# Examining the determinants of under-five mortality in Nigeria, Sierra Leone, and Guinea: a comparative study

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## ABSTRACT

**Background**: West Africa is one of the regions that still battles with a high rate of Under-five mortality, which exceeds the global target. Global under-five mortality has declined to 37 deaths per 1,000 live births; however, countries such as Sierra Leone, Nigeria, and Guinea reported the highest levels, ranging from 111 to 96 deaths per 1,000 live births. Hence, the need to examine factors associated with under-five mortality in Nigeria, Sierra Leone, and Guinea

**Methods**: The study used secondary data extracted from the 2018 Nigeria Demographic and Health Survey , 2019 Sierra Leone Demographic and Health Survey, and 2018 Guinea Demographic and Health Surbey. The study population consisted of women aged 15–49 who had given birth within the five years preceding each survey and were distributed as follows: 29,949 in Nigeria, 11,457 in Sierra Leone, and 7,689 in Guinea. Brass children ever born and children surviving method was used to estimate under-five mortality rate. The Chi-square test and logistic regression modelling were employed to explore the relationship between social and demographic factors and under-five mortality in the three countries.

**Results**: The study estimated that Nigeria recorded 146 deaths per 1,000 live births, followed by 140 in Sierra Leone and 118 in Guinea.

The results of logistic regression indicate that for Sierra Leone maternal age, sex of child, preceding birth interval and maternal education were significantly related to under-five mortality. For Nigeria, logistic regression indicates that sex of child, preceding birth interval, wealth index combined, place of delivery, and source of drinking water were significantly related to under five mortality. For Guinea, logistic regression shows that preceding birth interval, breastfeeding, education, wealth index combined were significantly related to child mortality.

The results further show a strong statistical relationship between under-five mortality, preceding birth intervals, and maternal education. Children who are born after longer birth intervals and those whose mothers had higher education levels were less likely to die before age five. However, the maternal education was stronger in Nigeria than in Sierra Leone and Guinea.

**Conclusion and recommendations**:

To accelerate progress towards SDG 3.2 on child survival, this analysis recommends a multi-pronged approach. Key priorities include strengthening health systems to ensure equitable, quality care for all mothers, regardless of education or wealth, through investment in facilities, staff, and regulation. This must be coupled with targeted community-based support, including family planning services to promote

healthy birth intervals and focused care for vulnerable populations such as young, old, poor and uneducated women. Furthermore, future interventions must address underlying socioeconomic conditions by improving access to clean water, tackling urban slum conditions, and strengthening social safety nets to protect the most vulnerable families from poverty.

**Keywords:** Under-Five Mortality, Child Survival, DHS, West Africa, Sustainable Development Goals.

## DECLARATION:

I, Given Andrey Mhlanga (38613670), declare that this work titled "Examining the determinants of under-five mortality in Nigeria, Sierra Leone, and Guinea: a comparative study" is my original research work, and has never been submitted for any degree or examination in any other University or Institution. I declare that the information contained in this document is a true copy of my thesis and has been approved for submission by my thesis supervisor. This work was supervised by Dr Boitshwarelo Ngake and Co-supervised by Prof. Martin Palamuleni from the Department of Population Studies and Demography. This work is submitted in partial fulfilment of the requirements for the degree Master of Social Science in Population and Sustainable Development at the North-West University, Mafikeng Campus, South Africa.

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**TABLE OF CONTENT**

**ABSTRACT** ..... **ii**

**DECLARATION:** ..... **iii**

**ACKNOWLEDGEMENTS** ..... **iv**

**TABLE OF CONTENT** ..... **v**

**LIST OF FIGURES** ..... **vi**

**LIST OF TABLES** ..... **vii**

**LIST OF ABBREVIATIONS** ..... **viii**

**CHAPTER ONE: INTRODUCTION** ..... **1**

1.1 Background ..... 1

1.2 Statement of the problem ..... 3

1.3.1 Main objective ..... 5

1.3.2 Specific objectives of the study ..... 5

1.4 Research questions ..... 4

1.5 Significance of the study ..... 5

1.6 Organization of the study ..... 5

**CHAPTER TWO: LITERATURE REVIEW** ..... **7**

2.1 Introduction ..... 7

2.2 Overview of Under-five mortality in Africa ..... 7

2.3. Factors influencing under five mortality ..... 8

2.4 Theoretical framework ..... 13

2.5 Conceptual framework ..... 15

**CHAPTER THREE: METHODOLOGY** ..... **18**

3.1. INTRODUCTION ..... 18

3.1.1 Study location ..... 18

3.2 Data source ..... 19

3.3 Research design ..... 20

3.4 Study sample ..... 20

3.5 Inclusion and exclusion criteria ..... 21

3.6 Study variable ..... 21

3.6.1 Dependent variable ..... 21

3.6.2 Independent variables ........ 21
3.7 Method of analysis ........ 23
3.8 Limitation of the study ........ 30
3.9 Ethical considerations ........ 30
**CHAPTER FOUR: DATA ANALYSIS AND INTERPRETATION OF RESULTS ........ 31**
4.1 Introduction ........ 31
4.2 Estimates of under-five Mortality ........ 31
4.3. Statistical findings ........ 39
4.3.1 Characteristics of the study population ........ 39
4.4. Relationship between under five mortality and background variables ........ 42
4.5. Factors determining under five mortality ........ 47
4.6 Comparative analysis ........ 52
**CHAPTER FIVE: DISCUSSIONS, CONCLUSIONS AND RECOMMENDATIONS OF THE STUDY ........ 53**
5.1 Introduction ........ 53
5.2. Summary of findings ........ 53
5.2. Discussions ........ 54
5.3 Conclusion ........ 59
5.4. Recommendations ........ 59
**REFERENCES ........ 60**
**APPENDIX ........ 70**

## LIST OF FIGURES

Figure 2.2.1 Trends in under-five mortality ........................................ 8

Figure 2.4.1 Theoretical framework by Mosley and Chen ........................................ 15

Figure 3.1.1 Geographical location of the three selected countries ........................................ 19

Figure A.1 Ethics approval letter ........................................ 70

## LIST OF TABLES

Table 3.5.1 Derivation of sample size ........................................ 21

Table 4.2.1 Estimating of under-five mortality using Brass method: Nigeria ........................................ 33

Table 4.2.3 Estimating of under-five mortality using Brass method: Guinea ........................................ 37

Table 4.2.4 Estimates of under-five mortality rate by selected variables for Nigeria, Sierra Leone and Guinea ........................................ 38

Table 4.4.5 Bivariate findings for the factors associated with under-five mortality in Guinea. ............. 46

## LIST OF ABBREVIATIONS

| | |
|---|---|
| **AIDS** | - acquired immunodeficiency syndrome |
| **BaSSREC** | - Basic and Social Science Research Ethics Committee |
| **DHS** | - Demographic and Health Survey |
| **EAs** | - Enumeration Areas |
| **GDHS** | - Guinea Demographic and Health Survey |
| **HIV** | - Human Immunodeficiency Virus |
| **Icf** | - Inner City Fund |
| **LMICs,** | - Low- and Middle-Income Countries |
| **NDHS** | - Nigeria Demographic and Health Survey |
| **NPC** | - National Population Commission |
| **NWU** | - Northwest University |
| **U5MR** | - Under five mortality rates |
| **Unicef** | - United Nations International Children's Emergency Fund |
| **SDG** | - Sustainable Development Goals |
| **SDHS** | -Sierra Leone Demographic and health survey |
| **WHO** | - World Health Organization |

# CHAPTER 1: INTRODUCTION

## 1.1 Background

Under-five mortality remains a major public health problem in different countries, especially the developing ones (Gleave, 2023). Under-five mortality rate refers to the probability that a new born will die before reaching exactly 5 years of age, expressed per 1,000 live births (Gleave, 2023). Under-five mortality is widely regarded as one of the key indicators of child health and overall national development, as it reflects the social, economic, and environmental conditions in which children are born and raised, including access to healthcare (Birhanie et al., 2025). Reducing under-five mortality has been mostly publicly targeted by health policies worldwide (Madewell et al., 2022). This is evident with its inclusion in both millennium development goals and the sustainable development goals. The millennium development goal 4 aimed to reduce under-five mortality by two-thirds from 1990 to 2015 (You, 2015). Whereas the sustainable development goal 3, aimed to ensure healthy lives and promote well-being for all at all ages, includes the reduction of the mortality rate of children under 5 years old (with a special target of 3.2 for reducing under 5 mortality to at least 25 deaths per 1000 live births)(UNICEF ET AL., 2024).

Survival gains have stagnated significantly since 2015, and 59 nations made a fall short of meeting the SDG target for under-5 mortality and only eight (Libya, Tunisia, Egypt, Morocco, Algeria, Seychelles, Mauritius, and Cabo Verde) out of 54 African countries had achieved the SDG 3.2 target (Adedini et al., 2024). Unless quick action is taken to improve health services and quality of care for new-borns and children under-5, many young lives will be unnecessarily wasted (Muhe, 2021). Globally, most under five deaths are as a result of diseases that are preventable or treatable with proven, cost-effective and quality-enhanced interventions (Petrou, 2019). Infectious diseases and neonatal complications are responsible for the vast majority of under-five deaths globally (Mekonnen et al., 2024). Both infant and under five child mortalities are mostly surveyed indicators as a result of them reflecting the access to children and communities' basic health intervention, including vaccination and adequate nutrition (Dlamini., 2024). Despite global interventions and efforts to reduce under-five mortality, developing countries have shown slow progress and continue to report the highest under-five mortality rates (Gleave, 2023).

In 2022, 13,400 under-five deaths occurred daily, resulting in an annual total of 4.9 million fatalities (UNICEF ET AL., 2024). Along with premature birth and difficulties interlinked to the postpartum period, infectious disorders such as pneumonia, diarrhoea, and malaria continue to be the primary causes of death for children under five worldwide (UNICEF ET AL., 2024). Between 1990 and 2022, the global under-five mortality rate decreased by 60%, from 93 deaths per 1,000 live births to 37 deaths in 2022 (Organization, 2023). Even with these significant advancements, there is still a pressing need to improve child survival (Requejo, 2015).

Since 1990, there has been significant progress in lowering under five mortality worldwide, with the number of under-5 deaths falling from 12.8 million in 1990 to 4.9 million in 2022. However, the decline in under five mortality has been slower than that of post-neonatal under-5 mortality, with about 6 300 new-born deaths per day, or nearly 47 % of all child deaths under the age of five (UNICEF ET AL., 2024). In 2010, records revealed about 1.731 billion episodes of diarrhoea in child younger than 5, worldwide (Bhutta, 2015). Viewing this issue in an African context we clearly see evidence that the leading cause of under-five mortality includes preventable diseases, but as a result of insufficient of measures and resources these diseases cannot be prevented, and they include: diarrhoea, pneumonia, malaria, and HIV, compounded by recurrent infections, malnutrition, and socio-economic factors like poverty, inadequate healthcare, and low maternal education (Avelino et al., 2025).

While still in the case of global overview of under-five mortality, there are regions influencing such an increase of under-five mortality globally (Liu, 2016). Under-five mortality rates exhibit significant regional disparities, reflecting variations in healthcare access, socioeconomic conditions, nutrition, and public health infrastructure across different geographical areas (Faruk et al., 2025). Under-five mortality is a major public health problem, reports from the world health organization reveals that the risk of a child dying before completing 5 years of age is still highest in the African regions, accounting for (76 per 1000 live births), around 8 times higher than that in the European regions (9 per 1000 live births) (WHO., 2018). There are significant regional differences in death rates (Avelino et al., 2025).With a U5MR of 98·7 fatalities per 1000 livebirths, West Africa continues to record the highest U5MR in the world (Ouedraogo, 2022). This is about 15 times higher than the average U5MR in high-income nations (6·8 deaths per 1000 livebirths) (Ouedraogo, 2022). West Africa alone accounted for 1·8 million deaths (1·6 million–2·1 million; 30% of all deaths worldwide), which is also a significant portion of the world's under-5 mortality rate. South Asia accounted for 1·9 million (1·7 million–2·1 million; 31%) of the deaths, while eastern and southern Africa accounted for 1·1 million (1·0 million–1·3 million; 18%) (Vakili, 2015).

Children in sub-Saharan Africa (Particular in West Africa region) have a significantly higher chance of dying before turning five: This indicates that children in these nations of the West Africa region are having limited access to basic health interventions and this includes vaccines, primary medical treatment, adequate nutrition, and clean water and sanitation, as well as being plagued by low levels of education (Ekholuenetale, 2020). From the regional rate of under-five mortality, three countries topped the list (United Nations Inter-agency Group for Child Mortality Estimation, 2023). These countries are Sierra Leone with a mortality rate of 111 per 1000 livebirths, Nigeria with 100 per 1000 livebirths and Guinea with 95,96 deaths per 1000 livebirths (United Nations Inter-agency Group for Child Mortality Estimation, 2023). The sub-Saharan region is followed by the South Asia with the highest under-five mortality estimated at 1.4 million under-five deaths, both of these regions accounted for more than 80% of the global under-five death in 2019 (Ekholuenetale, 2020). A previous study revealed that a vast number of these deaths in these regions are attributable to poor health care and lack of prevention, constituting the leading causes of death among children under age five (Van Malderen et al., 2019). This study also concluded that there are differentials in survival between boys and girls, these differentials exist at least up until the age of 5 years (Van Malderen et al., 2019). These two regions are facing such an increase of under-five deaths due to the growing child population and changes in the population distribution (Ekholuenetale, 2020).

Numerous studies, revealed that under-five mortality is highest in less-developed/ developing countries with denied access to developed healthcare, lack of vaccines, not enough food, poor sanitation. Children under-five die as a result of insufficient efforts or reduction of the spread of communicable and infectious illnesses (Boutayeb., 2023; Dhage & Nagtode, 2024; Margaret E. Kruk et al., 2018; Niohuru, 2023). Whereas the developed countries with developed economies, advanced medical technologies, enough diet and adequate public sanitation, experience under-five mortality rates that are very low (Boutayeb., 2023). Perinatal asphyxia and serious infections such sepsis, meningitis, and pneumonia were the two leading causes of infant mortality in Lower-Middle Income Countries (Popescu, 2020). Infections account for about 23% of the 2.5 million newborn deaths that occur each year (Popescu, 2020). About one-fifth of neonatal mortality in these nations are caused by problems related to preterm (UNICEF ET AL., 2024). After new-born disorders, respiratory infections are the largest cause of death for children under five in LMICs, despite improvements in living conditions and rising immunization rates (Sarfo et al., 2023). Every year, an estimated 100 million cases of pneumonia in children under the age of five are reported (World Health Organization, 2024). Pneumococcal conjugate and Haemophilus influenza have increased (World Health Organization, 2024). More than half of the approximately 635,000 malaria-related deaths that took place in LMICs in 2019 were in children under the age of five (Gleave, 2023). Additionally, malaria during pregnancy causes low birth weight, fatal growth retardation, and subsequent malaria infection in the baby, all of which raise neonatal mortality (Minwuyelet et al., 2025).

## 1.2 Statement of the problem

Under-five mortality, particularly in West African countries like Sierra Leone (111 deaths per thousand live births), Nigeria (100 deaths per thousand live births), and Guinea (95,96 deaths per thousand live births) remains largely high compared to the global average (37 deaths per thousand live births) and a developmental issue which demands governments to continue with proven interventions to help achieve the goal of drastically reducing childhood mortality (United Nations Inter-agency Group for Child Mortality Estimation, 2023). One-third of deaths in these three west African nations are due to premature birth, birth asphyxia and trauma, acute respiratory infection, sepsis (Ahmed et al., 2024; Gleave, 2023; Karlsen et al., 2017). These nations (Nigeria, Sierra Leone and Guinea) are also experiencing children between 1 and 59 months being affected by malaria, diarrhoea, acute respiratory infection (Gleave, 2023; Tizifa et al., 2021). Under nutrition is the cause of nearly half of all under five deaths (Madewell et al., 2022). According to UNICEF, in 2021 over 1.9 million children in these countries (Nigeria, Sierra Leone, and Guinea) died before reaching five, making up nearly 40% of all deaths worldwide (United Nations

Inter-agency Group for Child Mortality Estimation, 2023). Based on the highest continuation of statistics on the issue of under-five mortality in Nigeria, Sierra Leone, and Guinea, the study will explore and reveal factors associated with under five mortality and the researcher is arguing for increased interventions from different health organizations and policymakers which will alleviate this developmental issue.

While numerous studies have investigated the determinants of under-five mortality in various contexts, there is a lack of research examining the specific factors contributing to high under-five mortality rates in Nigeria, Sierra Leone, and Guinea. Existing studies have often focused on individual countries or regions, without considering the shared socio-economic, cultural, and health system factors that may be driving under-five mortality in these neighbouring West African countries (Gayawan et al., 2016; Gleave, 2023; Meara et al., 2015; Rademeyer, 2019).

Previous research, mostly focusing in rural and hard-to-reach areas, made it evident that factors associated with under-five mortality, include having insufficient access to health care services, and (Gleave, 2023; Rajapakse et al., 2025; Yaya et al., 2019). ). With this, the importance of these factors and how they are interconnected in the context of Nigeria, Sierra Leone, and Guinea remains poorly understood. Thus, this study mainly aims to add to the understanding provided by existing literature by examining the determinants of under-five mortality, highlighting the similarities and differences between Nigeria, Sierra Leone, and Guinea, providing recommendations for evidence-based decision-making and resource allocation which might be used to reduce under-five mortality and improve child health outcomes in these countries.

## 1.3 Research questions

The study answers the following research questions:

### 1.3.1 Main research question

- What are the factors associated with under-five mortality in Nigeria, Sierra Leone, and Guinea?

### 1.3.2 Specific research questions

- What is the prevalence of under-five mortality in Nigeria, Sierra Leone, and Guinea?
- What is under-five mortality rate by selected socio-demographic factors for Nigeria, Sierra Leone and Guinea?
- What are the socio-demographic factors associated with under-five mortality in Nigeria, Sierra Leone, and Guinea?

### 1.4 Study objectives

#### 1.4.1 Main objective

The main objective of the study is to examine factors associated with under-five mortality in Nigeria, Sierra Leone, and Guinea.

#### 1.4.2 Specific objectives of the study

The study addresses the following specific objectives:

- To assess the prevalence of under-five mortality in Nigeria, Sierra Leone, and Guinea.
- To estimate the under-five mortality rate by selected socio-demographic factors for Nigeria, Sierra Leone and Guinea.
- To investigate socio-demographic factors associated with under-five mortality in Nigeria, Sierra Leone, and Guinea.

## 1.5 Significance of the study

The importance of this study lies in its contributions towards the understanding and broad knowledge of factors associated with under-five mortality in Nigeria, Sierra Leone, and Guinea through the use of Nigerian, Sierra Leonean and Guinean demographic and health surveys. More explicitly, this is to be done by examining the maternal, socio-economic, individual-level and household level determinants contributing to under-five mortality. The findings of this study will contribute to understanding progress toward SDG 3.2 (reducing under-five mortality to at least 25 deaths per 1,000 live births) and Africa's Agenda 2063 targets on child health, while also examining the influence of socioeconomic factors in lowering under-five mortality rates. Outcomes from this study will reflect information that will be valuable for demographic assessment and evaluation of health policies and programmes that aimed to reduce child mortality.

## 1.6 Organization of the study

The mini dissertation has five chapters. Chapter one provides the introduction, which is broadly on background information, which is then followed and linked with the problem statement and the objectives. Chapter one also gives broad information on the significance of the study. Then chapter two provides literature review which focuses on examining the factors associated with under-five mortality in Nigeria, Sierra Leone, and Guinea, as well as the theoretical and conceptual frameworks. Moreover, chapter three is a chapter which focuses on the methodology and study limitations. This is followed by chapter four which presents the broad findings which came to the attention as the study was conducted. Lastly. Chapter five deals with the representation of outcomes and results obtained during the conduction of this study. This chapter also presents brief conclusions.

