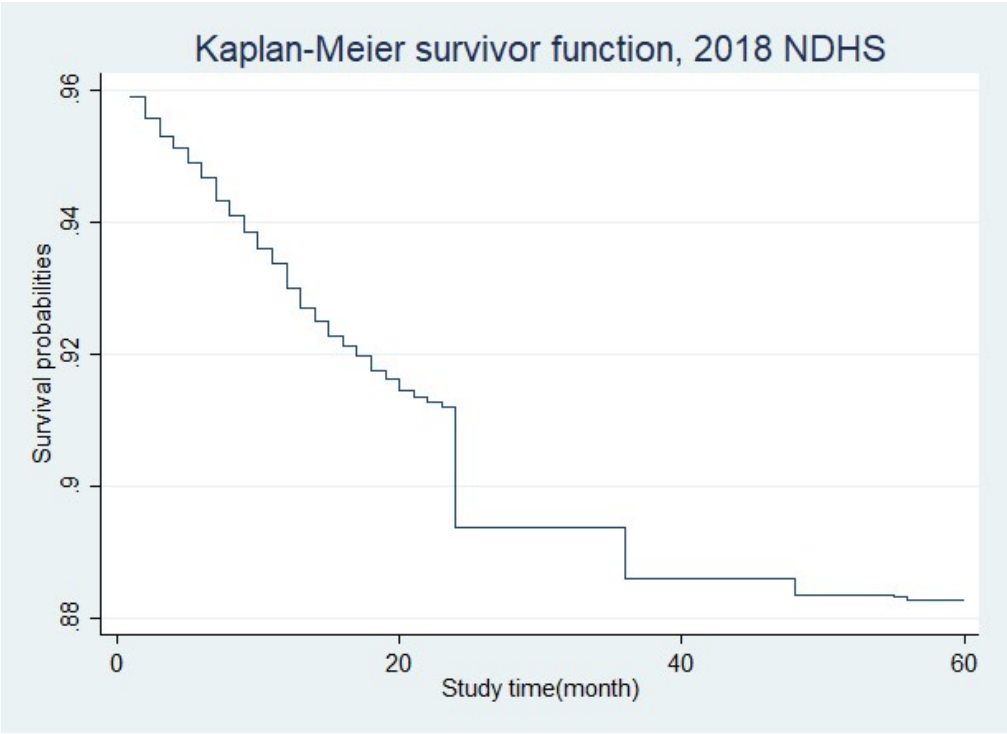

Figure 6.1: Kaplan Meier estimate of the survivor function for the under-five children in Nigeria

6.3.2 Under-five survival function by place of residence, geo-political zone, and state

The following analyses provide a more detailed breakdown of under-five survival by place of residence, geo-political zones, and states. This sub-national analysis is important for understanding how the survival pattern across early childhood varies in different locations. It highlights similar trends observed at the national level but with more variation, driven by the socio-economic characteristics at the sub-national level.

Table 6.2 illustrates that the under-five children resident in the rural areas had lower survival chances than those in the urban areas. A closer examination of the result also indicates a higher frequency of mortality risks in the first two years of life for the children resident in the rural areas. Surprisingly, less than 90 percent of the infants in the rural areas survived to the third year. The table further shows that only 83 percent of the children in the North West survived beyond five years of age, unlike the southern zones with more than 90 percent survival. The earliest censoring (i.e., children who did not experience death at the time of the interview) was in the South South at 36 months, while survival estimates for children in the North Central and North East zones continued to 57 months.

Table 6.2: Child survivor function by place of residence and geo-political zone

	Survivor Function									
	Time (in months)									
	1	**8**	**15**	**22**	**29**	**36**	**43**	**50**	**57**	**64**
Place of residence										
Urban	0.9622	0.9504	0.9379	0.9310	0.9201	0.9160	0.9160	0.9148	0.9135	.
Rural	0.9572	0.9361	0.9146	0.9032	0.8800	0.8701	0.8701	0.8671	0.8666	.
Geo-political zone										
North Central	0.9609	0.9436	0.9289	0.9235	0.9143	0.9065	0.9065	0.9034	0.9010	.
North East	0.9562	0.9349	0.9151	0.9082	0.8864	0.8794	0.8794	0.8775	0.8759	.
North West	0.9511	0.9298	0.9006	0.8818	0.8460	0.8327	0.8327	0.8300	0.8300	.
South East	0.9671	0.9531	0.9411	0.9317	0.9262	0.9249	0.9249	0.9224	0.9224	.
South South	0.9722	0.9566	0.9466	0.9438	0.9386	0.9355	0.9355	0.9355	0.9355	.
South West	0.9635	0.9546	0.9501	0.9462	0.9402	0.9348	0.9348	0.9322	0.9322	.

Figure 6.2 visualizes the mortality risks of under-five children in urban-rural residence and geo-political zones. Consistent with earlier results, under-five children in the North West had the lowest probabilities of survival, while those in the South West had the highest. Generally, children in the southern zones had a better survival experience than those in the north. The figure further shows that the odds of survival for under-five children in the southern zones followed each other more closely than those in the northern zones. These results support studies that have shown that socio-economic factors at the geo-political zones are significantly associated with under-five mortality (Adedini, Odimegwu, Imasiku, Ononokpono, et al., 2015; Antai, 2011b).

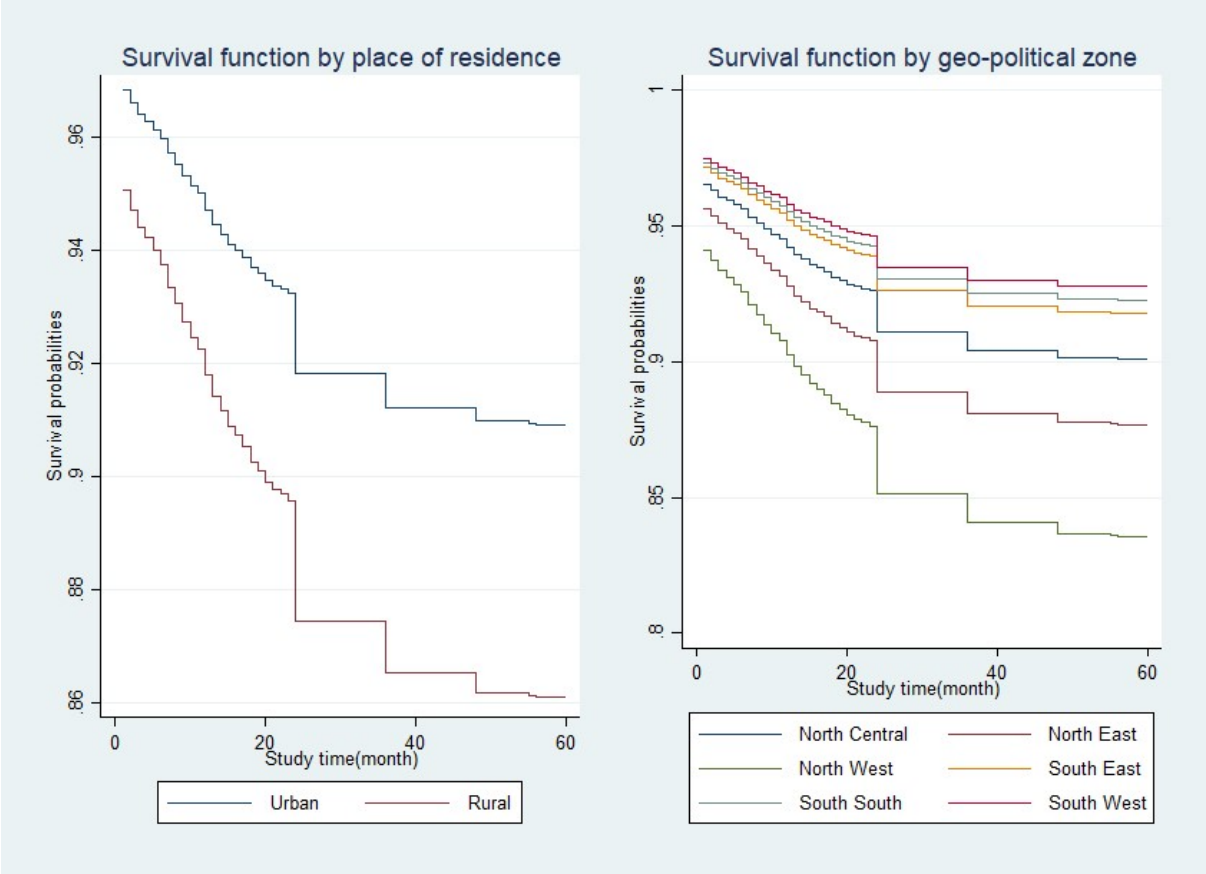

Figure 6.2: Estimates of the survivor function for the under-five children in Nigeria, by place of residence and geo-political zones

Having observed the survival function by place of residence and geo-political zones, the results below show a further breakdown at the state level and the considerable variations in the occurrence of under-five deaths amongst states in the same geo-political zone. Figure 6.3 and Table D.2 (Appendix D) show that three out of seven states in the North Central had less than 90 percent of the children still alive at the end of the study period. At 83 percent, Kogi had the lowest odds of survival past age five. In the North East, Borno had the highest survival function while Gombe had the lowest. Similarly, in the North West, children in Kebbi had a 77 percent chance of survival past five years of age, making it the lowest in the region. Between North East and North West states, only Borno had more than 90 percent probability of child survival beyond the early childhood stage.

In the South East, Imo state had the lowest under-five survival (89%) while Anambra had the highest (95%). A similar picture was also seen in the South South and South West, with Akwa Ibom and Ekiti states respectively having the lowest odds of child survival. Bayelsa

and Ogun at 97 percent had the highest odds of child survival in both zones. A closer look at Table D.2 (Appendix D) further suggests that while there was a zero chance of child death in Enugu state after the 22nd month, Kogi and Borno states still had likelihoods of child death until the 57th month.

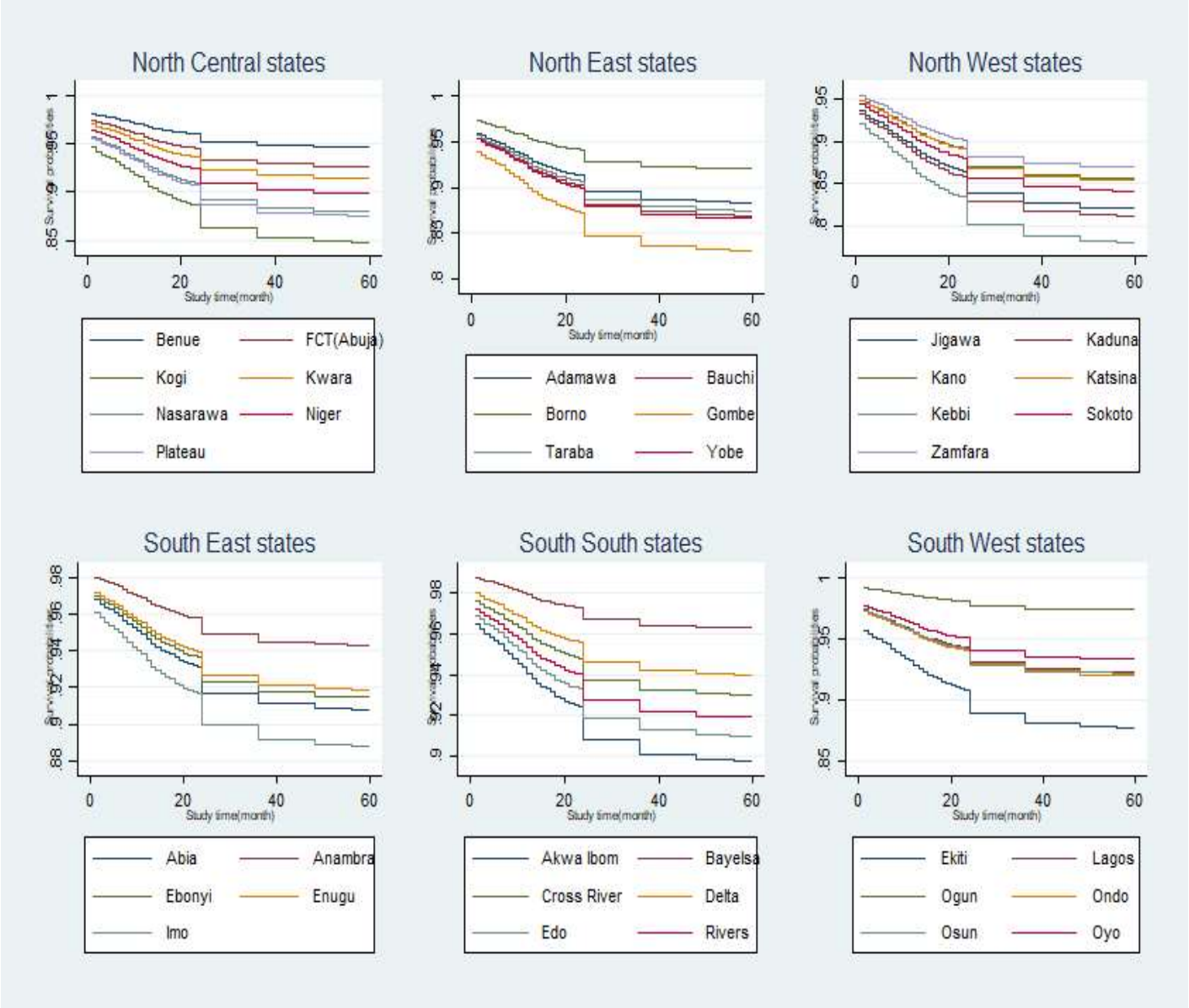

Figure 6.3: Estimates of the survivor function for the under-five children in Nigeria, by state

6.4 Sub-national variations in incidence rates of under-five death in Nigeria

This section presents findings on the incidence rates of under-five death across Nigeria. The incidence rate is the ratio of the number of children dying during the study period to the time at risk of death, which provides additional insight into the speed of occurrence of under-five deaths nationally and sub-nationally (Stel, Dekker, Tripepi, Zoccali, & Jager, 2011). From Table 6.3, it can be inferred that under-five mortality risks in the rural areas were 50 percent higher than those in the urban areas. Likewise, North East and North West had the two highest incidence rates, even higher than the national rate. Children in the North East and North West respectively had 28 and 73 percent higher mortality rates than children in the North Central. While those in the South East, South South, and South West respectively had 18, 30, and 31 percent lower mortality rates in comparison with children in the North Central. This confirms the finding in Chapter Five of higher mortality risks in the northern zones but goes a step further to also show the timing with which deaths occurred.

Table 6.3: Relative risk of under-five mortality by place of residence and geo-political zone

	Time at risk	Incidence rate	Relative risk	No. of subjects
Place of residence				
Urban	330046	0.0026	1	11699
Rural	604095	0.0039	1.5224	22225
Geo-political zones				
North Central	163487	0.0029	1	5875
North East	197132	0.0037	1.2826	7211
North West	274651	0.0050	1.7290	10305
South East	107004	0.0024	0.8190	3798
South South	90191	0.0020	0.6951	3202
South West	101676	0.0020	0.6950	3533
Total	**934141**	**0.0034**		**33924**

Although not shown here, Table D.3 (See Appendix D) further reveals wide within-zone variations in the incidence rate of under-five deaths across Nigeria. For instance, in the North Central, Kogi had the highest rate of under-five mortality, with 52 percent higher mortality rate than the North Central average, while Benue had the lowest with 48 percent lower mortality rates. A similar pattern is seen across the northern states down to the southern states. In the South East, Imo had the highest mortality rate with a relative risk of 40 percent higher than the zonal average while Anambra, at 40 percent lower, had the lowest mortality rate.

The South West reported the widest intra-zone variation in incidence rate of under-five deaths. Ekiti with a 76 percent higher mortality rate than the zonal rate was the highest in the zone, in contrast to Ogun with 64 percent lower death rate when compared with the zonal rate.

These state results further highlight the vast variation in early childhood mortality that exists amongst states in the same geo-political zone. Interestingly, while the South West had the lowest under-five mortality rate in Nigeria, it also recorded the highest within-zone variation. When the state incidence rates were compared with the national rate, Kebbi state had the highest incidence rate of under-five deaths in the country while Ogun state had the lowest, which is consistent with results on under-five mortality across states in 2018 NDHS report (National Population Commission Nigeria [NPC] & ICF International, 2019). These high disparities in mortality risks further underline the significance of this research, while at the same time informing further studies and initiatives aimed at suggesting long-term solutions to the problem. They suggest how the understanding of under-five mortality in Nigeria can shift depending on the level of analysis, and how care needs to be taken with spatially targeted approaches. Thus, a more productive point of intervention seems to be at the state level rather than the zonal level. In addition, these results further stress the need for a contextual analysis, which is being explored in this study as well, to have an all-inclusive assessment of the situation sub-nationally.

6.5 Log-rank test for equality of survival functions

The log-rank test for equality of survival functions is useful because it indicates whether the differences observed in the foregoing analyses are statistically significant. It also indicates if the structural and proximate factors are significantly associated with early childhood survival. If they are, then there is evidence to suggest that these background factors at the individual/household level explain sub-national differences in under-five mortality. Log-rank test for equality of survivor functions is used to examine these variations between categories. Conceptually, log-rank test compares the observed number of events (deaths) in each group to what would be expected if the survival curves were equal (i.e., if the null hypothesis were true). If the chi-2 is significant (i.e., $p<0.05$), the probability that the observed variations in under-five mortality risk occurred by chance is less than 0.00. Results from Table 6.4 show

significant chi-2 results, which suggests that sub-national variation in under-five survival across Nigeria did not occur by chance. Strengthening the argument that there appear to be contextual spatial factors driving these observed sub-national differences. Similarly, Table 6.5 indicates that all the covariates apart from marital status are significantly associated with risks of under-five mortality.

Table 6.4: Log-rank test for equality of survival function by spatial location

Background characteristics	Under-5 death (%)	Chi-2 (DF)	P-value
Place of residence		**103.41(1)**	**0.0000**
Urban	7.3		
Rural	11.2		
Geo-political zone		**336.08(5)**	**0.0000**
North Central	7.9		
North East	9.9		
North West	13.3		
South East	6.5		
South South	6.1		
South West	5.8		
State		**524.42(36)**	**0.0000**
North Central			
Benue	4.3		
FCT (Abuja)	5.8		
Kogi	12.3		
Kwara	6.8		
Nasarawa	9.6		
Niger	8.0		
Plateau	10.1		
North East			
Adamawa	9.2		
Bauchi	10.4		
Borno	6.5		
Gombe	13.6		
Taraba	10.0		
Yobe	10.8		
North West			
Jigawa	14.7		
Kaduna	15.1		
Kano	11.8		
Katsina	11.8		
Kebbi	18.2		
Sokoto	12.9		

Zamfara	10.3
South East	
Abia	7.3
Anambra	4.4
Ebonyi	6.8
Enugu	6.4
Imo	9.0
South South	
Akwa Ibom	8.0
Bayelsa	2.9
Cross River	5.5
Delta	4.7
Edo	7.2
Rivers	6.4
South West	
Ekiti	9.8
Lagos	6.2
Ogun	2.1
Ondo	6.5
Osun	6.3
Oyo	5.3

Table 6.5: Log-rank test for equality of survival function by structural factors

Background characteristics	Under-5 death (%)	Chi-2 (DF)	P-value
Structural factors			
Maternal education		**271.31(5)**	**0.0000**
No education	12.6		
Incomplete primary	10.3		
Complete primary	9.1		
Incomplete secondary	7.5		
Complete secondary	6.0		
Higher	5.5		
Drinking water		**20.20(1)**	**0.0065**
Non-improved source	10.5		
Improved source	9.2		
Toilet facility		**132.32(2)**	**0.0000**
None	8.9		
Non-improved	11.4		

Improved	6.2		
Household has electricity		**88.13(1)**	**0.0000**
No	11.5		
Yes	8.1		
ANC attendance		**62.88(2)**	**0.0000**
No visit	8.2		
Less than 4 visits	6.6		
4 or more visits	5.1		
Professional birth attendance		**138.44(1)**	**0.0000**
No	11.5		
Yes	7.3		
Proximate factors			
Religion		**192.05(2)**	**0.0000**
Christian	6.8		
Islam	11.4		
Other	4.9		
Maternal age		**21.14(3)**	**0.0001**
15-19	11.3		
20-29	9.5		
30-39	9.3		
40-49	11.6		
Sex of child		**11.04**	**0.0009**
Male	10.0		
Female	9.3		
Birth interval		**172.88(2)**	**0.0000**
Less than 2 years	14.5		
2-5 years	8.3		
More than 5 years	5.8		
Birth size		**103.40(2)**	**0.0000**
Large/very large	8.5		
Average	9.0		
Small/very small	14.3		
Children ever born		**166.28**	**0.0000**
1-2 children	7.2		

3-4 children	8.5		
5 or more children	12.5		
Marital status		**0.03(1)**	**0.8623**
Single/widowed/divorced/separated	***9.8***		
Married/co-habiting	***9.7***		

Results in bold italics are not significant.

6.6 Risk factors of under-five mortality at the individual and household level using Cox proportional hazards regression

Moving from a thick description of sub-national variation in early childhood survival, this section focuses on identifying how structural factors measured at the individual and household level impact the risks of under-five mortality. Cox proportional hazards regression is used to measure mortality risks among children less than five years in Nigeria by the selected measures of interest at the individual and household level. Findings here are consistent with results of the association of these factors with under-five deaths shown previously in Chapter Five.

6.6.1 Bivariate analysis between structural factors and under-five mortality in Nigeria

Unadjusted child survival estimations by structural factors are presented here. Graphs in Figure 6.4 show a much sharper decline in survivorship at age two years for the most deprived groups. The probability of child survival increased with increase in maternal education. Children born to women that attempted secondary or higher education had more than 90 percent chances of survival, while those born to women with no education had less than 85 percent chances of surviving beyond age five. Absence of maternal education has been identified in studies as a risk factor to under-five mortality (Wegbom et al., 2019; Yaya et al., 2017). The importance of maternal education on under-five mortality cannot be over-emphasized, as studies have shown that it influences reproductive and health choices, brings about behavioural change, as well as improves the socio-economic status of the household (Antai, 2011a; Dimbuene et al., 2018; Wagstaff et al., 2004; Yaya, Bishwajit, Okonofua, & Uthman, 2018).

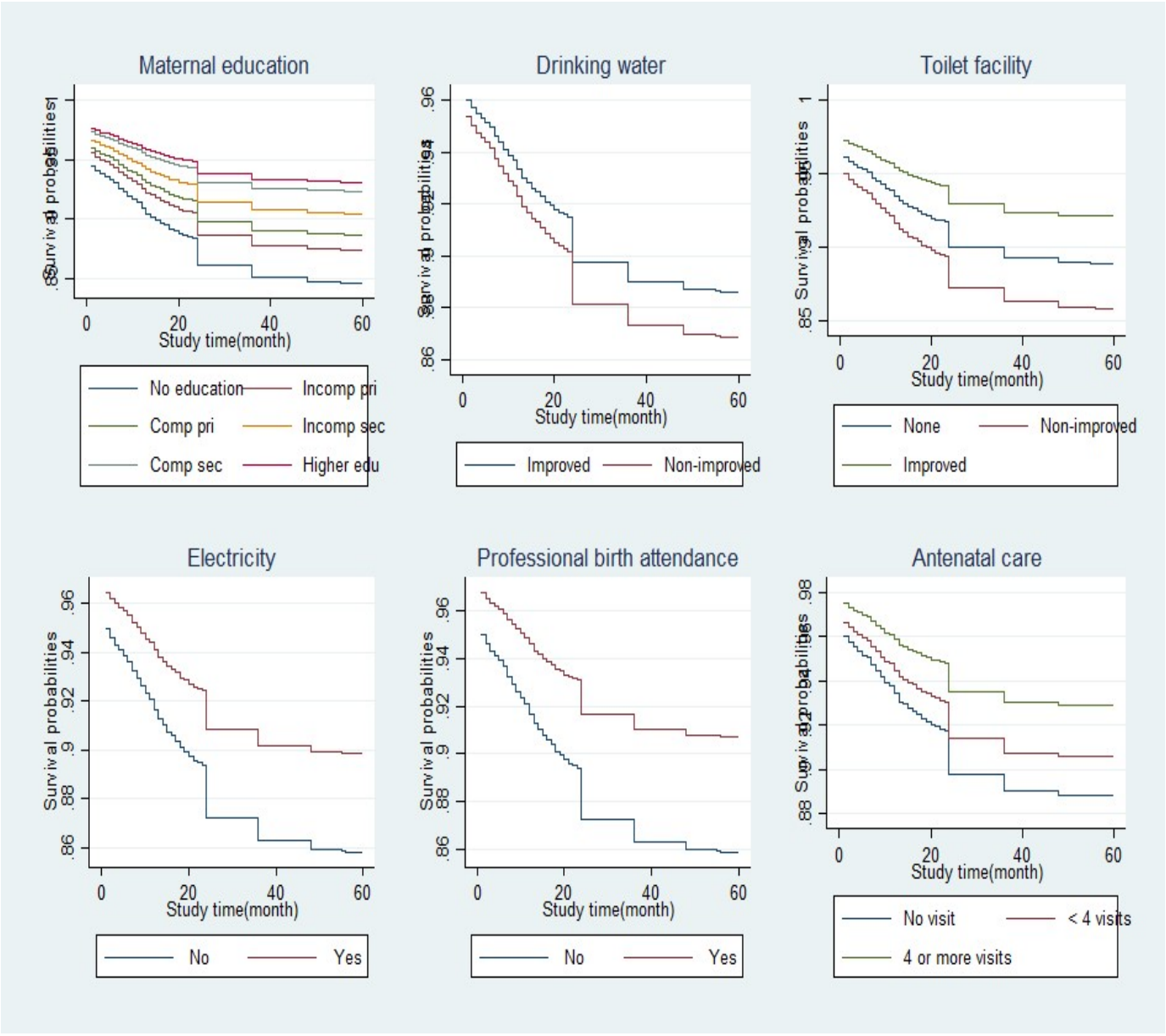

Figure 6.4: Estimates of the survivor function for the under-five children in Nigeria, by structural factors

Analysis by drinking water shows that children from households with improved sources of drinking water had lower mortality risks than those without improved sources of drinking water, and this relative advantage increased over the duration. Similarly, children from households with improved sources of toilet facility had higher chances of survival than those without such facilities. Results here are in line with findings by Akachi, Steenland, and Fink (2017) on sub-Saharan Africa, that improved water and sanitation facilities improve child health outcomes. This should not be surprising, because hygienic behaviours that improve

child health are easier when safe water and flush toilet are available in the household. For instance, there is evidence that improved water supply reduces instances of diarrhoeal and cholera (NPC & ICF International, 2019; Wagstaff et al., 2004).

The presence of electricity in a household is also associated with higher survival probabilities. In Nigeria, as with other developing countries, the impact of electricity is less direct. It does not replace the use of traditional fuel for cooking, which has a negative impact on health, but rather is associated with reduced indoor air pollution because of a switching from the use of traditional fuels to the use of electric lights. Electricity also improves the use of modern amenities (refrigerator, sterilizer, etc.) for preparing, preserving, and sterilizing foods in more hygienic ways, and enhances access to health information (Chen, Chindarkar, & Xiao, 2019; Fay, Leipziger, Wodon, & Yepes, 2005). Generally, household infrastructures like quality drinking water, improved toilet and sanitation facility, and electricity indirectly improve child survival outcomes, and should be incorporated into child care initiatives (Fay et al., 2005)

On access to maternal care, Figure 6.4 suggests that children delivered by professional birth attendants had higher chances of survival at all stages up to age five than those that were not. Similarly, children born to women who received antenatal care also showed higher survival odds than those born to women who did not receive any. The benefit of mothers attending at least four antenatal care visits is also evident in the figure, as it further improves the survival chances of the children born to those women. Attendance of antenatal care and supervised delivery by a professional health care attendant ensures that proper health care is provided, signs of abnormalities identified and treated on time, as well as proper handling of delivery conditions (Akinyemi et al., 2015; Blackstone et al., 2017). Investment in health care delivery and expansion of outreach services ensures that quality health care is easily accessible to everyone irrespective of location (Acharya & Cleland, 2000; Wagstaff et al., 2004).

6.6.2 Multivariate Cox proportional hazard regression of under-five mortality in Nigeria

Following on from the unadjusted analysis of structural variables, multivariate Cox proportional hazard regression is used to further assess the net effects of risk factors with early childhood survival outcomes. The multivariate Cox regression models, just like other regression models, controls for covariates by testing the effect of other independent variables on survival times of under-five children. The hazards ratio from the Cox regression output is the probability of dying at a given time assuming that the child had survived up to that given time. Three models are fitted to explore the factors associated with under-five mortality risks at the individual/household level. Model 1 examines the effect of the well-known proximate variables from the literature, Model 2 adjusts for the structural factors at the individual and household level while Model 3 further adjusts for place of residence and geo-political zones.

Consistent with existing literature, most of the proximate factors adjusted for in Model 1 (Table 6.6) are significantly associated with the hazards of under-five mortality. The results suggest that the hazards risk for children born into Islamic homes increased by 43 percent when compared with those in Christian homes. Also, children born to women 20 years and older had lower hazards than those born to women younger than 20 years old. Similarly, birth intervals of two years and above, and being born to mothers who were married, or cohabiting were associated with reduced mortality risks for under-five children. In contrast, under-five mortality risks increased with decrease in the child's size at birth, and high parity (three children and above). From the Cox regression models, sex of child was not significantly associated with under-five mortality.

When the structural factors were adjusted for in Model 2, the proximate factors, with the exceptions of religion and sex of child, remained significant. Amongst the structural factors, the results clearly indicate that maternal education improved chances of child survival. Children whose mothers had at least a secondary-level education had more than a 20 percent higher chance of surviving past five years of age when compared with those whose mothers had no education. Household use of electricity was also significantly associated with improved child survival (14%) compared with households without.

