Essays on Child Health Disparities in Nigeria

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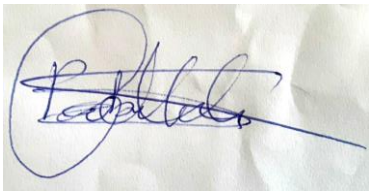
Declaration

This thesis is my original work and has not been presented for a degree in any other University



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Dedication

This work is dedicated to my husband: Dr. Ayobami Okanlawon Adesuyi and to my father: Prof David Oladipo Babalola, my mother Dr Rachel Babalola, My children Ayonitemi Michael Adesuyi and Ayodeji Gabriel Adesuyi.

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Abbreviations and Acronyms

2SLSPM	Two Stage Least Square Probit Model
AHU	Attitude towards health care service utilization
AR-S	Adjusted R-Squared
BDHS	Bangladesh Demographic and Health Survey
C./S.E.	Coefficient/ Standard Error
CI	Concentration Index
DALYs	Disability-Adjusted Life Years
DRC	Democratic Republic of Congo
EA	Enumeration Areas
EM	Exposure to Media
EST	Ecological Systems Theory
FCT	Federal Capital Territory
GHS	General Household Survey
GPR	Generalized Poisson Regression
HAZ	Height-for-Age
IC	International Children's Fund
iCCM	integrated Community Case Management
IMCI	Integrated Management of Childhood Illness
IMNCH	Integrated Maternal, Newborn and Child Health
IR	Individual Record
ISA	Integrated Surveys on Agriculture
KMO	Kaiser-Meyer-Olkin
LBW	Low Birth Weight

LGAs	Local Government Areas
LSMS	Living Standards Measurement Study
MDG	Millennium Development Goal
MES	Maternal Employment Status
MRB	Mother's Reproductive Behaviors
NBS	National Bureau of Statistics
NBS-NG	National Bureau of Statistics, Nigeria
NC	North Central
NCHS	National Center for Health Statistics
NDHS	Nigerian Demographic and Health Survey
NE	North East
NICHQ	National Institute for Children's Health Quality)
NW	North West
OPHI	Oxford Poverty and Human Development Initiative
OR	Odds Ratios
P > F	P-Value > F-statistic
PV	P Value
PCA	Principal Component Analysis
PSU	Primary Sampling Units
R. MSE	Root MSE
RR	Risk-Ratio
R-S	R- Squared
S.1	Stage One
S.2	Stage Two

SAC	Spatial Autocorrelation
SDGs	Sustainable Development Goals
SE	South East
SES	Socio-economic Status
SS	South South
SW	South West
U5M	Under-Five Mortality
U5MR	Under-Five Mortality Rate
UN	United Nations
UNDP	United Nations Development Programme
UNFPA	United Nations Population Fund
UNICEF	United Nations Children's Fund
WARDC	Women Advocacy Research and Documentation Centre
WAZ	Weight-for-Age
WB	World Bank
WE	Women (mother's) Empowerment
WHO	World Health Organization
WHZ	Weight-for-Height

Abstract

The United Nations has identified equity in health as a marker of overall development. Disparities abound in almost every facet in Nigeria, but disparities in the health sector, especially child health (i.e. child health care access, provision, and other factors connected with child health such as socio-economic status, maternal education, environmental and cultural factors) are of uttermost concern. Unfortunately, Nigeria is one of the nations with very high rates of child malnutrition and under-five mortality (U5M) in the world. The objectives of this study are to evaluate the relationship between the disparities in under-five child malnutrition and the socio-economic status in Nigeria; analyze the relationship between the disparities in U5M and maternal education in Nigeria; and analyze the profiles of the hotspots of U5M and their relationship to the main factors contributing to the high under-five mortality in the hot spots, such as poverty, religion, selected maternal and environmental variables in Nigeria. The study is divided into three essays, each essay for each objective. The first essay used the concentration index to examine the extent of malnutrition of under-five year children in Nigeria, while Z-scores were used to analyze the occurrence of stunting, wasting and underweight, using data from the LSMS/General Household Survey (GHS) 2015/2016 Nigeria. Essay two and three made use of the 2013 NDHS data, while using the following methodologies: two stage least square with an instrument to take care of the endogeneity; moderation and mediation methodologies to estimate the pathways to which maternal education affects under-five mortality; the concentration index to analyze the magnitude of the U5M in different categories and zones; the Moran's I to test for autocorrelation and finally the two stage least square to analyze the effects of the factors contributing to the high U5M in the hotspots in Nigeria. The findings revealed that stunted children had the highest percentage, followed by the percentage of underweight children, and lastly, the percentage of children wasted. The percentages of the three malnutrition measures were considerably larger in male children compared to female children. Stunting and underweight were responsive to household socio-economic status. A higher percentage of children under age five who were stunted, wasted and underweight lived in the rural areas of Nigeria compared to those residing in the metropolitan areas. The rate of stunting was highest in the North-West, followed by North-East, and lowest in the South-South. The concentration indices analysis revealed that stunting, wasting and underweight all had negative signs, signifying concentration among the poor household children. Finally, as one moves up the ladder of the socio-economic status, a significant fall in the rate of stunting is witnessed. An inverse relationship was observed between mother's education and under-five mortality. The levels of maternal education variables (secondary, primary and no education) were highly significant at one percent levels, and all had negative signs, implying an inverse relationship between maternal education and under-five mortality. It was observed that as one moved towards higher education, the impact on under-five mortality was reducing; in other words, the higher the education of the mothers, the lower the under-five mortality. Also, socio-economic status (SES) pathway was the most significant and important mediator/moderator between mother's education and under-five mortality. Spatial dependence across the study area was confirmed with Moran's I testing positive (0.4689 and a P-value of 0.01), an indication of the presence of autocorrelation. Six states, namely Zamfara, Bauchi, Jigawa, Sokoto, Kebbi and Katsina were identified as having the highest U5M, ranging from 162-221 deaths per 1000 live births from the spatial analysis. The variables identified as contributing to the high under-five

mortalities in these states were maternal education, age of the mother, religion, wealth index, antenatal visits, hospital delivery, post-natal visit, age at first birth, partner's education, distance to the nearest health care center and sanitation (flush toilet), and piped water. However, the age of the mother and age at first birth were relatively significant and consistent across the six states under examination. The six states were also observed to be part of the poorest states in the country. In conclusion, disparities in child health in Nigeria can be minimized through targeted policies: on poverty alleviation, on good nutrition and under-five healthcare provision, on factors that can improve socio-economic status, on a nationally enforceable minimum age for marriage, and by investing in health education for women and children.

CHAPTER 1: INTRODUCTION AND CONTEXT

1.1 Background to the Study

In 2015, the world began working towards a new global growth agenda by 2030. The United Nations had goals four and five in the Millennium Development Goals (MDGs) to reduce under-five mortality rate and improve maternal health; and yet still have it as SDG Target 3.2 in the Sustainable Development Goals for 2030, which is to end by the year 2030 preventable deaths of newborns and children under 5 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-5 mortality to at least as low as 25 per 1,000 live births (UNICEF, 2015).

Research such as this are of essence in helping meet this goal because the foundation and strength of any country is in its citizens, and the strength of its citizens resides in their health. Healthy citizens build a healthy and strong nation (Heiligman, 1940). However, it is difficult to build a strong nation when there are inequities in health among the citizens, especially the vulnerable – mothers and children. There is sufficient proof that social factors, such as employment status, education, wages and wealth, ethnic groups and gender have a noticeable effect on the health of an individual (Keeley, 2015).

Disparities in health status cut across socio-economic status and nations, regardless of the level of growth. The prevalence or magnitude, however, varies from one country to another (World Social Report, 2020). The United Nations (UN) has argued that fairness in health is an indicator of comprehensive development. Therefore, health disparities have been defined as variances in health care that are needless, prejudiced, partial and preventable (Braveman and Gruskin, 2003). It is this notion that advocates the necessity, in less developed countries, to center health fairness growth programmes on making better distribution of fairness of health care resources, especially among women and children (Orach, 2009).

Over the years, it has been observed that children are most susceptible and vulnerable between ages zero and five. Children under five years are susceptible to different kinds of diseases and infections that could ultimately lead to their death (WHO, 2018), and such conditions include

malaria, diarrhea, pneumonia, and malnutrition, among others. However, malnutrition (stunting, wasting and underweight) is responsible for around 45% of deaths among under-five year children (WHO, 2018). The global dilemma of stunted growth can be seen with the aid of information shown in Table 1.1 by a joint estimate by the WHO, UNICEF and World Bank (2017). An estimated 155 million children (22.9%) under five years of age were stunted in 2016. More than 90% of all stunted children in the world live in Africa and Asia.

Table 1.1: Estimated prevalence (%) of stunted school children, 1990-2020

UN region/sub region	1990	1995	2000	2005	2010	2016	2020
Africa	40.3	39.8	39.3	38.8	38.2	37.8	37.1
North Africa	29.4	27.4	25.5	23.7	21.9	20.3	18.7
Eastern	48.1	47.4	46.7	46	45.3	44.6	43.9
Middle	45.3	43.8	42.3	40.8	39.4	37.9	36.5
Southern	35.4	34.7	34.1	33.5	32.9	32.3	31.7
Western	38.4	38.1	38.1	38.1	38.2	38.2	38.2
Asia	48.6	43.1	37.7	32.6	27.6	22.9	19
Latin America and Caribbean	23.7	20.9	18.1	15.7	13.5	11.6	10
Oceania	n/a	39.8	39.1	38.5	37.8	n/a	n/a
All developing countries	44.4	40.1	36.1	32.5	29.2	26.2	23.7
Developed countries	6	6	6	6	6	6	6
Global	39.7	36.3	32.9	29.7	26.7	24.1	21.8

n/a – no data available

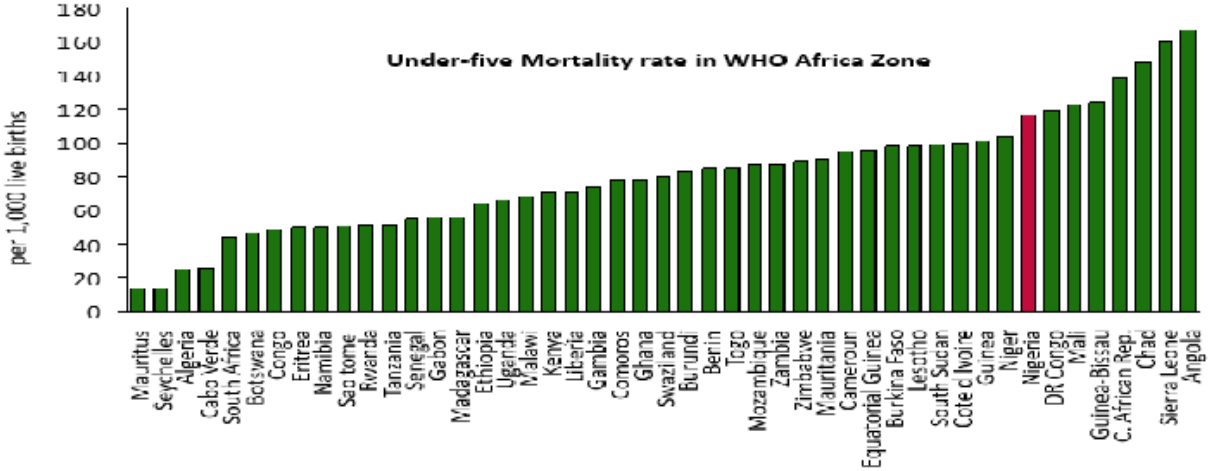
Source: Adapted from WHO global database on child growth and malnutrition

This high prevalence remains a huge public health burden that requires urgent attention. In developing countries, deeply rooted in poverty and starvation, stunting (low height-for-age) is more prevalent than underweight (low weight-for-age) and wasting (low weight-for height) as an increase in height responds faster to diet quality than a gain in weight (WHO, 2020).

Disparities in malnutrition related to various background characteristics are significant in Nigeria, but are often more pronounced for stunting, which is a long-term indicator of malnutrition. Sadly, Nigeria has the second highest number of children who are malnourished (UNICEF, 2018). Malnutrition hinders children from attaining their full potential, and it could have irreversible consequences on their health. Research has shown that the root cause of malnutrition is the disparity in an individual's or household's socio-economic status (Poel *et al.*, 2008). Evidence shows that the higher an individual's socio-economic status, the lower the risk of child malnutrition (Poel *et al.*, 2008).

Research has also shown that the early years of a child, especially ages one to five, are crucial as this is the formative years of a child and the most vulnerable years. In 2018, despite significant growth in decreasing under-five mortality, an estimated 5.3 million of them died mostly in Sub-Saharan Africa (UNICEF, 2018). Nigeria is one of the top countries by under-5 mortality rate in the world and in Africa (refer to Figure 1.1). As of 2019, under-5 mortality rate in Nigeria was 117.2 deaths per thousand live births. The top countries also include Algeria, Guinea Bissau, Chad, Central African Republic, and Sierra Leone.

Figure 1.1: Under-5 mortality rate in WHO Africa



Source: WHO data

The high malnutrition and under-five mortality rates in Nigeria is likely attributed to failure of the government in effectively addressing the challenges facing children's health; poor public health facilities, which are largely due to a weak medical system; high poverty levels; political uncertainty; corruption; inadequate institutional capability; and an unstable economy. These factors are accountable for the pitiable development of medical services in the country and have added to the insistent and high level of health disparities in children under the age of five (Aregbeshola, 2018).

Even though the government has put in place several policies and programmes to reduce under-five mortality, the disparities in the health of under-five children remains high. Such policies include the National Child Health Policy of 2006, which covers newborn, under-five and school-age children. Examples of agencies and programmes set up to implement these policies include: National Primary Health Care Development Agency (NPHCDA), National Malaria Control Programme (NMCP), Integrated Maternal, and Newborn and Child Health (IMNCH) (Kana *et al.,* 2015), among others.

However, despite all these policies, programmes and agencies in place, the under-five health disparity in Nigeria is still high, while households and individuals in the country continue to bear the most burden of the inequitable health system and medical services that are not affordable to the majority of people (Aregbeshola, 2018). This study examines health disparities in children under age five in Nigeria.

1.2 Statement of the Problem

With almost 200 million citizens, and the seventh largest population in the World, Nigeria has the biggest economy in Africa. Both the Government and private sector manage the health care system, with more than 65% of facilities owned by the private sector. However, despite the existence of a robust health care system in the country, and a robust cultural and religious heritage, Nigeria has been on the list of the top ten countries with the highest under-five mortality in the world (WHO, 2020). Inequalities rank top in the list as a likely cause of these mortalities among under-five children. Inequality persists in income, health services, education and virtually almost every aspect of the country (Cha and Jin, 2020).

According to the Nigeria Demographic and Health Survey (NDHS) 2013, about one in every eight children in Nigeria dies before their fifth birthday ((UNICEF/WHO/World Bank/UN, 2013).

Table 1.2: Under-5 mortality trend in Nigeria

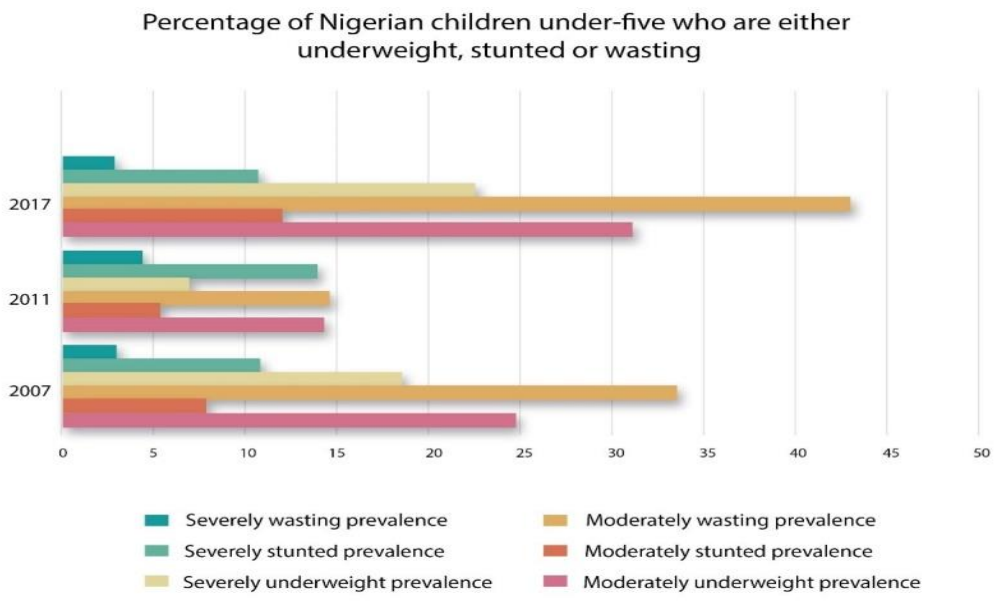
2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
135	133	131	129	128	126	125	122	120	117

Source: World Bank (2020) Database

Although the under-five (U5) death rate has declined from 129/1000 live births in 2013 to 117/1000 live births in 2019 (Table 1.2), the probability of dying between the day of birth and the age of five remains high (World Bank, 2019) and several factors may have contributed to this high mortality rates, including high population size, malnutrition, maternal education, inadequate health care facilities, maternal age at birth, environmental and cultural factors, income inequalities, disparities in socio-economic status, economic instability, the insurgency of the crisis in the north by the Boko Haram, to name a few (Emmanuelar, 2015).

Malnutrition is known as a major contributor to under-five mortality in Nigeria, and it remains a serious health issue among under-five children. For instance, in 2016, UNICEF reported that over 2.5 million children experienced severe malnutrition in Nigeria, a figure that calls for attention by planners and policy makers. Malnutrition is associated with the social-economic situation of a nation (Masters, 2016). For Nigeria, socio-economic development across its 36 states is not uniform due to differences in urbanization, commercial developments, poverty and continued decline in living conditions of the people.

Figure 1.2: Stunted growth in children under-5 in Nigeria



Source: UNICEF (2017), National Bureau of Statistics (2017)

Figure 1.2 shows summary statistics on the prevalence of moderate and severe underweight, stunting and wasting in children under-five in Nigeria (UNICEF, 2017; National Bureau of Statistics 2017). What stands out in the chart for Nigeria is the increasing trend of malnutrition in the under-fives over the years from 2011-2017 (Emmanuelar, 2015).

Although attempts have been made to examine inequalities in the under-five children in Nigeria, (Fotso, 2006; Poel *et al.,* 2007; Uthman, 2007; 2008 and 2009), malnutrition and under-five mortality persists, and there are hardly studies that have tried to quantify and examine the degree or extent of inequalities in malnutrition and under-five mortalities in Nigeria. Under-five mortalities are ascribable to mother's education, the influence of formal maternal education on under-five mortality, and mother's education. When it comes to measuring the growth of a nation, child health is one of the major indicators and under-five mortality is a commonly used tool in assessing child health. The major causes of child mortality in Nigeria and other growing nations are mostly avoidable and curable because the mortality happens mainly due to factors associated with low level of growth. This renders the under-five mortality a developmental issue.

Therefore, it is important to assess the effect of the magnitude of mothers' education on infant deaths, and to quantify the magnitude of inequities in under-five deaths ascribable to mothers' level of education, while checking for factors contributing to the high mortality, and recommend possible policy solutions.

The study, therefore, fills the knowledge gap and is well connected to the objectives, the research findings and recommendations. The objective of the research is to investigate the extent of health disparities in Nigeria and its effect on malnutrition and under five mortality, and add to the pool of information concerning the decline of disparities in health outcomes especially in child mortality. The study addressed the following research questions:

(i) What is the extent of inequality in under-five children malnutrition, especially those attributed to socio-economic statuses?
(ii) What are the levels of inequalities in under-five mortality ascribable to maternal level of education?
(iii) Does under-five mortality vary by region or state?
(iv) What factors contribute to the high under-five mortality in Nigeria?

1.3 Objectives of the Thesis

The overall objective of this thesis is to identify, analyze and quantify disparities in under-five health indicators in Nigeria. The specific objectives are:

(i) To evaluate the relationship between disparities in under-five child malnutrition and the socio-economic status in Nigeria.
(ii) To analyze the relationship between the disparities in under-five mortality and maternal education in Nigeria.
(iii) To analyze under-five mortality by region or state?
(iv) To analyze factors contributing to the high under-five mortality in Nigeria?
(v) To analyze the profiles of the hotspots of under-five mortality and their relationship to maternal, environmental and cultural factors contributing to the high under-five mortality in Nigeria.
(vi) To identify policy implications based on the study findings.

1.4 Contribution of the Thesis and Policy Implications

There are several contributions this study has made to literature and policy formations. The thesis contributes towards several policies that can help in reducing child health disparities in Nigeria. First, valuable information was determined for policy decisions by examining the socio-economic factors of child inequalities in Nigeria. Second, when poverty is discussed, rural areas are usually the focus. However, the study proposed targeted policies for the urban poor as well, and not just the rural poor. Third, because there could be irreversible damages caused to the developmental progress of a child under age five, it is important for the Government and other policy makers to have targeted policies (such as supplying lunch or milk at school) that will help give better nutrition to under-five children.

Four, socio-economic status has more implications on stunting than just a medical one; consequently, a more aggressive implementation of income-generating projects should be put in place by the Government to curb disparities in socio-economic status. Five, policies for investing in formal maternal education could be put in place by the Government and other policy makers, since an inverse relation was established between mother's formal schooling and under-five children's deaths. Policies such as fees reduction for women at the higher educational levels, lower entry scores for females to increase female enrolment at schools, among others, are needed. Six, after moderation and mediation analysis, the socio-economic pathway was found to be the most important because of its significance.

Therefore, policies that can help advance socio-economic status could be paramount to law makers, as this will help reduce the under-five mortality situation. Seven, specific intervention policies should be made for the six northern states with the highest under-five mortality in the country. The Sharia law on child marriages should be abolished, as this is a major contributor to the high under-five mortality and maternal mortality. Finally, poverty alleviation schemes, programmes and policies will help bring an end to these under-five mortality hotspot zones, as this is the bedrock reason for the occurrence of high under-five mortality in the affected zones.

Therefore, this thesis contributes to existing literature by providing evidence on disparities in malnutrition in under-5 years of age, inequality in mortality of under-five ascribable to maternal

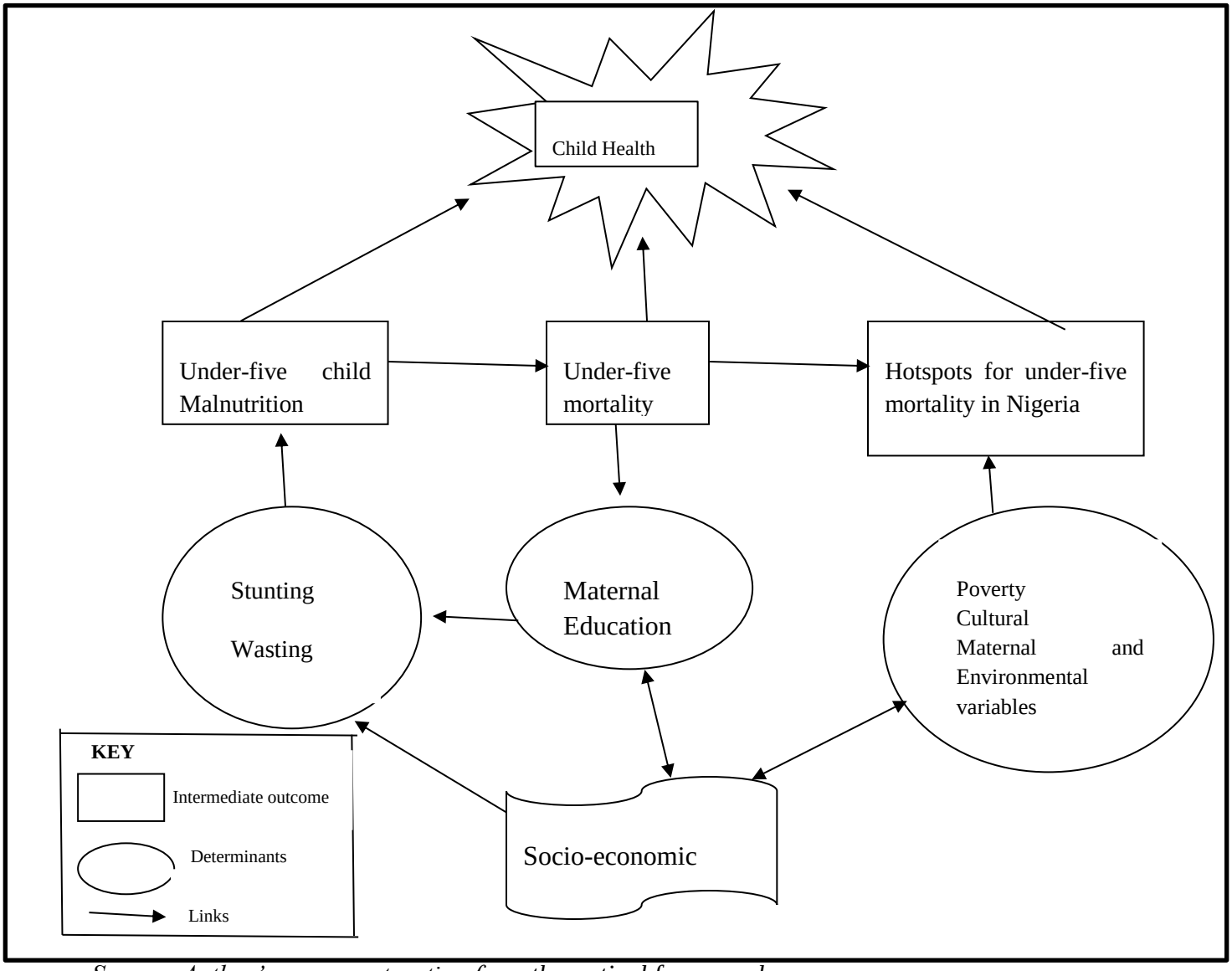
education, and the identified hot spots for under-5 deaths in Nigeria while checking the main maternal, cultural and environmental factors contributing to it, while doing a more rigorous analysis using the most recent data, and by comparing results with previous studies.

1.5 Conceptual Framework of the Study

Under-five child malnutrition and under-five child mortality both contribute to child disparities in children in Nigeria. However, the root of these disparities stems from the (low) socio-economic status of individuals/households, leading to low or inadequate provision of essential and balanced nutritional requirements for children, which in turn leads to malnutrition. Children at a tender age are usually vulnerable and prone to malnutrition and other diseases and sicknesses that could be physiological or otherwise. If these conditions are not managed properly, it could lead to the ultimate death of the children.

Figure 1.3 shows that the issue of child disparities starts from the foundation, which is the home or household, and it begins with the socio-economic status of a family. The socio-economic status of a household will usually determine the nutritional values and intake of a child. The maternal education and the socio-economic status of the household could affect vice versa (hence the two-way arrow heads); in other words, the mother's schooling could determine a family's financial status, and the financial rank of a family could also determine the academic achievement level and exposure of a mother, which in turn has an effect on the nutritional values that a child will be given, and which could lead to stunting, wasting and underweight if not properly handled. Socio-economic status of a household could also have an effect on the kind of environment the family will live in, the cultural practices they will engage in, the maternal issues and the poverty level of the household, and vice versa (hence the two-way arrow). All these are determinants of socio-economic status, and they lead to intermediate outcomes such as under-5 years malnutrition, under-5 deaths and concentration (hotspots) of under-5 deaths in Nigeria. These intermediate outcomes ultimately lead to child health disparities in the country.

Figure 1.3: Conceptual framework of the thesis



Source: Author's own construction from theoretical framework

1.6 Methodological Approach

This research used a series of methods to accomplish its objectives. To address the first objective, concentration index was used to analyze the extent of malnutrition of under-five year olds in Nigeria, while Z-scores were used to analyze the occurrence of stunting, wasting and underweight. To analyze the second objective, the two-stage least square was used because of the endogeneity problem, which stems from possible association between the error terms of mother's

education. To estimate the pathways to which maternal education affects under-five mortality, moderation (using stepwise probit regression analysis) and mediation effects (using Sobel-Goodman mediation test) methodologies were used, while analysis of the magnitude of the under-five mortality in different categories and zones was done using the concentration index. Finally, to address the third objective of determining the factors contributing to high under-five mortality in the hotspots in Nigeria, the Moran's I was used to test for autocorrelation, while the Two Stage Least Squares approach was used to analyze the effects of maternal, cultural and environmental variables while taking care of endogeneity.

1.7 Data Types and Sources

To analyze the first objective, which is to evaluate disparities in malnutrition for children under-five years, the study mainly used data from Nigeria LSMS/General Household Survey (GHS) 2015/2016.

The data used in essay two and three examining the disparities in the mortality of under-five children, the influence of mother's schooling and the cultural, maternal and environmental factors contributing to the high mortality, the study utilized data from the 2013 NDHS reports.

1.8 Structure of the Thesis

The other parts of this research are organized as follows: Chapter two examines the disparities in under-five malnutrition ascribable to socio-economic status. Chapter three analyzes disparities in under-five mortality ascribable to maternal level of education in Nigeria, which is the second essay and addresses the second objective. Chapter four presents hotspots for under-five mortality in Nigeria, the main factors responsible for increased under-five mortality in these hot spots, which is the third essay, and addresses the third objective. Finally, chapter five presents the conclusion and summary of the thesis.

CHAPTER TWO: SOCIO-ECONOMIC DISPARITIES OF UNDER-FIVE CHILD MALNUTRITION IN NIGERIA

2.1 Introduction

There has been more attention given over the years in socio-economic injustices in health, with individual countries and international groups renewing their efforts to restitute the health of the less fortunate and vulnerable in the society (Wagstaff, 2000; Gwatkin, 2000).

Children, especially under-fives in Nigeria, are vulnerable to many conditions and diseases that eventually lead to mortality due to their socio-economic status. The reason is not far-fetched from the inequality in socio-economic status among Nigerians, and low immune system. Some common conditions in children under-five years include chronic diarrhea, which affects close to 1.3 million episodes. Worldwide, close to 4 million people die due to preventable conditions. Over 80% deaths occur in Sub-Saharan countries. Worldwide, 300-500 million malaria cases are reported annually, with 80% occurring in Africa alone, resulting in about 0.7-2.5 million deaths in Africa. Nigeria ranks among the top 45 nations that contribute to 94% of the global life losses due to measles (Dadonaite and Ritchie, 2018).

In Nigeria, measles has a dominance of 1.3-5.1% of all pediatric records. However, most of these diseases and sicknesses are linked to malnutrition (Saunders and Smith, 2010). Poverty is a major cause of malnutrition, which has its roots from the socio-economic status of individuals and households.

Studies have shown the existence of a contrary relationship between socio-economic rank and malnutrition, sickness, and mortality (Chaturvedi *et al.,* 1998; Dray-Spira *et al.,* 2010; Secrest *et al.,* 2011; Wyk and Bradshaw, 2017). As the level of socio-economic status increases, malnutrition, illness and mortality decreases. This is because of inequality in socio-economic status, hence unfairness in healthcare sector within or among countries.

One indicator used by the World Health Organization (WHO) for household health and determination of child survival is the diet of babies under age five (Thomas *et al.,* 1990). Infant

dietary deficiency is among the leading causes of children mortality (Pelletier, 1995). Infant malnutrition is a predominant public health concern in growing nations, like some countries in Africa (de Onis *et al.,* 2012; Stevens *et al.,* 2012). There are 17.6 million babies in this African region suffering from chronic malnutrition (World Bank, 2016). In 2015, about 7.7% of babies died from malnutrition globally, 24.5% had under-heights whereas 15% had low weight. Sub-Saharan region and part of South-East Asia have reported many instances of malnutrition, with the former accounting for about 39.4% of under-heights, 24.9% of low weight and 10.3% children dying under five years (WHO, 2016). There was an increase in Sub-Saharan Africa from 181 million in 2010 to 272 million in 2016 due to the predominance of undernourishment in children. The malnutrition of children continued to rise over the years, with stunted children rising from 50.6 million children to 58.8 million; for wasted children it was 13.8 million; while children with weight problems were 9.7 million from 6.6 million, between the year 2000 to the year 2017 (UNICEF/ WHO/WB, 2018; Food and Agriculture Organization – FAO, 2018).

In Nigeria, close to 2.5 million children suffer from chronic malnutrition. Statistics showed that about 7.2% of children were wasted, 32.9% were stunted, and 19.4% were underweight (UNICEF, 2016). Thus, given the high level of inequalities among its states and provinces, it is anticipated that there will be mortality and morbidity differentials related to socio-economic status.

As pointed out earlier, there are six geopolitical zones in Nigeria, and they are diverse in economic development. According to Uthman (2009), the Northern regions (East and West) are largely agricultural farming areas and primarily rural. The populace has low level of education. The central part of the Northern province is a third developed. The eastern part of the Southern region is somewhat more developed than the northern regions. The Southern part of the Western part, which includes the previous federal capital territory, Lagos, is the most urbanized out of the six regions. The South South area is the least developed of the three southern areas. Therefore, the widely varied under-5 malnutrition disparities found in this study is not unexpected. The southern part of Nigeria receives about two times the yearly precipitation of the northern areas, hence rainfall becomes scarcer as you move up north (Kandala *et al.,* 2007). This informs the

type of agricultural activities practiced in the various regions, with intensive farming found in the southern part of the country.

Therefore, childhood malnutrition is worse in the Northern region because of the desert drought, which is likely one of the most prominent causes for such in the Northern regions of the country. Sometimes, the country experiences food crisis due to scarcity of rainfall, compelling people to eat unhealthy food and drink contaminated water, thereby affecting feeding practices. The western region, which is the most urbanized, has the lowest rates of malnutrition. This is possibly due to the educational levels of parents, who are likely to be more knowledgeable in child health care, enjoy better living conditions, have access to better agricultural produce, and have access to better medical care, which could translate into a lower prevalence of under-five malnutrition.

To reduce these health inequalities, the federal state and local governments have to formulate policies that will help eradicate or reduce health inequalities to the barest minimum. Analysis from this essay one seeks to add to the existing literature by looking at disparities in under-five children in Nigeria by determining the severity of these disparities in malnutrition of children under age five, which emanate from socio-economic status.

This chapter therefore seeks to analyze the socio-economic disparities in under-five child malnutrition in Nigeria. The specific aims of this chapter are: first, to evaluate and quantify the prevalence and extent of malnutrition in under five children and the relationship to socio-economic status across the 6 zones in Nigeria; and second, to recommend on the policy based on study findings.

2.2 Literature Review

This section discusses the theoretical foundations that form the basis of analysis of socio-economic disparities in under-five child malnutrition in Nigeria, in which two models/theories and their applications are reviewed. It also presents a review of existing empirical literature to identify the variables and methodologies in the literature relevant for this study.

2.2.1 Theoretical approaches

Inequalities in health outcomes among the less fortunate and the well-off are exceedingly arousing interest from academicians and legislators, as a result fostering a significant development in information on health equity (Braveman, 2002; Wagstaff, 2000; Gwatkin, 2000). Socio-economic inequality in malnutrition means the extent to which childhood under-nutrition cases diverge between more and less socially and economically merited groups (Poel *et al.*, 2008).

Two models that explain child malnutrition (under nourishment and overweight) are reviewed in this section. The models by Davison and Birch (2001), and the framework proposed by UNICEF (1990) recognize the various causes of childhood malnutrition conditions and the complicated interplay among family and societal-level variables. Proximate variables encompass the relationship condition of child and mother, such as parity and specific baby-care behaviours such as feeding programmes. Family variables consist of earnings, family structure and scholastic achievement, which may be significant to attaining food security. Societal-level variables comprise of the right to use fresh water, cleanliness and health services. Rudimentary sources of poor nourishment include communal organizations and procedures that disregard human privileges and propagate poverty, restraining or repudiating the access of susceptible populaces to vital resources. Communal, monetary, and governmental factors can have a lasting effect on motherhood and babyhood under nutrition. Moreover, chronic under nutrition can lead to poverty, creating a vicious cycle (World Bank, 2006).

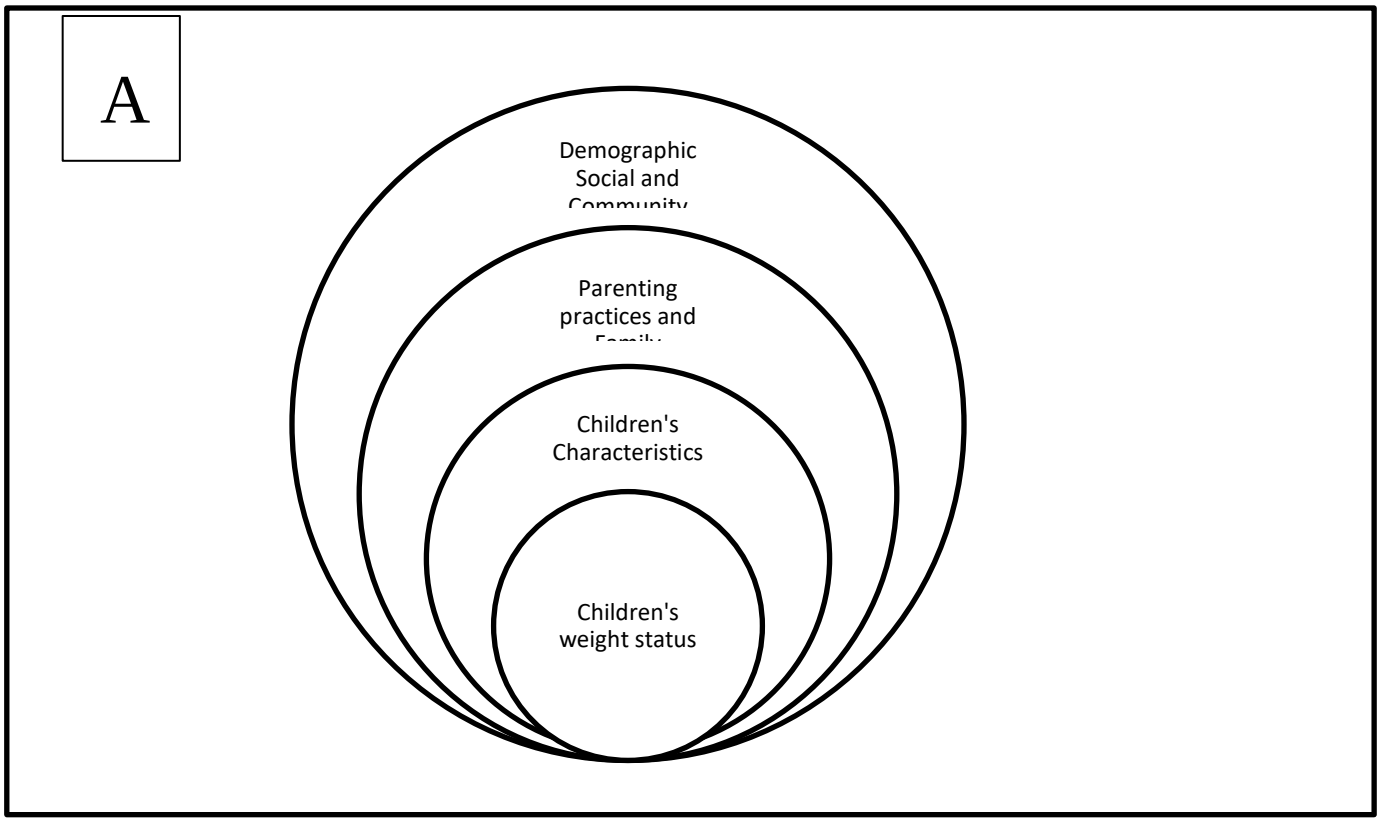
Just like other developing countries, Nigeria has her own share of under-5 nutritional problems. The nutritional problem in Nigeria tilts towards under-nutrition, and therefore the UNICEF (1990) framework is more applicable, even though the interplay of child characteristics, parenting styles and the community and communal features in the Davison and Birch (2001) model applies.

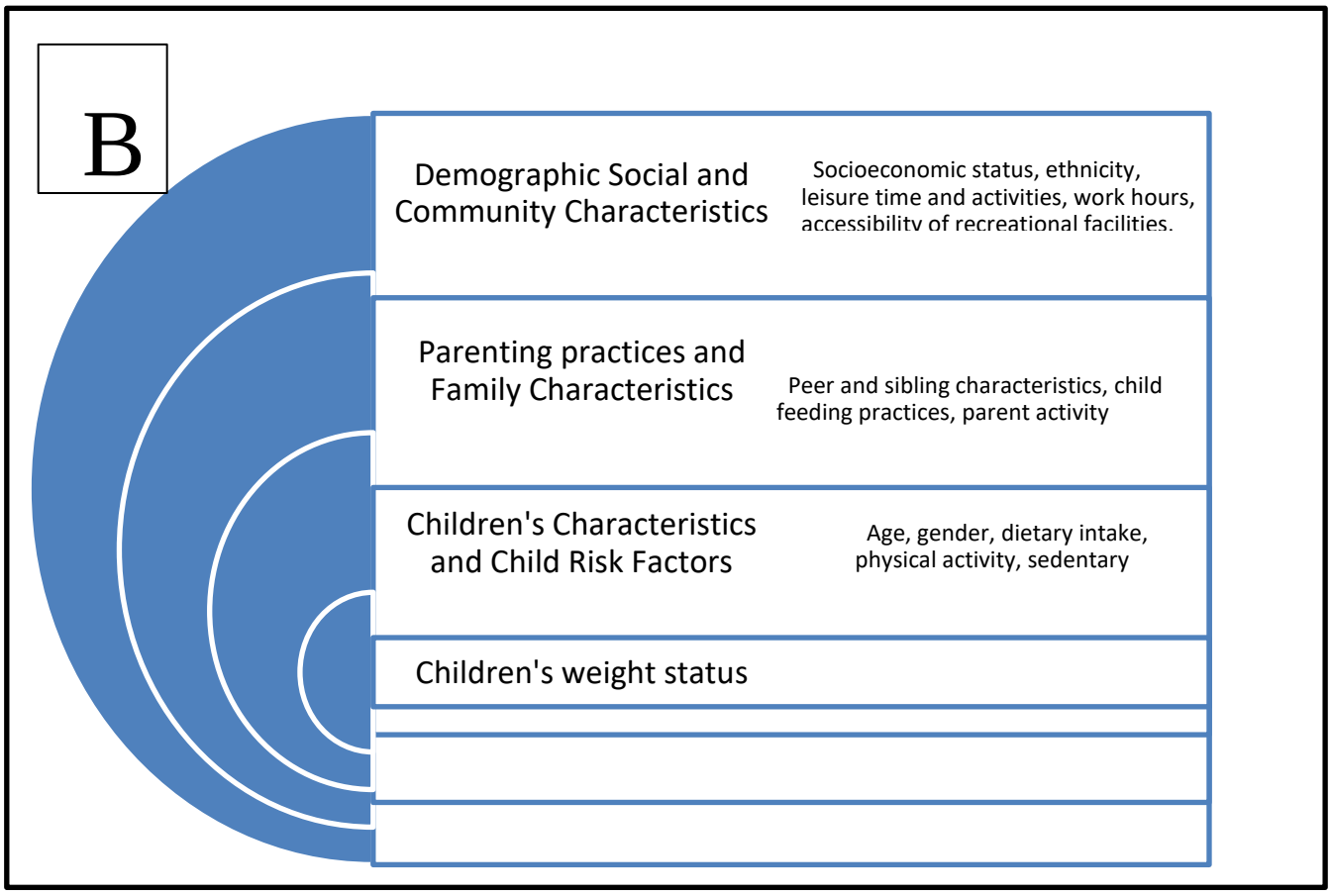
2.2.1.1 Davison and Birch and Mosley and Chen models

This model is centred on childhood overweight, which is believed to have doubled over the past two decades. The development of childhood overweight involves a complex set of factors from

multiple contexts that interact with each other to place a child at risk of overweight. This multifaceted system can be conceptualized using Ecological Systems Theory (EST). According to EST, development, or change in individual characteristics cannot be effectively explained without consideration of the context, or ecological niche in which the person is embedded in to understand the emergence of a particular characteristic. In the case of a child, the ecological niche includes the family and the school, which are in turn embedded in larger social contexts, including the community and society at large. In the case of a child, the ecological niche includes the family and the school, which are in turn embedded in larger social contexts including the community and society in general. In addition to these larger contexts, characteristics particular to the child, such as gender and age, interact with household and societal characteristics to influence development. Therefore, this development occurs because of interactions within and among these contexts; that is, characteristics of the child interact with processes in the family and the school, which themselves are influenced by characteristics of the community and society at large. These interactions are further illustrated in Figure 2.1 (A and B).