# CHAPTER TWO: LITERATURE REVIEW

## 2.1 Introduction

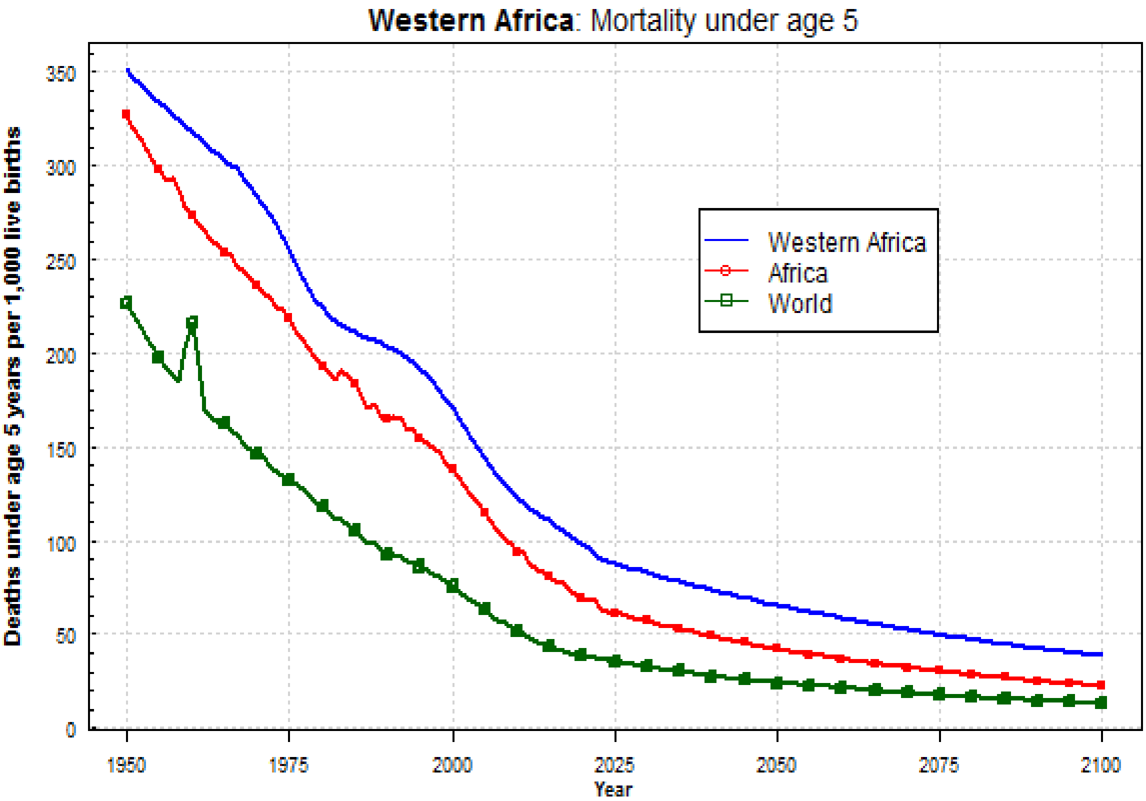
This chapter presents and reviews the literature on under five mortality focusing on Africa. The factors associated with under five mortality are also discussed. In addition, the chapter also presents the theoretical framework that is used in the study.

## 2.2 Overview of Under-five mortality in Africa

Figure 2.2.1. shows the number of deaths of children under five years per 1,000 live births for the World, the African continent, and the Western African sub-region from 1950 to the present, with projections to 2100. The figure shows a decline from 1950-2024, and the three lines show a significant and steady decline over the past 70+ years. For the world, under five mortality showed a decline dramatically from over 200 to well below 50 deaths per 1000 live births. In terms of Africa, it shows that the start was higher around 300 and has fallen sharply, but remains above the world average. Then there is West Africa, which started at an extremely high level around 350-400 deaths per 1,000 live births and has seen a substantial decline. However, it has consistently been the highest of the three groups and remains significantly above the African average today. The most critical observation from this chart is the wide and persistent gap between Western Africa and the rest of the world. While all regions are showing progress, Western Africa is left behind, indicating that the factors influencing under five mortality are more entrenched and harder to address. The figure 2.2.1. continue to show that the decline will continue throughout the 21st century, but Western Africa is not expected to meet with the global average for many decades.

The high but declining rates in Western Africa are the result of a various mix of factors, including infectious diseases. As it is mostly known that children in the West Africa are exposed to pneumonia, diarrhea, malaria, malnutrition, low birth weight and preterm birth, birth complications and weak health systems.

**Figure 2.2.1 Trends in under five mortality**




Source: *Own computation based on the United Nations data on under five mortality*

## 2.3. Factors influencing under five mortality

Under five mortality is influenced by so many factors including socio-economic, maternal, individual level, household level and community factors.

**Mothers age**

The relationship between maternal age and birth outcomes with under five mortality is becoming more widely acknowledged (Wu, 2021). Considering how crucial birth and growth outcomes are to children's survival, development, and well-being (Wu, 2021). Pregnancies at the extremes, between the ages of less than 17 years and greater than 40 years, are more likely to result in unfavorable birth outcomes than pregnancies in other age groups, according to previous studies (Wu, 2021). Especially in poorer nations, a significant percentage of young women still give birth when still in their teens(Wu, 2021). 15% of girls between the ages of 15 and 19 worldwide give birth before turning 18 (Wu, 2021). Babies born to young mothers (adolescent mothers aged 13-19 years) have a greater risk of very-pre-term and pre-term delivery, low birthweight, small for gestational age and neonatal mortality (Gobebo, 2021). Low birthweight and poor growth have implications on long-term health and are most likely to result or contribute to this high rate of under-five mortality and they are sabotaging the success of improvements made to alleviate the increase of maternal mortality (Gebreegziabher, 2023; Gobebo, 2021). They are experiencing such as a result of them facing higher risks of eclampsia, puerperal endometritis and systemic infections (Gebreegziabher, 2023). Being of low birthweight has been linked with subnormal growth, illnesses and neurodevelopmental delays which in some cases can still be apparent during adolescence and later life (Gebreegziabher, 2023). Other studies also revealed that both young and advanced maternal age have been associated with higher risk of neonatal mortality (Amir-ud-Din, 2022; Gebreegziabher, 2023).

**Sex of child**

Sex of a child is also crucial as it interlinked with under-five mortality, with its provision of gender differences of children dying in between ages of 5 years. In terms of under-five mortality, the gender gap has tended to close over time. Boys under the age of five are generally at a higher risk of dying than females (Janaína, 2017). However, in nations found in West and South Asia, the death rate for girls is significantly greater than anticipated due to regional vulnerabilities (Janaína, 2017). As a results of their greater biological frailty, males have higher mortality rates in situations when there is no discrimination in healthcare and where they have equal access to resources and care (Janaína, 2017). It has long been known that boys are frailer than girls, and that despite their higher birth weights, new born boys tend to be less mature than new born girls, present higher perinatal mortality, and have more frequent congenital malformation (Chao, 2023). Male hormones may contribute to poor lung maturation, which makes male infants more susceptible to respiratory distress; intestinal infection mortality is also typically higher for male children; and X-linked immunoregulatory genes increase females' resistance to infectious diseases (Anita, 2020). Therefore, equal mortality rates for boys and girls suggest gender bias, as lower mortality rates among girls would be expected (Anita, 2020).

**Mothers' education**

Mother's education is also associated with under-five mortality. The educational level of a mother influences under-five mortality, and here there are differentials in terms of under-five mortality in developing and developed nations (rural-urban differences) (Boutayeb., 2023). This means that rural women are exposed to lower levels of education due to the insufficient knowledge and infrastructure or resources provided to them and the mother's education is negatively associated with under five mortality (Boutayeb., 2023). This tends to increase unhealthy decisions taken in regards to children's lives, and increases child death (Boutayeb., 2023). Previous studies, have proven that educational levels of mothers tend to improve the health of children (Boutayeb., 2023). This results in enhancements of income and wealth, empowering women, changing attitudes, and improving their knowledge about health care (Boutayeb., 2023). This has been proven by previous studies which revealed differentials from Uganda and Malawi, whereby their educational level significantly increased the use of modern contraception, resulting in lower levels in under five mortality in both countries (Moradhvaj, 2023). This is also confirmed by a study done in Bangladesh whereby, women educational level and maternal education reduced under-five mortality through increasing wealth, lower fertility, increasing age at marriage and childbearing age, enhanced health knowledge, and better health-seeking (Hanbo, 2022). Education minimizes child health risk by improving economic status (Hanbo, 2022). More educated women are more likely to use effective healthcare facilities to treat and prevent their children's illnesses and prevalent diseases that are fatal among under-five children (Hanbo, 2022).

**Place of residence**

Another variable which relates with under five mortality is the place of residence, this variable is associated with the locational or environmental differentials determining accessibility and affecting children under five years. According to Malderen et al. (2019), place of residence has an impact on the survival and nutritional status of a living child, especially in developing countries. This is evident from the high experience of under-five mortality in non-urban areas compared to urban areas (Van, 2019). There are such experience and differentials as a result of having urban areas with better infrastructure for health services than in non-urban areas (Van, 2019). Having high under five mortalities in rural areas can be as a results of family poverty, and consequently the inaccessibility of paediatric health care service (Van, 2019). Rural children, are mostly exposed to poor access to healthcare services utilization: with this they are not undergoing early detection of abnormalities (Van, 2019). Furthermore, children in rural areas are exposed to the poor provision of basic needs, such as safe source of drinking water (Ekholuenetale, 2020). The distance from the nearest health facility, resulting in low use of institutional health facilities in rural areas (Ekholuenetale, 2020). Rural settlements in the West African regions are experiencing high under-five mortality as a result of the poor or lack of provision of health care services to child under five and this is evident with this statistic: Sierra Leone (92 death per 1000 live birth), Nigeria (75 deaths per 1000 live births), Guinea (73 death per 1000 live birth), Chad and Cote d'Ivoire (72 deaths per 1000 live births) (Ekholuenetale, 2020). There are rural households that lack access to proper toilets, here children have higher exposure than other children to diseases such as diarrhoea and other gastrointestinal disorders (Ekholuenetale, 2020). Moreover, Under five mortality is higher in the rural households that do not have access to a flush or pit toilet, especially where the bush or field is used as a type of sanitation (Ekholuenetale, 2020).

**Place of delivery**

Place of delivery is also associated with under- five mortality, as there tends to be differentials with the place where a newborn is delivered. This is as a result of the resources available to caretake the newborn from it first day of delivery. The fluctuating number of births delivered in health facilities proves a crucial factor in reducing deaths increasing from the complications of pregnancy (Budu, 2023). What is mostly expected is that when there are complications in such facilities during delivery, a skilled attendant can be able to assist manage the complication (Budu, 2023). In 2019, the total world under-five mortalities were estimated at about 5.2 million, Sub-Saharan Africa contributed about 55% of these global under-five mortalities (UNICEF ET AL., 2024). This means, the region on its own recorded about 2.8 million under-five deaths out of the global 5.2 million under-five mortalities in 2019 (United Nations Inter-agency Group for Child Mortality Estimation, 2023). With that, public health expenditure in Sub-Saharan Africa though very low as compared to other regions showed a steady increase over the years (Ayipe & Tanko, 2023). Sierra Leone also faced a consequence of having healthcare infrastructure which was inadequate to caretake for the number of pregnant women and young children; the great distances required for poor women in rural areas to reach healthcare facilities were extremely challenging; and women had poor nutrition and lacked proper care before and during pregnancies (Odland et al., 2020).

The West Africa region reported that, 56.6% of the women who are aged more than 34 years delivered in a health facility (public health facilities), 69.0% women aged below 18 years had health facility deliveries (WHO., 2018). Also, 63.8% of women with short birth interval delivered in a health facility while 65.0% of those with high parity gave birth in a health facility (Ajaari, 2018; WHO., 2018). Nigeria also showed that there are rural-urban differentials in terms of home delivery, with the number of home delivery in non-urban areas being 57.4%, as compared to 42.6% in urban areas (WHO., 2018). There is also a study which revealed that, the high proportion of maternal deaths in sub-Saharan Africa is a result of home delivery, with most births occurring at home (Regassa, 2022). In low- and middle-income countries (LMICs), many deliveries are still taking place at home without the assistance of trained attendants (Regassa, 2022). These deliveries are taking place in unhygienic environment, this leads to neonatal and maternal outcomes as risk of infection, postpartum haemorrhage and increase HIV/AIDS (Regassa, 2022).

**Preceding birth interval**

Preceding birth interval is seemingly another factor influencing and interconnected with infant and child mortality (Under-five mortality) (Tesema et al., 2023). Firstly, closely spaced pregnancies might compromise fetal growth because women lack adequate time to restore their nutritional reserves; again, mortality risk is approximately doubled for children born between 1-17 months after a sibling, and increased by one-third for those born 18-23 months later, relative to those born after 24-47 months (Li et al., 2022). Numerous studies have shown that short birth spacing is mostly intertwined with an increased risk of child mortality, preterm birth, small for gestational age, and low birth weight (Gleave, 2023; Yaya et al., 2020). Furthermore, it is proven that first born are at higher risks of dying as a result of the age of the mother, birth complications (Van Malderen et al., 2019). The mothers may not have enough experience or lack experience to raise and take care of an infant. High mortality has been associated with being the first born and high in the birth order (Tamirat et al., 2021; Van Malderen et al., 2019).

**Breastfeeding status**

The period of breastfeeding tends to have a significant impact in child mortality, as breastfeeding maximize a child’s chances of surviving past childhood, which lowers child mortality (Engelhart, 2022). Also, for the survival of a child under five, The World Health Organization (WHO) and United Nations Children's Fund (UNICEF) promoted the initiative of nursing within 1 hour of a child’s birth, this included exclusive breastfeeding for at least the first 6 months of the child’s life and the introduction of nutritious, complementary foods after 6 months (Debes et al., 2013). Another suggestion was made that, mothers should continue with breastfeeding until the child is at least 2 years old (Debes et al., 2013). There are high coverage rates of breastfeeding in lower-income countries, only 37% of infants under 6 months are exclusively breastfed (UNICEF et al., 2024). And an estimate is that 1 in 5 children in high income nations are breastfed for the first 12 months of their lives (Olufunlayo et al., 2019; UNICEF ET AL., 2024). Longer breastfeeding duration reduces the prevalence of infectious diseases, the number of under-5 child fatalities, and children’s risk of being exposed to chronic conditions: these are allergies, asthma, diabetes, obesity, irritable bowel syndrome, and Crohn’s disease throughout childhood and adulthood (24-32 years) (Froń & Orczyk-Pawiłowicz, 2024). West  African children are more than 14 times more likely than their counterparts in developed nations to die before turning five (Gayawan et al., 2016). This is primarily due to the region's high rates of maternal and child malnutrition, which impairs immune systems and increases susceptibility to illnesses like malaria, pneumonia, and diarrhoea (Engelhart, 2022; Gayawan et al., 2016).The inclusion of breastfeeding practices is strongly justified by its repeated identification as a critical determinant of under-five mortality in recent studies employing binary logistic regression (Aguade & Chen, 2025; Kong et al., 2024; Misau et al., 2024).

**Mother’s marital status**

Different authors have identified the interconnectedness between marital status and under-five mortality, in their identification conclusions were mostly that individuals who have never partaken in marriage and the ones who are divorced are negatively impacting and increasing under-five deaths and this might be as a result of insufficient resources which are necessity for a child’s survival (Gabriel, 2022). Married people tend to have better health than single people, this is as a result of their marriage having a greater favourable impact on their children’s health status (Gabriel, 2022). Married people are less likely than single people to experience psychological anguish and emotional difficulties (Gabriel, 2022). Human lifespan and health are interconnected with marital status, married people are mostly having longer life expectancies that their single counterparts (Lindström & Rosvall, 2019). Married couples prioritize their children firstly, as when it comes to their children spend a lot of time and money, non-resident parents typically divide resources among several family duties which is not healthy for an infant in this case (Lindström & Rosvall, 2019). Married mothers often benefit from their husbands' support, easily access work possibilities, and utilize healthcare facilities more effectively (Kanmiki et al., 2014). This is as a result that that both parents share responsibility for raising their children, thus it is proposed that marriage is a predictor of better health outcomes for children (Gabriel, 2022; Kanmiki et al., 2014). Parental death, sometimes known as "death shock," frequently has a detrimental effect on a child's health (Gabriel, 2022; Kanmiki et al., 2014).

**Household wealth**

Wealth index combined is another crucial factor associated with under five mortality as households categorized as being rich (mostly having high income) are expected to have full and sufficient access to child health care services and can maintain to pay medical expenses to escape and avoid child death (Rajapakse et al., 2025). Meanwhile households categorized to be poor or having lower income levels tend to have limited and therefore insufficient child health care services, such as access to medication (affordability plays a crucial role) (Gleave, 2023). These households are using public services which at some point run out of medication, at some point these services are not going to have sufficient resources (examples might be children insulin, vaccines are late delivered to them) to prevent children's ill health, hence risking the lives of children in danger (Rajapakse et al., 2025).

**Source of drinking water**

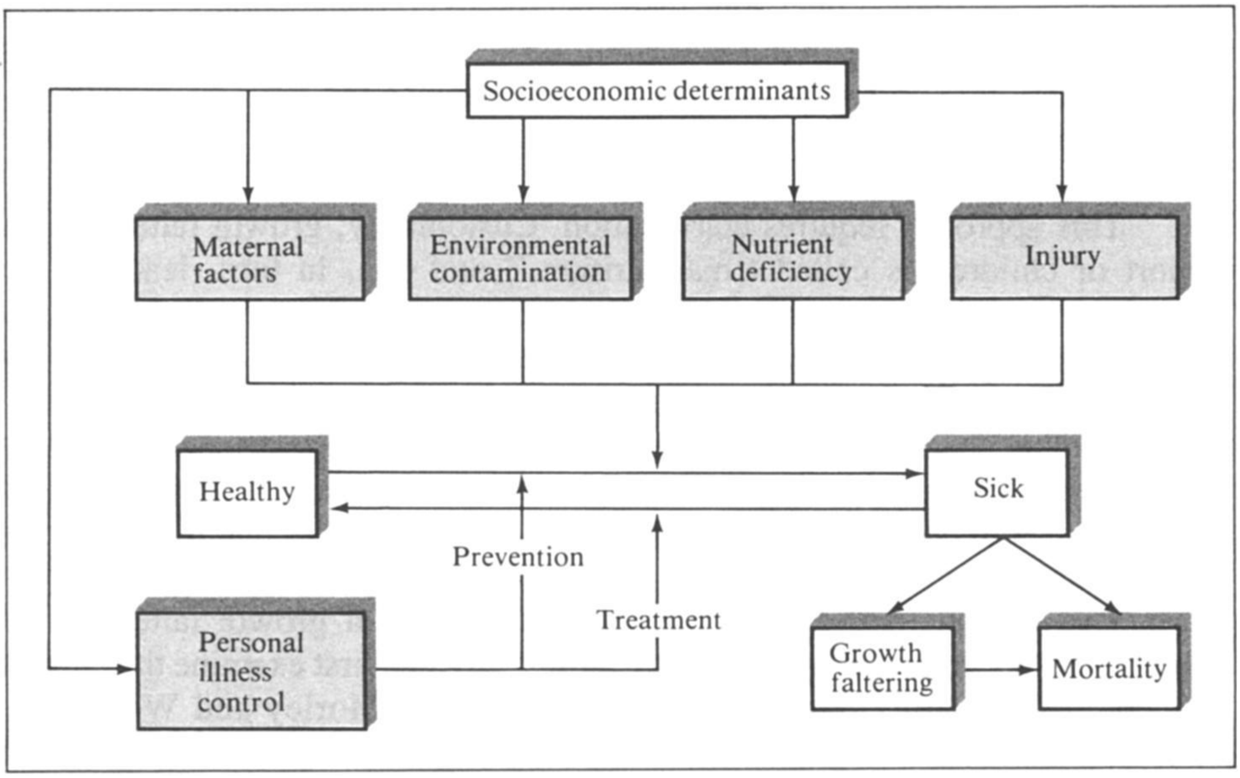
Source of drinking water has been evident to be associated with under five mortality, since many under five deaths reported to the department of health have the type of water consumption (where the water is taken from) as an underlying cause (Deribew et al., 2016). Under-five mortality rates are mostly lower among children residing in families who have access to drinking water from a safe source, compared to those who access drinking water from an unsafe source (Deribew et al., 2016). ). In most cases children who are living in households which have no access to purified and safe water, drinking which may contain dangerous bacterium are at higher risk of death (Howard, 2025). Then households which have access to piped water mostly maintained by municipality are at lower risk of under-five mortality compared to families who are mostly depending on boreholes, or unmaintained dams for drinking water (UMRA, 2020). Having access to clean water supports women during the perinatal period by enabling social support networks (Gleave, 2023). This, in turn encourages antenatal care visits and facility-based births, as hygiene becomes a primary priority (Lartey, 2019). Unimproved water supply and low levels of improved sanitation usage may result to negative impact on women during pregnancy or postnatally, Insufficient hygienic water causes poor nutrition which negatively affects breastfeeding, reducing birth weight and increasing the risk of death in children (Gleave, 2023). The inclusion of source of drinking water as a key environmental determinant in under-five mortality analysis is strongly justified by evidence from a study which employed the Brass indirect estimation method, which demonstrates that water infrastructure is fundamentally linked to child survival through the indirect mechanism (Monamo et al., 2024).

## 2.4 Theoretical framework

The theoretical framework for this study draws on the Mosley and Chen's model. This framework is well-known and widely used in studies examining the factors associated with child survival mostly in underdeveloped nations (Chao, 2023; Gleave, 2023; Nyaaba et al., 2020). This framework makes an assumption that "all economic and social determinants of child mortality operate through a common set of biological mechanisms proximate determinants or demographic variables to exert an impact on mortality"; this theory was chosen as a result of its application to the study and it connection with the variables chosen (Mosley, 1984).

Mosely and Chen, came up with the idea of proximate determinants, and these determinants have a direct influence on the risk of mortality and morbidity (Mamani, 2021). The proximate determinants have five categories, starting with the first one which is maternal factors: age, birth order, birth interval, sex of the child (Izulla et al., 2023). The second determinant is the environmental factors including: land, air, water and food contamination (Ahinkorah et al., 2022). The third determinant is the one of socio-economic determinants, and this determinant always interlinks with the demographic variables in order to results to risk of infectious diseases which may eventually lead to child morbidity and mortality (Gleave, 2023). There are also individual-level variables, including fathers and mothers' educational level, health status and period and space they have available to bear and rear a healthy surviving child as well as societal attitudes (Mendoza, 2021) followed by the house-hold level variables: income and health (Mosley, 1984). Lastly, the community level variables: ecological setting, health system and political economy (Ahinkorah et al., 2022; Mamani, 2021) (refer to figure 2.4.1.). As a result, this study employed the Mosley and Chen framework to examine the factors associated with under-five mortality, using the above-mentioned categories of proximate determinants interlinked to the original work of the framework. This study therefore uses four of them (maternal, socio-economic, individual-level variables and household level variables).