Table 6.6: Multivariate Cox proportional hazards regression model: risk factors of under-five mortality in Nigeria

Covariates	Model 1 HR (SE)	Model 2 HR (SE)	Model 3 HR (SE)
Religion			
Christian	1	1	1
Islam	1.43 [0.10]*	1.15 [0.10]	0.97 [0.12]
Other	0.81 [0.28]	0.69 [0.24]	0.59 [0.22]
Maternal age			
15-19 years	1	1	1
20-29 years	0.39 [0.11]*	0.42 [0.12]*	0.43 [0.12]*
30-39 years	0.30 [0.09]*	0.34 [0.09]*	0.35 [0.10]*
40-49 years	0.32 [0.09]*	0.36 [0.10]*	0.37 [0.10]*
Female	0.92 [0.05]	0.92 [0.05]	0.92 [0.05]
Birth interval			
Less than 2 years	1	1	1
2-5 years	0.63 [0.03]*	0.62 [0.03]*	0.62 [0.03]*
More than 5 years	0.47 [0.05]*	0.47 [0.05]*	0.48 [0.05]*
Birth size			
large/very large	1	1	1
average	1.11 [0.06]*	1.11 [0.06]*	1.13 [0.06]*
small/very small	1.67 [0.12]*	1.64 [0.12]*	1.65 [0.12]*
Children ever born			
1-2 children	1	1	1
3-4 children	1.53 [0.17]*	1.47 [0.16]*	1.47 [0.16]*
5 or more children	2.61 [0.28]*	2.30 [0.26]*	2.25 [0.26]*
Married/co-habiting	0.72 [0.09]*	0.71 [0.09]*	0.68 [0.09]*
Maternal education			
No education		1	1
Less than primary		0.84 [0.10]	0.86 [0.10]
Primary		0.84 [0.08]	0.90 [0.09]
Less than secondary		0.72 [0.08]*	0.77 [0.08]*
Secondary		0.73 [0.08]*	0.81 [0.09]*
Higher education		0.65 [0.11]*	0.71 [0.11]*
Non-improved source of drinking		1.01 [0.06]	1.00 [0.06]

water		
Toilet facility		
None	1	1
Non-improved facility	1.13 [0.09]	1.04 [0.08]
Improved facility	0.96 [0.10]	0.93 [0.10]
Electricity	0.86 [0.05]*	0.90 [0.05]
Professional birth attendance	1.04 [0.07]	1.12 [0.08]
Rural		1.16 [0.08]*
Geo-political zones		
North Central		1
North East		1.05 [0.12]
North West		1.37 [0.15]*
South East		0.88 [0.12]
South South		0.86 [0.13]
South West		0.88 [0.12]

HR = hazard ratio; SE = standard errors in parenthesis; *Significant at p < 0.05

Turning to Model 3 which includes spatial variables, we see that maternal age, birth interval, child's birth size, number of children ever born, and marital status were strong predisposing factors to the hazards of under-five mortality. Amongst the structural variables, only maternal education was significantly associated with the risks of under-five mortality, with increased years in education associated with improved survival outcomes. However, other structural factors - drinking water, toilet facility, electricity, and professional birth attendance – were not significantly associated with higher mortality risk. In terms of the spatial variables, the risks of under-five death for children in rural areas was 16 percent higher than those in urban areas. Analysis by geo-political zones also suggests that in comparison with the North Central, children in the North West were just under 40 percent more likely to experience under-five mortality.

6.7 Discussion

This chapter provided a more robust understanding of under-five mortality in Nigeria in two ways: by showing how survivorship chances vary at different time periods during the early childhood development stage; and how the survivorship function varies by spatial and structural factors. The analysis clearly shows that the highest risks of mortality occur in the first two years of a child's life and that this is consistent across all spatial contexts. Although results in this chapter follow similar pattern seen earlier in Chapter Five, they also offer additional insight by providing a more nuanced understanding of the survival changes across the childhood period. Critical time points which seem to be at the neonatal period, one year, and then two years are identified. Also, the gaps between the highest and lowest mortality groups (regardless of whether you are looking at spatial or structural variables) widen over time, even after age two. This is an indication of the prolonged effect of these factors on early childhood survival outcomes. This additional information overcomes some of the mortality study limitations of only having summary statistics at the end of a five-year period, as it identifies periods where the risks of death are highest over the early childhood stage.

The within-zone and state-level variations in the risks of under-five mortality found here underscore the need for state-level programmes and policies. This is consistent with previous studies that have identified high state-level differentials in under-five mortality in Nigeria (Ayoade, 2020; Ogbuoji & Yamey, 2019). Clearly, Nigeria cannot be treated as a uniform entity with regards to health outcomes. Even though some level of homogeneity exists within geo-political zones, there are still significant inter-state differences within all zones, albeit more marked in some. Furthermore, findings did not only highlight sub-national differences in child survival outcomes but also showed the importance of the measured structural factors at the individual and household levels. Other possible reasons for sub-national variations are state-level economic resources, rural-urban differentials, territorial advancement, and social development in the community (Wegbom et al., 2019). These variations would likely be more evident in the intersectionality of rurality and states, considering that the rural areas are less economically and socially developed. Some states in Nigeria, especially the northern ones, have more rural areas with a higher poverty profile, and the urban areas in the north are not as elaborate as the ones in the south (Adeoti, 2014; Obayelu & Awoyemi, 2010). By accounting for geographic dimension, these results reflect the impact of structural factors on

early childhood survival, and further underscore the importance of accounting for these factors sub-nationally.

Additionally, findings on under-five hazards risk and survival function shown here provides answers to the second research question on survivorship of under-five children in Nigeria. There were higher mortality risks for under-five children resident in the rural areas than those in the urban areas. The finding on association of place of residence with early childhood survival confirms what is in previous studies (Kayode et al., 2012; Wegbom et al., 2016). This rural-urban divide is heightened by the low availability of social and health services in the rural areas (Okoli, Hajizadeh, Rahman, & Khanam, 2020). Results further confirm that under-five deaths are significantly associated with geo-political zones and state of residence, with higher risks for under-five children resident in the North West and North East geo-political zones. In general, analysis show that under-five children resident in the northern states have higher incidence rate of death than those resident in the south. This is similar to what has been established in literature (Adedini, Odimegwu, Imasiku, Ononokpono, et al., 2015; Nwangwu, 2018; Wegbom et al., 2019).

Possible explanations for the higher risks in the North West and North East are seen in differences in maternal education, antenatal care, hospital delivery, and household wealth inequality shown in Chapter Four. For instance, maternal education, which has been confirmed in the literature as a key determinant of early childhood survival, is still low in the north. Less than 30 percent of the children in the north have mothers with up to secondary level education as against the south where more than 50 percent of the children were born to mothers with at least secondary level education. A similar scenario also plays out by measures of maternal care, where a greater proportion of the children in the northern states were either delivered at home and/or born to women who did not receive antenatal care. Indeed, these measured structural factors drive sub-national variations in under-five mortality across Nigeria. According to Adedini, et al. (2015) these under-five mortality risks in the North West are reinforced by the high rate of maternal illiteracy, high parity, women unemployment, and teenage marriage practiced in the zone. Results in this chapter validate the findings from Chapters Four and Five, as well as in the literature, that the northern regions have higher proportions of mothers with primary or no education, as well as higher

proportions of home delivery and low uptake of antenatal care (Antai, 2011b; O. M. Morakinyo & Fagbamigbe, 2017; Olufunke & Obafemi, 2011).

Like what was seen earlier in Chapter Five, the structural factors measured: maternal education, drinking water, toilet facility, electricity, and professional birth attendance, were predisposing factors to the risks of under-five mortality in Nigeria. Previous studies on under-five mortality have also identified these factors (Antai, 2011a; Koffi et al., 2017; Wagstaff et al., 2004). Even though in the multivariate Cox proportional hazards regression models, source of drinking water, toilet facility, and professional birth attendance were not significant, and the significance of household use of electricity on early childhood survival disappeared when the spatial variables were adjusted for, findings on these factors are still very relevant in understanding under-five mortality in Nigeria. Also worthy of note is that the effect of reliable electricity on mortality risks of under-five children in Nigeria is difficult to measure given that steady supply of electricity (hours per day) and voltage stability are still low in the country, thereby denying households the benefits of possessing electricity (Chen et al., 2019).

6.8 Conclusion

This chapter provides answers to research questions one and two by showing the survival pattern of children below five years of age and identifying individual and household level factors that are associated with under-five mortality. The first two years of a child's life have been shown to have more vulnerable risks than the rest. This chapter demonstrates that a suite of factors across geo-political zones and states: maternal age, preceding birth interval, birth size, number of children ever born, marital status, maternal education, electricity, and rural residence, puts children under risk of mortality between birth and five years of age. The detailed spatial analysis of early childhood survival carried out in this chapter is key to increased situational awareness and evidence-based decision making. These spatial gaps, if left unaddressed, can possibly exacerbate existing health inequities. The sub-national under-five mortality gap is driven by cultural, socio-economic, political, and health access barriers that negatively affect maternal and child health. Hopefully, the added value provided by these analyses would help better understand the problem of high under-five mortality in Nigeria and boost effective implementation of programmes. In the quest to provide more contextual

understanding of early childhood mortality beyond the household level, as well as overcoming the limitations in knowledge associated with studies that stop at the individual and household levels, the next chapter further explores the determinants of under-five mortality at the community level by investigating community contextual factors.

CHAPTER SEVEN INDIVIDUAL, HOUSEHOLD AND CONTEXTUAL LEVEL DETERMINANTS OF UNDER-FIVE MORTALITY: A MULTILEVEL ANALYSIS

7.1 Introduction

This chapter presents results from a multilevel analysis of under-five mortality in Nigeria. Having examined sub-national variations in the risks of infant and child deaths and their determinants at the individual and household level in Chapters Five and Six, this chapter explores the degree to which the community level factors explain these differences. Multilevel analysis is well suited to the hierarchical structure of the NDHS data, where the child is nested in the household, and the household is in turn nested in the community. In carrying out multilevel regression models, one can analyse data that have a multilevel structure while accounting for the clustering of lower-level units within higher-level units (Austin, 2017). The impact of factors at the individual and household level (lower-level units) on the risks of under-five mortality is further reinforced by community level factors (higher-level units). Since there have been lots of studies focused on individual and household level determinants, this study is unique in also accounting for the independent effects of community level factors.

Traditional regression models assume that subjects are independent of one another. But for complex sampling surveys such as the NDHS, subjects who are nested within the same higher-level unit are likely to have outcomes that are correlated with one another, thereby violating assumption of the independence of observations. Regression models that do not account for the clustering of subjects across different levels produce biased estimates, hence the use of a multilevel analysis approach here. The within-cluster homogeneity may be induced by cluster characteristics that are unaccounted for, such as socio-economic characteristics of the community, geographic and environmental factors, government policies, religion, culture, and ethnicity (Austin, 2017). These have been shown to affect the outcome of subjects within the cluster (Austin, 2017; Galster, 2012). Basically, this chapter is looking at determinants of under-five mortality above and beyond individual and household levels taking into consideration the broader community contexts.

Guided by the conceptual framework in Chapter Three, this chapter addresses the question: ***To what extent can community-level factors in the country influence child survival over and above individual/household-level factors?*** It has already been established in the literature that the social and environmental setting in which a child is raised affects his/her survival chances, and that household characteristics also moderate the impact of community factors (Adedini, 2013; Antai, 2011b; Galster, 2012; Sastry, 1996). Sastry (1996) found that the association between child mortality risks and community characteristics varied considerably by the level of maternal education. Despite the wealth of literature on under-five mortality in Nigeria, only a few studies have employed multilevel analysis to simultaneously adjust for individual, household, and community level effects (see, for example (Adedini, 2013; Antai, 2011b)). This study builds on those few studies by adopting a similar multilevel approach albeit with more recent NDHS data and including determinants that have not been previously explored (such as community level antenatal care attendance, cost of healthcare, and community level immunisation coverage).

The rest of the chapter proceeds as follows: the next section presents a detailed description of the methods used for the analysis, definition of measures, and bivariate analysis to measure the association of the community level factors of focus with under-five mortality. An explanation of the statistical methods used, and the results are also contained in the methods section. Finally, the discussion and conclusion sections evaluate the findings through the lens of the conceptual framework in Chapter Three and existing literature.

7.2 Methods

A growing number of health studies adopt multilevel analysis for the investigation of associations between community and individual health outcomes (Larsen & Merlo, 2005), and a more nuanced understanding of how broader contextual factors at the community level are important to a child's survival. The approach is well-suited for recognizing the broader social, economic, and environmental backgrounds in which a child lives and experiences a particular health outcome (Adedini, 2013; Griffiths et al., 2004). To illustrate, in their study on selected African and Indian regions, Griffiths et al. (2004) found that background characteristics can create an environment that either reduces or increases the risk of poor health among children of that community in comparison to the risk among children with similar individual characteristics but from a different community. The background

characteristics identified are socio-economic status, cultural beliefs, community services and amenities, access to health care, and the social support of community. This implies that when individuals with similar household characteristics reside in communities with different characteristics, they could have different health outcomes.

Using multilevel analysis, I examine the risks of under-five mortality in Nigeria focusing on the community level factors contained in Table 7.1, while controlling for key individual and household level factors. Dichotomous community variables were created with the selected community level variables and aggregated at the level of the primary sampling units (PSU) to create cluster-level proportions using Stata *'egen'* command.

Table 7.1: Table of measures, definition, and operationalisation of variables

Measures	Definition	Operationalisation
Outcome variable: Indicator of under-five mortality		**Missing values were set to system missing**
Under-five death	Died between birth and death of a child under five years of age	0 = none, 1 = yes
Key independent variables Individual/Household level		
Maternal education	Respondent's highest level of educational attainment	0 = no education, 1 = incomplete primary, 2 = complete primary, 3 = incomplete secondary, 4 = complete secondary, 5 = higher education.
Drinking water	Household's source of drinking water	0 = non-improved sources, 1 = improved sources. "Other" sources were categorised as non-improved facility.
Toilet facility	Type of toilet facility used by household	0 = none, 1 = non-improved type, 2 = improved type.
Electricity	Household has access to electricity	0 = none, 1 = yes

Professional birth attendance	Whether child delivery was handled by a doctor, midwife, or nurse	0 = none, 1 = yes
Community-level variables		
Place of residence	Urban, rural residence	1 = urban, 2 = rural
Geo-political zone	Region of usual residence of the respondent	Six geo-political zones of Nigeria (1 = North Central, 2 = North East, 3 = North Central, 4 = South East, 5 = South South, 6 = South West)
Community poverty level	Proportion of households living in poverty	0 = none, 1 = full
Community secondary level education	Proportion of children in the community whose mothers had at least secondary education	0 = none, 1 = full
Community ANC attendance	Proportion of children in the community whose mothers had at least 4 antenatal cares	0 = none, 1 = full
Community hospital delivery	Proportion of children in the community who were delivered in the hospital	0 = none, 1 = full
Community immunisation coverage	Proportion of children in the community aged 12-23 months with immunisation coverage	0 = none, 1 = full
Distance to health facility	Proportion of children in the community whose mothers perceive distance to a health facility a big problem	0 = none, 1 = full
Cost of healthcare	Proportion of children in the community whose mothers perceive cost of healthcare a big problem	0 = none, 1 = full

The multilevel analysis is undertaken using two analytical approaches. The first, multilevel mixed effects logistic regression, takes both individual/household level and community level clustering into account while also accounting for the complex survey structure of NDHS by applying weights to account for oversampling/under sampling of the survey sample. The multilevel analysis is performed on two levels. At the first level, children nested within

individual women and households are accounted for, while the second level measure households nested within clusters/communities using the Primary Sampling Units (PSU) (see Chapter Four for the details of the sampling design). This analysis is performed in Stata 14.

The second method is Cox proportional hazard regression with frailty. It follows on from the analytical approach used in Chapter Six, but accounts for the hierarchical structure of the data (by paying particular attention to the individual/household and community level factors). This analysis is performed in R-Studio. Both approaches are needed. The first does not account for censoring and the time it takes for the event (under-five mortality) to occur, but accounts for the complex NDHS survey structure. The latter accounts for censoring and the timing of the event but does not account for the complex survey structure[13]. By using both approaches together, which are explored in the following sections, I can account for the NDHS complex survey structure and censoring.

7.2.1 Community level factors associated with under-five mortality

Before proceeding with the multilevel analysis, I first evaluate the association between the community level factors and under-five mortality. Table 7.2 shows significant associations for all the hypothesized community level predictors, except for perception of distance to health facility. Rural (versus urban) residence was associated with higher odds of under-five mortality, as was living in the North East and North West (versus North Central). Living in the South South and South West had lower mortality risks when compared with living in the North Central.

Other factors associated with a higher risk of under-five mortality include a higher proportion of households in a community living in poverty and a higher proportion of women in the community who perceived cost of health care to be a big problem. On the other hand, factors associated with a lower risk of under-five mortality include a higher proportion of women in the community with at least secondary level education, a higher proportion of mothers in the community who had at least four antenatal cares, a higher proportion of hospital deliveries

[13] The use of both methods was necessary because Cox proportional hazard regression with frailty cannot be conducted in Stata, hence the use of R-Studio. Also, there is no current R-package that allows us to fit both frailty and complex survey structure in one command. My correspondence with Prof. Terry Therneau (author of survival package) on 3 Feb. 2022 and Prof. Thomas Lumley (author of survey package) on 10 Feb. 2022 confirmed this.

in the community, and a higher proportion of immunised children in the community. Results here are similar to findings in previous studies on community contextual factors associated with early childhood mortality in Nigeria (Adedini, 2013, 2014; Antai, 2011b). Having explored the unadjusted associations between the community level factors of interest and under-five mortality, the following sections utilize multilevel analysis using the two methods described earlier.

Table 7.2: Bivariate association between community level factors and under-five mortality, Nigeria 2018

	Unadjusted odds ratio	Wald chi2
Rural residence	1.60 [0.04]***	56.21***
Geo-political zones		171.41***
North Central	1	
North East	1.25 [0.12]**	
North West	1.79 [0.15]***	
South East	0.81 [0.09]	
South South	0.72 [0.08]***	
South West	0.70 [0.08]***	
Prop. of households in the community living in poverty	2.24 [0.16]***	133.24***
Proportion of women in the community with at least secondary level education	0.31 [0.03]***	132.58***
Proportion of maternal women in the community who received at least 4 ANC	0.36 [0.04]***	110.19***
Proportion of hospital deliveries in the community	0.34 [0.03]***	156.15***
Proportion of children in the community fully immunised	0.49 [0.05]***	53.04***
Proportion of women in the community who perceive distance to health facility a big problem	1.14 [0.12]	1.74
Proportion of women in the community who perceive cost of healthcare a big problem	1.24 [0.13]**	4.23**

Exponentiated coefficients (odds ratio). Standard errors in parenthesis. * p < 0.05, ** p < 0.01, *** p < 0.001

7.2.2 Multilevel mixed-effects logistic regression method

Mixed-effects logistic regression (melogit) is a logistic regression that contains both fixed effects (measures of association) and random effects (measures of variation) (StataCorp, 2021). The fixed effects are like standard regression coefficients and are estimated directly, while the random effects are not directly estimated but are summarized according to their estimated variances and covariances. Random effects which usually take the form of either random intercepts or random coefficients, and the grouping structure of the data may consist of multiple levels of nested groups (in this case two levels). In the literature, mixed-effects models are also known as multilevel models and hierarchical models. Their commands fit mixed-effects models for different distributions of the response, conditional on normally distributed random effects (StataCorp, 2021; Uthman, Moradi, & Lawoko, 2009).

For a two-level model being adopted in this study, with a binary outcome variable y_{ij}, the melogit model is expressed as:

$$\Pr(y_{ij} = 1 | x_{ij}, u_j) = H(x_{ij}\beta + z_{ij}u_j) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (7.1)$$

Where a series of M independent clusters $j = 1, \ldots, M$, with cluster j consisting of $i = 1, \ldots, n_j$ observations, are conditional on a set of random effects u_j. Vector x_{ij} are the covariates for the fixed effects, like the covariates found in a standard logistic regression model, with coefficients (fixed effects) β. Vector z_{ij} are the corresponding covariates for the random effects and is useful for representing both random intercepts and random coefficients. While $H(.)$ is the logistic cumulative distribution function, used in mapping the linear predictor to the probability of success ($yij = 1$), with

$$H(v) = \exp(v) / \{1 + \exp(v) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (7.2) \text{ (StataCorp, 2021)}$$

Before presenting results with predictors, a baseline model without any exposure variable is first analysed. This baseline model, presented in Table 7.3, is a simple component of variance analysis used to assess the importance of a multilevel analysis. From the output in Table 7.3, the random effects (measures of variation) estimates indicate variations in under-five mortality across clusters/communities, while the fixed effects (measures of association) estimates are specified as odds ratio with associated p-values. As shown in the table, the estimate intercept variance is the variance of random effects. It indicates a 58 percent

significant variation in under-five mortality across communities in Nigeria, which justifies the use of multilevel modeling in this study. This implies that 58 percent of the variation in under-five mortality was due to differences across the communities, the rest was due to variations at the individual/household level.

To understand the contextual implication, the intra-class correlation coefficient (ICC) also known as variance partition coefficient (VPC) is calculated. The ICC[14] is calculated using the linear threshold model method described by a series of scholars (Goldstein, Browne, & Rasbash, 2002; Merlo et al., 2006; Snijders & Bosker, 1999) and is a function of the community level variance. ICC provides measurements for clustering (values range between 0 and 1), where a value greater than zero supports that there is clustering in the data. An ICC of 0.15 shown in Table 7.3 suggests that 15 percent of the variance in under-five mortality could be attributed to the community level factors.

Table 7.3: Multilevel mixed-effects logistic regression model with no explanatory variable to check cluster effect

	Null model
Fixed effects	
Intercept (_cons)	0.93 [0.03]***
Random effects (PSU)	
Estimate intercept variance (var (_cons)) (standard error)	0.58 [0.05]***
ICC	**0.15 (0.01)**
MOR	**2.07**

Exponentiated coefficients (odds ratio). Standard errors in parenthesis. * p < 0.05, ** p < 0.01, *** p < 0.001

[14] ICC makes clear distinction between individual and community level variance, but this is only clear in a linear and multilevel linear regression (in the multilevel linear regression the individual and community level variances are on the same scale). This is not the case however for multilevel logistic regression, which is what this study is using (where the individual level variance is on the probability scale whereas the community level variance is on the logistic scale). Hence, the need to calculate ICC using the linear threshold model that is proposed by Goldstein and others to address this technical complexity with logistic regressions by converting the individual level variance from the probability scale to the logistic scale before calculating the ICC. Therefore, the MOR, which is a more straightforward measure as it translates the community level variance to the odds ratio scale, is also presented in the analysis.

Furthermore, an assessment of random effects is carried out using the median odds ratio (MOR) also known as the residual heterogeneity between communities. It is used to illustrate the extent to which the probability of under-five mortality is determined by community factors and is therefore appropriate for quantifying contextual phenomena (Merlo et al., 2006). MOR throws more light on the difference between clusters by comparing two children with identical background characteristics from two randomly chosen different clusters (Larsen & Merlo, 2005). A MOR equal to one suggests there is no difference between clusters in the probability of under-five mortality (Merlo et al., 2006). One interesting feature of the MOR as against the ICC is that it is directly comparable to the fixed effects odds ratios and is also a function of the random effects parameters (Larsen, Petersen, Budtz-Jørgensen, & Endahl, 2000). From Table 7.3, an MOR of 2.07 suggests strong community level differences, and indicates that community level contextual factors are relevant for understanding variations in under-five mortality in Nigeria. The 2.07 median odds ratio shows (in median) the increased risk of under-five mortality that would occur if moving to another community with a higher risk. By implication, the residual heterogeneity between communities increased by 2.07 times the odds of under-five mortality when two children from different communities were randomly picked. That is, if a child moved to a community with a higher probability of under-five mortality, their risk of experiencing early mortality will (in median) increase by 2.07 times.

Having established the presence of clustering and the need for a multilevel analysis from the results in Table 7.3, individual/household level and community level factors are adjusted for in Table 7.4. Findings in Table 7.4 are useful in assessing the association between community compositional factors (background characteristics of individuals and households within a shared community) and community contextual factors (socio-economic characteristics of the community itself) with the odds of under-five mortality. The accuracy of the random effects is expressed by the associated standard errors, with the Wald Chi-squared test showing whether the covariates contributed significantly to changes in under-five mortality. As shown in the table, the variations across communities shown in the random effects estimates are statistically significant, even after controlling for individual/household level factors in Model 1.

The results suggest that the individual and household level factors within a community accounted for 49 percent of the variance in the risks of under-five mortality across communities. The intra-class correlation coefficient (ICC) in Model 1 further shows that 13 percent of the variation in the odds of under-five mortality could be attributed to the community level factors. Similarly, median odds ratio (MOR) of 1.95 from Model 1 further underscores the important role community level contextual factors play in understanding variations in under-five mortality in Nigeria. As estimated from the model MOR, if a mother moved to a community that has a higher risk of under-five mortality, the likelihood of losing her child to death would nearly double. It is also important to note here that even though the ICC and MOR are related measures, they are not the same. ICC is a function of both the individual residual variance and the cluster variance, while the MOR is a function of only the cluster variance (Merlo et al., 2006).

Moving on to examining the main associations (fixed effects) of individual/household level factors contained in Model 1 suggest that children with mothers with at least secondary level education had lower chances of dying before age five when compared with those with no education. As highlighted in Chapters Five and Six, education raises the socio-economic status of mothers and enables them to make better reproductive and health decisions. Also, results show that children from homes with electricity had lower odds of under-five mortality in comparison to those with no electricity. In addition, children with mothers aged 30-39 were 49 percent less likely to die before the fifth birthday when compared with those whose mothers were below 20 years of age. Furthermore, preceding birth interval of more than two years was associated with decreased odds of under-five mortality, while smaller sized babies at birth were associated with increased odds of under-five mortality when compared with larger sized babies. The results also indicate that the increase in the number of children ever born (more than two) was associated with increased odds of under-five mortality, while marriage and co-habitation was associated with decreased odds of under-five mortality.

Table 7.4: Multilevel mixed-effects logistic regression modelling under-five mortality in Nigeria

Covariates	Model 1	Model 2
Fixed effects		
Individual/household level		
Maternal education		
No education	1	1
Less than primary	0.88 [0.11]	0.91 [0.11]
Primary	0.86 [0.09]	0.92 [0.10]
Less than secondary	0.75 [0.09]*	0.81 [0.10]
Secondary	0.76 [0.09]*	0.87 [0.11]
Higher education	0.66 [0.11]*	0.74 [0.13]
Non-improved source of drinking water	1.00 [0.07]	0.96 [0.07]
Toilet facility		
None	1	1
Non-improved facility	1.15 [0.09]	1.10 [0.09]
Improved facility	0.95 [0.11]	0.99 [0.12]
Has electricity	0.81 [0.06]**	0.88 [0.07]
Professional birth attendance	1.09 [0.09]	1.22 [0.11]*
Religion		
Christian	1	1
Islam	1.17 [0.13]	0.89 [0.14]
Other	0.55 [0.24]	0.48 [0.22]
Maternal age		
15-19 years	1	1
20-29 years	0.61 [0.17]	0.58 [0.16]
30-39 years	0.51 [0.15]*	0.51 [0.15]*
40-49 years	0.57 [0.17]	0.57 [0.16]*
Female	0.92 [0.06]	0.92 [0.06]
Birth interval		
Less than 2 years	1	1
2-5 years	0.53 [0.03]***	0.53 [0.03]***
More than 5 years	0.36 [0.04]***	0.36 [0.04]***
Birth size		
Large/very large	1	1
Average	1.14 [0.07]*	1.17 [0.07]*
Small/very small	1.56 [0.13]***	1.61 [0.13]***
Children ever born		
1-2 children	1	1

3-4 children	1.72 [0.19]***	1.77 [0.20]***
5 or more children	2.66 [0.32]***	2.64 [0.32]***
Married/co-habiting	0.59 [0.08]***	0.57 [0.08]***
Community level		
Rural residence		1.08 [0.09]
Geo-political zones		
North Central		1
North East		0.93 [0.12]
North West		1.21 [0.15]
South East		0.90 [0.14]
South South		0.68 [0.12]*
South West		0.92 [0.15]
Prop. Of households in the community living in poverty		1.16 [0.18]
Proportion of women in the community with at least secondary level education		1.08 [0.26]
Proportion of maternal women in the community who received at least 4 ANC		1.02 [0.18]
Proportion of hospital deliveries in the community		0.58 [0.12]**
Proportion of children in the community fully immunised		0.78 [0.10]*
Proportion of women in the community who perceive distance to health facility a big problem		0.79 [0.13]
Proportion of women in the community who perceive cost of healthcare a big problem		0.99 [0.15]
Intercept (_cons)	0.18 [0.31]***	0.23 [0.40]***
Random effects (PSU)		
Estimate intercept variance (var(_cons)) (standard error)	0.49 [0.05]***	0.46 [0.05]***
ICC	**0.13 (0.01)**	**0.12 (0.01)**
MOR	**1.95**	**1.91**
Wald χ^2	**405.79*****	**473.22*****

Exponentiated coefficients (odds ratios)
Standard errors in parenthesis. * p < 0.05, ** p < 0.01, *** p < 0.001

In comparison to Model 1, the variations of under-five mortality across communities shown in the random effects estimates are statistically significant after controlling for community level factors in Model 2. The full model (Model 2) accounted for 46 percent of variations in the likelihood of under-five mortality across communities in Nigeria. Findings from Model 2 suggest that both individual/household level and community level factors within the communities accounted for these variations. The intra-class correlation coefficient (ICC) in Model 2 further shows that 12 percent of the spatial variation in the odds of under-five mortality can be attributed to the community level factors. In addition, Model 2 returned an MOR of 1.91. From the results, clear changes are observed between the community level variance in under-five mortality between Model 1 and Model 2.

A comparison of the findings between Models 1 and 2 on the different measures of random effects used in this chapter further emphasize that over and above the individual and household level, community level contextual factors also impact on early childhood survival. An indication that programmes aimed at improving maternal and child health should not only focus on mothers and under-five children, but also on improving socio-economic characteristics at the community level that will improve living conditions and access to social and health services.