Figure 2.1: Children's dietary patterns and child characteristics (A and B)





Source: Davison and Birch (2001)

Children's nutritional configurations are central in the growth of overweight as extra caloric consumption, comparative to energy spending, will yield into the storing of energy as fat, ultimately resulting to extreme intensities of fat in the body. Meanwhile, the weight gain of a child is linked to the characteristics or traits of the family (such as obese parents), degree of development, and sex of the kid. Therefore, there is a likely different in the function of the characteristics of children as a result of the association between children's nutritional forms and weight status.

Parenting styles and family characteristics: within a household, a child's nutritional pattern changes, and it is not a thing of surprise that the nutritional intake of parents and children have similar patterns, and similar taste patterns, food preferences, all which could be genetic. Other

factors that may influence parent-child nutritional intake and preferences include nutritional knowledge of the parents, available foods within the reach of the parents, eating habits and practices, and interactions with their other family members.

*Society, demographic and communal features**:*** there is a form of ripple effect observed as the consumption practices of a child is a reflection of the family, which in turn is a reflection of the society. Family nutritional consumption can also be influenced by systems that are outside and do not have a direct influence on parenting styles, such as schools.

This model (Davison and Birch) is based on one aspect of malnutrition which is overweight; however, the principles and outline of the model is applicable to other forms of malnutrition. Therefore, this model will be applied to the focus of malnutrition for this study, which are underweight, stunting and wasting.

2.2.1.2 United Nations Children's Fund (UNICEF) malnutrition framework

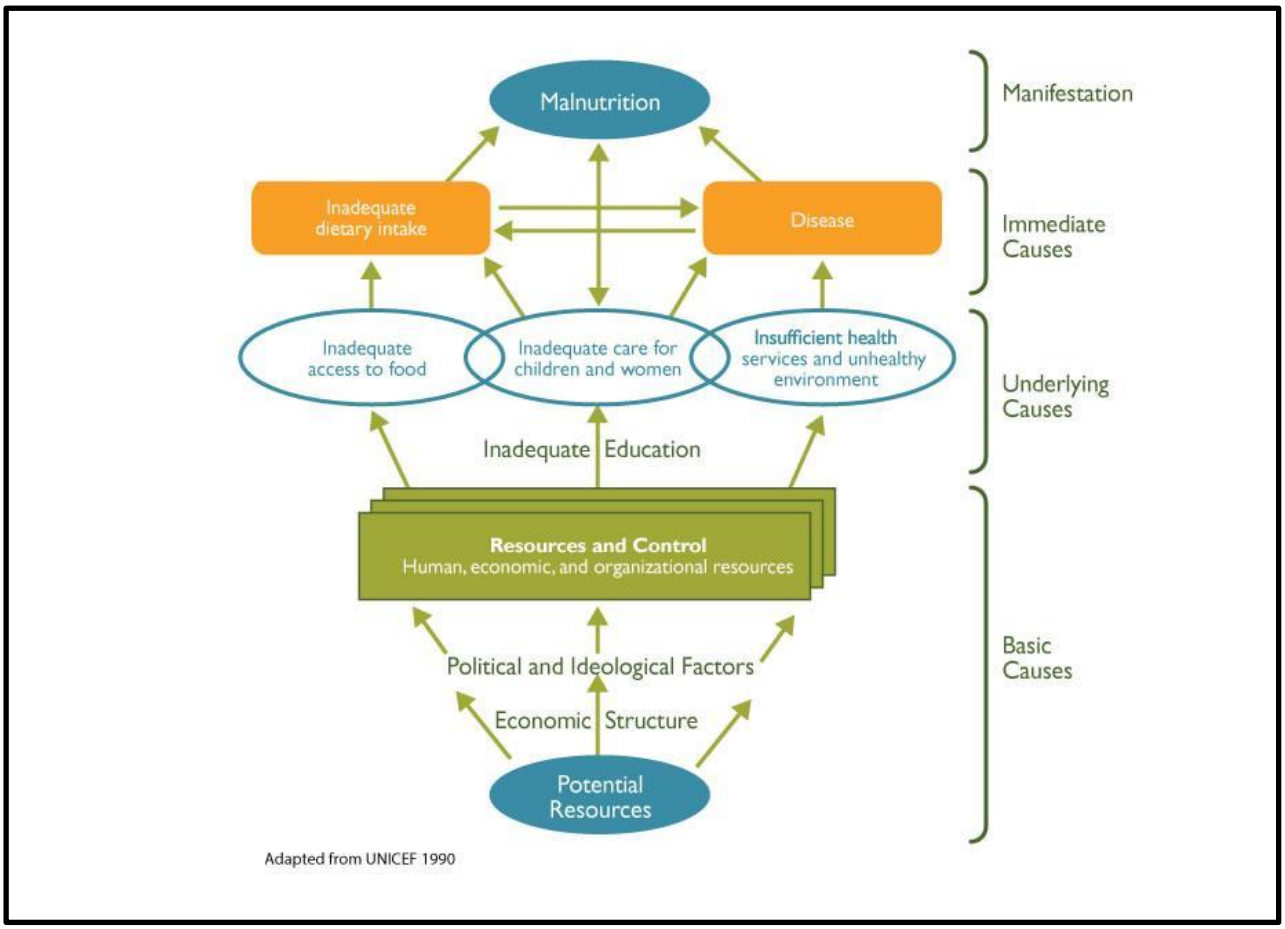
This conceptual framework on the causes of malnutrition was established in 1990 as part of the UNICEF nourishment strategy. Unlike Davison and Birch (2001), who focused on overweight, the UNICEF framework focuses on underweight malnutrition. The framework is used for planning at all national and local levels for improvement in diet and consumption. It works as a guide in evaluating and examining the causes and pathways of dietary problems and the actions to take to resolve it.

UNICEF (1990) defines malnutrition/under-nutrition as what happens when nutritional intake is insufficient and health unpleasant. The framework shows that the causes of malnutrition are multifaceted, inclusive of food consumption and health practices. They are also categorized as instant, fundamental, and rudimentary, whereby features at one level impact other levels.

The model shows that causes of malnutrition are related to national and community status; underlying causes include the families and household characteristics, and the immediate causes are the individuals. Therefore, these causes of malnutrition are categorized as follows: (i) fundamental or basic causes: this includes – availability and use of ample number of valuable resources by the family such as income, and education; (ii) rudimentary or underlying roots

include family food uncertainty, insufficient maintenance and food consumption practices, unwholesome family setting and insufficient health facilities; and (iii) instant or immediate reasons include insufficient nutritional consumption, and illness as outlined in Figure 2.2.

Figure 2.2: UNICEF malnutrition structure



Source: Adapted from UNICEF (1990)

The black arrows show that the consequences of malnutrition can feed back to the underlying and basic causes of malnutrition, perpetuating the cycle of malnutrition, poverty and inequities.

Figure 2.2 shows the interplay between the variables that could lead to malnutrition. The process begins with the basic causes, which include the outside or external factors such as the economic and political ideologies and influences that have impact on households, and the various affairs and activities that they engage in, such as the choice of health services for the children and

family as a whole, access to food that makes an household, among others. These are summed up and categorized as underlying causes.

The influence of basic causes on underlying causes was depicted with the backward arrow on the chat. The underlying causes in turn influence the instant reasons that are insufficient nutritional consumption by the children and Illnesses the children are affected by. This influence is depicted by the backward arrow on the chart. Finally, all these causes lead to a manifestation of malnutrition in children.

The two models by Davison and Birch (2001) and UNICEF (1990) are similar because the UNICEF (1990) model describes causes of childhood malnutrition (UNICEF, 1998), and that malnutrition arises as a result of a compilation of factors comprising of insufficient nutritional intake by the child, usually as a result of household level factors such as inadequate access to clean water and food, which themselves arise as a consequence of communal level issues such as absence of probable resources and limits in technology.

The foremost variance between these two models is that EST outlines bi-directional, rather than unidirectional, relations among the diverse levels of impact and considers how factors at one level moderate the effect of factors from another level (Davison and Birch, 2001). However, ultimately, the two models acknowledge that people and environmental resources, economic structures, political and principal variables are basic contributors to malnutrition.

The nutritional condition of under-five children is among the pointers of family-hood wellness and also a determining factor of baby subsistence (Thomas *et al.,* 1990). The status is a main contributor of mortality in minors of under-five (Pelletier *et al.,* 1995: Svedberg, 1987). In sub-Saharan Africa, nutrition status contributes nearly two of the mortalities and almost three percent of “disability-adjusted life years” (DALYs) in under-5 children. Under-nutrition may have adverse effects on the baby's intellectual growth and, as a result, health and viability in the future life (Cravioto and Arrieta 1986; WHO, 1995). It has high likelihood to foster inequities and imbalances in health, plus other spheres of family wellness. There is significant proof in health economics scholarly articles that indicate that minor’s nutritional condition is attributable to a collection of socio-economic variables such as family wealth, place of living (rural/urban),

women's enlightenment, demographic parameters and proximity of healthcare services (Novignon *et al.*, 2015).

2.2.2 Empirical literature

There is a sizable literature documenting the socio-economic inequality in malnutrition. Zere and McIntyre (2003) carried out a study to ascertain and quantify the prevalence of inequalities in under-5 baby's malnutrition, especially those attributable to socio-economic conditions. Family expenses was employed as the major pointer of a household's financial status. Socio-financial economic unfairness in malnutrition was derived from disease concentration index. The results showed that stunting was the major prevailing type of under-nutrition in South Africa. Its rate was highly prevalent in Eastern Cape and some sections of the North – provinces that have highest intensity of poverty. Stunting and underweight was predominant among the poor. Nevertheless, there was no change when it came to wasting as levels in socio-economic status changed. The findings further showed zero inequities among white babies. The most pro-rich injustices in stunting and underweight were common among colored babies and in cosmopolitan communities. Furthermore, they found that dealing with the problems of stunting and underweight were responsive to increase in family earning status. They therefore concluded that there were significant variances in under-5 child malnutrition, which favoured the wealthy in the society, which is needless, preventable and unfair.

Poel *et al.* (2007) did a study in Ghana with the aim of analyzing inequalities in children's z-scores and causative factors using a concentration index. The findings reveal that socio-economic disparities in malnutrition are associated to mother's schooling, health care, poverty and household planning and provincial structures and discrepancies. Using the new growth standards that was released by the World Health Organization, average malnutrition is greater; however, associated factors and socio-economic disparities are vigorously geared towards change in the reference population. The study concluded that there is a multi-facet problem in Ghana when it comes to child malnutrition. The factors that were found to be linked with average malnutrition rates are not essentially the same as those related with socio-economic disparity in malnutrition.

The leading cause of children deaths in Bangladesh is malnutrition. A study was done on Bangladesh by Islam *et al.* (2013) with the objective of proving the relevance of the GPR model as a substitute of other statistical approaches and to find some causes of malnutrition. The research found a number of significant causes of the resulting variable, which are mother's schooling, father's schooling, wealth index, cleanliness status, clean water source, and the number of children a woman gave birth to in totality. It was concluded that GPR model is a superlative substitute, similar to several other research in analyzing the number of malnourished children under age five in a household.

Despite several interventions, Bangladesh still has significantly high deaths of children under age five; therefore, another study was done on Bangladesh by Rahman *et al.* (2016) to examine the association between malnutrition and low birth weight. Malnutrition was measured using anthropometric measurements of Z-scores. If a score fell below two standard deviations from the reference population median, the children were considered wasted, stunted or underweight under specific Z-score analysis. The adjusted risk-ratio (RR) was used to analyze the relationship between malnutrition and Low Birth Weight. The findings revealed that the predominance of malnutrition was significantly greater in children with Low Birth Weight, than those with usual weights of birth. When identified risk factors were controlled for, the findings revealed that there was a greater malnutrition risk with children having Low Birth Weight compared to the ones with normal weights. It was concluded that the witnessed relationship between malnutrition and Low Birth Weight were not adjusted by the common factors such as higher maternal education, increased family socio-economic status, and birth intervals that are longer, which are usually known factors in decreasing the predominance of malnutrition.

Thang and Popkin (2003) focused on inequality in the transformations of child malnutrition between the duration of 1992/93 to 1997/98. They analyzed variables that may influence the incapability to swiftly lower baby malnutrition in the impoverished, rural and marginalized communities in Vietnam. The investigation focused on the factors related to family poverty conditions, overall expense levels, rural homes, and marginal status with restrains for other important economic and demographic strategies. A cross-sectional evaluation was carried out on the data using 4,305 families and 4,367 minors aged 2–11 years. The results showed that children

from rural homes, poor families, and cultural inferior backgrounds were considerably more probable to be under-nourished compared to urban dwellers, and the babies of the rich families. The findings indicate that improved economic status in Vietnam has, for the largest part, exceeded the rural poverty-stricken and minorities in Vietnam.

Kandala *et al.* (2011) gave a different twist to the study of malnutrition in the Democratic Republic of Congo (DRC) by examining spatial variation in under-5 malnutrition and the uncertainty in malnutrition among children. To evaluate significant spatial outline of malnutrition, determined by evident factors such as financial factors likely attributed to un-quantified factors just like fights, governmental, ecological and traditional factors. The analysis was done based on the statistics of each child in connection with their dietary level, and it was discovered that urban areas had children with malnutrition significantly lower compared to rural areas; even after several modifications were made, the results remained the same. Finally, the results revealed that malnutrition in the DRC is spatially structured, while the high rates of malnutrition persist.

In India, Sahu *et al.* (2015) analyzed the issue of over-nourishment and under-nourishment in children under age five, and their causal factors. The data used were gathered online, and the results revealed that children under age five with under-nourishment were more than children with over-nourishment. The research also established that studies done on over-nourishment in children under the age of five were very few, and concluded that strategies in reducing over-nourishment and under-nourishment at the regional level are the way forward in resolving these issues in India.

Nzefa *et al.* (2019) conducted research in Bandja village of Cameroon with the objective of evaluating the anthropometric rank of children under five years of age. Several maternal and children at various levels data were gathered for analysis and the results revealed the prevalence of malnutrition. Malnutrition was found to be more prevalent in male children compared to their female counterparts; it is predominant in smaller offspring, children born first in the family, babies that are being breastfed, and children born to mothers who engage in agricultural farming. Emphasis was laid on the significance of mediation of programmes to avert and decrease under-nourishment among children.

Hong (2007) estimated the effect of family economic condition on stunting using a sample size of 6,251 families in Ghana, comprising of 3,077 babies of between 0 and 59 months. The results showed that babies in least advantaged 20% of families are twice as more likely to undergo stunting as contrasted to babies from wealthiest 20% of families. In addition, minors in the second most impoverished and those in the central quintiles have higher chance of acute malnourished compared to babies in the wealthiest 20% of families. The author concluded that economic injustices are majorly related to chronic childhood under-nutrition in Ghana.

Poel *et al.* (2008) carried out a study involving 47 developing countries, Nigeria included, where the socio-economic imbalances in malnutrition of babies was evaluated, to provide proof for correlation in-between socio-economic imbalance and the mean level of under-nutrition, and to attract attention to diverse trends of socio-economic unfairness in malnutrition. They used data from the 47 Demographic and Health Surveys (DHSs) that had data on the nutritional cases of minors not exceeding 5 years.

The results showed that in nearly every country, stunting had disproportionate impact on the poor. The concentration index was notable in every country, except Madagascar. Socio-economic unfairness in stunting was uppermost in the Caribbean region and Latin America. Wasting was overlay concentrated in the poorest regions. However, socio-economic imbalance was less compared with stunting. For nearly one-third of nations, socio-economic imbalance was negligible. A comparison of the mean stunting and wasting cases was made in relation to WHO child development standards and NCHS development standards. For the two pointers of malnutrition, the mean rate was more when the new WHO basic guidelines were adhered to. Nonetheless, socio-economic imbalance was fairly comparable with the two distinct development standards.

A similar study by Uthman (2009) was carried out in Nigeria to determine the magnitude of inequalities for under-5 years suffering from malnutrition, which is linked to socio-economic rank. The data on 4,187 babies under five years came from the Nigeria Demographic and Health Survey (2003). The research used family possessions to represent socio-financial situation. The findings showed significant pro-rich unfairness in spreading stunting. The Southern part of the country (East and West) recorded few mean rates of childhood malnutrition; however, large

disparities occurred among the poor families versus the rich. Comparatively, North-East (NE) and North-West (NW) recorded narrow gaps among the underprivileged versus the rich on childhood malnutrition. He concluded that there were significant contrasts in malnutrition of children below 5 years that favour the rich in the society in every geopolitical locality.

Uthman (2009) also did another study with an objective to measure and decompose the socio-economic unfairness in under-nutrition of minors in Nigeria. Personal statistical records were formulated to represent a national sample of 4,187 babies under five years in Nigeria. The family's socio-economic condition was determined by applying the principal component evaluation technique. The concentration index (CI) of under-nourishment in babies determined the socio-economic injustices and dissembled into its causal variables. The enormous contributors of inequality in malnutrition of children were family's economic conditions (31%), healthcare service indicator (17%), motherly education (13%) and appropriate hygiene at 11%. The findings further showed that lactation length (8%), geopolitical areas (8%) and place of living (5%) additionally proved to be reasonable causes of the assessed inequality. Therefore, in conclusion, socio-economic disparity in childhood malnutrition in Nigeria was caused by health logistics and variables outside the jurisdiction of health authorities and care delivery system.

2.2.3 Overview of literature

The two models by Davison and Birch (2001) and UNICEF (1990) are applicable to this study, as the different categories of causes and variables that lead to malnutrition were outlined. For this study, the factors from the different categories of these causes were selected for analysis, while the focus was on the variables that involved the characteristics of households and the choices they make that have effects on the health status of a child. However, causes and variables such as socio-cultural, economic and political context found under the basic reasons of malnutrition in the UNICEF (1990) model are beyond the scope of this study. This was not captured in the empirical analysis; however, inferences were made built on the outcomes derived from the analysis.

Different authors did research on malnutrition, inequalities in malnutrition ascribable to socio-economic status, and variables underlying the cause or contributing to malnutrition in children.

The studies applied different methodology for this analysis; however, the most common methodology used was the concentration index. Concentration index was used by studies to check for inequalities in malnutrition and other health variables. Z-scores were also used to evaluate the anthropometric status of the children.

Results from majority of the studies showed that stunting was the major prevailing type of under-nutrition in Africa and other developing countries. Nevertheless, wasting showed no gradients attributed to socio-economic status. Furthermore, they found that as the financial status of the household improved, cases of underweight and stunting improved. All the studies found results that showed that children from rural homes, poor families, and cultural inferior backgrounds were considerably more probable to be under-nourished, likened to children residing in urban areas and the rich households' children. Therefore, a concentration of malnutrition among the underprivileged compared to the affluent in the society, which are unnecessary, avoidable and unjust. Results from various research also shows that rural areas had a higher rate of malnutrition compared to metropolitan areas. Also, studies showed that boys were more stunted than girls.

Malnutrition in children also had some other variables identified as causes or contributing factors. Some studies also identified several significant predictors of malnutrition. However, the research also observed in some studies that associations were not modified by factors known to reduce the prevalence of malnutrition.

In conclusion, therefore, findings from research shows that the occurrence of malnutrition among children below age five were significantly heightened and wide-ranging extensively, while one of the principal causes of deaths in children is malnutrition. This study, therefore, employed the use of Z-Score to evaluate the anthropometric status of the under-5 children, while the concentration index and curve were adopted to evaluate the prevalence of inequalities in malnutrition ascribable to socio-economic status of under-5 children in Nigeria.

2.3 Methodology

2.3.1 Theoretical model

Following the Rosenzweig and Schultz (1982), Davison and Birch (2001) and UNICEF (1990) model with a slight modification to them, we assume that child health production is rooted in a utility maximizing function of the mother. Therefore, the utility function is assumed as follows:

$$U = U(X, Y, H) \quad (4)$$

Where:

X = a good that yields utility, but is not directly related to health of the child, also known as health neutral good; e.g. a child's school uniform, the mother's clothing;

Y = a health-related good or behaviour that yields utility to the mother and also affects the child's survival, e.g., antenatal, child delivery and post-natal care:

H = health status of a child;

The health production function of a child is given as:

$$H = F(Y, Z, \mu) \quad (5)$$

Where:

Z = purchased market good and services inputs that affect the child health directly, such as medical care services that affects a child's health directly:

μ = the component of a child's health that is due to environmental or genetic conditions, which is not influenced by parental behaviour and preferences;

Equation (4) is the health production function of the mother, while equation (5) is the health production of the child. Y is a health-related good that affects the mother directly, and the child; however, Z is a health-related good, that is child-specific.

The mother maximizes equation (4) given (5) subject to the budget constraint given in equation (6)

$$I = XPx + YPy + ZPz \quad (6)$$

Where:

I = exogenous income;

Px = price of the health-neutral good, X;

Py = price of health-related consumer good, Y;

Pz = price of child investment good, Z;

Equations (4) and (5) assumes that the purchase of child investment good is solely for the purpose of child health improvement, so that it goes into a mother's utility function solely through H.

As stated above, a child's health production through the mother is described in equation (5). Embedded in the constrained utility maximization actions of the mother (equations 4 and 6) is the property of child's health production function. Expressions (4) - (6) can be used to produce health input demand functions expressed as:

$$X = Dx\ (Px, Py, Pz, I, \mu) \quad (7.1)$$

$$Y = Dy\ (Px, Py, Pz, I, \mu) \quad (7.2)$$

$$Z = Dz\ (Px, Py, Pz, I, \mu) \quad (7.3)$$

The influence of price changes of the three commodities on child health can be obtained from equations (7.1-7.3) since from equation (5), a variation in the health of a child can be stated as

$$dH = Fy \bullet dY + Fz \bullet dZ + F\mu \bullet d\mu \quad (8)$$

where:

Fy, Fz, Fμ are marginal products of health inputs Y, Z and μ, respectively.

From equation (5), the change in the health of a child can be connected to variations in the prices of health inputs, respectively, and expressed as below:

$$dH/dPx = Fy \bullet dY/dPx + Fz \bullet dZ/dPx + F\mu \bullet d\mu/dPx \quad (9.1)$$

$$dH/dPy = Fy \bullet dY/dPy + Fz \bullet dZ/dPy + F\mu \bullet d\mu/dPy \quad (9.2)$$

$$dH/dPz = Fy \bullet dY/dPz + Fz \bullet dZ/dPz + F\mu \bullet d\mu/dPz \quad (9.3)$$

where:

$d\mu/dPi = 0$, for i = x, y, z so that in equation (9), the terms $F\mu \bullet (.) = 0$, since μ is a random variable unrelated to commodity prices.

The equation expressions we have above show that the prices of goods are correlated with a child's health status.

The signs and sizes of effects of commodity prices on health depend on:

(a) Degrees of variations in demand for health inputs following price changes; and on

(b) Sizes of the marginal products of health inputs.

Note that from equation (6.1), the modifications in prices of health-unbiased commodities also influence the health of a child through the budget constraint of the household. Therefore, those making policies need to know the framework of the production know-how of a child's health, and the health input demand connected to it to foretell the influence of health on variations in the prices of inputs. To get such details, health production and input demand parameters must be estimated simultaneously. Such analysis is complex because of the necessity to recognize input demands from the production technology of health.

2.3.2 Empirical model

To analyze and check for the interplay of variables and different categories of causes and the effect/influence they have on malnutrition of under-5 children stipulated by Davison and Birch (2001) and UNICEF (1990) in their models, we analyze the prevalence and magnitude of malnutrition in under-5 children in Nigeria. The prevalence will be analyzed using the Z-score on the anthropometric data, while the magnitude of malnutrition will be analyzed using the concentration index.

2.3.2.1 The concentration curve and index (C)

The concentration index, which was developed by Kakwani (1977; 1980) is related to the concentration curve directly and it computes the extent of socio-economic status associated with inequality in a health variable (Kakwani, Wagstaff and van Doorslaer, 1997; Wagstaff, van Doorslaer and Paci, 1989).

Concentration Index (C) refers to double (twice) the area between the concentration curve and the line of equality, while the diagonal has values ranging from +1 to -1. Therefore, in the instance where socio-economic-derived imbalance is lacking, C is zero. The index takes a negative figure when the curve is above the line of equality, depicting disproportionate concentration of the wellness parameter for the less-fortunate or the poor, and a positive figure when it is under the line of equality, meaning disproportionate concentration of the wellness parameter for the rich (O'Donnell *et al.*, 2016), meaning a negative illness concentration index depicts the existence of inequalities (Zere and McIntyre, 2003).

Therefore, following from Wagstaff *et al.*, (1991), the illness concentration index is stated as:

$$C = 1 - 2\int_0^1 L_h(p)dp \quad (10)$$

The index is bounded between -1 and 1. For a discrete living standards variable such as this study, the concentration index (C) formula can be written as:

$$C = \frac{2}{N\mu}\sum_{t=1}^{n} x_i r_i - 1 - \frac{1}{N}, \quad (11)$$

Where: C = Concentration index

x_i = the health variable

μ = represents the mean

r_i= i/N is the miniscule rank of person i in the living standards distribution, where we have i = 1 for the most underprivileged and i = N for the richest.

Equation (11) can further be simplified as:

$$C = \frac{2}{N\mu}\sum_{i=1}^{n} x_i R_i - 1 \quad (12)$$

Where: n = the sample size

x_i (i = 1,...n) = the malnutrition gauge of the *ith* under- five child;

μ = the malnutrition mean level; and

Ri = denotes the socio-economic status level of the *ith* under-5 child.

Another concentration index formula was also formulated and it is defined in relation to the covariance amid the health factor and the small rank in the living standards distribution (Jenkins, 1988; Kakwani, 1980; Lerman and Yitzhaki, 1989). It is defined as:

$$C = \frac{2}{\mu} COV(h, r) \quad (13)$$

Concentration curves can be used to detect whether socio-economic disparity in malnutrition occurs and whether it is further noticeable at a point in time than another. There are two key variables that underline the definition of concentration curve, which are: the health parameter, the spread of which is the matter of concern, and a factor capturing living conditions, onto which the spread is to be evaluated.

According to Zere and McIntyre (2003), the concentration index (C) is determined from the curve of the concentration curve. The disease concentration graph plots the total proportions of under-5 ranked basing on family's socio-economic position versus the total proportion of malnutrition.

The concentration index (C) should meet the following three vital criteria that a satisfactory measure of unfairness demands:

(i) Inequalities in the socio-economic dimension is accounted for;

(ii) Rather than reflecting the experience of two extreme groups, it depicts the experience of the whole population; and

(iii) It is sensitive to transformations in the inhabitants across socio-economic divisions.

2.3.2.2 The Z-Score

There are many methods of determining the nutritional condition of children under five years. It can be measured using clinical signs, biochemical pointers or anthropometry (de Onis, 2000). However, the most commonly used tool is the anthropometric approach (WHO, 1986) and is more advantageous compared to the other two (de Onis, 2000). Therefore, following the measurement stipulated by WHO (2006), this study used Z-score for the analysis of the prevalence of malnutrition. The Z-score, which is also called the “Standard Deviation” (SD) score is said to be the measure of the spread or deviation of data from the average/ mean /median figure; i.e., a measure of the distance between the child’s value and value of the reference population.

Malnutrition is measured using the following key measurements, which are expressed in terms of Z-scores:

(i) **Stunting**: height-for-age (HAZ), which is lower than the international standard value by more than two standard deviations;

(ii) **Wasting**: weight-for-height (WHZ), lower than the international reference value by more than two standard deviations; and

(iii) **Underweight**: weight-for-age (WAZ), that is more than two standard deviations below the international reference value.

These classifications are further explained in Tables 2.1 and 2.2.

Table 2.1: Classification table of Z-scores

Different Measurements	**Classification**
Height for Age Z-Score	
-1< HAZ < 0	Normal (Well Nourished)
-2 < HAZ < -1	Marginally Stunted (Mildly Malnourished)
-3 < HAZ < -2	Moderately Stunted/Malnourished
HAZ < -3	Severely Stunted/Malnourished
Weight for Height Z-Score	
-1< WHZ < 0	Normal (Well Nourished)
-2 < WHZ < -1	Marginally Wasted (Mildly Malnourished)
-3 < WHZ < -2	Moderately Wasted/Malnourished
WHZ < -3	Severely Wasted/Malnourished
Weight for Age Z-score	
-1< WAZ < 0	Normal (Well Nourished)
-2 < WAZ < -1	Marginally Underweight (Mildly Malnourished)

-3 < WAZ < -2	Moderately Underweight/Malnourished
WAZ < -3	Severely Underweight/Malnourished

Source: WHO classification

For further clarification, and for the purpose of this study, the following Z-score measurement of malnutrition classification was used:

Table 2.2: Z-score measurement of malnutrition classification

Measurements in Z-score	**Classification**
Height for Age Z-Score	
< -2 Z score	Stunting
< -2 to -3 Z score	Average Stunting
< -3 Z score	Extreme Stunting
Weight for Height Z-Score	
< -2 Z score	Wasting
< -2 to -3 Z score	Moderate Wasting
< -3 Z score	Severe Wasting
Weight for Age	
< -2 Z score	Underweight
< -2 to -3 Z score	Moderate Underweight
< -3 Z score	Severe Underweight

Source: WHO classification

For the purpose of this study, we focused our analysis and interpretation on the first category of malnutrition classification; in other words, we analyzed stunting, wasting and underweight of under-5 children in Nigeria.

For the purpose of public health significance, health policy for a country, and policy implications for this study, it is important to know the prevalence ranges of malnutrition. Understanding from past research and studies have contributed to the emphasis of the helpfulness of identifying prevalence ranges of malnutrition to assess the magnitude of a situation as the foundation for making health policies and public health decisions. The aim of this prevalence range is to assist in giving some sort of guidelines for establishing the level of public health importance, and targeting purposes when establishing intervention priorities (WHO, 2019) as indicated in Table 2.3.

Table 2.3: Classification for assessing severity of malnutrition by prevalence ranges among under-5 children

Malnutrition	**Severity of Malnutrition by Prevalence Ranges**
Stunting	< 20%: Low prevalence
	20-29%: Medium prevalence
	30-39%: High prevalence
	≥ 40%: Very high prevalence
Wasting	< 5%: Acceptable
	5-9%: Poor
	10-14%: Serious
	≥ 15%: Critical
Underweight	<10%: Low prevalence
	10-19%: Medium prevalence
	20-29%: High prevalence

	≥ 30%: Very high prevalence

Source: WHO classification

2.3.3 Estimation techniques

2.3.3.1 Concentration curve and index estimation and inference

The concentration index is explained as double the region amid the concentration curve and the diagonal. The concentration index was computed using the following formula for a grouped data (Fuller and Lury 1977):

$$C = (p_1 S_2 - p_2 S_1) + (p_2 S_3 - p_3 S_2) + \ldots\ldots + (p_{T-1} S_T - p_T S_{T-1}) \quad (14)$$

Where:

p_1 = the aggregate percentage of the under-5 children sample classified by socio-economic rank in group 1

S_1 = corresponding concentration curve ordinate of group 1

p_2 = the cumulative percentage of the under-5 children sample ranked by socio-economic status in group 2

S_2 = corresponding concentration curve ordinate of group 2

p_t = the cumulative percentage of the under-5 children sample ranked by socio-economic status in group t

S_t = corresponding concentration curve ordinate of T

T = the number of socio-economic groups

C = Concentration index for t = 1,….,T groups

When the number of under-5 children are given in each wealth group over a period of time, stating these as proportions of the total number of under-5 children, and cumulating them gives

the cumulative proportion of under-5 children, ordered by wealth. This can be applied to get the percentage of under-5 children malnutrition for each of the wealth groups. This is then plotted on the concentration curve diagram A negative concentration index, reflecting a higher incidence of malnutrition among poorer children.

The Standard Error and Variance, therefore, for further statistical inference and estimation is therefore given as:

$$2\sigma_R^2\left[\frac{x_i}{\mu}\right]=\beta_0 + \beta_1 R_i + \epsilon_i \quad (15)$$

Where: σ_R^2 = the variance of R

$x_i = x_i$ (i = 1,...n) = the malnutrition indicator of the *ith* under-5 child;

β_1 = the concentration index (C)

Ri = represents the socioeconomic status rank of the *ith* under-five child.

ϵ_i = error term

The standard error of the least squares estimates of β_1 serves as a standard error of the estimate of the concentration index.

The general C was determined (i.e. for all children under five years in the sample), and C for certain immediate, underlying, and basic causes of malnutrition, including place of residence, zones, gender, etc , and the spread of malnutrition across family wealth index quintiles is assessed for every socio-economic sub-group.

2.3.3.2 The Z-score

When analyzing Z-Sscores in nutrition and health of a child, the positive or negative value of the SD of a particular child with respect to the median of a carefully selected sample or a predetermined population is the Z-score. Estimation of the Z-score was done using the formula:

$$Z = \frac{X-\mu}{\sigma} \quad (16)$$

Where: Z = Z-score

X = Measured value

μ = the mean or average value in the reference population

σ = the standard deviation of the reference population

Therefore, in applying the Z-score to the measurement of malnutrition, the World Health Organization (WHO) gave the guideline in a form of reference table for the measurement of malnutrition using the Z-score as a value (see the shaded part in Figure 2.4).

The analysis of the three standard measurements for malnutrition, namely stunting, wasting and underweight are discussed in (a), (b) and (c).

(a) Height-for-age Z-score (HAZ) (stunting)

A Height-for-Age Z Score (HAZ) is explained as the SD number of a child's real height from the average height of children within the child's age bracket from a standard sample. This figure takes on either a positive or a negative sign, which is dependent upon where the child's height falls (below or above the median height). We have HAZ to be equal to zero when a child's real height is equivalent to the median. The global standard stipulated by WHO can be seen in Table 2.2, with the stated categories. Where we have a case of a child having a HAZ below the median and is lower than the universal standard figure by standard deviation figure greater than two (Zere and McIntyre, 2003), the child is stunted, and it is an indication of malnutrition. This is measured using the following formula:

$$Z = \frac{X - \mu}{\sigma} \qquad (17)$$

Where: Z = HAZ

X = Measured value of height

μ = the mean or average value of height in children under-five years of age in Nigeria

σ = the standard deviation of children under-5 years in Nigeria

(b) Weight-for-Height Z-score (WHZ) (wasting)

A Weight-for-Height Z-Score (WHZ) is expressed as the SD number of a child's weight from the average weight of children within the child's age bracket from the standard sample. This figure, just like HAZ, also takes on either a positive or a negative sign, which equally is dependent upon where the child's weight falls (below or above the median weight). We have WHZ to be equal to zero when a child's real weight is equivalent to the median. The global standard stipulated by WHO can be seen in Table 2.2, with the stated categories. A child is said to be wasted when the WHZ figure falls below the two standard deviations of WHO scale. The formula is given as:

$$Z = \frac{X - \mu}{\sigma} \quad (18)$$

Where: Z = WHZ

X = measured value of weight

μ = the mean or average weight in children under-five years of age in Nigeria

σ = the standard deviation of children under-5 years in Nigeria

(c) Weight-for-Age Z-Score (WAZ) (underweight)

For Weight-for-Age Z Score (WAZ), it is defined as the SD number of a child's weight from the average weight of children within the child's age bracket from the standard sample. This figure, just like HAZ, also takes on either a positive or a negative sign, which is equally dependent upon where the child's weight falls (below or above the median weight). We have WAZ to be equal to zero when a child's real weight is equivalent to the median. This can equally be found on Table 2.2 in accordance with the global standards categories. It was analyzed using the following formula:

$$Z = \frac{X - \mu}{\sigma} \quad (19)$$

Where: Z = WAZ

X = measured value of weight

μ = the mean or average value of weight in children under-5 years of age in Nigeria

σ = the standard deviation of children under-5 years in Nigeria

2.3.3.3 Principal Component Analysis

Principal Component Analysis (PCA) is a method frequently used to reduce large data sets' dimensionality into a smaller set with most of the information still preserved (Jaadi, 2019). The NDHS data has no information on family income or expenditure as a variable because the correctness of income data is challenging to establish, principally in nations such as Nigeria with huge informal sub-divisions. Therefore, the socio-economic rank was measured using the household wealth/asset index. The wealth index is a composite determinant of a family's aggregate living standard. The wealth index was computed using readily available information on a family's ownership (assets) of preferred resources such as televisions and bicycles, materials used to construct a house, and types of water avenue and sanitation propensity. The index was therefore developed using the principal component analysis (PCA) (Filmer and Pritchett, 2001).

Therefore, the asset index for individual i is defined as:

$$A_i = \sum_k \left[f_k \frac{(a_{ik} - \underline{a}_k)}{s_k} \right] \quad (20)$$

Where:

a_{ik} = the value of asset k for household i

$\underline{a}_k$ = the sample mean

s_k = the sample standard deviation

This conversion is done in such a way that the first major element is given the uppermost possible variance; in other words, it accounts for as much of the inconsistency in the data as

likely, while the other succeeding components are given the highest possible variances. The result of the components will be an uncorrelated orthogonal basis set.

The PCA, therefore, uses the goods index areas person families on a timeless scale of relative goods and then breaks off all evaluated families into wealth groups such as quintiles (poorest, poorer, poor, rich, richer).

Following the work of Uthman (2009), this study examined socio-economic status of household using a wealth index on the LSMS. Health status was determined in the DHS analysis in terms of goods and other assets. An index of economic position for every family was computed using Principal Component Analysis. The following parameters (assets) were used in principal constituents' investigation: representation of rooms per capita, possessing a car, securing a motorcycle, owning a bicycle, owning a fridge, owning a television, cellphone, and sort of heating system. From this computation, the socio-economic wealth was grouped into five wealth quintiles, namely: poorest, poorer, middle, richer, and richest.

There are tests that were carried out on the data before the PCA was done; they are namely the correlation test, the Barlett test and the Sphericity test (tests for homogeneity of variances, i.e. tests that variances are equal for all samples) and the KMO, which measures the accuracy of the data sampling. Its values indicates whether or not all of the variables are indeed apt for inclusion into the analysis.

In summary, the three anthropometric measures of malnutrition (stunting, wasting and underweight) were measured using the Z-score. The concentration index and curve were used to check for the inequality in malnutrition ascribable to the socio-economic status. The wealth index was used for the socio-economic status of the families, and this was done using the Principal Component Analysis (PCA). However, before the PCA was done, Correlation test, Barletta test and Sphericity test, and Kaiser-Meyer Olkin tests were all carried out on the data to check for homogeneity of variance, sampling adequacy of the data and whether or not all of the variables are indeed apt for inclusion into the analysis.

2.3.4 Description of variables

2.3.4.1 Dependent variable

The Dependent Variable, which is the nutritional status/malnutrition was measured using the three anthropometric measures, which are expressed in terms of Z-scores, namely: Stunting: height-for-age (HAZ), Wasting: weight-for-height (WHZ) and Underweight: weight-for-age (WAZ).

2.3.4.2 Independent variables

There are many factors that are important in influencing nutrition, such as health outcomes, uptake of intercessions to avert malnutrition by mothers of undernourished and well-nourished in under-5s attending public hospitals, amongst others. However, this paper will focus on the influence of socio-economic status on malnutrition.

The independent variable is the socio-economic status of an individual is expressed as the wealth index in the study. Other variables used for analysis include: gender, place of residence, and zones in Nigeria. Table 2.4 provides a summary of the variables in this analysis.

Table 2.4: Variable summary

Name of variable	Definition	Measurement	Expected effect
Nutritional status of Under-5	i. Stunting ii. wasting iii. Underweight	i. height-for-age (< -2 Z score) ii. weight-for-height (< -2 Z score) iii weight-for-age (< -2 Z score)	
Socio-economic status	This is the household assets index/ wealth index, which is used to represent the key pointer of household financial status. It is constructed using the Principal Component Analysis	Measured in quintiles, and categorized into: 1. Poorest 2. Poorer	

		3. Average 4. Richer 5. Richest	
Socio-economic inequalities in malnutrition	The range of C if from -1 to +1	i. Negative value means malnutrition is concentrated amid the poor ii. Positive value means malnutrition is concentrated among the rich iii. Zero value means both rich and poor suffer equally from malnutrition	Negative
Gender	Represents male or female	The male or female variable taking the value of 1 if malnourished, and 0 if otherwise	Negative
Place of residence	Represents rural or urban	The Rural or urban variable taking the value of 1 if malnourished, and 0 if otherwise	Negative
Zones in Nigeria	Represents the six geo-political zones in Nigeria	Each zone taking the value of 1 if malnourished, and 0 if otherwise. The zones include: 1. North Central 2. North East 3. North West 4. South East	Negative

		5. South South 6. South West	

Source: Author's analysis

2.3.5 Data sources

Using the LSMS/GHS 2015/2016 Nigeria data, the Nigerian General Household Survey (GHS) is implemented in collaboration with the World Bank Living Standards Measurement Study (LSMS) team as part of the Integrated Surveys on Agriculture (ISA) programme and was revised in 2010 to include a panel component (GHS-Panel). The objectives of the GHS-Panel include the development of an innovative model for collecting agricultural data, inter-institutional collaboration, and comprehensive analysis of welfare indicators and socio-economic characteristics. The GHS-Panel is a nationally representative survey of 5,000 households, which are also representative of the geopolitical zones (at both the urban and rural level).

A multi-stage stratified sample design was used for the GHS and the Panel Survey. The GHS-Panel sample is fully integrated with the 2010 GHS Sample. The GHS sample is comprised of 60 Primary Sampling Units (PSUs) or Enumeration Areas (EAs) chosen from each of the 37 states in Nigeria, a total of 2,220 EAs nationally. Each EA contributes 10 households to the GHS sample, resulting in a sample size of 22,200 households. Out of these 22,000 households, 5,000 households from 500 EAs were selected for the panel component and 4,916 households completed their interviews in the first wave. Given the panel nature of the survey, some households had moved from their location and were not able to be located by the time of the Wave 3 visit, resulting in a slightly smaller sample of 4,581 households for Wave 3. However, the data on 3,716 children that were under-5 years of age (0-60 months) were derived from the household data. These were the figures used for analysis in this study.

2.4 Results from the Analysis

2.4.1 Descriptive statistics

From Table 2.5, the study's dependent variable is the under-5 children, with the under-5-year olds measured in months having a mean of 32.3 months. The independent variables are gender, which has the proportion of female with a mean of 47.9 percent in the sample. The highest

population of the under-5 children in the sample was found in the North-West zone with 33.4%. The rural dwellers were greater than the urban with 74% of people living in the rural areas of the country. Lastly, the poorer and average categories of household wealth index with under-5 year olds were highest with 21.2% and 21.1%, respectively.