**Figure 2.4.1 Theoretical framework by Mosley and Chen**




*Mosley and Chen (1984).*

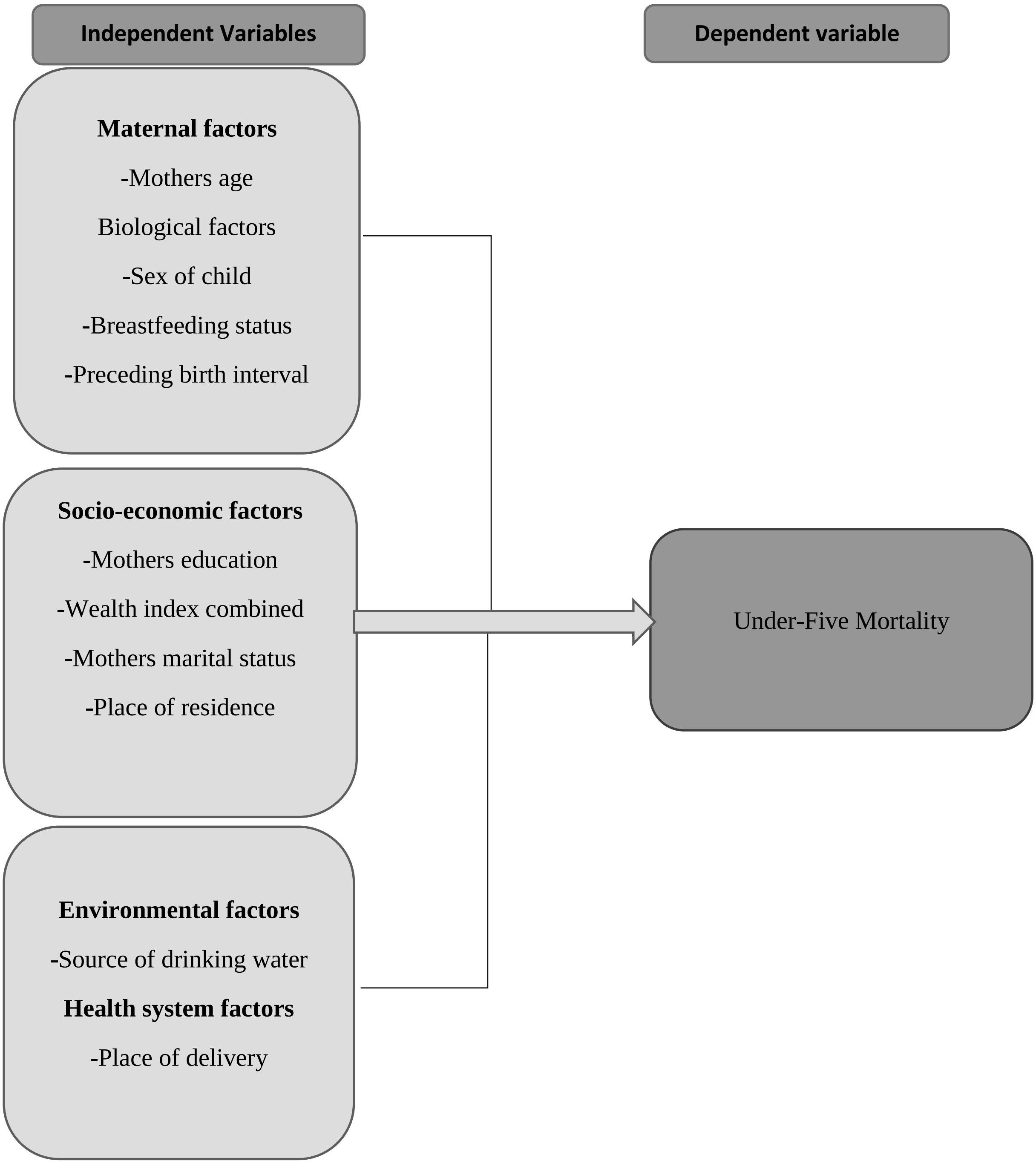
## 2.5 Conceptual framework

This study adopted Mosley and Chen's conceptual framework for child survival in developing nations. This study adopted this framework because it best explains and demonstrates the variables under consideration. Refer to Figure 2.5.1. This study includes socio-economic variables, maternal variables, individual level variables and household level variables. The variables used in this framework were taken from the Mosley and Chen framework, and it showed the influence of common sets of socio-economic variables and maternal variables which influence the chances or possibilities of diseases. Socio-economic variables, maternal variables and demographic variables may impact one another ending up resulting in chances and risk of diseases such as pneumonia and measles, and these diseases are as a result of malnutrition which makes immune system of a child to be weak in fighting any diseases (Gleave, 2023). An argument postulated by Mosley and Chen was that weakness of a child's immune system results to risky diseases and this brings forward the significance of a mother to provide basic care and medical assistance (Gleave, 2023). But then if a mother is young, lacking experience or having low levels of education and being unemployed may lead to having challenges in protecting the child from diseases and end up failing to raise the child well (Mosley, 1984). This study is anchored in the conceptual framework for child survival in developing countries, originally developed by Mosley and Chen (1984). This framework is particularly suited to this investigation because it moves beyond simple biological explanations of child mortality and integrates social, economic, and environmental factors with biological processes, positing that all socioeconomic determinants of child mortality must ultimately operate through a common set of proximate determinants (also known as intermediate variables) that directly influence the risk of disease and the outcome of disease episodes in children.

As illustrated in Figure 2.5.1, the original framework organizes variables into two primary tiers: socioeconomic determinants, which are the background factors at individual, household, and community levels that shape access to resources and exposure to risk; and proximate determinants, which are the biological and behavioral mechanisms through which the socioeconomic variables operate, grouped into categories such as maternal factors (e.g., age), environmental contamination (e.g.,water). In adapting this framework for the current study, we have operationalized it to reflect the specific variables available in our dataset and the context of Nigeria, Sierra Leone, and Guinea, structuring the adaptation to show a clear pathway from distal factors to the health outcome, ensuring that the framework is not merely a list of variables but a causal model.

The Mosley-Chen framework is highly relevant for this study on under-five mortality in Nigeria, Sierra Leone, and Guinea for several specific reasons. First, it provides the theoretical justification for holistic variable integration, allowing this study to include a mix of socio-economic variables (education, wealth), maternal variables (age, birth interval), and household-level variable (water) within a single analytical model by explaining why a mother's age as a proximate determinant and her education level as a distal determinant must be considered together because the former is often the mechanism through which the latter operates. Second, the framework is instrumental in explaining the causal pathway, as this study does not merely seek to identify which factors are associated with under-five mortality but also how they are connected, enabling us to hypothesize and test pathways such as whether the effect of household poverty on measles mortality is mediated by low vaccination rates and malnutrition, which is critical for making informed policy recommendations regarding investments in health facilities versus poverty alleviation and education. Third, the framework demonstrates strong contextual applicability to West Africa, where Nigeria, Sierra Leone, and Guinea face a triple burden of infectious diseases, neonatal conditions, and malnutrition, making the Mosley-Chen framework uniquely designed for this high mortality context where multiple overlapping risks are present and child survival is determined by the complex interaction of social, biological, and environmental processes. Finally, the framework explicitly addresses the role of the mother by formalizing it through the "maternal factors proximate determinant, providing a theoretical basis for investigating why a young, inexperienced, or uneducated mother faces challenges in child care, as noted in Mosley-Chen framework (1984) and Gleave (2023), by positing that these maternal characteristics affect her productivity in managing illness, ensuring proper nutrition, and preventing environmental exposure, relationships which this study will quantitatively examine.

**Figure 2.5.1 Analytical framework for the study**



## CHAPTER THREE: METHODOLOGY

### 3.1. INTRODUCTION

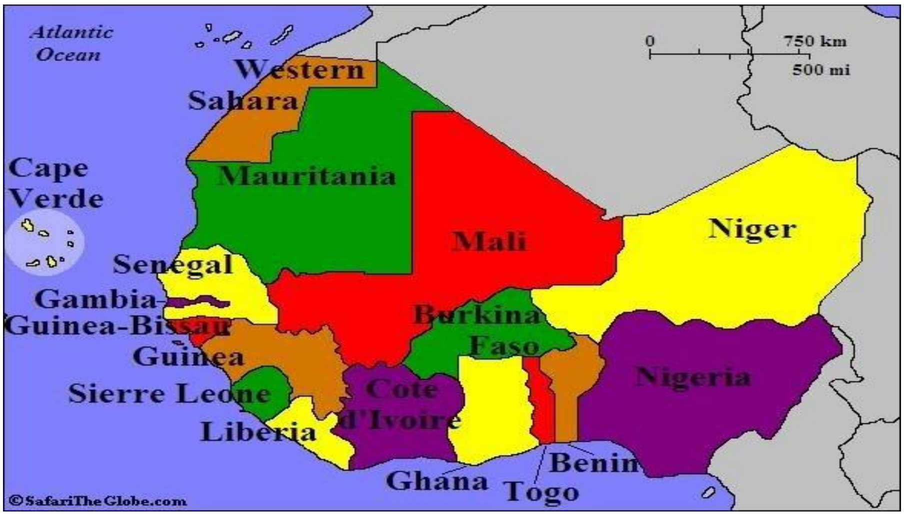
This chapter presents the methodology which includes presentation of sources of data, study population, description of study variable, methods of analysis as well as ethical consideration. Additionally, the chapter highlights methods of analysis such as the brass children ever born method, univariate, bivariate as well as binary logistic regression.

### 3.1.1 Study location

The study is located within the West African region, where the focus is on Nigeria, Sierra Leone, and Guinea. Nigeria is a country which is located in the west Africa it is located in the Gulf of Guinea and its population is estimated at around 227.9 million (with major ethnics groups which includes: Hausa, Yoruba, and Igbo) and it shares borders with Benin to the west, Chad and Cameron to the east, Niger to the north and the Gulf of Guinea to the South (Gleave, 2023). Sierra Leone is a small nation located on the West Africa’s Southwest coast, and it shares borders with Guinea to the north and Liberia to the South, and its population is estimated around 7.7 million people, mostly dominated by the Temne and Mende ethnic groups (Gleave, 2023). Then Guinea is located on the West Africa’s Atlantic coast, sharing borders with Senegal to the north, Sierra Leone to the Southwest (Gleave, 2023). Guinea has a population of about 14.14 million, and 60% of this population lives in rural areas, and consists of three dominant ethnic groups which are: the Fulani, Malinke, and soussou with a life expectancy of 58 years (Gleave, 2023).

The selection of Nigeria, Sierra Leone, and Guinea as the focal countries for this study is justified by their disproportionately high under-five mortality rates, which rank among the most severe globally, with Nigeria accounting for the highest absolute number of child deaths worldwide at approximately 100 deaths per 1,000 live births, while Sierra Leone and Guinea exhibit similarly alarming rates of 111 and 95.96 deaths per 1,000 live births respectively (UNICEF ET AL., 2024; World Bank Group, 2023; World Health Organization, 2024). These three West African nations share common underlying vulnerabilities, including pervasive poverty, fragile health systems characterized by critical shortages of skilled professionals and inadequate infrastructure, and significant urban-rural disparities in healthcare access that leave children in remote areas particularly susceptible to preventable causes of death (World Health Organization, 2024). Furthermore, they exhibit a strikingly similar epidemiological profile, facing the triple burden of infectious diseases such as pneumonia, malaria, and measles, neonatal conditions, and malnutrition, which weakens children's immune systems and increases both susceptibility to and severity of common infections (UNICEF ET AL., 2024). The selection also acknowledges the critical role of maternal factors emphasized in the Mosley-Chen framework, as all three countries share concerning indicators related to maternal health, including high fertility rates, early childbearing, low levels of female education, and limited healthcare utilization. Collectively, Nigeria, Sierra Leone, and Guinea provide a representative spectrum of the child survival challenges facing West Africa, making findings from this study potentially generalizable to neighboring countries while offering valuable opportunities for cross-national learning and regional intervention design.

**Figure 3.1.1 Geographical location of the three selected countries**




*Whang, 2020*

### 3.2 Data source

This study used secondary data from the 2018 Nigeria Demographic And Health survey. Secondly this study used secondary data from the 2019 Sierra Leone demographic and health survey and lastly from the 2018 Guinea Demographic And Health Survey. The largest survey in the world that offers trustworthy data on child and infant mortality, health care indicators, and child health status is still the Demographic And Health Survey (DHS). The 2018 Nigeria Demographic And Health Survey (2018 NDHS) is the sixth survey of its kind to be implemented by the National Population Commission. The 2018 NDHS is a nationwide sample survey that offers current data on health and demographic variables. Enumeration areas (EAs) served as the sampling units for the first stage of the stratified, two-stage cluster design used to select the sample (National Population Commission - NPC & ICF, 2019). A thorough listing of all the homes in each of the 1,400 chosen EAs was the second step (National Population Commission - NPC & ICF, 2019). Women aged 15–49 and males aged 15–59 living in randomly chosen households throughout Nigeria were the target populations (National Population Commission - NPC & ICF, 2019). For the poll, a representative sample of roughly 42,000 households was chosen (National Population Commission - NPC & ICF, 2019). In order to test for malaria, anaemia, and the genotype of children aged 6 to 59 months, one-third of the families (14,000) were chosen (National Population Commission - NPC & ICF, 2019). Additionally, one eligible woman per family was chosen at random to answer extra questions about domestic abuse in the subsample of houses chosen for the men's survey (National Population Commission - NPC & ICF, 2019).

Then the 2019 Sierra Leone Demographic And Health Survey, Enumeration areas (EAs) served as the sampling units for the first stage of the stratified, two-stage cluster design used to select the sample (Statistics Sierra Leone - StatsSL & ICF, 2020). A thorough listing of all the homes in each of the 578 chosen EAs was the second step (Statistics Sierra Leone - StatsSL & ICF, 2020). Women aged 15–49 and males aged 15–59 living in randomly chosen households nationwide were the target populations. For the poll, a representative sample of roughly 13,872 households was chosen (Statistics Sierra Leone - StatsSL & ICF, 2020). Interviews with men and biomarkers were conducted with 6,936 homes, approximately half of the total. Half (50%) of the sample households participated in the men's survey, and all of the men in those households between the ages of 15 and 59 were included (Statistics Sierra Leone - StatsSL & ICF, 2020).One qualified woman from each home was chosen at random to receive extra questions regarding domestic abuse in this subsample (Statistics Sierra Leone - StatsSL & ICF, 2020).

Lastly, there is the 2018 Guinea Demographic And Health Survey (GDHS), two stages of stratified sampling were used to choose respondents for the GDHS (Institut National de la Statistique & ICF, 2019). Clusters, commonly referred to as enumeration areas (EAs), were chosen in the first step, and homes were chosen for the survey in the second (Institut National de la Statistique & ICF, 2019). EAs had an average size of 153 households, with 186 households in urban areas and 140 households in rural areas. Interviews were conducted with 10,874 women from these families (Institut National de la Statistique & ICF, 2019).

### 3.3 Research design

This study adopted a cross-sectional research design. The cross-sectional research design mostly incorporates assessments of population data at a particular moment in a time, this design observes variables without influencing them (Wang 2020). This design measures the prevalence of an outcome of interest in a defined population, also determines the interconnectedness among variables. In this study the relevance of cross-sectional research design lies in its ability to measure the prevalence of under-five mortality and describes the factors or features of the under-five population.

### 3.4 Study sample

The sample of the study is drawn from the demographic and health survey (different years for all the three countries (Nigeria, Sierra Leone and Guinea). Therefore, the study was limited to a total of 29949 women aged 15-49 in Nigeria, 11457 women aged 15-49 in Sierra Leone, and 7689 women aged 15-49 in Guinea who gave a live birth were included. The sample sizes were derived through a systematic weighting process applied to the most recent Demographic and Health Survey (DHS) data for each respective country. The initial unweighted samples were obtained from the women's recode files, which contained 41,821 women for Nigeria, 15,574 women for Sierra Leone, and 10,874 women for Guinea. However, to account for the complex survey design employed by the DHS, which involves stratified multi-stage cluster sampling that results in unequal probabilities of selection across different regions and households, the variable V005 (the women's individual sample weight) was applied to all analyses. This weighting variable, which must be divided by 1,000,000 for proper application, adjusts for differential response rates and oversampling of specific populations to ensure that the sample is representative of the true population distribution. The application of these survey weights resulted in the final weighted samples of 29,949 for Nigeria, 11,457 for Sierra Leone, and 7,689 for Guinea, which are the figures used throughout this study to ensure that all estimates, proportions, and statistical analyses accurately reflect the population of women of reproductive age in each country and yield findings that are generalizable beyond the survey respondents. Refer to table 3.5.1.

**Table 3.5.1 Derivation of sample size**

| **Countries** | **Year of the survey** | **Records available (Households Sample for women 15-49)** | **Records used (weighted)** |
|---|---|---|---|
| Nigeria | 2018 | 41 821 | 29949 |
| Sierra Leone | 2019 | 15 574 | 11457 |
| Guinea | 2018 | 10874 | 7689 |

## 3.5 Inclusion and exclusion criteria

This study included children who are aged under five years and from Nigeria, Sierra Leone and Guinea, however this study excluded children who are aged six years old and above, it also excluded children from the other countries which are following these top three from the West African region. Also, this study, excluded women who did not give birth in the last 5 years.

## 3.6 Study variable

### 3.6.1 Dependent variable

The dependent variable in this study is under-five mortality. Under-five mortality is a statistic based on death that was reported to have happened before the age of five. The dependent variable was derived from the variable “child is still alive?”, and from the question 0 “No” for the child is not alive, and 1 “Yes” for the child is still alive.

### 3.6.2 Independent variables

Ten independent variables are used in this study. The independent variables selected for this study includes Mothers age, Sex of child, Mothers’ education, Place of residence, Place of delivery, Preceding birth interval, breastfeeding duration, Marital status, wealth index combined, source of drinking water. The selection of the ten independent variables examined in this study was guided primarily by the theoretical propositions of the Mosley-Chen framework for child survival, which posits that child mortality outcomes are determined by the interaction between socioeconomic background factors and proximate determinants that directly influence disease risk. As such, variables were deliberately chosen to represent both tiers of this framework while also ensuring alignment with the specific context of under-five mortality in Nigeria, Sierra Leone, and Guinea. The socioeconomic determinants selected include maternal education as individual-level variable, household wealth index as a household-level economic indicator, and place of residence (urban/rural) as a community-level contextual factor, as these have been consistently identified in the literature as distal factors that shape access to resources, health information, and care-seeking behavior. The proximate determinants were selected to capture the biological and behavioral mechanisms through which socioeconomic factors operate, and these include maternal age at birth and birth interval as maternal factors directly impacting child viability and care capacity; source of drinking water as measure of environmental contamination influencing exposure to pathogens; breastfeeding status as indicator of nutrient deficiency affecting immune competence. This combination of variables ensures comprehensive coverage of the causal pathway hypothesized by Mosley and Chen, allowing the study to examine not only which factors are associated with under-five mortality but also how socioeconomic conditions translate through proximate mechanisms to influence child survival outcomes in the three selected countries, while also being constrained by the availability and consistency of these variables across the Demographic and Health Survey datasets for Nigeria, Sierra Leone, and Guinea. A detailed description of the variables and how they are coded is presented in Table 3.6.2.1.

**Table 3.6.2.1: Description of independent variables**

| **Variables** | **Description** | **Coding** |
|---|---|---|
| Child alive | Children under the age of five who were reported to be dead | 0=No<br>1=Yes |
| Mothers Age | The mother’s age at first birth it shows and explains the mother’s age from the reproductive ages of 15-49. | 0=15-24<br>1=25-34<br>2=35-44<br>4=45-49 |
| Sex of child | The sex of the child with two categories with one being male and the other one female. | 0= Male<br>1=Female |
| Mothers Education | The mother’s highest educational level | 0= No education<br>1= Primary<br>2 =Secondary or higher |
| Place of residence | Whether the mother resided in urban or rural areas. | 0= Urban<br>1= Rural |

| Variables | Description | Coding |
| --- | --- | --- |
| Place of delivery | The environment where the new-born got delivered to. | 0=Home delivery<br>1= Public Hospital delivery<br>2= Private Hospital delivery |
| Preceding birth interval | The mothers' differences between birth date of child and birth date of preceding child in months | 0= Less than 33<br>1= Greater than 33 |
| Breastfeeding status | The status of the breastfeeding to the new-born | 0=Never breastfed<br>1=Ever breastfed |
| Mother's marital status | The mother's marital status | 0= Never married<br>1= Ever married |
| Wealth index combined | The household wealth index | 0=Poor<br>1=Middle<br>2=Rich |
| Source of drinking water | The source where they receive water consumed by the child | 0=Pipe water<br>1=well water<br>2= Other non-portable services |

## 3.7 Method of analysis

### 3,7.1 Demographic analysis

### 3.7.1 method of estimating childhood mortality

The brass children ever born method is a demographic technique which is used to estimate child mortality, and it is useful for many developing countries; again, this method was used for analysis in this study. It was used to estimate under-five mortality in a manner derived from the number of children who are still alive, the number of children ever given birth to, as well as the estimation of the probability of dying before age 5 (Pison & Langaney., 2023). The method was first developed by the late William Brass and was later revised by other scholars such as Sullivan, Trussell methods and Feeney.