Additionally, a measure of the main associations of individual/household and community levels factors adjusted for in Model 2 suggests that children delivered by professional birth attendants were 22 percent more likely to die in childhood. As discussed in Chapter Five, the negative impact which can be explained by the poor health care in the country (Akinyemi et al., 2013) and misidentification of professional birth attendants (especially by rural women) is during the infant stage. This counter-intuitive finding is further explored in the discussion section. The results also show that maternal age above 30 years was associated with reduced odds of under-five mortality. Also, birth interval of more than two years and marriage or cohabitation were associated with reduced odds of under-five mortality. In contrast, smaller sized babies, and parity above two children were associated with increased odds of under-five mortality. These findings echo the prevalence of high fertility rate and short birth intervals in Nigeria. As put forward by Adedini, Odimegwu, Imasiku, and Ononokpono (2015), if cultural practices such as early marriage and teenage pregnancy, having higher

order births and short birth intervals are not discouraged, then the regional disparity in under-five mortality in Nigeria will continue.

With regards to the community level factors, children resident in the South South region were 32 percent less likely to die during childhood when compared with those in the North Central. Also, an increase in the proportion of hospital deliveries in the community was associated with 42 percent lower odds of under-five mortality. Delivery in a health facility help in the management of obstetric and pregnancy complications that may arise during delivery, provide a clean and hygienic environment for delivery, and ensure that adequate health procedures are followed (National Population Commission Nigeria [NPC] & ICF International, 2019). In addition, risks of under-five mortality reduced with an increase in the proportion of children in the community immunised. Immunisation has been recognised as one of the most cost-effective public health interventions against childhood illness (NPC & ICF International, 2019)

7.2.3 Cox proportional hazards regression with random effects (frailty models) method

Here we consider censoring while measuring shared frailty in the community using Cox proportional hazards regression with random effects. As highlighted in Chapter Six, survival analysis helps us account for censoring in mortality data. Survival analysis with frailty models reveals the extent to which community contextual factors explain the risks of under-five mortality over and above individual and household level factors. The term frailty model or shared frailty model refers to a survival regression model that includes random effects, association, and unobserved heterogeneity, since similar random effect is shared by all subjects within the same cluster (Austin, 2017; Wienke, 2003). It is a type of mixed effects survival model with only a random intercept (Austin, 2017; Crowther, Look, & Riley, 2014). In a random effect or shared frailty model, it is assumed that frailty is independent across clusters while survival times of individuals in the same cluster are conditionally dependent (Wienke, 2010; Zike, Fenta, Workie, & Swain, 2018). Incorporation of a random effect in the Cox model denotes increased or decreased hazard for a particular group, cluster/community in the case of our study. Cox models that incorporate cluster-specific random effects account for similarity in outcomes within a cluster (Austin, 2017).

The distributions of the individual/household-level and community-level characteristics are examined spatially, to assess how much of the observed sub-national variations in the risks of under-five mortality are attributed to the individual/household-level and community-level factors. Individuals and households within communities share common frailties.

Assuming that subjects are nested in one of N clusters. A Cox proportional hazards regression model with mixed effects can be expressed as:

$$h_i(t) = h_0(t) \exp(\mathbb{X}_j\beta + a_j) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (7.3)$$

Where a_j denotes the random effect associated with the j-th cluster, while the exponential of the random effect (exp (a_j)) is also denoted as shared frailty (Austin, 2017; Rabe-Hesketh & Skrondal, 2008). The random effect is a random intercept that modifies the linear predictor, while the shared frailty term has a multiplicative effect on the baseline hazard function, and this effect varies across clusters:

$$h_i(t) = h_0(t) \exp(a_j) \exp(\mathbb{X}_j\beta) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (7.4)$$

The Cox regression models with mixed effects are identified by the distribution of the shared frailty terms (Austin, 2017). In this study, the gamma distribution which is the most used distribution is used. In the gamma frailty model, the cluster-specific random effects are distributed as the logarithms of independent identically distributed gamma random variables having variance θ (Austin, 2017). In the analysis, θ estimate measures the variance of the frailty distribution, and is interpreted as a measure of unobserved heterogeneity in the cluster (Wienke, 2010). The estimate θ lies between 0 and α, where large variance values suggest high heterogeneity between households (Ayele, Zewotir, & Mwambi, 2017). Furthermore, the within-cluster correlation of subjects which tells the percentage of variance driven by the cluster-specific factors is formulated as $\frac{\theta}{\theta+2}$ (Austin, 2017). In their study on under-five mortality in Ethiopia, Zike et al. (2018) found the gamma frailty model to be a suitable method for investigating under-five mortality.

Similar to the analysis carried out earlier using the mixed-effects logistic regression, a baseline model with no explanatory variable is also used to justify the use of the frailty term. In the baseline frailty model shown in Table 7.5, the frailty distribution for the variance of

random effect is significant. The estimate of θ, which is the variance of the frailty distribution, is 0.36. This suggests that 36 percent of the variance observed in the hazards of under-five mortality in Nigeria can be attributed to variations across the communities. This is considerably lower than the 58 percent inter-community variance seen in Table 7.3 from the baseline model using mixed-effects logistic regression and underlines the use of both methods. Additionally, the corresponding estimate of the within-cluster correlation, which is a similar estimation to the intra-class correlation (ICC) using the mixed-effects logistic regression method seen in the previous sub-section, also supports the presence of clustering in the data. The finding suggests that 15 percent of the variance in under-five mortality was due to community-specific factors. The result is like the ICC estimate from Table 7.3.

Table 7.5: Frailty model with no explanatory variable to check cluster effect

	Null model
Frailty (PSU, distribution)	**1151***
Variance of random effect θ	**0.36**
Within-cluster correlation ($\theta/(\theta+2)$)	**0.15**

Significant at p < 0.05

As shown in Table 7.6, the variance of the frailty distribution across communities, after adjusting for individual/household level factors in Model 1, is still statistically significant when compared with the null model. This further backs up the findings in Table 7.4 that unobserved factors operating in the community are driving the hazards of under-five mortality. Variance of random effect result in Model 1 signifies that the composition of individual and household level factors within a community explained about 20 percent of variations in under-five mortality across communities in Nigeria. Furthermore, the estimate of the within-cluster correlation of under-five mortality, which shows the percentage of risks driven by community level factors, was nine percent. Again, in comparison with the intercept variance and ICC results from Model 1 of Table 7.4 using mixed-effects logistic regression, Cox frailty models returned lower estimates.

With respect to the measures of association (fixed effects) of the individual and household level factors with under-five mortality shown in Model 1 of Table 7.6, children born to mothers with at least secondary level education had lower odds of under-five mortality when

compared with those born to women with no education. Also, in comparison with children in households with no toilet facility, children in households with non-improved toilet facility were 1.13 times more likely to die before age five. In addition to that, use of electricity in the household was associated with reduced odds of under-five mortality. Similarly, children from Islamic homes were 22 percent more likely to die in childhood when compared with those from Christian homes. Furthermore, maternal age above 20 years, female children, birth interval of more than two years, and marriage or co-habitation were associated with lower odds of under-five mortality. While smaller birth size and parity above two children were associated with higher odds of under-five mortality. These results mirror those seen earlier in Table 7.4.

Table 7.6: Multilevel Cox proportional hazards regression of under-five mortality in Nigeria

Covariates	Model 1 HR [SE]	Model 2 HR [SE]
Individual/household level		
Maternal education		
No education	1	1
Less than primary	0.93 [0.09]	0.97 [0.09]
Primary	0.88 [0.08]	0.95 [0.08]
Less than secondary	0.88 [0.09]	0.96 [0.09]
Secondary	0.82 [0.08]*	0.96 [0.09]
Higher education	0.73 [0.13]*	0.81 [0.14]
Non-improved source of drinking water	1.03 [0.05]	1.00 [0.05]
Toilet facility		
None	1	1
Non-improved facility	1.13 [0.06]*	1.07 [0.06]
Improved facility	0.93 [0.08]	0.95 [0.09]
Electricity	0.85 [0.05]*	0.91 [0.06]
Professional birth attendance	1.04 [0.05]	1.21 [0.06]*
Religion		
Christian	1	1
Islam	1.22 [0.06]*	0.95 [0.0.08]
Other	0.59 [0.33]	0.55 [0.33]

Maternal age		
15-19 years	1	1
20-29 years	0.62 [0.22]*	0.59 [0.22]*
30-39 years	0.51 [0.22]*	0.51 [0.22]*
40-49 years	0.54 [0.23]*	0.53 [0.23]*
Female	0.88 [0.04]*	0.88 [0.04]*
Birth interval		
Less than 2 years	1	1
2-5 years	0.62 [0.04]*	0.62 [0.04]*
More than 5 years	0.53 [0.09]*	0.53 [0.10]*
Birth size		
large/very large	1	1
average	1.08 [0.05]	1.10 [0.05]*
small/very small	1.49 [0.06]*	1.54 [0.06]*
Children ever born		
1-2 children	1	1
3-4 children	1.36 [0.09]*	1.39 [0.09]*
5 or more children	2.10 [0.09]*	2.09 [0.09]*
Married/co-habiting	0.65 [0.10]*	0.63 [0.10]*
Community level		
Rural residence		1.10 [0.07]*
Geo-political zones		
North Central		1
North East		1.00 [0.09]
North West		1.22 [0.10]*
South East		0.88 [0.12]
South South		0.68 [0.13]*
South West		0.87 [0.12]
Prop. Of households in the community living in poverty		1.06 [0.13]
Proportion of women in the community with at least secondary level education		1.05 [0.19]

Proportion of maternal women in the community who received at least 4 ANC		1.04 [0.14]
Proportion of hospital deliveries in the community		0.64 [0.17]*
Proportion of children in the community fully immunised		0.74 [0.10]*
Proportion of women in the community who perceive distance to health facility a big problem		0.78 [0.13]*
Proportion of women in the community who perceive cost of healthcare a big problem		1.04 [0.12]
Frailty (PSU, distribution)	**514.59***	**405.40***
Variance of random effect θ	**0.20**	**0.16**
Within-cluster correlation (θ/ (θ+2))	**0.09**	**0.07**
Likelihood ratio test	**1401***	**1343***

HR = hazard ratio; SE = standard error; *Significant at p < 0.05

Again, in comparison to Model 1, the variance of the frailty distribution across communities after adjusting for community level factors in Model 2 is statistically significant. Findings from Model 2 show that the variance of random effect θ is 16 percent. Suggesting that the full model, comprising of individual, household, and community level factors, accounted for 16 percent of the variance in under-five mortality across various communities. Furthermore, the estimate of the within-cluster correlation of under-five mortality in Model 2 is seven percent. An indication that seven percent of the variance in under-five mortality were driven by community level factors. The difference in the variance of random effect and within-cluster correlation between Models 1 and 2, yet again underscores the need to always consider community-level contextual factors in child health programmes.

Additionally, individual and household level factors measured in Model 2 indicate that children delivered by professional birth attendants had 21 percent higher odds of dying before

age five. Again, as pointed out in Chapter Five, this effect is during infancy, and the effect is still noticeable across the childhood period because a higher proportion of children die in the first month of life. Poor primary health care, particularly in the rural areas, has been identified as a key determinant of this unexpected impact of professional birth attendance on early childhood mortality (Adeyinka et al., 2020; Greenwell & Winner, 2014). Also, maternal age above 20 years, female children, birth interval above two years and marriage or co-habitation were associated with lower odds of under-five mortality, while smaller sized babies and parity above two children were associated with higher odds of under-five mortality.

Amongst the community level variables shown in Model 2, Children resident in the rural areas were associated with about 10 percent increased risks of under-five mortality when compared with those in the urban areas. In comparison with the North Central, children in the North West were 1.22 times more likely to die before age five while those in the South South zone were 0.68 times less likely to die before age five. Also, a higher proportion of hospital deliveries in the community reduced the hazards of under-five mortality by 36 percent compared with children living in communities with lower hospital deliveries. Similarly, risks of under-five mortality reduced with an increase in the proportion of immunised children in the community. In line with earlier results with the mixed-effects logistic regression method, hospital delivery and child immunisation are important community level factors that protect children against early mortality. The need to have them accessible to maternal women and children cannot be over-emphasized.

The results also imply that a mother's perception of distance to a health facility as a big problem reduced risks of under-five mortality. As evident in the study, the association between maternal perception of distance to a health facility and under-five mortality suggest that despite the challenge involved, mothers have no other option than to travel long distance, provided they can access a health facility and desired service. It is therefore necessary that government at all tiers in Nigeria increase public investment on the provision of more health facilities, particularly for rural dwellers, to reduce the economic and logistics burden on households.

Findings from the variance of random effects in Tables 7.4 and 7.6 further suggest that not only is a substantive proportion of the spatial variation in under-five mortality explained by the socio-economic and biological composition of individuals and households in the

community, but that clusters within the same geographical environment are also homogenous. Variance results using both methods are less than one. This shows that individuals and households in each community in Nigeria have, to a large extent, similar background characteristics. Previous results from Chapters Four to Six also reflect similarities in structural and proximate factors of individuals and households in any geo-political zone or state. Thus, children residing in the same community will most likely have similar health outcomes, since they are vulnerable to similar contextual influences. It has been established in the literature that children raised in the same community are exposed to similar conditions such as availability of health services, electricity, quality drinking water, good toilet facilities and others (Adedini, 2014). Ethnicity and culture, which encourage homogenous living in the country, have also been found to play key roles in the risks of under-five mortality in Nigeria. Most of the association between ethnicity and under-five mortality is explained by maternal socio-economic and demographic differences such as age, education, preceding birth interval and parity among the ethnic groups (Adedini, Odimegwu, Imasiku, & Ononokpono, 2015; Antai, Wedrén, Bellocco, & Moradi, 2009). Common cultural norms in the communities that influence child rearing practices, like birth spacing and birth order, need to be addressed.

Having assessed the impact of community contextual factors on under-five mortality using multilevel mixed-effects logistic regression and Cox proportional hazards regression with random effects, it can be established that a good proportion of the sub-national variations in under-five mortality in Nigeria are due to variances across different communities. These differences are on two levels: 1) the socio-demographic composition of individuals and households within a community, and 2) the socio-economic characteristics of the community itself. Findings from mixed-effects logistic regression suggest more variation at the community level than the ones from Cox frailty models. Recall that the mixed-effects logistic regression accounts for the complex sampling structure of the NDHS while the Cox frailty models do not, hence the differences. After adjusting for the community level effects in Model 2 of Tables 7.4 and 7.6, results identify geo-political zones, higher proportion of hospital delivery and child immunisation in the community as key community-level contextual determinants of under-five mortality. Given the poor immunisation coverage and high proportions of home deliveries in Nigeria, with the North West as high as 84 percent

(see Chapter Four), government at all levels need to expand strategies aimed at improving maternal and child health care.

In addition, both methods recognize professional birth attendance, maternal age, preceding birth interval, child birth size, number of children ever born, and marital status as key individual level factors associated with the odds of under-five mortality. The case of the association of professional birth attendance with early childhood mortality is also related to the provision of quality health care delivery that needs to be urgently addressed by the government. In the context of Nigeria, results on the association with maternal age, preceding birth interval, and high-order births with under-five mortality echo findings in the literature on practices such as early marriage, frequency of births, and high parity prevalent in the country, especially in the North East and North West geo-political zones (Adedini, Odimegwu, Imasiku, & Ononokpono, 2015; Antai, 2011a; Kozuki et al., 2013).

7.3 Discussion

Using a multilevel approach, this chapter investigated the extent to which community level factors influence early childhood survival above and beyond individual and household level factors. Multilevel analysis was used to account for the hierarchical nature of the NDHS data, because the children are nested within households, and households within communities. Multilevel analysis has provided evidence that the socio-economic characteristics of the community environment are pre-disposing factors to individual health outcomes (Larsen & Merlo, 2005). Two methods, the multilevel mixed-effects logistic regression and the multilevel Cox proportional hazards regression, were applied to 2018 NDHS data regarding community level contextual effects on the risks of under-five mortality.

Measures of variations observed in this chapter underscore the relevance of community contexts in shaping under-five mortality and establishes that the spatial variations in under-five mortality are due to community contextual variation (i.e., the community characteristics) and community compositional variation (i.e., the characteristics of the people living in the community). The patterns of statistically significant random effects results observed with both statistical methods give enough evidence to the existence of unobserved heterogeneity at the community level. This means that explanations focused only on individual and household level composition factors are not sufficient for explaining variations in under-five

mortality across communities in Nigeria. Findings here does not only corroborate previous studies on the influence of community contextual factors on under-five mortality, but also expands the structure used in the previous studies (Adedini, 2014; Adedini, Odimegwu, Imasiku, Ononokpono, et al., 2015; Adekanmbi, Kandala, Stranges, & Uthman, 2015; Antai, 2011b; Fagbamigbe, Afolabi, Alade, Adebowale, & Yusuf, 2019).

This community contextual lens is substantiated by the findings that communities with a higher proportion of hospital delivery were associated with lower risks of under-five mortality. The benefit accruing from a facility-based birth seen in this study agrees with existing literature on under-five mortality. Studies that have explored the influence of the child's place of birth on the risks of under-five mortality have consistently found that place of birth matters (Adedini, 2013; Antai, Wedrén, Bellocco, & Moradi, 2010). Findings from this chapter also lend credence to the importance of improving access to maternal health care services such as delivery care. It further underscores the need to adopt appropriate strategies that will promote child immunisation among women who do not deliver in health care facilities, so that children are not vulnerable to childhood infections and diseases. Results in Chapter Four suggest that there is still high rate of home deliveries in Nigeria, especially amongst women in the North East and North West. According to Ononokpono and Odimegwu (2014) health facility delivery has also been associated with higher maternal age, education, and household wealth status, as well as geo-political zone of residence.

Findings on childhood immunisation in this chapter further suggests that programmes that promote the concept that immunisation is a community norm should be adopted as a measure to help improve the full immunisation of children below two years of age within a community. This position is also supported in an existing literature (Babalola, 2009) and aligns with findings that individual, community, and state level factors influence the risks of children being fully immunised in Nigeria (Adedokun et al., 2017; Antai, 2009). Furthermore, Antai (2009) found that at the community level, the proportion of mothers that had hospital delivery was a pre-disposing factor for full immunisation. Additionally, children who were not vaccinated on the day of contact with the health facility had higher chances of missing out on full immunisation (Adamu, Uthman, Gadanya, Adetokunboh, & Wiysonge, 2019).

The strong effects of maternal reproductive behaviour (mothers below 20 years of age, preceding birth interval and parity) even after the introduction of community factors in the model emphasizes the impact of ethnicity and culture as well as maternal knowledge and attitudes in Nigeria. These results have policy implications for maternal and child health programming in Nigeria. Studies have confirmed that early marriage and early childbearing, too close births, and high parity are prevalent in the North East and North West geo-political zones (Adedini, Odimegwu, Imasiku, & Ononokpono, 2015; Antai, 2011a). Results from Chapter Five also showed that these geo-political zones have the highest under-five mortality rates in Nigeria. Thus, cultural practices that enable early motherhood, too close births, and high parity should be discouraged to reduce sub-national inequality in early childhood survival in the country. A shorter birth interval and high parity may negatively impact on maternal health, increase the chances of infectious diseases, and most likely increase competition for available resources among children in a household (Khan & Awan, 2017; Omariba, Beaujot, & Rajulton, 2007). Further pointing to the need to target maternal education and understanding of safe reproductive health behaviours. Maternal education shapes and modifies economic choices and reproductive health behaviours (Omariba et al., 2007). While education to at least secondary level is strongly advocated for, messages and activities strategically designed to educate mothers and create awareness on safe reproductive health behaviours should also be organized, especially in the rural areas.

The association between professional birth attendance and under-five mortality is still puzzling. It is not yet clear why the presence of a professional birth attendance during birth, which ought to be protective, should be linked with higher odds of mortality. However, findings from Chapter Five showed that the negative effect was in infancy (due to high neonatal mortality) and reversed afterwards. Possible explanations could be the improper identification of community health extension workers (CHEWS), with minimal health training, as professional birth attendants (Adeyinka et al., 2020), and poor knowledge skillset of health care providers (Greenwell & Winner, 2014). Likewise, as mentioned earlier in Chapter Five, many primary health care centres in Nigeria, especially in the rural areas are being managed solely by CHEWS in the absence of doctors, midwives, and nurses. Solanke and Rahman (2018) found that utilisation of skilled birth attendance is very poor in the rural areas of Nigeria. They pointed out the challenge of poor health infrastructure in the rural areas plagued with difficulty in retaining skilled health personnel, unavailability of

midwives, and lack of political will by states and local governments in the country (Solanke & Rahman, 2018). Further qualitative analysis needs to be carried out to gain more insight into this unexpected result.

7.4 Conclusion

The significance of this chapter is that it confirms the importance of community level contextual factors in understanding spatial inequality in under-five mortality in Nigeria. There are unobserved factors within communities that are predisposing under-five children to premature mortality over and above the factors in the households. While efforts to increase hospital delivery and child immunisation in the community could reduce spatial inequities, there are other factors at play that need to be better understood and responded to as well. Community contextual factors impact the quality of life of mothers and under-five children and restrict or enable their access to opportunities and services. Hence, interventions that are not sensitive to community context will most likely yield limited impact.

The results of this chapter confirm the need to reduce individual and community level inequalities in the occurrence of early childhood mortality. Emphasis should be placed on interventions needed to improve key socio-economic characteristics of individuals and communities such as promoting women's education and improving social and health services in the community. Also, specific attention must be paid to the rural areas and the North West. These interventions are expected to have far-reaching impacts in improving early childhood survival outcomes. The importance of these results lies in the need to identify vulnerable groups with high under-five mortality, and to channel interventions appropriately among the Nigerian population with vast geographical dispersion and cultural diversity.

The implication of these findings is that efficient measures to improve early childhood survival would adopt a broader perspective and address pertinent community contextual factors. Community stakeholders should be engaged in such measures that aim to recognise contextual factors that promote under-five mortality, ascertain the resources that foster positive maternal and child health practices, and design and implement appropriate interventions. Effective strategies to improve early childhood survival will have to engage the community while also addressing the individual and household factors that increase risks of under-five mortality. The mechanisms through which wider societal and political

structures promote the unequal delivery of maternal and child health care, thereby enabling sub-national inequities in under-five mortality, need to be evaluated and remedied when planning child health programmes.

CHAPTER EIGHT CONCLUSION

8.1 Introduction

Early childhood mortality in Nigeria has remained stubbornly high over a sustained period, even as it has reduced in other sub-Saharan African countries. In the 2018 NDHS report, the mortality rate increased from 128 deaths per 1, 000 live births to 132 deaths. Under-five mortality rates also vary tremendously across the country. Concerns about the high under-five mortality, coupled with spatial inequality continue to be one of the top population health issues of concern in Nigeria.

This study contributes to the literature and evidence base by providing a detailed examination of the underlying and community level determinants of early childhood mortality in Nigeria. In so doing it marks a significant departure from most studies on the topic which have tended to privilege individual and household factors, leaving community contextual factors relatively unexamined. This study also provides insights into sub-national trends and patterns of under-five deaths over a decade (2008 – 2018). In this concluding chapter I reflect on what the empirical chapters mean in the context of the motivating research questions, and the broader knowledge base on childhood mortality in Nigeria, and efforts to reduce it. I discuss the policy implications, the study limitations, and suggest directions for future research. First, I return to the study's objectives and what motivates this inquiry in the first place.

8.2 Overview of study objectives, questions, and methodology

The goal of this study was to conduct an in-depth analysis of the underlying determinants of under-five mortality in Nigeria, with particular emphasis on the impacts of community contextual factors and socio-economic change. I wanted to move beyond the narrow focus on individual and household level explanations to better understand how and why community context matters, and the potential direct or indirect implications for individual health outcomes. My argument is that the wide sub-national variation in under-five mortality across Nigeria cannot be effectively addressed without considering variation in community context. The study focused on four questions:

1. What are the trends and patterns of under-five deaths in Nigeria?
2. What is the survival pattern of under-five children in Nigeria?

3. What are the determinants of under-five mortality at the individual/household level across various states and geo-political zones in Nigeria?
4. To what extent can community-level factors in the country influence child survival over and above individual/household-level factors?

To answer these questions, I synthesized three frameworks: an analytical framework for the study of child survival in developing countries; the mechanisms of neighbourhood effects; and a framework for the study of access to medical care. An underlying premise of my approach is that while political, socioeconomic, and environmental contextual factors have a strong impact on under-five mortality, and especially spatial variation, these factors are indirect and difficult to measure. Rather than having a direct impact on early childhood mortality, these factors operate through proximate factors which, in turn, impact on a wide range of health behaviours and social services (i.e., household wealth, availability of social and health infrastructure), giving rise to spatial inequities in under-five mortality. The conceptual framework helps to crystallize these complex relationships and impacts on under-five mortality in Nigeria. Nevertheless, the analysis was limited to variables available in the NDHS.

Chapter Two synthesised evidence from previous studies on under-five mortality in Nigeria. It identified a marked north-south divide in the incidence of under-five deaths in the country, with far higher mortality in the north. It also identified the major causes of under-five mortality in Nigeria – neonatal tetanus, malaria, maternal anaemia, diarrhoea, and acute respiratory infection. Health interventions to improve antenatal care include the provision of anti-tetanus injections, anti-malarial drugs, insecticide treated mosquito nets, and iron supplements to pregnant women to reduce health risks, particularly during the neonatal stage (National Population Commission Nigeria [NPC] & ICF International, 2009, 2014, 2019).

The review provides justification for the conceptual approach distinguishing socio-economic (indirect) and proximate (direct) factors associated with risks of under-five mortality (Mosley & Chen, 1984). The literature review showed that most studies do not extend beyond regional level analysis and are thus poorly placed to account for state-level variation. Yet, understanding spatial inequalities is important for understanding the wider Nigerian situation and the lack of improvement in under-five mortality over time.

Similarly, while the review found a plethora of studies on the impact of socio-economic and proximate determinants on under-five mortality in Nigeria, they were largely focused on the proximate factors. Very few explored the community context, and those that did used basic analytical techniques. The result is a significant knowledge gap in terms of the interplay of individual/household and community factors and how they influence a child's health and survivorship (Earls & Carlson, 2001).

Given the limitation of the NDHS in terms of measuring indirect factors and underlying determinants, it is important to set this study within a wider historical and political context. Chapter Three did this, providing a historical account of Nigeria from the colonial regime to the present time. It highlighted how colonial institutions and foreign policies continue to impact on the structure and functioning of Nigeria's health care system and access to it. It also revealed how deep-seated inequities by geographical location, socio-economic status, and availability of social and health infrastructure are not created in a historical vacuum but are the products of government policies, economic and health systems, and socio-cultural structures. This inequity operates through various factors that invariably impact on early childhood mortality, contributing to disparities sub-nationally and across different socio-economic groups. These structural factors (e.g., governance, corruption, culture, and environment) are often challenging to measure but essential to recognise.

8.3 Key findings

8.3.1 Trends and patterns of under-five deaths in Nigeria

Chapters Four and Five showed trends and patterns of under-five deaths in Nigeria using 2008, 2013, and 2018 NDHS data. The results confirmed that deaths in the neonatal period constituted a greater proportion of deaths during the infant stage, with infant deaths at each survey point being more than 60 percent of total under-five deaths. This means that mortality risks during infancy (0-11 months) are higher than mortality risks in the childhood period (between 12-59 months). Findings also echo the lack of progress in improving child survival in Nigeria during the study period. Additional sub-national analysis showed wide-ranging between-zone and within-zone disparities in under-five mortality. While the percentage of under-five deaths declined steadily in the South East, South South, and South West throughout the study period, the reverse was the case in the North Central, North East, and North West from 2013 to 2018. This was an important finding, indicating that the increase

in under-five mortality at the national level from 2013 to 2018 is disproportionately due to the situation in the northern regions.

To illustrate, while infant deaths reduced by 39 percent in the South East, in the North West it increased by five percent. With regards to child deaths, the South South zone mortality rate decreased by 55 percent while the North West only decreased by nine percent. Varying within-zone temporal patterns in incidences of early childhood mortality seen across the study period also confirms the importance of a state-level analysis. For instance, in the South West, Ogun state with more than 70 percent decrease in infant deaths recorded the most progress within the zone while Osun state with more than 80 percent increase recorded the least progress. These details are hidden in studies that only disaggregate to the zonal level.

8.3.2 Survival pattern of under-five children in Nigeria

Having undertaken a granular spatial analysis of under-five mortality, another important contribution of this study was to delve more into patterns of under-five survivorship at the national and sub-national levels using 2018 NDHS data. This provides insights into the critical time points in the first five years when the risk of mortality is highest, and how the distribution of risk varies spatially and across different groups. Generally, the risk of death was highest at birth and in the first month of life. The risk of child death also appears to reduce after the second birthday. In line with this study's findings on sub-national variations in under-five mortality, results from child survival estimates and incidence rate of death also confirm that under-five children in the North East and North West had lower survival probabilities (i.e., higher mortality rates) than their counterparts in the other geo-political zones. Even though the sub-national description mirrors the pattern observed at the national level, under-five children that were resident in the rural areas, North East, and North West had higher hazard rates than those in the urban areas and other geo-political zones. Findings by state further mirror the situation at the zonal level, underscoring the conceptual approach of investigating these variations down to the state level, and challenging the prevailing practice of limiting a study's scope to the zonal level. It is quite alarming that while the results suggest that under-five children in Kebbi (North West) had only about 77 percent chance of surviving the first five years of life, those in Bayelsa (South South) and Ogun (South West) had about 97 percent chance. Generally, I found that under-five children in Kebbi state (North

West) had the highest incidence rates of death while those living in Ogun state (South West) had the lowest.