Table 2.5: Variable descriptive statistics

Variable	Obs.	Mean	Std. Dev.	Min	Max
Dependent Variable					
Under-5 children (in months)	3,716	32.3868	20.4004	0	60
Independent Variables					
Wealth index: (poorest)					
Poorer	3,697	0.2126	0.4092	0	1
Average	3,697	0.2110	0..4081	0	1
Richer	3,697	0.1728	0.3782	0	1
Richest	3,697	0.1390	0.3460	0	1
Other Variables:					
Gender: (Male)					
Female	3,716	0.4793	0.4996	0	1
Place of residence: (Urban)					
2. Rural	3,713	0.7406	0.4383	0	1
Geo-political Zones: (North Central)					
2. North East	3,713	0.2055	0.4041	0	1
3. North West	3,713	0.3342	0.4718	0	1
4. South East	3,713	0.0988	0.2985	0	1
5. South South	3,713	0.1134	0.3171	0	1
6. South West	3,713	0.0975	0.2967	0	1

Source: Author's analysis

2.4.2 Empirical results: Socio-economic disparities in under-5 child malnutrition in Nigeria

2.4.2.1 Principal Component Analysis

The result of the tests (Correlation test, Barlett test, Sphericity test and the Kaiser-Meyer-Olkin - KMO) that were carried out before the construction of the PCA showed that the data was fit because the correlation test showed correlation above 0.3, the overall Kaiser-Meyer-Olkin (KMO) was 0.8990, which is very high and meritorious since its values (0.8990) are between 0.80 to 0.89.

After the construction of the PCA, the wealth group was organized into five quintiles, representing five socio-economic groups in Nigeria, namely: Poorest, Poorer, Average, Richer, Richest (Table 2.6). After the grouping, the asset weight derived from the data was applied to the wealth groups to derive the weighted asset data of the wealth index. The purpose of this application of the asset weight is to adjust for differences in probability of selection between cases in the sample, either due to design or coincidence, to produce the proper representation. The five socio-economic groups are presented in Table 2.6. From Table 2.6, we observe that the poorest quintile is the largest group in Nigeria with 24.53% of the population. This is closely followed by the poorer quintile with 21.27% while the average in the country was 19.73% of the population. The richer and richest households in Nigeria are 16.78% and 16.68%, respectively.

Table 2.6: Weighted asset wealth index scores by quintile

Quintile weight	Obs.	Mean	Std. Dev.	Min	Max	Freq.	Percent	Cum
Poorest	917	1.00	0.00	1.00	1.00	1,119	24.53	24.53
Poorer	905	1.78	0.42	1.00	2.00	970	21.27	45.80
Average	911	2.71	0.46	2.00	3.00	900	19.73	65.53
Richer	915	3.72	0.45	3.00	4.00	811	17.78	83.32
Richest	913	4.83	0.37	4.00	5.00	761	16.68	100
Total						4,561	100	

Source: Author's analysis

2.4.2.2 Malnutrition Z-score analysis

Analysis for stunting (HAZ), wasting (WHZ) and underweight (WAZ): The Z-score analysis was done to derive the Height-for-Age (HAZ), which represents the stunting, the weight-for-height (WHZ), which represents wasting and the weight-for-age (WAZ), which represents underweight. Table 2.7 presents the results of Z-score analysis of stunting, wasting and underweight for Nigeria. From the table, the highest percentage of children stunted (HAZ) was with 37.8% while the percentage of children not stunted are 62.23%. This was followed by the number of children that are underweight (WAZ) with 20.25% and 79.75% of the children not underweight. Wasting (WHZ) was the lowest category with 9.63% of children wasted and 90.37% of the children not wasted.

Table 2.7: Analysis for stunting (HAZ), wasting (WHZ) and underweight (WAZ)

Variable	Mean	Std. Dev.	Min	Max	Freq.	Percent
Stunted: 0	-1.2689	1.9899	-4.9907	4.9809	1,553.17	62.23
1	0.3821	0.4860	0.0000	1.0000	942.83	37.77
Wasting: 0	-0.1594	1.5814	-4.9938	4.9708	3,210	90.37
1	0.0990	0.2988	0.0000	1.0000	342	9.63
Underweight: 0	-0.7658	1.6244	-4.9679	4.9911	2,074.34	79.75
1	0.2064	0.4048	0.0000	1.0000	526.66	20.25

Source: Author's analysis

Figure 2.5 shows the distribution of the results presented in Table 2.7. The graph A, which is a bell curve, in Figure 2.5 displays the dispersal on stunting of children under-5 years of age. It can also be observed from the results that the distribution is skewed more towards the left-hand side of the mean, and a number of the under-5 children fall below the -2 Z-score. This further confirms the 37.8% of the stunted under-5 children reported in Table 2.7. The graph B, which is also a bell curve in Figure 2.5, shows the distribution of wasting in under-5 children. The graph

shows a distribution that is fairly normal; i.e., bell shaped, with majority of the children within the 95% bracket on the graph, and a few below the -2 Z-score. This further confirms the results from Table 2.7 that reported that 9.63% of the children under-5 years of age were wasted. The graph C, which is also a bell curve in Figure 2.5, shows the distribution of children who are under-5 years of age who are underweight. The distribution is skewed more towards the left side of the mean, and a number of the children fall below the -2 Z-score. This ascertains the figure presented in Table 2.7 that 20.25% of the under-f5 children were underweight.

Also, going by the classification in Table 2.3, we observed that the percentage of stunted children presented in Table 2.7, i.e., 37.77% falls in the category WHO interprets as high prevalence. In other words, Nigeria has a high prevalence of stunted children. Also, the percentage of children underweight (20.25%) falls in the classification of high prevalence, meaning also that there is a high prevalence of underweight children in Nigeria. However, the 9.63% for wasted children falls on the borderline of poor and serious prevalence classification.

Analysis by gender. Table 2.8 shows that the percentage of stunting is significantly higher in male children compared to female children (39.88% vs 35.59%; $\chi^2 = 6.1$, $p = 0.014$). Also, the rates of wasting were higher in male children compared to female children with 10.37% vs 8.87% ($\chi^2 = 3.7525$ $P = 0.053$), and the same was the situation with underweight with males' rate higher than females' with 23.24% vs 17.11% ($\chi^2 = 17.5210$, $P = 0.000$). Given the level of statistical significance, underweight is observed to be more statistically significant compared to wasting and stunting, which were significant at five and one percent levels.

Table 2.8: Analysis of malnutrition by gender

	Male	Freq	Percent	Female	Freq.	Percent
Stunting	0	780.39	60.12	0	771.59	64.41
	1	517.62	39.88	1	426.41	35.59
Total		1298.00	100		1198	100
Wasting	0	1,642.94	89.63	0	1567.36	91.13

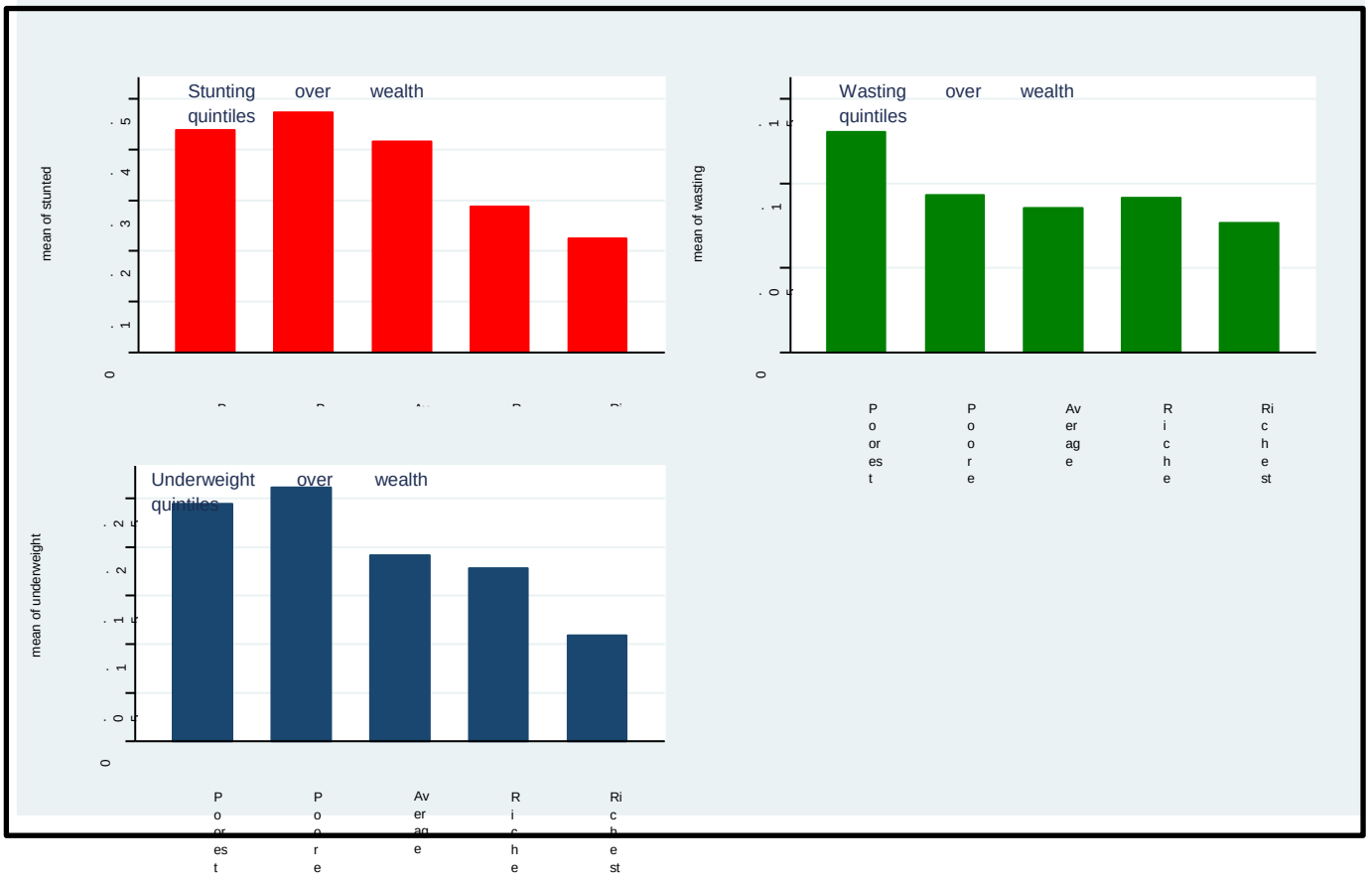
	1	190.06	10.37	1	152.64	8.87
Total		1,833.00	100		1720	100
Underweight	0	1041.62	76.76	0	1031.11	82.89
	1	315.38	23.24	1	212.89	17.11
Total		1357	100		1244	100

Source: Author's analysis

Figure A1 (in the Appendix) gives the graphical representation of stunting, wasting and underweight by gender and by wealth quintiles. The chart and explanation is consistent with the explanation of Table 2.8.

Analysis of malnutrition by socio-economic quintiles: Further analysis of the three states of child malnutrition was done using the wealth quintiles (Figure 2.3). The results revealed that underweight was reactive to household socio-economic status; the same was true for stunting as well. The higher the wealth or the richer the household gets, the less stunted and underweight the children. However, wasting did not appear to be so sensitive to changes in socio-economic status. Majority of the children that were stunted and underweight fell within the first three poorest, poorer and average wealth quintiles, while a few fall among the last two wealth quintiles, which are for the rich.

Figure 2.3: Malnutrition across wealth quintiles



Source: Author's analysis

Analysis of malnutrition by place of residence: Analysis of the three states of malnutrition was done using the areas or residence of the children. The results from Table 2.9 showed that a higher percentage of children under five years of age who were stunted, wasted and underweight (40.41%, 10.23%, and 21.91%, respectively) lived in the rural areas of Nigeria compared to children living in urban areas of the country (32.41%, 8.45%, 16.81%, respectively).

Table 2.9: Malnutrition analysis by place of residence

	Urban	Freq.	Percent	Rural	Freq.	Percent
Stunting	0	446.80	67.59	0	1,093.41	59.59
	1	214.20	32.41	1	741.59	40.41
Total		661.00	100.00		1,835.00	100.00
Wasting	0	853.29	91.55	0	2,352.99	89.77
	1	78.71	8.45	1	268.01	10.23
Total		932.00	100.00		2,621.00	100.00
Underweight	0	564.02	83.19	0	1501.67	78.09
	1	113.98	16.81	1	421.33	21.91
Total		678.00	100.00		1,923.00	100.00

Source: Author's analysis

Figure A2 (in the Appendix) gives a graphical representation of malnutrition by place of residence and by wealth index. This buttresses the findings on Table 2.9.

Malnutrition analysis across the six geopolitical zones in Nigeria: The rates of the three types of child malnutrition have a wide spread of geographical variations, with the highest found mostly in the North West and North East zones. These are the two zones with the highest poverty rates in the country, based on the poverty indicator of the country.

The comprehensive concentration indicators for stunting, wasting and underweight were -0.1217, -0.0938 and -0.1310, respectively. The three categories of child malnutrition show important disparities, which are in favour of the rich. This means that a greater burden of malnutrition is being born by those children in the lowest socio-economic status. However, for wasting, this socio-economic gradient is not witnessed, as it is not so responsive to changes in socio-economic

status. Figures A3.1, A3.2 and A3.3 (in the Appendix) give the visual and graphical clarity, which further buttresses the findings on Table 2.10.

Table 2.10: Malnutrition analysis across the six geopolitical zones in Nigeria

Variable	Rate (%)	C	SE	P-Value
Stunting	38.21	-0.1217	0.0141	0.0000
Wasting	9.94	-0.0938	0.0294	0.0012
Underweight	20.67	-0.1310	0.0209	0.0000
Stunting: NC	27.82	-0.0929	0.0473	0.0504
Stunting: NE	43.00	0.0049	0.0291	0.8655
Stunting: NW	52.91	0.0088	0.0181	0.6225
Stunting: SE	23.55	0.0157	0.0632	0.8029
Stunting: SS	20.67	-0.1659	0.0651	0.0114
Stunting: SW	22.48	-0.0920	0.0636	0.1493
Wasting: NC	7.09	0.0372	0.0899	0.6790
Wasting: NE	9.19	-0.0880	0.0655	0.1796
Wasting: NW	11.99	-0.1082	0.0432	0.0125
Wasting: SE	7.88	0.1835	0.1006	0.0692
Wasting: SS	7.7	-0.1349	0.0953	0.1579
Wasting: SW	8.64	0.0009	0.0935	0.9922
Underweight: NC	11.21	-0.0045	0.0813	0.9559
Underweight: NE	23.26	-0.0089	0.0435	0.8373
Underweight: NW	28.83	-0.0233	0.0297	0.4328

Underweight: SE	12.55	-0.1058	0.0910	0.2464
Underweight: SS	10.71	-0.2441	0.0951	0.0108
Underweight: SW	13.74	-0.0485	0.0851	0.5689

Source: Author's analysis

Table 2.10 also presents the analysis of the three categories of malnutrition within all the political sub-divisions of Nigeria. The stunting rate is highest in the North West (NW) at 52.91% followed by the North East (NE) at 43.00% and lowest in the South South (SS) at 20.67%. The results also showed that North West has the highest number of children with wasting at 11.99% followed by North East at 9.19%, and the lowest numbers of children with wasting are found in the North Central (NC) with 7.09%, South South 7.7% and South East (SE) at 7.88%. However, wasting does not show significant socio-economic disparities among the zones. Similarly, North West zone also has the highest percentage of underweight children with a rate of 28.8%, also closely followed by North East with a rate of 23.3%. Meanwhile, the zones with the lowest rates are again the South and the North Central with 10.7% and 11.2%, respectively.

2.4.2.3 Analysis of malnutrition concentration indices

Table 2 reports the concentration index analysis of malnutrition done on children under 5 years of age in Nigeria. The negative signs revealed by the analysis done on stunting, wasting and underweight showed that they were only found within poor households. The standard errors for the three measures of malnutrition are small, indicating that their sample means are a more accurate reflection of the actual population mean. The results also indicate that stunting, wasting and underweight are significant at one percent level.

Table 2.11: Concentration indices of malnutrition

Variable	Obs.	Index Value	Std. Error	P-value	Con. Index	Std. E of CI
Stunting	2,488	-0.1217346	0.014402	0.0000	-0.1217	0.0141
Wasting	3,541	-0.0938281	0.028979	0.0012	-0.0938	0.0294
Underweight	2,592	-0.131037	0.021942	0.0000	-0.1310	0.0210

Source: Author's analysis

This results equally show for the concentration curve of stunting that income-related and socio-economic-related inequalities are the strongest in stunting because the stunting concentration curves is far from the line of equality, which is an indication of long-lasting malnutrition associated with socio-economic deprivation.

Furthermore, socio-economic-related inequalities are strong in underweight, which is also an indication of chronic malnutrition often associated with socio-economic deprivation. However, as anticipated, no significant socio-economic inequalities are observed in wasting because the concentration curve almost overlaps with the equality line. This is because income has little effect on conditions that usually precipitate wasting, such as diseases and unexpected environmental factors.

Concentration index analysis by geopolitical zones: The results from Table 2.10 show that stunting has equal division among the zones, with half of the zones having stunting concentrated among the poor, and about half having stunting concentrated among the rich. The pro-rich concentration indices are significant at 5 and 1 percent level of significance, while South West zone was not significant, which shows that it does not exhibit income-related inequalities. The remaining three zones (North East, North West and South East) are concentrated among the rich. However, the pro-poor concentration indices are statistically not significant; in other words, they do not exhibit income-related inequalities.

Wasting is concentrated among the rich in the North Central, South East and South West zones; however, their concentration indices are not statistically significant. Wasting is concentrated

among the poor in the North East, North West and South South, with their concentration indices not statistically significant, except for the North West zone, which is significant at one percent level of significance, implying that the inequality is income-related.

Similarly, in all the zones, the results show that underweight is highly concentrated among the poorest; however, the pro-rich concentration indices are not statistically significant, except for the South South zone. This suggests that the disparities found in underweight concentration indicators are not income-related.

Concentration index analysis by place of residence: Table 2.12 reveals that disparities related to income in stunting and underweight go up proportionally with the level of urbanization the household resides; that is, the rate of malnourished children is lower in urban areas compared to children living in rural areas of the country. Wasting is also observed to have a higher concentration among rural area children compared with urban area children, although the difference between the urban and rural is not as much as the ones observed in stunting and underweight.

Table 2.12: Concentration indices by place of residence

Variable	Rate (%)	C	SE	P-Value
Stunting: Urban	31.75	-0.1269	0.0313	0.0001
Stunting: Rural	40.41	-0.0904	0.0157	0.0000
Wasting: Urban	8.59	-0.1218	0.0591	0.0398
Wasting: Rural	10.23	-0.0748	0.0323	0.0207
Underweight: Urban	16.53	-0.1554	0.0476	0.0011
Underweight: Rural	21.91	-0.0888	0.0239	0.0002

Source: Author's analysis

Between the two areas of residence, that is the metropolitan and rural, the poorest are more affected by the three categories of malnutrition. However, wasting was not responsive to socio-economic status irrespective of individuals and their places of residence.

2.4.3 Discussion of the results

This research examined the socio-economic disparities in health with distinctive reference to under-five child malnutrition. Child malnutrition is a challenge in Nigeria as it is in other countries especially in the developing countries. From Table 2.6, we observe that the percentage of stunted children derived from the study (i.e 37.77%) falls in the category WHO interprets as high prevalence. In other words, Nigeria has a high prevalence of stunted children. This suggests that there should be targeted health policies to help reduce this high prevalence. The results are consistent with the study done by Uthman (2009), which observed that there was a high dominance of stunted children in Nigeria, and also observed that going up the northern part of Nigeria, there is a notable rise in the fraction of stunted children. This was similar to the results observed in this study, with the North West and North East zones having the maximum rate of stunted children. Also, the percentage of children underweight (20.25%) fell in the classification of high prevalence. In other words, there is a high prevalence of underweight children in Nigeria. This equally calls for targeted policies by the government and other relevant organizations to reduce this high prevalence of underweight in children. However, the 9.63 per cent for wasted children falls on the borderline of poor and serious prevalence classification. This equally calls for attention by policy makers, especially since wasting is known as the global acute malnutrition.

The results of the rate of stunting, wasting and underweight between male and female under-5 children is consistent with the results by Zere (2003), where these rates are found to be lower in female children compared to male children. This follows the trend in many African and developing countries where stunting, underweight and wasting are still a challenge and especially a challenge with stunting being very slow on the decline. It has been well established in literature that the socio-economic status of a household is a significant determinant of whether a child is stunted or underweight (Zere and McIntyre, 2003; Mosley and Chen, 1984).

Taking a leaf from other studies (Zere and McIntyre, 2003; Mosley and Chen, 1984) and relying on global averages alone can conceal information and could be misleading when used to formulate policies. Therefore, breaking it down into several indicators on the basis of financial status is very important for producing useful facts or data for policy making.

Disparities in the areas of residence is to some extent attributable to rural-urban differential in income disparities between places of residence, with rates of stunting and underweight lower in urban areas than in rural areas. The concentration indices for stunting, wasting and underweight show that they are concentrated among the underprivileged in both rural and urban areas of residence, even though the pro-rich indices are highest among rural dwellers. However, it should be noted that stunting and underweight are higher with the poor in both urban and rural areas. Therefore, there is need for targeted policies and other ways of combating utter poverty in urban areas, and not just focus on rural areas alone. This finding is consistent with other research works (Basta, 1977; Bradley *et.al*., 1992; Haddad *et.al.,* 1999; Menon *et.al*., 2000; Zere, 2003) which found prevalent concentration of ailment among the poor people residing in urban areas. They also pointed out that urban population experience significant variations in socio-economic status compared to rural dwellers. This is true for a country such as Nigeria which has a high level of socio-economic disparities.

If these disparities are not effectively addressed, they have long-term effects on children under the age of five. It has been observed that malnutrition has a lifelong impact on people's ability to earn their livelihood. This fact inevitably leads to perpetuation of pre-existing high levels of income disparities in the nation. It is urgent to address malnutrition, as it may lead to irrevocable damages to children's cognitive development (Behrman and Hoddinott, 2000).

2.5 Summary, Conclusions and Recommendations

2.5.1 Summary

A notable fall in stunting is evident as one moves up the ladder of socio-economic status. This implies that improvement in household's socio-economic status will likely bring about a reduction in the probability of stunting of children. This has been highlighted by several studies indicating that a rise in income of the underprivileged is a good policy to curb malnutrition

(Sahn, 1994). Therefore, the cycle of disparities in socio-economic status, stunting and underweight among regions in a country can be curbed by the government or policy makers through projects that generate incomes, and direct money or resources being given to the poor in the society. The indicators of malnutrition should be viewed in a wider dimension and not just in a narrow medical or biological view.

2.5.2 Conclusions

In conclusion, the study found significant disparities in malnutrition of children under the age of five, favoring the rich in the community, and which is unnecessary, unjust and avoidable. Just like other studies have pointed out, dependence on universal averages can only be deceptive (Zere and McIntyre, 2003; Mosley and Chen, 1984), but when indicators are broken down, and analysis are conducted on specific and smaller indicators, the results are more reliable for policy formation and targets. Addressing malnutrition in under-5, especially stunting which has been established to be somewhat receptive to improvement in socio-economic rank of households, needs urgent attention from policy makers or government to formulate policies that would improve the socio-economic status of households, which in turn would help reduce malnutrition, an initiative that would surpass the medical arena. Finally, good nutrition is crucial to a child's survival, health and development, and adversely will affect a child's survival negatively and productivity later in adulthood (Thomas *et. al.,* 1990; Pelletier *et. al.,* 1995). Therefore, well-nourished children make better adults, who in turn make a strong and better nation.

2.5.3 Recommendations

The findings from this chapter have several policy implications for socio-economic disparities of under-5 child malnutrition in Nigeria. Breaking various indicators down by socio-financial levels is very important for producing important information for decision makers because relying on global averages alone can conceal information and could be misleading when used to formulate policies. When the different categories of under-5 malnutrition is broken down by various indicators such as geographic, demographic and socio-economic status, asides from wasting, the rate of disparity in under-five malnutrition is very much pronounced. Therefore, when indicators

are broken down, and analyses are conducted on specific and smaller indicators, the results are more reliable for policy formation and targets.

There is a need for targeting policies and other ways of combating utter poverty in urban areas, and not just focus on the rural areas alone. While stunting and underweight were higher with the poor in rural areas, the same was the case with the poor in urban areas, which is as a result of the existence of significant concentration of ill-health among the urban poor.

It is essential to have targeted policies that will focus on this age group (children under five years of age), because its future benefit is very significant, while irreversible damages to these children could manifest in the future can be avoided, and ultimately reduce pre-existing income disparities in the country

Good nutrition is crucial to a child's survival, health and development, while malnutrition will adversely affect a child's survival, which in turn may affect productivity and health negatively. Therefore, well-nourished children make better adults, who in turn make a strong and better nation.

Finally, the government should increase the income of the poorest in the society to improve their socio-economic status. This is a strategy that will help control socio-economic disparities resulting in high stunting rates in households. The formulation and implementation of these policies should therefore be aggressively pursued to curb disparities in stunting and underweight among regions in the country.

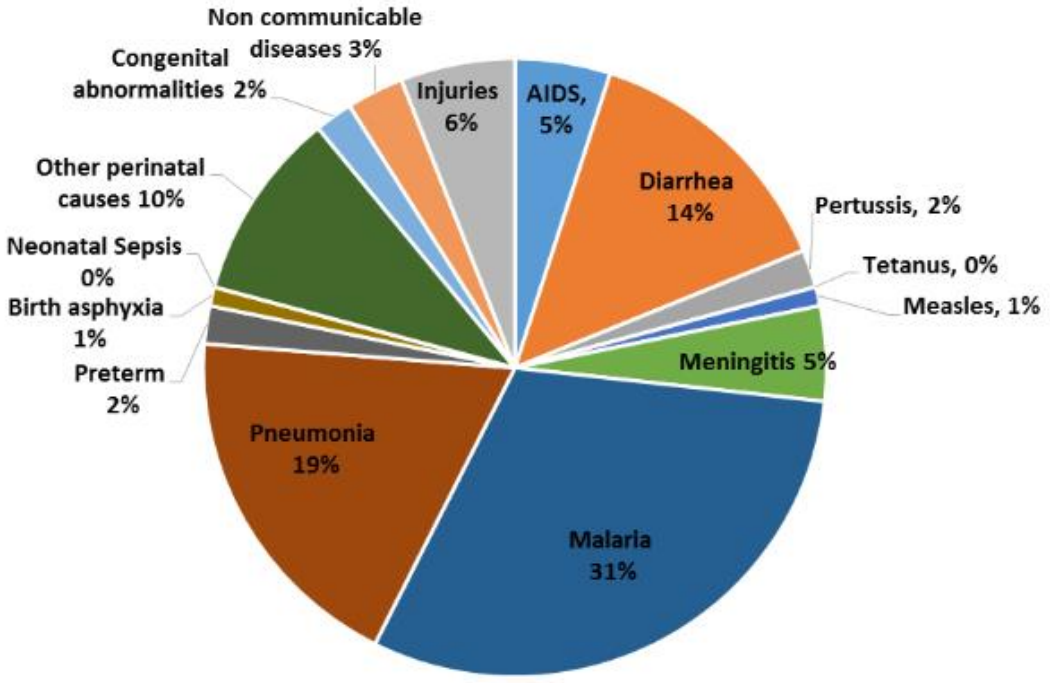
CHAPTER THREE: MATERNAL EDUCATION AND UNDER-FIVE MORTALITY DISPARITIES IN NIGERIA

3.1 Introduction

Generally, child health and childhood mortality are used as wide pointers of social growth (Zachary *et.al.*, 2013). This is the reason for the infant death reduction being part of the 8 Millennium Development Goals (MDGs) drafted in the year 2000 (WHO, 2000). It is still one of the targets in the new goal three rolled out under the Sustainable Development Goals (SDGs) formulated in the year 2015 (UNDP, 2016). The SDGs target for infant mortality aims to end avoidable deaths of infants and children 5 years and under by the year 2030 (UNDP, 2016). In view of this, all countries, Nigeria included, are targeting to lower neonatal mortality to below 12 mortalities in every 1000 successful births and under-5 mortalities to below 25 deaths in every 1000 live births (WHO, 2015).

There are several causes, illnesses or contributors to under-5 mortality that have been identified, and in the year 2014, WHO identified three major illnesses: Malaria, Pneumonia and Diarrhea as the leading illnesses contributing to the high under-5 mortality rate in Nigeria in the year 2013 (see Figure 3.1).

Figure 3.1. Illnesses causing under-5 mortality in Nigeria, 2013



Source: WHO (2013)

In Nigeria, there has been a gradual decline in under-5 mortality from the year 1990-2019. In the year 1990, there was a decline in mortality of children, resulting in a statistic of death of a child in every five Nigerian children, with a mortality data of 201 deaths in every 1000 live births. In the year 2000, the under-5 mortality decreased to 183 deaths per 1000 live births. Nigeria had a further decrease to 136 under-5 mortality per 1000 live births in the year 2010. Yet, still in 2015, the country had a further decrease to 127 under-5 mortality per 1000 live births, while the figure for the year 2019 was 117 under-5 mortality per 1000 live births (World Bank, 2021) (See Table 1.2). There is a tendency to wonder what seems to be the problem with under-5 mortality in Nigeria; after all, there seems to be a declining trend.

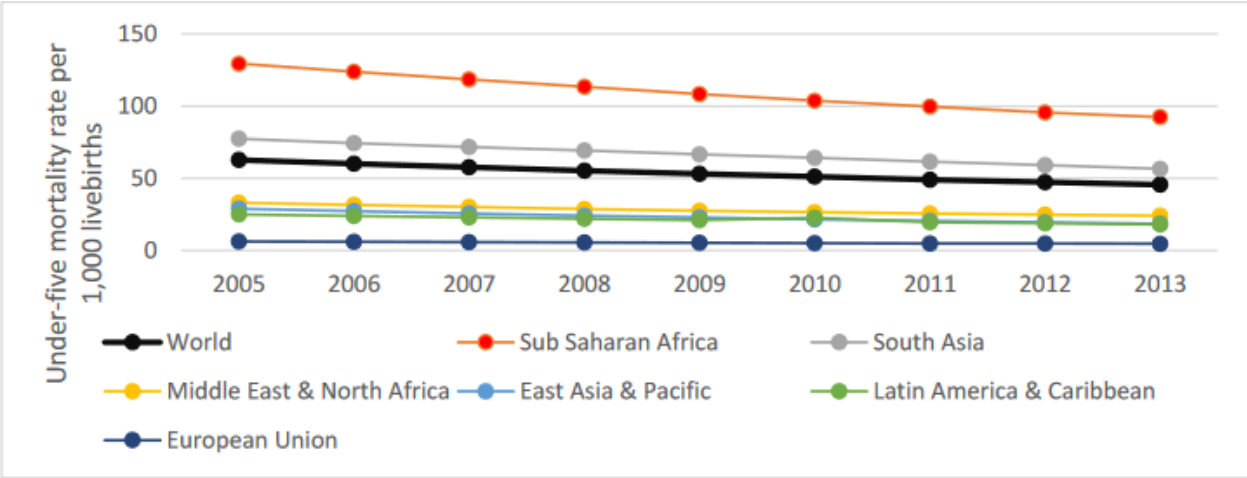
Nigeria being the country with the highest population in Africa estimated at 200 million people accounted for 12% of the world's under-5 mortality in 2008 (UNICEF, 2010). It was reported by Adetunji (2002) that the decline in under-5 mortality has been unstable in Nigeria over the last four decades, stating that the decline is slower in recent years compared to the 1960s and 1970s.

Between the year 1990 and 2000, the under-5 mortality average annual rate of reduction was 0.3%, a percentage that rated the country below the probability of attaining the MDG 4 (Murray *et al.,* 2007).

The decline in absolute numbers continued over the years, and the situation seemed to be improving with a report that under-5 mortality reduced from 177-157 per 1000 live births between 2000 -2010, given an annual rate of about 2.0% (Rajaratnam *et al.,* 2010). Similarly, in 2013, despite different kinds of interventions, the mortality of children under the age of five continued to climb. In the same year, the NDHS suggests that out of 128 deaths per 1000 children born alive, one per eight children experienced mortality before they turned five years old, which is about 21 times more common than the rate in more economically advanced countries (UNICEF/WHO/World Bank/UN, 2013.) In 2015, according to UNICEF, five nations contributed half of all new-born deaths in the world, and Nigeria was among them, contributing 9%. Yet still in the year 2017, the country rate of under-5 deaths was 104 out of 1000 children born alive, placing the country in the 6th position among average-income nations with very high children mortalities (Lawn, 2014; UNICEF, 2018), and within the top 10 nations in the world with very high death rates of children under the age of five years (Figure 1.1) (Liu *et al.,* 2016).

Data continued to show that over the years, two regions have been mostly hit by this under-5 mortality as can be seen in Figure 3.2

Figure 3.2: Global trends of under-5 mortality



Source: WHO (2014)

In 2019, worldwide statistics recorded about 5.2 million under-5 mortality, with southern and central Asia and the Sub-Saharan Africa having the highest rates of about 2.8 million and 1.5 million deaths, respectively. When these death records from the two regions were summed together, the percentage was more than 80% of the global deaths recorded (UNICEF/WHO/World Bank/UN, 2019). Further statistics for 2019 showed that among the affected countries in Sub-Saharan Africa, five countries had more than 49% of the total under-5 deaths recorded, of which Nigeria was one. Also, looking at the records from Nigeria and India alone, these two countries recorded about a third of the global under-5 deaths (UNICEF/WHO/World Bank/UN, 2019). Although there is a gradual reduction in the under-5 mortality rate in Nigeria, the country did not meet the child mortality reduction rate in the Millennium Development Goal in 2015 (Lykens *et al.*, 2009), and it still no doubt has a long way to go in meeting the Sustainable Development Goals of 2030.

Indeed, some policies and programmes have been put in place by the Government, such as the National Child Health Policy of 2006 which covers newborn, under-5 and school age children. This policy sets forth priorities, strategies and interventions necessary to overcome the challenges of child health care, such as measles, diarrhea, acute respiratory infections, malnutrition, low birth weight, asphyxia, sepsis, neonatal jaundice and neonatal tetanus, malaria

and helminthic infections such as ascariasis and schistosomiasis. Other policies include: Ministry of Education's free education for children in public schools, among others, which is also intended to help reduce the problems facing children under-5 children. Examples of programmes and agencies that implement these policies are Midwives Service Scheme, Subsidy Reinvestment and Empowerment Program (SURE-P), Saving One Million Lives Initiative (SOML), National Programme on Immunization (NPI), Integrated Management of Childhood Illnesses (IMCI), among many others. These are interventions and key child survival initiatives used by the Federal Republic of Nigeria to combat the elevated diseases and deaths of children under five years-old (WHO, 2019).

Among all these interventions stated above and variables that help reduce under-5 mortality, this study will explore the effect of maternal education on under-5 mortality because under-5 mortality remains an important measure of health and development of any society and is a leading indicator of child health and overall development. Globally, there has been a decline in the under-5 mortality rate; however, Africa is still one of the regions with the highest rates, while Nigeria is a major contributor to that rate. This makes the study of interventions or policies that would help reduce this rate and possibly help the country meet the SDG target of 2030 for under-5 mortality rate of less than 25 deaths per 1000 live births by the year 2030 a needed study.

Studies such as Caldwell (1979), Schultz (1993), World Bank (1993), Desai and Alva (1998) have shown that minors of literate parents have reduced mortality compared to those of illiterate parents. Many research findings (Schultz, 1993; World Bank 1993; Desai and Alva, 1998) on human population show a strong relationship between parent education and infant mortality. The public opinion increasingly assumes that commitments in mother's education are very key ingredients in reducing infant and child deaths while improving child health (Schultz, 1993; World Bank, 1993; Desai and Alva, 1998). However, none has attempted to evaluate the extent of inequities in under-5 mortality ascribable to maternal level of education in Nigeria or the impact of mothers' formal education on the rate of deaths of the children under five years. This paper intends to bridge that gap.

This chapter therefore seeks to determine and quantify the extent of disparities in under-5 mortality attributable to maternal level of education and recommends policy solutions based on the findings. The specific objectives of this chapter are:

1. To determine and quantify the extent of disparities in under-5 mortality attributable to maternal level of education and socio-economic status across the country;
2. To check for the effect of the moderation and mediation of maternal education on under-5 mortality using different pathways; and
3. To recommend policy solutions based on study discoveries.

3.2 Literature Review

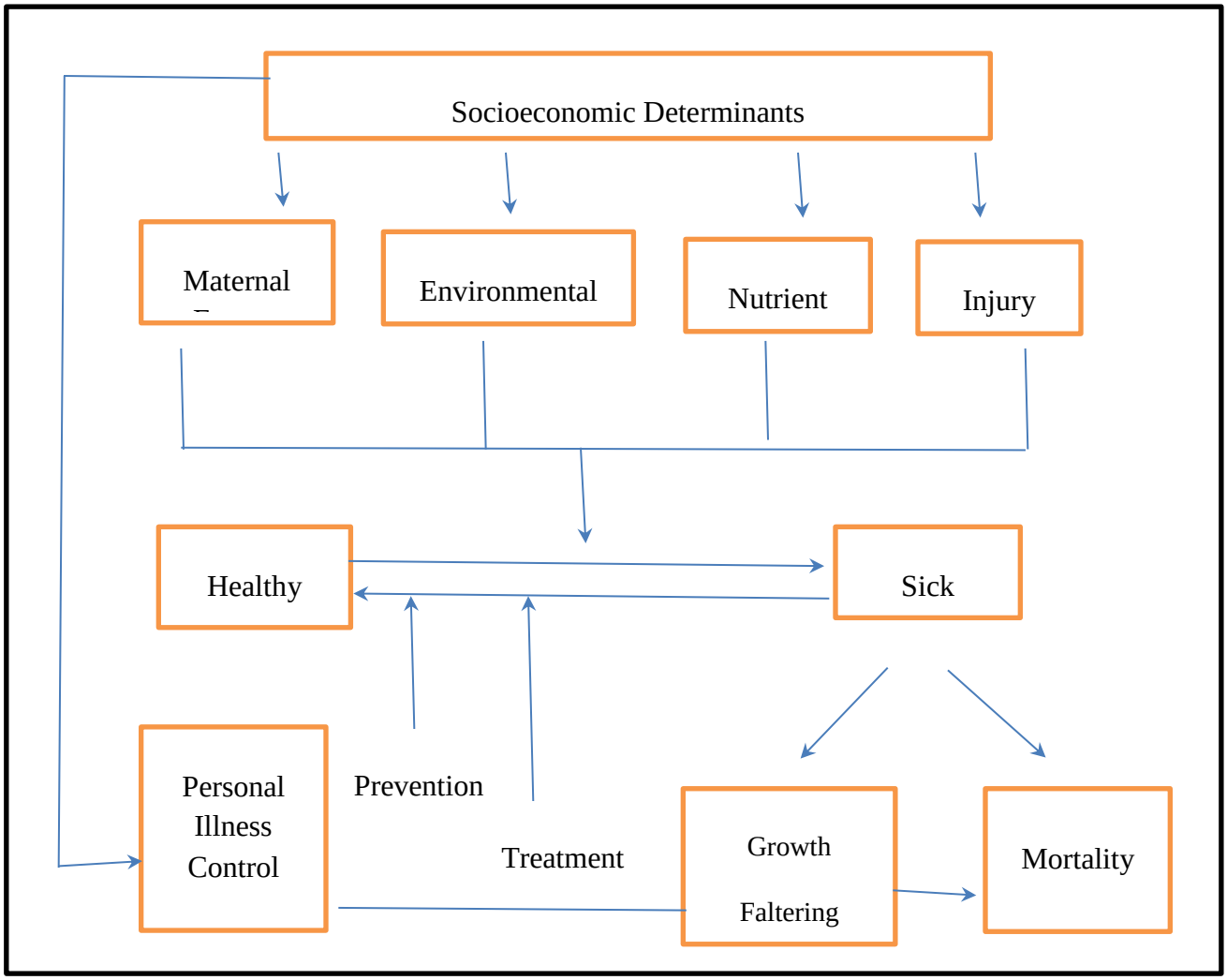
This section reviews both theoretical and empirical literature. Section 3.3.1 reviews two models on child mortality and maternal education. The first model is adapted from Mosley and Chen (1984), which shows the interplay of factors that could eventually lead to child death. The second model is adapted from Aslam and Kingdon (2012), Frost *et al.* (2005) and Hassen (2014). It describes how there can be child mortality because of direct or indirect effect of maternal education through other mediating variables. Section 3.3.2 reviews empirical literature to identify the variables and methodologies in the literature that this study should take inferences from and identify the gaps to fill.

3.2.1 Theoretical review

3.2.1.1 Mosley and Chen (1984) model

An analytical framework that is applicable to the growing countries was established by Mosley and Chen (1984). The framework considers both social and biological variables that impact on mortality. Mosley and Chen framework identified proximate roots of mortality and morbidity and separated them into five main groups: 1) Maternal variables; 2) Environmental contaminants; 3) Nutrient deficiency; 4) Injury; and 5) Personal illness management (treatment and prevention).

Figure 3.3: Mosley and Chen (1984) framework



Source: Mosley and Chen (1984)

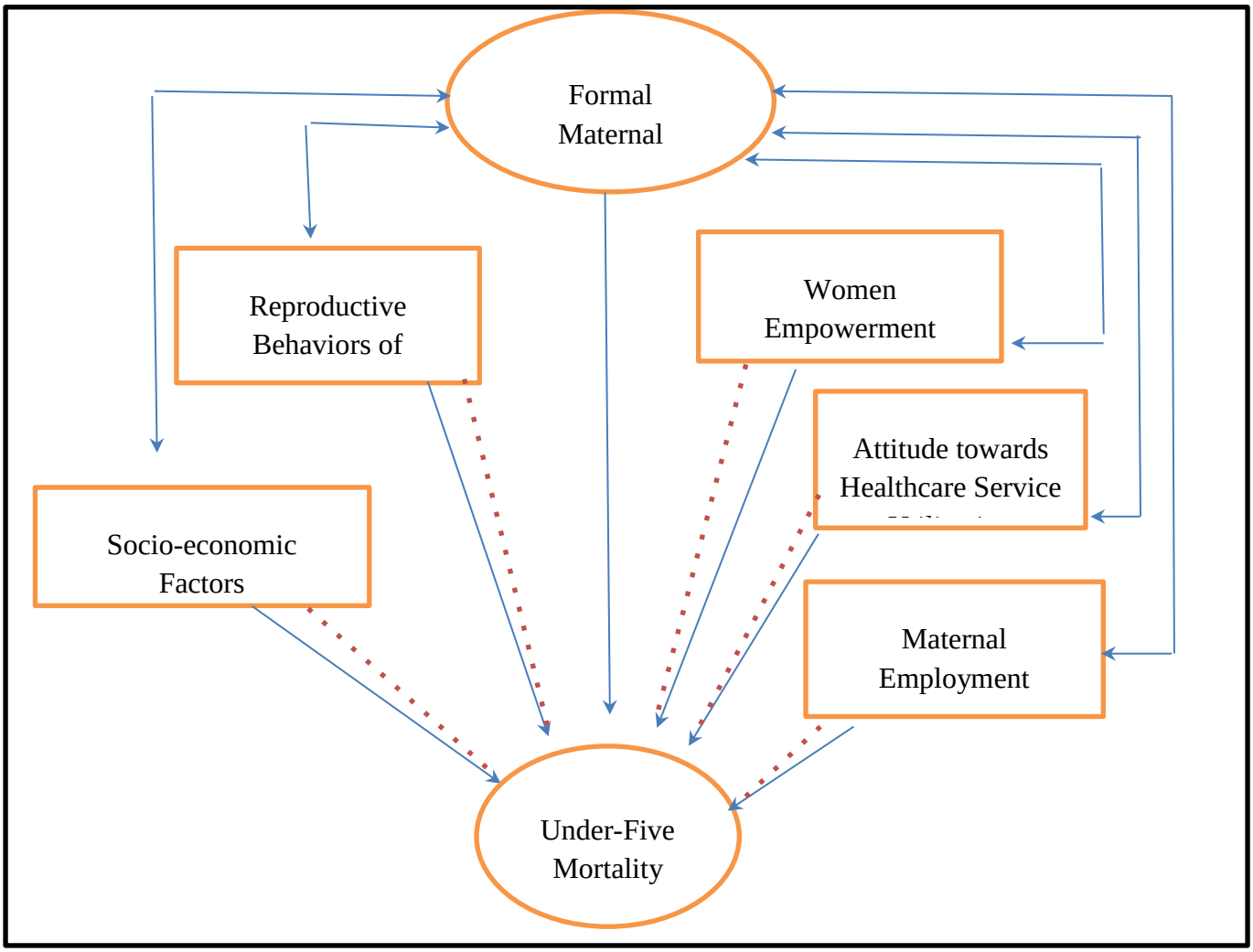
Mosley and Chen (1984) named the categories in this model as: 1) Maternal variables (parity, age and birth interval); 2) Environmental variables (air, water, food, etc.); 3) Injury (individual precautionary measures and healthcare remedies, among others. Some of these variables are directly measured, while others are indirectly measured using proxies. Figure 3.3 shows the way child mortality is affected by these factors. It depicts interrelationships amidst the determinants, which could have a direct or indirect effect through other factors on the death of children. Mosley and Chen (1984) theorized that this model assumes that exogenous and endogenous variables, or biomedical factors affecting the rate of deaths in children function through a set of endogenous factors.