The method is based on data on child ever born and children surviving per woman for each five-year age group (Koosheshi, 2020; Verhulst, 2016). In the DHSs women of the reproductive age were asked the following questions: "How many sons and daughters have you ever given birth to?", "How many of these children are still alive?" "Where did you give birth?" (home, government facility, private facility, other), "Did you ever breastfeed?", "What is the main source of drinking water for your household?". Based on the responses from these questions, the proportion surviving of children surviving and proportion of children dead are calculated for each five-year age group. The proportion of children surviving are computed by dividing children surviving per woman by corresponding children ever born (Verhulst, 2016). These proportions are then subtracted from one to get proportion dead, denoted D(i), which are further multiplied by factors, K(i), developed by Brass to estimate the probability of dying from birth to different ages. In particular, $q_x$, the probability of dying before age x is calculated using the equation:

$$q_X = D(i).K(i)$$

The multipliers, K(i), are selected according to the value of P1/P2 and P2/P3, which are good indicators of the slope of fertility curve at the beginning of the reproductive period. In the case of Trussell method, K(i) is calculated by fitting regression coefficients a(i), b(i) and c(i) into the following equation:

$$K(i) = a(i) + b(i)P1/P2 + c(i)P2/P3$$

Where K(i) is defined as above and P1, P2 and P3 are the mean parities for the respective age groups 15-19, 20-24 and 25-9. The values of the coefficients a(i), b(i) and c(i) are given in the UN (1993) (Koosheshi, 2020).

$$P1= CEB1/W1$$

$$P2 =CEB2/W2$$

$$P3=CEB3/W3$$

The fundamental power of the Brass method is mostly based on the use of cross-sectional data from a single survey to redesign a timeline of child mortality (Verhulst, 2016). It works on the principle that the children of older women, who were born further in the past, have been exposed to the risk of death for a longer period and under the mortality conditions of years ago. Conversely, the children of younger women represent more recent births and thus reflect current mortality risks. The method efficiently changes a snapshot of a population's fertility and child survival at a specific moment into a retrospective analysis of mortality trends over the past two decades by examining the proportion of deceased children across various maternal age groups (Koosheshi, 2020). This gives demographers to estimate trends in key indicators like the probability of dying before age five (5q0) without needing reliable historical birth and death records.

The method is based on certain assumption. First, fertility and mortality are assumed to be constant over time. Second, there is no major fluctuations due to epidemics, wars, or sudden policy changes. This ensures that the relationship between children born and children surviving reflects long-term mortality patterns. The population under study is treated as closed, so mortality estimates are not distorted by in- or out-migration of mothers or children.

The Brass indirect method operates on several fundamental assumptions that were systematically evaluated for each country before estimation. The first assumption relates or assumes the stability of fertility and mortality in the recent past, which was assessed by examining age-specific fertility rates and parity ratios across successive maternal age groups; in all three countries, the parity ratios P2/P1 and P3/P2 fell within expected ranges, and sensitivity analyses comparing estimates from different maternal age groups confirmed consistency despite known disruptions such as the Ebola epidemic in Sierra Leone and conflicts in parts of Nigeria (Keita et al., 2024). The second assumption pertains to the accuracy of reporting of children ever born and children surviving, which was assessed by examining sex ratios of children ever born and parity consistency across age cohorts; while minor age heaping was detected in Nigeria and post-conflict concerns arose in Sierra Leone and Guinea regarding issues such as omission of birth histories for deceased women, the application of DHS sampling weights partially mitigated survivorship bias, and historical precedence for the method's applicability in this context was established by Brass's original work with Nigerian, Sierra Leonean and Guinean data (Fayehun et al., 2020). The third assumption concerns the selection of an appropriate model life table system, which was evaluated by comparing the implied relationships between infant mortality (1q0) and child mortality (4q1) derived from preliminary estimates against the standard patterns embedded in the North family; in all three countries, the ratio of child to infant mortality most closely resembled the North family pattern, consistent with West African epidemiological profiles where neonatal conditions remain highly prevalent while early childhood deaths from infectious diseases follow a predictable trajectory. The fourth assumption relates to the reference period for each estimate, which relies on the calculated average parities P1, P2, and P3 to position each mortality estimate on a historical timeline, enabling trend analysis across Nigeria, Sierra Leone, and Guinea.

To estimate under five mortality, excel spreadsheets were used and the results were cross checked using MORTPAK software. The estimates derived from the North family of the Coale-Demeny model life tables accepted to adequately represent under five mortality in the three countries. The selection of the North family of the Coale-Demeny model life tables for estimating under-five mortality in Nigeria, Sierra Leone, and Guinea was informed by demographic research across Sub-Saharan Africa which has consistently demonstrated that the North model provides the most appropriate fit for countries with mortality regimes heavily influenced by infectious diseases and maternal factors, as it was originally derived from Scandinavian data but has proven remarkably adaptable to contexts where early life mortality is sensitive to maternal age and birth spacing both central variables in this study's analytical framework.

The decision to employ the Brass indirect method for estimating childhood mortality in this study, rather than relying solely on direct estimates, is grounded in both methodological necessity and analytical purpose. Direct methods of childhood mortality estimation need complete birth histories, including precise ages at death and exposure times, which are typically available in DHS datasets and are used to produce the published under-five mortality rates found in the respective country reports (Silva, 2012). However, this study specifically utilized the Brass indirect method to compare the DHS estimates to this one, which showed slight differences and proved the use of different methods.

Following the initial application of the Brass Trussell multipliers to obtain probabilities of dying ($q(x)$) for various childhood ages, the relational model life table system was employed to derive a single, robust estimate of under-five mortality ($5q0$) and to smooth irregularities arising from age misreporting or sampling variability. This system is based on the logit transformation, a mathematical function that linearizes the relationship between two life tables, enabling comparison and adjustment of mortality patterns.

The logit transformation of the survivorship probability $l(x)$—the probability of surviving from birth to exact age x—is defined as:

$$\mathrm{logit}[l(x)] = ½ \ In\ (1\text{-}l(x)/l(x) = ½ \ In\ (l(x)/\ 1\text{-}l(x))$$

With a logit value of 0 denoting a survivorship probability of 0.5, this transformation converts survivorship probabilities, which range from 0 to 1, onto a linear scale from negative infinity to positive infinity.

The Brass relational model posits that the logit of the survivorship function for a given population is a linear function of the logit of a standard survivorship function derived from a chosen model life table family. The relationship is expressed as:

$$\mathrm{logit}[l(x)] = \alpha + \beta\times \ \mathrm{logit}\ [ls\ (x)]$$

Where $l(x)$ is the survivorship probability at age x for the study population, $ls(x)$ is the survivorship probability at age x for the standard (North family), α (alpha) is the intercept parameter representing the level of mortality in the study population relative to the standard, and β (beta) is the slope parameter representing the pattern of mortality relative to the standard.

Following standard demographic practice for developing country contexts, β was assumed to be 1 in this study. This assumption implies that the age pattern of mortality in Nigeria, Sierra Leone, and Guinea is similar to that of the North family standard, and only the overall level of mortality differs.

Under this formulation, alpha (α) represents the shift parameter measuring the difference in mortality level between the study population and the North standard. A positive alpha indicates that mortality in the study population is higher than the standard (since $\mathrm{logit}[l(x)] > \mathrm{logit}[ls(x)]$, implying lower survivorship), while a negative alpha indicates lower mortality than the standard.

The alpha parameter was estimated by averaging the differences between the logits of the observed $q(x)$ values derived from the Brass method and the logits of the standard North family $qs(x)$ values for corresponding childhood ages:

$$A = 1/n \sum [\mathrm{logit}(q(i)) - \mathrm{logit}\ (qs\ (i))]$$

Where $q(i)$ represents the observed probability of dying derived from maternal age group i using the Brass Trussell multipliers, $qs(i)$ represents the standard probability of dying from the North family for the same childhood age, and n is the number of age groups used in the estimation (typically age groups 20-24 through 40-44, excluding the youngest and oldest groups which may be less reliable).

Once a single, summary value of alpha was obtained for each country, it was used to generate a complete life table consistent with the estimated mortality level. The key output for this study, the under-five mortality index (5q0) , was derived from this relational model life table as:

$$5q0=1-l(5)$$

Where l(5) is the estimated probability of surviving from birth to exact age 5, calculated by applying the estimated alpha to the North standard logits and then back-transforming:

$$l\,(5) = 1/1+\exp\,(2[\alpha+\mathrm{logit}\,(ls\,(5))])$$

This relational model approach offers several advantages that justify its application in this study. First, it produces a single, smoothed estimate of under-five mortality that synthesizes information from all maternal age groups, reducing the influence of random fluctuations or data errors in any single age group. Second, it enables the estimation of a complete age pattern of mortality, including the specific under-five probability required for comparison with the Mosley-Chen framework variables. Third, the estimated alpha parameter itself serves as a useful summary measure of mortality level, facilitating comparisons across Nigeria, Sierra Leone, and Guinea, and across subgroups defined by socioeconomic and proximate determinants. The resulting 5q0 estimates and their corresponding alpha values, disaggregated by the variables specified in the analytical framework, constitute the core dependent variables for examining the determinants of under-five mortality in the three selected countries.

### 3.7.2. Statistical analysis

The data in this study was analyzed using Stata version 16. Three analyses were carried out: a univariate analysis incorporating frequencies, bivariate analysis and a multivariate analysis. The univariate analysis, which includes frequencies, for the objective of estimating under five mortality rate, brass children ever born or children survival method was utilized. A chi-square test was used in the bivariate analysis to examine the relationship between the dependent variable and the chosen independent variables. The 95% confidence interval and a 5% significance threshold were used to calculate the relationships' level of significance. For each of the several measures of association, a p-value of less than 0.05 serves as the foundation for all statistics generated. The chi square test is a statistical test for categorical data. It focuses on frequency count data and makes comparison between a set of observed frequencies obtained from a random sample and a set of expected frequencies that describes the null hypothesis (H0) (Hazra & Gogtay, 2016). The chi square statistics is denoted as, and a summation of the squared deviations between the observed and expected frequencies (Hazra & Gogtay, 2016). Observed frequency count for the level of the categorical variable and is the expected frequency count for level of the categorical variable (Tang et al., 2023).

The equation used for the Pearson Chi-square test is as follows:

$$x^2 = \sum_{i=1}^{n} \frac{(Oi - Ei)2}{Ei}$$

Binary logistics regression models were employed to investigate the relationship between the dependent variables in two models and the maternal, socio-economic, individual-level variables and household level variables.

The binary logistic regression model applied in the study is as follows:

$$(\frac{P}{1-P}) = \alpha + \beta 1x1 + \beta 2x2 + \beta 3x3 + \beta 4x4 + \cdots + \beta ixi$$

The dependent variable in this model is child is alive which is denoted as $(\frac{p}{1-p})$. The independent variables in this model are either nominal, ordinal or binary. The logistic regression makes predictions that the likelihoods measured by probabilities, odds, and log-odds function as means to link the dependent variable to the set of independent variables (Muller & MacLehose, 2014). The regression coefficient indicates the degree of change in the dependent variable for every one-unit of change in the independent variable (Hirsch, 2023). This means that the regression coefficient increases the natural logarithm (log-odds) for a one-unit increase in the independent variable when all other variables are constant (Hirsch, 2023). How the selected factors related to the dependent variable were identified and interpreted through the exponential Beta coefficient (Exp β), which is the odds associated with child is alive/ Under five mortality.

Binary logistic regression was selected as the primary analytical method for this study because the dependent variable: under-five mortality is inherently dichotomous, meaning a child either dies before age five or survives, and linear regression models are not suitable for such binary outcomes as they can produce predicted probabilities outside the meaningful 0-1 range and break assumptions of constant variance and normally distributed errors (Harris, 2021). Logistic regression addresses this by using the logit transformation to constrain predicted probabilities between 0 and 1, and it offers exceptional interpretability through odds ratios, which provide intuitive measures of association between each independent variable and the likelihood of under-five mortality which is a feature particularly valuable for policy oriented research where findings must be accessible to public health practitioners and decision-makers (Harris, 2021; S et al., 2014). Additionally, logistic regression is computationally efficient and less prone to overfitting given the study's ten independent variables and large sample sizes (29,949 for Nigeria, 11,457 for Sierra Leone, and 7,689 for Guinea), and it is well-suited for cross-sectional study designs with binary health outcomes, enjoying widespread acceptance in demographic and public health research using

Demographic and Health Survey data. While alternatives such as log-binomial or robust Poisson regression exist for estimating prevalence ratios directly when outcomes are frequent, this study aims to identify factors associated with under-five mortality and examine their relative contributions within the Mosley-Chen framework rather than to estimate prevalence ratios (Pinheiro Guedes et al., 2024).

Binary logistic regression operates under several key assumptions that were carefully evaluated prior to model estimation. The first and most fundamental assumption concerns the form of the relationship between continuous independent variables and the dependent variable, requiring linearity between each continuous predictor and the logit of the outcome variable, which was evaluated using the Box-Tidwell transformation and visual inspection of plots, with appropriate transformations or categorization applied where non-linearity was detected (Fiveable., 2024; Harris, 2021). The second assumption is the independence of observations, which is potentially violated given the hierarchical structure of DHS data where children are nested within households and communities, However this was addressed by applying sampling weights (V005) and clustering variables to adjust standard errors and account for correlated observations within primary sampling units (Harris, 2021). The third assumption is the absence of perfect multicollinearity among independent variables, meaning no predictor is a perfect linear combination of others, which was rigorously assessed using variance inflation factors and tolerance statistics (Bahovec, 2025). The fourth assumption concerns the absence of influential outliers that disproportionately affect parameter estimates, and standardized residuals and influence statistics such as Cook's distance were examined, although the large sample sizes minimized concerns regarding individual outliers (Li et al., 2022). The fifth assumption is that the sample size is sufficiently large to provide stable parameter estimates, with a common rule of thumb requiring a minimum of 10 events (deaths) per predictor variable, and this assumption was comfortably satisfied given the weighted sample sizes.

Despite its appropriateness for this study, binary logistic regression has several limitations that must be acknowledged. First, the method assumes that the relationship between predictors and the outcome is adequately captured by the specified model form, meaning it cannot automatically detect complex interactions or non-linear relationships without explicit specification by the analyst, and while the Mosley-Chen framework guided the inclusion of theoretically justified interaction terms, some unspecified interactions may remain undetected (Ranganathan et al., 2017). Second, when the outcome is frequent exceeding 10% odds ratios obtained from logistic regression may overestimate the strength of association compared to relative risks or prevalence ratios, and with under-five mortality rates ranging from approximately 10% to 13% across the three countries, this study falls at the threshold where such overestimation becomes a concern; however, as Pinheiro-Guedes et al. (2024); Bui, (2025) note. Third, logistic regression is sensitive to separation or quasi-separation, where a predictor perfectly or nearly perfectly predicts the outcome and leads to unreasonably large parameter estimates and standard errors, but this issue was assessed by examining cross-tabulations of each predictor with the outcome and monitoring for excessively large odds ratios or standard errors during estimation (Clark et al., 2023).

Fourth, the method assumes that missing data are missing at random or that complete case analysis does not introduce bias, and although DHS datasets have minimal missing data for key variables, any remaining missingness was handled appropriately with its potential impact on results considered (Harris, 2021).

### 3.8 Limitation of the study

The study followed a cross-sectional design, as a result there are difficulties in measuring causation between dependent and independent variables. For instance, one cannot assume and state that poor sanitation causes under-five mortality. Outcomes may be that some under-five deaths were underreported due to cultural and religious values. This study made reference to data that was gathered from individuals self-reporting during data collection and could have been influenced by social desirability bias. Furthermore, the possibilities are that some data on first childbirth age may have been over or under reported.

### 3.9 Ethical considerations

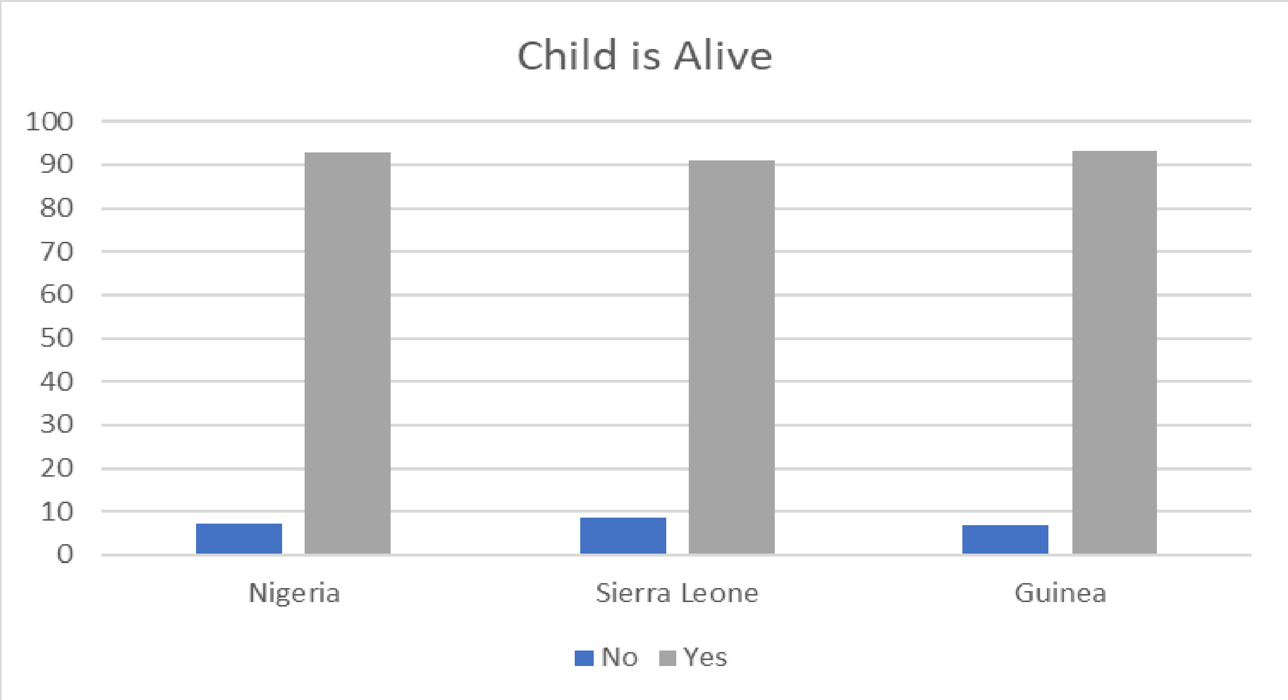
The study used demographic and health survey for all the three countries (Nigeria, Sierra Leone and Guinea). The DHS datasets are in the public domain; however, the user registered first. The DHS Program ensures that ethics-related issues are taken care of and the data released to the user does not have any identifying information. The researcher applied to Basic and Social Sciences Research Ethics for institutional ethical clearance and received ethical clearance, at Northwest University (ethics number NWU-00976-25-A7). Refer to appendix one.

# CHAPTER FOUR: DATA ANALYSIS AND INTERPRETATION OF RESULTS

## 4.1 Introduction

The study's findings are presented in this chapter. The chapter is organized into four sections: the results of the Brass children ever born/children surviving method are shown in the first section, the results of the univariate analysis are presented in the second part, and the findings of the bivariate analysis are presented in the third part, lastly the findings of the binary logistic regression are presented in the last section. The percentage distribution of the dependent variable is displayed by the univariate analysis. The bivariate also displays the correlation between under five mortality and a few chosen independent variables.

**Figure 4.1.1. Proportion of under-five mortality**




*Own computations from the 2018 Nigeria, 2019 Sierra Leone, and 2018 Guinea demographic and health survey.*

Figure 4.1.1. presents the proportion of children reported as alive across Nigeria, Sierra Leone, and Guinea. In each country, approximately 90% of children were reported as alive, while 10% were deceased. These figures are derived from the analysis of Nigeria, Sierra Leone and Guinea demographic and health survey data which reflect child survival status at the time of data collection.

## 4.2 Estimates of under-five Mortality

This section presents estimates of under-five mortality rates for Nigeria, Sierra Leone and Guinea by selected background variables. The study used Brass children ever born/ surviving method for the three countries and selected (highest level of education, wealth index combined, place of residence and source of drinking water). These are the only selected variables because, they are strong proxies for underlying socio-economic and environmental conditions that directly influence a mother's ability to bear and raise children who survive. The results of this exercise are presented in Tables 4.2.1, 4.2.2 and 4,2.3 and in appendix Table 4.2.1.1- 4.2.3.1.