8.3.3 Determinants of under-five mortality at the individual/household level across various states and geo-political zones in Nigeria

The study identified the determinants of under-five mortality at the individual and household levels from Chapters Five and Six, so that strategies can be effectively targeted. Maternal education, place of residence, geo-political zone, state, antenatal care (ANC), professional birth attendance, alongside other well-known proximate factors such as maternal age, sex of child, birth interval, child's size at birth, number of children ever born, and marital status played more crucial roles in predicting under-five mortality than source of drinking water, toilet facility, and electricity. However, a contradictory result where professional birth attendance was associated with increased risks of infant mortality was also observed. Prompting the need for a qualitative study to further investigate it. The findings on the association of these study variables with under-five mortality makes more sense when compared with the sub-national distribution of children by the study variables, an indication that they play significant roles in the variations in under-five survival outcomes across the country. They show that the clear inequality in under-five mortality by state cannot be considered in isolation from the background characteristics of the states. Sub-national differentials in under-five mortality are partly explained by differences in socio-economic, nutritional, environmental, cultural, and behavioural characteristics (Adedini, Odimegwu, Imasiku, Ononokpono, et al., 2015; Joshua Odunayo Akinyemi et al., 2015; Antai, 2011a; Antai et al., 2009).

For instance, the prevalence rate of female illiteracy was higher in the north than in the south. The North West consistently had the highest levels of female illiteracy over the focal period from 78 to 73 percent while the South East with seven to three percent had the lowest. I found that across states, Sokoto (North West) at 93 percent had the highest proportion of children born to women with no education in 2018 while Imo with (South East) less than one percent had the lowest. Education is a major aspect of economic and social development and is strongly associated with different socio-demographic factors such as income, lifestyle, fertility, and health behaviour. Wealth inequality was also more prevalent amongst the northern states than the south. The pattern continued with results on maternal health care. A

high proportion of the children were also delivered outside a health facility. The highest proportion of home deliveries by state was Sokoto's (North West) 92 percent, while Imo's (South East) five percent was the lowest. Taken together, sub-national variations in access to maternal health care are reflected in early childhood survival outcomes in Nigeria. Adding an additional layer of knowledge to the situation at the states.

Given how important it is for a child below two years to be fully immunised, it was pertinent to examine immunisation coverage across the country and see if it compared with under-five mortality. At the end of the survey period, the North West had the lowest vaccination rate (20%) while the South East (58%) had the highest. Only six states (all in the southern zones) had up to 50 percent immunisation coverage. I also found that there is a need to prioritise universal access to maternal and child health care in Nigeria. The high percentage of children (30% at the zonal level) that had diarrhoea without receiving medical treatment as reported in the 2018 NDHS, coupled with the growing preference for chemists/shops as against health facility by mothers led to further investigation of health care access and the National Health Insurance Scheme (NHIS) coverage. Findings indicate that a large proportion of women still found distance to a health facility and cost of medical treatment challenging. Further investigation on this reveals that NHIS coverage is still very low in Nigeria. The North East with only one percent had the lowest NHIS coverage, while the South West with only three percent had the highest. With only about 11 percent, Sokoto (North West) and Abia (South East) report the highest NHIS coverage in the country in 2018. These findings thus suggest that access to affordable and accessible health care is still a burden on households in Nigeria. In line with the results here, Koffi et al. (2017) found the main barriers to access to health care in Nigeria to be cost of care, transportation, and distance.

8.3.4 Impact of community-level contextual factors on child survival over and above individual/household-level factors

This study further found from applying a multilevel lens in Chapter Seven that community level factors influence under-five mortality above and beyond individual and household level factors. Generally, there were substantial sub-national variations in the study variables across the country. Hence, living in different communities in Nigeria seem to significantly influence variations in under-five mortality between and within communities. I found a big difference in the level of variations in the risks of under-five mortality due to differences across

communities when applying the two multilevel analytical methods. Although both methods showed that a significant proportion of the risk was solely driven by factors at the community level, confirming the relative importance of community context. Thus, community infrastructures are relevant contextual factors that might influence early childhood survival. This study also found that there are increased risks of under-five mortality when moving from a community with higher survival probabilities to one with lower survival probabilities.

Contextual factors such as community hospital delivery and full immunisation played crucial roles in reducing under-five mortality when compared with communities with low hospital deliveries and immunisation coverage. Consequently, differences in health care contexts are vital contextual determinants of sub-national variations in under-five mortality in Nigeria. These proximate factors in the community are important because they impact directly on the survival outcomes of the child and need to be addressed accordingly. However, I also found that there are unmeasured factors in the community that are driving under-five mortality. This underscores the argument in the conceptual framework about the difficulty in measuring government policies and socio-cultural factors, thereby raising awareness to them. The study also found that place of residence (rural-area disadvantage) and geo-political zones impact on the risks of under-five mortality. The characteristics of the community contexts in the North West seem to intensify under-five mortality risks while the community contexts in the South South appear to ease the risks of under-five mortality.

8.4 Implications for policy and future research

This study has several implications for policy recommendations in Nigeria and future research in the field of maternal and child health. First, this study has recognised that the high rate of under-five mortality is largely due to high infant mortality, particularly in the first month of life. Hence, there is a need to expand programs targeted at protecting children during the first year of life. While policymakers and programme implementers need to prioritize action in the north, they should also take a community-level approach across all states. Findings from this study suggest that policies aimed at addressing teenage pregnancy and early marriage, child spacing and family planning, number of children born (high fertility rate), as well as indirect factors that result in small sized babies will also prove useful in achieving substantial reductions in early childhood mortality. Ill health, maternal malnutrition, and poor health care during pregnancy can lead to low birth weight.

Second, this study has shown that the factors that impact on early childhood survival are not limited to the household but extend to the broader socio-economic context in the community. Hence, accounting for community level factors in programming is as important because different social ecologies act differently on individuals and households, even if they have similar socio-economic status. This study suggests that if Nigeria is serious about meeting SDG 3.2, then maternal and child health programmes should incorporate contextual factors at the communities, especially policies that improve the accessibility of health and social services such as hospital delivery and child immunization. A key action plan would be for the government to seriously consider providing free health services to mothers and children below five years of age to reduce preventable deaths to the barest minimum. Also, governments at all levels should scale up plans for even socio-economic development across the country to reduce inequalities in under-five mortality, with concerted efforts made to address rural-urban differentials in the delivery of social and health services. The impact of community level contextual factors on early childhood survival, especially those not measured in this study such as socio-cultural factors, government policies, and access to quality health care, also need to be further explored qualitatively.

Third, findings across states should create more conversation aimed at addressing observed spatial variations in under-five mortality across the country. Most studies have focused on studying under-five mortality at the geo-political zones, and the assumption has been that the risks of under-five mortality is similar in each zone. This study clearly shows that even though states within a geo-political zone have some level of homogeneity, there still exist within-zone variations in the occurrence of under-five mortality. Additional trend analysis also revealed that states performed differently during the period under review. While under-five mortality in some states declined from 2008 to 2018, it increased in several others. To this end, if policies and interventions are not designed and implemented to address sub-national variations in under-five mortality at the state level, then under-five mortality levels in Nigeria would most likely continue to be high. Socio-economic and demographic gaps in the composition of individuals, households, and communities at the states that are creating these inequalities in early childhood mortality should be addressed, otherwise the inequalities will persist. More importantly, factors such as maternal education and reproductive behaviour, teenage pregnancy, and quality maternal and child health care need to be critically addressed. Strategies that target contextual factors at the state-level that exacerbate under-

five mortality risks must also be expanded. This study further suggests that child health interventions that are not just targeted at the zonal level but stepped down to the state level would most likely be more effective.

Fourth, the identification of the socio-economic factors contributing to the sub-national inequality in under-five mortality in Nigeria deserve to be further investigated. To this end, factors such as professional birth attendance, availability of electricity in the household, distance to a health facility, cost of health care, and quality of care should be explored in a qualitative study since the information available in the NDHS dataset are not enough to unpack further. With regards to professional birth attendance, the knowledge, and skills of maternal and child health care providers, especially those in the primary health centres, should be reviewed. Another way forward would be to trace the impact of major policies and crises in the country, along with sub-national changes in under-five mortality and socio-economic factors.

Fifth, while the government has emphasized that immunization should be available to children below two years of age, and even makes it available for free, this study found that a greater percentage of the target population are still not immunized. This study advocates that instead of just rolling out annual immunization campaigns that are not reaching the end-users, adequate measures should be put in place at the grassroots to ensure that the children are reached. This study also recommends that measures such as education of women, adequate sensitization at the rural areas, and proper management of supply chain of immunization services (vaccines, cold chain for storage, and health personnel) at the primary health care centres should be properly addressed. A qualitative study on the low uptake of immunization would also provide additional valuable information.

Finally, given that it was difficult to measure the effect of government policies, socio-cultural factors, and assess health service providers with NDHS data, I recommend further qualitative investigation using this study's framework to provide more insight into spatial inequity in early childhood survival.

8.5 Limitations of study

Studies of mortality in developing countries with poor administrative register and vital statistics inevitably face data limitations. DHS surveys are thus an important evidence base, providing a critical data source on population health. However, while the DHS programme provides quality survey data through continuous quality assurance and control procedures, as well as through transparent data files and survey methods description (Fabic, Choi, & Bird, 2012; Ties Boerma & Sommerfelt, 1993; Van Malderen et al., 2019), there are still significant limitations that should be borne in mind when interpreting the results of this study.

1. Given that this study is based on cross-sectional secondary datasets collected retrospectively, it is subject to under-reporting of child deaths due to recall bias or the reluctance of respondents to speak about their dead children. Similarly, there is also a high possibility of misreporting a child's age at death, especially in months, leading to age heaping which can alter the age pattern of under-five mortality. Omission and misreporting can affect levels and patterns of under-five mortality. However, due to the data quality assessment done for 2008, 2013 and 2018 NDHS data, which indicated that these surveys produced far more reliable mortality data compared to the earlier surveys, it is not envisaged that the data limitations mentioned here will pose a serious challenge to this study.

2. The multilevel analysis in this study used clusters or primary sampling units (PSU) as a proxy for community/neighbourhood, which may lead to data biases because of misclassifying respondents into wrong administrative boundaries (Adedini, 2014; Antai, 2011).

3. The DHS sample does not include child mortality datasets for deceased mothers. This could introduce some bias in child survival outcomes in Nigeria since the sample is not exhaustive. But then, they do not constitute a large component of any datasets in Nigeria and should not change the results in this thesis significantly if captured. Nonetheless, given that mothers are primary care givers, the important interaction between maternal mortality and early childhood mortality should not be overlooked. This, however, calls for further investigation into the survival outcomes of children with deceased mothers in Nigeria.

4. Information on electricity was only collected on the availability of electricity in the household and not on the frequency of usage, which made it difficult to measure whether electric power was supplied for households to use.

5. Some important structural factors such as distance to health facilities, cost of healthcare (proxies were only used), and those pertaining to cultural practices and norms were not available and could not be accounted for in the study.

6. Information on immunisation coverage and access to medical treatment for a sick child were collected only for children alive at the time of the survey and not on all children ever born. This made direct analysis between these factors and early childhood mortality impossible. However, sub-national differences in immunisation coverage and access to medical treatment for a sick child were examined.

7. There is currently an analytical challenge when combining NDHS complex survey design and survival analysis with random effects (multilevel analysis). To limit the effect of this methodological limitation on this study, parallel comparable analyses were done both in Stata and R. Multilevel mixed-effects logistic regression with NDHS complex survey design was done in Stata while Cox proportional hazards regression with random effects (without NDHS complex survey design) was carried out in R.

8.6 Contribution to knowledge

Despite the unavoidable caveats, the findings from this thesis address important knowledge gaps around the way under-five mortality is studied in Nigeria. Most studies on under-five mortality in Nigeria have been focused on individual and household explanations rather than the external socio-economic contextual conditions at the community that modify the impacts of the individuals and households. Presently, this thesis is the most comprehensive study ever conducted using NDHS for Nigeria.

The use of the complex multilevel analysis approach has helped to highlight the multidimensional realities of under-five survival. It has also illustrated the limitation of relying only on a single level analysis at the individual/household level, and the need to further extend the scope and range of inquiry on under-five mortality. No child can exist in

isolation of the community contextual factors. The clear association of factors at the community level with under-five mortality also reflect inequalities in the wider social structure (especially by rural/urban residence and states), as well as identifies the interplay between individual/household and community level factors. More so, this thesis has lent its voice to studies aimed at improving maternal and child health programming, in the quest to end preventable deaths of new-borns and under-five children.

State-level analysis of under-five mortality and socio-economic factors, with associated patterns and trends, has highlighted the realities on ground at the micro level, and has also underscored the limitation of relying only on zonal level analysis. It is hoped that this more granular spatial analysis will provide policy makers and implementers with novel knowledge of state-specific problems to achieve better results in maternal and child health programming. Also, the use of a survival analysis to describe in detail under-five survival function and relative risk of under-five death at the sub-national level is new in the literature.

Information on the possible socio-economic drivers of child immunization provided in this study provides substantive knowledge in attempting to explain the low immunization coverage across the country. Despite ongoing efforts by the government to develop strategies and programmes that provide free immunization to eligible children, there is sufficient evidence that the programmes have not been effective given the wide-spread low immunization coverage. Gaps identified in the delivery chain include poor maternal socio-economic status, rural residence, and poor health care delivery.

This research also filled the gap on the quality of antenatal care (ANC) women received during pregnancy by examining if their blood pressure, urine, and blood were checked. These examinations are important as they help for early detection and management of neonatal tetanus, malaria, and maternal anaemia, which are currently among the leading causes of under-five mortality in Nigeria. Findings showed that more than 70 percent of pregnant women who attended ANC had their blood pressure, urine and blood checked. However, the challenge still lies with the high percentage of pregnant women in the North Central, North East, and North West who did not receive any antenatal care. There is also plenty of opportunity for a bigger focus on antenatal care in future studies given the limited information from the NDHS questionnaire.

8.7 Concluding remarks

Under-five mortality in Nigeria is persistently high, so much so that only a minimal decline was observed from 2008 to 2018, at odds with improvements occurring elsewhere. Children below the age of five are exposed to risks of avoidable deaths due to maternal and child factors, as well as poor social and health services in the country. Identifying these predisposing factors at the micro-level is important to guide research and strategies aimed at reducing sub-national (and by population subgroups) inequality in under-five mortality in Nigeria. This thesis balanced the often-excessive focus on the individual and household level with broader scope and equity aspects of socio-economic change and health services. The goal is to provide useful results for policies and programme implementations in Nigeria. The large sample size of Nigeria Demographic and Health Survey allowed for extensive analyses of different socio-demographic subgroups and community differentials. Besides that, the sample design and survey methodology of the NDHS provided an important opportunity for measuring the association between individual, household, and community level factors on under-five mortality in Nigeria.

This study established that the marked sub-national inequality in under-five mortality is driven by variations across communities in Nigeria. These variations are evident in the community contexts as well as in the composition of individuals and households. I found that there is need for initiatives to increase women's education, especially in the northern regions and rural areas to influence better health choices. Community-based initiatives aimed at improving uptake of maternal health services and child immunisation should also be targeted. Further attempts should also be made to discourage unhealthy cultural practices that enable early motherhood, short birth interval, and high parity. Findings from this study should not be ignored because they have raised awareness to critical issues that permeate the persistently high under-five mortality, and sub-national inequality, in Nigeria.

This study also showed that under-five deaths pattern, trend, and determinants at the state level differ from those at the national and zonal levels and that such differences do, in fact, matter. To that end, I hope that this study helps to inform evidence-based initiatives to reduce under-five mortality and advance maternal and child health and overall wellbeing in Nigeria. Increasing action plans that incorporate economic and social structures in the community in

child health programmes would yield sustainable results in improving early childhood survival.

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Appendices

Appendix A

Table A. 1: Chronological history of Nigeria

Period	Event
9000 BCE	Late Stone Age evidence of indigenous habitation in Iwo Eleru rock shelter in southwestern Nigeria.
600 BCE	Evidence of iron technology used by Nok civilization, near present-day Abuja.
1000–1500 CE	Foundation of centralized states such as Kanem, Borno, Benin, Ife, Oyo, and the Hausa city states.
1100–1400 CE	Introduction of Islam into savanna and Sahelian states of Northern Nigeria.
1300–1600	The ‘‘golden age’’ of the trans-Saharan trade. Gold, slaves, and other commodities are traded from the states of northern Nigeria across the Sahara Desert to the states of the north African littoral, Europe, and the Middle East. The trans-Saharan trade continued through the nineteenth century, but in a diminished capacity after the rise of direct trade with Europeans on the coast in the fifteenth century AD.
1450–1850	Contacts with Europeans on the coast brought about monumental changes to the political, economic, and social institutions of southern Nigerian states. The trade in slaves dominates relations between Nigerians and Europeans at this time, changing forever the histories of four continents as goods and people engaged in a growing transatlantic trade.
1804	Beginning of Islamic revolution that results in the creation of the Sokoto Caliphate in northern Nigeria. The Sokoto Caliphate expands the frontiers of Islam and spread the religion beyond the ruling classes to common people to a greater extent than existed previously.
1807	British abolition of the slave trade. Although the trade in slaves continued from southern Nigerian ports for another forty years, trade in palm oil and other forms of ‘‘legitimate’’ commerce expands rapidly from this point.
1833	Final collapse of Oyo empire, which marked the beginning of 60 years of instability and war among Yoruba states in the southwest.
1841	The Niger Expedition marked the first attempt by Europeans and African Christians to spread Christianity into the interior of Nigeria. In 1846 Church Missionary Society (CMS) missionaries established a mission at Abeokuta; from that point Christianity spread rapidly in southern Nigeria for the first time. A new elite emerged in the south, educated in European mission schools, and sharing many European cultural attributes. Christianity and Islam have since become the two dominant religions in Nigeria.
1861	British annexed Lagos as a Crown Colony.

1885	Establishment of the Oil Rivers Protectorate in Southeastern Nigeria, renamed the Niger Coast Protectorate in 1893.
1886	Formation of the Royal Niger Company (RNC), which monopolized trade in the Niger basin until the revocation of its charter in 1900. In the same year a peace treaty was signed, ending the prolonged war among the Yoruba-speaking peoples of the southwest.
1887	King Jaja of Opobo was exiled to the West Indies for abrogation of Treaty of Protection.
1893	Establishment of a British protectorate over Yoruba territories in the southwest.
1894	Revolt of Brassmen against the Royal Niger Company. In the same year, Nana, the Itsekiri governor of the river Benin, was deposed and deported for hindering British access to interior markets.
1898–1909	Ekumeku underground resistance movement fought against the RNC and British colonial rule.
1900	Creation of the Protectorate of Northern Nigeria. Extension of the northern protectorate was concluded in 1903, when British forces conquered the Sokoto Caliphate and killed the Sultan.
1902–3	The Aro Expedition, part of the British effort to ‘‘pacify’’ the hinterlands of Eastern Nigeria.
1908	Protests in Lagos against the water rate, fueled by the reporting of Nigerian journalists such as Herbert Macaulay, often dubbed the ‘‘father of Nigerian nationalism.’’ Macaulay and other journalists used newspapers to report on and critique the performance of the colonial government.
1914	Amalgamation of northern and southern protectorates. Before this time, there were over 350 cultural, ethnic, and linguistic groups that lived in kingdoms and emirates with sophisticated systems of governance, such as the Oyo, Benin, Nupe, Jukun, Kanem-Bornu, Hausa-Fulani empires, Igbos, Ibibios, Ijaws, and Tivs amongst others, who still claimed their own separate language, heritage, and culture even after being called a nation-state.
1914–18	Nigerian troops aid the British cause in the First World War.
1923	Establishment of the Clifford Constitution, which allowed for elected representation in the governance of Nigeria for the first time.
1929	Aba women riot, a major protest against British indirect rule in Southeastern Nigeria took place.
1944	Nnamdi Azikiwe founded the NCNC, the National Council of Nigeria and the Cameroons (later Nigerian Citizens), which immediately became an influential political party that pushed for the independence of Nigeria from British colonial rule. In the same year Mrs. Olufunmilayo Ransome-Kuti founded the Abeokuta Ladies' Club, later renamed the Abeokuta Women's Union (AWU), to lobby against the injustices of colonial indirect rule.

1945	Nigerian labour unions organized a general strike that brought work and business to a standstill. The strike precipitated important economic changes in the form of the first Ten Year Plan, adopted later the same year.
1946	The Richards Constitution was enacted, it provided a central legislature and divided Nigeria into three regions: North, West, and East. This is the first set of constitutional reforms that led to independence for Nigeria.
1948	First university in Nigeria established in Ibadan.
1949	Northern People's Congress (NPC) founded under the leadership of Tafawa Balewa, Aminu Kano, and Ahmadu Bello, the Sardauna of Sokoto.
1951	The MacPherson Constitution amends the Richards Constitution, moving Nigeria closer to independence. In the same year the Action Group (AG), a Yoruba-dominated political party in the southwest, was founded under the leadership of Obafemi Awolowo.
1954	The Lyttleton Constitution established a federal system of government for Nigeria.
1956	Petroleum discovered in the Niger delta region.
1957	Regional self-government attained in the East and West.
1959	Regional self-government attained in the North.
1960	Nigeria becomes independent from the United Kingdom on October 1.
1963	Nigeria becomes a republic, replacing the queen with an indigenous president as the symbolic head of state.
1966	A military coup on January 15 brought down the First Republic and installed General John Aguiyi-Ironsi as head of state. Countercoup on July 29 brought General Yakubu Gowon to power.
1967	Emeka Ojukwu declared independence of Eastern Region as the sovereign Republic of Biafra on May 30. In the same year Gowon created twelve states out of the existing three regions. From this point, there was constant clamour for the creation of more states. Since 2000 Nigeria has been made up of thirty-six states and a Federal Capital Territory (FCT) at Abuja, with 774 Local Government Areas divided into North Central, North East, North West, South East, South South, and South West geo-political zones.
1967–70	Civil war between the forces of the Federal Military Government (FMG) and Biafran separatists. War ended with the surrender of Biafra on January 12, 1970, and the reincorporation of Biafra into Nigeria.
1971	Nigeria joins the Organization of Petroleum Exporting Countries (OPEC).
1973	Rising price of oil resulted in a booming economy for Nigeria. Since this time Nigeria has been heavily dependent on its oil exports to supply government revenues.

1975	The Gowon regime was overthrown in a coup on July 30. General Murtala Mohammed becomes the new head of state.
1976	General Mohammed was assassinated on February 13 in an unsuccessful coup. And his deputy, Lieutenant General Olusegun Obasanjo, took over as head of state.
1979	Political power handed to civilian administration of the Second Republic under President Alhaji Shehu Shagari. The Second Republic presided over a declining economy as the oil boom was followed by an oil bust.
1983	Second Republic overthrown in military coup of December 31. General Muhammadu Buhari becomes head of state.
1985	General Ibrahim Badamasi Babangida overthrew the Buhari regime on August 27. Under Babangida the Nigerian economy continued its decline and saw the implementation of Structural Adjustment Programme (SAP).
1991	The Federal Capital Territory was moved from Lagos to Abuja.
1993	A presidential election was held on June 12 to decide the civilian successor to Babangida. Chief M. K. O. Abiola, a Yoruba Muslim from the southwest won what has been called the freest and fairest election in Nigerian history. Disappointingly, the election results were annulled, which threw the country into chaos. Babangida handed power to an Interim Governing Council (IGC), led by Chief Ernest Shonekan, on August 27. On November 17 the IGC was overthrown by General Sani Abacha, who became the new head of state.
1994–8	Under Abacha Nigeria became an international pariah state. Abacha refused to recognise the election of June 12, 1993, and used violence and manipulation to suppress dissent.
1995	Ken Saro-Wiwa and other members of the 'Ogoni Nine' were executed. The executions became a symbol of the tyranny of the Abacha regime and resulted in international protest and condemnation.
1998	Abacha died on June 8, and power was transferred to General Abdulsalami Abubakar, who organizes a quick transition to civilian rule.
1999	The Fourth Republic commenced with a democratic civilian rule under the leadership of President Olusegun Obasanjo.
2006	National Population and Housing Census was conducted, with Nigeria's population recorded at over 140 million.
2007	Inauguration of President Umaru Yar'Adua on May 29, this transition marked the first time in Nigeria's history that power was transferred from one civilian regime to another.

Source: Davis & Kalu-Nwiwu, 2001; Falola & Heaton, 2008; Josephson, (2017)

Appendix B

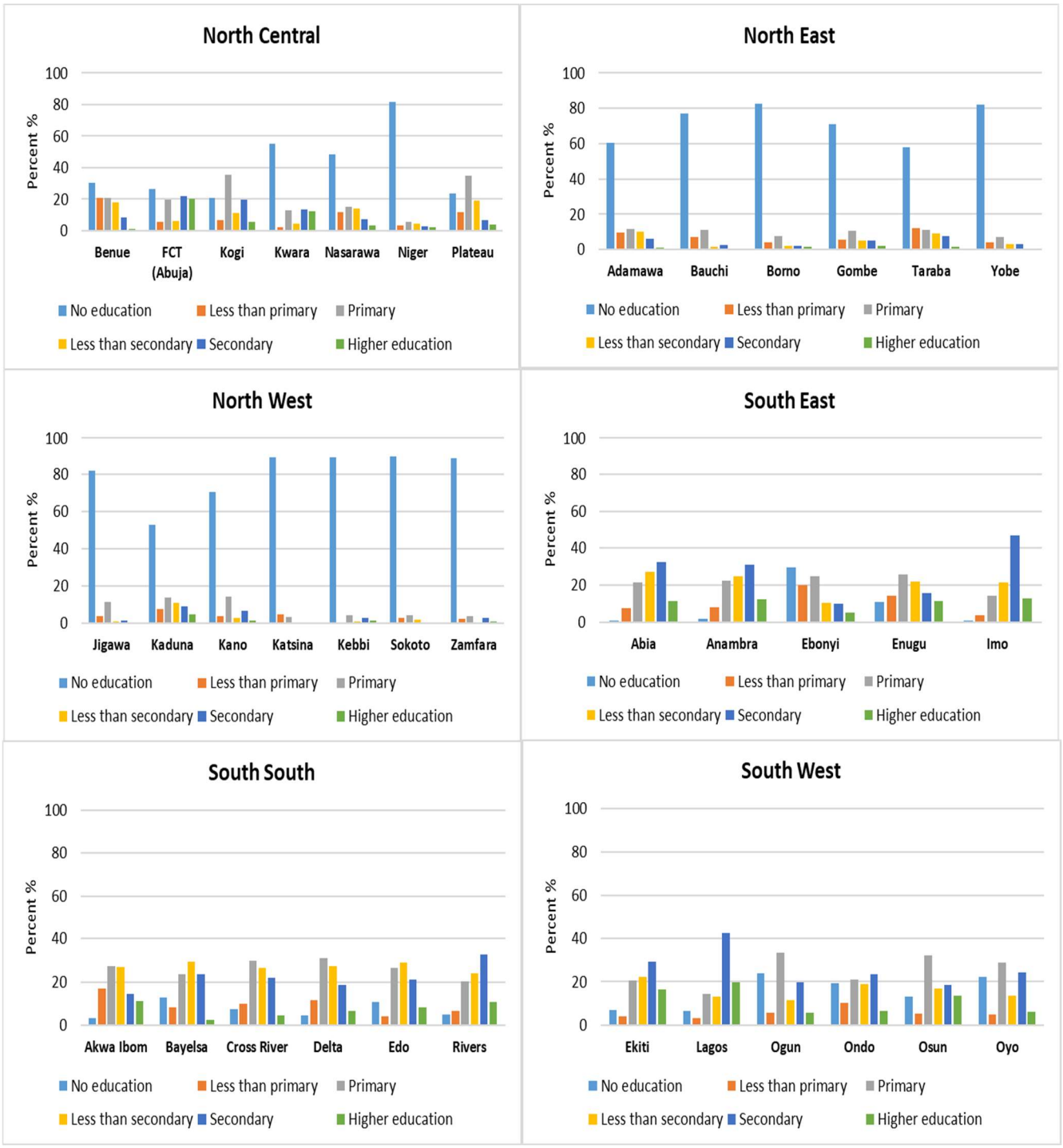

Figure B. 1: Distribution of children born in the five years preceding 2008 NDHS by mother's educational attainment and state, Nigeria 2008

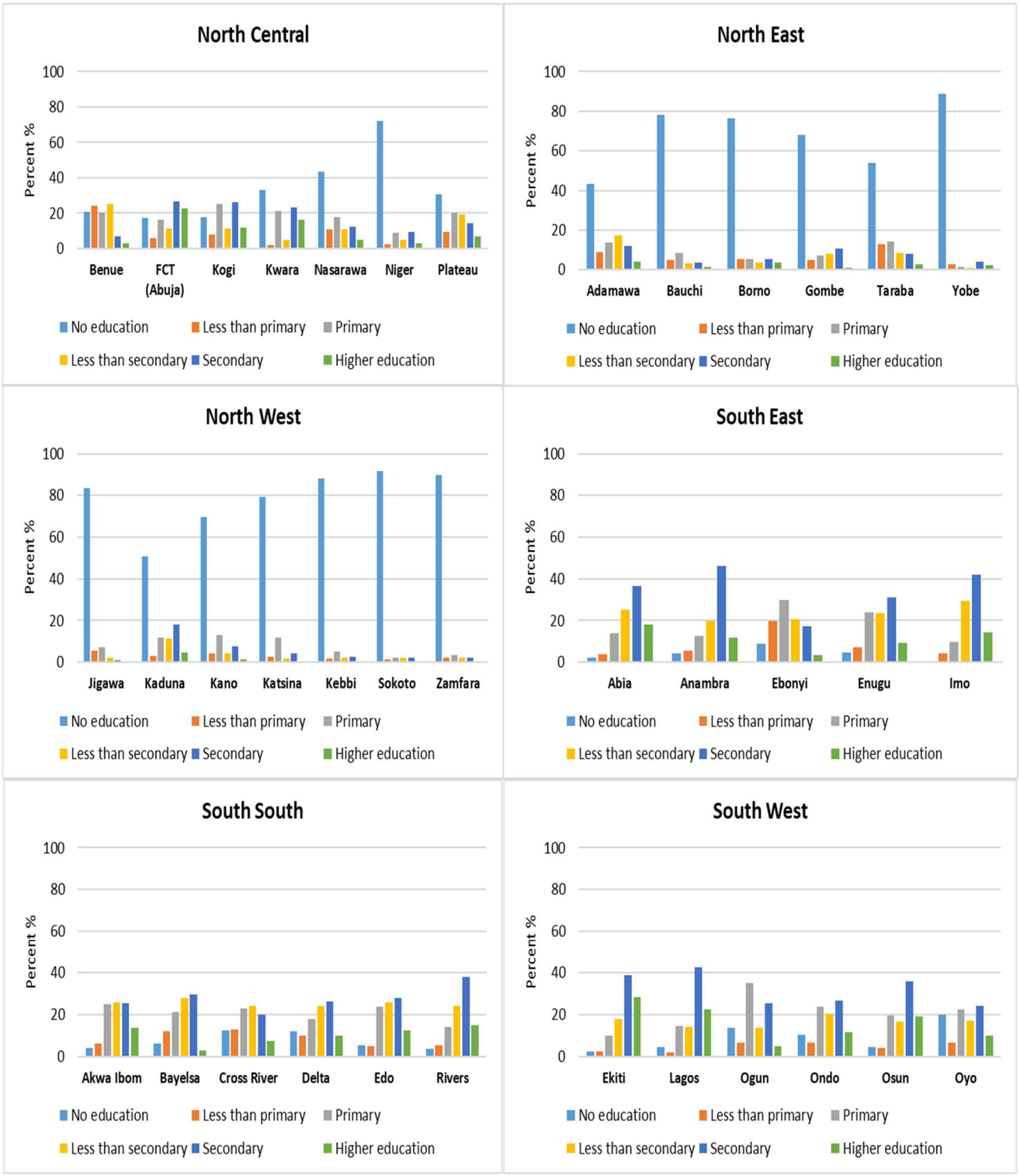

Figure B. 2: Distribution of children born in the five years preceding 2013 NDHS by mother's educational attainment and state, Nigeria 2013