The theory stipulates that the survival or mortality of under-5 depends mostly on interactions of several variables that stem from the socio-economic status of the child's family. These factors operate at different levels, but they have direct or indirect effects on the child. The maternal variables such as maternal age, education, among others, will have some form of effect either directly or indirectly on the health of a child, which could lead to its survival or death while interacting with other variables. The environment in which a child lives could have significant effect on a child; for example, a child living in a slum and a mosquito infested area would likely be sickly most of the time, and it could lead to the mortality of such under-5. The nutritional intake a child is given also contributes to his survival or mortality. While, finally, an injury to an under-5 could be life-threatening and could also lead to mortality.

3.2.1.2 Aslam and Kingdon (2012) model

Several studies such as Hassen (2014), Cochrane *et al.* (1982), Aslam and Kingdon (2012), Kassauf and Senaur (1996), Frost *et al.* (2005) all have shown that the impact of mother's formal schooling on child wellness indicators may be explicit and/or ambiguous. One or a combination of these variables forms the pathways or mechanism through which mother's educational development impacts child wellness and consequently child mortality. Adapting from Hassen (2014), Figure 3.4 explains the explicit and ambiguous impact of mother's formal education on under-5 mortality.

Figure 3.4: Pathways showing the effect of mother's education on the health of under-5



Source: Hassen (2014)

At the top of the chart is the formal maternal education variable. Groups of other variables or pathways that are possible causes of under-5 mortality are shown at the bottom right and left, while under-5 deaths is at the base. Double-arrowed blue lines between maternal education and determinants present the likely association that exists among them. Maternal education could influence reproductive behaviours, socio-economic factors, women empowerment, attitude towards healthcare and maternal employment. Consequently, the reverse could also be the case. The single one direction-arrow head blue line between maternal education and under-5 mortality indicates the direct impact of education on lowering under-5 mortality. Unlike the double-arrow

on the determinants, it has just one arrow-head, indicating only one direction and only one way impact (Hassen, 2014).

The implication of this model is that maternal education could have a direct effect on under-5 mortality, and at the same time, the effect could be indirect going through another variable or pathway, which could be mediated or moderated. Take for example an educated mother would likely get a better employment compared to an illiterate mother. When she gets this employment, there is likely to be a good remuneration or pay package that would accompany it. These funds could translate to a better living standard and conditions, and better nutritional intake. Consequently, it could give the child a better chance of survival as adequate health care, nutrition, living conditions and other necessary factors for survival would be taken care of.

Furthermore, some of the main variables causing deaths in children under five years are grouped (the pathways, which are reproductive behaviours, socio-economic factors, women empowerment, attitude towards healthcare and maternal employment) inside the boxes in the chart. The two lines (i.e. the solid (blue) and broken lines (red)) drawn from the rectangular boxes to under-5 mortality indicate two types of impact, this means that the dotted red lines represent the impact of variables on under-5 mortality as a result of formal education. The blue line type only occurs when maternal education influences those selected channels (pathways), plus if the impact is influential enough on under-5 deaths. Solid blue lines between boxes and under-5 mortality indicate the remaining impact of those variables. Thus, the total influence of maternal education is the direct impact and indirect impacts (Hassen, 2014).

3.2.2 Empirical review

Researchers are having a renewed interest in the study of why maternal education is expected to improve child health. Most existing literature highlights that a mother's educational development is critical in reducing children's deaths (Ouedraogo, 1994; Bado and Susuman, 2016). Several empirical studies have found positive effects of mother's education on a child's survival (Badji, 2016; Shariff. And Ahn, 1995; Laari, 2016).

Child health and maternal education have direct associations, and at the same time have indirect associations through pathways or variables that influence maternal education, which in turn

influences child health/mortality. According to Cleland (1990), education is connected to household socio-economic status, which in itself is a factor that determines the health of child. In addition, mother's education is postulated to cause certain transformations in personal behaviour that leads to good child wellness. Caldwell and Caldwell (1993) propose two paths in their work: (1) maternal education enhances the health of a minor exclusively through creating awareness and ensuring utilization of good health facilities; and (2) maternal education leads to a broad spectrum of acceptable behaviours linked to child care, which is important for uplifting children wellness (Desai and Alva, 1998).

Maternal education also creates a mother's awareness of the significance of healthy medical practices, minor's diseases, and accessibility to medical services. Therefore, the variable is being regarded as having a positive influence on a child's wellness (Bado and Susuman, 2016). Consequently, it is inferred that education transforms women attitudes and manners, which in turn helps them to be independent and efficient. It has also been emphasized that mothers that are educated are better enlightened in identifying healthcare services for the treatment of their child's diseases (Hobcraft, 1993). They usually have increased receptivity to current health-related education; they are familiar with the latest medical services and culture; they have access to financial resources and are aware of health insurance; and finally, they have good decision-making abilities and increased self-importance and self-confidence (Hobcraft, 1993; and Ouedraogo, 1994).

In 1998, analyzing records from the paramount round of Demographic and Health Surveys for 22 developing nations, Desai and Alva (1998) analyzed the influence of maternal educational development on the following indicators of children's wellness: newborn babies deaths, immunization record, and children's height-for-age. They argued that a causative relationship is not close to being established, even though there is a strong correlation between maternal education and markers of child health. They argued that education is seen as a proxy for the socio-economic status of the family and geographic place of abode. In view of this, control variables were introduced, such as paternal education, access to piped water, toilet and place of abode into the fixed-effects models. The results showed that mother's schooling has a statistically significant effect on child death and height-for-age in only a few countries. More so,

mother's schooling stayed statistically significant for children's vaccination status in about one-half of the nations. However, pathways of variables that influence maternal education were not clearly earmarked.

To test for the impact of maternal educational development on young child wellness, Chen and Li (2009) used a huge example of adopted kids from China. This was done because children adopted were not related to the adopted parents genetically. The only link found was the influence of maternal education on the nurturing process of the children. The findings showed that the health of these adopted children was dependent on the maternal education, even after control variables were introduced. The research established that the main effect of maternal educational development on the health of a child is in the post-birth care, because the influence of the maternal educational development was similar to the sample for children adopted and the sample of the biological births.

A comparison of father's and mother's formal educational development on the survival of a child was done by Caldwell and McDonald (1982). Using data from the World Fertility Survey, the results confirmed the importance of parental education in reducing child mortality, an impact which is possibly bigger than both access to medical care facilities and income variables altogether. The effect of rural/urban differentials was not significant after controlling for parental education.

In Ghana, Buor (2013) analyzed the impact of mother's education on the rate of children's deaths. The findings established that mother's academic level and the rate at which children survive have an inverse relationship. In addition, accessibility to fundamental medical healthcare that is connected to the survival of children and revealed a direct relationship with maternal academic level.

Bado and Susuman (2016) carried out a study that spanned from 1990 to 2015 on certain African countries to examine the association occurring between mother's education, and rate of deaths of children under five years. The statistical analyses used were Logistic regression, and Buis' decomposition method. As stated previously with Buor's findings (2013), Bado and Susuman (2016) also discovered that there was an inverse relationship occurring between the mortality

rates of children under five years old born to mothers without formal education. The higher the level of education of the mother, the lower the mortality rates of the under-5 children. From the findings, it was also observed that there was 20% survival chances up to age five for children belonging to mothers who have up to six years of education, compared to those belonging to uneducated mothers. However, there was no significant difference when comparison was made between children born by mothers with low-level of education and the uneducated ones in Namibia, Congo, and Malawi. It was therefore concluded that women's education policies by the government was probably responsible for decline in the rates of under-5 mortality observed for the duration of the last two eras.

Cochrane *et al.* (1982) examined the interaction between paternal level of schooling and the child's health. The study's findings indicated that the impact of the father's level of education on children's mortality was approximately one half that of mother's education. Yaya *et al.* (2017) used the Nigerian DHS (2013) to examine the rates and factors related to children's mortality in Nigeria. The study's results were determined based on the total number of children who died to married fathers and married mothers, respectively. Their results showed that age, zones, place of dwelling, academic level, family income, age when she had the first baby and belief were positively and negatively correlated with babies' deaths. The association between the mortality of a child and the parent's ages was found to be a parallel relationship, because for every unit increase in age, an increase in the incidence of outcome was found. However, the opposite was the case and was statistically significant for the variable age when she had her first baby. Lastly, deaths among children were lower, with mothers with various levels of formal education compared to the mothers without any formal education.

Hassen (2014) analyzed the influence of mother's education over the rate of under-5 mortality. The study used data from Ethiopia DHS for the years 2000, 2005 and 2011. To find the fractional effect of mother's education on the rate of under-5 mortality, various types of variables were used in the regression analysis: effect of maternal education Linear Probability Model regression method and pooled regression methods were used for analysis. To control mainly for endogeneity in the regression that may arise from geographical differences among the sampled children, regional dummies, area of residence (rural), and distance to health facility variables

were used. The results showed that death incidence in children under five years of age decreased with the increasing ranks of mother's education.

Hessen (2014) equally found results of the mediation effect of maternal education on under-5 mortality. The study found that nearly 50% of the effect of mother's education was mediated through socio-economic factors. The study concluded that if some factors such as socio-economic status, health behaviours of women, and the use of health services could be improved upon, it would have a greater degree of influence on mother's educational development. Therefore, maternal education, being a part of the socio-economic variables of a mother, will be analyzed to check its effect on under-5 mortality while controlling for other maternal variables, and to see if similar results or otherwise will be gotten as shown in the studies above. One of the most important ways is to invest in the education of girls as it enhances child health, in the long-run.

3.2.3 Overview of literature

Mosley and Chen (1984) showed the interplay of factors such as socio-economic factors, maternal and environmental factors, nutrient deficiency and injury that could eventually lead to the mortality of a child. The model adapted from Hassen (2014) described how there can be child mortality because of direct or indirect effect of maternal education through other mediating variables or pathways such as reproductive behaviours of women, socio-economic factors, maternal employment status, women empowerment, and attitude towards healthcare service utilization.

Most studies reviewed above have shown that maternal education has a desirable impact on reducing child deaths. However, a few studies have mixed results, indicating an insignificant effect of maternal education on children's health and mortality, and other findings denote that there is no association connecting the schooling levels of mothers, and children's health or mortality (Desai and Alva, 1998; Hessen, 2014). The implication of these findings is that in spite of the mothers' levels of schooling impacting the child's health and mortality, the outcome may differ based on each country (Hessen, 2014).

3.3 Methodology

3.3.1 Conceptual/theoretical framework

Following the works of Becker (1965; 1981), Rosenzweig and Schultz (1983), Glewwe (1999), Glewwe and Miguel (2007) and Grossman (2006), we develop the model for maternal education and child health/mortality. We assume that households derive utility from non-market or home produced goods using market goods and time, such good produced for example is child health (Becker, 1965). Decisions made by household on resource allocation have influence on child health (Rosenzweig and Schultz, 1983). The model assumes that households maximize utility over market goods, child health (quantity and quality of children), and leisure. Therefore, households face three constraints: a time constraint, a budget constraint, and a child health production function. Given a utility function as:

$$U = u(X, H) \quad (21)$$

Where:

X = a vector of market goods

H = health of a child

Leisure time is assumed to be fixed; therefore, it does not enter the utility function. Glewwe and Miguel (2007) postulate that time is costly and its price is the parents' wages since parents use their time to produce children's health.

The child health production function is given as:

$$H = h(I, E, \mu) \quad (22)$$

Where:

I = a vector of health and nutritional inputs (food and calorie intake, medical care, etc) that affect utility only through their effect on H;

E = a vector of household characteristics and environmental variables that directly affects child health; and

μ = a child-specific health endowment.

The child-specific health endowment is potentially known to the household but is not controlled by it; health inputs are in the household's choice set whereas environmental variables are not.

The budget constraint is given as:

$M = P_1X + P_2I$ (23)

Where:

M = money income

P_1 *and* P_2 = vector of prices for X and I

Therefore, to derive the reduced form demand function for X, I and H, we maximize equations (21), (22), subject to the budget constraint of equation (23)

X = x(P, E, M, μ) (24.1)

I = i(P, E, M, μ) (24.2)

H = h(P, E, M, μ) (24.3)

Where P = (P_1, P_2, P_3)

Equations 24.1 to 24.3 are called the "reduced form demand for child health" (Maiga, 2015) and are a function of family features, prices, environmental factors, the health endowment of a child, and income. The family features comprise the child's features (age, gender), father and mother's features (age, schooling), kind of residence, type of toilet amenities, source of water, etc; the environmental factors comprise of existence of medical facilities in the neighborhood, piped water availability, etc. To link maternal (parental) education and its impact on child health, consider the following specific equations (adapted from Maiga, 2015):

$H_i = h(CC_i, MS_i, FS_i, M_i, HEV, \mu_i)$ (25)

$MS_i = f(EI_i, HA_i, HEV, \epsilon_i)$ (26)

Where:

H_i = Child i's health/mortality

CC_i = Child i's characteristics

MS_i = Child i's mother's schooling

FS_i = Child i's father's schooling

M_i = household income

HEV = vector of household environmental variables, which is inclusive of community characteristics and area of residence

μ_i = a child's health endowment

EI_i = a vector of educational inputs

HA_i = mother's family household assets

ϵ_i = a vector of maternal endowments, such as genetic makeup, and ethnic background

It is imperative to note that the child health endowment(μ_i) and a vector of maternal endowments (ϵ_i) from the reduced form equations are unobserved. The endogeneity of maternal formal schooling stems from probable connection between μ_i and ϵ_i: family background may affect both the mother's education and the child's health (Maiga, 2015).

3.3.2 Empirical and econometric model

However, to link maternal education and child death, the study used a model that specifically linked mother's education and child death (health), where child health is determined by maternal education, while controlling for various child and household characteristics. To cater for the many unobservable factors that may influence a mother's education and health of a child or mortality (such as maternal morbidity and mortality, child stunting), the model incorporated these unobservable factors in the process of estimation.

Therefore, given a regression equation:

$$S_1 = \alpha_1 S_2 + \beta_0 + \beta_1 X_1 + \mu \qquad (27)$$

Where:

S_1= Under-5 mortality

X_1 = Other maternal variables

S_2 = maternal education, which is an endogenous variable. Given that there is one m instrumental variable, instrument, Z = (1, X_1, Z_1,..., Z_M), is correlated with S_2, we therefore get an equation in

a reduced form for S_2 with all exogenous factors (combination of exogenous independent variables and instrument), we have:

$$S_2 = \delta_0 + \delta_1 X_1 + \delta_m Z_m + \varepsilon \quad (28)$$

$$S_2 = \hat{S}_2 + \varepsilon \quad (29)$$

$\hat{S}_2$ is a direct prognosis of S_2 with all exogenous factors. Because $\hat{S}_2$ is projected with all exogenous factors that are not connected with the error term, μ in (eqn. 27), $\hat{S}_2$ is not associated with μ, although ε is associated with μ. Therefore, it can be said that by estimating all exogenous variables with S_2, we have divided into two parts: one is not connected with μ and the other is.

Therefore, the prognosis of S_2 with Z is given as:

$$\hat{S}_2 = Z\hat{\delta} = Z(Z'Z)^{-1}Z'S_2 \quad (30)$$

The two-step procedure was used; therefore, in the first step $\hat{S}_2$ was used in place of S_2. But now, treating S_2 as an element in X, we project X itself with Z:

$$\widehat{X} = Z\hat{\Pi} = Z(Z'Z)^{-1}Z'X = P_z X \quad (31)$$

$\hat{\Pi}$ is a (k+m+1)-by-k matrix with coefficients, thus, S_2 in X is articulated as a direct projection, and other independent factors in X is articulated by itself. $P_z = Z(Z'Z)^{-1}$, in other words ($P_z^{'P_z} = P_z$). Therefore, using $\hat{X}$ as instrument for X and applying the IV estimation we obtain:

$$\beta_{2SLS} = (\hat{X}X)^{-1}\hat{X}'S \quad (32)$$

$$= (X'P_z X)^{-1} X'P_z X \quad (33)$$

$$= (X'Z(Z'Z)^{-1}Z'X)^{-1}X'Z(Z'Z)^{-1}Z'S \quad (34)$$

This can be rewritten as:

$$\hat{\beta}_{2SLS} = (\hat{X}\hat{X})^{-1}\hat{X}'S \quad (35)$$

This is the 2SLS estimator. Stage one is equation 27, and stage 2 is equation 34. Therefore, for the first Stage regression, we obtained $\hat{S}_2$ by estimating an OLS against all of the exogenous variables, including the instrument (Place of residence).

In the Second Stage regression, we used $\hat{S}_2$in the place of Y_2 to estimate S_1 against $\hat{S}_2$ and all of the exogenous independent variables, not instrument.

3.3.2.3 Pathways channeling the effect of mother's education on under-5 mortality

Studies have shown that among child health inputs, maternal education is of the most interest, because generally, especially in Africa, mothers spend more time caring for the children compared to fathers (Maiga, 2015). The question then is how exactly does maternal education lead to better child health or mortality? This can be seen through several pathways suggested by literature. Following Frost *et al.,* (2005) and Kingdon and Aslam (2012), a child's health on multiple pointers can be influenced by mother's level of schooling through different pathways. There are two types of effects that maternal education can have on under-5 health or mortality and they are the moderation and mediation effects. Therefore, in the same vein, this research has examined the subsequent pathways referent to their moderation and mediation effect of the mother's formal education on the under-5 mortality. These channels were selected based on the theory that maternal education will be highly influenced by these variables, and these variables will subsequently impact the rates of under-5 mortality. These pathways include:

(a) Socio-economic status (SES): this is also known as income effect. This channel includes the wealth index, which consisted of household assets and wealth status. Several studies have found an association between socio-economic rank of the household and deaths of children. Bawah and Zuberi (2004) in their work on three South African countries tested association between socio-economic status and childhood mortality, and their results were reasonably consistent with expectations, which is that the higher the levels of socioeconomic status index of childhood mortality decreased consistently. Also, Cleland (1990) found that education is connected to household socio-economic status, which in itself is a factor that determines the health of child.

For instance, mothers who have formal schooling are most likely going to marry men who equally have formal schooling, which is similar to the findings by Ikeako *et al.,* (2006) where a

positive and significant association was found between mothers with formal schooling and fathers with formal schooling in Nigeria. Also, husbands with formal education are likely to have better financial opportunities, which as a result may give better socio-economic indicators and ultimately improve the health of a child. In the same vein, mothers with formal schooling are expected to be more financially stable, and therefore have the resources that can improve the health of children, consequently, reducing child mortality.

(b) Attitude towards health care service utilization (AHU): this is also known as information processing effect. The attitude towards the utilization of modern medical facilities by mothers is likely influenced by their education. Mothers who have formal schooling experiences will most likely make use of modern medical facilities and medications for themselves and their children.

A study that was done by Bicego and Boerma (1993) also had a similar submission of the utilization of medical facilities by mothers being influenced by their formal schooling. This in turn had a significant contribution towards the reduction of child mortality and improvement in child health as regards prevention diseases and sickness, birth delivery, post-partum issues, better information processing of medical information in many countries (Govindasamy and Ramesh 1997; Ikeako *et al.*, 2006; Glewwe, 1999; Maiga 2015; Thomas, Strauss and Henriques, 1991).

(c) Mother's reproductive behaviors (MRB): this is also known as health knowledge effect. Formal schooling shepherds a mother towards a better understanding of her health and how to take care of her children's wellness and medical needs (Glewwe, 1999; Webb and Block, 2004; Appoh and Krekling, 2005). Fertility issues and reproduction decisions that need to be made by mothers are usually guided by their academic level of achievement, and these decisions affect the wellness of a child. A study discovered that mothers who were very young or underage had an increasing probability of malnourished children. Also, issues such as unwanted fetus, birth weight of a child, number of births in total by a mother, and birth of twins are all associated to the above (Raj *et al.*, 2010).

(d) Women (mother's) empowerment (WE): this has to do with the freedom by a mother to take a decision, especially decisions over the wellness of a child and be able to take the child for medical attention when needed, as well as freedom to be able to take decisions on family

finances, birth control, violence, family visitation. These are all very crucial to the wellness of a child considering that most of the time children are direct responsibilities of a mother. Frost *et al.* (2005) did a mediation study of mothers' education and one of the pathways used to test for this mediation was the maternal empowerment pathway, even though the results showed that it was not significant.

(e) Maternal employment status (MES): this is the engagement of a mother in a job where she is being paid. This is with the notion that a mother's academic level will determine the kind of paying job that she would be able to engage in, and this will in the long-run affect the health of a child. Macassa *et al.* (2003) carried out a study in Mozambique, and they discovered that mothers who were agrarian and those who were blue-collar were with children having a greater probability of not surviving, compared to children of the white-collar parents.

(f)Exposure to media (EM): this has to do with the processing and understanding of information coming from media sources. It is based on the notion that mothers who are educated have the tendency to easily grasp and understand information coming from the media, and this in turn would decrease the incident of deaths in children under-5 years. In a study done by Handa (1999), it was discovered that there was an improvement in the use of health services and all other medical benefits by mothers because of quicker and efficient processing of information, which was seen to have been influenced by a higher level of education.

To estimate these pathways, we incorporate the pathways into the child's health/mortality conditional demand function, i.e. into equation (25), which is stated as:

$$H_i = h(CC_i, FS_i, AHU_i(MS_i), MRB_i(MS_i), ME_i(MS_i), MES_i(MS_i), EM_i(MS_i), M_i(MS_i), MS_i HEV_i, \mu_i) \quad (36)$$

Where:

H_i = Child's health/mortality

CC_i = Child's characteristics

FS_i = Father's schooling

AHU_i = Attitude of mother towards the use of medical care services

MRB_i = Mother's reproductive behavior

ME_i = Maternal empowerment

MES_i = Maternal employment status

EM_i = Mother's exposure to media

$M_i(SS)$ = Household income or socio-economic status

MS_iHEV_i = vector of household environmental variables, which is inclusive of community characteristics and area of residence

μ_i = child's specific health endowment

To estimate the effect of these pathways on maternal education as it affects under-5 mortality, the study made use of the moderation and mediation effects of mother's education on under-five mortality.

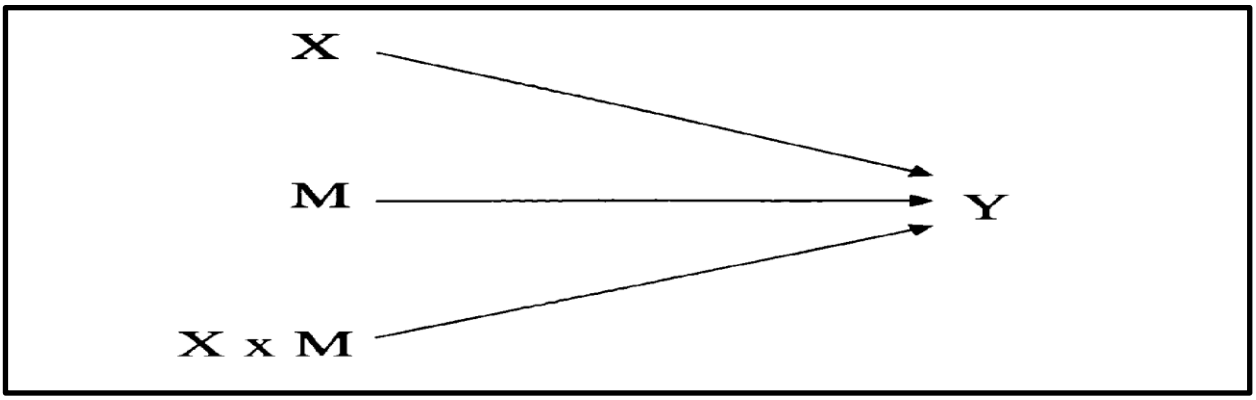
3.3.2.4 Moderation and mediation by Kenny and Baron 1986

It is of essence to differentiate between moderation and mediation of variables on maternal education and under-5 mortality. By definition, moderation and mediation comprise of factors or sets of factors that influence relationships between intermediations and outcomes, in our case between maternal education and under-5 mortality.

i. Moderation

Following the framework of Baron and Kenny's (1986), moderation includes a third factor (or set of factors) acting as a controlling condition for the influence of factors (or sets of factors) on other factors (or sets of factors). In this case, the frequency of exposures to an intervention (M) moderates the effect of that intervention (X) on the outcome (Y) (Figure 3.5).

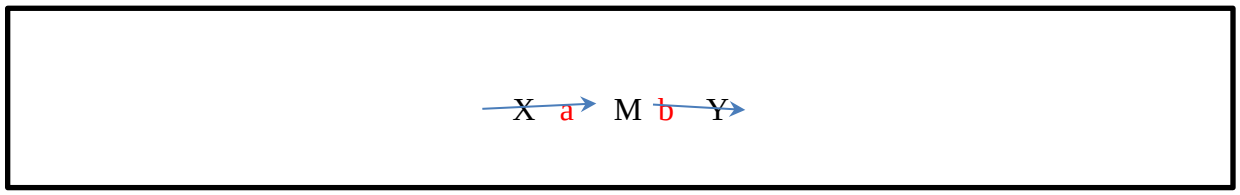
Figure 3.5: Moderation model



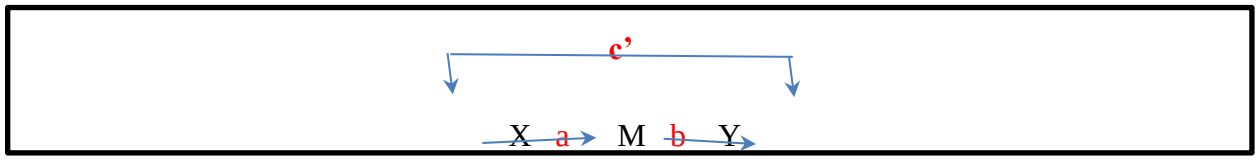
Therefore, a moderator is a variable that affects the direction and the power of the association amid an independent element and a dependent element (Baron and Kenny, 1986).

ii. Mediation

Adapted from Hayes and Rockwood (2017), mediation is an assumed causal chain where one element influences a second element that, in turn, influences a third element. The variable intervening, which is M, is the mediator. It "mediates" the association between a predictor X, and an outcome Y. This can be depicted graphically below:



Paths *a* and *b* are called direct effects. The mediational effect, in which X leads to Y through M, is called the *indirect effect*. The indirect effect represents the portion of the relationship between X and Y that is mediated by M.



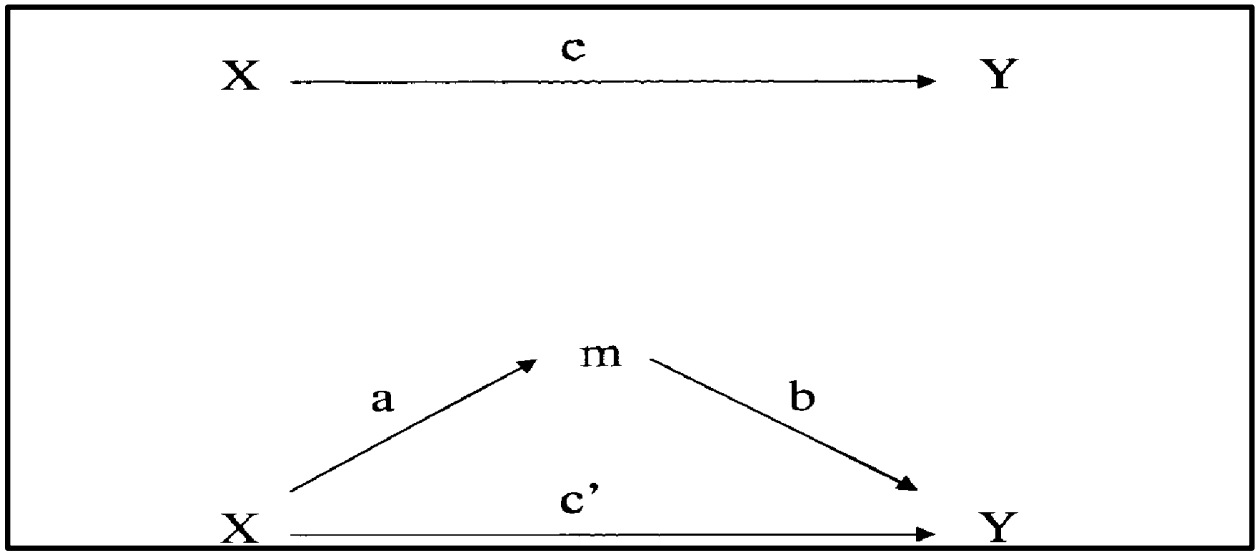
Newsom framework (2017) defined the variables as:

X = Maternal education

Y = Under-5 mortality

M = Mediator (representing the six pathways: socio-economic pathway, attitude of the mother towards the use of health care services pathway, mother's reproductive behaviour pathway, media influence on mothers' pathway, mother's job employment pathway and empowerment of mothers)

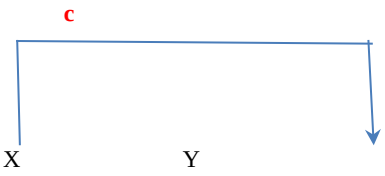
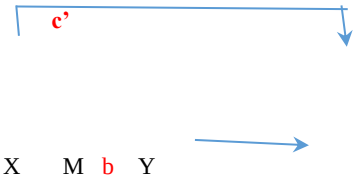
Figure 3.6: Mediation model



Source: Baron and Kenny (1986)

To test for mediation, four steps were provided by Baron and Kenny (1986) as reflected in Table 3.1.

Table 3.1: Four steps to test for mediation

	Analysis	Visual Depiction
Phase 1	Conduct a simple regression analysis with X predicting Y to test for path c alone, $Y = B_0 + B_1X + e$	
Phase 2	Conduct a simple regression analysis with X predicting M to test for path a, $M = B_0 + B_1X + e$	
Phase 3	Conduct a simple regression analysis with M predicting Y to test the significance of path *b* alone, $Y = B_0 + B_1M + e$	
Phase 4	Conduct a multiple regression analysis with X and M predicting Y, $Y = B_0 + B_1X + B_2M + e$	

The tenacity of Phase 1 to Phase 3 is to institute that there exists among the factors, zero-order associations. Generally, scholars agreed that there is likely no mediation if associations are not significant with one or more of these (even though, this may not be the case all the time, like in MacKinnon *et al*, 2007). Supposing a significant association is found from Phases 1 through Phase 3, one continues to Phase 4. When in Phase 4 model, after regulating for X and the influence of M (path *b*) remains significant, then some sort of mediation is supported. However, the result supports *full mediation*, if X is no longer significant when M is regulated. But the

partial mediation is supported, if X is still significant (i.e., Y is significantly predicted by both X and M).

3.3.2.5 Calculating the indirect effect

The four phases methodology is the widespread methodology that is used by many analysts; however, there are potential challenges with the approach. Two methods have been proven to be useful in the estimation of the indirect coefficient. The first one is by calculating the difference in coefficients of two regressions, which is suggested by Judd and Kenny (1981). The second approach is an equivalent one, and it multiplies the coefficients of two regressions to get the indirect effect, which is suggested by Sobel 1982 (Newsom, Psy 523/623 Structural Equation Modeling, Spring 2020), (Table 3.2). This study will make use of the Sobel Product Coefficient Approach.

Table 3.2: Difference of coefficients approach by Judd and Kenny

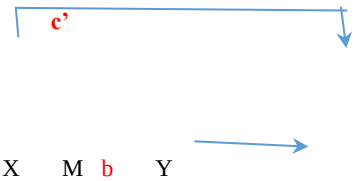
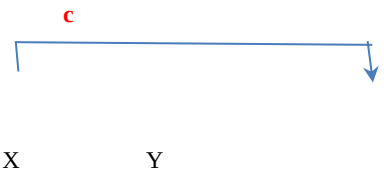
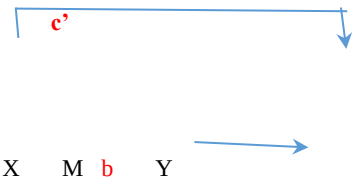
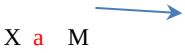
	Analysis	Graphic Representation
Model 1	$Y = B_0 + B_1X + B_2M + e$	
Model 2	$Y = B_0 + BX + e$	

Table 3.3: Sobel product of coefficients approach

	Analysis	Visual Depiction
Model l	$Y = B_0 + B_1X + B_2M + e$	
Model 2	$Y = B_0 + BX + e$	

Therefore, even though moderation and mediation are usually mistaken one for another, they are two very different concepts. Although both concepts are about examining how a third factor/variable enters into such relationship, mediation is more direct in that it mediates or arbitrates the relationship between the independent and dependent variables, thereby clarifying the purpose for such a relationship to exist. Also, mediation analysis is done to check if the influence of a mediator is greater than the direct effect of the independent variable. Meanwhile, moderation checks whether the third variable has an influence on the strength or course of the relationship between an independent and dependent variable.

Therefore, to estimate the mediation effect, the Sobel mediation test was used while to estimate the moderation effect, probit stepwise regression model (marginal effect) was used to test for effects of moderation of pathways (pathways discussed in section 3.3.2.2) of the maternal education on under-5 mortality.

The following analysis were done on the six pathways and other control variables given below were the procedures followed for the moderation analysis:

1. Holding the pathway (no pathways), estimation was done with just the under-5 mortality, the maternal education and the control variables.

2. Using the stepwise regression, the six pathways in which mother's education was anticipated to influence under-5 mortality were presented one after the other while checking its effect on the coefficient of the maternal education.
3. All the pathways were combined and regressed to also check for the effect on the coefficient of maternal education.

The first column has the list of variables; the second column estimated the under-5 mortality, maternal education and the other control variables. Observation of the variation in size and significance of mother's schooling coefficient with and without the pathways and also as the pathways are added one after the other. Sobel mediation test was used to test mediation effect of the pathways on mother's education on under-5 mortality.

Mother's schooling is still the focus variable, and its coefficient is reported for each of the pathways, without the pathways, and all the pathways combined. Maternal education can explicitly or implicitly affect or impact the occurrence of under-5 mortality. The under-5 mortality was regressed over the maternal education, the six pathways, namely the socio-economic pathway, attitude of mothers towards the usage of medical care services pathway, mothers reproduction behaviour pathway, media influence on mothers pathway, mother's job employment pathway and empowerment of mothers; while the other control variables included age, partner's education, preceding birth interval, birth order, religion, residence, environmental factor/sanitation (flush).

3.3.2.6 Concentration index

Finally, to measure the inequality and determine the extent (magnitude) to which under-5 mortality is ascribable to maternal level of education, the concentration index was used.

Following from Wagstaff *et.al.* (1991), the concentration index (C) assumes values with a range of −1 and +1. The negative values show that a parameter is concentrated among less fortunate people whereas the contrast is true for its positive values. When there is equality, the concentration index will be zero (Wagstaff *et.al.*, 1991).

$$C = \frac{2}{\mu} \mathrm{COV}w(yi, Ri), \qquad (37)$$

Where y_i and R_i are the health condition of the *i*th person and the fractional rank of the *i*th person (for weighted data) in terms of *the "index of family economic status"*; μ is the (weighted) average of the health of the sample and cov_w represents the weighted covariance.

The methodology suggested by Wagstaff *et al (*2003) was applied in disintegrating socio-economic inequality in infant deaths into its causes. A decomposition evaluation makes it possible for one to approximate how determining factors proportionally, leading to inequality (the separation between impoverished and wealthy) in a health variable.

3.3.3 Estimation issues

3.3.3.1 Endogeneity of mother's education

The maternal education endogeneity comes from potential association found between the error terms μi and ϵi: family background may affect both the mother's education and the child's health; also, the health endowment of a child might relate to the variables observed, such as mother's understanding of health. The difficult faced in analyzing this reduced form equation is that the family is aware of potentially hereditary health endowment, but the researcher cannot observe it. This was shown by Rosenzweig and Schultz (1983) that it would give biased OLS estimates because of the biased estimates. Also, variables that cannot be observed (such as religion, ethnicity etc.) may relate to maternal education that if the health of a child is influenced directly by them, it would result into omitted variable bias.

Therefore, to analyze the probable endogeneity of maternal education, this study was estimated using the two-stage least square method, using the place of residence as an instrument (Somanathan, 2008; Andriano and Monden, 2019; Maiga, 2015) so as to elude prejudice. The validity of the instrument was tested with the "first stage regression" and the Durbin and Wu-Hausman post estimation tests, and the instrument was found to be significant and good. The place of residence of the mother captures regional disparity in education over time. Thus, this instrument captures the appropriate school resource during the age of when the mother was in which is connected with mother's education and not correlated with the child's error term and unobserved variables that could affect child health.

3.3.2.2 Endogeneity and the instrument

Just like most studies researching the association between maternal education and child health or mortality, this study deals with the likely endogeneity that may arise because of the interaction between the maternal education, unobservable variables and the error terms by introducing an instrument: place of residence (Somanathan, 2008; Andriano and Monden, 2019; Maiga, 2015). Because of the data limitation, their current place of residence is assumed to be the place of their dwelling in their school going age. There are three key properties that determine the validity of an instrument. (i) First, it has to be relevant, which is tested by the significances of the t-values and p-values; (ii) Second, it has to be strong; which is tested by the significance of the F-statistics. In other words, if the F-statistic is less than 0.05, then it is a strong instrument; (iii) Lastly, it has to be exogenous. This implies that the instrument should be uncorrelated with the structural error term, and in our case, it should be correlated with the endogenous regressor (which is the maternal education), but should be uncorrelated with the outcome variable (in our case, health/mortality/nutrition of under-five children), and the structural error term; (iv) Overall, according to Mwabu (2009), if you have an F-Statistic value that is greater than 10 for a single endogenous variable, then the instrument is valid.

The reason the current residence is a good instrument is because urban residence is good for maternal education, and this is because educational opportunities are available in urban areas (e.g., primary and secondary schools are available, and the mother as a child could have attended them or actually for that reason did attend them). But why did the mother attend them as a child? It is because her mother/father took her to those schools. The situation may be the opposite for a rural setting. There is a high possibility that mothers who schooled in urban areas still live in urban areas and are probably employed and established there as a result of their exposure to the urban schooling (Andriano and Monden, 2019). There is also a high possibility that mothers who grew up and schooled in rural places are established also in the rural place, also based on their level of education, quality of education and exposure. The urban residence today (with respect to mother's education already attained, is not supportive), and it is equally unsupportive for her child's health. For instance, a child with malaria who lives near a free clinic and there is no mother to take him/her to the clinic for treatment, or the mother is there but is uneducated and

does not understand the importance of prompt treatment when the child has malaria will be disadvantaged. In this scenario, the child does not benefit from the urban residence where she lives with the mother. Therefore, urban residence helps the child through the education of the mother, which the mother received as a child in the urban setting (Maiga, 2015).

Therefore, during the period of 1950 to 1990, there was a huge variation in Government educational investment in Nigeria. The place of residence of the mother captures regional disparity and variation. Thus, this instrument captures the appropriate school resource during the mother's school-going age, which is correlated with mother's schooling and uncorrelated with the child's error term and unobserved variables that could affect child health. We therefore categorized all the mothers in the sample into seven birth cohorts, 1964-1968, 1969-1973, 1974-1978, 1979-1983, 1984-1988, 1989-1993, and 1994-1998, and their place of residence as stated in Table 3.4.

Table 3.4: Cohort by place of residence

Cohort	Residence (Rural)	Residence (Urban)	Total
1964-1968	1,322	263	1,585
1969-1973	5,889	2,057	7,946
1974-1978	12,828	5,313	18,141
1979-1983	14,079	7,281	21,360
1984-1988	16,488	8,194	24,682
1989-1993	14,617	7,228	21,845
1994-1998	15,377	8,450	23,827
Total	**80,600**	**38,786**	**119,386**

Source: Author's analysis

Table 3.1 displays mothers' average levels of education for different cohorts and places of their dwelling and we see an increase in the number of mothers attending school as the years advanced

in other words, the average level of education increased and varied significantly across the different cohorts regardless of their dwelling place, because significant increase can be observed in both the rural and urban dwellers. About 67.5% ((80600/119386)*100) of the mothers were rural dwellers, indicating that a larger proportion of the women were rural dwellers and had their education in schools located in the rural areas.

Looking through the regions, we observed that for each cohort, the average level of education varied significantly. The educational levels observed on the average varied from cohort to cohort, with older mothers having less education when compared with the younger mothers, and this was regardless of where their place of residence was as children. This was credited to the rise of establishment of schools over the years. However, a drop in the sixth cohort was observed, which was likely because of fewer investments in education between the 1980s and early 1990s.

Therefore, the place of residence of the mother was used as an instrument capturing the appropriate school resource during the age mother was going to school, which is correlated with mother's schooling and uncorrelated with the child's error term and unobserved variables that could affect child health.

3.3.3.1 Heteroscedasticity

This study made use of a cross-sectional data, which often have very small and large values and, thus, are more likely to have heteroscedasticity. In this study, we make use of the Robust Standard Error, which controls for the lack of constant variance or absence of constant variance in an analysis.

3.3.4 Description of variables used in the model

Dependent variable: Under-5 child mortality: this represents likelihood of losing a life between birth and five years of age indicated as per 1000 live deliveries.

Others infant and child mortality definitions include:

- **Neo-natal mortality** – this is the likelihood of a child dying in the first month of his/her existence.

- **Infant mortality** – this is the likelihood of a child of dying before his/her 1st birth anniversary.
- **Under-5 mortality** – this is the likelihood of a child of dying prior to his/her fifth years birth anniversary
- **Child mortality** – this is the likelihood of dying within the first and fifth year birth anniversary.

Independent variable: Maternal education: Maternal education refers to the category of maternal schooling which are primary, secondary, higher and no education.

Maternal and other control variables include:

***Age*:** refers to respondents' current age in years

***Preceding birth interval*:** is the break in between a preceding child and an index child

Birth order: is the sequential order of genealogical births in a household

Partner's education: refers to the formal schooling/ education by the partner or father

Religion: refers to a particular system of faith and worship, specifically the type of religion a mother belongs to. This is measured as Christianity, Islam, Traditional and others

Residence: refers to the dwelling place of the mother, and it is defined as mothers living in either rural or urban areas

Sanitation: this refers to the type of toilet facility present in the homes of mothers. It includes pit latrine, no flush system and flush system

Distance to health facility: this variable checks if there is a problem or not in the distance of getting to the medical facility where the respondent goes for help when needed

Selection of pathways for moderation and mediation of mother's education on under-5 mortality: For this analysis, the following pathways were used: socio-economic status, mother's attitude towards the utilization of medical care service, women's reproductive behavior, mother's

empowerment, mother's paid job status, exposure to media. A summary of the variables is given in Table 3.5 below.