(Appendix two-three)

**Table 4.2.1 Estimating of under-five mortality using Brass method: Nigeria**

| | women | Children ever born | Children dead | Mean parity | Proportion Dead | Multipliers | Probability of dying | Adjusted qx | Alpha | Reference period |
|---|---|---|---|---|---|---|---|---|---|---|
| **Age groups** | | | | **Pi** | **Di** | **Ki** | **qx** | | **α** | **T(x)** |
| 15-19 | 8448 | 1489 | 119 | 0.18 | 0.080 | 1.103 | 0.088 | 0.079 | -0.171 | -1.228 |
| 20-24 | 6835 | 8568 | 999 | 1.25 | 0.117 | 1.012 | 0.118 | 0.112 | -0.200 | -1.036 |
| 25-29 | 7255 | 19202 | 2344 | 2.65 | 0.122 | 1.122 | 0.137 | 0.129 | -0.195 | -0.956 |
| 30-34 | 6178 | 24026 | 3299 | 3.89 | 0.133 | 0.979 | 0.130 | 0.146 | -0.297 | -0.882 |
| 35-39 | 5463 | 26642 | 3682 | 4.88 | 0.138 | 1.039 | 0.144 | 0.173 | -0.343 | -0.781 |
| 40-44 | 3940 | 23081 | 3738 | 5.86 | 0.162 | 1.025 | 0.166 | 0.184 | -0.294 | -0.744 |
| 45-49 | 3701 | 23532 | 4335 | 6.36 | 0.184 | 1.007 | 0.186 | 0.202 | -0.285 | -0.686 |
| | | | | **P1/P2=** 0.14 | | | | | | |
| | | | | **P2/P3=** 0.47 | | | | | -0.231 | |

*Source: Nigeria Demographic and Health Survey 2018*

Table 4.2.1 uses the Brass indirect estimation method to track child mortality in Nigeria over time by analyzing survey data from mothers of different ages. The main finding of this is that mortality has shown a significant decline. The estimates from older mothers, which reflect the past, show higher child mortality, for example a 0.202 risk of death for children born to women now aged 45-49, while the estimates from younger mothers, reflecting recent conditions, show a much lower risk of 0.129 for children of women aged 20-24.

**Table 4.2.2. Estimating of under-five mortality using Brass method: Sierra Leone**

| | N of women | CEB | CD | Mean parity | Proportion Dead | Multipliers | Probability of dying | logits | | Alpha | Reference period | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Age groups** | | | | **Pi** | **Di** | **Ki** | **qx** | **reported** | **standard** | **α** | **T(x)** | **Adjusted qx** |
| 15-19 | 3427 | 686 | 71 | 0.20 | 0.104 | 1.020 | 0.106 | -1.065 | -0.997 | -0.067 | -1.255 | 0.075 |
| 20-24 | 2629 | 2976 | 312 | 1.13 | 0.105 | 0.980 | 0.103 | -1.083 | -0.805 | -0.277 | -1.063 | 0.107 |
| 25-29 | 2728 | 6175 | 755 | 2.26 | 0.122 | 1.105 | 0.135 | -0.929 | -0.725 | -0.203 | -0.983 | 0.123 |
| 30-34 | 1942 | 6638 | 895 | 3.42 | 0.135 | 0.975 | 0.132 | -0.944 | -0.651 | -0.292 | -0.909 | 0.140 |
| 35-39 | 2224 | 9588 | 1447 | 4.31 | 0.151 | 1.039 | 0.157 | -0.841 | -0.550 | -0.291 | -0.807 | 0.166 |
| 40-44 | 1337 | 6710 | 1198 | 5.02 | 0.178 | 1.026 | 0.183 | -0.748 | -0.513 | -0.235 | -0.771 | 0.176 |
| 45-49 | 1288 | 6991 | 1494 | 5.43 | 0.214 | 1.008 | 0.215 | -0.646 | -0.455 | -0.191 | -0.713 | 0.194 |
| | | | | **P1/P2=** 0.18 | | | | | | | | |
| | | | | **P2/P3=** 0.50 | | | | | | -0.258 | | |

*Source: Sierra Leone demographic and health survey 2019*

Table 4.2.2 applies the same Brass indirect estimation method to Sierra Leone, showing a similar but steeper decline in child mortality over time. The data shows that children born in the past, to mothers who are now older, faced significantly higher risks of death with a 0.192 risk for children of women aged 45-49, while children born more recently to younger mother's face considerably lower risks 0.107 chance of dying for children of women aged 20-24.

**Table 4.2.3 Estimating of under-five mortality using Brass method: Guinea**

| | N of women | CEB | CD | Mean parity | Proportion Dead | Multipliers | | Logits | | Alpha | Reference period | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Age groups** | | | | **Pi** | **Di** | **Ki** | **qx** | **reported** | **standard** | **α** | **T(x)** | **Adjusted qx** |
| 15-19 | 2605 | 680 | 59 | 0.26 | 0.087 | 0.931 | 0.081 | -1.212 | -0.997 | -0.215 | -1.351 | 0.063 |
| 20-24 | 1758 | 2216 | 208 | 1.26 | 0.094 | 0.960 | 0.090 | -1.156 | -0.805 | -0.350 | -1.159 | 0.090 |
| 25-29 | 1908 | 4808 | 509 | 2.52 | 0.106 | 1.090 | 0.115 | -1.018 | -0.725 | -0.293 | -1.079 | 0.104 |
| 30-34 | 1437 | 5137 | 550 | 3.57 | 0.107 | 0.985 | 0.105 | -1.069 | -0.651 | -0.418 | -1.005 | 0.118 |
| 35-39 | 1312 | 5887 | 707 | 4.49 | 0.120 | 1.051 | 0.126 | -0.968 | -0.550 | -0.418 | -0.904 | 0.141 |
| 40-44 | 947 | 4787 | 696 | 5.06 | 0.145 | 1.038 | 0.151 | -0.863 | -0.513 | -0.350 | -0.867 | 0.150 |
| 45-49 | 908 | 4676 | 720 | 5.15 | 0.154 | 1.018 | 0.157 | -0.841 | -0.455 | -0.386 | -0.809 | 0.166 |
| | | | | **P1/P2=** 0.21 | | | | | | | | |
| | | | | **P2/P3=** 0.50 | | | | | | -0.354 | | |

*Source: Guinea demographic and health survey 2019*

Based on the Brass estimation method applied to Guinea on table 4.2.3; the data indicates a pronounced historical decline in child mortality. The pattern shows that children born in the past to older mothers faced a much higher risk of death 0.166 for children of women now aged 45-49 compared to children born more recently with 0.090 for children of women aged 20-24.

The detailed Brass estimation steps for all selected background variables, using the North model family, are provided in the appendix. The results are summarized in Tables 4.2.1 to 4.2.3.

**Table 4.2.4 Estimates of under-five mortality rate by selected variables for Nigeria, Sierra Leone and Guinea**

| Variables | Nigeria | Sierra Leone | Guinea |
|---|---|---|---|
| **Highest level of education** | | | |
| No education | 187 | 134 | 123 |
| Primary | 131 | 161 | 131 |
| Secondary | 089 | 119 | 073 |
| Higher | 068 | 097 | 038 |
| **Wealth Index combined** | | | |
| Poor | 186 | 145 | 135 |
| Middle | 139 | 149 | 133 |
| Rich | 084 | 123 | 084 |
| **Place of residence** | | | |
| Urban | 101 | 121 | 078 |
| Rural | 169 | 177 | 133 |
| **Source of drinking water** | | | |
| Tap water | 135 | 130 | 094 |
| Well water | 140 | 140 | 114 |
| Other non-portable sources | 155 | 141 | 140 |
| **Total** | 146 | 140 | 118 |

Source: *Own computations from the 2018 Nigeria, 2019 Sierra Leone, and 2018 Guinea demographic and health survey.*

Table 4.2.4 shows the estimates of under-five mortality rates based on the indirect method developed by Brass. Furthermore Table 4.2.1 indicate that under five mortality varies by selected background variables. Table 4.2.1 indicate that the under-five mortality rate was 146/1000 in Nigeria, 140/1000 in Siera Leone and 118/1000 in Guinea. This means that under-five mortality is highest in Nigeria, followed by Sierra Leone and lowest in Guinea. However, when looking on the direct estimates reported in the respective demographic and health surveys of the three countries, the rates are lower: 132 deaths per 1000 live births in Nigeria, 122 per 1000 live births in Sierra Leone and 111 per 1000 in Guinea (United Nations Inter-agency Group for Child Mortality Estimation, 2023). The rates may vary however they are close to each other, the demographic and health surveys reports used the direct Estimation (DHS Standard Method), whereby mothers were asked to provide a complete birth history (dates of birth and survival status of each child) and mortality rates (neonatal, infant, and under-five) were calculated directly from these reported outcomes (United Nations Inter-agency Group for Child Mortality Estimation, 2023). Mostly such rates for both the direct and indirect estimation method are as a results of several proximate and socio-economic determinants and this includes young maternal age and short birth intervals increase risk, low maternal education reduces awareness of preventive health practices, limited antenatal care and skilled birth attendance, poor availability of child health services, especially in rural areas, poverty and low household income limit access to nutritious food and healthcare, and rural households facing greater barriers compared to urban ones. Both estimations methods resonate with sustainable development goal 3.2, which calls for ending preventable deaths of children under five by 2030, making a huge emphasis on urgent need for increased progress in child health across the region.

Under-five mortality is negatively associated with the level of education. For Nigeria UFMR ranges from 187 under five deaths per 1000 live births for women with no education, followed by those with primary education estimated at about 131, for the ones with secondary education (089), and the ones with higher (068). Then Sierra Leone, the ones with no education estimated at (134), for the ones with primary education (161), followed by the ones with secondary education (119) and the ones with higher education (097). Moreover, in Guinea 123 of under five deaths per 1000 live births for those with no education was estimated, with primary education (131), followed by those with secondary education (073) and the ones with higher education (038).

Regarding wealth index combined; there is high under five mortality rates for those from poor households in Nigeria (186), followed by Sierra Leone (145), and Guinea (135). The is also high under five mortality for the middle-class households in Sierra Leone (149), followed by Nigeria (139), Guinea (133). Estimated under five mortality for Rich households in  Nigeria (084), Sierra Leone (123), and Guinea (084).

More under five mortality rates are reported by the ones coming from rural areas in Nigeria (169), Sierra Leone (177), and Guinea (133). Pertaining the ones from urban Nigeria; under five mortality estimated at about 101 deaths per 1000 live births, Sierra Leone (121), and Guinea (078).

Lastly; high under five mortality was also estimated mostly for source of drinking water; whereby Nigeria showed more estimate for the ones having access and drinking water from tap (135), Sierra Leone (130), and Guinea (094). Again, the ones having access and drinking water from non-portable sources from Nigeria reported a high estimate of about 155 deaths, Sierra Leone (141), and Guinea (140). Lastly, we have drinking well water; Nigeria (140), Sierra Leone (140), and Guinea (114).

## 4.3. Statistical findings

### 4.3.1 Characteristics of the study population

This section presents the statistical findings derived from the analysis of the three countries' dataset, employing univariate, bivariate, and multivariate techniques to examine the determinants of under-five mortality.

The analysis shows that the majority of the women were aged 25-34, with prevalences of 39.5% in Nigeria, 37.7% in Sierra Leone, and 38.5% in Guinea. This was followed by the 35-44 age group (30.0% in Nigeria, 30.4% in Sierra Leone, and 28.1% in Guinea), then 15-24 age group (Nigeria: 18.4%, Sierra Leone: 20.8%, and Guinea: 22.3%), and finally the 45-49 age group (12.0%, 11.0%, and 11.2%).

Regarding the sex of the child. Male children reported by the women were 51.3% in Nigeria, 50.3% in Sierra Leone, and 51.4% in Guinea. Female children were 48.7%, 49.7%, and 48.6% of deaths.

A critical factor appears to be the preceding birth interval. A large majority of women interviewed had a short interval of less than 33: 59.5% in Nigeria, 51.1% in Sierra Leone, and 51.1% in Guinea. Intervals of greater than 33 months accounted for 40.5 % (Nigeria), 48.9% (Sierra Leone), and 48.9% (Guinea) of deaths.

Concerning the duration of breastfeeding. In Nigeria, the highest proportion (71.0%) was among women who had ever breastfed, Sierra Leone (62.0%), and Guinea (62.9%). Those who never breastfed at the time of the survey accounted for 29.0%, 38.0%, and 37.1% of deaths in Nigeria, Sierra Leone, and Guinea.

The highest level of maternal education revealed stark contrasts. In Nigeria, mothers with no education accounted for 42.2% of deaths, Sierra Leone (56.9%), and Guinea (78.2%), while for those with primary education in Nigeria (16.9%), Sierra Leone (13.2%) and Guinea (9.8%). The ones with secondary and higher education in Nigeria accounted for 40.9%, Sierra Leone (30.0%), and Guinea 12.0%.

The wealth index combined shows that the majority women were from the poor wealth quintile: 40.5% in Nigeria, 40.4% in Sierra Leone, and 43.3% in Guinea. The middle quintile had the smallest share: 20.0% (Nigeria), 19.8% (Sierra Leone), and 19.9% (Guinea). The rich quintile accounted for 39.5% in Nigeria, 39.7% in Sierra Leone, and 36.8% in Guinea.

For current marital status, the vast majority was ever married mothers: 97.3% in Nigeria and 86.9% in Sierra Leone then in Guinea (95.2). Never married mothers accounted for 2.7% (Nigeria) and 13.1% (Sierra Leone), Guinea (4.8%).

The place of delivery was also a significant factor. In Nigeria, most mothers/ women (69.9%) delivered at home, then Sierra Leone (45.9%), and Guinea (61.4%). In contrast, in Sierra Leone, the vast majority (52.4%) delivered in a government institution, Nigeria (20.4%), and Guinea (34.7%). Private institution deliveries accounted for the smallest proportion women in each country, Nigeria:9.8%, Sierra Leone:1.7% and Guniea:3.9%.

Regarding place of residence, rural areas women accounted for 57.6% in Nigeria, 59.3% in Sierra Leone, and 68.6% in Guinea. Women from urban areas accounted for 42.4%, 40.7%, and 31.4%.

Finally, the source of drinking water indicates that using well water was common. In Nigeria, 66.0% women used well water, Sierra Leone (57.1%), Guinea (70.5%), and 23.1% women used other non-portable sources in Nigeria, followed by Guinea (24.9%) and Sierra Leone (8.6%). In Nigeria 10.9% used piped water, Sierra Leone (17.9% and Guinea (20.9%).

**Table 4.3.1. Percentage distribution of background characteristics of the study population.**

| **Variable** | **Nigeria** | | **Sierra Leone** | | **Guinea** | |
|---|---|---|---|---|---|---|
| | **Frequency** | **Percentage** | **Frequency** | **Percentage** | **Frequency** | **Percentage** |
| **Child is alive** | | | | | | |
| No | 2128 | 7.1 | 1013 | 8.8 | 525 | 6.8 |
| Yes | 27820 | 92.9 | 10444 | 91.2 | 7163 | 93.2 |
| **Maternal age** | | | | | | |
| 15-24 | 5524 | 18.4 | 2389 | 20.8 | 1718 | 22.3 |
| 25-34 | 11842 | 39.5 | 4320 | 37.7 | 2957 | 38.5 |
| 35-44 | 8986 | 30.0 | 3483 | 30.4 | 2157 | 28.1 |
| 45-49 | 3595 | 12.0 | 1265 | 11.0 | 857 | 11.2 |
| **Sex of child** | | | | | | |
| Male | 15355 | 51.3 | 5766 | 50.3 | 3953 | 51.4 |
| Female | 14593 | 48.7 | 5692 | 49.7 | 3736 | 48.6 |
| **Preceding birth interval** | | | | | | |
| Less than 33 | | | | | | |
| Greater than 33 | 17834 | 59.5 | 5854 | 51.1 | 3927 | 51.1 |
| **Breastfeeding status** | 12115 | 40.5 | 5604 | 48.9 | 3762 | 48.9 |
| Never breastfed | | | | | | |
| Ever breastfed | 8684 | 29.0 | 4348 | 38.0 | 2854 | 37.1 |
| **Highest level of education** | 21265 | 71.0 | 7109 | 62.0 | 4835 | 62.9 |
| No education | | | | | | |
| Primary | 12635 | 42.2 | 6517 | 56.9 | 6012 | 78.2 |
| Secondary or Higher | 5062 | 16.9 | 1509 | 13.2 | 753 | 9.8 |
| | 12251 | 40.9 | 3432 | 30.0 | 924 | 12.0 |
| **Wealth Index combined** | | | | | | |
| Poor | | | | | | |
| Middle | | | | | | |
| Rich | 12132 | 40.5 | 4632 | 40.4 | 3327 | 43.3 |
| **Current marital status** | 5976 | 20.0 | 2270 | 19.8 | 1533 | 19.9 |
| Never married | 11841 | 39.5 | 4554 | 39.7 | 2828 | 36.8 |
| Ever married | | | | | | |
| **Place of delivery** | 823 | 2.7 | 1501 | 13.1 | 367 | 4.8 |
| Home delivery | 29126 | 97.3 | 9957 | 86.9 | 7322 | 95.2 |
| Government institution | | | | | | |
| Private delivery | 20933 | 69.9 | 5261 | 45.9 | 4719 | 61.4 |
| **Place of residence** | 6095 | 20.4 | 6002 | 52.4 | 2668 | 34.7 |
| Urban | 2921 | 9.8 | 194 | 1.7 | 302 | 3.9 |
| Rural | | | | | | |
| **Source of drinking water** | 12690 | 42.4 | 4664 | 40.7 | 2413 | 31.4 |
| | 17259 | 57.6 | 6793 | 59.3 | 5276 | 68.6 |
| Piped water | | | | | | |
| Well water | | | | | | |
| Other non-portable sources | 3268 | 10.9 | 2055 | 17.9 | 1603 | 20.9 |
| | 19766 | 66.0 | 6544 | 57.1 | 5424 | 70.5 |
| | 6914 | 23.1 | 2858 | 24.9 | 661 | 8.6 |
| **Total** | | | | | | |

| Variable | Nigeria | | Sierra Leone | | Guinea | |
|---|---|---|---|---|---|---|
| | **Frequency** | **Percentage** | **Frequency** | **Percentage** | **Frequency** | **Percentage** |
| | **29949** | **100.0** | **11457** | **100.0** | **7689** | **100** |

*Own computations from the 2018 Nigeria, 2019 Sierra Leone, and 2018 Guinea demographic and health survey.*

## 4.4. Relationship between under five mortality and background variables

This section looks at the relationship between background variables and under-five mortality in the selected countries. Chi-square test is used to measure the strength. The results of this exercise are presented in Table 4.4.1.

**4.4.1. Nigeria**

The findings show that Maternal age, sex of child, preceding birth interval, duration of breastfeeding, highest level of education, wealth index combined, place of delivery, place of residence and Source of drinking water were statistically associated with child is alive. The only variable that is not significant is current marital status.

The prevalence of under-five mortality was highest among children born to mothers aged 45-49(11.5%%), followed by those aged 35-44 (7.7%%), then those aged 15-24 (6.7%), and 5.7 % for those aged 25-34.

Sex of child prevailed high prevalence of under five mortality among male children under five (7.5%), followed by females (6.6%).

Another determinant of under five mortality, which is preceding birth interval showing high prevalence of under five mortality for preceding birth interval of less than 33 months (7.8%), followed by greater than 33 months (6.0%).

Regarding duration of breastfeeding, there was high prevalence of under five mortality for those who never breastfed during the course of five years (12.9% %), followed by those who ever breastfed (4.7%).

The prevalence of under-five mortality is high among children born to women with no education and no children alive (9.4%%), those with primary education (7.4%%), followed by those with secondary or higher education (4.6%%).

Looking at wealth index combined, high prevalence of under five mortality was reported to poor households (9.4 %), middle households (7.0 %), and rich households (4.8 %).

High prevalence of under-five mortality was also reported for children born to women who delivered at home (7.9 %), then 5.6 % for private institution and 5.0 % for government delivery.

There was also high prevalence of under five mortality among children born to mothers from rural areas (8.2%), followed by the ones from urban areas (5.7%).

Pertaining to source of drinking water, major under five deaths were reported among children born to mothers who had access and were using well water (7.5%), piped water (6.8%), and other non-portable sources with 6.2%.