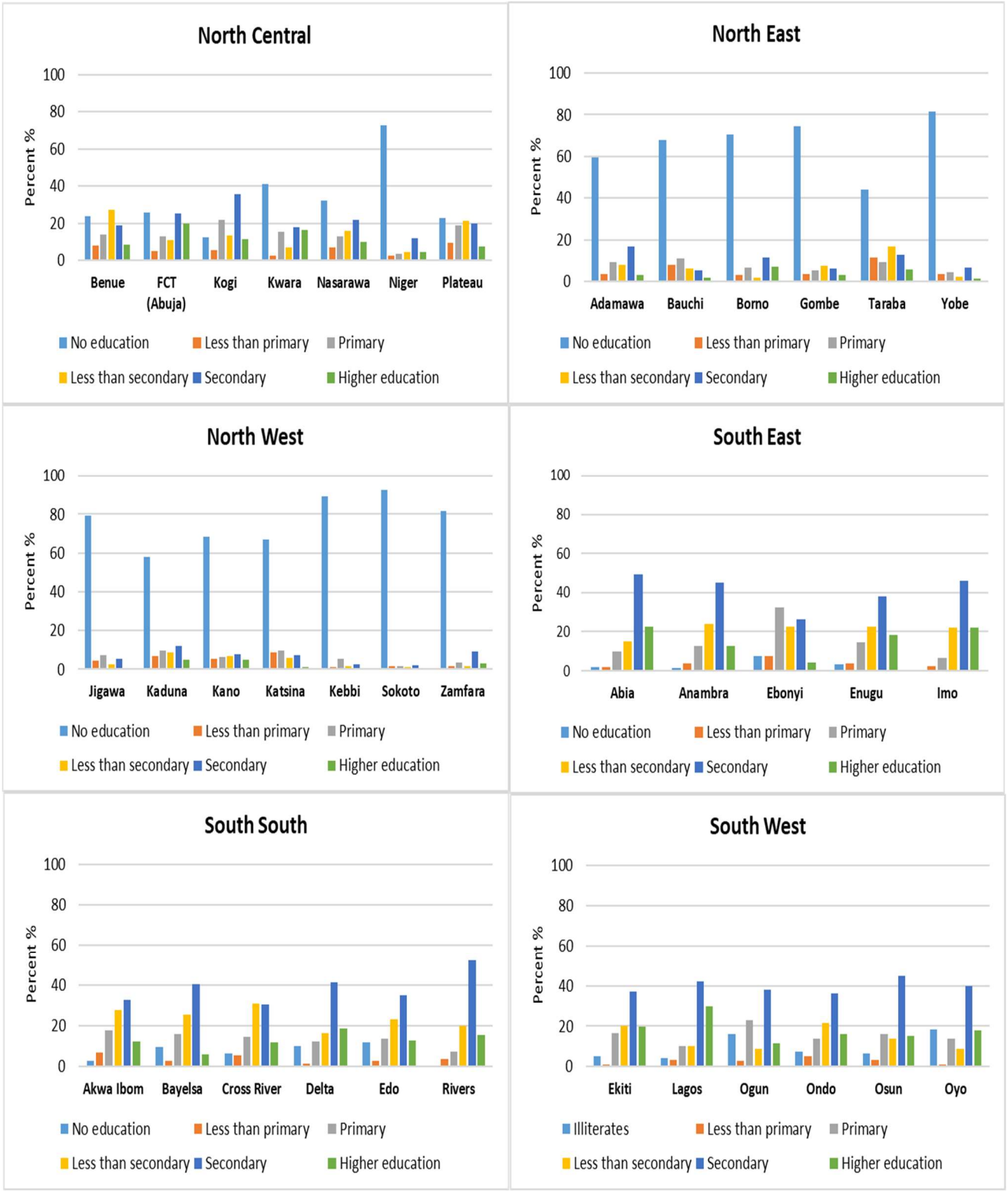

Figure B. 3: Distribution of children born in the five years preceding 2018 NDHS by mother's educational attainment and state, Nigeria 2018

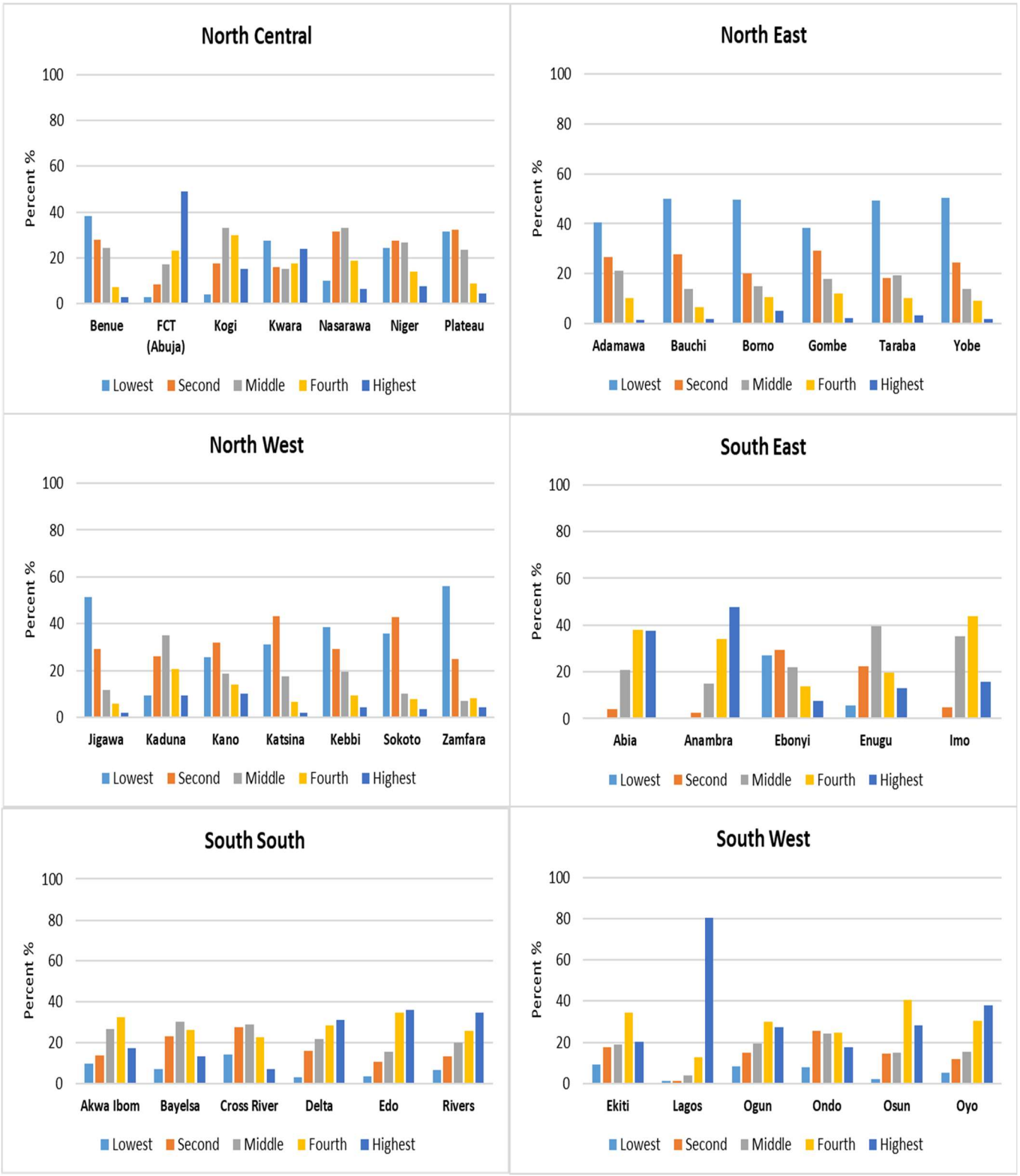

Figure B. 4: Distribution of children born in the five years preceding 2008 NDHS by household wealth and state, Nigeria 2008

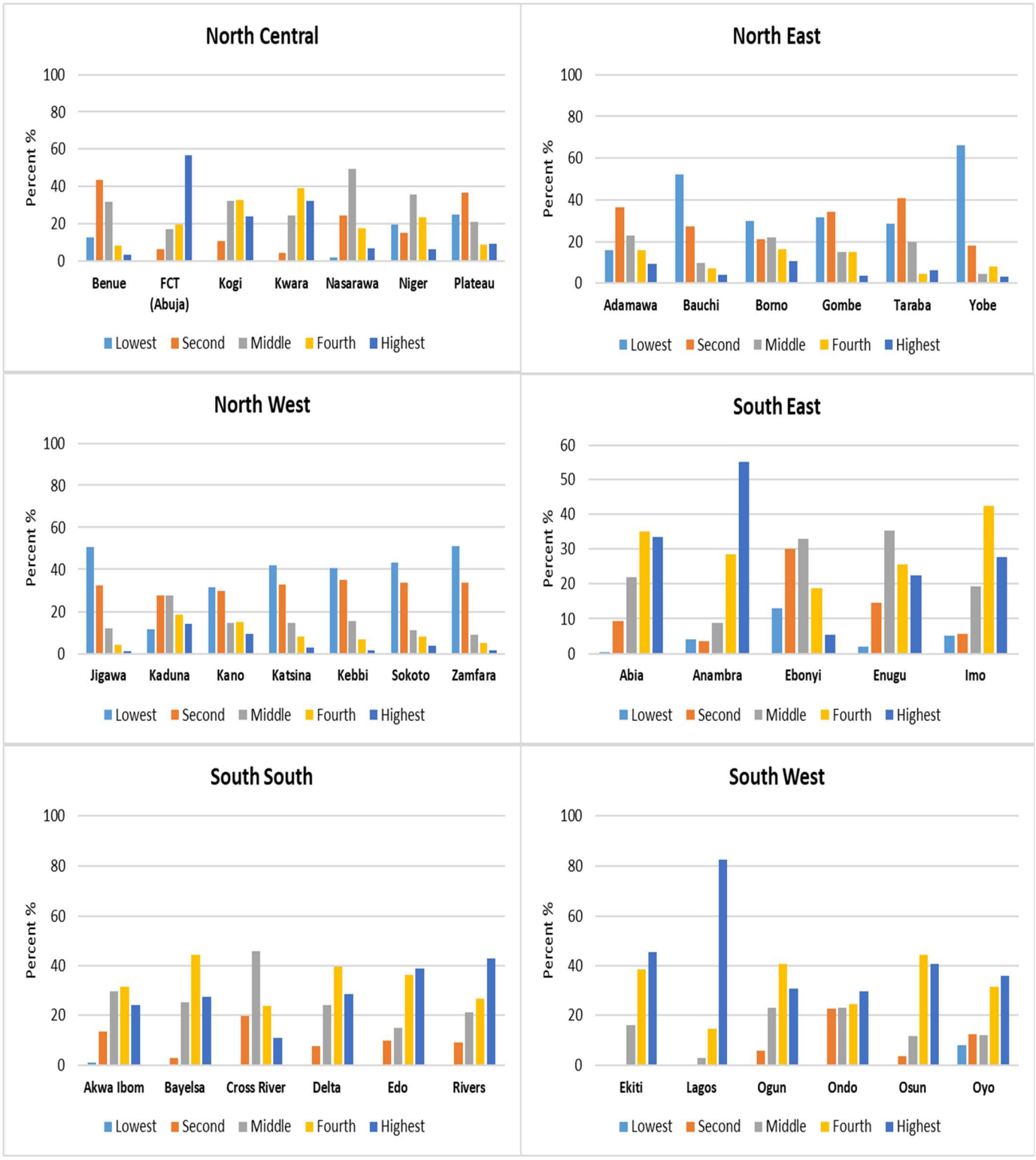

Figure B. 5: Distribution of children born in the five years preceding 2013 NDHS by household wealth and state, Nigeria 2013

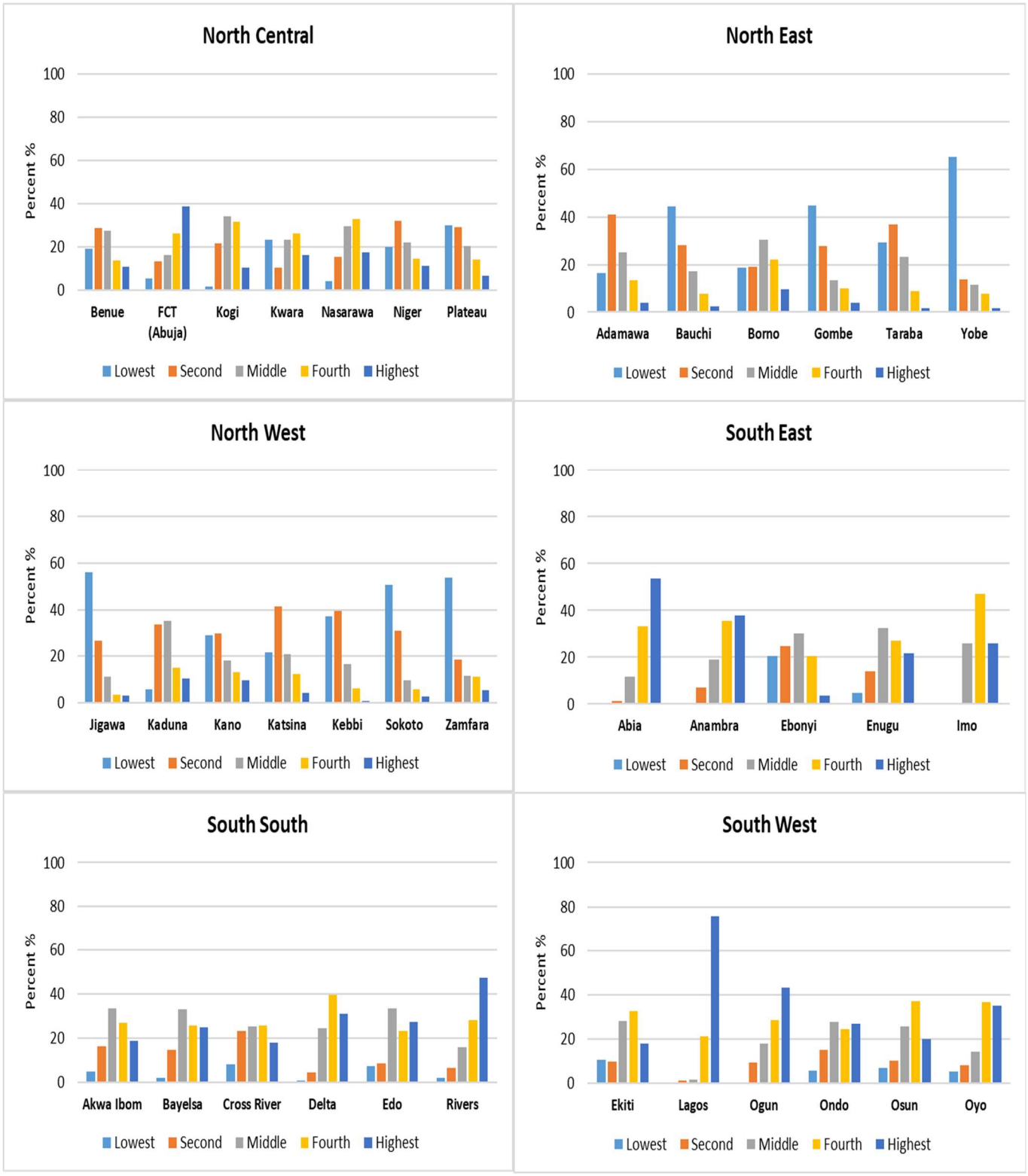

Figure B. 6: Distribution of children born in the five years preceding 2018 NDHS by household wealth and state, Nigeria 2018

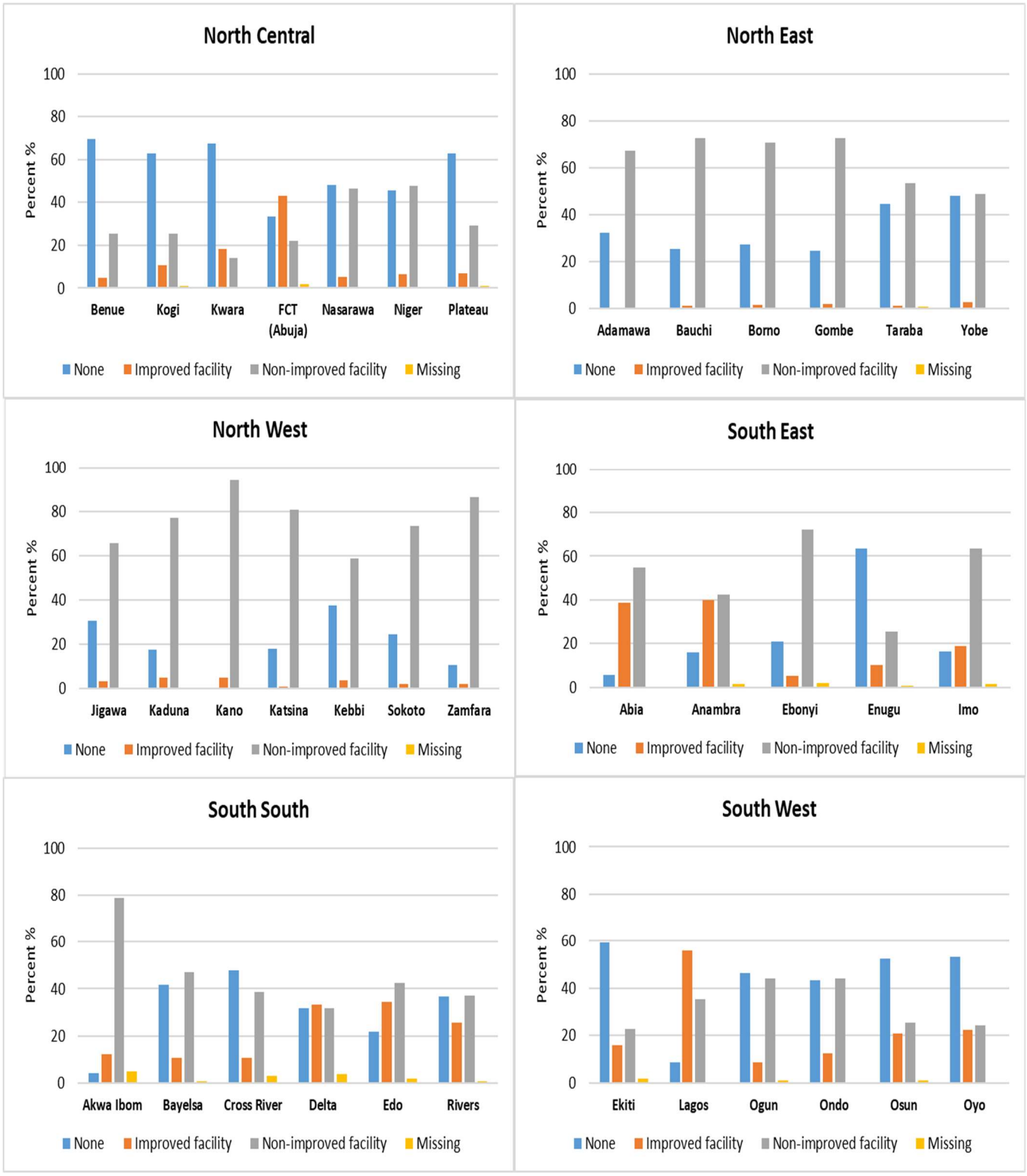

Figure B. 7: Distribution of children born in the five years preceding 2008 NDHS by household's type of toilet facility and state, Nigeria 2008

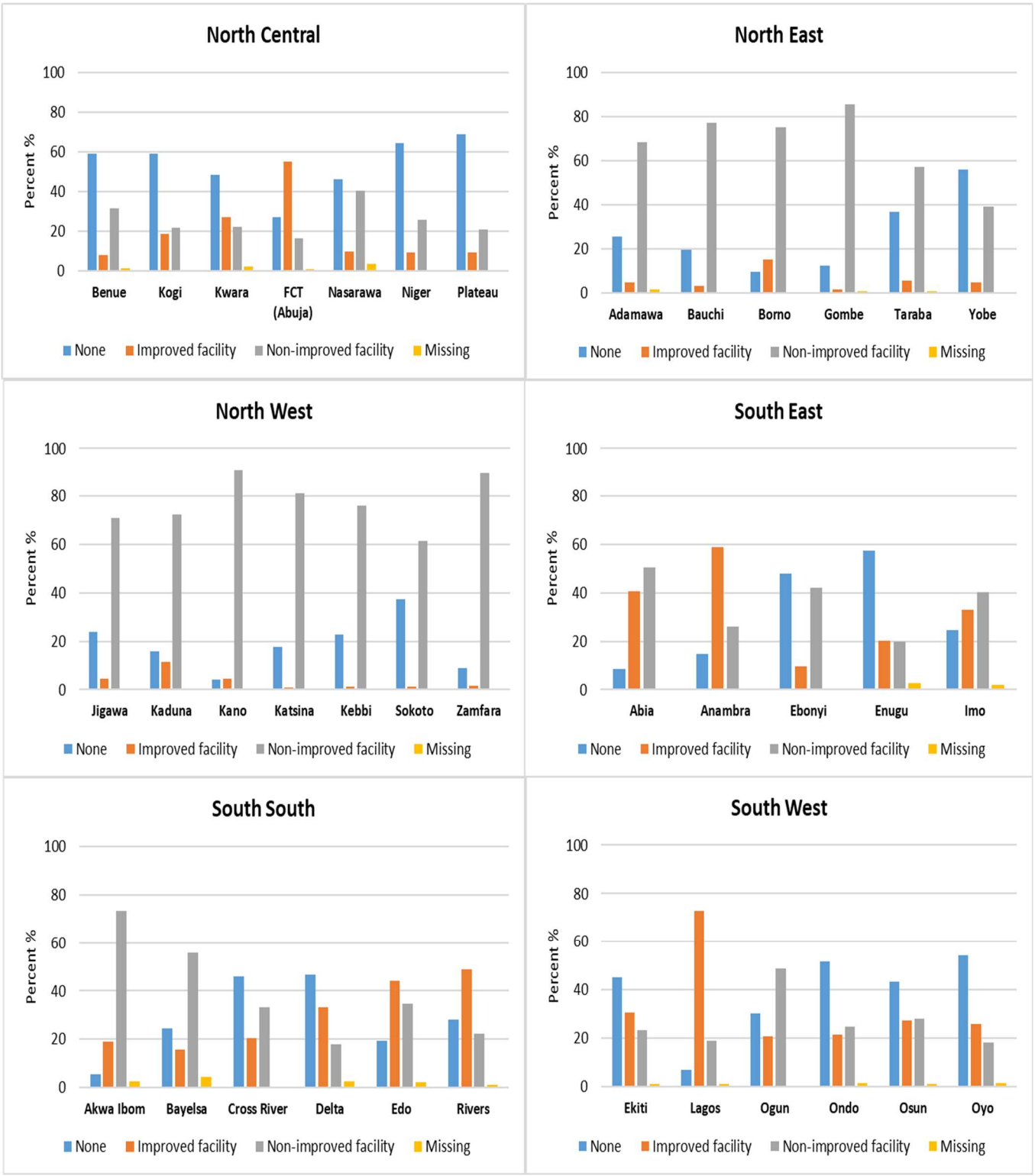

Figure B. 8: Distribution of children born in the five years preceding 2013 NDHS by household's type of toilet facility and state, Nigeria 2013

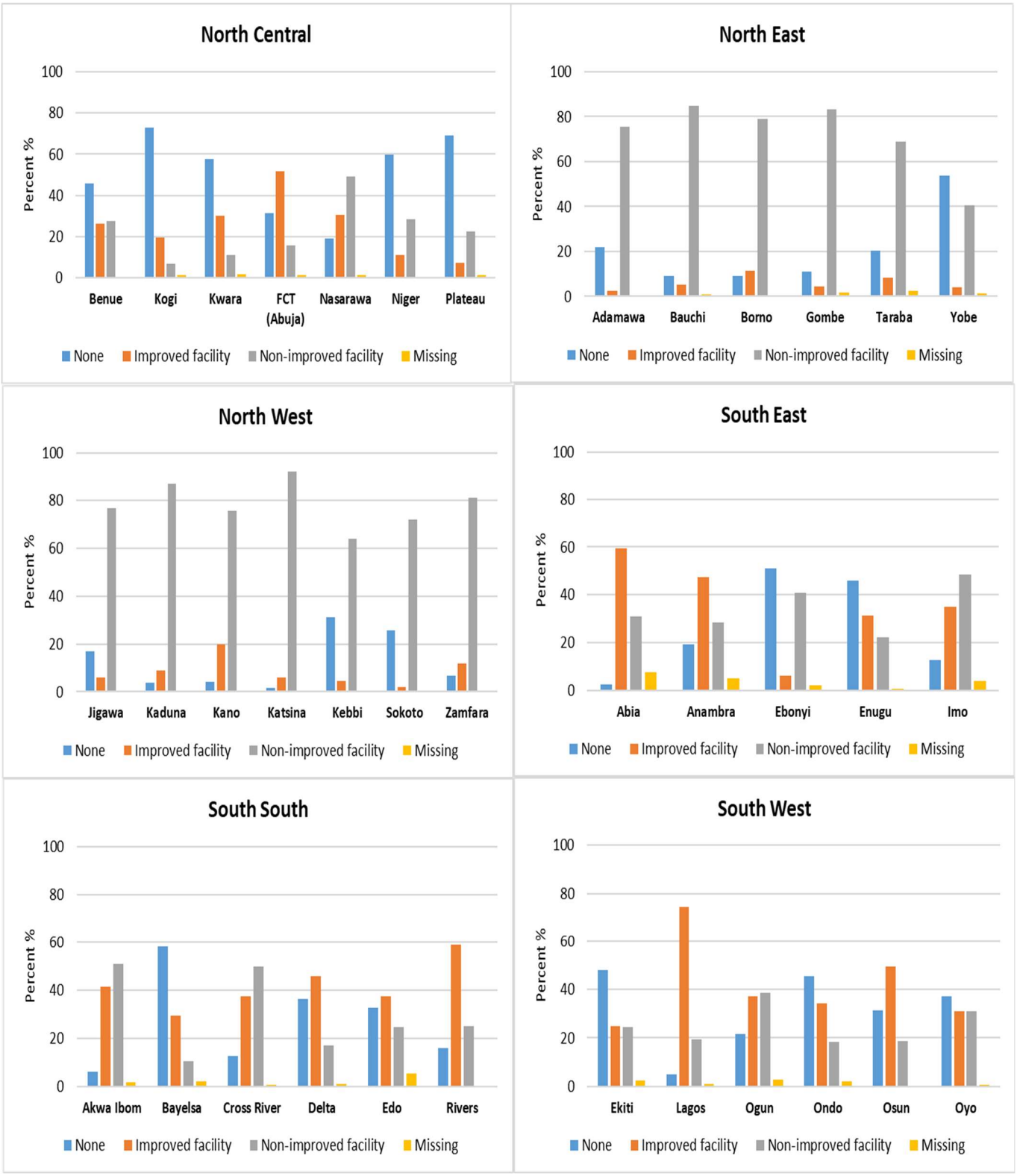

Figure B. 9: Distribution of children born in the five years preceding 2018 NDHS by household's type of toilet facility and state, Nigeria 2018