Table 3.5: Summary of variables

Name of variable	**Variable description**	**Expected effect**
Under-5 mortality	Under-5 death rate is a binary parameter taking the value of either one or zero, in relation to whether the under-5 lives or dies in the 0-59 months after birth. Therefore, 1 if child is dead, 0 otherwise	
Maternal education:	Category of maternal formal schooling, where 0 = Higher Education, 1 = Secondary Education, 2 = Primary Education, and 3 = No education	Positive
Maternal age	Age in years	Positive
Preceding birth interval/ spacing	A variable measured in months: from 9 – 59 months	Negative
Birth order	A variable measured in ranks: from 1 to 5 years.	Negative
Partner's education	A binary variable measuring the education of the father/partner; and taking the value of 1 if partner is educated, and 0 otherwise	Negative
Religion	A dummy variable taking the value of 0 if Traditional (reference), 1 if Christian, and 2 if Islam	Negative
Residence	A dummy variable taking the value of 0 if Rural, and 1 if Urban	Negative
Sanitation	A dummy variable taking the value of 0 if no flush toilet in the house and 1 if flush toilet in the house	Negative
Distance	A dummy taking the value of 1 for nearer distance to the health facility, and 0 otherwise	Negative

Pathways for maternal analysis, moderation and mediation of mother's education and under-5 mortality	Socio-economic status (measured by the wealth index).	Positive
	Attitude towards health care service utilization (measured by health insurance coverage)	Positive
	Reproductive behaviors of women (measured by respondents on contraceptives)	Positive
	Women empowerment (measured by the decision to spend respondents' earnings)	Positive
	Maternal employment status (measured by the respondents' employment)	Positive
	Exposure to Media (measured by frequency of listening to radio)	Positive

Source: Author's analysis

3.3.5 Data types and sources

3.3.5.1 Data Sources

This study used secondary data from the 2013 Nigeria Demographic Health Survey (NDHS) reports. The NDHS is structured to avail data for the populace and health status in Nigeria. The sample for the 2013 NDHS was a national representation, which covered the entire population of Nigeria and the population living in non-institutional areas in the nation. The survey used three-stage sampling technique to select the respondents, while the 2013 NDHS sample selection was multi-stage stratified cluster design and is made up of 904 clusters, 372 in urban regions and 532 in rural areas.

Primary information about households, sexual and reproductive health and history were collected from women aged 15-49 years within the selected households. A sample of 119,386 women from the data collected specifically on women (Individual Women's Data - Individual Recode (IR); ngir6adt) was used for analysis. The child record data, which contains all follow-up information on all children born to the interviewed women within five years preceding the survey was used. The survey recorded 82,936 births in the preceding five years before the survey, and 20,239

deaths. The study therefore extracted under-5 deaths from the deaths recorded using the variable "age at death (in months), and extracting from 0-59 months, we arrived at a sample size of 18,525 under-5 children mortality (age in months), which was used for the analysis. The analysis merged the household data and individual variables/data. Using the individual unique identification number, case identification number, cluster number and household number, the wealth index was merged with the individual women data for analysis.

3.4 Results of Objective Two

This section presents results from the analysis done on this study. First it presents descriptive statistic on the variables and across zones and states, then results from the two stage least square, followed by moderation and mediation analysis on under-5 mortality and maternal education; and finally the different categories of under-5 mortality across the geopolitical zones in Nigeria, by gender, by place of residence, and across wealth quintiles.

3.4.1 Descriptive statistics of the study variables

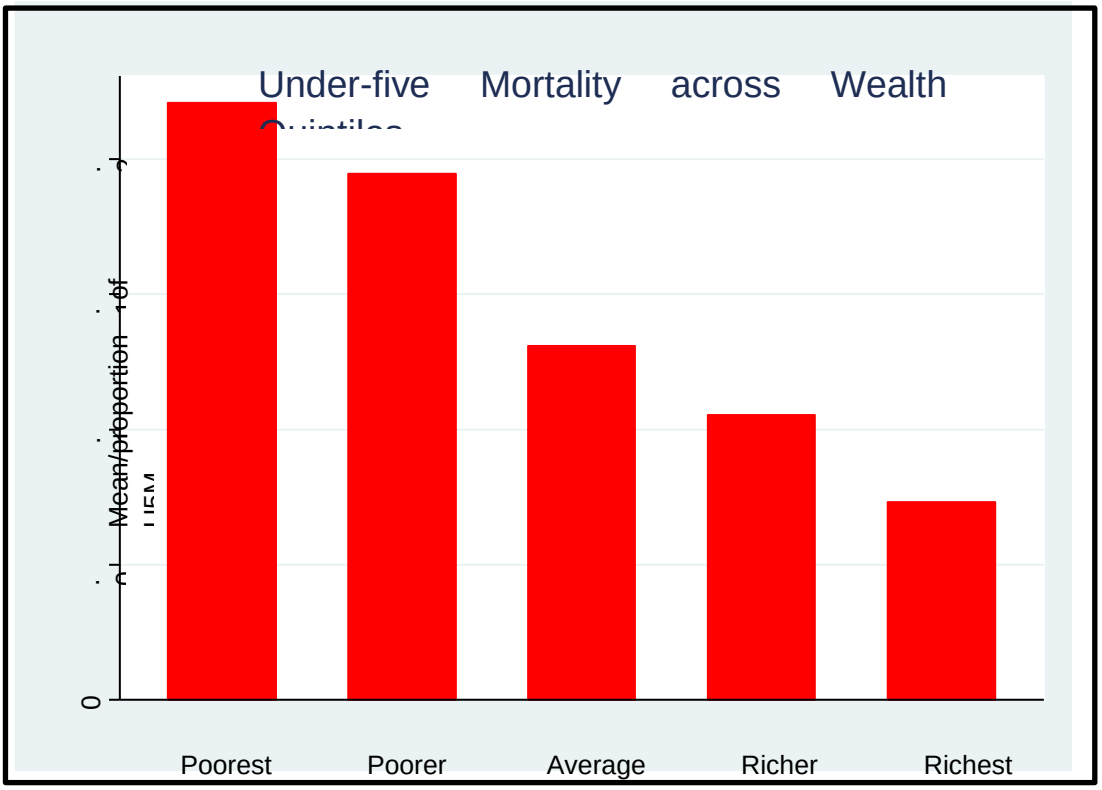
The study's dependent variable is the "under-5 mortality" with a mean percentage of 15.5% under-5 mortality in the study sample; in other words, it suggests that about 15.5% mortality among children under the age of 5 died before reaching their fifth birthday.

The study's independent variable is maternal education, with a mean average of about 34.2% of the mothers in the study sample having a form of formal education with: mothers with a secondary education having 19.5%, primary 12.4%, and mothers with no education being 2.28%. Other variables are: age of the mother, having the average age of the mothers in the sample as 36.9 years old. The variable Partner's (father's) education had 43.1% of the partners having some form of formal education in the sample. The mean/average preceding birth interval/spacing of the women in the sample was about 27.6 months. Comparing this to the birth interval categorization of the WHO-recommended birth interval of ≥24 months (WHO, 2007), on average, the women in the sample met and exceeded the recommendation. In the birth order variable, the majority of women in the sample are middle-borns, which means they are neither the first-borns nor the last-borns in their families; other terms used can be middle child or middle children. The religions of the mothers were about 28.8% Christians, and 69.6% Islam compared

to Traditionalists and others. An average of 23.3% of the women in the sample reside in urban areas. Sanitation (flush toilet) variable has 4.42% of the women in the sample having it. The Distance variable indicated that the sample had 35.6% of the women having a nearer distance to the health facility, while 64.3% of the women had a farther distance to the health facility.

The pathways socio-economic status measured as the Wealth Index variable had 28.6% of the sample population falling within the poorer quintile, which reduced to the probability 17.5% in the middle quintile, then 12.7% in the richer quintile, and which further reduced to a probability 6.8% with the richest quintile. This is further explained graphically in Figure 3.7, with the decent of the bars representing under-5 mortality from the poorest to the richest.

Figure 3.7: Distribution of under-5 mortality across income quintiles



Source: Author's analysis

The women empowerment pathway measured by who makes the decision to spend respondents' earnings indicated that about 50.1% of the women in the sample make such a decision. The attitude towards health care service utilization pathway, which is measured by the health insurance coverage of the women in the sample, shows that only 0.74% of the women have health insurance coverage, and most of the payments were done out of pocket. About 8.6% of the women in the sample are on one type of contraceptive, which is used to measure the reproductive behaviors of the women pathway. The Exposure to Media pathway, which is measured by frequency of listening to radio, showed that 52.9% of the women listen to radio and are well exposed to media. Lastly, about 74.1% of the women are employed, which was used to measure the maternal employment status pathway.

Table 3.6: Descriptive statistic table

Variable	Observ	Mean	Std. Dev.	Min	Max
Dependent Variable					
Under-5 Mortality	18,525	0.15493	0	1	1
Independent Variables					
Maternal Education:	18,525	0.34299	0.47472	0	3
Secondary	18,525	0.19568	0.39673	0	1
Primary	18,525	0.12448	0.33013	0	1
No education	18,525	0.02283	0.14937	0	1
Maternal Age:	18,525	36.9283	8.03075	15	49
Partner's (Father) education	18,249	0.43110	0.49525	0	1
Preceding birth interval/spacing	14,178	27.6534	15.0352	9	59
Birth order	18,525	3.75184	2.56841	1	5
Religion: (Traditionalist and others)	18,439	1.68181	0.49655	0	2
Christianity	18,439	0.28857	0.45311	0	1
Islam	18,439	0.69662	0.45973	0	1
Residence: (Urban)	18,525	0.23330	0.42294	0	1

Sanitation (flush)	18,525	0.04426	0.20568	0	1
Distance	18,458	0.35697	0.47912	0	1
Pathways:					
Socio-Economic Status: (Poorest)					
Poorer	18,525	0.28669	0.45222	0	1
Middle	18,525	0.17533	0.38026	0	1
Richer	18,525	0.12766	0.33372	0	1
Richest	18,525	0.06812	0.25196	0	1
Women empowerment	18,525	0.50051	0.50001	0	1
Mother's attitude towards utilization of medical care services	18,467	0.00741	0.08581	0	1
Mother's reproduction behaviors	18,525	0.08621	0.28067	0	1
Media exposure	18,465	0.52975	0.49912	0	1
Maternal employment status	18,470	0.74104	0.43807	0	1
Zone: (North Central)					
North East	18,525	0.23373	0.42321	0	1
North West	18,525	0.45290	0.49779	0	1
South East	18,525	0.07800	0.26818	0	1
South South	18,525	0.07525	0.26380	0	1
South West	18,525	0.07535	0.26397	0	1
State	18,525	127.313	102.858	10	370

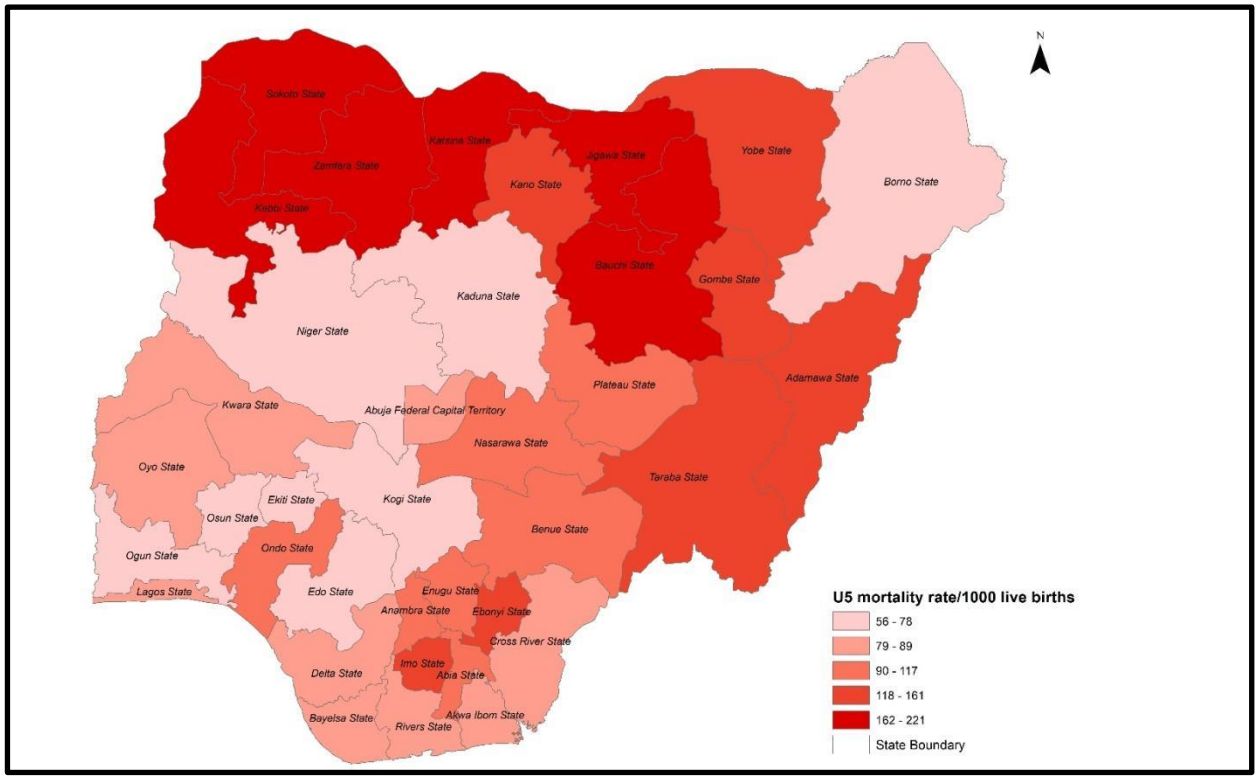
In DHS, there are six geopolitical zones in Nigeria: North Central, North East, North West, South East, South South and South West

The table also shows the distribution of under-5 mortality across the six zones in Nigeria. Our results suggest that the highest under-5 mortality rate was in the North-West with a mean percentage of 45.2% deaths. This is followed by the North East region with a mean percentage of

23.3%. Furthermore, the smallest figure of under-5 mortality recorded from the result was for the South-West with a probability of 7.53%. The mean of Kano state and Zamfara state were the highest, while Osun State had the lowest.

Table A1 in the Appendix shows the dispersal of under-5 mortality across the Federal Capital Territory and 36 states, which was done by the number of under-5 mortality by 1000 live births. The results indicate that the highest mortality was in the State of Zamfara with a probability of 22.1% deaths per 1000 live births, which was followed by the State of Bauchi with a probability of 21.0% deaths per 1000 live births. However, findings showed that the State of Edo had the lowest under-5 mortality rate with a probability of 5.6% deaths per 1000 live births followed by the State of Osun with had a probability of 5.8% of under-5 mortality per 1000 live births. This result of under-5 mortality rate per state was plotted on the Nigerian map in Figure 3.8. Our results still confirmed that the under-5 mortality rates were still more rampant in Zamfara and Bauchi States while the lowest under-5 mortality rates were confined in Osun and Edo states. The map also suggested a cluster pattern of under-5 mortality rates between one state and the neighbouring state. These clustering patterns could be explained by the environmental/climatic conditions, culture and religion (this is explored in Chapter Four).

Figure 3.8: Distribution of under-5 mortality rates across Nigerian states



Source: Author's analysis

3.4.1 Empirical results-disparities in under-5 mortality attributed to maternal level of education

This section presents the regression results of the under-5 mortality. This model examined the influence of mother's education on under-5 mortality measured in binary-wise. It also focuses on the interpretation of its magnitude and direction from the two-stage least square regression results.

From the first stage regression results in Table 3.7, all maternal variables are significant at one and five percent levels, except for flush (sanitation) which is not significant. All the pathways are positively related to maternal education; in other words, the higher the maternal education, the higher or more the pathways. The more the employment opportunities, the more likely media

exposure, the more enlightenment with birth controls or contraceptives, a better attitude towards the use of health facilities and the more income.

However, the empowerment pathway has a negative sign, implying an inverse relationship with maternal education. Interestingly, the father's different levels of education were also significant with positive signs, an indication of educated fathers more likely to marry educated mothers, and that fathers' education is also positively linked to mothers' education. This is consistent with the findings by Toros and Kulu (1988), Akile GŸrsoy (1994), United Nations Population Fund - UNFPA, and GŸrsoy-Tezcan (1992).

The Christianity religion has a positive sign, while the Islamic religion has a negative sign. This implies, that there is a probability that the Christianity religion supports girl or female or maternal education, while the Islamic religion does not support maternal education as such, or by contrast to the Christianity religion, the Muslim's societies' cultural and religious norms often hinder women's education. It could also imply an educational gap between Christian mothers and Muslim mothers, which is consistent with Rahman (2012), Hackett *et al.* (2018), although this view has been contested by many authors; it still remains a controversial and sensitive topic.

The variable distance has a negative coefficient, indicating an inverse relationship between maternal education and distance to health care facilities. This could be an indication or probability of availability of health care facilities, but poor utilization. The utilization of health care facilities may be poorly done because of many variables that may play implicit roles in the inefficient utilization of these medical facilities; this is consistent with Chopra *et al.* (2019).

Table 3.7: Regression results (dependent variable-under-5 mortality)

First Stage Least Squares			Second Stage Least Squares		
Variable	**Coef. (Std. error)**	**P-value**	**Variable/ U5M**	**Coef. (Std. error)**	**P-value**
Education			Edu: Secondary	-0.0379 (0.0029)	0.000
			Primary	-0.0487 (0.0035)	0.000
			No Education	-0.0537 (0.0056)	0.000
Empowerment	-0.023 (0.0024)	0.0000	Empowerment	-0.0059 (0.0063)	0.3540
Employment	0.04 (0.0028)	0.0000	Employment	0.0261 (0.0103)	0.0110
Media	0.0839 (0.0022)	0.0000	Media	0.0732 (0.0205)	0.0000
Contraceptives	0.0811 (0.0029)	0.0000	Contraceptives	0.0415 (0.0199)	0.0370
Wealth Index			Wealth Index		
Poorer	0.0398 (0.0029)	0.0000	Poorer	0.0188 (0.0105)	0.0730
Middle	0.1327 (0.0033)	0.0000	Middle	0.0447 (0.0329)	0.1740

	0.2234			0.1012	
Richer		0.0000	Richer		0.0680
	(0.0038)			(0.0554)	
	0.2837			0.1353	
Richest		0.0000	Richest		0.0560
	(0.0051)			(0.0708)	
	0.0192			-0.0041	
Attitude		0.0130	Attitude		0.7200
	(0.0078)			(0.0114)	
	-0.0015			0.0019	
Age		0.0000	Age		0.0000
	(0.0001)			(0.0004)	
Partner Education			Partner Education		
	0.2846			0.2158	
Primary		0.0000	Primary		0.0020
	(0.003)			(0.0683)	
	0.3448			0.2582	
Secondary		0.0000	Secondary		0.0020
	(0.0032)			(0.0825)	
	0.3476			0.2527	
Higher		0.0000	Higher		0.0020
	(0.0039)			(0.0831)	
	-0.0039			-0.0055	
Birth Order		0.0000	Birth Order		0.0000
	(0.0004)			(0.0011)	
Religion			Religion		

	0.2159			0.1649	
Christianity		0.0000	Christianity		0.0020
	(0.0085)			(0.0525)	
	-0.0834			-0.0463	
Islam		0.0000	Islam		0.0460
	(0.0084)			(0.0232)	
	-0.0058			-0.0093	
Flush toilet		0.1760	Flush toilet		0.1150
	(0.0043)			(0.0059)	
	-0.0112			-0.0206	
Distance		0.0000	Distance		0.0000
	(0.0022)			(0.0042)	
	0.0143				
Residence (Rural)		0.0000			
	(0.0025)				
	0.1535			0.2378	
_cons		0.0000	_cons		0.0000
	(0.0101)			(0.0393)	
Obs. Number = 115,648			**Post-Estimation Results**		
F(20, 115627) = 7658.98			Number of Obs. = 115,648		
P > F = 0.0000			Wald $Chi^2(20)$ = 2399.71		
R-S = 0.5699			Prob > Chi^2 = 0.0000		
AR-S = 0.5698			R-squared = .		
R. MSE = 0.3279			Root MSE = .44185		
			Tests of Endogeneity		
			Ho: variables are exogenous		

	Durbin (score) chi2(1) = 16.9184 (p = 0.0000) Wu-Hausman F(1,115626) = 16.9176 (p = 0.0000)

In the Second stage of the regression, the variable of interest is also mother's education and under-5 mortality. The levels of maternal education variables (secondary, primary and no education) are highly significant at one percent levels, and all have negative signs, implying an inverse relationship between maternal education and under-5 mortality. The secondary variable has a coefficient of -0.0379, the primary a coefficient of -0.0487, while no education has a coefficient of -0.0537. It can be observed that as one is moving towards higher education, the impact on under-5 mortality is reducing; in other words, the higher the education of the mother the lower the under-5 mortality. This is consistent with findings by Wamani *et al.* (2004), Desai and Alva (1998), Vikram *et al.* (2010), Grépin and Bharadwaj (2015), Caldwell and McDonald (1982). The overall estimation is highly significant at one percent level of significance.

3.4.2.2 Validity of the instruments

The NDHS 2013 did not have any data on the childhood place of residence of the mothers. Therefore, their current place of residence was assumed to be their childhood place of residence, and it was used as the instrument for the analysis. Below are the results of the validity tests run on it:

- *Comparing four NDHSs (1999, 2003, 2008, 2013), less than 10% change (higher or lower) was observed in the percentages for maternal level of education by their places of residence (rural and urban).* Percentages for maternal level of education by their places of residence (rural and urban) were extracted from the Nigeria Demographic Health Surveys for 1999, 2003, 2008, and 2013 (Table 3.8). The statistics in Table 3.8 show that the percentage of women with no education in 1999 is about 5% higher than the same in 2013. For primary school category, women with primary education in 2003 were about 3% and about 4.5% higher than women of the same educational level in urban and rural areas, respectively, for 2013. For the secondary category, however, the 2013 percentage is about 8% higher than in 2003. The case is similar with mothers who have higher education than secondary living in urban areas, with about 4% higher than year 2003 and 0.8% for rural dwellers. In general, the percentage changes in maternal education level for each category and over the years are less than 10% (higher or lower). This will not make a significant difference nor a

magnanimous change in the outcome, hence making place of residence a significant instrument for analysis because the percentage change of the childhood place of residence is not so different from their current place of residence.

- Also, another reason the current residence is a good instrument is because urban residence is good for maternal education, and this is because educational opportunities are available in urban areas (e.g., primary and secondary schools are available, and mother as a child could have attended them or actually for that reason did attend them). But why did mother attend them as a child? It is because her mother/father took her to those schools. The situation may be the opposite for rural settings. There is a high possibility that mothers who schooled in urban areas still live in urban areas and are probably employed and established there as a result of their exposure to urban schooling (Andriano and Monden, 2019). There is also a high possibility that the mothers who grew up and schooled in rural places are established also in the rural place, also based on their level of education, quality of education and exposure. The urban residence today (with respect to mother's education already attained, is not supportive), and it is equally not supportive for her child's health. Take for instance, a child with malaria who lives near a free clinic and there is no mother to take him/her to the clinic for treatment, or the mother is there but is uneducated and does not understand the importance of prompt treatment when the child has malaria. In this scenario, the child does not benefit from the urban residence, where she lives with mom. Therefore, urban residence helps the child through the education of the mother, which the mother received as a child in the urban setting (Maiga, 2015).

Table 3.8: Percentage of women level of education in urban and rural areas

Year		No Edu.	Some Primary	Primary	Some Secondary	Secondary	Higher	Total number of women
1999	Urban	25.4		32.0		29.9	8.1	4,529
	Rural	43.3		29.8		16.7	2.1	10,745
2003	Urban	24.9	7.6	12.0	24.3	19.1	12.1	2,629
	Rural	50.4	9.6	12.7	16.5	8.1	2.7	4,991
2008	Urban	22.0	19.2	11.3	17.2	17.5	11.4	20,294
	Rural	48.9	18.7	10.6	10.8	6.5	2.5	40,585
2013	Urban	15.5	4.1	12.5	22.0	29.0	16.9	16,414
	Rural	54.1	6.0	11.8	14.1	10.5	3.5	22,534

Statistical and econometrical instrument validity test

Test 1:

Tests for the correlation between the endogenous variable: Maternal education and its instrument: place of residence (this should not be equal to zero), i.e.

E [x'z] $\neq 0$

Where:

Z = Instrumental variable (place of residence)

X = Maternal education

Table 3.9: Matrix of correlations

Variables	(1)	(2)
(1) Maternal Education	1.000	
(2) Place of Residence	0.394	1.000

Maternal education is almost 40%, instrumented by the place of residence (instrument) as seen in Table 3.9. It shows that place of residence is a valid instrument for maternal education.

Test 2:

This is the exogenity test, that the instrument (Z) does not explain the structural error term (μ), i.e.

E [z'μ] = 0

Table 3.10: Matrix of correlations

Variables	(1)	(2)
(1) Place of Residence	1.000	
(2) residual	-0.003	1.000

The instrument is insignificantly correlated with the residual or structural error term in Table 3.10; in other words, it is not correlated with the residual. This equally implies that the instrument is valid.

Estimation result validity test

The validity of the instrument was also tested with the "first stage regression" and the Durbin and Wu-Hausman post-estimation tests. From the first stage regression results in Table 3.7, the instrumented variable (IV) (place of residence) is highly significant at one percent level (P-values), implying that the instrument is good. Also, our F-statistic value was larger than any of the critical values, implying that our instrument was not weak, but strong. Also, overall, according to Mwabu (2009), the F-Statistic value is greater than 10 for a single endogenous variable, and the instrument is valid. Finally, the post-estimation tests of Durbin and Wu-Hausman show significant P-values, which means the Ho (which is all variables are exogenous) should be rejected.

3.4.3 Results of moderation and mediation analysis

3.4.3.1 Moderation

The mechanism through which mother's schooling impacts the health/mortality of under-5s (Moderation)

Using the stepwise probit regression analysis, we report the maternal education coefficient as stated in the hypothesis above for each of the pathways, without the pathways, and all the pathways combined. Maternal education can implicitly or explicitly affect or impact the occurrence of under-5 mortality; therefore, Table 3.11 reports the stepwise Probit regression (Marginal effect table) estimates from the six pathways above and some other control variables.

In the second column on Table 3.11, the coefficient of maternal education is negative 0.0299 and statistically significant at one percent level (p value = 0.000). This implies that there is a probability of 2.99% effect of maternal education on under-5 mortality. This coefficient reveals the effect of maternal education and other control variables on under-5 mortality, while holding the pathways constant.

In the third column, socio-economic pathway (wealth index) was introduced. This changed (lowered) the coefficient of the maternal education to 0.0157. However, it maintained the

negative sign, which depicts the inverse relationship between mother's education and under-5 mortality, and it still maintained its level of significance at one percent.

This coefficient of maternal education decreased, giving a change (difference) of 0.0142, i.e. (0.0322 - 0.0168) which moderated the effect of maternal education through the socio-economic pathway. This implies that about 50% (47.8%) of mother's educational influence is moderated through the socio-economic pathway variables. The result is consistent with the results of Hassen (2014) and Frost *et al.* (2005) who also discovered that socio-economic pathway variables were significant and accounted for almost 50% of the influence of mother's education on under-5 mortality in Ethiopia and for child nutritional status in Bolivia, respectively.

When other pathways were added one after the other, there was insignificant variation (change) observed with the maternal education coefficient, compared with the significant change that was observed when the socio-economic pathway was added. However, a small significant change was observed in the mother's reproductive behavior pathway with 11.8% change in the maternal education coefficient. However, this change is not as significant as the socio-economic status. Therefore, mother's attitude towards the utilization of medical services pathway, mothers' reproduction behaviour pathway, media influence pathway, maternal job employment, and maternal empowerment pathways have little or no effect on moderation of maternal education on under-5 mortality. This is consistent with the findings of Hassen (2014), who equally found the pathways as not having any mediation effect on mother's education on children under the age of five.

Also, for column 9 (the combination of all the pathways excluding the other control variables) did not have much effect on the maternal coefficient, even though there was a slight increase and it maintained its negative sign and its level of significance at one percent.

However, the maternal education coefficient in the last column where all the pathway variables and other control variables were combined is significant at one percent level of significance, even though its enormity is greatly less than the first column when no pathway was added. Regardless, it is an indication that all maternal variables and pathways, in one way or another, no matter how minute, effect maternal education, and the negative sign on the coefficient indicates

an inverse relationship between them and under-5 mortality; in other words, they bring about a reduction in under-5 mortality. The post-estimation test (Classification test) is 84.45%, an indication that the data and model are good fit and correctly stated.

Table 3.11: Marginal effect: Association of maternal education with different pathways

List of Variables	No pathway with control variables	Pathway one – SS	Pathway two – AHU	Pathway three - MRB	Pathway four - Media	Pathway five – Empl.	Pathway six – Empowr.	Combined Pathway	Combined pathways with control variables
Maternal Education	-0.0322*** (0.0031)	-0.0168*** (0.0033)	-0.0320*** (0.0031)	-0.0284*** (0.0135)	-0.0319*** (0.0031)	-0.0324*** (0.0031)	-0.0324*** (0.0031)	-0.0334*** (0.0027)	-0.0154*** (0.0032)
Socio-economic factors (wealth index)		#						#	#
Mother's attitude to the utilization of medical care services (Health Insurance)			#					#	#
Reproductive behaviour of mothers (contraceptive method)				#				#	#
Media influence (frequency of					#			#	#

listening to radio)									
Employment (mother's job employment)						#		#	#
Empowerment (who decides on how to spend mother's earnings							#	#	#
Age	#	#	#	#	#	#	#		#
Partner's edu.	#	#	#	#	#	#	#		#
Birth order	#	#	#	#	#	#	#		#
Religion	#	#	#	#	#	#	#		#
Residence	#	#	#	#	#	#	#		#
Sanitation (flush)	#	#	#	#	#	#	#		#
No of Observations	116,804	116,804	116,428	116,804	116,525	116,436	116,806	118,210	115,782
Post-Estimation Test									
Classification Test	84.45%	84.45%	84.45%	84.45%	84.45%	84.45%	84.45%	84.48%	84.44%

= the pathway(s) analyzed

3.4.3.2 Mediation

Still maintaining the variables used above but using years of schooling to represent maternal education, mediation analysis was done using the six pathways above, and below are the results in Table 3.12.

Table 3.12: Sobel-Goodman mediation test as described by Kenny and Baron (1986): Mediation of mother's education on under-5 mortality through pathways

Pathway	SES	Attitude	Contra	Media	Employ	Empowr
Indirect effect	-0.045668*** (0.001496)	-.001332 (.00023)	-.010319*** (.000741)	-.002849*** (.000706)	.000409 (.000415)	-.000758 (.000136)
Direct effect	-0.04617*** (0.002548)	-.090594*** (.002095)	-.081519*** (.002204)	-.089183*** (.002198)	-.092475*** (.002124)	-.09108*** (.002083)
Total effect	-0.0918*** (0.002079)	-.091926*** (.002083)	-.091838*** (.002079)	-.092032*** (.002082)	-.092066*** (.002083)	-.091838*** (.002079)
Fraction mediated of the total	0.49726789	.01448703	.11236413	.03095927	-.00444511	.00825605
Indirect to direct effect ratio:	0.98913096	.01469999	.1265881	.03194837	-.00442544	.00832478
Ratio of total to direct effect	1.989131	1.0147	1.1265881	1.0319484	.99557456	1.0083248

Source: Author's analysis

i. Mediation effect of socio-economic status (household wealth)

The result from the Sobel-Goodman mediation test on socio-economic factors on maternal education showed that the direct effect was -0.04617, which was significant at one percent and

the negative sign signifying an inverse relationship between maternal education and under-5 mortality. The indirect effect was negative -0.045668, which was equally significant at one percent. Total effect was -0.0918, which was negative and significant at one percent. The total effect proportion mediated was 0.4972, meaning that 49.72% (i.e. almost 50%) of maternal education is mediated by socio-economic status. This implies that socio-economic pathway is a significant mediator. The percentage mediated is similar to the percentage moderated by the socio-economic pathway in the moderation section above. This further affirms and validates the socio-economic status as a significant variable in helping to decrease under-5 mortality.

ii. Mediation effect of attitude towards health care

For the effect of attitude towards health care factors, the result from the Sobel-Goodman mediation test showed that the maternal education direct effect was -0.090594. The negative sign indicates an inverse relationship between maternal education and under-5 mortality and it is significant at one percent level of significance. The indirect effect was -0.001332, which was equally negative and significant at five percent level. The total effect was -0.091926, which was also negative and significant at one percent. The proportion of total effect that is mediated was 0.01448703, which is 1.45%. This implies that attitude towards health care pathway is not a significant mediator because of the low percentage.

iii. Mediation effect of reproductive behaviour of mother's pathway

The results for the effect of reproductive behaviour of mother on maternal education showed a direct effect of -0.081519. The negative sign indicates an inverse relationship between maternal education and under-5 mortality, and it is significant at one percent level of significance. The indirect effect was -0.010319, which was negative and significant. The total effect was -0.091838, which was also negative and significant at one percent. The proportion of total effect that is mediated was 0.11236413, which is 11.24%. This implies that attitude towards health care pathway is a minimal significant mediator.

iv. Mediation effect of media on mothers

The direct effect of media on maternal education was -0.089183, while the indirect effect was -0.002849. They are both inversely related to under-5 mortality, but the indirect effect was not significant, while the direct effect was significant at one percent level. The total effect was -0.092032, also significant at one percent level. Therefore, the proportion of total effect that was mediated by media was 0.03095927, which is 3.09%. This is an indication that media is a very minute significant mediator.

v. Mediation effect of mother's job employment pathway

For the pathway of a mother's job employment on maternal education, the direct effect was -0.092475, the negative sign also indicating an inverse relationship between maternal education and under-5 mortality, and it is significant at one percent level of significance. The indirect effect was 0.000409, which was positive and was not significant. However, the total effect was -0.092066, which was negative and significant at one percent. The proportion of total effect that is mediated was -0.00444511, which is 0.44%; however, it had a negative sign, which implies an inverse relationship. This implies that attitude towards health care pathway is not a significant mediator.

vi. Mediation effect of empowerment of mothers

The results for the empowerment of mother's pathway on maternal education showed a direct effect of -0.09108, where the negative sign indicates an inverse relationship between maternal education and under-5 mortality and it is significant at one percent level of significance. The indirect effect was -0.000758, which was negative and was not significant. However, the total effect was -0.091838, which was negative and significant at one percent. The proportion of total effect that is mediated was 0.00825605, which is 0.83%. This implies that attitude towards health care pathway is not a significant mediator.

3.4.4 Concentration indices analysis results

For the concentration indices, sampling weights and clustering were used to account for sampling design of the survey. The Standard errors are in parentheses and the p-values are denoted by stars, meaning * p < 0.10, ** p < 0.05, *** p < 0.01. The negative values of the concentration index mean that infant, child and under-5 mortality is more concentrated among the poor, while positive values of the concentration index denote that mortality is concentrated among the rich.

For more specific results, under-5 mortality was sub-divided into infant mortality (which is the death of an infant before his or her first birthday), and child mortality (which refers to the death of a child under the age of five); and then the combination of these two therefore gives the under-5 mortality. The results shown in Table 3.13 suggest that the proportion of deaths among infant, child and under-5 children were 14.7%, 27.8%, and 22.2%, respectively, and were more prevalent among poor households, since the value of the concentration index was negative and statistically significant at 1 percent level of significance for these three variables. These results were further substantiated by the findings of Figure 3.9, which suggest a decreasing pattern of infant child and under-5 children deaths as the income quintile increased.

Table 3.13: Concentration index (nationwide), Wagstaff index

Dependent variables	**Concentration index-Wagstaff index**				
		Gender		**Residence**	
	Overall	**Male**	**Female**	**Urban**	**Rural**
Infant deaths	-0.147	-0.152	-0.1789	-0.152	-0.107
	(0.007)***	(0.008)***	(0.009) ***	(0.012)***	(0.007)***
Child deaths	-0.278	-0.2802	-0.281***	-0.301	-0.194
	(0.007)***	(0.009)***	(0.009)	(0.014)***	(0.007)***

Under-5 children deaths	-0.222	-0.228	-0.247	-0.225	-0.164
			(0.007) ***		
	(0.005)***	(0.006)***		(0.009)***	(0.005)***

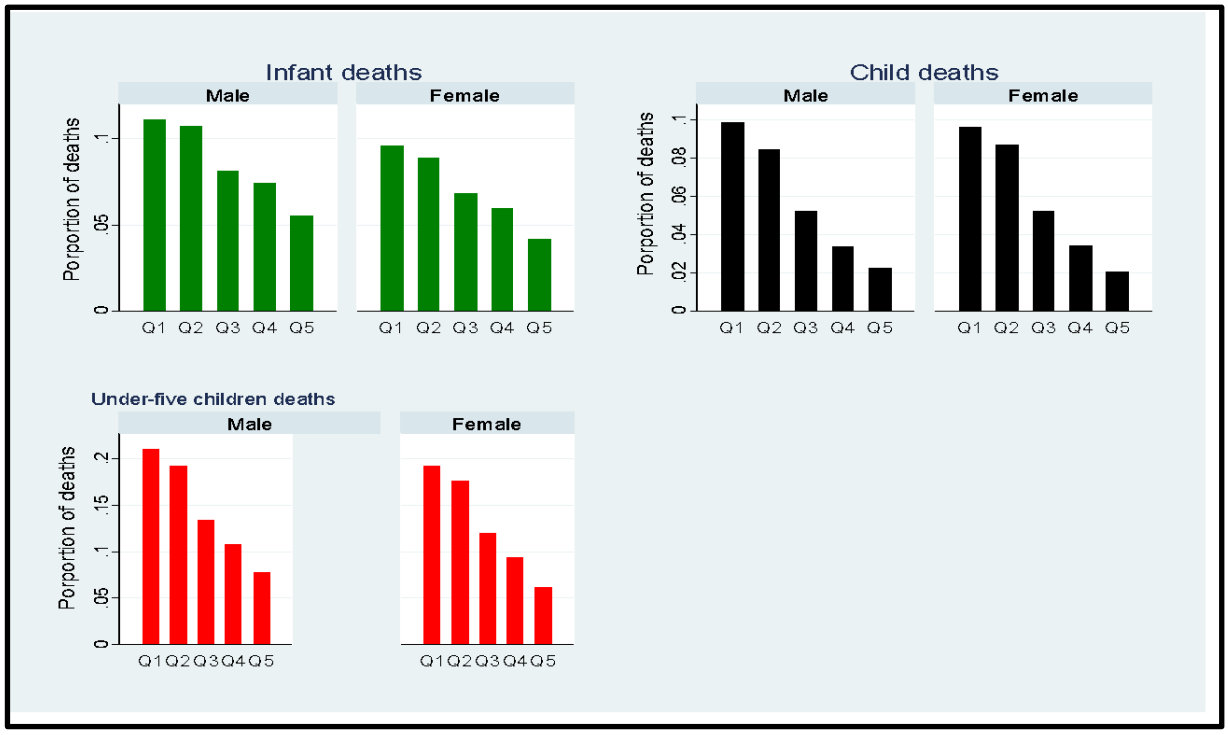
Notes: Standard errors in parentheses.* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Negative values of the concentration index mean that infant, child and under-5 mortality is more concentrated among the poor.

Furthermore, we explored the socio-economic inequality of infant an under-5 children deaths, stratified by gender (with a proportion of 15.2% deaths among infant males and 22.8% among under-5 males, which is compared with a proportion of 17.9% deaths among infant females and 24.7% among the under-5 females. The place of residence was also analyzed and the results showed a proportion of 15.2% of deaths among infants and 22.5% deaths among under-5 children living in urban areas. Meanwhile, for the rural dwellers, it was a proportion of 10.7% deaths among infants and a proportion of 16.4% deaths among under-5 children. The results also suggest that irrespective of the gender and place or residence, the infant and under-5 children deaths were still more rampant among poor households, since the concentration indices across gender and place of residence were all negative and statistically significant at one percent level.

Figures 3.9 and 3.10 give graphical representations of the results analyzed above. Figure 3.9 shows a decline of the bars on the chart from the poorest to the richest irrespective of the gender. There is a decline for infant, child and under-5 deaths, with the highest bars on the poorest households (Q1). This implies a concentration of deaths among children from poor households irrespective of their gender.

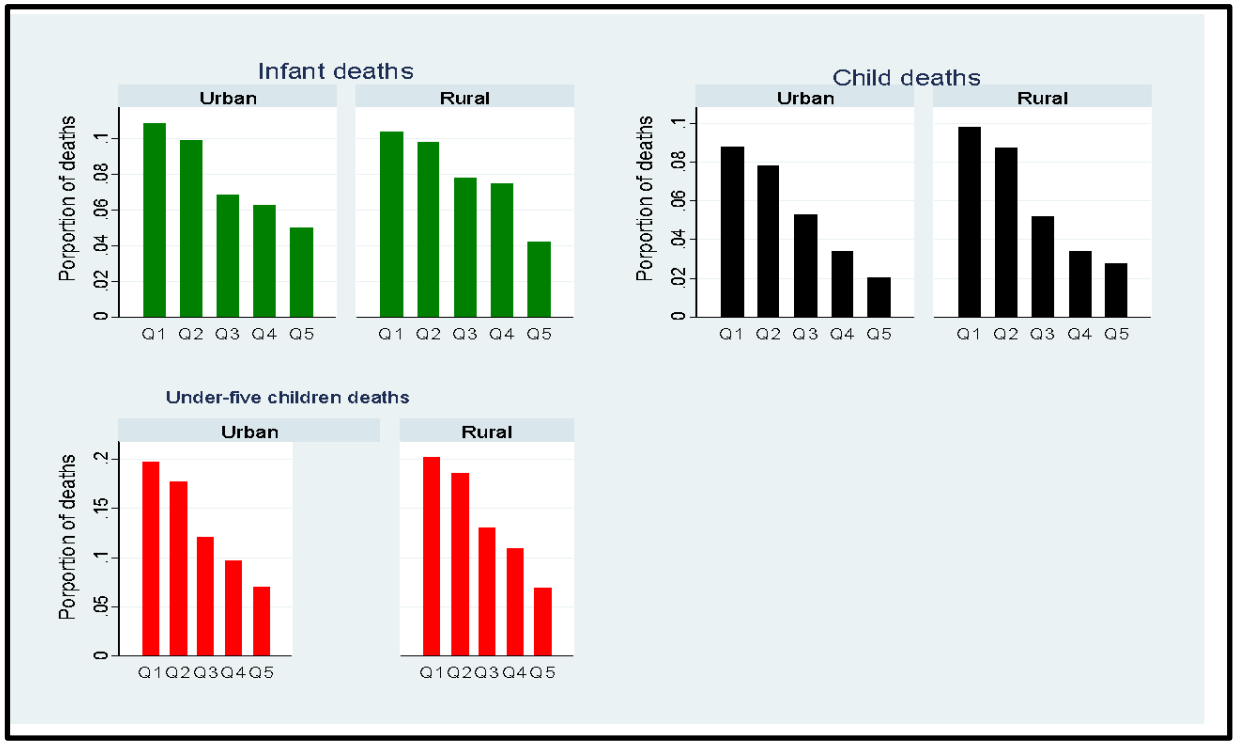
Figure 3.10 shows the concentration of deaths stratified by place of residence. Regardless of whether the children were urban or rural dwellers, the death concentration was among the poor households in the country. This is shown by the tallest bars on the chart for Q1 (poorer) and Q2 (poor), on each of the graphs.