**Table 4.4.2. Bivariate findings for the factors associated with under five mortality in Nigeria.**

| **Child is alive** | | | | | **Chi-Square** | |
|---|---|---|---|---|---|---|
| **Characteristics** | **Dead** | **Alive** | **Total** | **Prevalence** | **Value** | **P-value** |
| **Maternal age** | | | | | | |
| 15-24 | 6.2 | 93.8 | 5525 | 6.2 | 151.808 | 0.000 |
| 25-34 | 5.7 | 94.3 | 11842 | 5.7 | | |
| 35-44 | 7.7 | 92.3 | 8986 | 7.7 | | |
| 45-49 | 11.5 | 88.5 | 3595 | 11.5 | | |
| **Sex of child** | | | | | | |
| Male | 7.5 | 92.5 | 15355 | 7.5 | 9.039 | 0.003 |
| Female | 6.6 | 93.4 | 14593 | 6.6 | | |
| **Preceding birth interval** | | | | | | |
| Less than 33 | 7.8 | 92.2 | 17834 | 7.8 | 35.080 | 0.000 |
| Greater than 33 | 6.0 | 94.0 | 12114 | 6.0 | | |
| **Breastfeeding status** | | | | | | |
| Never breastfed | 12.9 | 87.1 | 8683 | 12.9 | 634.470 | 0.000 |
| Ever breastfed | 4.7 | 95.3 | 21264 | 4.7 | | |
| **Highest level of education** | | | | | | |
| No education | 9.4 | 90.6 | 12635 | 9.4 | 210.267 | 0.000 |
| Primary | 7.4 | 92.6 | 5061 | 7.4 | | |
| Secondary or higher | 4.6 | 95.4 | 12251 | 4.6 | | |
| **Wealth Index combined** | | | | | | |
| Poor | 9.4 | 90.6 | 12131 | 9.4 | 189.433 | 0.000 |
| Middle | 7.0 | 93.0 | 5976 | 7.0 | | |
| Rich | 4.8 | 95.2 | 11840 | 4.8 | | |
| **Current marital status** | | | | | | |
| Never married | 7.3 | 92.7 | 822 | 7.3 | 0.033 | 0.855 |
| Ever married | 7.1 | 92.9 | 29126 | 7.1 | | |
| **Place of delivery** | | | | | | |
| Home delivery | 7.9 | 92.1 | 20933 | 7.9 | 74.213 | 0.000 |
| Government institution | 5.0 | 95.0 | 6094 | 5.0 | | |
| Private delivery | 5.6 | 94.4 | 2920 | 5.6 | | |
| **Place of residence** | | | | | | |
| Urban | 5.7 | 94.3 | 12689 | 5.7 | 69.467 | 0.000 |
| Rural | 8.2 | 91.8 | 17258 | 8.2 | | |
| **Source of drinking water** | | | | | | |
| Piped water | 6.8 | 93.2 | 3268 | 6.8 | 13.941 | 0.001 |

| Child is alive | | | | | Chi-Square | |
|---|---|---|---|---|---|---|
| **Characteristics** | **Dead** | **Alive** | **Total** | **Prevalence** | **Value** | **P-value** |
| Well water | 7.5 | 92.5 | 19766 | 7.5 | | |
| Other non-portable sources | 6.2 | 93.8 | 6913 | 6.2 | | |

Source: *NDHS 2018*

**Table 4.4.2 Sierra Leone**

The findings show that Maternal age, Sex of child, preceding birth interval, duration of breastfeeding, highest level of education, wealth index combined, and place of delivery were statistically associated with child is alive. The only variables that are not significant are, marital status, place of residence, and source of drinking water.

The prevalence of under-five mortality was highest among children born to mothers aged 45-49 (15.5%%), followed by those aged 35-44 (10.1 %%), then those aged 15-24 (7.1%), and 6.9 % for those aged 25-34.

Sex of child prevailed high prevalence of under five mortality among male children under five (10.0 %), followed by females (7.7 %).

Another determinant of under five mortality, which is preceding birth interval showing high prevalence of under five mortality for preceding birth interval of less than 33 months (10.5 %), followed by greater than 33 months (7.1 %).

Regarding duration of breastfeeding, there was high prevalence of under five mortality for those who never breastfed during the course of five years (13.9 % %), followed by those who ever breastfed (5.7%).

The prevalence of under-five mortality is high among children born to women with no education and no children alive (9.9%%), those with primary education (7.9%%), followed by those with secondary or higher education (7.2%%).

Looking at wealth index combined, high prevalence of under-five mortality was reported by middle households (10.3%), poor households (9.0%), and rich households (7.9 %).

Regarding place of delivery, highest under five deaths were reported among children born to mothers who delivered at home (11.6%), followed by the ones who delivered at government institutions (6.6%), and 4.8% for the ones who delivered at private institutions.

## Table 4.4.3 Bivariate findings for the factors associated with under five mortality in Sierra Leone.

| Child is alive | | | | | Chi-Square | |
|---|---|---|---|---|---|---|
| **Characteristics** | **Dead** | **Alive** | **Total** | **Prevalence** | **Value** | **P-value** |
| **Maternal age** | | | | | | |
| 15-24 | 7.1 | 92.9 | 2388 | 7.1 | 106.590 | 0.000 |
| 25-34 | 6.9 | 93.1 | 4320 | 6.9 | | |

| Child is alive | | | | | Chi-Square | |
|---|---|---|---|---|---|---|
| **Characteristics** | **Dead** | **Alive** | **Total** | **Prevalence** | **Value** | **P-value** |
| 35-44 | 10.1 | 89.9 | 3482 | 10.1 | | |
| 45-49 | 15.5 | 84.5 | 1265 | 15.5 | | |
| **Sex of child** | | | | | | |
| Male | 10.0 | 90.0 | 5765 | 10.0 | 19.480 | 0.000 |
| Female | 7.7 | 92.3 | 5691 | 7.7 | | |
| **Preceding birth interval** | | | | | | |
| Less than 33 | 10.5 | 89.5 | 5853 | 10.5 | 40.756 | 0.000 |
| Greater than 33 | 7.1 | 92.9 | 5603 | 7.1 | | |
| **Breastfeeding status** | | | | | | |
| Never breastfed | 13.9 | 86.1 | 4348 | 13.9 | 222.228 | 0.000 |
| Ever breastfed | 5.7 | 94.3 | 7108 | 5.7 | | |
| **Highest level of education** | | | | | | |
| No education | 9.9 | 90.1 | 6516 | 9.9 | 23.399 | 0.000 |
| Primary | 7.9 | 92.1 | 1509 | 7.9 | | |
| Secondary or higher | 7.2 | 92.8 | 3431 | 7.2 | | |
| **Wealth Index combined** | | | | | | |
| Poor | 9.0 | 91.0 | 4633 | 9.0 | 11.275 | 0.004 |
| Middle | 10.3 | 89.7 | 2269 | 10.3 | | |
| Rich | 7.9 | 92.1 | 4554 | 7.9 | | |
| **Current marital status** | | | | | | |
| Never married | 9.1 | 90.9 | 1500 | 9.1 | 0.128 | 0.721 |
| Ever married | 8.8 | 91.2 | 9956 | 8.8 | | |
| **Place of delivery** | | | | | | |
| Home delivery | 11.6 | 88.4 | 5260 | 11.6 | 89.828 | 0.000 |
| Government institution | 6.6 | 93.4 | 6002 | 6.6 | | |
| Private delivery | 4.8 | 95.2 | 193 | 4.8 | | |
| **Place of residence** | | | | | | |
| Urban | 8.0 | 92.0 | 4664 | 8.0 | 7.437 | 0.006 |
| Rural | 9.4 | 90.6 | 6792 | 9.4 | | |
| **Source of drinking water** | | | | | | |
| Piped water | 8.4 | 91.6 | 2055 | 8.4 | 0.977 | 0.614 |
| Well water | 9.1 | 90.9 | 6543 | 9.1 | | |
| Other non-portable sources | 8.7 | 91.3 | 2858 | 8.7 | | |

Source: *SLDHS 2019*

**Table 4.4.4. Guinea**

The findings show that Maternal age, preceding birth interval, duration of breastfeeding, wealth index combined, place of deliver, and source of drinking water were statistically associated with child is alive. The only variables that are not significant are, sex of child, highest level of education, current marital status, and source of drinking water.

Under five mortality, was high among children born to mothers who were aged 45-49 (9.7% %), followed by 35-44 (7.8 %), then 15-24 (6.2 %), and 25-34 (5.6%).

Another determinant of under five mortality, which is preceding birth interval showing high prevalence of under five mortality for preceding birth interval of less than 33 months (7.8%), followed by greater than 33 months (5.8 %).

Regarding duration of breastfeeding, there was high prevalence of under five mortality for those who never breastfed during the course of five years (10.4 % %), followed by those who ever breastfed (4.7%).

Looking at wealth index combined, high prevalence of under five mortality was reported to poor households (8.3 %), middle households (7.9 %), and rich households (4.5 %).

High prevalence of under-five mortality was also reported for children born to women who delivered at home (8.0 %), then 3.5 % for private institution and 5.2 % for government delivery.

There was also high prevalence of under five mortality among children born to mothers from rural areas (8.0 %), followed by the ones from urban areas (4.4 %).

**Table 4.4.5 Bivariate findings for the factors associated with under-five mortality in Guinea.**

| **Child is alive** | | | | | **Chi-Square** | |
|---|---|---|---|---|---|---|
| **Characteristics** | **Dead** | **Alive** | **Total** | **Prevalence** | **Value** | **P-value** |
| **Maternal age** | | | | | | |
| 15-24 | 6.2 | 93.8 | 1717 | 6.2 | 22.865 | 0.000 |
| 25-34 | 5.6 | 94.4 | 2956 | 5.6 | | |
| 35-44 | 7.8 | 92.2 | 2156 | 7.8 | | |
| 45-49 | 9.7 | 90.3 | 857 | 9.7 | | |
| **Sex of child** | | | | | | |
| Male | 7.2 | 92.8 | 3952 | 7.2 | 1.975 | 0.160 |
| Female | 6.4 | 93.6 | 3735 | 6.4 | | |
| **Preceding birth interval** | | | | | | |
| Less than 33 | 7.8 | 92.2 | 3927 | 7.8 | 12.824 | 0.000 |
| Greater then 33 | 5.8 | 94.2 | 3761 | 5.8 | | |
| **Breastfeeding status** | | | | | | |
| Never breastfed | 10.4 | 89.6 | 2853 | 10.4 | 91.285 | 0.000 |
| Ever breastfed | 4.7 | 95.3 | 4834 | 4.7 | | |
| **Highest level of education** | | | | | | |
| No education | 7.5 | 92.5 | 6011 | 7.5 | 22.157 | 0.703 |
| Primary | 5.7 | 94.3 | 752 | 5.7 | | |
| Secondary or higher | 3.4 | 96.6 | 924 | 3.4 | | |
| **Wealth Index combined** | | | | | | |
| Poor | 8.3 | 91.7 | 3327 | 8.3 | 38.535 | 0.000 |
| Middle | 7.9 | 92.1 | 1533 | 7.9 | | |
| Rich | 4.5 | 95.5 | 2828 | 4.5 | | |
| **Current marital status** | | | | | | |
| Never married | 5.0 | 95.0 | 367 | 5.0 | 2.095 | 0.148 |
| Ever married | 6.9 | 93.1 | 7321 | 6.9 | | |
| **Place of delivery** | | | | | | |
| Home delivery | 8.0 | 92.0 | 4718 | 8.0 | 25.856 | 0.000 |
| Government institution | 5.2 | 94.8 | 2668 | 5.2 | | |
| Private delivery | 3.5 | 96.5 | 301 | 3.5 | | |
| **Place of residence** | | | | | | |

| Child is alive | | | | | Chi-Square | |
|---|---|---|---|---|---|---|
| **Characteristics** | **Dead** | **Alive** | **Total** | **Prevalence** | **Value** | **P-value** |
| Urban | 4.4 | 95.6 | 2412 | 4.4 | 33.795 | 0.000 |
| Rural | 8.0 | 92.0 | 5276 | 8.0 | | |
| **Source of drinking water** | | | | | | |
| Piped water | 5.2 | 94.8 | 1603 | 5.2 | 9.320 | 0.009 |
| Well water | 7.2 | 92.8 | 5424 | 7.2 | | |
| Other non-portable sources | 8.0 | 92.0 | 608 | 8.0 | | |

Source: *GDHS 2018*

## 4.5. Factors determining under five mortality.

The relationship between under-five mortality and background is further explored using logistic regression.

Table 4.5.1 presents the multivariate regression results for the relationship between under five mortality and background characteristics in Nigeria.

**Table 4.5.1 Nigeria**

The findings show that under five mortality to female children was 0.861 [95% CI: 0.787-0.943] times less likely to contribute to under five mortality compared to male children.

Then children born to mothers with preceding birth interval of greater than 33 were 0.726 [95% CI: 0.658-0.800] times less likely to contribute to under five mortality compared to the ones with greater than 33 months.

Children born to mothers who ever breastfed were 4.343 [95% CI: 3.854-4.893] times more likely to contribute to under five mortality compared to the ones who never breastfed.

Again, children born to mothers with primary education were 0.531 [ 95% CI: 0.463-0.608] times less likely to contribute to under five mortality compared to the ones with no education. The ones with secondary or higher education were 0.695 [ 95 %CI: 0.601-0.805] times less likely to contribute to under five mortality compared to the ones with no education.

Regarding wealth index combined; children born to women who belongs to middle class household were 0.520 [95% CI: 0.449-0.602] less likely to contribute to under five mortality compared to the ones from poor households. Also, the ones from Rich households were 0.708 [ 95% CI: 0.613-0.819] times less likely to contribute to under five mortality compared to the ones from poor households.

Children born to women who delivered at government institutions were 2.454 [95% CI: 2.026-2.972] more likely to contribute to under five mortality compared to the one who delivered at home. Children born to women who delivered at private institution were 1.516 [95 % CI: 1.239-1.855] more likely more likely to contribute to under five mortality compared to the one who delivered at home.

The ones born to mothers who had access to well water were 0.837 [95% CI: 0.705-0.995] less likely to contribute to under five mortality compared to the one accessing piped water. Furthermore, children born to mothers who had access to other non-portable sources were 0.896 [95% CI: 0.798-1.006] less likely to contribute to under five mortality compared to the having access to piped water.

**Table 4.5.1 Regression findings for the factors determining under five mortality in Nigeria**

| | | | | | 95% C.I | |
|---|---|---|---|---|---|---|
| **Characteristics** | **B** | **S.E** | **Sig** | **Exp (B)** | **Lower** | **Upper** |
| **Maternal age** | | | | | | |
| 15-24 ® | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 25-34 | -0.099 | 0.092 | 0.284 | 0.906 | 0.756 | 1.085 |
| 35-44 | -0.030 | 0.077 | 0.691 | 0.970 | 0.835 | 1.127 |
| 45-49 | 0.000 | 0.069 | 0.997 | 1.000 | 0.874 | 1.145 |
| **Sex of child** | | | | | | |
| Male ® | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| Female | -0.149 | 0.046 | 0.001 | 0.861 | 0.787 | 0.943 |
| **Preceding birth interval** | | | | | | |
| Less than 33 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| Greater than 33 | -0.320 | 0.050 | 0.000 | 0.726 | 0.658 | 0.800 |
| **Breastfeeding status** | | | | | | |
| Never breastfed | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| Ever breastfed | 1.468 | 0.061 | 0.000 | 4.343 | 3.854 | 4.893 |
| **Highest level of education** | | | | | | |
| No education ® | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| Primary | -0.633 | 0.069 | 0.000 | 0.531 | 0.463 | 0.608 |
| Secondary or higher | -0.363 | 0.075 | 0.000 | 0.695 | 0.601 | 0.805 |
| **Wealth Index combined** | | | | | | |
| Poor ® | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| Middle | -0.654 | 0.075 | 0.000 | 0.520 | 0.449 | 0.602 |
| Rich | -0.345 | 0.074 | 0.000 | 0.708 | 0.613 | 0.819 |
| **Current marital status** | | | | | | |
| Never married® | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| Ever married | -0.106 | 0.142 | 0.456 | 0.900 | 0.682 | 1.187 |
| **Place of delivery** | | | | | | |
| Home delivery ® | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| Government institution | 0.898 | 0.098 | 0.000 | 2.454 | 2.026 | 2.972 |
| Private delivery | 0.416 | 0.103 | 0.000 | 1.516 | 1.239 | 1.855 |
| **Place of residence** | | | | | | |
| Urban ® | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| Rural | 0.067 | 0.058 | 0.248 | 1.070 | 0.954 | 1.200 |
| **Source of drinking water** | | | | | | |
| Piped water® | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| Well water | -0.177 | 0.088 | 0.044 | 0.837 | 0.705 | 0.995 |
| Other non-portable sources | -0.110 | 0.059 | 0.062 | 0.896 | 0.798 | 1.006 |
| **Constant** | **2.065** | **0.132** | **0.000** | **7.882** | | |

*Note: P-values = P ≤ 0.001; P ≤ 0.01; P < 0.05; ® -Reference category; CI = confidence interval*

Table 4.5.1 presents the multivariate regression results for the relationship between under five mortality and background characteristics in Sierra Leone.

The findings show that under five mortality occurred or got to be experienced the most among children born to mothers aged 25-34 and were 1.649 [ 95% CI: 1.248-2.180] times more likely to contribute to under five mortality compared to those aged 15-24. Also, the ones aged 35-44 were 1.683 [95% CI: 1.355-2.091] times more likely to contribute to under five mortality compared to those aged 15-24 and 25-34. The ones aged 45-49 were 1.331 [95% CI: 1.096-1.616] times more likely to contribute to under five mortality compared to the ones aged 15-24 and the ones aged 35-44.

Female children born to mothers from Sierra Leone were 0.722 [95% CI: 0.633-0.824] times less likely to contribute to under five mortality compared to male children.

Then children born to women with preceding birth interval of greater than 33 months were 0.616 [95% CI: 0.534-0.710] times less likely to contribute to under five mortality compared to the ones with greater than 33 months.

Regarding duration of breastfeeding, children born to mothers who ever breastfed were 3.765 [ 95% CI: 2.911-4.870] more likely to contribute to under five mortality compared to the ones who never breastfed.

Furthermore, children born to mothers with primary education were 0.823 [95% CI: 0.683-0.992] less likely to contribute to under five mortality compared to the ones with no education. Also, children born to mothers with secondary or higher education were 0.948 [95% CI: 0.745-1.207] less likely to contribute to under five mortality compared to the ones with no education.

**Table 4.5.2 Regression findings for the factors determining under five mortality in Sierra Leone**

| | | | | | 95% C. I | |
|---|---|---|---|---|---|---|
| **characteristics** | **B** | **S.E** | **Sig** | **Exp (B)** | **Lower** | **Upper** |
| **Maternal age** | | | | | | |
| 15-24 ® | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 25-34 | 0.500 | 0.142 | 0.000 | 1.649 | 1.248 | 2.180 |
| 35-44 | 0.521 | 0.111 | 0.000 | 1.683 | 1.355 | 2.091 |
| 45-49 | 0.286 | 0.099 | 0.004 | 1.331 | 1.096 | 1.616 |
| **Sex of child** | | | | | | |
| Male ® | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| Female | -0.325 | 0.068 | 0.000 | 0.722 | 0.633 | 0.824 |
| **Preceding birth interval** | | | | | | |
| Less than 33 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| Greater than 33 | -0.485 | 0.073 | 0.000 | 0.616 | 0.534 | 0.710 |
| **Breastfeeding status** | | | | | | |
| Never breastfed® | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| Ever breastfed | 1.326 | 0.131 | 0.000 | 3.765 | 2.911 | 4.870 |
| **Highest level of education** | | | | | | |

| characteristics | B | S.E | Sig | Exp (B) | 95% C. I | |
|---|---|---|---|---|---|---|
| | | | | | Lower | Upper |
| No education ® | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| Primary | -0.194 | 0.095 | 0.041 | 0.823 | 0.683 | 0.992 |
| Secondary or higher | -0.054 | 0.123 | 0.664 | 0.948 | 0.745 | 1.207 |
| **Wealth Index combined** | | | | | | |
| Poor ® | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| Middle | -0.024 | 0.128 | 0.849 | 0.976 | 0.760 | 1.254 |
| Rich | -0.189 | 0.121 | 0.119 | 0.828 | 0.653 | 1.050 |
| **Current marital status** | | | | | | |
| Never married ® | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| Ever married | -0.143 | 0.109 | 0.188 | 0.867 | 0.701 | 1.072 |
| **Place of delivery** | | | | | | |
| Home delivery ® | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| Government institution | 0.442 | 0.359 | 0.218 | 1.556 | 0.770 | 3.145 |
| Private delivery | -0.184 | 0.342 | 0.591 | 0.832 | 0.425 | 1.628 |
| **Place of residence** | | | | | | |
| Urban ® | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| Rural | 0.170 | 0.115 | 0.141 | 1.185 | 0.945 | 1.486 |
| **Source of drinking water** | | | | | | |
| Borehole/rain ® | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| River/Stream lake | -0.067 | 0.112 | 0.550 | 0.935 | 0.752 | 1.164 |
| Other non-portable sources | -0.074 | 0.083 | 0.368 | 0.928 | 0.790 | 1.092 |
| **Constant** | **1.754** | **0.393** | **0.000** | **5.778** | | |

*Note: P-values = P ≤ 0.001; P ≤ 0.01; P < 0.05; ® -Reference category; CI = confidence interval*

Table 4.5.3 presents the multivariate regression results for the relationship between under five mortality and background characteristics in Guinea. The findings shows preceding birth interval, breastfeeding, education, wealth index combined are significantly related to child mortality.

The findings show that children born to mothers with preceding birth interval of greater than 33 were 0.690 [95% CI: 0.570-0.835] times less likely to contribute to under five mortality compared to the ones with less than 33 months.

Regarding duration of breastfeeding, children born to women who ever breastfed were 2.456 [ 95% CI: 1.976-3.054] more likely to contribute to under five mortality compared to the ones who never breastfed.

Furthermore, children born to mothers with primary education were 0.653 [ 95% CI: 0.437-0.976] times less likely to contribute to under five mortality compared to the ones with no education. The ones with secondary and higher education were 0.691 [ 95 %CI: 0.427-1.117] times less likely to contribute to under five mortality compared to the ones with no education.

Followed by children born to mothers who belongs to middle class households who were 0.654 [ 95 % CI: 0.470-0.909] times less likely to contribute to under five mortality compared to the ones from poor households. Also, the ones from rich households were 0.698 [ 95% CI: 0.495-0.984] times less likely to contribute to under five mortality compared to the ones from poor households.