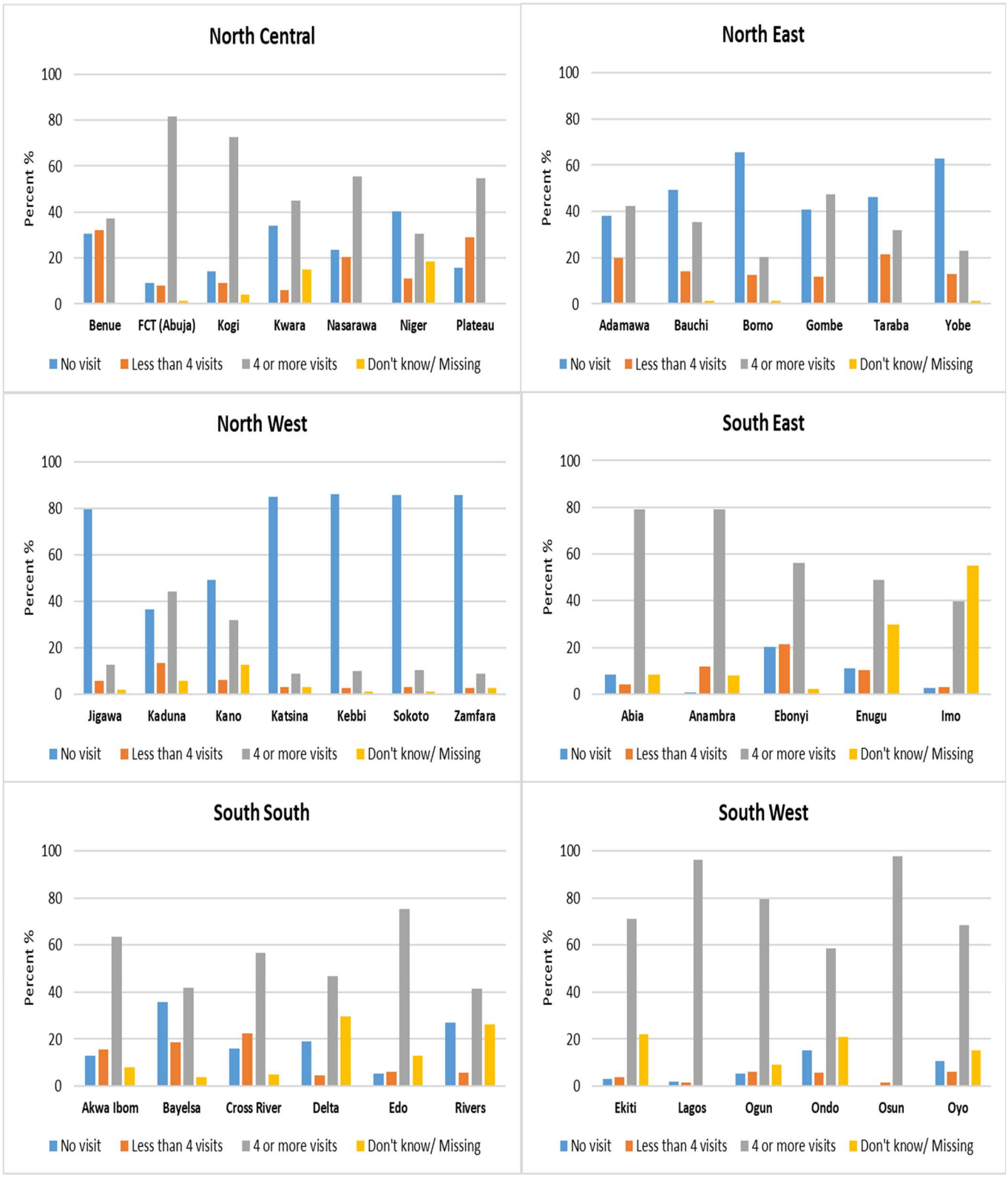

Figure B. 10: Distribution of children born in the five years preceding 2008 NDHS by mother's ANC attendance and state, Nigeria 2008

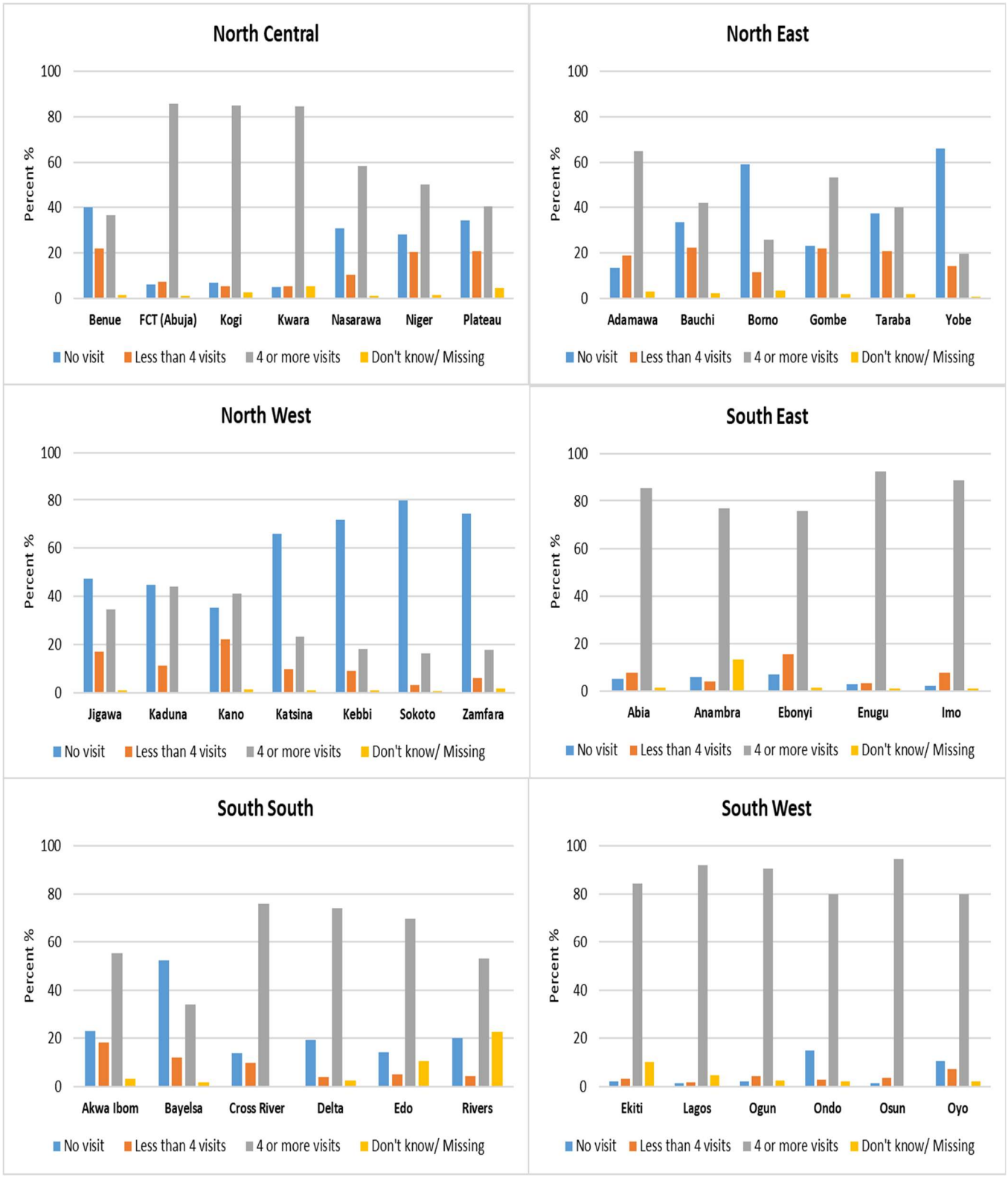

Figure B. 11: Distribution of children born in the five years preceding 2013 NDHS by mother's ANC attendance and state, Nigeria 2013

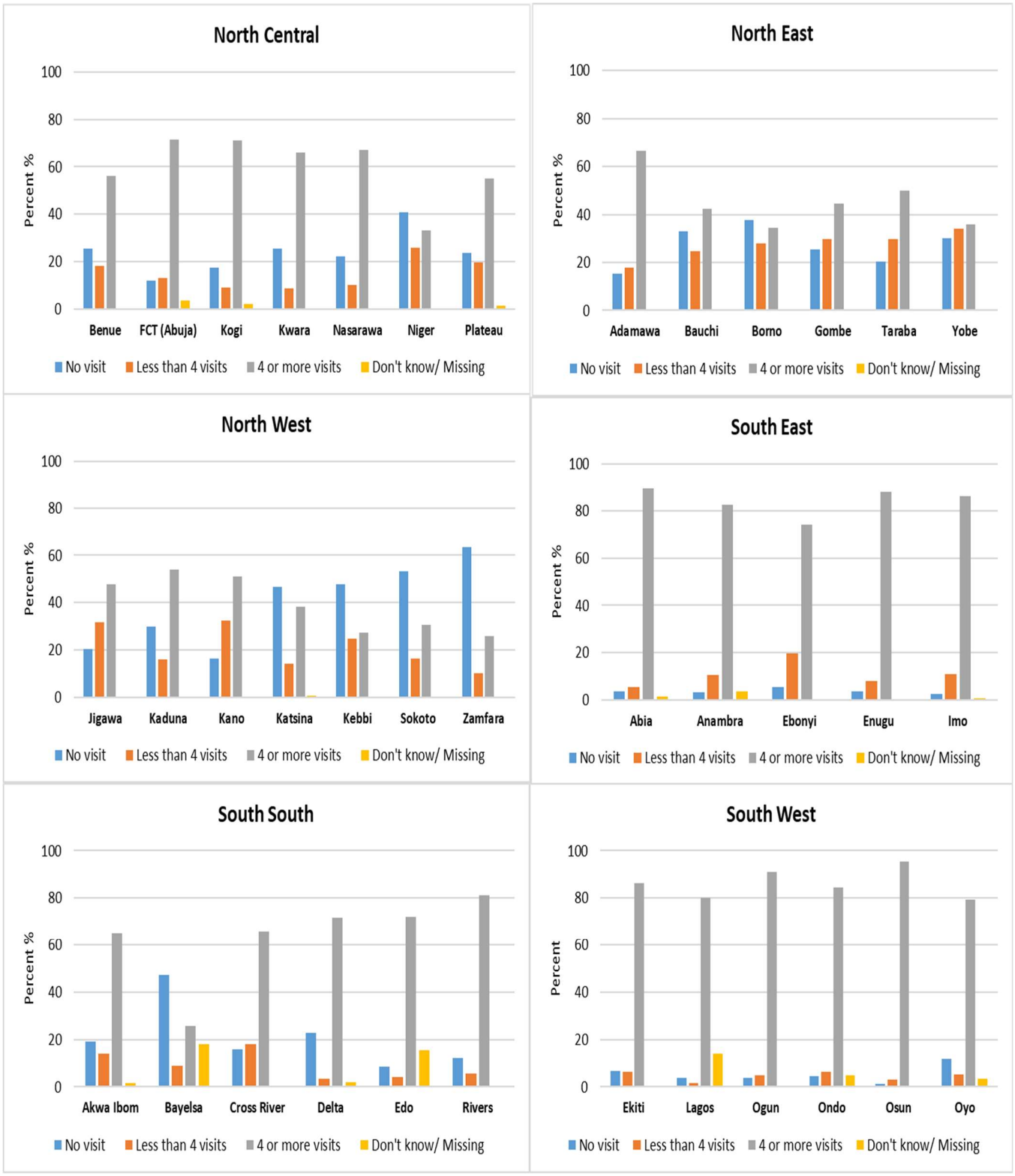

Figure B. 12: Distribution of children born in the five years preceding 2018 NDHS by mother's ANC attendance and state, Nigeria 2018

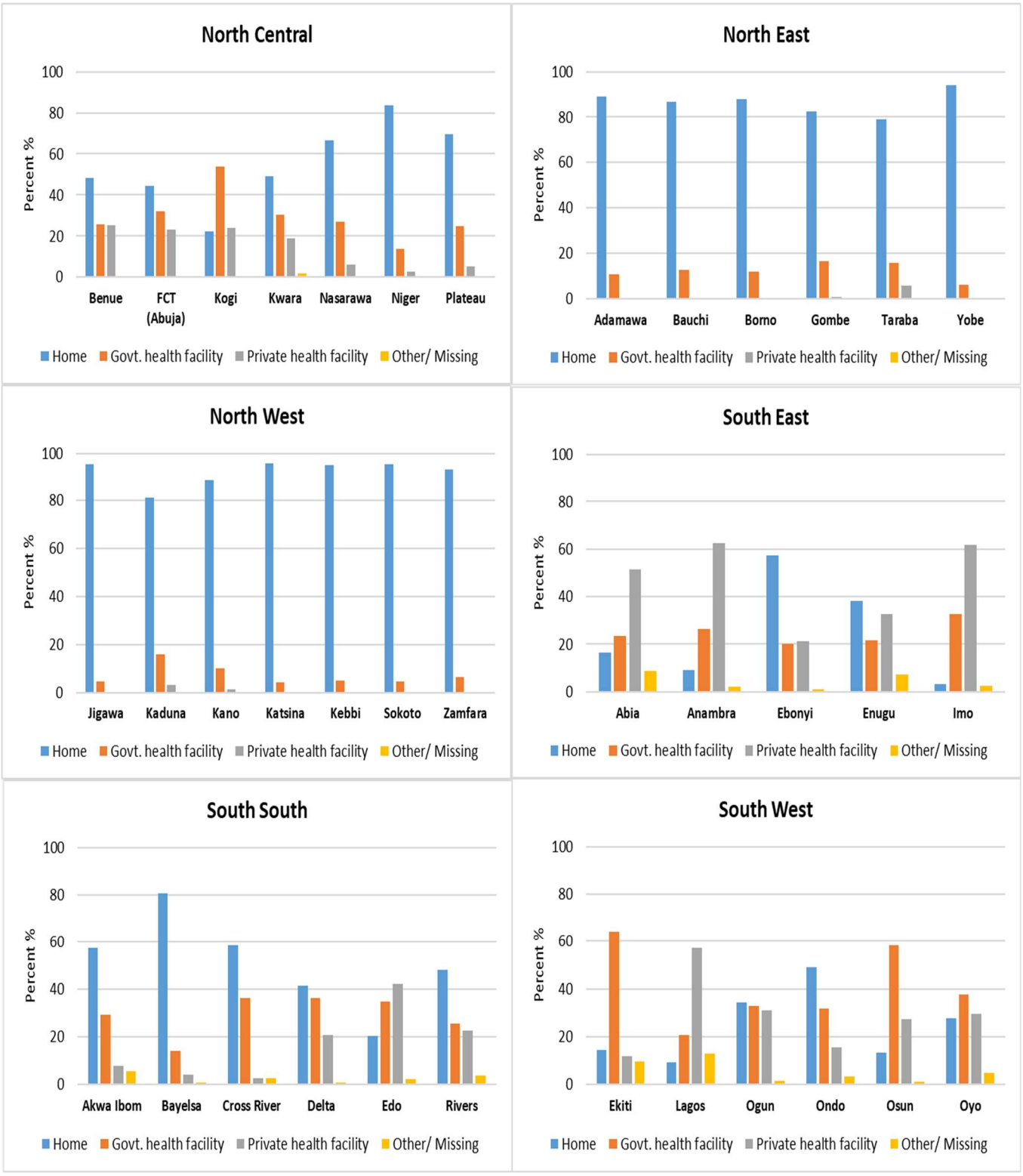

Figure B. 13: Distribution of children born in the five years preceding 2008 NDHS by place of delivery and state, Nigeria 2008

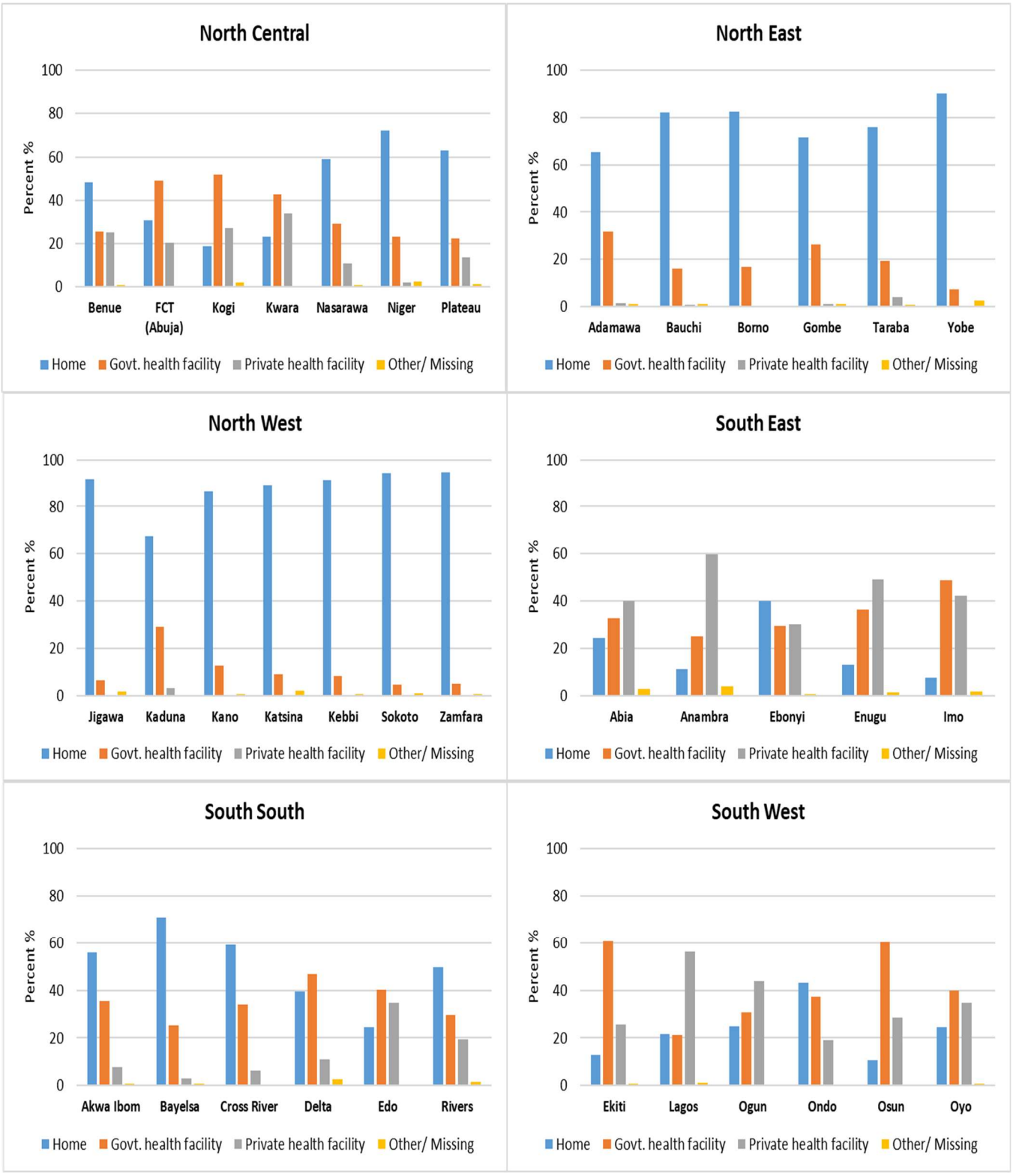

Figure B. 14: Distribution of children born in the five years preceding 2013 NDHS by place of delivery and state, Nigeria 2013

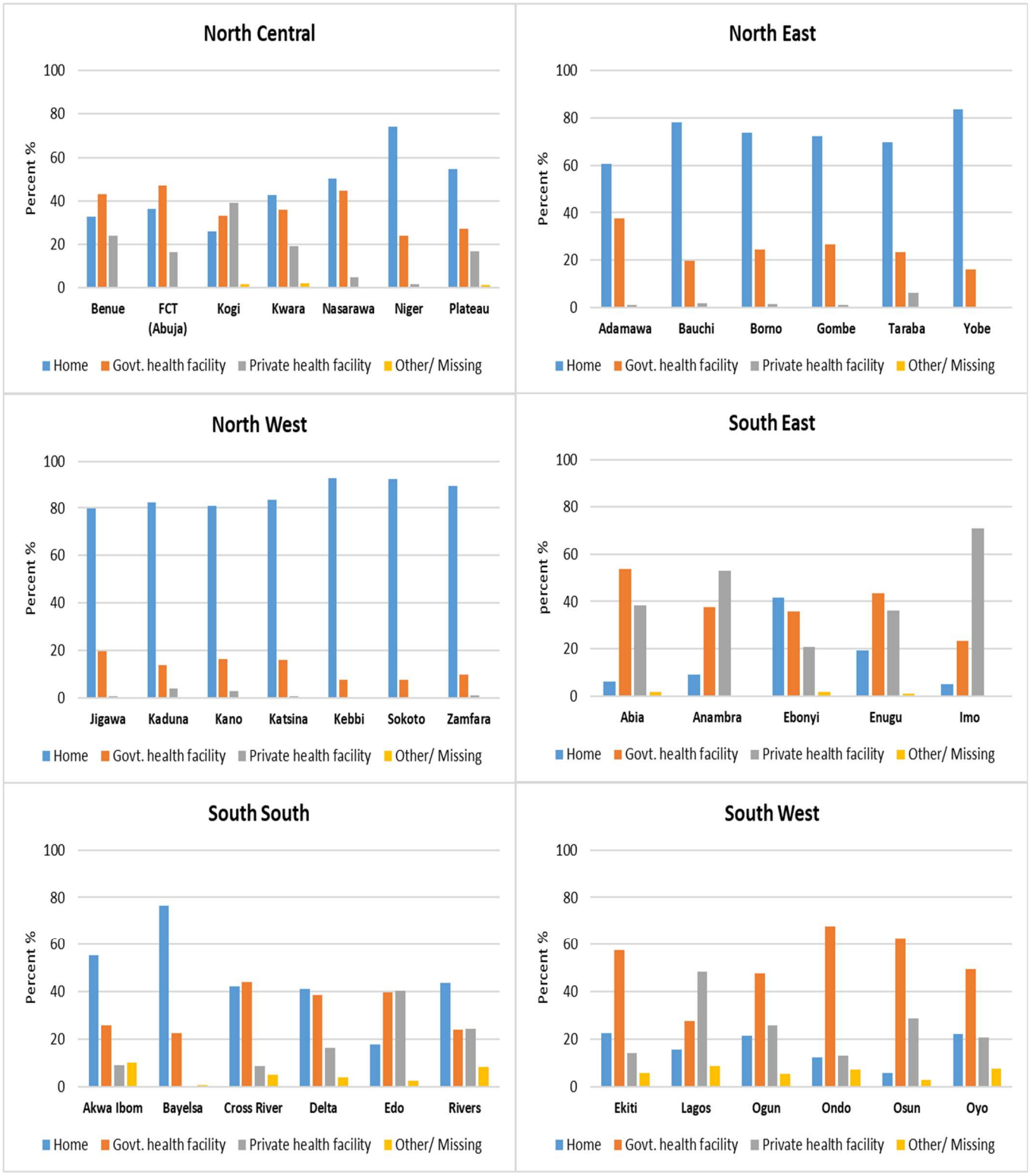

Figure B. 15: Distribution of children born in the five years preceding 2018 NDHS by place of delivery and state, Nigeria 2018

Appendix C

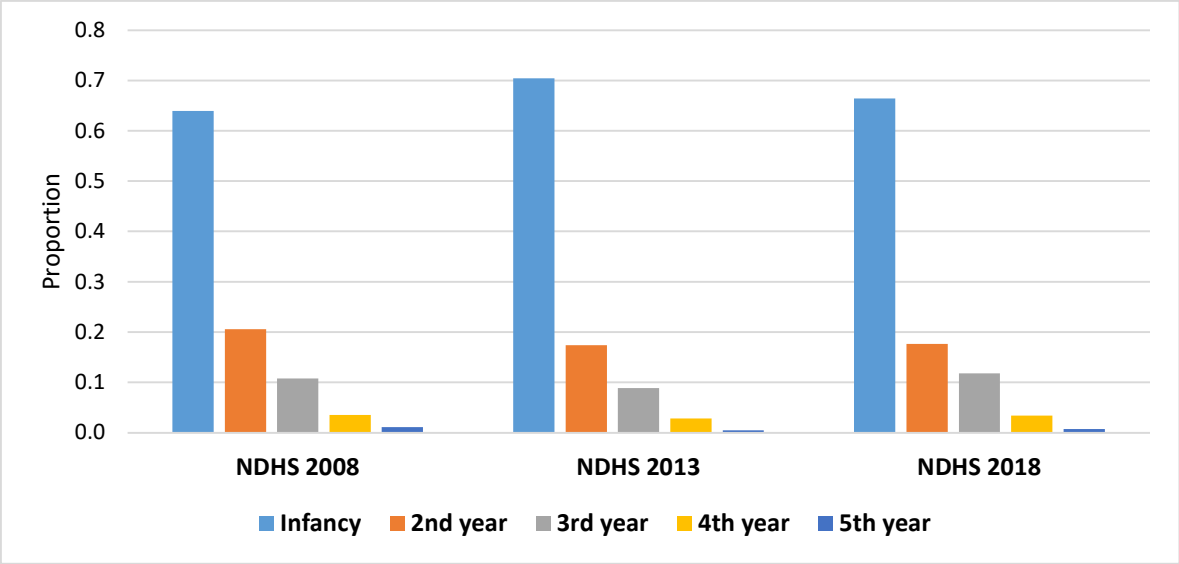

Figure C. 1: Proportion of under-five deaths by year of life, Nigeria 2008-2018

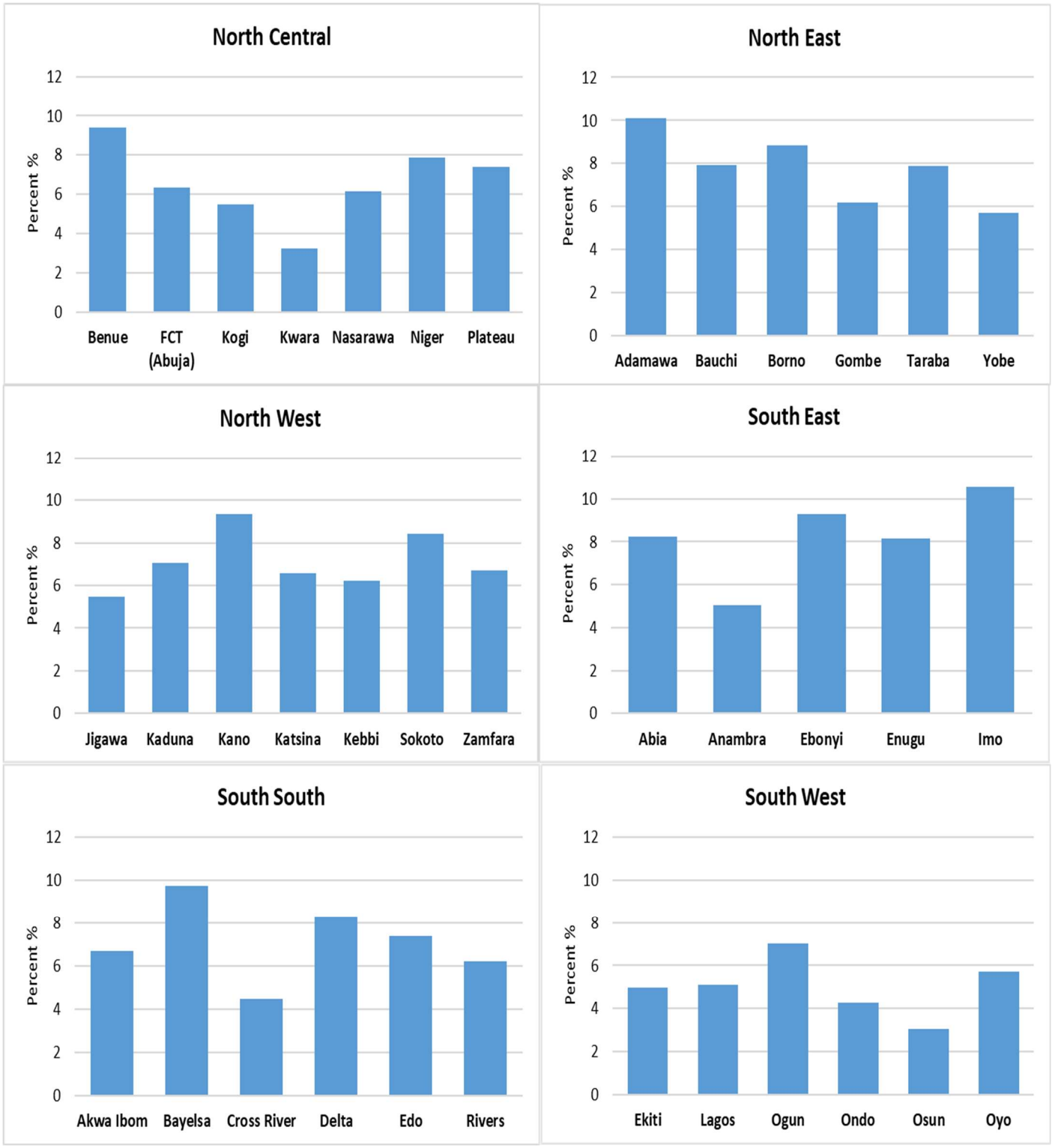

Figure C. 2: Percentage distribution of infant (0-11 months) deaths by state of residence, Nigeria 2008

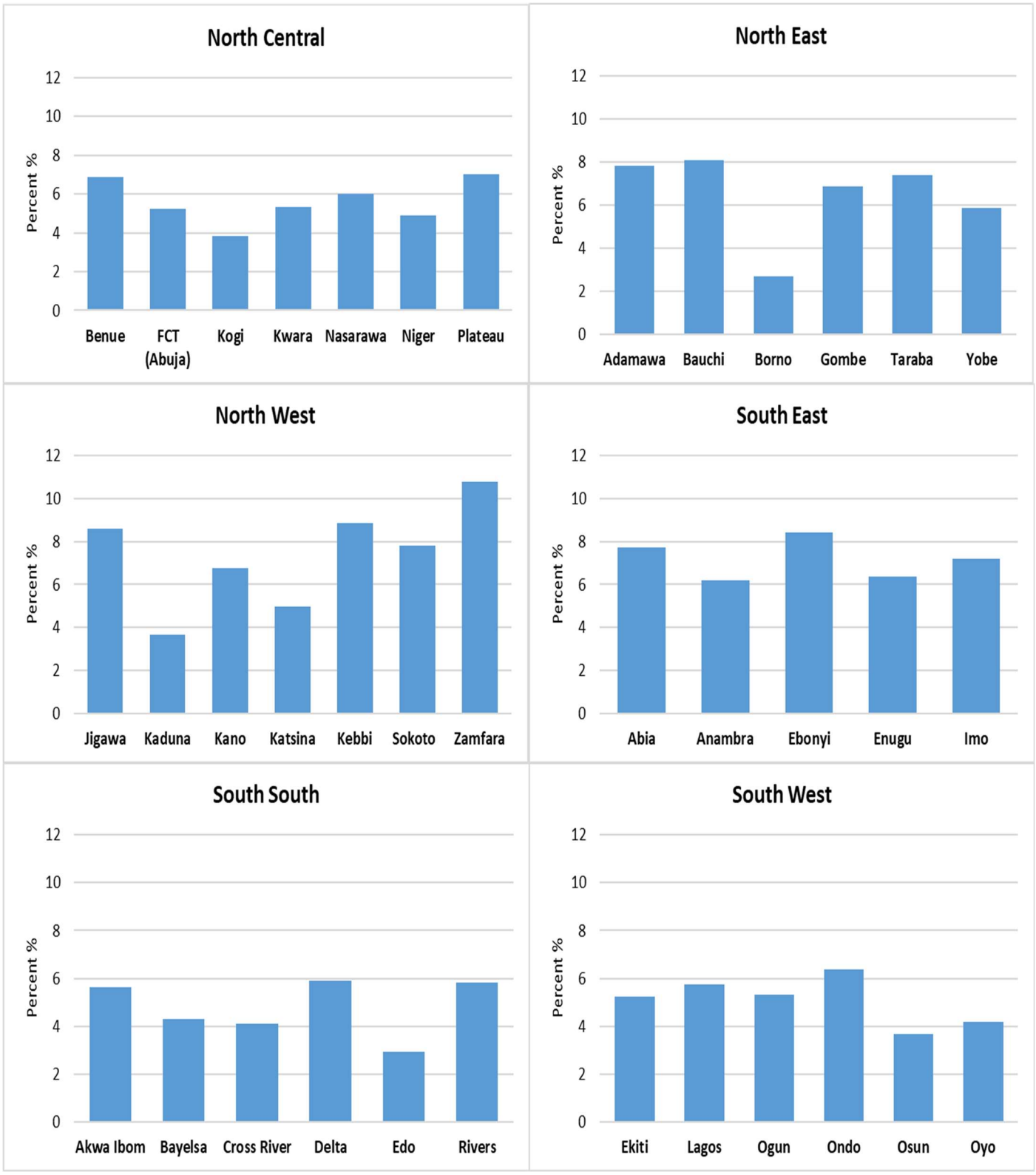

Figure C. 3: Percentage distribution of infant (0-11 months) deaths by state of residence, Nigeria 2013