Figure 3.9: Distribution of infant, child and under-5 mortality across income quintiles by gender



Source: Author's analysis

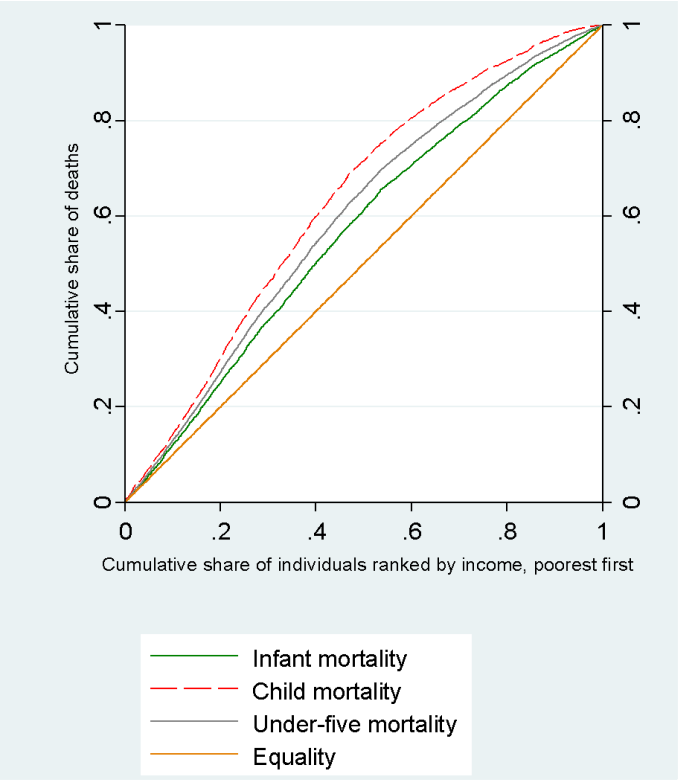
Figure 3.10: Distribution of infant, child and under-5 mortality across income quintiles by place of residence



Source: Author's analysis

The findings also show that the concentration curves derived from the concentration indices for child death is higher compared to infant or under-5 children deaths. This is further confirmed by Figure 3.11, where the Lorenz curve for child death is farer than the Lorenz curve of infant and under-5 deaths. This indicates that child death in Nigeria is more unevenly distributed across households than infant and under-5 children deaths.

Figure 3.11: Concentration curves for infant, child and under-5 mortality in Nigeria



Source: Author's construction

Finally, concentration indices were carried out on the 36 states and the Federal Capital Territory (FCT) of Nigeria. The results suggest that 23 states out of the 36 states have negative concentration indices and are significant at one, five and ten percent significance level. This implies that infant mortality is more concentrated among the poor. Specifically, for child mortality, 18 states had negative concentration indices and were significant at one, five and ten percent level of significance, implying that child mortality is concentrated among the poor.

Our findings also show that almost all the states, 22 states out of the 36 states, and the Federal Capital Territory all had negative concentration indices for under-5 mortality and were significant at one, five and ten percent significance level, implying that under-5 mortality is more concentrated among the poor (see Table 2 in the Appendix).

3.5 Summary, Conclusions and Recommendations

3.5.1 Summary

In conclusion therefore, the results show that by improving on other variables that can enhance socio-economic status and the mother's reproduction behaviour, a large portion of the influence of mother's schooling can be substituted.

Of all the pathways used for analysis, socio-economic status had the highest level of significance and importance in the mediation/moderation between mother's education and under-5 mortality, which is consistent with Caldwell (1981), Cleland and Kaufman (1993), Frost, Forste and Haas (2005), World Bank (1993) and Abuya *et al*. (2010). Maternal schooling is linked to the socio-economic rank of a household. A child's health status, survival or mortality can be predicted by maternal education and socio-economic rank, as the attitude, knowledge and behaviour of mothers are influenced by them, and they in the long-run influence the outcomes of children health-wise (Abuya *et al*., 2010; Cleland, 1990).

Better child health is also linked mediation of socio-economic status between maternal education, which gives the mother the purchasing power to buy necessary services and goods that would give a better health to the child and reduce mortality (Abuya *et al*., 2010). In other words, maternal schooling appears to be linked to better revenue, which in the long-run produces a better health. Also, mothers are more likely to obtain better paying employment with higher educational levels obtained, which helps in increasing family income. In addition, vastly educationally accomplished women are more likely to marry vastly educationally accomplished men, with good paying jobs; this will eventually boost the family income (Barrette and Brown, 1996; Cleland and Van Ginneken, 1988 and Abuya *et al*., 2010). This boosted family income will translate into access to better health care service for the children and family as a whole, improved living conditions and facilities, good/balanced nutrition for the children and ultimately good health for the children (Barrette and Brown, 1996: Frost, Forste and Haas, 2005; Martin *et al.,* 1983; Desai and Alva, 1998 and Abuya *et al*., 2010).

3.5.2 Conclusions

Therefore, we reiterate the conclusions based on findings that mother's schooling and SES are linked to child health or mortality by stressing that socio-economic status elucidates more than average of the mediating and moderating influence of mother's education on the health or mortality outcomes of children under five years (Cleland and Van Ginneken, 1988; Desai and Alva, 1998).

3.5.3 Recommendations

The findings from this chapter have several policy implications for maternal level of education disparities in under-5 mortality in Nigeria. Since an inverse relationship was observed between maternal education and under-5 mortality, the Government and other policy makers should focus and invest in maternal education by giving free or subsidized education, scholarships, grants to women and the girl child, enhanced medical services usage, and advancement in wellness activities and practices (Abuya *et al*., 2010). Also, investments should be made on health education and facilities that help create awareness and take care of women health issues, such as antenatal clinics, family planning clinics, post-natal clinics, public health facilities, etc. One of the best ways to combat children's deaths in the long-term and improve their health is to invest in the schooling of girls. Also, health knowledge should be incorporated into the elementary school syllabuses to influence a larger group of children, especially young girls, who are the future mothers.

The socio-economic pathway compares to other pathways, and is observed to be the most significant for both moderation and mediation of mother's education on under-5 mortality. This implies that the Government and other policy makers could invest in factors that can improve socio-economic status, because it influences the mothers' education, child health knowledge, attitudes and behaviour towards health, and these in turn influence the health outcomes of children under five years and consequently reducing their deaths.

CHAPTER FOUR: CULTURAL, MATERNAL, ENVIRONMENTAL FACTORS and UNDER-5 MORTALITY

4.1 Introduction

The use of geographic information systems to support public health systems is already spreading across the world. The importance of spatial assessment and map view to health analysis and planning cannot be over-emphasized. Maps provide better information about health phenomenon and presents to health officers' alternatives through which proper intervention activities can be carried out (Musa *et al.,* 2013). Autocorrelation is one of the ways to achieve this. Tobler (1970) captured the core of spatial autocorrelation as all is associated to everything else, but close things are more associated than aloof things. In other words, spatial autocorrelation could be said to characterize factors (say death) of proximal things (say cosmopolitan areas) will probably be more clustered or share alike factors than aloof ones. For example, if there is water pollution, it is expected that the contamination levels would be more alike between Lagos and Abeokuta (a close city), than between Lagos an Ile-Ife (a distant city). This may be because of resemblances in the fundamental communal and economic developments that cause contamination or water procedures that hold contaminants over huge distances and scatter contaminants from area to area.

Autocorrelation checks use point, line, or place structures that have characteristic principles committed to them. Therefore, when health officers view the location of the health incidents, facilities and infrastructure that are located around it and the location of households that are affected, then more insights can be gained into the magnitude of the effect of the occurrences. However, studies on spatial analysis of under-5 mortality clustering (Noori *et al*., 2020), maternal and environmental factors contributing to it are limited in resource-constrained countries. This limits opportunities for deploying effective and appropriate health interventions.

Without any doubt, outstanding improvements in the survival of children, in the earlier few eras was made worldwide. Children survival is higher now (1out of 26 in the year 2017) compared to 1990 (1 out of 11 children under the age of five) (UNICEF, 2019). Furthermore, compared to the 1990s, the goal of reducing the deaths of children has been fast-tracked in the 2000s, resulting in

a 1.9% to 4.0% improvement. However, despite this progres worldwide, records of under-5 mortality amounting to about 5.4 million was witnessed in the year 2017; and sadly, Sub-Saharan Africa recorded about half of this figure. There is a wide variation between the developed and the developing countries in terms of their contribution to the global under-5 mortality burden, but the situation is worse for the countries in African countries. Some examples of contributing factors are the poor or inadequate health facilities, care, and may be linked to cultural, political and environmental factors (Tanja *et al.,* 2011).

Under-5 mortality rate in Nigeria is among the world's highest, with northern Nigeria having the most appalling under-5 health indicators. Despite the streams of studies, research and knowledge on determinants of under-5 mortality in Nigeria, such as Klouda and Adamu (2013), Alabi *et al.*, (2014), Salau *et al.* (2007), there is still a gap in knowledge, especially in under-5 mortality clustering and factors contributing to the clustering observed in the northern parts of Nigeria, and the factors contributing to this clustering of high under-5 mortalities. Under-5 mortality clustering refers to the variability in the spread of under-5 mortality in a population. It explores why under-5 mortality is clustered within certain individuals, families or communities, because child mortality is unevenly distributed among women (Vandezande *et al.,* 2010). Child deaths tend to concentrate in some families or regions and among few women with certain characteristics. This study will check if the clustering observed is autocorrelated, and will check cultural, maternal and environmental factors contributing to it. This aspect of under-5 mortality study is relatively new in Nigeria and this study will contribute to it.

In chapter three, the results revealed a clustering pattern of under-5 mortality in the northern part of Nigeria, especially in the north-east and north-west geo-political zones of the country. These findings formed the basis for chapter four, which identifies the states that are clustered with the highest under-5 mortality rates and to check for maternal and environmental variables associations, i.e. variables that may be contributing to this clustering of the high mortality rates.

This chapter therefore seeks to examine the cultural, maternal and environmental factors contributing to under-5 mortalities in identified hotspots in Nigeria and recommend policy prescriptions based on the findings. The specific objectives of this chapter are: to determine if the under-5 mortality is spatially autocorrelated or it occurs independently in Nigeria; to explore the

association of cultural, environmental, and maternal factors on the identified hotspots for under-5 mortality in Nigeria; and to recommend policy prescriptions based on study findings.

4.2 Literature Review

This section reviews both theoretical and empirical literature. Section 4.2.1 reviews the theoretical theory applicable to under-5 mortality. Section 4.3.2 reviews empirical literature to identify the variables and methodologies of studies done in the past.

4.2.1 Theoretical approaches

The theoretical structure used in this study is based on the model of five groups of health determinants theory formulated by Mosley and Chen (1984). This illustrates the effect of proximate determining factors on the existence of children in developing nations. The proximate determining factors are classified into five groups: maternal factors, environmental factors, nutritional deficiency, injury, and personal illness control (prevention, treatment)**.**

The survival of a child is linked to several social and biological factors surrounding it, especially the mother's cultural, maternal and environmental factors amidst others. The uniqueness of this model is the use of proximate determinants approach to the study of child survival, and this is based on a number of principles. When children are born, they are expected to survive (about 97%). However, this is mostly not the case because of the biological, economic, environmental and social factors. These factors operate through more specific determinants, which in turn influence the survival of a child.

The model, therefore, identified these key proximate determinants in which all economic and social must function through, and categorized them into five groups as described below.

Maternal factors are the factors surrounding the health of the mother, which in turn have an impact on the pregnancy outcome and the survival of the newborn. These factors could be the young age of the mother (underage), the spacing of births which are short, among others.

Environmental contamination refers to the transmitters of infections in the environment, which includes water, air, food, skin, among others. These are the means whereby infectious diseases can be transmitted to the mother and child, which could viral and parasitic diseases, respiratory and intestinal diseases, skin infections and other diseases that lead to sicknesses of the mother and infant.

Nutritional deficiency is about the nutritional intake of both the mother and the infant. Proper nutrition should start with the mother right from the pregnancy or gestation period, because the mother's nutritional intake has effect on the fetus's health and birth weight. After the baby is

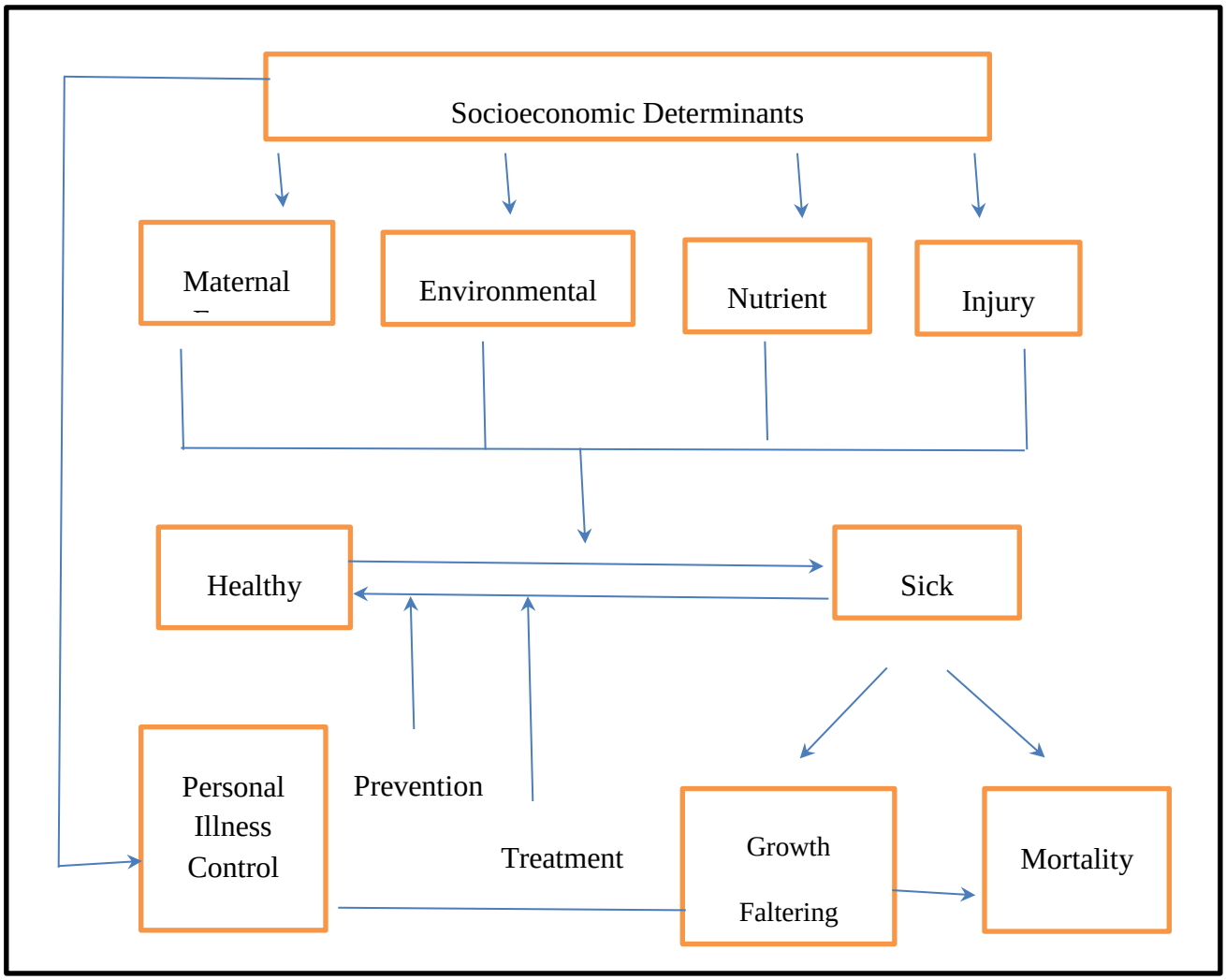
born, the nutritional intake of the mother will affect milk production and lactation for the proper growth and development of the baby, and for the health restoration of the mother. If the case is reversed when it comes to proper nutrition of the mother and child, diseases and sicknesses could set in or ultimately death.

Injury such as burns, poisoning and physical injury mostly cannot be predicted. Injuries are mostly random occurrences; however, there are some instances where it can be intentional, such as an extreme case of infanticide. The types of injuries and their frequency in occurrences on the mother or infant depend on the environment and socio-economic status.

Personal illness deals with prevention and treatment illnesses. A hale and hearty person takes necessary measures in avoiding diseases. However, even after taking necessary measures to avoid illnesses, the person takes necessary steps to receive medical treatments, and other steps needed to remedy the illness.

These five groups of proximate determinants operate on the health dynamics of a population. The framework depicts how these five categories of proximate determinants impact the likelihood of healthy people experiencing illness, where sickness is influenced or impacted through prevention and treatment. Precise conditions of illness (infection or nutrient deficiency) are mostly short-lived. Eventually, the person will either recover from the illness completely or the sickness could get worse into a permanent state or disability, or it could result into death.

Figure 4.1: An analytical structure for the study of child survival in developing countries adapted from Mosley and Chen (1984)



Source: Mosley and Chen (1984)

4.2.2 Empirical literature

Burke *et al.* (2016) carried out a study with the objective of analyzing the spatial factors linked with variation in deaths across some countries in Africa and examined spatial information to establish the sources of variation in mortality within-country and between-countries to determine the correlation between the decline/increase of mortality, places of residence and the influence of local contributing factors. The findings showed that about 74% to 78% overall differences in disparities of under-5 mortality rate was accounted for in under-5 deaths over time within-country, while death across countries and borders was 8–15%, indicating that factors within a country were the main drivers of the observed mortality patterns. They noted that if children continued to live in the high mortality areas, the countries will not be able to meet the SDG

mortality targets. Multivariate regression analysis found that resident temperature, malaria sickness, and history of battles were significantly associated with under-5 mortality.

Salau (2013) investigated district level variations in under-5 mortality rate in South Africa using Moran's I and LISA (Abuya *et al*., 2010). The result showed that under-5 mortality rate appeared to cluster in certain parts of the country. Also, the Moran's I showed statistically significant SAC in under-5 mortality rate (Moran's I = 0.5185, $p < 0.0001$). The richer provinces of Gauteng and Western Cape had low under-5 mortality rate surrounded by areas of equally low mortality. In summary, the results showed clustering of under-5 mortality rate at the district level.

Uthman (2007) carried out a study to analyze the effect of basic ecological services and neighborhood deficiency of under-5 mortality rate on state level in Nigeria. The study used exploratory spatial data analyses to determine the state-level association between environmental, neighbourhood deprivation and under-5 mortality rate. The results showed that spatial distribution of under-5 mortality rate was clustered. The spatial result showed that the "hot-spots" (i.e. areas with the highest level of under-5 mortality rate) were to the North-west and the North-east, while Southwest, South-south, and South-east were grouped under under-5 mortality rate "cold-spot" (that is, areas with the lowest level of under-5 mortality rate).

Singh and Tripath, (2013) conducted a study in India to check motherly factors contributing to under-5 mortality rate at delivery. Data from India National Family Health Survey 2007 was separated according to birth order 1 to 5. The survey data contained information on maternal profession, schooling, child's sex, age, area of abode, wealth index, maternal anemia level, pre-birth care, support at birth, prenatal care, place of birth and other motherly issues causative to under-5 mortality. The results showed that mother's schooling, family income and breastfeeding were defensive factors through all delivery orders.

Mesike and Mojekwu (2012) study explored the effect of household's environmental and socio-economic factors on child mortality. To cloister the influence of singular factors for appropriate remedial solutions, the research used PCA and simultaneous multiple regression for child mortality modeling in Nigeria. The results for variables that were correlated at moderate level from the stepwise regression model identified eleven factors, with the total variance in child mortality explained as 90.38%. The results show that 30.8% of the variance in child mortality was accounted for by the first factor (the index of household dwelling infrastructure) while the second (index of maternal education) and third (index income) factors were, respectively, 16.5% and 15.3%. The first three variables were responsible for a variation of about 60%. The study concluded that a composite of a number of environmental and socio-economic factors were predictors of the number of deaths in the society.

A study was done by Alaba *et al* (2014) to identify hotspots of under-5 mortality rate in Nigeria. The study used two proximate determinants, including environmental contamination and

maternal factors "obtained from the Nigerian Demographic Health Survey, 2008" (Exavery *et al*., 2011). The analysis showed that there was less than 1% likelihood that the observed clustering pattern in under-5 mortality rate was a result of random chance. The hotspots were found to have the lowest prevalence of under-5 mortality rate.

The highest incidence of under-5 mortality rate that resulted from unprotected water, unavailability or use of unprotected toilet facility, high illiteracy level, the type of cooking fuel, the poorest wealth index group, the rural place of residence, and the use of inappropriate place of delivery were found and concentrated among several states from the North East, West and Central Zones of Nigeria, namely Taraba, Plateau, Katsina, Kano, Bauchi, Jigawa, Zamfara, Gombe, Sokoto, Borno and Yobe States. The study concluded that the Government and other relevant organizations should focus on and take into consideration regional peculiarities when planning and providing aids and programmes for regions and states.

4.2.3 Overview of literature

There are several variables that contribute to under-5 mortality. Mosley and Chen (1984) illustrated the effect of proximate determinants on the survival/mortality of children in developing countries, which are linked to many maternal, environmental and nutritional factors. These factors bring about variations in under-5 mortality across space. Most of the studies above tested for spatial clustering and patterns and the variables associated with them. The findings revealed a positive and significant spatial autocorrelation (Salau, 2013; Kumar *et al.*, 2012) in some areas. Factors/variables such as (maternal and environmental) within a country as opposed to across countries and borders were the main drivers of observed mortality patterns in many countries (Burke *et al.*, 2016). The results also showed that mother's ethnicity and household wealth (Quattrochi *et al.*, 2015), urbanization, female literacy, households having below poverty line cards, coverage gap index, and newborn care (Kumar *et al.*, 2012); vaccination, low type of energy contamination and the type of family residence structure and amenities (Mesike and Mojekwu, 2012), poor access to health care facilities, poor sanitation and living conditions (Alabi *et al.*, 2016) were significant predictors, determinants and variables associated with under-5 mortality, as well as protective factors across all birth orders.

The highest incidence of under-5 mortality rate that were found in the northern parts of Nigeria in the research done by Alabi *et al.* (2016) were as a result of unprotected water, unavailability or use of unprotected toilet facility, high illiteracy level, the type of cooking fuel, the poorest wealth index quintile, the rural place of residence, and the use of inappropriate place of delivery. However, this study is different from the works done above, especially by Alaba *et al.* (2014) as newer data was used while employing different econometric techniques, and the study focused on the areas with the highest under-5 mortality in the country. Also, this study introduced some cultural variables, as opposed to only maternal and environmental variables carried out by Alaba *et al.* (2014). This study explored the association and contribution of child marriage variable,

while controlling for environmental and other maternal variables contributing to the high under-5 mortality in these hotspot regions, using a more recent data and econometric techniques.

4.3 Methodology

The study made us of two methodologies. For the first part, the under-5 mortality (death of a child between 0-59 months) for all the 36 states and Federal Capital Territory (FCT) were tabulated. The data counts were then exported into the ArcGIS environment for further analysis. The coefficient of spatial dependence because of the spillover effects between the states across the country was calculated using the Moran's I index. The states with the highest and lowest concentration of under-5 mortality were identified as the hotspots and cold spots. The ArcGIS was also used to measure the coefficient of spatial dependence/autocorrelation on the identified hotspots and for cluster analysis.

For the second part, the variables were categorized according to their supposed effects on under-5 mortality rate (see Table 4.1): cultural, maternal and environmental variables. Therefore, to determine if cultural, maternal and environmental variables contributed to the high under-5 mortality of the states that fall under the hotspots (red zone or color on the map (Figure 3.5), which are the states with the highest mortality rates), the Two Stage Least Square regression (to control for endogeniety) using cultural, maternal and environmental variables was used for analysis. The Gini coefficient analysis was also used to measure the poverty index for each state under investigation.

4.3.1 Theoretical model

The study used two theories: the Moran's I to measure special distribution of under-5 mortality, and the theoretical framework from Mosley and Chen (1984), and Rosenzweing and Schultz (1983), which are based on the interactions between the determinants of health and different types of health inputs and possible health outcomes.

4.3.1.1 Theory 1: Measure of spatial distribution-Moran's I

Moran developed a spatial dependence methodology in 1948. It quantifies spatial dependency using location features and attributes values. The methodology result shows either a clustered pattern or a random/dispersed pattern. When there is a positive Moran's I index value, it means there is a clustered pattern or tendency for one, while a negative value indicates a disperse pattern, and also its values range from -1 to +1. For this analysis:

The null hypothesis (Ho) = no spatial autocorrelation (dependence) across the study area (random),

The alternate hypothesis (H_1) = there is autocorrelation (clustered)

Therefore, Moran's I is expressed as:

$$I = \frac{N}{W}\frac{\Sigma_i\Sigma_j w_{ij}(x_i-\underline{x})(x_j-\underline{x})}{\Sigma_i(x_i-\underline{x})^2} \quad (38)$$

Where:

X = "variable of interest" (Rahman, 2017)

N = "number of spatial units indexed by i and j" (Rahman, 2017)

$\underline{x}$ = the mean of x

w_{ij} = is a matrix of spatial weights with zeros on the diagonal (i.e., $w_{ii} = 0$) and (Ahrens and Bhattacharjee, 2015)

W = sum of all w_{ij} (Ahrens and Bhattacharjee, 2015)

The value of *I* in equation (38) depends on the speculations made into the spatial weights' matrix w_{ij}. The clue is to build a matrix that precisely mirrors the expectations about the precise spatial spectacle in question. A shared method is to give a weight of 1 if two regions are neighbours and 0 if not. The choice of spatial weights matrix is directed by philosophy about the spectacle in question.

"The expected value of Moran's I under the null hypothesis of no spatial autocorrelation is" (ArcGIS Pro 2.8, Getis and Ord, 1992) given as:

$$E(I) = \frac{-1}{N-1} \quad (39)$$

At large sample sizes (that is, as N approaches infinity), the expected value approaches zero. Its variance is obtained as:

$$Var(I) = \frac{NS_4-S_3S_5}{(N-1)(N-2)(N-3)W^2} - (E(I))^2 \quad (40)$$

Where:

$$S_1 = \frac{1}{2}\sum_i\sum_j(w_{ij} + w_{ji})^2 \quad (41)$$

$$S_2 = \sum_i(\sum_j w_{ij} + \sum_j w_{ji})^2 \quad (42)$$

$$S_3 = \frac{N^{-1}\sum_i (x_i - \bar{x})^4}{(N^{-1}\sum_i (x_i - \bar{x})^2)^2} \quad (43)$$

$$S_4 = (N^2 - 3N + 3)S_1 - NS_2 + 3W^2 \quad (44)$$

$$S_5 = (N^2 - N)S_1 - 2NS_2 + 6W^2 \quad (45)$$

I values are from −1 to +1 range. When the values of I are significantly below -1/(N-1), it connotes a negative SAC. Similarly, when the values of I are significantly above -1/(N-1), it signifies a positive SAC (Bailey, 1995).

For statistical hypothesis testing, Moran's I values can be transformed to z-scores, given as:

$$Z(I_i) = (I_i - E(I_i))/\sqrt{Var(I_i)} \quad (46)$$

4.3.1.2 Theory 2: Mosley and Chen (1984) and Rosenzweing and Schultz (1983) framework

These frameworks guide in understanding the variables connected and linked with child survival or under-5 mortality. They also guide in the selection of proximate causes that influence the likelihood of child survival through a group of genetic mechanisms. Following Rosenzweing and Schultz (1983), we assume that households maximize utility given a utility function as:

$$U=(X, Y, H) \quad (47)$$

Where U is the utility function, X is a set of alternatives of goods and services that have no direct effect on health, Y signifies the consumption of goods and services that give direct utility and directly affect the health of an individual, and H the health status of an individual. Therefore:

$$U=U (H, Xa, Yb), a= 1...,n;b=n+ 1,...,m.(1) \quad (48)$$

Where *H* is the child health, *Xa = n* goods that do not affect child health (e.g. Clothing), and *Yb* = m−n goods that affect child health (e.g. food). However, child's health is influenced by exogenous variables and household choose these variables in such a manner that it will maximize the health outcome of a child (survival or mortality). The variables depend on the child health endowment (μ), household preferences, market prices and household physical environmental constraints and household wealth. These characteristics are presumed to be exogenous to the

household choices about mannerism and investment connected to child health (Thomas *et al*., 1999). According to Schultz (1984), the "production function" is given as:

$$H=h\,(Y, Z, C, \mu) \tag{49}$$

Given H as the child health, *Y* represents proximate maternal and environmental inputs to child health, such as maternal education, residence, sanitation, birth order; *Z* represents the health input of a child such as preventive and curative health care; *C* represents other inputs, and μ refers to the child's unobserved health endowment. Household therefore maximizes utility equation 46, given the production function equation 48, subject to household's budget constraint expressed as:

$$I=Px+Py+Pz+Pc \tag{50}$$

Where *I* is the total household income, Px represents the price per unit of X, Py represents the price per unit of *Y*, Pz represents the price per unit of Z and *Pc* represents the price per unit of Z. Solving the household's maximization model in equations 48, 49 and 50 yields the following reduced-form of input demand equations:

$$X = X(P_x, P_y, P_z, P_{c,}\, I, \mu) \tag{51}$$

$$Y = Y(P_x, P_y, P_z, P_{c,}\, I, \mu) \tag{52}$$

$$Z = Z(P_x, P_y, P_z, P_{c,}\, I, \mu) \tag{53}$$

$$C = C(P_x, P_y, P_z, P_{c,}\, I, \mu) \tag{54}$$

Using the technique of total differentiation, and following Mwabu (2009), the price effects of child health and survival is contingent on the influence of variations in prices on the demand for health production inputs, and on the marginal products of these inputs in the production of child health and survival. This in effect means that concurrently, we must estimate the child health production function and input demand parameters, so that the effect of changes in the prices of the various health inputs on child health and survival can be predicted.

Causal effect from inputs to outputs cannot be determined by the estimation of equations (51)-(54) alone because there is no direct link between them. Therefore, to bridge this disconnect we follow Mwabu (2007) who proposed the use of hybrid health production functions. The health outcome (child survival or mortality) *(H)* is a function of a good (*Y)* that affects health either directly or indirectly, and *(C)* is the other variables, prices P, income I and child health endowments μ, in the reduced form, as given in equation (55):

$$H = h(Y, P_x, P_z, P_c, I, \mu) \quad (55)$$

In equation (55), the hybrid equation, Y is potentially endogenous as it may be affected by the initial health status of the child (Mwabu, 2008). The marginal product of μ cannot be observed; therefore, care should be taken when inferring Y, because it creates complications in the interpretation if not controlled for (Rosenzweig and Schultz, 1982). The estimation method therefore considered the endogeneity of Y (Mwabu, 2008). The endogeneity problem in this study was addressed using an instrumented variable (place of residence).

4.3.2 Empirical econometric model

After the Moran's I analysis, the study used the Two stage least square to determine the effects of the cultural, maternal and environmental variables contributing to the high under-5 mortality in the identified hotspot areas.

4.3.2.1 Instrumental variables estimation (Two stage least square)

Refer to section 3.3.3 for the instrument used for this analysis and section 3.4.2.2 for the validity of the instrument. Therefore, to analyze the probable endogeneity of maternal education, this study estimated using the two-stage least square method, using the place of residence as an instrument (Somanathan, 2008; Andriano and Monden, 2019; Maiga, 2015) so as to elude prejudice.

Given a population model:

$$Y_1 = \alpha_1 Y_2 + \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \mu \quad (56)$$

Where:

Y_1= under-5 mortality

X_1 = Maternal variables

X_2 = Cultural variables

X_3 = Environmental variables

Y_2 = Maternal education, which is an endogenous variable. Given that there is one m instrumental variable, Instrument Z = (1, X_1,….X_3, Z_1,..., Z_M) is correlated with Y_2, we therefore obtain a reduced form equation for Y_2 with all exogenous variables (exogenous independent variables plus instrument), we have:

$$Y_2 = \delta_0 + \delta_1 X_1 + \delta_1 X_2 + \delta_1 X_3 + \delta_m Z_m + \varepsilon \quad (57)$$

$$Y_2 = \hat{Y}_2 + \varepsilon \quad (58)$$

Therefore, the projection of Y_2 with Z can be written as

$$\hat{Y}_2 = Z\hat{\delta} = Z(Z'Z)^{-1}Z'Y_2 \quad (59)$$

The two-step procedure was used; therefore, in the first step $\hat{Y}_2$ was used in place of Y_2. But now, treating Y_2 as a variable in X, we project X itself with Z:

$$\widehat{X} = Z\hat{\Pi} = Z(Z'Z)^{-1}Z'X = P_z X \quad (60)$$

$\hat{\Pi}$ is a (k+m+1)-by-k matrix with coefficients, thus Y_2 in X is expressed as a linear projection, and other independent variables in X is expressed by itself. $P_z = Z(Z'Z)^{-1}$, in other words, ($P_z'^{P_z} = P_z$). Therefore, using $\hat{X}$ as instrument for X and applying the IV estimation we obtain:

$$\beta_{2SLS} = (\hat{X}X)^{-1}\hat{X}'Y \quad (61)$$

$$= (X'P_zX)^{-1}\, X'P_zX \quad (62)$$

$$= (X'Z(Z'Z)^{-1}Z'X)^{-1}X'Z(Z'Z)^{-1}Z'Y \quad (63)$$

This can be rewritten as

$$\hat{\beta}_{2SLS} = (\hat{X}\hat{X})^{-1}\hat{X}'Y \quad (64)$$

This is the 2SLS estimator. Stage one is equation (56), and stage 2 is equation (63). Therefore, for the First Stage regression, we obtained $\hat{Y}_2$ by estimating an OLS "against all of the exogenous variables, including the instrument" (Place of residence). In Second stage regression, we used $\hat{Y}_2$in the place of Y_2 to estimate Y_1 against $\hat{Y}_2$ and all of the exogenous independent variables, not instrument.

The place of residence of the mother was used as an instrument (Somanathan, 2008; Andriano and Monden, 2019; Maiga, 2015) to the regional disparity in education over time. The validity of the instrument was tested with the first stage regression by checking for the significance levels of the t-statistics and the p-values. Their current place of residence is assumed to be the place of their residence in their school-going age. The main characteristic of an instrument is that it should be connected with the endogenous regressor (in our case, maternal education), but ought not be directly linked with the result variable (in our case, health/mortality/nutrition of under-5 children). The reason the current residence is a good instrument is because urban residence is good for maternal education, and this is because educational opportunities are available in urban areas (e.g., primary and secondary schools are available, and mother as a child could have attended them or actually for that reason did attend them). But why did mother attend them as a child? It is because her mother/father took her to those schools.

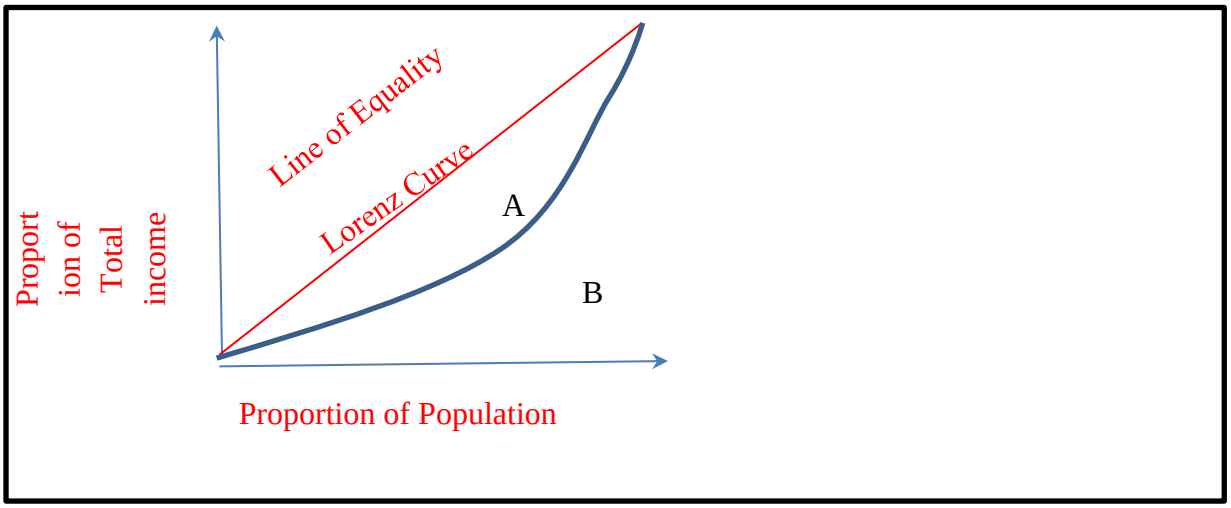
The situation may be the opposite for a rural setting. There is a high possibility that mothers who schooled in urban areas still reside in urban areas and are probably employed and established there as a result of their exposure to urban schooling (Andriano and Monden, 2019). There is also a high possibility that the mothers who grew up and schooled in rural places are established also in the rural place, also based on their level of education, quality of education and exposure. The urban residence today (with respect to mother's education already attained, is not supportive), and it is equally unsupportive for her child's health. Take for instance, a child with

malaria who lives near a free clinic and there is no mother to take him/her to clinic for treatment, or the mother is there but is uneducated and does not understand the importance of prompt treatment when the child has malaria. In this scenario, the child does not benefit from the urban residence, where she lives with the mother. Therefore, urban residence helps the child through the education of the mother, which the mother received as a child in the urban setting (Maiga, 2015).

4.3.2.2 Lorenz curve and the Gini coefficient

The Gini index or Gini coefficient is used as a gauge of economic inequality, measuring income distribution among a population. The Gini coefficient is usually displayed with the use of a graph known as the Lorenz curve as seen in Figure 4.2 below. The graph usually has on the x-axis the population, while the y-axis displays the proportion of the total income of the population. The Lorenz curve denotes inequality in the distribution of either wealth or income.

Figure 4.2: Lorenz curve



Source: www.economicshelp.org

The Gini coefficient is given as the ratio of the area that lies between the line of equality and the Lorenz curve. It is the area between the straight line and the curved line, expressed as a ratio of the area under the straight line, a scalar measurement of inequality. On Figure 4.2, the area is marked as "A" on the diagram, over the total area under the line of equality. This is given as:

$$G = \frac{A}{A+B} \quad (65)$$

The Gini coefficient is as a measure of deviation from perfect equality. The farther away the curve is from the line of equality, represented by the straight diagonal line, the higher the level of inequality.

4.3.2.3 Principal Component Analysis

To calculate the wealth index variable used for this study, the Principal Component Analysis - PCA (Joseph, 2020) was used. The NDHS data does not have statistics on family revenue or expenditure as a variable because the correctness of income data is challenging to establish, principally in nations such as Nigeria with huge informal subdivisions. Therefore, socio-economic status was measured using household wealth/asset index. The wealth index is a composite determinant of a family's aggregate living standard. The wealth index was computed using readily available information on a family's ownership (assets) of preferred resources such as televisions and bicycles; materials used to construct a house, etc. The index was therefore developed using the PCA (Filmer and Pritchett, 2001).

Therefore, the asset index for individual i is defined as:

$$A_i = \sum_k \left[f_k \frac{(a_{ik} - \underline{a}_k)}{s_k} \right] \quad (66)$$

Where:

a_{ik} = the value of asset k for household i

$\underline{a}_k$ = the sample mean

s_k = the sample standard deviation

This conversion is completed in such a technique that the leading principal component is given the highest probable variance (Scot Schraufnagel *et al*., 2020). The result of the components will be an uncorrelated orthogonal basis set. The PCA therefore uses the goods index areas person

families on a timeless scale of relative goods and then breaks off all evaluated families into wealth groups such as poor, middle, rich.

4.3.3 Description of Variables

4.3.3.1 Description of variables used in the model

Dependent variable: "Under-5 child mortality"

Mortality of under-5 children represents likelihood of a child dying after birth and before the child turns age 5 indicated as in every 1000 birth deliveries.

Independent variable: These are grouped into three: Maternal, Cultural and Environmental

Maternal variables

Maternal education**:** Refers to the formal schooling of the mother.

Age of the mother: Refers to the current age of the respondent as at the time the sample was collected; it ranged between the age of 15-49 years.

Religion: Refers to a particular system of faith and worship, specifically the type of religion a mother belongs to. This is measured as Christianity, Islam, Traditional and others.

Wealth index: This measures the household's cumulative living standard, generated using the PCA. The wealth index was then grouped into poor, middle/average and rich.

Antenatal care visits: Refers to antenatal visitation number while pregnant. It was captured as mothers who went for at least four antenatal visits and more. The minimum prenatal visitation recommended by WHO during the gestational period of a woman is four (WHO Recommendations on Antenatal Care, 2018).

Hospital delivery: Refers to babies born in the hospital or delivered by a skilled worker.

Post-natal care: This is known as the medical examination done on both mother and baby within 2 months of delivery.

Cultural Variables

Age at first birth: Refers to maternal age at first birth (age in years of the mother when she had her first child). This is captured under cultural variables because it is assumed that age at first birth (Fishman, 2020) is synonymous to age at first marriage (Fishman, 2020), especially in some cultures and religion where under-age marriages are supported. Bumpass and Mburugu (1977) found this to be true in a study done in Kenya where age of sexual experience was tantamount to age at first marriage, making it a proxy for age at first birth. This means that girls or women who are exposed to early sexual relations or early marriage mostly as a result of their culture are at a greater risk of unwanted pregnancies, birth and post-partum complications, which are some of the contributors to under-5 mortality.

Partner's education: Refers to the years of formal education or schooling by the partner or father. The level of involvement of a father during the pregnancy, birth and life of a child is usually cultural, and this is usually dependent on their educational level or exposure (Opondo *et al.,* 2016). This was also consistent with the findings by NICHQ 2021 and Quirk, 2019. However, in most African cultures, and African-American settings, mothers have the traditional role of taking care of a child, while fathers very much are the economic providers, and are not usually so much involved with child care and support. However, this is not the case with other cultures and traditions. Most of these practices in these cultures and traditions are hinged on the educational levels and exposures of these fathers hence, for this analysis, this variable is categorized as traditional/cultural.

Environmental Variables

Place of residence: Refers to the dwelling place of the mother, and it is defined as mothers living in either rural or urban areas.

Distance: This variable checks if the mothers have a nearer or far distance to the health facility where the respondent goes for help when needed.

Piped wate*r*: Refers to the type of water system in-let present in homes. The study focused on the piped water system in homes.

Sanitation (flush toilet): This refers to the type of toilet facility present in the homes of mothers. It includes pit latrine, no flush system and flush system. However, the study focused on flush system.