**Table 4.5.3. Regression findings for the factors determining under five mortality in Guinea**

| characteristics | B | S.E | Sig | Exp (B) | 95% C.I Lower | 95% C.I Upper |
|---|---|---|---|---|---|---|
| **Maternal age** | | | | | | |
| 15-24 ® | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 25-34 | 0.027 | 0.178 | 0.879 | 1.027 | 0.725 | 1.455 |
| 35-44 | 0.162 | 0.152 | 0.287 | 1.175 | 0.873 | 1.583 |
| 45-49 | 0.006 | 0.144 | 0.965 | 1.006 | 0.758 | 1.335 |
| **Sex of child** | | | | | | |
| Male ® | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| Female | -0.105 | 0.092 | 0.252 | 0.900 | 0.752 | 1.078 |
| **Preceding birth interval** | | | | | | |
| Less than 33 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| Greater than 33 | -0.371 | 0.098 | 0.000 | 0.690 | 0.570 | 0.835 |
| **Breastfeeding status** | | | | | | |
| Never breastfed® | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| Ever breastfed | 0.899 | 0.111 | 0.000 | 2.456 | 1.976 | 3.054 |
| **Highest level of education** | | | | | | |
| No education ® | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| Primary | -0.427 | 0.205 | 0.037 | 0.653 | 0.437 | 0.976 |
| Secondary or higher | -0.370 | 0.245 | 0.132 | 0.691 | 0.427 | 1.117 |
| **Wealth Index combined** | | | | | | |
| Poor ® | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| Middle | -0.425 | 0.168 | 0.012 | 0.654 | 0.470 | 0.909 |
| Rich | -0.360 | 0.175 | 0.040 | 0.698 | 0.495 | 0.984 |
| **Current marital status** | | | | | | |
| Never married® | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| Ever married | 0.227 | 0.255 | 0.374 | 1.255 | 0.761 | 2.068 |
| **Place of delivery** | | | | | | |
| Home delivery ® | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| Government institution | 0.116 | 0.334 | 0.728 | 1.123 | 0.584 | 2.161 |
| Private delivery | -0.043 | 0.331 | 0.897 | 0.958 | 1.202 | 1.833 |
| **Place of residence** | | | | | | |
| Urban ® | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| Rural | 0.306 | 0.177 | 0.083 | 1.358 | 0.960 | 1.919 |
| **Source of drinking water** | | | | | | |
| Piped water® | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| Well water | 0.033 | 0.202 | 0.869 | 1.034 | 0.696 | 1.536 |
| Other non-portable sources | 0.148 | 0,155 | 0.338 | 1.160 | 0.856 | 1.570 |
| **Constant** | **2.720** | **0.438** | **0.000** | **15.176** | | |

*Note: P-values = P ≤ 0.001; P ≤ 0.01; P < 0.05; ® -Reference category; CI = confidence interval*

## 4.6 Comparative analysis

This chapter presented the findings of the study. The results revealed that under-five mortality is highest in Nigeria, followed by Sierra Leone, and lowest in Guinea. Background characteristics of the study populations and their relationship with under-five mortality are also presented.

**Similarities**

The analysis reveals a strong set of similarities across Nigeria, Sierra Leone, and Guinea, underscoring shared regional challenges in child survival. A consistent socioeconomic gradient is evident, where higher levels of maternal education and wealth are powerfully associated with lower under-five mortality rates. Furthermore, key behavioral and biological factors operate uniformly as critical protective measures: children who were ever breastfed and those born after a birth interval greater than 33 months have a dramatically lower risk of death across all three countries. The data also persistently shows a significant rural-urban divide, with children in rural areas facing a higher mortality risk, and a universal trend of male children being more vulnerable than females.

**Distinctions/differences**

Despite these common patterns, important distinctions exist in the significance of these risk factors. Nigeria suffers from the highest overall under-five mortality rate, followed by Sierra Leone and then Guinea. The impact of maternal education also varies notably; while higher education consistently reduces risk in Nigeria and Guinea, Sierra Leone presents an anomaly where mothers with only a primary education have a higher mortality rate than those with no education. The multivariate analyses further highlight these differences. In Nigeria, a wide range of factors, including water source and place of delivery which remain significant predictors. In contrast, Sierra Leone's model uniquely identifies advanced maternal age as a strong risk factor, while Guinea's model is more streamlined, with fewer variables retaining statistical significance.

**Uniqueness**

Each country also demonstrates a point of uniqueness. Nigeria stands out for a perplexing paradox where, contrary to global evidence, children born in health facilities or with access to piped water show a higher risk of mortality in the regression analysis, suggesting potential issues with healthcare quality or confounding factors. Sierra Leone is distinguished by its unusual education pattern and the pronounced effect of maternal age on child survival. Guinea presents the most intriguing case, as it has the lowest overall mortality rate despite having the highest proportion of mothers with no formal education. This suggests that other, unmeasured cultural or programmatic factors may be powerfully at work, making Guinea's success in reducing child mortality a unique phenomenon within the region.

# CHAPTER FIVE: DISCUSSIONS, CONCLUSIONS AND RECOMMENDATIONS OF THE STUDY

### 5.1 Introduction

This chapter presents the study's conclusions and suggestions while also discussing the findings that were previously presented in the previous chapters and also highlights the key findings. The study bases its approach to these talks on the predictors chosen for the investigation, also the recommendations for the study are then identified with suggestions for possible future research are provided.

## 5.2. Summary of findings

The first objective is to assess the prevalence of under-five mortality in Nigeria, Sierra Leone, and Guinea and this study revealed a disproportionate share of under-five mortality among children born to women from the three countries. Specifically, children born to women from Sierra Leone accounted for a proportion of 8.8 % of all under-five deaths in the sample, while those from Nigeria and Guinea each accounted for 7.1% and 6.8%. This finding is supported by other similar studies. Whereby Adama et al (2025); and (Mouteyica & Ngepah, 2025); , revealed differentials in broader regional trends, and Nigeria, Sierra Leone and Guinea were among the highest countries in the West Africa region with high under five mortality, persistently high under-five mortality rates for Nigeria (84.5 per 1,000 live births) and Sierra Leone (64.3) by 2030, revealing the challenge these countries face in meeting Sustainable Development Goal 3 (SDG 3) targets. In terms of estimates under-five mortality rates ranged from 146 per 1000 live births in Nigeria, 140 per 1000 live births in Sierra Leone, and 118 per 1000 live births in Guinea. This finding is supported by other similar studies (Birhanie et al., 2025); (Ogbuoji & Yamey, 2019).

The second specific objective is to investigate socio-demographic factors associated with under-five mortality in Nigeria, Sierra Leone, and Guinea. Across these three West African nations the study revealed that survival of a child is deeply related to a complex interplay of maternal and household factors. Common factors, such as the mother's age, sex of child the spacing between births, the family's economic standing, and where they live, were consistently significant in all three countries. However, the picture also has different direction, with Nigeria showing additional links to factors like source of drinking water and place of delivery, while in Guinea, a mother's education and breastfeeding duration did not show the same statistical relationship to child survival as they did elsewhere. This finding is supported by other similar findings (Avelino et al., 2025); (Faruk et al., 2025); (Ezeh et al., 2015).

The third specific objective is to estimate the under-five mortality rate by selected socio-demographic factors for Nigeria, Sierra Leone and Guinea. The multivariate findings revealed that maternal age, preceding birth interval, highest level of education, wealth index combined, current marital status and place of residence are statistically associated with under five mortality in Nigeria. Secondly, maternal age, preceding birth interval, duration of breastfeeding, current marital status and place of residence are statistically associated with under five mortality in Sierra Leone, and in Guinea only maternal age, preceding birth interval, duration of breastfeeding, highest level of education, wealth index combined and current marital status are statistically associated with under five mortalities. This findings are supported different studies (Zuma et al., 2020); (Rademeyer, 2019).

### 5.2. Discussions

This study aimed to examine factors associated with under-five mortality in Nigeria, Sierra Leone, and Guinea. This study revealed a disproportionate share of under-five mortality among children born to women from the three countries. Specifically, children born to women from Sierra Leone accounted for 8.8 % of all under-five deaths in the sample, while those from Nigeria and Guinea each accounted for 7.1 % and 6.8 %. This finding is supported by other similar studies. These results tended to have slight differences from the broader regional trends identified by Adama et al., (2025), who estimated persistently high under-five mortality rates for Nigeria (84.5 per 1,000 live births) and Sierra Leone (64.3) by 2030, revealing the challenge these countries face in meeting Sustainable Development Goal 3 (SDG 3) targets. The elevated mortality rates in these findings reveal systemic health inequities, including limited access to maternal care, poor infrastructure, and socioeconomic vulnerabilities that disproportionately affect child survival (Adama et al., 2025).

For this study on estimates of under-five mortality rates by selected variables for Nigeria, Sierra Leone and Guinea found that there is high under five mortality rates for children born to mothers with no education, compared to the ones with primary education, secondary education and last the ones with higher education across the three countries. This is supported by others studies (Bado & Sathiya Susuman, 2016; Mazumder et al., 2024; Tessema & Geda, 2024).

The authors revealed that this is as a result of poor health-seeking behavior and limited access to antenatal care (Bado & Sathiya Susuman, 2016; Mazumder et al., 2024). This is not ending, as other studies revealed that maternal education had limited impact on child mortality as a result of systemic healthcare failures and conflict-related disruptions (Bbaale, 2016

; Lassi, 2019; Okeke et al., 2024). Evidently, educated mothers faced barriers to accessing services.

The study also revealed that Nigeria had high under five mortality rates for children born to mothers/ women from poor/their wealth index combined is poor compared to the ones from rich status from the three countries. These differentials tend to be characterized by food insecurity, poor sanitation, and limited access to any form of quality healthcare, and this tends to results to a survival deficit that is difficult to eliminate or eradicate. This finding of wealth index combined for the three different countries is strongly supported by the work of other authors (Nwosu & Ataguba, 2020; Victora et al., 2018). However other authors came with contradicting findings, that in weak countries, even people with the economic means to seek care often face health facilities that lack skilled providers, essential medicines, and reliable equipment (M. E. Kruk et al., 2018; Mugisha et al., 2022). This makes up a case whereby wealth does not reliably translate into better health outcomes, as the quality of care is low for everyone. This directly paints a picture and evidence why in Sierra Leone, a family from the middle or even rich wealth quintile may still face a high risk of losing a child.

Another finding from the study, Under five mortality rate is high among children born to women from rural areas than the ones from urban areas. This finding is similar to other studies (Sarkodie, 2021). Contrarily, other studies found that there is a higher urban under five mortality rate than that in rural areas, and they revealed it as urban penalty in places with weak governance and infrastructure. One of those studies, found that slum populations in informal settlements in West Africa, with their high density, poor sanitation, and intense poverty can constitute health risks that rival or even exceed those in rural areas (Mekonnen et al., 2024; Olufadewa et al., 2025).

In its last finding from the estimates, the study found high UM5R for the children born to women accessing other non-portable sources for drinking water in all the three countries. The under-five mortality rate is high among children born to women having access to other non-portable sources compared to the ones using borehole/ rainwater. The finding that Nigeria had the highest U5MR among children born to women using other non-portable sources, followed by Sierra Leone and Guinea, relate or is similar other work by other authors (Picarelli, 2019; Wolf et al., 2018).

Another study by Feleke (2018), in Bangladesh and Ethiopia revealed that water from improved sources was generally safe at the point of collection, widespread contamination occurred during transport and storage in the household as a result of unhygienic practices (Feleke et al., 2018). In contrast, a study done in Kenya found that having access to protected springs significantly minimized child diarrheal prevalence (Peletz et al., 2018; Waruguru & Chege, 2019).

The over emphasis of under-five deaths among children born to women from Sierra Leone and Nigeria may be partially explained by maternal and household-level factors. Koroma et al. (2022) found that in Sierra Leone, maternal age below 20 years, inadequate birth spacing, and male child gender mostly increased mortality risk, while protective factors included exclusive breastfeeding and maternal age above 20 (Eke, 2020; A. H. Koroma et al., 2022). These findings raise eyebrows for the importance of maternal health interventions and targeted education programs to address preventable mortality risks in high-burden regions (Eke, 2020).

In terms of bivariate analysis, the study findings indicated that Maternal age, Sex of child, preceding birth interval, duration of breastfeeding, highest level of education, wealth index combined, place of delivery, place of residence and Source of drinking water were statistically associated with child is alive in Nigeria, then for Sierra Leone the findings show that Maternal age, sex of child, preceding birth interval, duration of breastfeeding, highest level of education, wealth index combined, and place of delivery were statistically associated with child is alive and in Guinea the findings show that Maternal age, preceding birth interval, duration of breastfeeding, wealth index combined, place of delivery, and place of residence were statistically associated with child is alive.

The study found that maternal age is significant related to under fie mortality in Nigeria, Sierra Leone and Guinea. Under five mortality is higher among children born to women aged 45-49 than the ones aged 15-24, 25-34, 35-44. Also, under five mortality is higher among children born to women aged 35-44 than the ones ages 25-34 across the three countries. This finding is supported by other studies. (Rademeyer, 2019; Yaya, 2018; Yaya et al., 2019). Mostly as a result that mothers aged 35-49 in these three countries face complications such as hypertension, gestational diabetes, and placental problems, again older mothers are facing high chances to experience preterm births, low birth weight, and congenital anomalies, all of which increases under-five mortality (M. M. Koroma et al., 2022). In contrast, there are studies with different findings from this one (Ahinkorah, 2021; Birhanie et al., 2025). These studies also found that maternal age is associated with under five mortality, however it found higher odds of under-five mortality among children of adolescent mothers (<20 years) compared to those born to mothers aged 20–34. Mostly because of adolescent mothers being less likely to seek antenatal care early or consistently, as a result of stigma, lack of autonomy, or financial barriers (Adama et al., 2025).

The study found that place of residence is significant related to under five mortality in Nigeria, Sierra Leone, and Guinea. Across the three countries under five mortality is higher among children born to women from rural areas than urban areas. Mostly such a case revealed by the findings as a result of having areas with poorly regulated health care facilities, staffed by unqualified personnel, and not inappropriate interventions, such as unnecessary caesarean sections or improper management of neonatal complications, which can result in high prevalence of mortality risk. This pattern is similar to findings by various researchers (Adewuyi et al., 2024; Ngene et al., 2023; Ooreoluwa Onakalu et al., 2025). However, some studies revealed urban settings with high cases of under five mortality (Birhanie et al., 2025; Dendup et al., 2021). This is as a result of having urban slums exposing children to infectious diseases, unsafe water, and environmental hazards, reducing the healthcare advantage of cities.

Factors like home deliveries, while risky, may often be uncomplicated births managed by traditional birth attendants, highlighting better outcomes for low-risk pregnancies than a poorly managed delivery in a substandard private clinic (Adewuyi et al., 2024; Rezaei et al., 2019). In contrary, Ekholuenetale et al. (2020), found that there is triple threat of rural residence in Nigeria and this includes distance, poverty, and poor health literacy (Ekholuenetale, 2020). Again, that there are urban slums in Freetown, seen with extreme overcrowding, poor sanitation, and limited access to clean water, create a high-risk environment for infectious diseases that kill children.

The study also revealed that duration of breastfeeding is significantly associated with under five mortality across the three countries. Under five mortality is higher among children whose mothers never breastfed, than those who ever breastfed. This study is supported by a systematic review and meta-analysis which showed that non-breastfed children had significantly higher risks of under-five mortality, particularly from infectious diseases such as diarrhea and pneumonia(Pretorius et al., 2020).In contrast, another study revealed that continued breastfeeding (ever breastfed) was related with higher under-five mortality in some Sub-Saharan African contexts. Another study revealed that suboptimal breastfeeding (never or early cessation) contributed substantially to under-five mortality worldwide, with the highest burden in Sub-Saharan Africa and South Asia (Koray et al., 2025). The authors found that mothers may prolong breastfeeding for ill children, which could be the reason behind the elevated under five mortality among those still breastfed. Koray et al. (2025) observed that children exposed to illness were less likely to be exclusively breastfed, proving that breastfeeding status may results to underlying health conditions. This supports the idea that continued breastfeeding may associates with child vulnerability (Koray et al., 2025). In contrary of this finding, there is a systematic review which found that exclusive and early breastfeeding is key in reducing under-five mortality (A. H. Koroma et al., 2022). Children who were never breastfed had the highest mortality risk, directly contradicting the current study's finding that never-breastfed children had the lowest mortality (Diabelková et al., 2023).

The study also revealed that place of delivery and place of residence are significantly associated with under five mortality across the three countries. Under five mortality is higher among children born to mothers who delivered at home compared to the ones who delivered at private and government institutions. Similar study identified place of delivery as a major predictor of under-five mortality, with home births highly associated with higher death rates compared to institutional deliveries (Editor, 2025; Tekeba et al., 2025). In contrast, a study done in rural South Africa came up with different results as it highlighted that in some contexts, community-level poverty and healthcare access outweighed delivery location. In certain rural areas, even facility deliveries did not guarantee lower mortality due to poor quality of care (Birhanie et al., 2025; Price et al., 2019).

The multivariate findings revealed that sex of child, preceding birth interval, duration of breastfeeding, highest level of education, wealth index combined, place of delivery, and source of drinking water are statistically associated with under five mortality in Nigeria. Secondly, Maternal age, preceding birth interval, duration of breastfeeding, and highest level of education are statistically associated with under five mortality in Sierra Leone, for Guinea only preceding birth interval, duration of breastfeeding, highest level of education, and wealth index combined are statistically associated with under five mortality.

This study revealed that there are maternal age differentials when coming to factors associated with under five mortality in Nigeria, Sierra Leone and Guinea. This study found that children born to mothers/ women aged 35-44, 45-49, and 25-34 had high odds to contribute to under five mortality compared to those aged 15-24. Similarly, other studies found same results (Ahinkorah, 2021; Yaya et al., 2018). In contrast, other studies found that babies born to adolescent mothers face a higher risk of preterm birth, low birth weight, and neonatal mortality compared to those born to mothers aged 20-35, due to biological immaturity and socio-economic disadvantages (Diabelková et al., 2023; Fall et al., 2015; Victora et al., 2018).

The study also found that, in Nigeria, Sierra Leone, and Guinea children born to mothers with preceding birth interval of greater than 33 months had less odds to influence under five mortality compared to those with preceding birth interval of less than 33 months. Other studies support this finding with evidence that promoting birth intervals of at least 24 months is one of the most effective child survival interventions, with good benefits persisting across diverse cultural and economic places (Bermejo et al., 2015; Davanzo et al., 2020; Mare et al., 2023). However, some studies showed that longer intervals had no significant survival advantage (Budu et al., 2021; Tesema et al., 2023).

Another finding from the study, is that education level is significantly associated with under five mortality in Nigeria, Sierra Leone, and Guinea. There is evidence that children born to mothers with primary, secondary or higher education had less odds to contribute to under five mortality compared to those no education. This finding is supported by other studies (Adamu & Ango, 2024; Mensch et al., 2019). Educated mothers have better knowledge on childcare practices, and on the required nutrition and health of a child. When a child is sick, they are well aware that they must seek professional help. In contrast, other authors revealed different findings, that in regions with poor healthcare infrastructure, education alone may not result to better survival outcomes (Bado & Sathiya Susuman, 2016; Goudet et al., 2017; Karlsen et al., 2017).

Duration of breastfeeding is also another finding from the study which influenced under five mortality in Nigeria, Sierra Leone and Guinea. With that, it is evident that children born to mothers who ever breastfed had less odds to influence the increasing prevalence of under five mortality, compared to the ones born to mothers who never breastfed, and not currently breastfeeding. A study by Bernasconi (2022), in humanitarian settings revealed that sustained breastfeeding was a main factor in preventing malnutrition and mortality among children aged 6-23 months, especially when other food sources were scarce or unsafe. Then, Victora et al. (2021) made conclusions with statistic that universal breastfeeding could prevent 823,000 annual child deaths in low- and middle-income countries, primarily by minimizing the incidence of diarrhea and pneumonia.

This study found that children born to mothers' whose wealth index combined falls under rich and middle had less odds to contribute to under five mortality compared to the one's whose wealth falls under poor across the three countries. Research by Onwujekwe et al. (2019), in Nigeria highlighted most that wealthier households were significantly more likely to use private healthcare, which, despite its own quality issues and more chances for child survival, is often perceived as more reliable and accessible than the public alternative (Onwujekwe et al., 2019; Victora et al., 2018). In contrast Kuddus (2020), revealed that, where wealthy urbanites face high-risk environments, this can weaken the wealth advantage (Kuddus et al., 2020).

The last finding was source of drinking water, which was mostly influential in Nigeria, whereby children born to mothers having access to well water and other non-portable sources had less odds to contribute to under five mortality than the ones having access from piped water. A study done in Rwanda supports this finding, as it found that children in households using protected wells or boreholes sometimes had lower under-five mortality odds compared to piped water, likely due to contamination in piped systems in rural areas (Birhanie et al., 2025; Karpouzoglou et al., 2025; Wapenaar., 2025) . In contrast a study by Wapener (2025), revealed that piped water access improved child health outcomes (Wapenaar., 2025). Also, a report from UNICEF (2025), with its global monitoring it showed piped water as consistently protective against child mortality compared to wells/unprotected sources.

## 5.3 Conclusion

In conclusion, this study underlines that under-five mortality in Nigeria, Sierra Leone, and Guinea is not due to a single factor but complex interactions of maternal, socioeconomic, and health system determinants. The findings highlight country specific tendencies that compete certain conventional views.