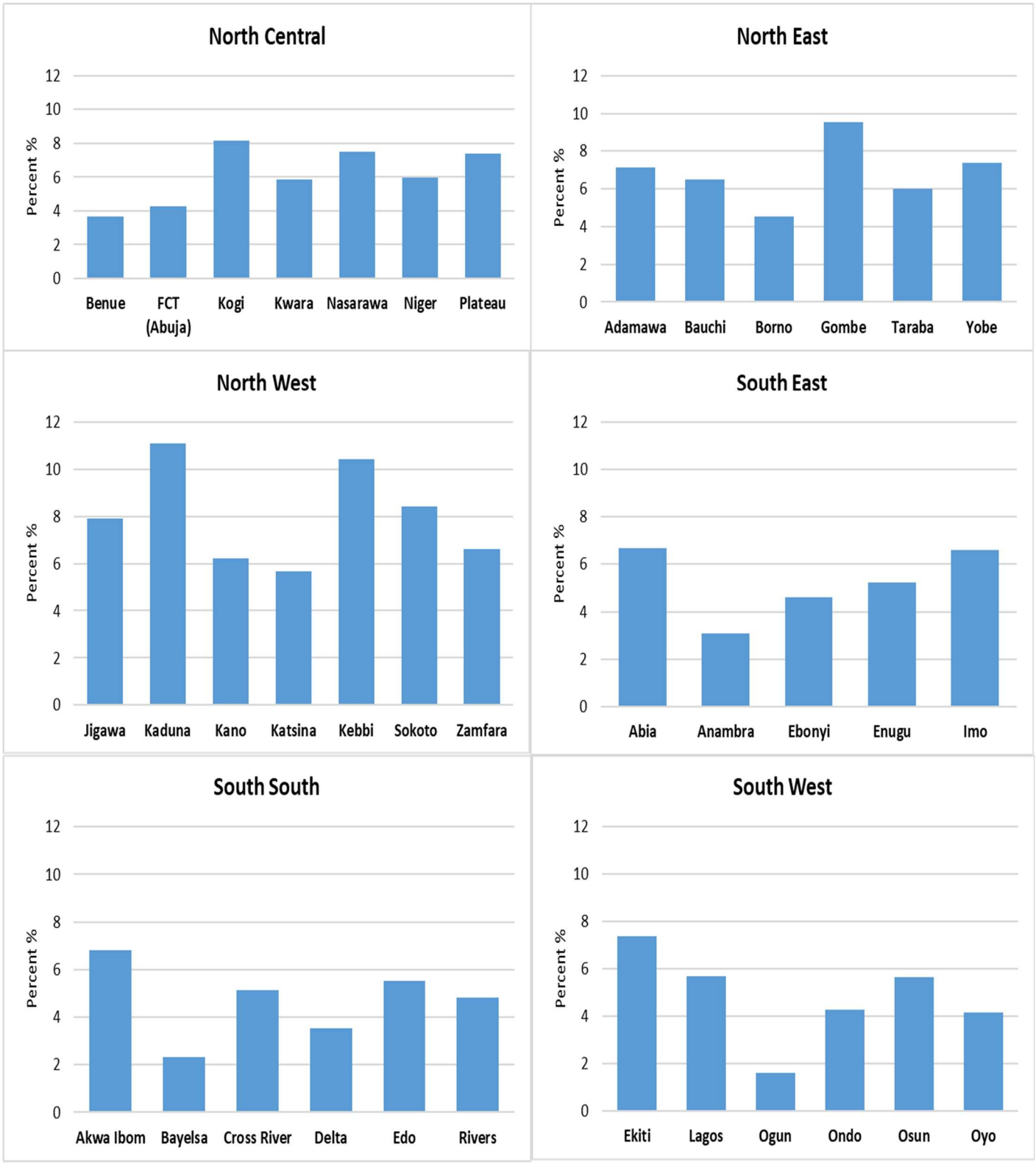

Figure C. 4: Percentage distribution of infant (0-11 months) deaths by state of residence, Nigeria 2018

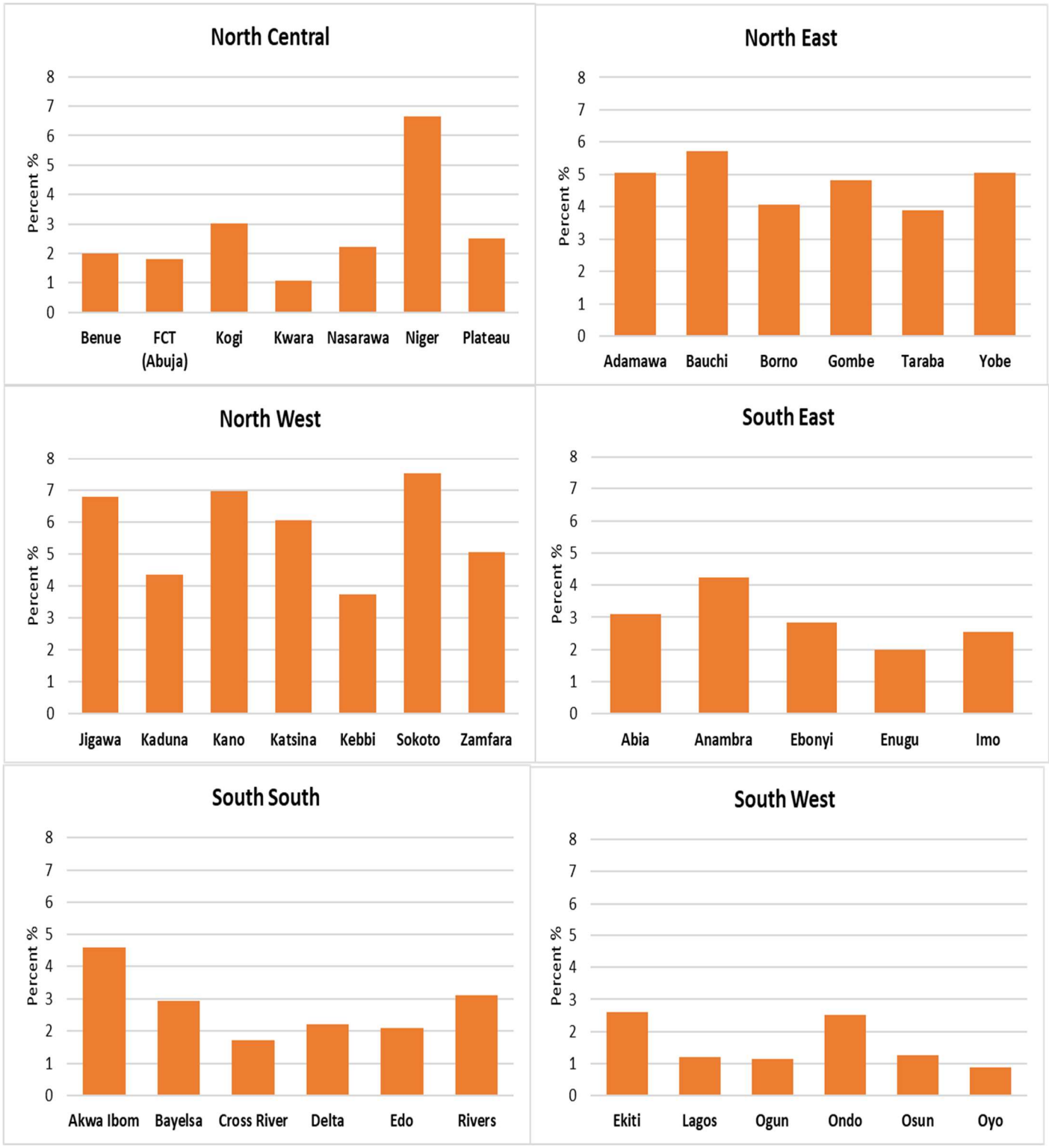

Figure C. 5: Percentage distribution of child (12-59 months) deaths by state of residence, Nigeria 2008

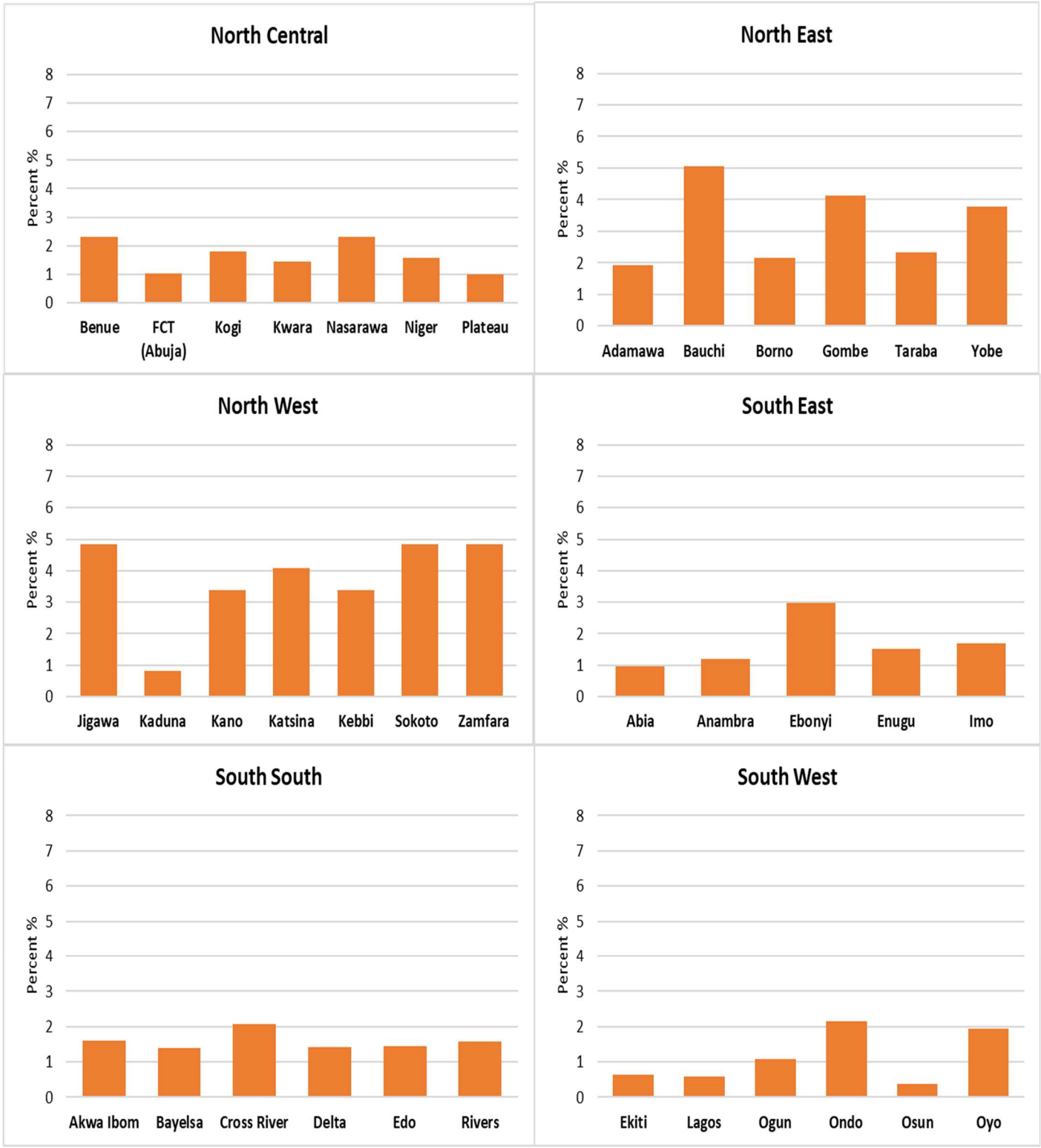

Figure C. 6: Percentage distribution of child (12-59 months) deaths by state of residence, Nigeria 2013

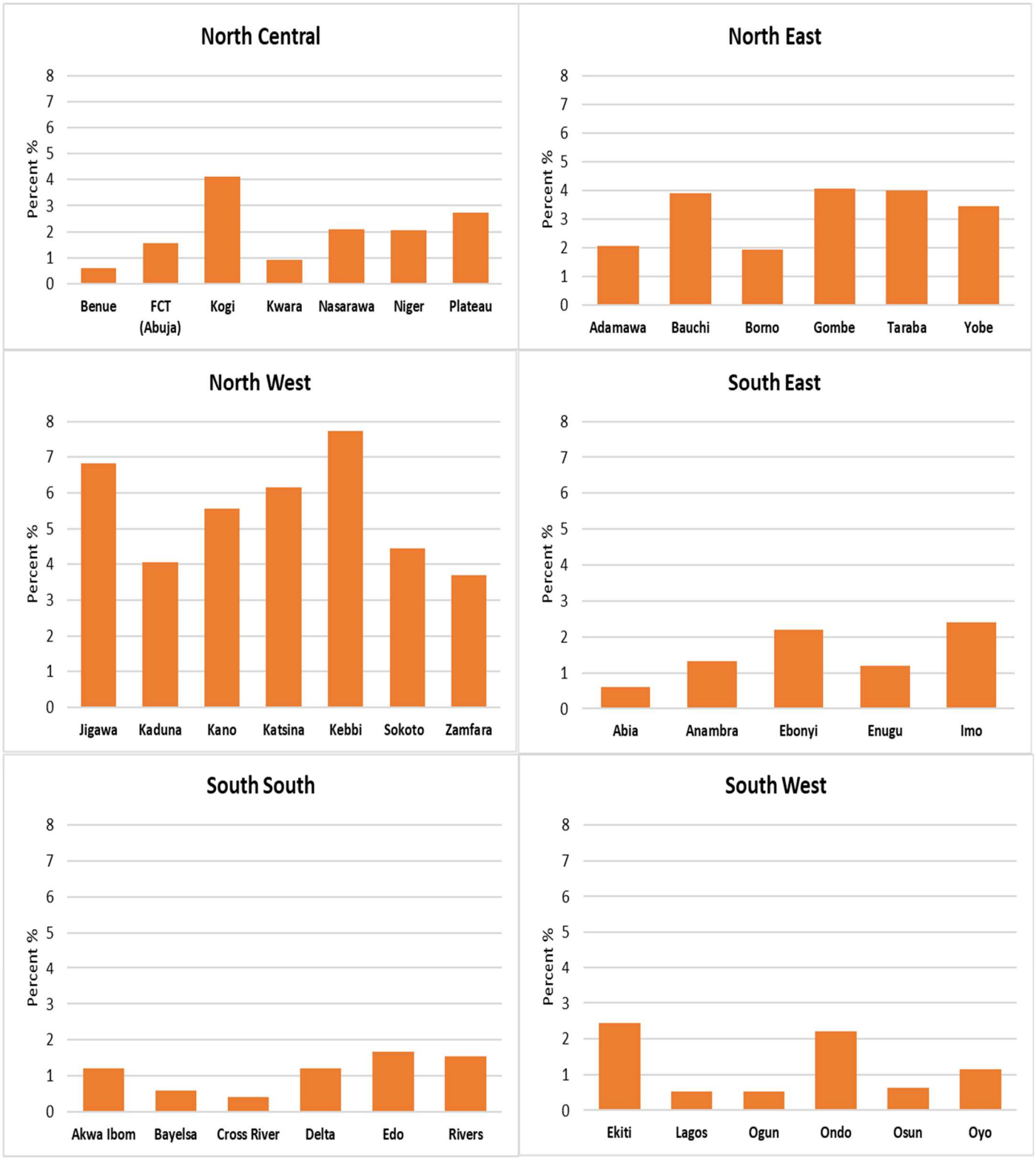

Figure C. 7: Percentage distribution of child (12-59 months) deaths by state of residence, Nigeria 2018

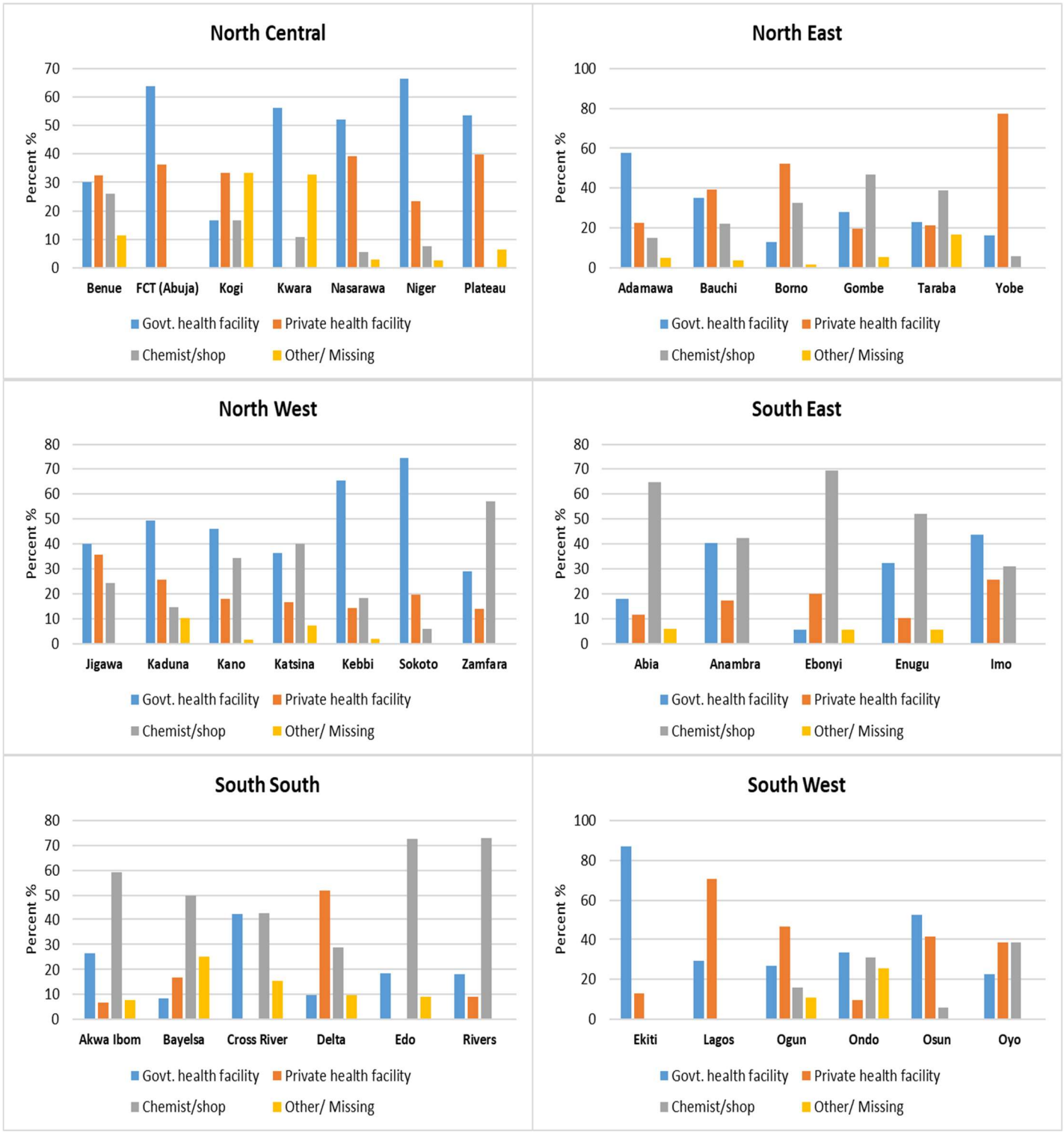

Figure C. 8: Percentage of children born in the five years preceding 2008 NDHS by place their mothers' first sought advice/treatment for child's diarrhoea and state, Nigeria 2008

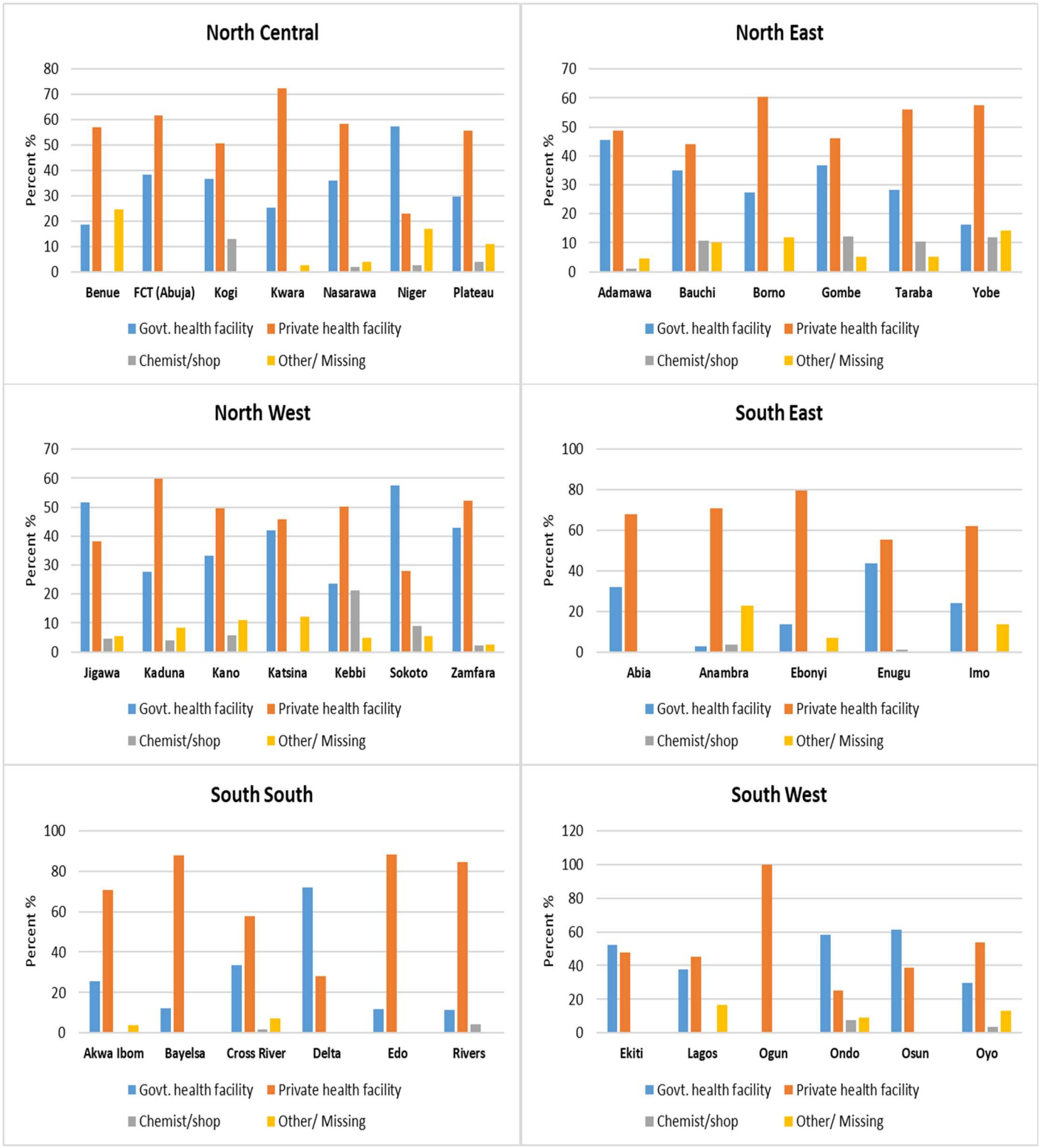

Figure C. 9: Percentage of children born in the five years preceding 2013 NDHS by place their mothers' first sought advice/treatment for child's diarrhoea and state, Nigeria 2013

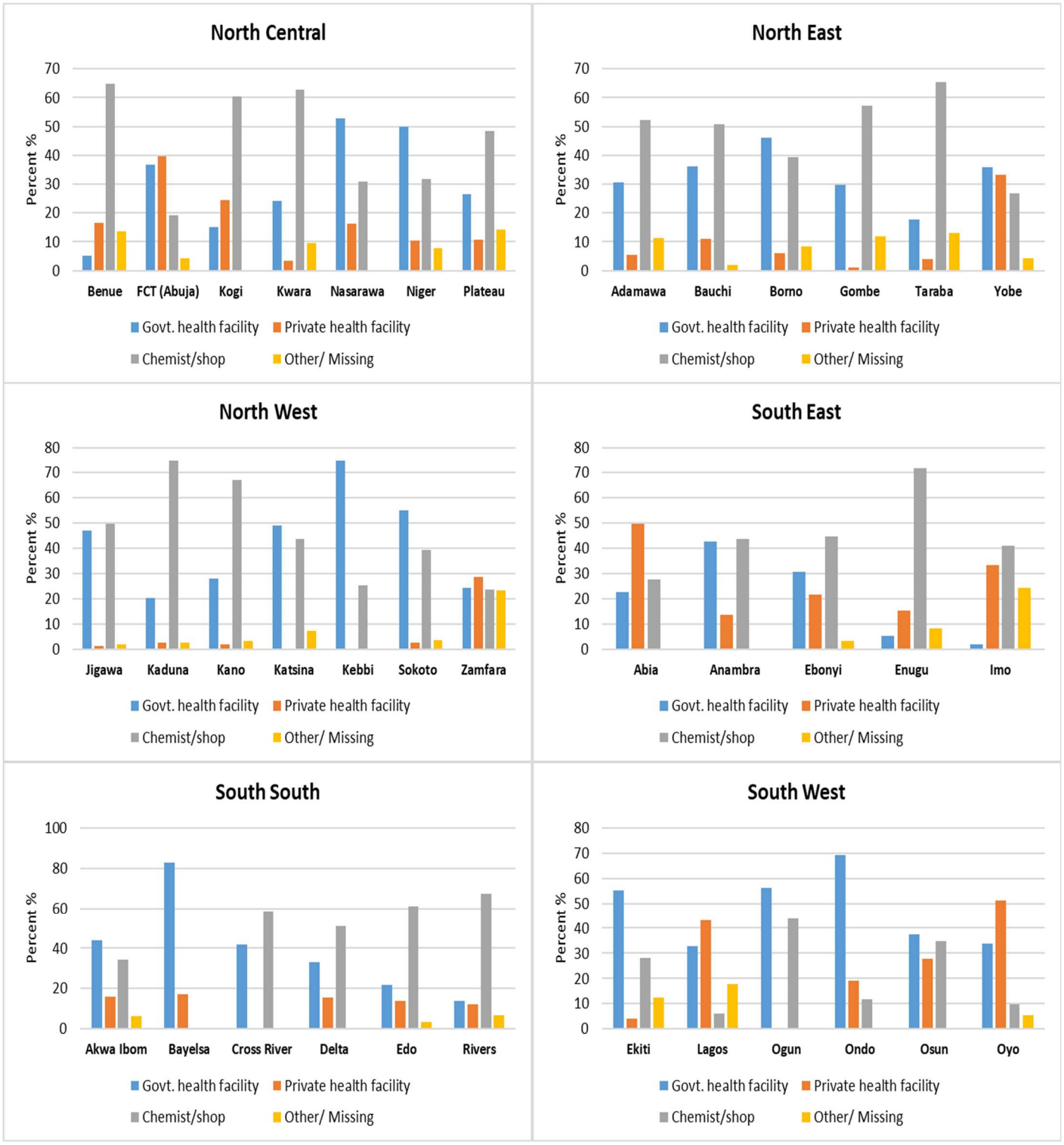

Figure C. 10: Percentage of children born in the five years preceding 2018 NDHS by place their mothers first sought advice/treatment for child's diarrhoea and state, Nigeria 2018

Table C. 1: Temporal effects on under-five mortality in Nigeria with interaction effect between geo-political zones and year of survey, 2008-2018