Table 4.1: Meaning and measurement of variables

Variables	**Meaning/ Measurement**	**Apriori Expected Effect**
Dependent variable		
Under-5 mortality	It is measured as a dummy variable taking the value of 0 if child is dead, and 1 if otherwise	
Independent variables		
Maternal variables		
Maternal education	Measured as the education of the mother with a dummy variable taking the value of 1 if mother has any form/level of formal education, and 0 otherwise.	Positive
Age of the mother	A dummy variable taking the value of 1 if mother is between the age of 15-49 years, and 0 otherwise.	Positive
Religion	A variable taking the value of 0 if Traditional and other religions, 1 if Christian, and 2 if Islam. The reference group is the traditional religion.	Negative
Wealth index	A variable taking the value of 0 if Poor, 1 if middle/average and 3 if in the rich group. The reference group is the poor category.	Positive
Antenatal care visits	A dummy variable taking the value of 1 if at least 4 ANC visits, and 0 otherwise.	Positive
Hospital delivery	A dummy variable taking the value of 1 if baby was delivered in the hospital and 0 otherwise.	Positive

Post-natal Care	A dummy variable taking the value of 1 for if mother went for post-natal check and 0 otherwise.	Positive
Cultural Variables		
Age at first birth	Age at first birth variable is grouped into four. Group 1: underage mothers (ages 12-17); Group 2: Ideal age (ages 18-25); Group 3 which is the reference group (ages 26-35) and group 4: (ages 36-45). The variable therefore takes the values of 0-3, representing each of the groups	Positive
Partner's education	Measures the formal education of the partner/father with a dummy variable taking the value of 1 if father has a form of formal education, and 0 otherwise	Positive
Environmental Variable		
Place of residence	A dummy variable taking the value of 1 if urban and 0 if rural	Positive
Distance	A dummy taking the value of 1 for nearer distance to the health facility, and 0 otherwise.	Negative
Piped water	A dummy variable taking the value of 0 if no piped water in the house and 1 if piped water in the house.	Negative
Flush toilet	A dummy variable taking the value of 0 if no flush toilet in the house and 1 if flush toilet in the house.	Negative

Source: Author's analysis

4.3.4 Data sources and types

The study used the 2013 NDHS data. The NDHS is structured to avail data for the populace and health status in Nigeria. The sample for the 2013 NDHS was a national representation, which covered the entire population of Nigeria, and the population living in non-institutional areas in the nation.

Nigeria administrative system is divided into states; the states are divided into local governments, and the local governments into localities. From these localities, 500 enumeration areas or clusters were gotten, of which the data for analysis was collected. A representative sample of 40,680 families was picked for the research. A stratified three-stage group design made up of 904 clusters, 532 in rural regions and 372 in urban regions, was used in selecting the representatives. A consistent sample take of 45 families were chosen per cluster. All females aged 15–49 who were either fixed inhabitants of the families in the 2013 NDHS representative or guests within the household on the night before the research were entitled to the evaluation. An aggregate of 38,948 females were interrogated out of which 15,545 lived in urban regions and 23,403 in rural regions. 24,529 minors with efficient and imperforate data on date of birth and height (in centimeters) were also collected. The analysis used 119,386 children under the age of five (age in months), and 18,525 under-5 children mortality (age in months), also 119,386 female respondents between the ages of 15-49.

4.4 Results of Objective Three

4.4.1 Descriptive statistics

The study's dependent variable is the under-5 mortality, which has a mean percentage of 15.5% out of the deaths in the study sample.

The study grouped the independent variables into maternal, cultural and environmental variables. The maternal variables are: Maternal education; Age of the mother; Religion of the mother; Wealth index; Antenatal Visits of the mother; Hospital delivery of the mother; and Post-natal Check.

About 49% of the mothers in the study sample had a form of formal education, while the average age of the mother in the sample was 35years old. The religion of the mothers was about 40.9% Christians and about 57.7% Islam. The Wealth Index variable had 46.8% of the sample population falling within the poor category, 20.6% were in the middle category, while 32.5% of the sample fell within the rich category. 48.8% of the mothers went for at least four antenatal visits and more, 32.4% of the women had hospital delivery, while 25.3% of the women went for post-natal checks from the sample.

The variables testing for the cultural aspect of the study were age at first birth, with data ranging from ages 12 to 45. The percentage of the underage mothers was between ages of 12-17 (group 1) was 46.8% of the study sample. 46.7% were within the age group of 18-25 years old, 6.2% of the mothers were in the 26-35 age group, while 0.11% of the women were from ages 36-45. Almost half of the samples, i.e. 46.8% of the mothers fell within the age of under-aged mothers or child marriage/ birth (12-17), which is a call for concern. The second variable is partner's education variable with 57% of the partners having some form of formal education in the sample.

The environmental variables have place of residence variable, with 32.4% of the women in the sample living in an urban area and 67.5% living in rural areas. The distance variable indicated that the sample had 32% of the women having a nearer distance to the health facility while 68% of the women had a far distance to the health facility. Mothers with piped water variable have 9.7% of the woman in the sample and lastly, the flush toilet variable has 9% of the women in the sample.

Table 4.2: Descriptive statistics of the variables

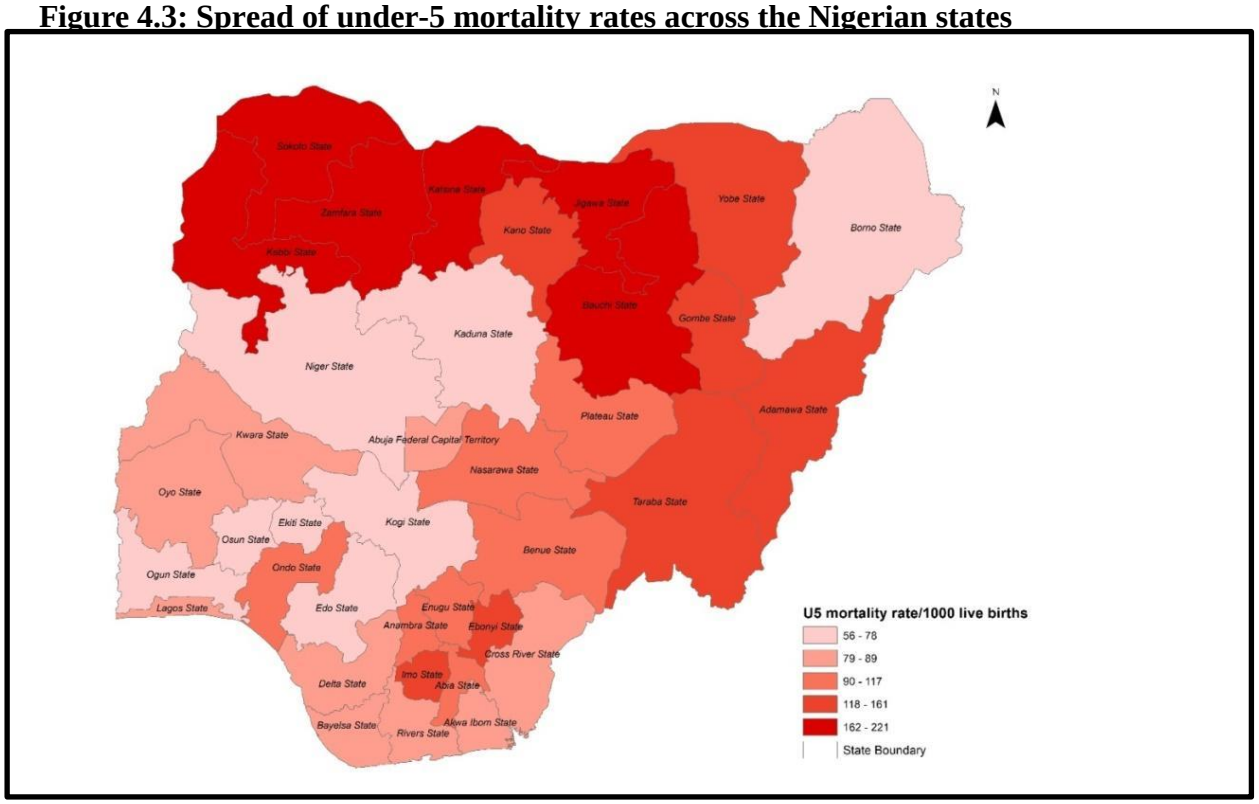
Variable	Obs.	Mean	Std. Dev.	Min	Max
Dependent variable					
Under-5 mortality	119,386	0.15517	0.36207	0	1
Independent variables					
Maternal variables					
Maternal education	119,386	0.49091	0.49992	0	1
Age of the mother	119,386	35.88806	8.09178	15	49
Religion:					
Christian	118,825	0.40947	0.49174	0	1
Islam	118,825	0.57708	0.49402	0	1
Wealth index:					

Poor	119,386	0.46858	0.49901	0	1
Middle	119,386	0.20600	0.40444	0	1
Rich	119,386	0.32542	0.46853	0	1
Antenatal visits	80,888	0.48818	0.49986	0	1
Hospital delivery	82,582	0.32419	0.46807	0	1
Post-natal care	82,419	0.25284	0.43464	0	1
Cultural Variables					
Age at first birth:					
Ages 12 – 17	119,386	0.46879	0.49903	0	1
Ages 18 – 25	119,386	0.46717	0.49892	0	1
Ages 26 – 35	119,386	0.06290	0.24278	0	1
Ages 36 - 45	119,386	0.00114	0.03373	0	1
Partner's education	117,358	0.57170	0.49484	0	1
Environmental Variable					
Place of residence					
Rural	119,386	0.67512	0.46833	0	1
Urban	119,386	0.32488	0.46833	0	1
Distance	118,918	0.32713	0.46917	0	1
Piped water	119,386	0.09757	0.29673	0	1
Flush toilet	119,386	0.09111	0.28776	0	1

4.4.2 Empirical results

The spatial distribution of the under-5 mortality rate as shown in Figure 4.3 map has six states with the highest under-5 mortality rate marked in red color. This ranged from 162-221 demises per 1000 live deliveries. The State of Zamfara had the highest under-5 mortality rate with an estimate of 221 deaths per 1000 live births, followed by the State of Bauchi which had an under-5 mortality rate of 210 deaths per1000 live births, Jigawa state with 200 under-5 mortality rate /1000 live births, Sokoto with 185 under-5 mortality rate/1000 live births, Kebbi state with 183 under-5 mortality rate/1000 live births, and Katsina state with 183 under-5 mortality rate/1000 live births.

Figure 4.3: Spread of under-5 mortality rates across the Nigerian states



Source: Author's analysis

The "spatial" autocorrelation (Moran's I) (Li, 2019) suggests a cluster pattern of under-5 mortality rates between one state and the neighbouring state, indicating possible autocorrelation presence. The Moran's I test used to check for the presence of autocorrelation confirmed this, with an index of 0.4689 and a value of P of 0.01. The results indicate that there is probability of a random chance result, which is as a result of the clustered pattern observed, which in turn has likelihood smaller than 1%. Therefore, there is a strong spatial dependence across Nigeria because the spatial pattern is clustered. The null hypothesis is rejected and we accept the

alternative hypothesis, which states that there is spatial dependence across the study area (clustered). This therefore led to further analysis of checking for possible associations of cultural, maternal and environmental variables that could possibly be contributing to this high under-5 mortality rate and clustering in these regions.

The econometric regression results of the analysis for determining variables contributing to the high under-5 mortality in Nigeria as a whole and in the six states identified as the hotspots in the country using the two-stage least square probit model. The two-stage least square model produces instrumented results, which are meant to correct likely endogeneity problem.

4.4.2.1 The country as a whole

The regression result carried out on the country presented a result where the coefficient of maternal education was negative and statistically significant in the 2SLS at one percent level (ß = -0.5977; P <0.01). The coefficient of christianity was positive and statistically significant at the one percent level (ß = 0.2628; p <0.01). Wealth index variable (rich) had a negative significant coefficient at less than five percent level (ß = -0.2521; P<0.05). Antenatal visits, hospital delivery and post-natal care variables were positive and significant at one percent levels (ß = 0.0523, and 0.1275 and 0.0525; P<0.01).

The category of ages 12-17 in the variable of age at first birth had its coefficient significant at less than ten percent (ß = 0.1341; P<0.10). The partner's education variable coefficient had a negative sign and was significant at less than one percent, (ß = -0.2252; P<0.01). Under the environmental variables, the negative coefficients of the distance to the nearest health care facility and flush toilet were significant at less than one percent levels (ß -0.0265 and -0.1989; P<0.01 respectively). Finally, the piped water variable had a negative coefficient significant at one percent level (ß = -0.0237; P<0.01).

A separate regression analysis was performed for each of the six states. Below are the results for Sokoto, Zamfara, Katsina, Bauchi, Jigawa and Kebbi states.

4.4.2.2 State 1: Sokoto

Table 4.3 presents the 2SLS regression results for both first and second stages for Sokoto State. In the first stage, the instrument (place of residence) is statistically significant ($p < 0.01$, $t = -11.27$). In the second stage, the coefficient of maternal education was statistically significant at one percent level ($ß$=-0.0384, $p < 0.01$) in the 2SLS model. Similarly, the coefficient of the partner's education variable was also significant, although with a low level of significance of 10% compared to mother's education ($ß = -0.0438$, $p < 0.10$).

The coefficient of the maternal age variable was highly significant at one percent level (($ß$ = 0.0041, $p < 0.01$) in the 2SLS analysis, while the wealth index coefficient of the middle and rich

category was significant at less than one and five percent levels of significance (ß = -0.0643 and -0.1257; , $p < 0.01$ and , $p < 0.05$, respectively). The coefficient of the sanitation variable (flush) was significant at five percent level (ß = - 0.4276; $p < 0.05$). The overall model fits reasonably well because it is correctly classified at 84.33%.

Table 4.3: Regression results for Sokoto and Zamfara states

	State 1 – Sokoto				**State 2 – Zamfara**			
	Two Stage Least Square Probit Model				***Two Stage Least Square Probit Model***			
	Stage one		**Stage two**		**Stage One**		**Stage two**	
Variable	**Coeff./ Std. Error.**	**P-Value**	**Coeff./ Std. Error.**	**P-Value**	**Coeff./ Std. Error.**	**P-Value**	**Coeff./ Std. Error.**	**P-Value**
Maternal variables								
Maternal education			0.1626 (0.0914)	0.0750			0.2150 (0.1758)	0.2210
Maternal age	0.0027 (0.0009)	0.0050	0.0041 (0.0010)	0.0000	-0.0023 (0.0008)	0.0030	0.0044 (0.0011)	0.0000
Religion (Traditional)								
Christianity					-0.0779 (0.0541)	0.1500	-0.0089 (0.0677)	0.8950
Islam	0.5196 (0.1378)	0.0000	-0.0792 (0.1514)	0.6010	0.0095 (0.0411)	0.8170	0.0030 (0.0501)	0.9520
Wealth index (poor)								
Middle	0.0651	0.0080	-0.0643	0.0090	0.2605	0.0000	-0.0868	0.0380

	(0.0244)		(0.0245)		(0.0267)		(0.0417)	
	0.5622		-0.1257		0.9666		-0.2753	
Rich	(0.0294)	0.0000	(0.0499)	0.0120	(0.0350)	0.0000	(0.1598)	0.0850
	0.0247		0.0013		0.0575		-0.0365	
Antenatal visits	(0.0216)	0.2530	(0.0221)	0.9520	(0.0181)	0.0010	(0.0234)	0.1190
	0.1850		-0.0543		0.1267		-0.0490	
Hospital delivery	(0.0381)	0.0000	(0.0404)	0.1790	(0.0267)	0.0000	(0.0390)	0.2090
	0.3152		-0.0809		0.0461		0.0006	
Post-natal care	(0.0448)	0.0000	(0.0514)	0.1160	(0.0191	0.0160	(0.0246)	0.9790
Cultural Variables								
Age at first Birth: (Ages 26-35)								
	-0.1341		0.0122		-0.0507		0.1150	
Ages 12 – 17	(0.0552)	0.0150	(0.0579)	0.8330	(0.0389)	0.1930	(0.0509)	0.0240
	-0.1057		-0.0034		-0.0963		0.0438	
Ages 18 – 25	(0.0551)	0.0550	(0.0584)	0.9540	(0.0387)	0.0130	(0.0486)	0.3670
	0.1684		-0.0438		0.1121	0.0000	-0.0641	
Partner's education	(0.0163)	0.0000	(0.0235)	0.0630	(0.0155)		(0.0282)	0.0230
Environmental Variable								
	-0.0278		0.0127		-0.0062		-0.0503	
Distance	(0.0141)	0.0480	(0.0143)	0.3750	(0.0144)	0.6660	(0.0177)	0.0040
Piped water	0.0608	0.0030	-0.0290	0.1670	0.5467	0.0000	-0.1420	0.1450

	(0.0207)		(0.0209)		(0.0429)		(0.0976)	
Flush toilet	1.6175		-0.4276		-0.1807		0.0548	
	(0.1024)	0.0000	(0.1881)	0.0230	(0.0592)	0.0020	(0.0773)	0.4780
Place of residence (Urban) (Abuya, 2010)	-0.2640				-0.1545			
	(0.0234)	0.0000			(0.0222)	0.0000		
Cons.	-0.4583				0.1607	0.0130		
	(0.1531)	0.0030			(0.0649)			
Number of obs.	3,680		3,695		4,032		4,032	
F(14, 3680)/ F(15, 4016)	129.41				171.63			
Prob > F	0.0000		73.68		0.0000		69.81	
R-squared	0.3299		0		0.3906		0	
Adj R-squared	0.3274				0.3884			
Root MSE	0.3849		0.3966		0.3663		.44714	
Wald $Chi^2(14)$/ Wald $Chi^2(15)$			73.68				69.81	
Prob > Chi^2			0.0000		0.0159		0.0000	
R-squared			.-		-2608.02		.	
Correctly classified			84.33%				84.97%	

4.4.2.3 State 2: Zamfara state

From Table 4.3, Zamfara State had the instrument (place of residence) to be statistically significant (t=-6.94, p < 0.01) in the first stage of the regression. In the second stage, the coefficient of maternal age was significant at less than one percent (ß = 0.0044; p<0.01) for the 2SLS analysis. The partner/father's education variable coefficient was significant at less than five percent level of significance (ß = -0.0641; p<0.05).

The variable Age at first birth had the coefficient of the ages 12-17 category (under-age) significant at less than five percent level of significance (ß = 0.1150; p<0.05). The coefficients of the wealth index variable (middle and rich) (ß = -0.0868 and ß = -0.2753) were statistically significant at five and ten percent levels, respectively (p <0.05 and p< 0.10), although at a low level of significance for the middle and rich class.

The negative coefficient of the Distance variable was another significant variable at one percent level of significance (ß = -0.0503; p <0.01). The overall model is correctly classified at 84.93%.

4.4.2.4 State 3: Katsina state

The 2SLS analysis done on Katsina state had in the first stage of the regression the instrument (place of residence) to be statistically significant (t = -2.8300, p < 0.01). In the second stage, the coefficient of 0.0059 of maternal age was significant at less than one percent level of significance ($ß$ = 0.0059; p<0.01) in Table 4.4. The coefficients of the variable age at first birth were significant at five and one percent levels of significance (p<0.05and p<0.01) for the categories of the ages 12-17 (under-age) and ages 36-45, respectively ($ß$ = 0.1453 and $ß$ = 0.5531, respectively). The overall model is correctly classified at 84.58%.

Table 4.4: Regression results for Katsina and Jigawa states

	State 3 – Katsina				**State 4 – Jigawa**			
	Two Stage Least Square Probit Model				***Two Stage Least Square Probit Model***			
	Stage One		***Stage Two***		***Stage One***		***Stage Two***	
Variable	**Coeff./ Std. Error.**	**P-Value**	**Coeff./ Std. Error.**	**P-Value**	**Coeff./ Std. Error.**	**P-Value**	**Coeff./ Std. Error.**	**P-Value**
Maternal Variables								
Maternal education			0.1275 (0.3330)	0.7020			0.1269 (0.1620)	0.4330
Maternal age	-0.0054 (0.0010)	0.0000	0.0059 (0.0020)	0.0040	-0.0032 (0.0008)	0.0000	0.0072 (0.0010)	0.0000
Religion (Traditional)								
Christianity	0.0321 (0.1793)	0.8580			0.2672 (0.3531)	0.4490	0.2180 (0.3809)	0.5670
Islam					0.4209 (0.2739)	0.1240	0.0696 (0.3013)	0.8170
Wealth index (Poor)								
Middle	0.2479 (0.0217)	0.0000	-0.1102 (0.0782)	0.1590	0.0882 (0.0227)	0.0000	-0.0734 (0.0327)	0.0250
Rich	0.4883 (0.0294)	0.0000	-0.1517 (0.1516)	0.3170	0.3325 (0.0392)	0.0000	-0.1945 (0.0781)	0.0130

Antenatal visits	0.0055		0.0162		0.1046		0.0162	
	(0.0179)	0.7570	(0.0170)	0.3390	(0.0145)	0.0000	(0.0225)	0.4720
Hospital delivery	0.1681		-0.0400		0.0342		-0.0217	
	(0.0258)	0.0000	(0.0628)	0.5240	(0.0254)	0.1780	(0.0281)	0.4400
Post-natal Care	-0.1049		-0.0229		0.0086		-0.0245	
	(0.0347)	0.0030	(0.0512)	0.6540	(0.0179)	0.6300	(0.0193)	0.2060
Cultural Variables								
Age at first birth (ages 26-35)								
Ages 12 – 17	-0.1608		0.1453		0.1377		0.1063	
	(0.0479)	0.0010	(0.0776)	0.0610	(0.0381)	0.0000	(0.0447)	0.0170
Ages 18 – 25	-0.1872		0.1131		0.1206		0.0575	
	(0.0477)	0.0000	(0.0708)	0.1100	(0.0374)	0.0010	(0.0465)	0.2160
Ages 36-45	-0.1346		0.5531					
	(0.2240)	0.5480	(0.2155)	0.0100				
Partner's Education	0.3273		-0.0553		0.1733		-0.0313	
	(0.0158)		(0.1109)	0.6180	(0.0155)	0.0000	(0.0333)	0.3480
Environmental Variable								
Place of residence (Urban)	-0.0643				0.1747			
	(0.0227)	0.0050			(0.0264)	0.0000		
Distance	-0.0664		-0.0132		0.0044		-0.0477	
	(0.0152)	0.0000	(0.0252	0.6020	(0.0138)	0.7500	(0.0148)	0.0010

Piped water	-0.0166		0.0121		0.0831		-0.0220	
	(0.0205)	0.4170	(0.0208)	0.5620	(0.0153)	0.0000	(0.0217)	0.3110
Flush toilet					0.2874		-0.0941	
					(0.0475)	0.0000	(0.0723)	0.1930
Cons	0.4115				-0.4265			
	(0.0632)	0.0000			(0.2785)	0.1260		
Number of obs.	4,102		4,108		3,974		3,976	
F(14, 4093)/ F(15, 3960)	130.02		94.15		68.80		124.02	
Prob > F	0.0000		0		0.0000		0.0000	
R-squared	0.3078		-		0.2067		0.0132	
Adj R-squared	0.3055				0.2037			
Root MSE	-2446.06		0.4126		0.3858		0.41339	
Wald $Chi^2(14)$			94.15					
Prob > Chi^2			0.0000					
Correctly classified			84.93%				84.83%	

4.4.2.5 State 4: Jigawa state

Jigawa state had data limitation challenge; however, from Table 4.4, the instrument (place of residence was statistically significant ((t = 6.6100, p < 0.01) in the first stage of the regression, while from the second stage of the regression the coefficient of maternal age was significant at less than one percent level of significance (ß = 0.0072; p <0.01). The category of ages 12-17 in the variable age at first birth had its coefficient significant at five percent level of significance (ß = 0.1063; p <0.05).

The categories of middle (ß= -0.0734; P<0.05) and rich (ß = -0.1945; p <0.01) for the wealth index variable were significant at less than five and one percent levels of significance. The

Distance variable also had a significant coefficient at less than one percent significance level (ß = -0.0477; p <0.01). The overall model is correctly classified at 84.54%.

4.4.2.6 State 5: Bauchi state

From Table 4.8 for Bauchi, there was only one significant coefficient of a variable under the 2SLS analysis, which was the category of ages 12-17 years (under-aged mothers) under the variable age at first birth, which was significant at less than five percent level of significance (ß = 0.1063; p<0.05). In the first stage of the regression, the instrument (place of residence was statistically significant (t = 1.1900, p < 0.05) and the overall model is correctly classified at 84.97%.

Table 4.5: Regression results for Bauchi and Kebbi states

	State 5 - Bauchi				**State 6 - Kebbi State**			
	Two Stage Least Square Probit Model				***Two Stage Least Square Probit Model***			
	Stage One		**Tage Two**		**Stage One**		**Stage Two**	
Variable	**Coeff./ Std. Error.**	**P-Value**	**Coeff./ Std. Error.**	**P-Value**	**Coeff./ Std. Error.**	**P-Value**	**Coeff./ Std. Error.**	**P-Value**
Maternal variables								
Maternal education			--1.1104 (1.1485)	0.3340			0.7092 (0.2588)	0.0060
Maternal age	-0.0055 (0.0011)	0.0000	-0.0034 (0.0064)	0.5920	0.0036 (0.0009)	0.0000	0.0000 (0.0015)	0.9730
Religion (Traditional)								
Christianity	1.3469 (0.1203)	0.0000	1.5268 (1.5563)	0.3270	0.0152 (0.0619)	0.8060	-0.0015 (0.0770)	0.9850
Islam	0.5073	0.0000	0.6945	0.2510	0.0490	0.1410	0.0395	0.3550

	(0.0921)		(0.6046)		(0.0333)		(0.0427)	
Wealth index: (Poor)								
	0.1958		0.2154		0.0417		0.0275	
Middle	(0.0270)	0.0000	(0.2334)	0.3560	(0.0207)	0.0430	(0.0259)	0.2880
	0.6693		0.6642		0.4028		-0.2896	
Rich	(0.0381)	0.0000	(0.7959)	0.4040	(0.0348)	0.0000	(0.0939)	0.0020
	-0.0206		-0.0463		0.0931		-0.1133	
Antenatal visits	(0.0168)	0.2200	(0.0333)	0.1640	(0.0208)	0.0000	(0.0346)	0.0010
	0.1639		0.1926		0.0662		-0.0253	
Hospital delivery	(0.0232)	0.0000	(0.1916)	0.3150	(0.0261)	0.0110	(0.0362)	0.4860
	0.1077		0.1387		0.5119		-0.2839	
Post-natal care	(0.0179)	0.0000	(0.1275)	0.2770	(0.0422)	0.0000	(0.1431)	0.0470
Cultural Variables								
Age at first birth:								
(ages 26-35)								
	0.0672		0.1063		-0.1113		0.2083	
Ages 12 – 17	(0.0505)	0.1840	(0.0447)	0.0170	(0.0341)	0.0010	(0.0510)	0.0000
	-0.1469		0.0575		-0.1115		0.1588	
Ages 18 – 25	(0.0502)	0.0030	(0.0465)	0.2160	(0.0347)	0.0010	(0.0507)	0.0020
	0.3475		0.3831		0.3437		-0.2658	
Partner's education	(0.0192)	0.0000	(0.3991)	0.3370	(0.0187)	0.0000	(0.0898)	0.0030
Environmental Variable								

Place of residence (Urban) (Abuya, 2010)	0.0387 (0.0326)	0.0236			-0.1246 (0.0260)	0.0000		
Distance	-0.0387 (0.0167)	0.0200	-0.0449 (0.0520)	0.3880	-0.0126 (0.0135)	0.3530	-0.0155 (0.0171)	0.3660
Piped water	-0.0965 (0.0297)	0.0010	-0.1352 (0.1076)	0.2090	-0.0886 (0.0457)	0.0530	0.0169 (0.0635)	0.7900
Flush toilet	0.4923 (0.0662)	0.0000	0.5540 (0.5825)	0.3420				
Cons	-0.2165 (0.1151)	0.0600			-0.0144 (0.0595)	0.8090		
Number of obs.	3,929		3,929		3,552		3,552	
F(15, 3913)/ F(14, 3537)	221.76		24.89		94.11			
Prob > F	0.000				0.0000		0	
R-squared	0.4595		.--		0.2714		-	
Adj R-squared	0.4574				0.2685			
Root MSE	0.471		0.6415		0.3876		0.48081	
Wald $Chi^2(15)$			24.89				49.15	
Prob > Chi^2			0.0514				0.0000	
Correctly classified			84.97%		Correctly classified		84.97%	

4.4.2.7 State 6: Kebbi state

From Table 4.5 for Kebbi state, the results from the first stage of the 2SLS showed that the instrument was statistically significant at (ß = -4.7900; p<0.01). In the second stage, the coefficients of maternal education and partner's education variables were significant at less than one percent level of significance (ß = 0.7092 and -0.2658; p <0.01). Two categories under the age at first birth variable: underage mothers, i.e. ages 12-17years and 18-25 years, were significant at less than one percent level of significance (ß = 0.2083 and ß = 0.1588; p <0.01).

The antenatal visits variable had a negative coefficient, which was significant at less than one percent level of significance (ß = -0.1133; p <0.01), while the post-natal check had a significant negative coefficient at five percent level of significance (ß = -0.2839; p <0.05). The wealth index (rich) variable was also significant at one percent level of significance with a negative coefficient (ß = -0.2896; P<0.01).

Table 4.6: The Gini coefficient analysis result

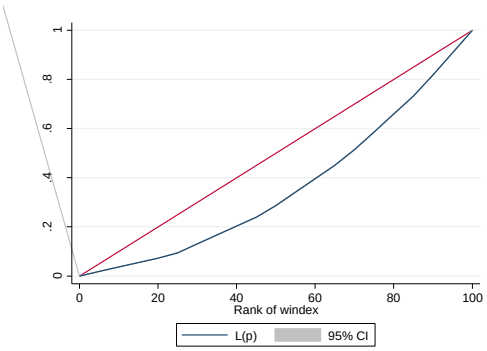
Gini Index:	Nigeria	Sokoto	Zamfara	Katsina	Jigawa	Bauchi	Kebbi
No. of obs.	119386	5308	5245	5790	5163	5102	4935
Index value	0.5468	0.7962	0.8887	0.7811	0.8850	0.8121	0.8261
Std. error	0.0001	0.0024	0.0035	0.0025	0.0037	0.0027	0.0033
p-value	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

From Table 4.6, the Gini index value for the country was 0.546, implying that the level of income inequality is about 54.6% in the country. This corresponds with the Lorenz curve, which was far away from the line of equality. Sokoto state had a Gini index of 0.7962, an indication of about 79.6% inequality in Sokoto state. Zamfara state had 0.8887 as a Gini index, implying 88.8% inequality in the state. Gini index 0.7811 was for Katsina State, a 78.1% income inequality for the state. Jigawa state had a percentage of 88.5% in income inequality with a Gini index of 0.8850. Bauchi state also had a Gini index of 0.8121, also implying an 81.2% income inequality. Finally, Kebbi state had a Gini index of 0.8261, an indication of 82.6% income inequality in Kebbi state.

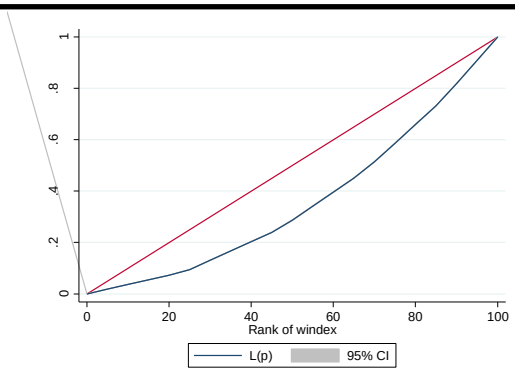
The further away a Lorenz curves deviates from the lines of equality in Figure 4.4 below, the higher the inequalities in such states. Nigeria as a whole and all the six states under analysis had their Lorenz curves far away from their lines of equality in Figure 4.4 and were all below the

lines of equality. This is an indication of an uneven distribution of resources in these states, and uneven distribution of assets and wealth amongst their citizens.

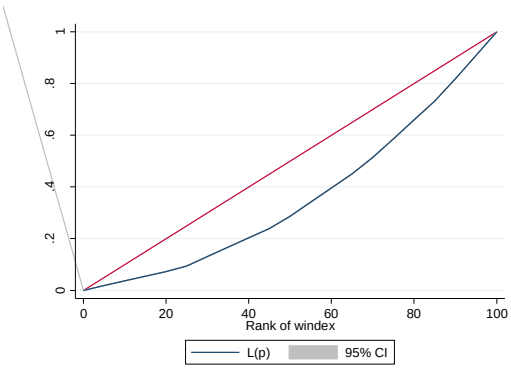
Figure 4.4: Lorenz curves for Nigeria and the six affected states

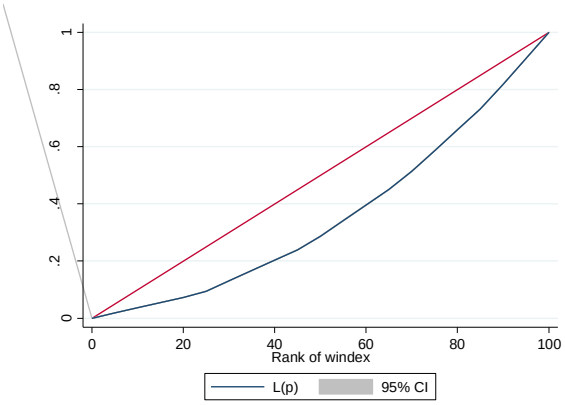


Lorenz curve for Nigeria



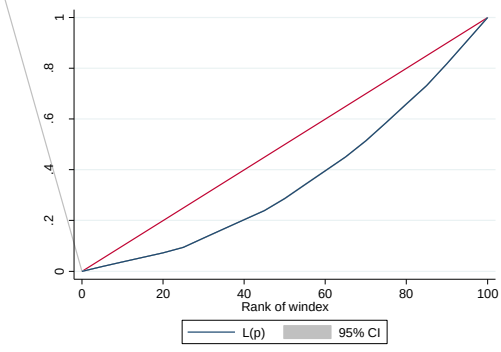
Lorenz curve for Sokoto State

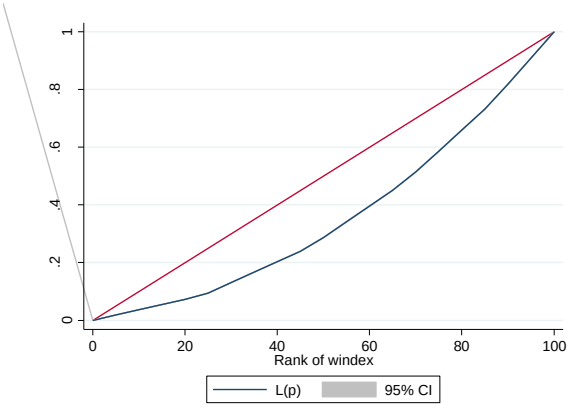




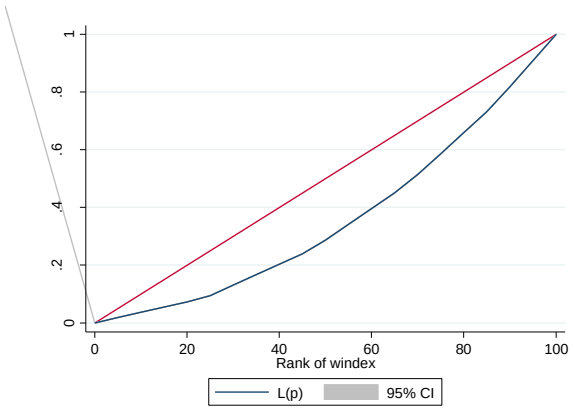
Lorenz curve for Zamfara State

Lorenz curve for Katsina State





Lorenz curve for Jigawa State ***Lorenz curve for Bauchi State***



Lorenz curve for Kebbi State

Source: Author's analysis

4.4.3 Discussion of the Results

4.4.3.1 The whole country

The analysis on the country as a whole showed that increasing the level of education by one unit will reduce the probability of under-5 mortality by about 60%. The partner's education was equally a significant variable, an indication that the education of fathers had an influence and increasing the father's level of education by one year would reduce the probability of under-5 mortality in the country. Usually, educated fathers are most likely to marry educated mothers and vice versa.

The practice of delivering babies at the church or its environs is common in Nigeria, which could be the possible reason for the significance of the coefficient of Christianity variable. A times, complications which can only be handled by trained medical professionals are experienced and this could lead to the mortality of the child or mother, thereby contributing to the high under-5 mortality in the country. Such cases have contributed about 26.2% under-5 mortality to the national percentage.

From the descriptive statistics, 51.2% percent of the women in the country went for less than four or no antenatal visits. Therefore, about 5.2% of the country's under-5 mortality was because of the no or low antenatal visits. From Table 4.2, it is alarming that only 32.4% of the women had their babies delivered at the hospital through the help of a skilled worker; in other words, 67.6% of the women in the country had their babies delivered outside the hospital without

necessarily a skilled worker. This had contributed to the high under-5 mortality in the country. Similarly, the significance of the post-natal variable contributing to the under-5 mortality is likely as a result of just 25.2% of the women in the country going for post-natal check-ups, an indication that 74.8% of the women in the country did not go for post-natal checks, and this has contributed to the under-5 mortality in the country by 5.2%. The coefficient of variable wealth index was also significant with an inverse relationship, implying that if wealth index increased by one unit, the probability of under-5 mortality will decrease by 0.2521 or by 25.2% in the country.

The category of mothers within the ages of 12-17 years under the variable of age at first birth had its coefficient significant, an indication that if the country stops the pregnancy and birth of an under-age child by one, there is a probability of 13.4% reduction of under-5 mortality. This is consistent with the findings from Finlay *et al.* (2011), which emphasized teen pregnancy as a risk factor with a result showing 23.9% of infant mortality with women between the ages of 15 and 17 at their first birth and 35.2% with women between the ages of 18 and 20. Children born to women aged 12–14 or 15–17were significantly more likely to die in their first year of life than children born to women aged 27–29.

Under the environmental variables, the distance and the flush toilet variables were significant. Nearer distance to health facility reduces under-5 mortality by 0.0265, with the inverse relationship observed, while for the flush toilet variable, it contributed 19.9% to the national under-5 mortality. This is possibly because just 9.1% of the women under investigation have flush toilets, thereby making 90.9% of the women without flush toilets as can be seen on the descriptive statistics Table 4.2. Finally, the piped water variable was also significant, and also an indication that if an additional one unit of piped water is consumed, there would be a possibility of a reduction in the probability of under-5 mortality by 2.37%. The Gini coefficient of the country was 0.5468. Compared with other African countries with low index such as Algeria with a Gini coefficient of 27.6, Nigeria still has a high level of income inequality among her citizens. When a country has a high percentage of income inequality, it could lead to higher degrees of health and societal glitches, lower proportions of social goods, a lesser population-wide satisfaction and contentment, lesser level of economic growth and development, among other problems.

4.4.3.2 Sokoto state

Sokoto state is located in the northwestern part of Nigeria and the analysis showed a positive sign on the coefficient of maternal education, implying that maternal education is a contributing factor to the high under-5 mortality in Sokoto state. This is against apriori knowledge; however, it could imply that the high percentage of 16.2% of mothers with non-formal education contributed to the high under-5 mortality in the state. This further implies that the higher the

level of education, the lower the under-5 mortality. Also, the more mothers are educated, the less under-5 mortality will be. Furthermore, education should have a positive influence on reducing and not increasing under-5 mortality. Similarly, the coefficient of partner's education variable was also significant, although with a lower level of significance compared to mother's education, implying that the level of education of the father played a role in reducing under-5 mortality in Sokoto state by 4.3%.

The positive sign on the age of the mother is as expected. This implies that, generally, at a certain point, the older a woman gets the higher the chances of her losing a child because of her biological and physiological composition, especially during child birth. This variable is also a contributor to the high under-5 mortality in Sokoto state.

The negative sign on the variable coefficients is an indication that if there was an increase of wealth index and flush by units of one, the probability of under-5 mortality will reduce by 6.4% (middle), 12.5% (rich) and 42.7%, respectively. This attests to the state of urbanization in the state of Sokoto, and environmental factors likely contributing to the high under-5 mortality. Sokoto is located in one of the poorest geo-political zones in Nigeria. According to the National Bureau of Statistics (NBS) 2013 report, Sokoto State has remained the poorest state in the nation, with 81.2% poverty rate. This implies that the high poverty level of the state will influence some basic amenities necessary for its citizens and their places of residence, which will mostly be a poor state of living. Table 4.3 and Figure 4.3 show the Lorenz curve and the inequality index for Sokoto state. The curve in Figure 4.3 is far away from the equality line, implying an unequal distribution of income with more income being held by the rich in the society. The Gini coefficient of 0.7962 is an implication of 79.6% income inequality in Sokoto state. This in turn could have had an impact and contributed to the high under-5 mortality rate in the state.

4.4.3.3 Zamfara state

Zamfara state had the maximum number of under-5 mortality rate in Nigeria with a rate of 221 deaths per 1000 live births (Gani, 2009). The positive sign on the coefficient of the (Gani, 2009) maternal age is an indication that maternal age is a contributing factor to under-5 mortality. This could possibly be a situation of under-age mothers or over-age mothers in the state. However, this was affirmed by the variable Age at first birth, which had the coefficient of the ages 12-17 category (under-age) significant. Sadly, this could be a possible implication of the practice of child marriage in the state. Zamfara state was the first state to officially adopt the Sharia legal system in 2002, and child marriage is endemic in the state (Iyabode, 2011) just like most Northern states in Nigeria. This practice being a ripple effect will equally affect negatively the education of these children brides, thereby also contributing to high under-5 mortality rate in the state. However, the partner's education variable helped to reduce under-5 mortality in Zamfara state by 6.4%.

The negative coefficients of the middle and rich class of the wealth index variable were an indication of an inverse relationship between wealth and under-5 mortality. In other words, the wealthier a person or household is, the lesser the under-5 mortality. However, looking at the socio-economic status of Zamfara state, according to the National Bureau of Statistics record in 2017, Zamfara was the poorest state in Nigeria with 91.9% (H incidence K=33.3%) and MPI = 0.605 and 65.8% A-intensity. Although Sokoto state was said to be the poorest state in Nigeria as at the year 2019, Zamfara state also fell among the 10 poorest states in the country with 70.8% poverty rate. This was confirmed by our Gini coefficient calculation of 0.8887 on Table 4.6, implying 88.9% income inequality in Zamfara state. Poverty affects living standards, which in turn could contribute to under-5 mortality in the state.

Another interesting variable to note was the distance to the closest health care facility. The negative coefficient was an indication of an inverse relationship between distance to the nearest health care facility and the under-5 mortality. A study carried out in Zamfara state by Alabi *et al*. (2014) showed that maternal and child mortality rates were high in the state because of factors such as under-utilization of health care facilities. This may be because of bad and poor attitude of some health care service providers, and the way women were treated, which may have compounded the situation of underutilization of health care by women, who also may have to travel hours and long distances coupled with long waiting hours at the health facility for them to receive care. This may have contributed to the bad situation of health care service utilization and delivery in Zamfara state.

4.4.3.4 Katsina state

In Katsina state, the maternal age variable was also significant. The same explanation as in other states above also applies for Katsina as there may be presence of under-age or over-age mothers in the state, contributing to the high under-5 mortality, with the variable being significant and positive. This was also further affirmed by the coefficient of age at first birth being significant. This implies that 14.5% of under-5 mortality was contributed by under-aged mothers, while 55.3% of the under-5 mortality was contributed by over-aged mothers. This also affirms the significance of the maternal age coefficient above. Furthermore, the significance of the variables could also imply that Katsina State also has some significant form of child marriage practice, which is likely influenced by cultural and religious believes. Therefore, just like the states analyzed above, Katsina state also has all the negative effects that come with under-aged marriages and births, including under-5 mortalities equally applying in the state.

Katsina had a poverty rate of 74.5% in 2014, which increased to 82.2% in 2017 (National Bureau of Statistics, Nigeria - NBS-NG | Data 2017). Katsina state fell among the 10 poorest states in Nigeria, a state located at the deepest part of the north western area of Nigeria, with fewer or no solid investment or sector that generates revenue for the state. The Gini coefficient from the

inequality analysis in Table 4.6 was 0.7811, while the Lorenz curve in Figure 4.3 was equally far away from the equality line, signifying a large range of income inequality in the state. Therefore, just like the states mentioned above, poverty, affects living standards, which in turn could contribute to the high under-5 mortality rate of 183 deaths per 1000 live births in the state.