	Infant mortality	Child mortality	Infant mortality	Child mortality
Maternal education				
No education	1	1	1	1
Incomplete primary	1.124	0.852	1.097	0.771*
	(0.107)	(0.141)	(0.085)	(0.086)
Complete primary	0.971	1.000	0.935	0.906
	(0.075)	(0.122)	(0.063)	(0.077)
Incomplete secondary	0.928	0.710*	0.912	0.713**
	(0.081)	(0.109)	(0.072)	(0.080)
Complete secondary	0.793*	0.665**	0.863	0.684**
	(0.078)	(0.104)	(0.079)	(0.080)
Higher	0.825	0.240***	0.859	0.261***
	(0.108)	(0.083)	(0.108)	(0.071)
Rural	1.080	1.178	1.206***	1.404***
	(0.065)	(0.127)	(0.063)	(0.105)
Improved source of drinking water	0.928	1.084	0.945	1.031
	(0.048)	(0.089)	(0.041)	(0.054)
Toilet facility				
No facility	1	1	1	1
Non-improved facility	1.076	1.006	0.983	1.043
	(0.062)	(0.089)	(0.049)	(0.065)
Improved facility	0.971	0.771	0.926	0.765*
	(0.091)	(0.142)	(0.078)	(0.100)
Has electricity	0.858*	0.947	0.963	0.889
	(0.052)	(0.091)	(0.048)	(0.057)
ANC				
No visit	1	1		
Less than 4 visits	0.849*	0.816		
	(0.067)	(0.095)		
4 or more visits	0.805**	0.850		
	(0.057)	(0.079)		
Do not know	1.150	0.942		
	(0.181)	(0.212)		
Professional birth attendance	1.338***	0.793*	1.222***	0.862*
	(0.092)	(0.087)	(0.070)	(0.061)
Geo-political zones				
North Central	1	1	1	1

North East	1.047	1.203	1.095	1.188
	(0.128)	(0.238)	(0.119)	(0.164)
North West	0.884	1.884***	1.041	1.582***
	(0.102)	(0.329)	(0.110)	(0.208)
South East	1.181	1.683	1.110	1.598**
	(0.170)	(0.455)	(0.143)	(0.285)
South South	0.966	0.927	1.110	1.178
	(0.133)	(0.255)	(0.139)	(0.196)
South West	0.741	0.637	1.124	0.742
	(0.122)	(0.193)	(0.161)	(0.153)
Year of survey				
2008	1	1	1	1
2013	0.737*	0.539*	0.769*	0.608**
	(0.105)	(0.160)	(0.095)	(0.103)
2018	0.924	0.792	1.001	0.720
	(0.127)	(0.175)	(0.114)	(0.123)
Interaction with geo-political zone and year of survey				
North Central # 2008	1	1	1	1
North East # 2013	1.051	1.579	0.983	1.065
	(0.203)	(0.547)	(0.156)	(0.219)
North East # 2018	1.005	1.163	0.921	1.016
	(0.184)	(0.342)	(0.141)	(0.215)
North West # 2013	1.436*	0.973	1.359*	0.929
	(0.245)	(0.313)	(0.202)	(0.178)
North West # 2018	1.302	1.149	1.109	1.226
	(0.216)	(0.290)	(0.152)	(0.234)
South East # 2013	1.281	1.517	1.143	1.028
	(0.292)	(0.665)	(0.224)	(0.298)
South East # 2018	0.830	0.936	0.682*	0.951
	(0.176)	(0.361)	(0.123)	(0.265)
South South # 2013	1.273	1.516	0.803	1.093
	(0.257)	(0.684)	(0.151)	(0.295)
South South # 2018	0.947	1.253	0.715	0.870
	(0.205)	(0.532)	(0.139)	(0.281)
South West # 2013	1.492	2.842*	1.147	1.717
	(0.353)	(1.372)	(0.249)	(0.574)
South West # 2018	1.178	0.995	0.776	1.477
	(0.279)	(0.493)	(0.168)	(0.467)
Religion				
Christian			1	1
Islam			0.903	1.212*
			(0.069)	(0.113)
Other			0.945	0.470**
			(0.144)	(0.126)
Maternal age				

15-19			1	1
20-24			0.496***	1.714
			(0.072)	(0.495)
25-29			0.384***	1.460
			(0.055)	(0.426)
30-34			0.349***	1.460
			(0.052)	(0.440)
35-39			0.364***	1.399
			(0.055)	(0.419)
40-44			0.397***	1.274
			(0.063)	(0.381)
45-49			0.491***	2.254**
			(0.084)	(0.699)
Female			0.838***	0.976
			(0.033)	(0.047)
Birth interval				
Less than 2 years			1	1
2-5 years			0.541***	0.573***
			(0.021)	(0.030)
More than 5 years			0.410***	0.414***
			(0.033)	(0.047)
Birth size				
Large/very large			1	1
Average			1.137**	1.039
			(0.047)	(0.054)
Small/very small			1.898***	1.026
			(0.099)	(0.071)
Children ever born				
1-2 children			1.000	1.000
3-4 children			1.645***	1.730***
			(0.122)	(0.187)
5 or more children			2.511***	2.374***
			(0.217)	(0.277)
Marital status			0.704***	0.564***
			(0.064)	(0.067)
Observations	**58767**	**58767**	**73187**	**73187**

Exponentiated coefficients (odds ratios). Standard errors in parenthesis
*** p < 0.05, ** p < 0.01, *** p < 0.001***

Appendix D

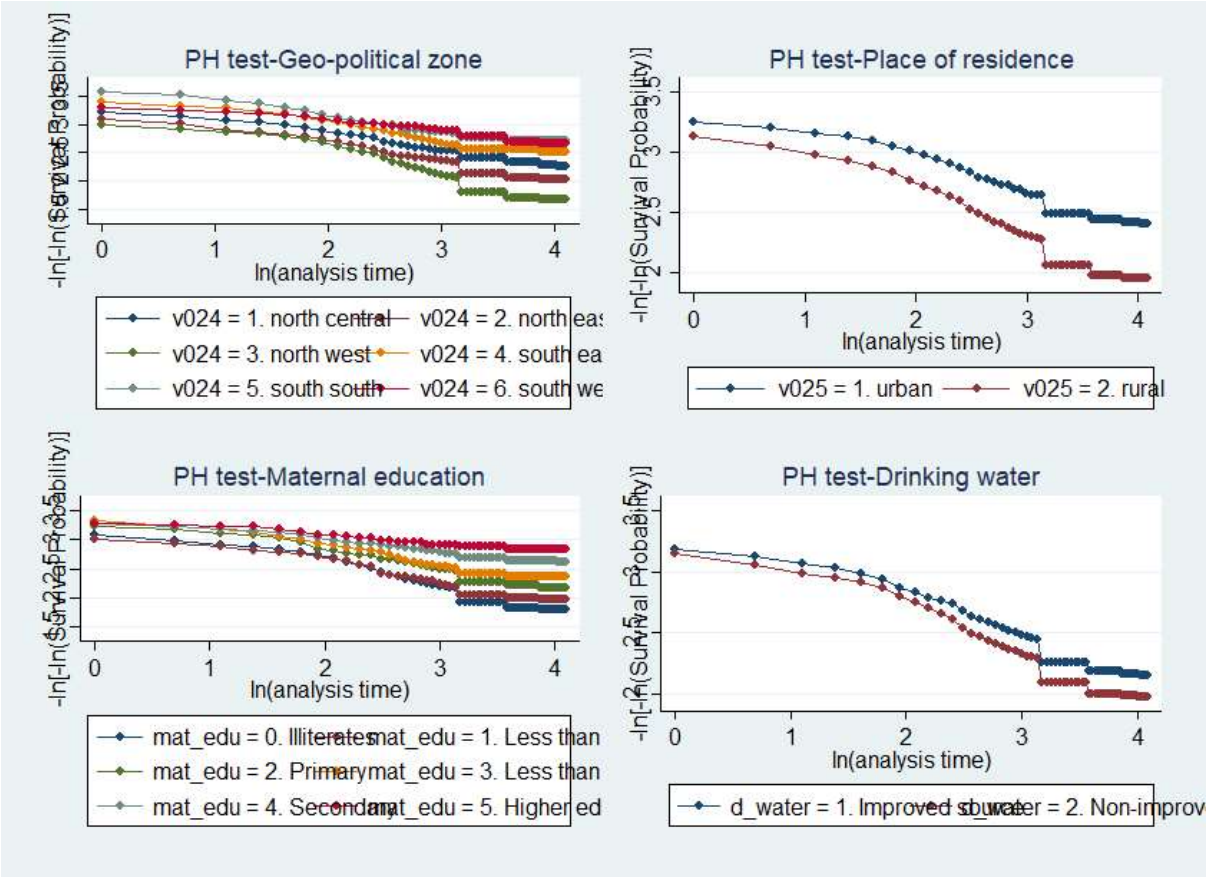

Figure D. 1: Proportional hazards tests for geo-political zones, place of residence, maternal education, and drinking water

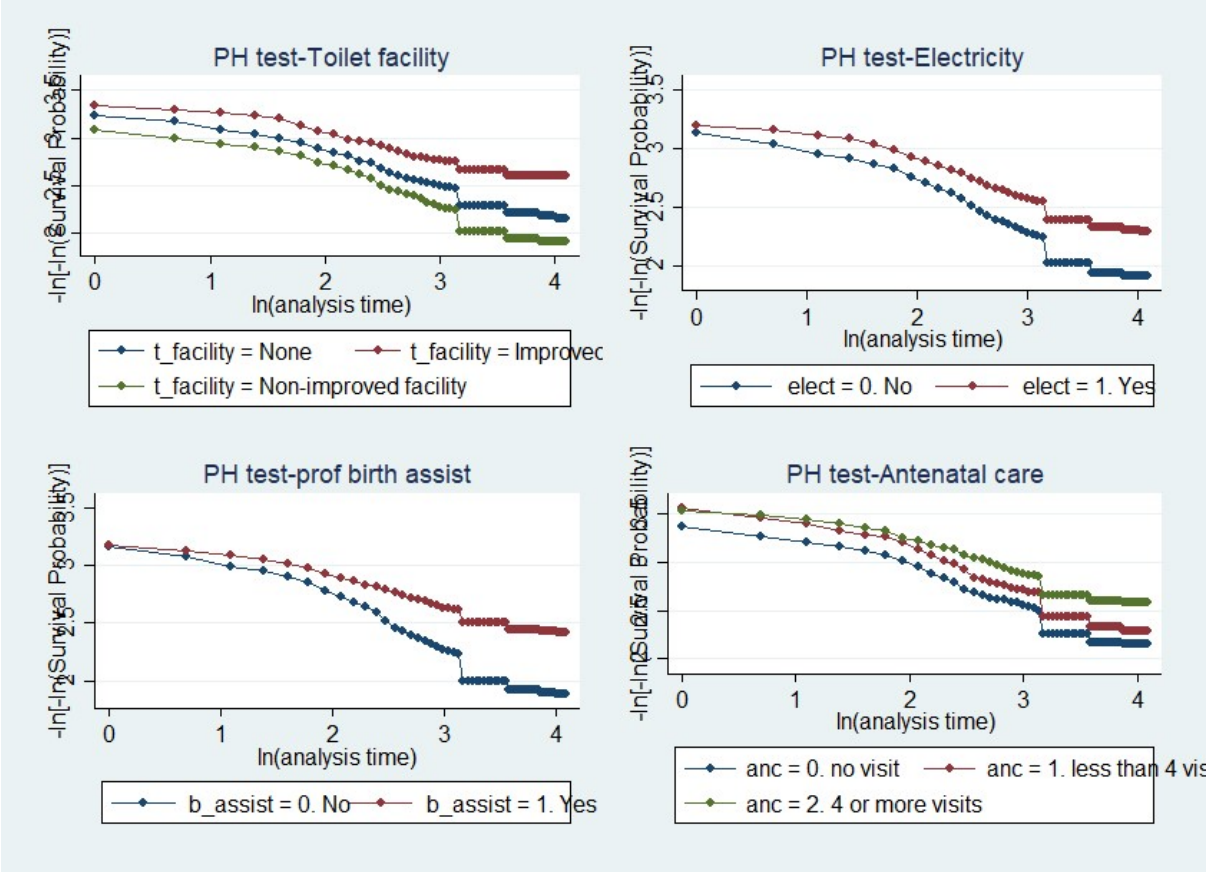

Figure D. 2: Proportional hazards tests for toilet facility, electricity, birth attendance, and antenatal care

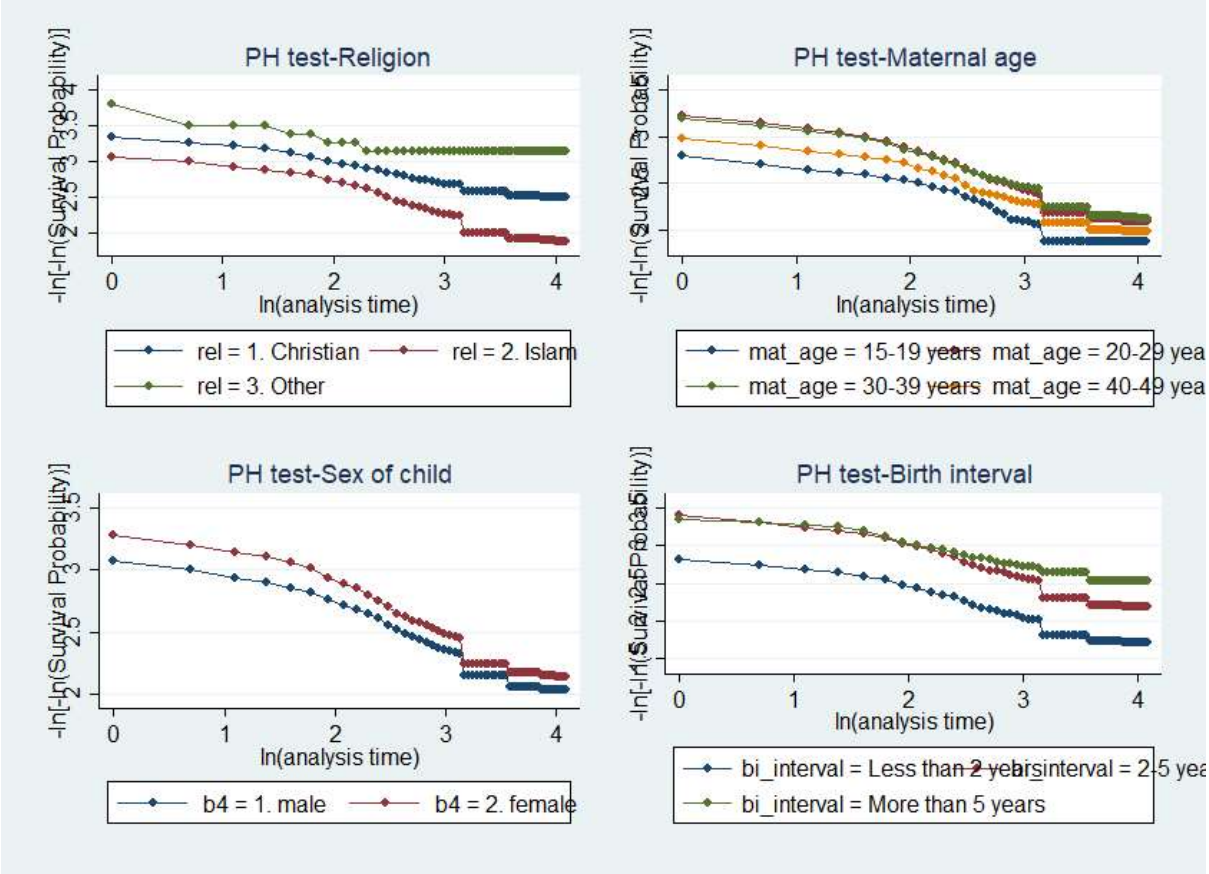

Figure D. 3: Proportional hazards tests for religion, maternal age, sex of child, and preceding birth interval

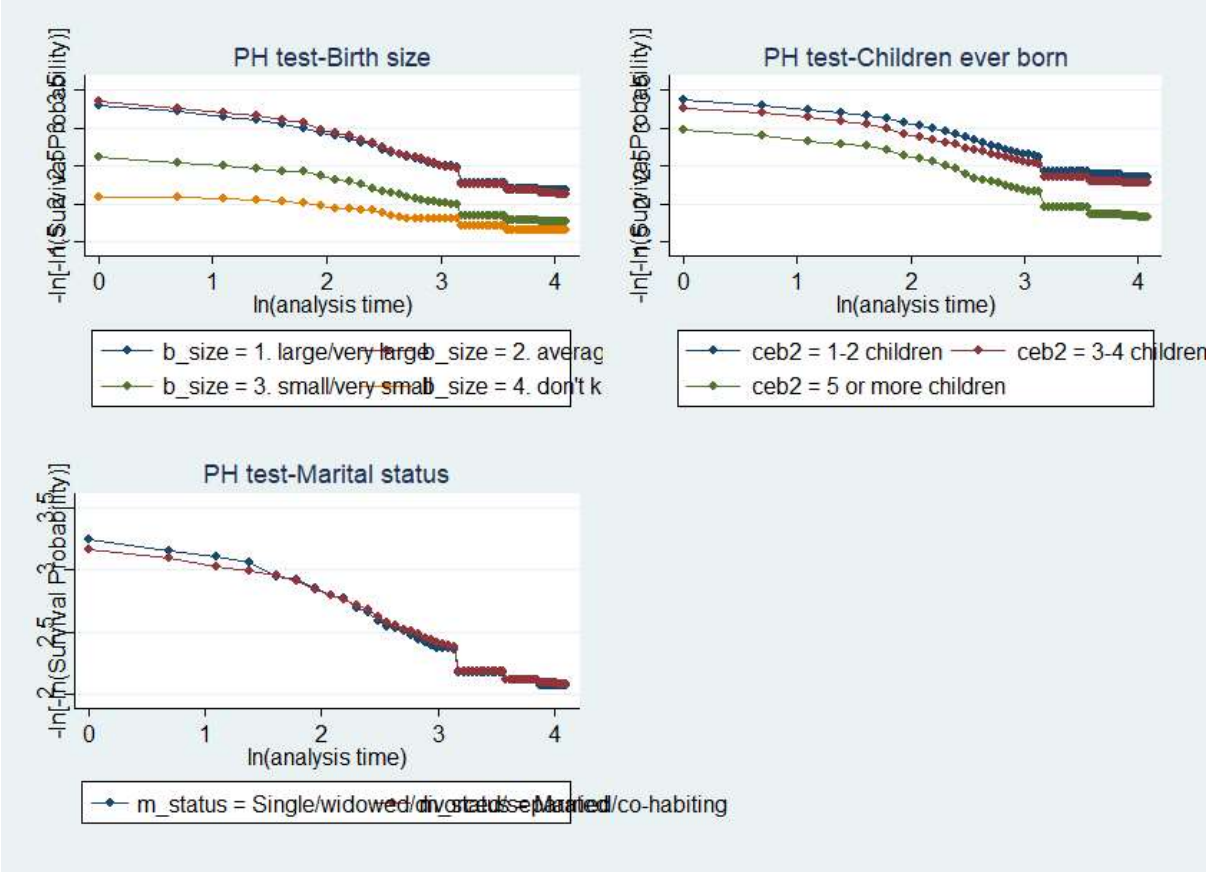

Figure D. 4: Proportional hazards tests for birth size, number of children ever born, and marital status

Table D. 1: Under-five survivor function in Nigeria, 2018 NDHS

Time (In months)	Beg. Total	Fail	Net Lost	Survivor function	Std. Error	95% Conf. Int.	
1	33924	1393	887	0.9589	0.0011	0.9568	0.9610
2	31644	102	477	0.9558	0.0011	0.9536	0.9580
3	31065	92	521	0.9530	0.0012	0.9507	0.9552
4	30452	57	531	0.9512	0.0012	0.9489	0.9535
5	29864	66	577	0.9491	0.0012	0.9467	0.9514
6	29221	70	589	0.9469	0.0012	0.9444	0.9492
7	28562	105	595	0.9434	0.0013	0.9408	0.9458
8	27862	70	560	0.9410	0.0013	0.9384	0.9435
9	27232	72	524	0.9385	0.0013	0.9359	0.9411
10	26636	71	462	0.9360	0.0014	0.9333	0.9386
11	26103	60	471	0.9339	0.0014	0.9311	0.9365
12	25572	108	562	0.9299	0.0014	0.9271	0.9327
13	24902	79	602	0.9270	0.0015	0.9241	0.9298
14	24221	53	577	0.9249	0.0015	0.9220	0.9278
15	23591	58	545	0.9227	0.0015	0.9197	0.9256
16	22988	34	539	0.9213	0.0015	0.9183	0.9242
17	22415	39	551	0.9197	0.0015	0.9166	0.9227
18	21825	52	548	0.9175	0.0016	0.9144	0.9205
19	21225	30	514	0.9162	0.0016	0.9131	0.9193
20	20681	39	486	0.9145	0.0016	0.9113	0.9176
21	20156	23	420	0.9134	0.0016	0.9102	0.9166
22	19713	13	374	0.9128	0.0016	0.9096	0.9160
23	19326	19	366	0.9119	0.0016	0.9087	0.9151
24	18941	374	520	0.8939	0.0019	0.8902	0.8975
25	18047	0	587	0.8939	0.0019	0.8902	0.8975
26	17460	0	538	0.8939	0.0019	0.8902	0.8975
27	16922	0	510	0.8939	0.0019	0.8902	0.8975
28	16412	0	501	0.8939	0.0019	0.8902	0.8975
29	15911	0	530	0.8939	0.0019	0.8902	0.8975
30	15381	0	520	0.8939	0.0019	0.8902	0.8975
31	14861	0	508	0.8939	0.0019	0.8902	0.8975
32	14353	0	470	0.8939	0.0019	0.8902	0.8975
33	13883	0	429	0.8939	0.0019	0.8902	0.8975
34	13454	0	376	0.8939	0.0019	0.8902	0.8975
35	13078	0	380	0.8939	0.0019	0.8902	0.8975
36	12698	113	448	0.8860	0.0020	0.8820	0.8898
37	12137	0	607	0.8860	0.0020	0.8820	0.8898
38	11530	0	557	0.8860	0.0020	0.8820	0.8898
39	10973	0	623	0.8860	0.0020	0.8820	0.8898
40	10350	0	528	0.8860	0.0020	0.8820	0.8898
41	9822	0	602	0.8860	0.0020	0.8820	0.8898

42	9220	0	600	0.8860	0.0020	0.8820	0.8898
43	8620	0	509	0.8860	0.0020	0.8820	0.8898
44	8111	0	483	0.8860	0.0020	0.8820	0.8898
45	7628	0	454	0.8860	0.0020	0.8820	0.8898
46	7174	0	425	0.8860	0.0020	0.8820	0.8898
47	6749	0	331	0.8860	0.0020	0.8820	0.8898
48	6418	17	458	0.8836	0.0021	0.8795	0.8876
49	5943	0	520	0.8836	0.0021	0.8795	0.8876
50	5423	0	576	0.8836	0.0021	0.8795	0.8876
51	4847	0	593	0.8836	0.0021	0.8795	0.8876
52	4254	0	569	0.8836	0.0021	0.8795	0.8876
53	3685	0	583	0.8836	0.0021	0.8795	0.8876
54	3102	0	551	0.8836	0.0021	0.8795	0.8876
55	2551	1	584	0.8833	0.0021	0.8791	0.8873
56	1966	1	537	0.8828	0.0021	0.8786	0.8869
57	1428	0	500	0.8828	0.0021	0.8786	0.8869
58	928	0	393	0.8828	0.0021	0.8786	0.8869
59	535	0	369	0.8828	0.0021	0.8786	0.8869
60	166	0	166	0.8828	0.0021	0.8786	0.8869

Table D. 2: Under-five survivor function by state, 2018 NDHS

	Survivor Function									
	Time (in months)									
State	**1**	**8**	**15**	**22**	**29**	**36**	**43**	**50**	**57**	**64**
North Central										
Benue	0.9747	0.9652	0.9598	0.9582	0.9564	0.9537	0.9537	0.9485	0.9485	.
FCT (Abuja)	0.9751	0.9589	0.9465	0.9409	0.9266	0.9266	0.9266	0.9266	0.9266	.
Kogi	0.9484	0.9255	0.8992	0.8902	0.8721	0.8614	0.8614	0.8472	0.8255	.
Kwara	0.9640	0.9545	0.9381	0.9360	0.9312	0.9312	0.9312	0.9312	0.9312	.
Nasarawa	0.9496	0.9277	0.9144	0.9092	0.8975	0.8830	0.8830	0.8773	0.8773	.
Niger	0.9557	0.9387	0.9273	0.9187	0.9104	0.9005	0.9005	0.9005	0.9005	.
Plateau	0.9573	0.9318	0.9087	0.9036	0.8956	0.8801	0.8801	0.8801	0.8801	.
North East										
Adamawa	0.9563	0.9320	0.9138	0.9107	0.8966	0.8911	0.8911	0.8861	0.8861	.
Bauchi	0.9542	0.9391	0.9185	0.9068	0.8801	0.8697	0.8697	0.8662	0.8662	.
Borno	0.9773	0.9638	0.9509	0.9446	0.9305	0.9264	0.9264	0.9264	0.9180	.
Gombe	0.9435	0.9124	0.8828	0.8719	0.8421	0.8368	0.8368	0.8368	0.8368	.
Taraba	0.9550	0.9402	0.9129	0.9090	0.8864	0.8737	0.8737	0.8737	0.8737	.
Yobe	0.9545	0.9265	0.9166	0.9131	0.8930	0.8893	0.8893	0.8860	0.8860	.
North West										
Jigawa	0.9474	0.9322	0.9067	0.8850	0.8307	0.8170	0.8170	0.8108	0.8108	.
Kaduna	0.9345	0.9131	0.8835	0.8674	0.8428	0.8316	0.8316	0.8286	0.8286	.
Kano	0.9568	0.9398	0.9158	0.8946	0.8611	0.8463	0.8463	0.8463	0.8463	.
Katsina	0.9646	0.9520	0.9226	0.8989	0.8688	0.8503	0.8503	0.8471	0.8471	.
Kebbi	0.9413	0.9029	0.8556	0.8311	0.7917	0.7758	0.7758	0.7725	0.7725	.
Sokoto	0.9507	0.9257	0.9006	0.8879	0.8565	0.8466	0.8466	0.8424	0.8424	.
Zamfara	0.9600	0.9368	0.9125	0.9062	0.8691	0.8630	0.8630	0.8630	0.8630	.
South East										
Abia	0.9579	0.9444	0.9389	0.9325	0.9300	0.9300	0.9300	0.9300	0.9300	.
Anambra	0.9801	0.9737	0.9680	0.9573	0.9532	0.9532	0.9532	0.9532	0.9532	.
Ebonyi	0.9684	0.9566	0.9417	0.9332	0.9237	0.9213	0.9213	0.9124	0.9124	.
Enugu	0.9643	0.9467	0.9335	0.9260	0.9260	0.9260	0.9260	0.9260	0.9260	.
Imo	0.9602	0.9366	0.9171	0.9041	0.8955	0.8923	0.8923	0.8923	0.8923	.
South South										
Akwa Ibom	0.9628	0.9302	0.9152	0.9101	0.9040	0.8998	0.8998	0.8998	0.8998	.

Bayelsa	0.9860	0.9766	0.9745	0.9717	0.9657	0.9657	0.9657	0.9657	0.9657	.
Cross River	0.9603	0.9425	0.9368	0.9332	0.9332	0.9332	0.9332	0.9332	0.9332	.
Delta	0.9803	0.9718	0.9642	0.9642	0.9574	0.9526	0.9526	0.9526	0.9526	.
Edo	0.9656	0.9537	0.9427	0.9396	0.9396	0.9347	0.9347	0.9347	0.9347	.
Rivers	0.9745	0.9615	0.9449	0.9427	0.9328	0.9291	0.9291	0.9291	0.9291	.
South West										
Ekiti	0.9349	0.9307	0.9194	0.9113	0.8893	0.8893	0.8893	0.8893	0.8893	.
Lagos	0.9554	0.9449	0.9449	0.9417	0.9397	0.9368	0.9368	0.9368	0.9368	.
Ogun	0.9862	0.9840	0.9816	0.9788	0.9788	0.9741	0.9741	0.9741	0.9741	.
Ondo	0.9742	0.9617	0.9570	0.9516	0.9427	0.9299	0.9299	0.9209	0.9209	.
Osun	0.9598	0.9490	0.9419	0.9390	0.9390	0.9342	0.9342	0.9342	0.9342	.
Oyo	0.9726	0.9609	0.9571	0.9549	0.9499	0.9427	0.9427	0.9361	0.9361	.

Table D. 3: Relative risks of under-five mortality by state, 2018 NDHS

States	Time at risk	Incidence rate	Relative risk	No. of subjects
North Central		**0.0029**	**1**	
Benue	26058	0.0015	0.5184	908
FCT (Abuja)	22947	0.0022	0.7547	803
Kogi	17067	0.0044	1.5221	620
Kwara	19660	0.0022	0.7576	694
Nasarawa	22703	0.0037	1.2663	834
Niger	32861	0.0031	1.0751	1219
Plateau	22191	0.0036	1.2487	797
North East		**0.0037**	**1**	
Adamawa	25588	0.0036	0.9604	962
Bauchi	38028	0.0040	1.0723	1442
Borno	32617	0.0021	0.5713	1099
Gombe	35161	0.0052	1.4132	1344
Taraba	30455	0.0037	1.0020	1112
Yobe	35283	0.0035	0.9338	1252
North West		**0.0050**	**1**	
Jigawa	40485	0.0053	1.0688	1502
Kaduna	38432	0.0053	1.0582	1451
Kano	55728	0.0044	0.8807	2037
Katsina	41967	0.0042	0.8401	1555
Kebbi	36355	0.0070	1.4051	1397
Sokoto	30350	0.0047	0.9439	1137
Zamfara	31334	0.0042	0.8503	1226
South East		**0.0024**	**1**	
Abia	17817	0.0024	0.9970	641
Anambra	23983	0.0014	0.5996	856
Ebonyi	28710	0.0024	1.0312	1012
Enugu	15756	0.0024	1.0200	561
Imo	20738	0.0033	1.4072	728
South South		**0.0020**	**1**	
Akwa Ibom	15347	0.0033	1.6234	564
Bayelsa	16440	0.0010	0.5153	570
Cross River	11837	0.0023	1.1366	428
Delta	14394	0.0014	0.6924	508
Edo	13389	0.0020	1.0048	465
Rivers	18784	0.0021	1.0611	667
South West		**0.0020**	**1**	
Ekiti	14467	0.0035	1.7570	522
Lagos	23609	0.0020	1.0133	807
Ogun	15014	0.0007	0.3651	508
Ondo	15548	0.0020	0.9937	542

Osun	14020	0.0021	1.0665	498
Oyo	19018	0.0017	0.8648	656
Total	**934141**	**0.0034**		**33924**