4.4.3.5 Jigawa state

Jigawa State is situated in the north-western part of the country, and for Jigawa state we had data limitation challenge. However, maternal age was equally confirmed by the category of ages 12-17 years in the variable age at first birth having a significant coefficient. Also, the results still indicated that just like the other northern states examined above, child marriage is practiced, or under-aged giving birth can be found in this state and it is widespread. Therefore, this cultural and religious practice brings about all the negative side effects of children brides and underage marriages in Jigawa state, one of which is the rate of high under-5 mortality in the state.

The negative coefficient of wealth index for Jigawa state, being an inverse relationship between wealth index and under-5 mortality was consistent with some of the other northern states earlier discussed. An increase in wealth index will bring about the probability of a decrease in under-5 mortality. The distance also had an inverse relationship, implying that nearer distance to the health care facility reduces the under-5 mortality by 0.047 units. The significance of the wealth index and distance could be an indication of a likely poor standard of living, and an indication of inadequate environmental and basic amenities such as good roads or hospitals. According to Bichi (2014) and the study conducted in Kazaure, Jigawa, the healthcare facilities were categorized into primary, secondary and tertiary, where by primary was having 78.95%, secondary 21.05% and tertiary 0.00%. Another study carried out by Musa Jaro and Adamu Ibrahim (2019) examined and explained how accessibility problems affected the level of utilization of the primary health care system (as measured by the location hospitals) in Jigawa state. Findings showed that inhomogeneous facilities and he distance problems contributed to the high under-5 mortality rate of 200 deaths per 1000 live deliveries in the year 2013.

Jigawa state is also one of the 10 poorest states in Nigeria with a poverty rate of 74.1% in 2014 and increased to of 88.4% in 2017 but dropped a bit in the year 2019 to 72.1% (National Bureau of Statistics, Nigeria, 2019). This is as a result of low literacy level and low economic growth in the state. From Table 4.6 showing the inequality analysis, the Gini coefficient of Jigawa state was 0.8850, implying 88.5% income inequality in the state, and the Lorenz curve is far away from the equality line, signifying a wide income inequality distribution in the state.

4.4.3.6 Bauchi state

Bauchi state is located in the eastern part of the north of Nigeria, and the only significant coefficient variable was age at first birth. The analysis revealed that about 10.6% of the under-5

mortality was as a result of under-aged mothers. According to a report on the status of women's rights in Nigeria presented by Women Advocacy Research and Documentation Centre (WARDC) 2017, Bauchi state was one of the states having the highest number of child marriages at 84% in Nigeria. Citing United Nations statistics, the organization also announced that girls under 17 years were responsible for 7.3 million babies in developing countries. Bauchi is a war-torn zone and statistics from the National Bureau of Statistics showed that the bulk of the populace in this area do not have the basic amenities of life. The death rate recorded after the various rebellious attacks were devastating. No doubt, this situation had contributed to the high under-5 mortality rate in the state, coupled with the negative effects of these children marriages on their education, health and life as a whole as mentioned earlier above.

In 2014, according to a report by OPHI, extreme poverty highest percentage was in Bauchi, closely followed by Kebbi. According to the NBS 2019 report, Bauchi ranked among the 10 poorest states in Nigeria with 86.6% poverty rate. Also, from the inequality analysis on Table 4.6 and Figure 4.3, the Gini coefficient of Bauchi state was 0.8121, and the Lorenz curve is far away from the equality line, an implication of a wide income inequality. This was also a contributing factor to the high under-5 mortality rate of 210 deaths per 1000 live births in Bauchi state.

4.4.3.7 Kebbi state

The maternal education variable had an affirmative indication on its coefficient, which is conflicting to a prior expectation because maternal education should lower under-5 mortality. However, this could be a possible indication of a low level of formal education for the mothers in this state, or probably girls' enrolment in schools is low. The negative sign on the coefficient of fathers/partner's education variable is an indication that the educational level of the father brings about a reduction to the level of under-5 mortality. If the level of partner's education is increased by one, there is a probability that under-5 mortality will reduce by 26.6% in Kebbi state. In a situation where mother's education is a contributing factor to under-5 mortality in the state and the opposite is the situation for father's education, it signifies that the efforts on maternal education or girl's enrolment is low in Kebbi state. There is an indication of possible practice of child marriages or under-age girls having babies, with a significant coefficient of age at first birth variable. This, just like the other states discussed above, could lead to many issues, one of which is the high under-5 mortality in the state.

The antenatal visits variable was significant ($P<0.01$), with a negative coefficient of -0.1133, while the post-natal check was significant as well ($P<0.05$) with a negative coefficient of -0.2839. They are both contributing factors to under-5 mortality; however, if the antenatal visits or post-natal checks were to increase by one, there is a probability of under-5 mortality reduction by 11.3% and 28.3%, respectively, of which Kebbi state has a mortality rate of 183 deaths per 1000 live births.

The wealth index (rich) variable was also significant (P<0.01) with a negative coefficient of -0.2896, an indication of an inverse relationship between wealth index and under-5 mortality. Therefore, if wealth index is increased by one unit, there is a probability of 28.9% decrease in under-5 mortality. According to the report by OPHI 2014, Kebbi state has the second highest percentage of people living in extreme poverty in Nigeria. A report by OPHI 2017 reported that Kebbi state has a poverty rate of 86.0%. From the analysis on inequality in the state, the Gini-coefficient was 0.8261, while the Lorenz curve was far away from the line of equality. The urban areas in Kebbi state accounted for only about 12.5% of the population of the state. Thus, more than 80% of the population lives in rural areas with limited resources and amenities. This could also be a contributing factor to the high under-5 mortality in the state. The overall model is correctly classified at 84.53%.

4.5 Summary, Conclusions and Recommendations

4.5.1 Summary

In summary, the results have shown that the variables age of the mother and age at first birth were significant predictors of under-5 mortality rate. The plausible explanation for this could be early child marriage common in most of the states in Northern Nigeria. To address the issue of early marriages, the Government has put in place laws, for example the Child Rights Act. However, this Act has not been effective because it is optional for states, and child marriage can be practiced within the states that have not enacted the law locally.

Another significant variable that was relatively consistent in the hotspot states was the distance to the nearest health care centre. Accessibility to the nearest health care centre is also a major challenge in these states (especially in the rural areas) because of the distance to the health facilities and poor road connection. When there is a problem with accessibility to a health centre, the level of utilization of such centres can be a problem. Also because of the unequal distribution of medical centres around these states, accessibility and utilization becomes more challenging. If the structures and amenities are improved upon, the standard of living in these rural places will also improve, as a result the probability of under-5 mortality will also be reduced. In other words, the more an area is urbanized the less the under-5 mortality.

4.5.2 Conclusion

The clustering pattern observed after the mapping of the under-5 mortality led to the testing of the spatial autocorrelation using the Moran's I. the results revealed that there was a positive spatial autocorrelation. It was observed that the red zone, which had a cluster of states with the highest number of under-5 mortality in the country were located in the northern part, precisely the north-east and north-western part of Nigeria. This led to checking for variables that could be contributing to the clustering pattern observed in the regions, thereby checking some maternal

environmental and cultural variables for association with the under-5 mortality rate, to see if these variables can explain the high rates and the spatial clustering pattern. From the results, we observed that the coefficient of the variable age of the mother, and age at first birth were relatively significant across the six states under examination.

We observed that the states were part of the poorest states in the country, with high poverty rates. Poverty affects the living standards of people and dictates their life choices, such as places of residence, types of healthcare insurances, etc. This could be one of the reasons for the clustering pattern observed and the high under-5 mortality rates. We also observed that Islam is the main religion in these states and all the states under analysis had adopted the Sharia law and all its guiding principles as their operational law.

It was also observed that cultural and religious practices in these states support children marriages; i.e. marriages of children less than 18 years of age. Statistics of child marriage in Nigeria in the year 2017 was 43% of girls married off before the age of 18, 17% were married before they turned 15 (Child marriage around the world: Nigeria, Girls Not Brides [website], 2018). Nigeria is at the 11^{th} position among nations with the highest number of child marriages globally (New York Times, Child, Bride, Mother: Nigeria, 2017). Meanwhile, the zones with the highest percentage in Nigeria are the North West and North Eastern regions with 68% and 57% of child marriages, respectively. The negative effects of this practice can be seen across the six states because children marriages led to the low level of education especially for the girl child, health issues that came with children having children, which eventually led to complications, a high mortality rate of under-5 children and even their mothers.

In conclusion, therefore, awareness through the media and all available means needs to be intensified on the practice of child marriages, while emphasis needs to be laid on effective programmes, policies and amendments of laws (especially the laws that affect child marriages. Part 1 Section 61 of the 1999 Constitution of the Federal Republic of Nigeria should be amended, and the Child Rights Act (2003) should be automatically enacted in all states. Unvarying age should be set for a child to marry to protect the rights of children in the country in the affected areas by the Government and other relevant associations or institutions to help eradicate/decrease the rate of under-5 mortality and to help break this clustering pattern observed in the regions. Programmes that will help alleviate poverty in these regions should be of uttermost priority as this will go a long way to stabilize the families financially, improve living standards, provide better health care, eradicate/reduce child marriages/under-aged mothers, which eventually will reduce under-5 mortality in these regions.

4.5.3 Recommendations

The findings from this chapter have several policy implications. The Government and other relevant organizations should have policies targeted towards the variables contributing to the

high under-5 mortality in the six northern states examined above. Child marriage practice, which is a key contributor to under-5 mortality, cuts across all the six states affected. It is a very sensitive issue because the practice has become the way of life of the people, and people have the freedom and rights to their choices. However, the laws on child marriages need to be reviewed as the disadvantages especially on the girl child outweigh the advantages, and because it violates a child's rights. Nigeria as a country needs to set a nationally enforceable minimum age for marriage, even though the Child Rights Act (2003) placed marriageable age at 18 years. Only 24 states out of the all the Nigerian states have taken steps to implement it as at the year 2016. Sadly, 11 out of the 12 states that are yet to internalize this law are found in the Northern part of the country.

Based on the study findings, targeted policies, interventions, initiatives, and programmes that will alleviate poverty, which is a major factor underlying child marriage, especially for girls viewed as economic burdens, and low-income households should be rolled out by the Government in these affected states. Also, policies that minimize gender inequality, social exclusion, marginalization and insecurity, which are some of the factors that drive the practice of early marriage, should be put in place.

The Government and other relevant organizations should also have policies targeted towards the six states with the highest under-5 mortality by investing in health education by increasing levels of health knowledge among women; targeted information campaign through the media (television, radio and newspapers) on complete immunization of mothers and children, balanced nutrition and enlightenment of the use of modern medicine and facilities. This will help create awareness and improve knowledge on child-bearing, issues and challenges that come with it.

CHAPTER FIVE: SUMMARY, CONCLUSIONS AND POLICY IMPLICATIONS

5.1 Overview

This chapter summarizes and concludes the thesis. Section 5.2 presents a summary of the thesis. Section 5.3 presents the main conclusions of the study and highlights the contribution of the thesis. Section 5.4 presents policy implications of the study findings, while section 5.5 presents areas for further research.

5.2 Summary

Despite the natural endowment and human capital Nigeria is blessed with, the county still battles disparities, inequalities and inequities in health. The statistics of child and maternal mortality is alarming in the country. Nigeria's inability to effectively address the challenges facing women and children health and the country's numerous public health challenges has contributed to the persistent and high level of poverty and the weakness of the health system (Aregbeshola, 2019). The United Nations (UN) has argued that fairness in health is an indicator of comprehensive development. Therefore, the notion of health parity has been defined as variances in health care that are needless, prejudicial, unfair and preventable (Braveman and Gruskin, 2003). Health inequities is not just a problem unique to Nigeria alone, but it is a global concern and has brought renewed interest in the study of injustices in health, with individual countries and international groups renewing their efforts to restitute the health of the less fortunate and vulnerable in the society. In Nigeria, children especially under five years of age are vulnerable to many conditions and diseases, which eventually lead to their deaths. Generally, child health and childhood mortality are used as wide pointers of social growth (Hill, 1992). This is why infant mortality reduction is among the 8 Millennium Development Goals (MDGs) drafted in the year 2000 and is still one of the goals in the new targets rolled out under the Sustainable Development Goals (SDGs) formulated in 2015.

Nigeria is not an exception in making progress over mortality reduction because, over the years, mortality of children under the age of five has also been reducing. However, recently, nearly 10% of the under-five deaths happened in Nigeria, and the country ranked third on the list of contributors. Therefore, despite improvements in child survival, Nigeria has an alarming rate of children mortalities, especially under-5 mortality. Therefore, under-5 mortalities are a major challenge facing the Nigeria Government. Some empirical studies have researched and exploited disparities in health in Nigeria. They have researched into inequities of child health and mortality because of malnutrition, socio-economic status, maternal education, geographical locations and determinants of child mortality. However, literature on the magnitude of these health disparities in under-5 children and the associated maternal and environmental casualty variables are scarce. This thesis addresses this gap through three main objectives: first we investigated the socio-economic disparities in under-5 child malnutrition in Nigeria (essay one). Second, we

investigated the disparities in under-5 mortality ascribable to maternal level of education in Nigeria (essay two). Thirdly, we investigated associations of environmental contamination and maternal factors on identified hotspots for under-5 mortality in Nigeria (essay three).

The first objective (essay one) was analyzed using a cross sectional data from the Living Standards Measurement Study (LSMS)/General Household Survey (GHS) 2015/2016 (NBS), 2020), https://microdata.worldbank.org/index.php/catalog/2734). Data on 3698 children that were under-5 years of age (0-59 months) were derived from the household data. These were the figures used for analysis in this study. The analysis was done using the Principal Component Analysis, followed by the concentration index and curve, while for further statistical inference, the regression model was used.

To address the disparities in under-5 mortality ascribable to maternal level of education in Nigeria (essay two), we used the NDHS 2013. An illustrative sample of 40,680 families was selected. All females aged 15-49 who were either fixed inhabitants of the families in the 2013 NDHS representative or guests present in the families on the night before the research were entitled to the evaluation. The analysis used 119,386 children under the age of five (age in months), and 18,525 under-5 children mortality (age in months), and also 119,386 female respondents between the ages of 15-49. The estimation was done using the concentration index, followed by the probit model to measure the inequality and magnitude in under-5 mortality; and then the Stepwise Probit regression model was used to estimate the moderation and mediation effect; i.e. the influence or relations between interventions and outcomes, in our case between maternal education and under-5 mortality.

To address the associations of environmental contamination and maternal factors on identified hotspots for under-5 mortality in Nigeria (essay three), which was a further study of the result gotten from essay two analysis, the Nigerian Demographic and Health Survey (NDHS) 2013 was equally used. As stated earlier, this is a representative sample of the country. The analysis used 119,386 children under the age of five (age in months), and 18,525 under-5 children mortality (age in months), and also 119,386 female respondents between the ages 15-49. The analysis was done using the ArcGIS for the cluster analysis to measure the coefficient of spatial dependence and identify the hotspots of under-5 mortality in the country. The states with the highest and lowest concentration of under-5 mortality rate were identified as the hotspots and cold spots. The coefficient of spatial dependence and autocorrelation were calculated by means of the Moran's I index. The probit model was used to check for the possible associations of cultural, maternal and environmental variables contributing to the high rate of under-5 mortality.

From essay one result, the percentages of stunted, wasted and underweight children were 37.8%, 9.9%, and 20.3%, respectively. The percentages of stunting, underweight and wasting were significantly higher in the male children compared to female children. The results revealed that

stunting and underweight were responsive to household socio-economic status. However, wasting did not appear to be so sensitive to changes in the socio-economic status. The places of residence of the children were also analyzed and results showed that a higher percentage of children under five years of age who were stunted, wasted and underweight lived in the rural areas of Nigeria compared to children living in the urban areas of the country.

The results also showed that out of the six zones in Nigeria, the percentage of stunting, wasting and underweight were highest in the North West and North East zones, but lowest in the South South and North Central zones of the country. The overall concentration indices for all the three malnutrition measures showed significant inequities, which were more in favour of the rich households, meaning that a greater burden of malnutrition was taken by children found within the last rank of the socio-economic scale (Zere and McIntyre, 2003; Nigatu, 2018). However, for wasting, this socio-economic gradient was not witnessed, as it was not so responsive to changes in socio-economic status.

The results also indicated that income-related and socio-economic-related inequalities were the strongest in stunting and underweight, which are indications of long-lasting malnutrition and of chronic malnutrition, which are often associated with socio-economic deprivation. However, as anticipated, no palpable socio-economic inequalities could be detected in children wasted because its concentration curve nearly overlapped with the line of equality. This is because income has little effect on conditions that usually precipitate wasting, such as diseases and unexpected environmental factors.

The results also showed that stunting has equal division among the zones, with half having concentration among the poor and half having concentration amongst the rich. The pro-rich concentration indices were significant at 5 and 1 percent levels, while findings also show that underweight had an unusually high concentration amongst the most deprived in the entire zones. However, the pro-rich concentration indices were not statistically significant, except for the South South zone which was significant at 10%. Finally, the concentration indices on the place of residence indicated that income-linked disparities in underweight and stunting increased as there were rises in the degree of urbanization of the families' places of abode. This means that the rate of malnourished children was lower in urban areas compared to children living in rural areas of the country. Wasting had similar results, but at a lower magnitude.

The results from essay two showed that from the probit analysis for every 1000 live births, the probability of death was 12.8% in under-5 mortality rate and was statistically significant at one percent level of significance. Across the six zones, our results suggested that north-west had the most under-5 mortality with a probability of 16.4% mortality in every 1000 live births, while South-West had the lowest under-5 mortality rate with a probability of 8.1% deaths per 1000 live births, and they were statistically significant at one percent level of significance.

Comparison was done between male and female children, and our findings show that all indicators related to child mortality have a higher probability among male children compared to females, although the difference is not significant at one percent level of significance. For the place of residence, the findings showed that the probability of under-5 mortality was higher among children who were rural dwellers, compared to urban dwellers.

The results from the analysis done on the 36 states and the Federal Capital Territory of Nigeria indicated that the State of Zamfara had the highest under-5 mortality rate with a probability of 22.1% deaths per 1000 live births, while Edo state had the lowest under-5 mortality rate with a probability of 5.6% deaths per live births. This was consistent with the results reported on the indicators across the six regions. The spatial analysis was done and the results were also consistent with the above. The results also suggested a decreasing pattern of under-5 mortality rate as the income of households increased.

The results from the concentration indices revealed that the proportion of death among under-5 children was 22.2% and was more prevalent among poor households, since the value of the concentration index was negative and statistically significant at 1 percent level of significance, as a decreasing pattern of under-5 child deaths was observed as the income groups increased. Also, concentration indices of socio-economic inequality of under-5 child deaths, stratified by gender and place of residence showed a higher percentage of under-5 mortality among the males compared to the females, and the percentage of under-5 mortality in the urban areas was higher compared with the rural areas. However, regardless of the place of residence or gender, under-5 mortality was still rampant among poor households.

The results from the two-stage least square showed that the instrumented variable (IV) was highly significant at one percent level, implying that the instrument was good. All the maternal variables were significant and positively related at one and five percent levels, except for flush (sanitation), which is not significant. However, the empowerment pathway had a negative sign, implying an inverse relationship with maternal education. Interestingly, father's different levels of education were also significant with positive signs, an indication of educated fathers more likely to marry educated mothers, and that fathers' education was also positively linked to mothers' education. There was an interesting twist with the religion variable, where Christianity religion had a positive sign, while the Islamic religion had a negative sign, implying a probability of the Christianity religion in support of girl or female or maternal education, while the Islamic religion not as much, or a possibility of an educational gap between Christian mothers and Muslim mothers. Also, there could be a possibility of poor utilization of health care because of the negative coefficient of the distance variable. Overall, the maternal education variable had a negative sign, implying an inverse relationship between maternal education and under-5 mortality, with a magnitude (coefficient) of 81.6%, an indication that 81.6% of children born to mothers with formal education are less likely to pass away under the age of five.

For the findings on the moderation analysis of different pathways, the socio-economic pathway variables moderated almost 50%. The other pathways did not have as much variation and effect on under-5 mortality as the socio-economic pathway did. The results gotten from the mediation test were similar to the results from the moderation test, with socio-economic pathway being a significant mediator having the proportion of the total effect mediated as 49.72% (almost 50%). Other pathways were not as significant as the socio-economic mediator.

Findings from essay three show that there was a clustering pattern of the under-5 mortality in Nigeria. Moran's I index was 0.4689, and the P-value was 0.01, an indication that there is less than 1% likelihood that this clustered pattern could be a result of random chance, but a strong spatial dependence across Nigeria because the spatial pattern is clustered. Therefore, the results showed existence of spatial autocorrelation. Findings from the association of possible cultural, maternal and environmental variables with under-5 mortality for the six states with the cluster of highest under-5 mortality in the country show the coefficients of the age of the mother, maternal education, partner's education, age at first birth, sanitation (flush toilet), piped water and post-natal checks as significant factors for Sokoto state. Zamfara state has the coefficients of maternal education, partner's education wealth index, age of the mother, age at first birth, antenatal visits, distance to the nearest health care facility and sanitation (flush toilet) as significant contributing variables; Katsina State has the coefficients of age of the mother, and age at first birth, as significant contributing variables. Jigawa state has the coefficients of mother's age, age at first birth and distance to the nearest health facility age of the mother, age at first birth as significant contributing variables, while Bauchi state has the coefficients of wealth index, age of the mother, and age at first birth as significant variables. Finally, Kebbi state has the coefficients of maternal education, partner's education, wealth index, age at first birth and antenatal visits as significant contributing variables.

5.3 Conclusions

Health disparities in child health care and mortality are still prevalent in Nigeria. Child malnutrition is a challenge in Nigeria, and the severity is seen as one move up the northern part of the country, because a notable rise in the fraction of stunted offspring was witnessed. The North West and North East zones had the highest rate of stunted children in the nation. The rate of stunting, wasting and underweight are found to be greater in male children compared to female children, which is consistent with many African and developing countries. The likelihood of children being underweight and stunted is greatly significantly influenced by their household's financial status. Meanwhile, it has been established in past research that the relationship seen between the socio-economic status of a household and stunting is inversed (meaning as the socio-economic status of a family improves or rises, stunting rate drops remarkably), hence socio-economic status has a significant impact on stunting, implying that an improvement in a

household's socio-economic status will likely bring about a reduction in the probability of stunted children.

A disparity in the areas of residence was observed, and it is to some extent attributable to rural-urban differential in income variations between areas of residence, whereby urban areas had less stunted children than rural areas. The concentration indices for the three malnutrition indicators were concentrated among the poor in both rural and urban areas of residence, even though the pro-rich indices are highest among rural dwellers. However, it should be noted that while stunting and underweight are higher with the poor in rural areas, the same goes for the poor in urban areas. This is likely due to the huge diverseness that can be seen among societal classes in the metropolitan areas due to the huge disparities in their socio-economic ranks. Therefore, the concentration indices for the three malnutrition measurements are concentrated among the poor both in rural and urban areas of residence. The observed disparities in children under age five, which favors the rich in the communities are unnecessary, unjust and avoidable.

Statistics from the findings show a high rate of infant, child and under-5 mortality in Nigeria. Across the six zones in Nigeria, the highest under-5 mortality rate is seen in the North-West and the North Eastern regions, while the lowest under-5 mortality rate can be found in the South-West. Also, across the states, the state of Zamfara had the highest under-5 mortality rate, while Edo state had the lowest rate.

In comparison between male and female children, mortality is higher among the male under-5 children. In comparison also, rural dwellers have higher under-5 mortality compared with the urban dwellers. This equally shows the effect of the socio-economic status disparity observed in the country, because there is a decreasing pattern of child mortality rate and under-5 mortality rate as the income of households increased.

On the analysis between maternal education and under-5 mortality, an inverse relationship was observed between them, because as maternal level of education increases, the probability of under-5 mortality reduces. The socio-economic pathway compared to other pathways is observed to be the most significant for both moderation and mediation of maternal education on under-5 mortality. An inverse relationship is also observed.

After the mapping of the under-5 mortality was done, a clustering pattern was observed. The red zones on the map which had the highest number of under-5 mortality were located in the northern part of Nigeria. The results of the clustering pattern observed revealed a positive spatial autocorrelation, which led to the checking of variables that could be contributing to the clustering pattern observed in the regions. From the results, we observed that the coefficients of the age of the mother, age at first birth and age at first cohabitation variables were relatively significant and consistent across the six states under examination. The significance of these

variables was an indication of the presence of the practice of child marriages in these states, which is an important contributing factor to the high under-5 mortality and clustering pattern observed in these states. Unfortunately, these states have not domesticated the law that prohibits this hideous practice, which is the Nigerian Child Rights Act (2003), thereby not making it enforceable. Instead, cultural and religious beliefs and practices in these states support child marriages; i.e. marriages of children less than 18 years of age.

Unfortunately, the negative effect of this practice cuts across the six states, because child marriages could lead to low level of education especially for the girl child observed in some of the states; there are health issues that come with children having children, which eventually could lead to complications, a high mortality rate of under-5 children and even their mothers. These states were also observed to have high poverty rates and were part of the poorest states in Nigeria. Poverty affects the living standards of people and dictates their life choices, such as places of residence, types of healthcare insurance, etc. These are some of the variables identified to be possible reasons for the clustering pattern observed and the causes of the high under-5 mortality rates in these regions.

5.4 Policy Implications

The findings from this thesis have several policy implications for reducing health disparities in Nigeria. First, breaking various indicators down by socio-economic rank is very important for producing useful information necessary for policy making, because relying on global averages alone can conceal information and could be misleading when used to formulate policies. Therefore, when indicators are broken down, and analyses are conducted on specific and smaller indicators, the results are more reliable for policy formation and targets.

Second, there is a need for targeting policies and other ways of combating utter poverty in urban areas, and not just focus on the rural areas alone because, while stunting and underweight were higher with the poor in rural areas, the same was the case with the poor in urban areas, which is because of the presence of considerable concentration of ailment among the metropolitan underprivileged.

Third, it is crucial to have targeted policies that will focus on this age group (children under five years of age) because, in the future, it has a considerable benefit. This is because systematic inequalities in long-standing under-5 malnutrition have far reaching consequences. Therefore, well-nourished children make better adults, who in turn make a strong and better nation.

Fourth, the Government could increase the income of the poorest in the society to improve their socio-economic status. Therefore, implementation of revenue-generating schemes and direct allocations of income to the underprivileged to curb disparities in the health of children among

regions in the country could be aggressively pursued to break the cycle of disparities in socio-economic status in the future.

Fifth, since an inverse relationship was observed between maternal education and under-5 mortality, the Government and other policy makers could focus and invest in maternal education by giving free or subsidized education, scholarships, grants to women and the girl child, reduction of entry score for women to gain admission into higher institutions to increase enrollments, improve the usage of medical services, and, while investments could be made on health education and facilities that help create awareness and take care of women health issues. Therefore, investment in girls' schooling should be targeted.

Sixth, the socio-economic pathway compared to other pathways is the most significant for both moderation and mediation of mother's education on under-5 mortality. This implies that the Government and other policy makers could invest in factors that can improve socio-economic status, because it influences mothers' education, child health knowledge, attitudes and behavior towards health, and these in turn influence the health outcomes of children under-5 years of age and consequently reducing their mortality.

Seventh, the Government and other relevant organizations could have policies targeted towards the variables contributing to high under-5 mortality in the six northern states examined above. Child marriage practice was found to be a key contributor to high under-5 mortality, which cuts across all the six states affected. Therefore, laws on child marriage need to be reviewed, and Nigeria as a country needs to set a nationally enforceable minimum age for marriage, while investments in targeted policies, interventions, initiatives, and programmes that will alleviate poverty, minimize gender inequality, social exclusion, marginalization and insecurity should be increased.

The Government and other relevant organizations could also have policies targeted towards these six states with the highest under-5 mortality by investing in health education by increasing levels of health knowledge among women; targeted information campaigns through the media (television, radio and newspapers) on complete immunization of mothers and children; and balanced nutrition and enlightenment of the use of modern medicine and facilities. This will help create awareness and improve knowledge on child-bearing issues and challenges that come with it.

5.5 Areas for Further Research

While this research contributed to the analysis of child health disparities in Nigeria, further studies could provide a broader study of the under-5 mortality hot spots and their associated and contributing factors with a more rigorous spatial analysis, which this study could not explore due to limited data and software packages.

Also, only a few variables were used to analyze the moderation and mediation pathways due to limited data; further studies could analyze more variables under each pathway to see if there will be changes in their outcomes.

Even with the vital contributions this research made in health disparities of children, there is still a need for broader and further study on the topic to reduce to the barest minimum the health challenges and mortality found especially among children and mothers in Nigeria.

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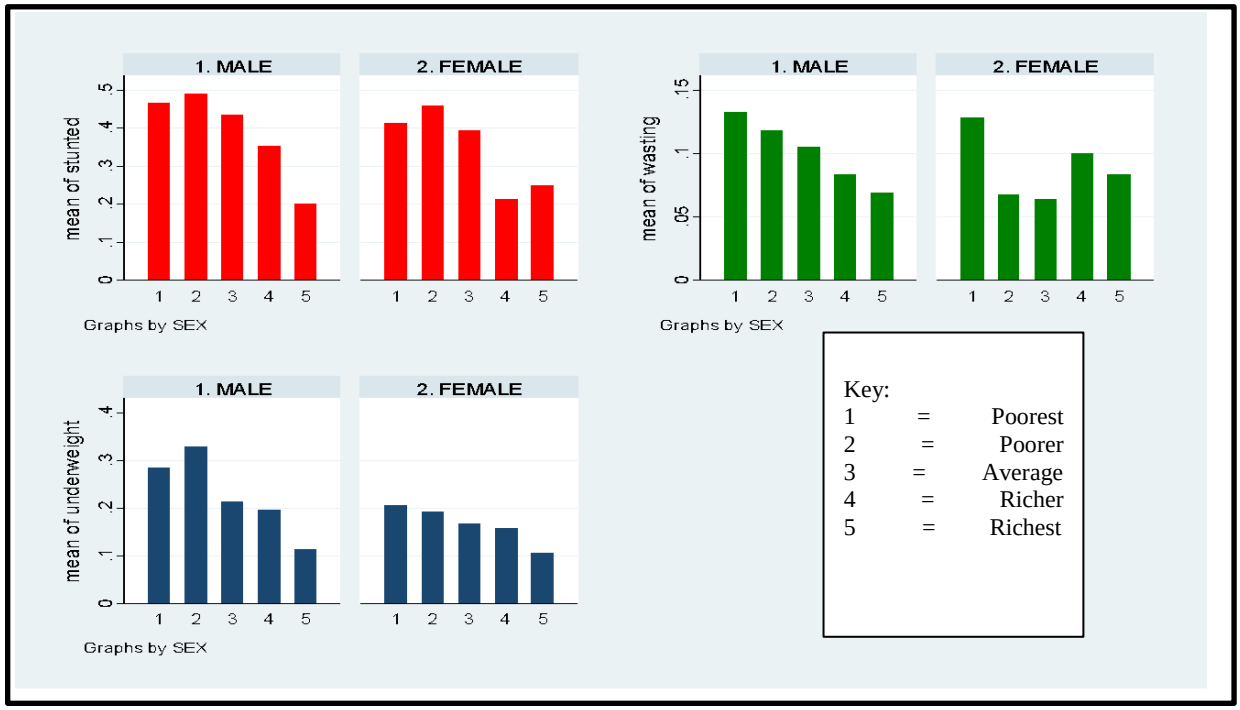
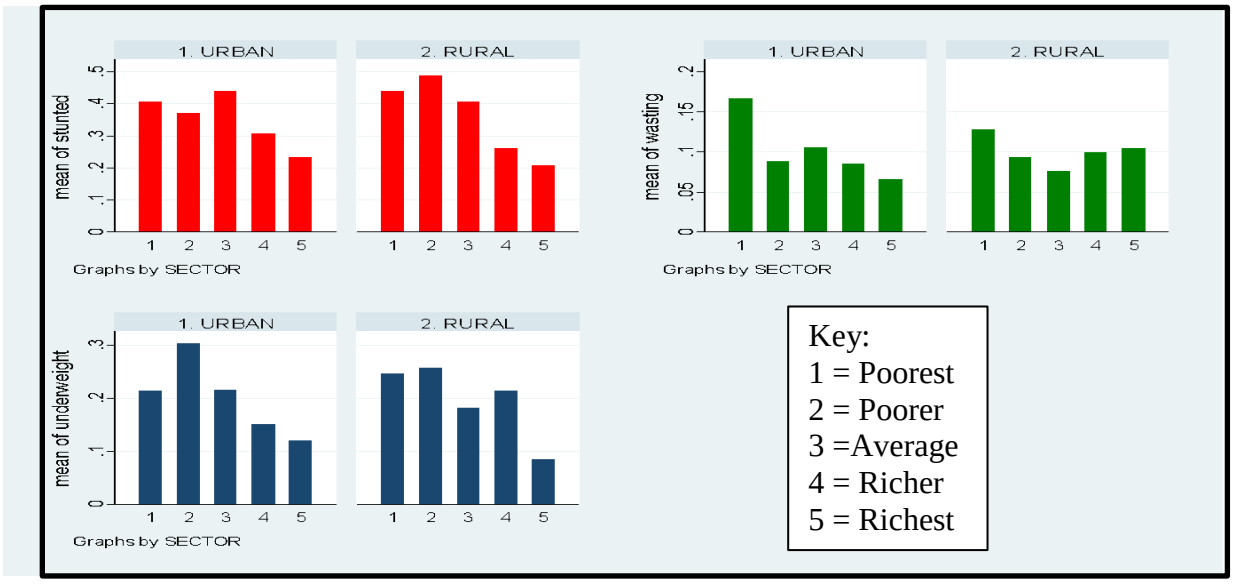
APPENDIX

Figure A1: Malnutrition analysis by gender



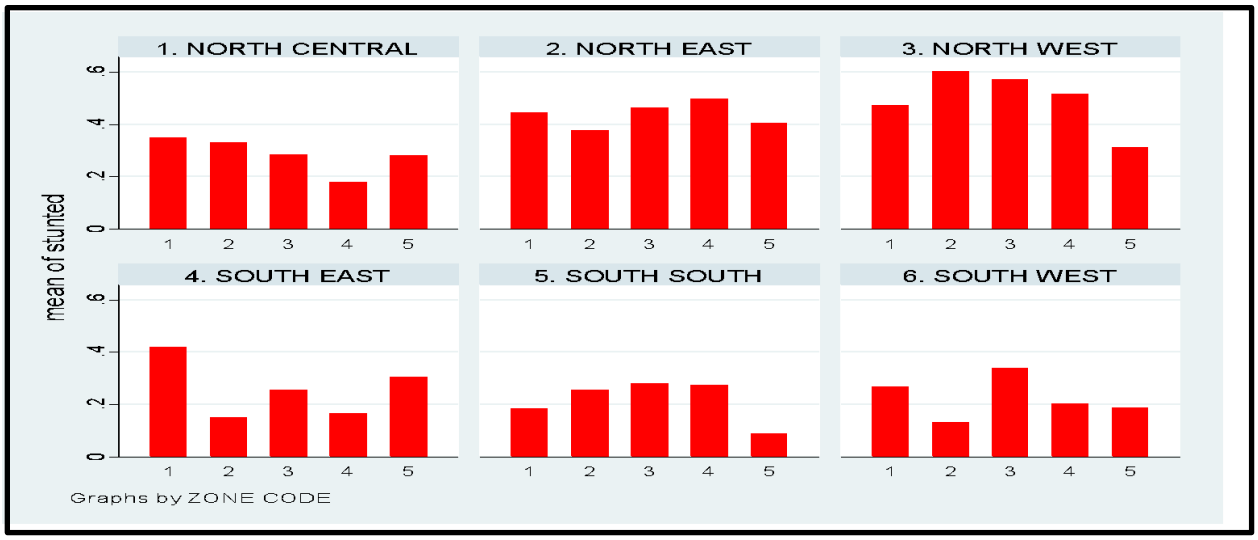
Source: Author's analysis

Figure A2: Malnutrition analysis by place of residence



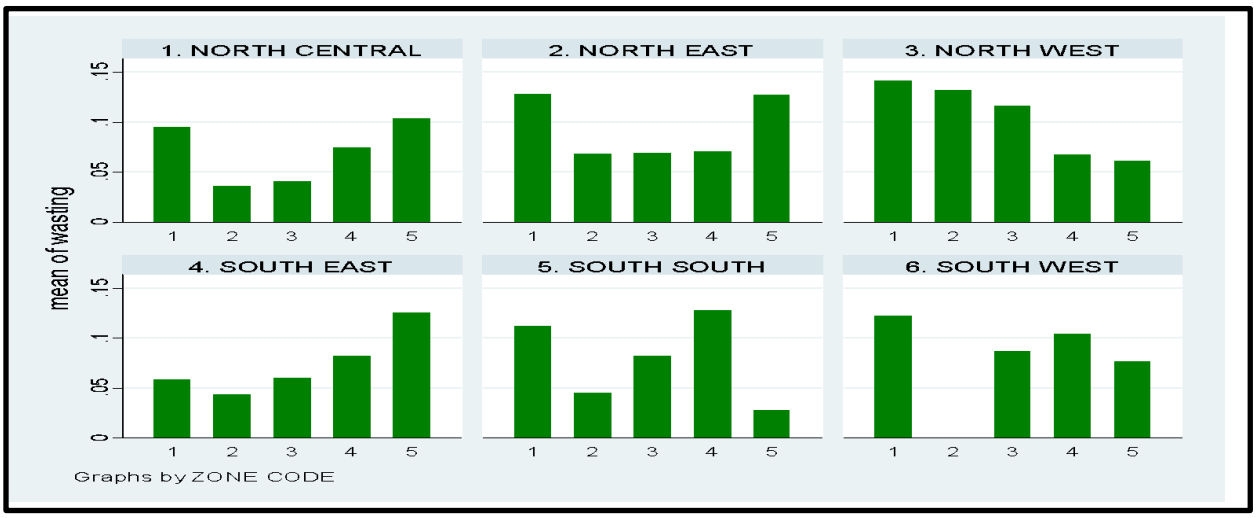
Source: Author's analysis

Figure A3.1: Stunting across the six geopolitical zones in Nigeria



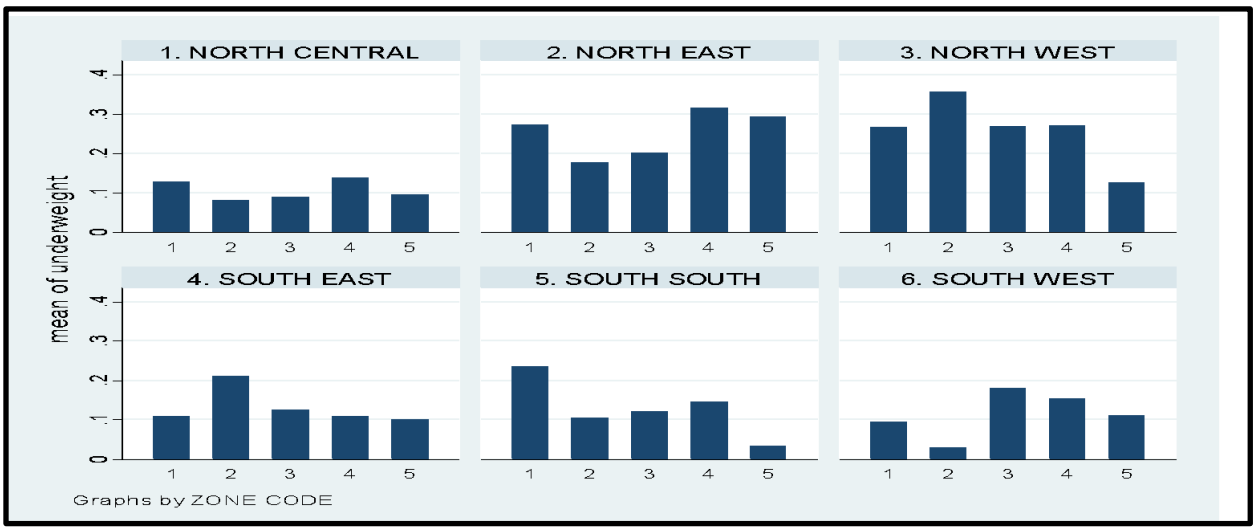
Source: Author's analysis

Figure A3.2: Wasting across the six geopolitical zones in Nigeria



Source: Author's analysis

Figure A3.3: Underweight across the six geopolitical zones in Nigeria



Source: Author's analysis

Key for Figures 3A, 3B and 3C:

1 = Poorest; 2 = Poorer; 3 = Average; 4 = Richer; 5 = Richest

Table A1: Estimates of under-5 mortality rates across states in Nigeria

Nigerian States				
States	**Variables**	**Coefficient**	**95% CI**	**U5M per 1000 Live Births**
Sokoto	**U5MR**	**0.185**	**[0.153, 0.217]**	**185**
Zamfara	**U5MR**	**0.221**	**[0.198, 0.244]**	**221**
Katsina	**U5MR**	**0.183**	**[0.149, 0.217]**	**183**
Jigawa	**U5MR**	**0.200**	**[0.173, 0.228]**	**200**
Yobe	U5MR	0.134	[0.108, 0.160]	134
Borno	U5MR	0.066	[0.036, 0.096]	66
Adamawa	U5MR	0.136	[0.107, 0.165]	136
Gombe	U5MR	0.158	[0.124, 0.191]	158
Bauchi	**U5MR**	**0.210**	**[0.174, 0.247]**	**210**

Kano	U5MR	0.140	[0.118, 0.162]	140
Kaduna	U5MR	0.065	[0.046, 0.085]	65
Kebbi	**U5MR**	**0.183**	**[0.146, 0.221]**	**183**
Niger	U5MR	0.078	[0.055, 0.101]	78
FCT-Abuja	U5MR	0.080	[0.055, 0.105]	80
Nasarawa	U5MR	0.107	[0.081, 0.134]	107
Plateau	U5MR	0.097	[0.080, 0.114]	97
Taraba	U5MR	0.137	[0.110, 0.164]	137
Benue	U5MR	0.111	[0.095, 0.127]	111
Kogi	U5MR	0.070	[0.043, 0.097]	70
Kwara	U5MR	0.079	[0.054, 0.103]	79
Oyo	U5MR	0.079	[0.045, 0.113]	79
Osun	**U5MR**	**0.058**	**[0.027, 0.089]**	**58**
Ekiti	U5MR	0.072	[0.045, 0.098]	72
Ondo	U5MR	0.109	[0.078, 0.141]	109
Edo	**U5MR**	**0.056**	**[0.033, 0.078]**	**56**
Anambra	U5MR	0.091	[0.057, 0.125]	91
Enugu	U5MR	0.105	[0.076, 0.134]	105
Ebonyi	U5MR	0.161	[0.121, 0.201]	161
Cross River	U5MR	0.080	[0.055, 0.104]	80
Akwa Ibom	U5MR	0.082	[0.059, 0.104]	82
Abia	U5MR	0.117	[0.086, 0.148]	117
Imo	U5MR	0.120	[0.083, 0.158]	120
Rivers	U5MR	0.089	[0.070, 0.110]	89
Bayelsa	U5MR	0.086	[0.057, 0.115]	86
Delta	U5MR	0.089	[0.055, 0.123]	89

Lagos	U5MR	0.081	[0.051, 0.110]	81
Ogun	U5MR	0.076	[0.047, 0.105]	76
	Average for all states			4191/37 = 113.27

Notes: In this table we focus only on under-5 mortality rate. Sampling weights and clustering are used to account for sampling design of the survey. We are using five years preceding the survey.