While maternal education and wealth are generally protective, their influence can be muted or even reversed as a result of systemic healthcare failure, extreme urban poverty, and environmental contamination. The continuous vulnerability related to specific maternal age groups and non-optimal birth intervals further reveals the biological and programmatic dimensions of under-five mortality. The disproportionate burden carried by Sierra Leone and the delicate patterns within each country, such as the high mortality among seemingly advantaged groups in Sierra Leone and Guinea paints a picture of health systems and social environments that are currently failing to guarantee child survival, irrespective of individual socioeconomic status. Ultimately, achieving SDG 3 in these nations requires moving beyond broad generalizations to implement targeted, context-specific interventions that address these deep-rooted, multifaceted challenges.

## 5.4. Recommendations

To accelerate progress towards achieving Sustainable Development Goal 3.2, targeted interventions are urgently needed. To protect the children's futures, government and various stakeholders must build a world where every mother, regardless of her education or wealth, can access quality healthcare that doesn't fail her. This means urgently investing in and regulating health facilities from staffing rural clinics to ensuring private hospitals provide reliable care, while developing community-based health insurance to protect families from financial ruin. They also need to meet mothers where they are, with targeted support for both young adolescents and older women and empower all parents with family planning services to ensure healthy timing between pregnancies. Beyond the clinic, our efforts must extend to the roots of child health: ensuring every community has clean, safe water to drink; tackling the dire conditions in urban slums where overcrowding and pollution thrive; and strengthening social safety nets to lift the most vulnerable, including single mothers, out of poverty.

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# APPENDIX

## Appendix one: Ethics approval letter


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**Basic and Social Sciences Research Ethics Committee (BaSSREC)**

**Faculty of Humanities Ethics Office for Research, Training and Support**
Tel: 018 285 2457
Email: Erhabor.Idemudia@nwu.ac.za

**Senate Committee for Research Ethics**
Tel: 016 103 4446
Email: Feziwe.Mseleni@nwu.ac.za


29 September 2025

### ETHICS APPROVAL LETTER OF STUDY

Based on approval by the **Basic and Social Sciences Research Ethics Committee (BaSSREC)** on **07/08/2025**, the Basic and Social Sciences Research Ethics Committee hereby **approves** your study as indicated below. This implies that the North-West University Senate Committee for Research Ethics (NWU-SERC) grants its permission that, provided the special conditions specified below are met and pending any other authorisation that may be necessary, the study may be initiated, using the ethics number below.

**Study title: Examining the determinants of under-five mortality in Nigeria, Sierra Leone, and Guinea: A comparative study.**

**Study Leader/Supervisor (Principal Investigator)/Researcher: Dr. B.K.M. Ngake and Prof. M.E. Palamuleni**

**Student/Research Team: G.A. Mhlanga (38613670)**

**Ethics number:** N W U - 0 0 9 7 6 - 2 5 - A 7

Institution Study Number Year Status

Status: S = Submission; R = Re-Submission; P = Provisional Authorisation; A = Authorisation

**Application Type: Single study**

**Commencement date: 07/08/2025** **Risk:** No risk

**Expiry date: 07/08/2026**

**Approval of the study is initially provided for a year, after which continuation of the study is dependent on receipt and review of the annual (or as otherwise stipulated) monitoring report and the concomitant issuing of a letter of continuation.**

**Special in process conditions of the research for approval (if applicable):**

**General conditions:**

*While this ethics approval is subject to all declarations, undertakings and agreements incorporated and signed in the application form, the following general terms and conditions will apply:*

- *The study leader/supervisor (principal investigator)/researcher must report in the prescribed format to the BaSSREC:*
  - *annually (or as otherwise requested) on the monitoring of the study, whereby a letter of continuation will be provided, and upon completion of the study; and*

1

  - *without any delay in case of any adverse event or incident (or any matter that interrupts sound ethical principles) during the course of the study.*
- *The approval applies strictly to the proposal as stipulated in the application form. Should any amendments to the proposal be deemed necessary during the course of the study, the study leader/researcher must apply for approval of these amendments at the BaSSREC, prior to implementation. Should there be any deviations from the study proposal without the necessary approval of such amendments, the ethics approval is immediately and automatically forfeited.*
- *Annually a number of studies may be randomly selected for an external audit.*
- *The date of approval indicates the first date that the study may be started.*
- *In the interest of ethical responsibility, the NWU-SCRE and BaSSREC reserves the right to:*
  - *request access to any information or data at any time during the course or after completion of the study;*
  - *to ask further questions, seek additional information, require further modification or monitor the conduct of your research or the informed consent process;*
  - *withdraw or postpone approval if:*
    - *any unethical principles or practices of the study are revealed or suspected;*
    - *it becomes apparent that any relevant information was withheld from the BaSSREC or that information has been false or misrepresented;*
    - *submission of the annual (or otherwise stipulated) monitoring report, the required amendments, or reporting of adverse events or incidents was not done in a timely manner and accurately; and / or*
    - *new institutional rules, national legislation or international conventions deem it necessary.*
- *BaSSREC can be contacted for further information or any report templates via BaSSREC-Admin@nwu.ac.za.*

The BaSSREC would like to remain at your service as scientist and researcher, and wishes you well with your study. Please do not hesitate to contact the BaSSREC or the NWU-SCRE for any further enquiries or requests for assistance.

| | | |
|---|---|---|
| **Ethics number:** | N W U - 0 0 9 7 6 - 2 5 - A 7 | |
| | Institution / Study Number / Year / Status | |
| | Status: S = Submission; R = Re-Submission; P = Provisional Authorisation; A = Authorisation | |
| **Application Type: Single study** | | |
| **Commencement date: 07/08/2025** | **Risk:** | **No risk** |
| **Expiry date: 07/08/2026** | | |

**Approval of the study is initially provided for a year, after which continuation of the study is dependent on receipt and review of the annual (or as otherwise stipulated) monitoring report and the concomitant issuing of a letter of continuation.**

**Special in process conditions of the research for approval (if applicable):**

**General conditions:**

*While this ethics approval is subject to all declarations, undertakings and agreements incorporated and signed in the application form, the following general terms and conditions will apply:*

- *The study leader/supervisor (principal investigator)/researcher must report in the prescribed format to the BaSSREC:*
  - *annually (or as otherwise requested) on the monitoring of the study, whereby a letter of continuation will be provided, and upon completion of the study; and*

1

  - *without any delay in case of any adverse event or incident (or any matter that interrupts sound ethical principles) during the course of the study.*
- *The approval applies strictly to the proposal as stipulated in the application form. Should any amendments to the proposal be deemed necessary during the course of the study, the study leader/researcher must apply for approval of these amendments at the BaSSREC, prior to implementation. Should there be any deviations from the study proposal without the necessary approval of such amendments, the ethics approval is immediately and automatically forfeited.*
- *Annually a number of studies may be randomly selected for an external audit.*
- *The date of approval indicates the first date that the study may be started.*
- *In the interest of ethical responsibility, the NWU-SCRE and BaSSREC reserves the right to:*
  - *request access to any information or data at any time during the course or after completion of the study;*
  - *to ask further questions, seek additional information, require further modification or monitor the conduct of your research or the informed consent process;*
  - *withdraw or postpone approval if:*
    - *any unethical principles or practices of the study are revealed or suspected;*
    - *it becomes apparent that any relevant information was withheld from the BaSSREC or that information has been false or misrepresented;*
    - *submission of the annual (or otherwise stipulated) monitoring report, the required amendments, or reporting of adverse events or incidents was not done in a timely manner and accurately; and / or*
    - *new institutional rules, national legislation or international conventions deem it necessary.*
- *BaSSREC can be contacted for further information or any report templates via* BaSSREC-Admin@nwu.ac.za.

The BaSSREC would like to remain at your service as scientist and researcher, and wishes you well with your study. Please do not hesitate to contact the BaSSREC or the NWU-SCRE for any further enquiries or requests for assistance.

Yours sincerely

Prof. E. Idemudia

Chairperson NWU Basic and Social Sciences Research Ethics Committee

Original details: (22351930) C:\Users\22351930\Desktop\ETHICS APPROVAL LETTER OF STUDY.docm
8 November 2018

File reference: 9.1.5.4.2

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**Appendix two: estimating under five mortality for Nigerian by selected variables Nigeria detailed estimation steps:**

**Highest level of education**

1. No education

| Age | N of women | CEB | CD | Pi | Di | Ki | qx | standard | alpha | Time | Tx | Adjusted qx |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15-19 | 2182 | 907 | 119 | 0.42 | 0.131 | 1.200 | 0.125 | -0.997 | 0.023 | 2017.5 | 1.2 | 0.115 |
| 20-24 | 2201 | 4334 | 676 | 1.97 | 0.156 | 4.297 | 0.148 | -0.805 | -0.071 | 2017.6 | 4.3 | 0.145 |
| 25-29 | 2562 | 9392 | 1495 | 3.67 | 0.159 | 2.628 | 0.173 | -0.725 | -0.056 | 2017.4 | 2.6 | 0.166 |
| 30-34 | 2249 | 11941 | 2169 | 5.31 | 0.182 | 19.653 | 0.175 | -0.651 | -0.123 | 2018.2 | 19.7 | 0.752 |
| 35-39 | 2049 | 13073 | 2378 | 6.38 | 0.182 | 39.452 | 0.188 | -0.550 | -0.183 | 2018.4 | 39.5 | 0.220 |
| 40-44 | 1699 | 12634 | 2654 | 7.44 | 0.210 | 53.997 | 0.214 | -0.513 | -0.137 | 2018.4 | 54.0 | 0.233 |
| 45-49 | 1661 | 1270 | 2956 | 7.68 | 0.232 | 48.618 | 0.232 | -0.455 | -0.142 | 2018.2 | 48.6 | 0.254 |
| | | | | **P1/P2=0.21** | | | | | **-0.082** | | | |
| | | | | **P2/P3=0.54** | | | | | | | | |

2. Primary

| Age | N of women | CEB | CD | Pi | Di | Ki | qx | Standard | alpha | Time | Tx | Adjusted |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15-19 | 881 | 197 | 119 | 0.22 | 0.603 | 0.714 | 0.726 | -0.997 | 1.483 | 2017.3 | 0.069 | 0.7 |
| 20-24 | 720 | 1257 | 120 | 1.75 | 0.095 | 4.367 | 0.095 | -0.805 | -0.320 | 2017.6 | 0.098 | 4.4 |
| 25-29 | 871 | 2765 | 343 | 3.17 | 0.124 | 1.894 | 0.140 | -0.725 | -0.184 | 2017.3 | 0.113 | 1.9 |
| 30-34 | 875 | 3987 | 487 | 4.56 | 0.122 | 11.115 | 0.114 | -0.651 | -0.375 | 2017.8 | 0.129 | 11.1 |
| 35-39 | 949 | 5017 | 661 | 5.29 | 0.132 | 30.101 | 0.130 | -0.550 | -0.400 | 2018.1 | 0.154 | 30.1 |
| 40-44 | 809 | 4687 | 618 | 5.80 | 0.132 | 36.976 | 0.129 | -0.513 | -0.442 | 2018.0 | 0.164 | 37.0 |
| 45-49 | 934 | 5773 | 902 | 6.18 | 0.156 | 40.547 | 0.151 | -0.455 | -0.407 | 2018.0 | 0.180 | 40.5 |
| | | | | **P1/P2=0.13** | | | | | **-0.303** | | | |
| | | | | **P2/P3=0.55** | | | | | | | | |

3. Secondary

| Age | N of women | CEB | CD | Pi | Di | Ki | qx | Standard | alpha | Time | Tx | Adjusted qx |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15-19 | 5162 | 383 | 119 | 0.07 | 0.311 | 0.734 | 0.379 | -0.997 | 0.751 | 2017.3 | 0.7 | 0.044 |
| 20-24 | 3101 | 2764 | 190 | 0.89 | 0.069 | 3.611 | 0.074 | -0.805 | -0.461 | 2017.5 | 3.6 | 0.063 |
| 25-29 | 2793 | 6013 | 458 | 2.15 | 0.076 | 1.552 | 0.087 | -0.725 | -0.447 | 2017.3 | 1.6 | 0.073 |
| 30-34 | 2054 | 6243 | 452 | 3.04 | 0.072 | 4.730 | 0.072 | -0.651 | -0.626 | 2017.4 | 4.7 | 0.083 |
| 35-39 | 1697 | 6457 | 520 | 3.81 | 0.080 | 16.784 | 0.084 | -0.550 | -0.642 | 2017.7 | 16.8 | 0.100 |
| 40-44 | 1005 | 4332 | 373 | 4.31 | 0.086 | 28.375 | 0.089 | -0.513 | -0.651 | 2017.9 | 28.4 | 0.107 |
| 45-49 | 772 | 3684 | 372 | 4.77 | 0.101 | 35.751 | 0.102 | -0.455 | -0.630 | 2017.9 | 35.8 | 0.119 |
| | | | | **P1/P2=0.08** | | | | | **-0.548** | | | |
| | | | | **P2/P3=0.41** | | | | | | | | |

4. Higher

| Age | N of women | CEB | CD | Pi | Di | Ki | qx | Standard | Alpha | Time | Tx | Adjusted qx |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15-19 | 224 | 1 | 119 | 0.00 | 119.857 | 0.668 | 154.069 | -0.997 | -0.571 | 2017.2 | 0.7 | 0.031 |
| 20-24 | 814 | 214 | 13 | 0.26 | 0.060 | 2.765 | 0.070 | -0.805 | 1.324 | 2017.4 | 2.8 | 0.045 |
| 25-29 | 1028 | 1031 | 49 | 1.00 | 0.047 | 2.393 | 0.056 | -0.725 | -0.714 | 2017.4 | 2.4 | 0.053 |
| 30-34 | 1000 | 1855 | 93 | 1.85 | 0.050 | 14.644 | 0.053 | -0.651 | -0.788 | 2018.0 | 14.6 | 0.060 |
| 35-39 | 768 | 2094 | 123 | 2.73 | 0.059 | 35.047 | 0.065 | -0.550 | -0.780 | 2018.3 | 35.0 | 0.073 |
| 40-44 | 428 | 1427 | 94 | 3.34 | 0.066 | 47.537 | 0.072 | -0.513 | -0.768 | 2018.3 | 47.5 | 0.078 |
| 45-49 | 335 | 1325 | 105 | 3.96 | 0.079 | 49.904 | 0.084 | -0.455 | -0.739 | 2018.2 | 49.9 | 0.087 |
| | | | | **P1/P2=0.02** | | | | | **-0721** | | | |
| | | | | **P2/P3=0.26** | | | | | | | | |

**Type of place of residence**

5. Urban

| Age | N of women | CEB | CD | Pi | Di | Ki | qx | Standard | alpha | Time | Tx | Adjusted qx |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15-19 | 3813 | 298 | 119 | 0.08 | 0.399 | 0.815 | 0.471 | -0.997 | 0.939 | 2017.3 | 0.8 | 0.049 |
| 20-24 | 2924 | 2450 | 181 | 0.84 | 0.074 | 3.539 | 0.079 | -0.805 | -0.424 | 2017.5 | 3.5 | 0.071 |
| 25-29 | 3263 | 6818 | 571 | 2.09 | 0.084 | 2.788 | 0.096 | -0.725 | -0.397 | 2017.4 | 2.8 | 0.082 |
| 30-34 | 3001 | 9516 | 842 | 3.17 | 0.088 | 17.687 | 0.089 | -0.651 | -0.512 | 2018.1 | 17.7 | 0.094 |
| 35-39 | 2676 | 11046 | 1056 | 4.13 | 0.096 | 39.806 | 0.101 | -0.550 | -0.541 | 2018.4 | 39.8 | 0.113 |
| 40-44 | 1780 | 8762 | 974 | 4.92 | 0.111 | 55.142 | 0.116 | -0.513 | -0.502 | 2018.5 | 55.1 | 0.120 |
| 45-49 | 1705 | 9602 | 1286 | 5.63 | 0.134 | 54.667 | 0.137 | -0.455 | -0.464 | 2018.3 | 54.7 | 0.133 |
| | | | | **P1/P2=0.09** | | | | | **-0481** | | | |
| | | | | **P2/P3=0.40** | | | | | | | | |

6. Rural

| Age | N of women | CEB | CD | Pi | Di | Ki | qx | Standard | Alpha | Time | Tx | Adjusted qx |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15-19 | 4635 | 1191 | 119 | 0.26 | 0.100 | 1.004 | 0.106 | -0.997 | -0.069 | 2017.4 | 1.0 | 0.091 |
| 20-24 | 3912 | 6118 | 817 | 1.56 | 0.134 | 4.113 | 0.132 | -0.805 | -0.136 | 2017.6 | 4.1 | 0.128 |
| 25-29 | 3992 | 12384 | 1773 | 3.10 | 0.143 | 2.393 | 0.159 | -0.725 | -0.107 | 2017.4 | 2.4 | 0.147 |
| 30-34 | 3177 | 14510 | 2359 | 4.57 | 0.163 | 14.644 | 0.158 | -0.651 | -0.187 | 2018.0 | 14.6 | 0.166 |
| 35-39 | 2787 | 15594 | 2626 | 5.60 | 0.168 | 35.047 | 0.174 | -0.550 | -0.230 | 2018.3 | 35.0 | 0.196 |
| 40-44 | 2160 | 14318 | 2764 | 6.63 | 0.193 | 47.537 | 0.197 | -0.513 | -0.191 | 2018.3 | 47.5 | 0.208 |
| 45-49 | 1996 | 13930 | 3049 | 6.98 | 0.219 | 49.904 | 0.219 | -0.455 | -0.180 | 2018.2 | 49.9 | 0.228 |
| | | | | **P1/P2=0.16** | | | | | **-0.156** | | | |
| | | | | **P2/P3=0.50** | | | | | | | | |

**Wealth Index combined**

7. Poor

| Age | N of women | CEB | CD | Pi | Di | Ki | qx | Standard | alpha | Time | Tx | Adjusted qx |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15-19 | 1758 | 335 | 119 | 0.29 | 0.129 | 0.969 | 0.139 | -0.997 | 0.085 | 2017.4 | 1.0 | 0.101 |
| 20-24 | 1380 | 1861 | 191 | 1.80 | 0.144 | 4.176 | 0.142 | -0.805 | -0.093 | 2017.6 | 4.2 | 0.141 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 25-29 | 1430 | 3985 | 451 | 3.48 | 0.162 | 2.463 | 0.180 | -0.725 | -0.032 | 2017.4 | 2.5 | 0.162 |
| 30-34 | 1169 | 5019 | 698 | 5.15 | 0.178 | 15.597 | 0.172 | -0.651 | -0.135 | 2018.0 | 15.6 | 0.183 |
| 35-39 | 993 | 5348 | 681 | 6.23 | 0.190 | 36.518 | 0.195 | -0.550 | -0.160 | 2018.3 | 36.5 | 0.215 |
| 40-44 | 727 | 4488 | 683 | 7.22 | 0.222 | 53.819 | 0.225 | -0.513 | -0.107 | 2018.4 | 53.8 | 0.228 |
| 45-49 | 750 | 4719 | 759 | 7.67 | 0.248 | 54.367 | 0.247 | -0.455 | -0.102 | 2018.3 | 54.4 | 0.249 |
| | | | | **P1/P2=0.16** | | | | | **-0.098** | | | |
| | | | | **P2/P3=0.52** | | | | | | | | |

8. Middle

| Age | N of women | CEB | CD | Pi | Di | Ki | qx | Standard | alpha | Time | Tx | Adjusted qx |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15-19 | 1758 | 335 | 119 | 0.19 | 0.355 | 0.918 | 0.394 | -0.997 | 0.782 | 2017.4 | 0.9 | 0.072 |
| 20-24 | 1380 | 1861 | 191 | 1.35 | 0.103 | 4.000 | 0.104 | -0.805 | -0.273 | 2017.6 | 4.0 | 0.102 |
| 25-29 | 1430 | 3985 | 451 | 2.79 | 0.113 | 1.854 | 0.127 | -0.725 | -0.239 | 2017.3 | 1.9 | 0.118 |
| 30-34 | 1169 | 5019 | 698 | 4.29 | 0.139 | 9.147 | 0.135 | -0.651 | -0.276 | 2017.7 | 9.1 | 0.134 |
| 35-39 | 993 | 5348 | 681 | 5.39 | 0.127 | 27.711 | 0.131 | -0.550 | -0.394 | 2018.1 | 27.7 | 0.160 |
| 40-44 | 727 | 4488 | 683 | 6.17 | 0.152 | 36.045 | 0.155 | -0.513 | -0.334 | 2018.0 | 36.0 | 0.170 |
| 45-49 | 750 | 4719 | 759 | 6.30 | 0.161 | 41.796 | 0.161 | -0.455 | -0.369 | 2018.1 | 41.8 | 0.187 |
| | | | | **P1/P2=0.14** | | | | | **-0.281** | | | |
| | | | | **P2/P3=0.48** | | | | | | | | |

9. Rich

| Age | N of women | CEB | CD | Pi | Di | Ki | qx | Standard | alpha | Time | Tx | Adjusted qX |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15-19 | 3523 | 233 | 11 | 0.07 | 0.511 | 0.888 | 0.587 | -0.997 | 1.173 | 2017.4 | 0.9 | 0.041 |
| 20-24 | 2819 | 1976 | 125 | 0.70 | 0.063 | 3.353 | 0.068 | -0.805 | -0.504 | 2017.5 | 3.4 | 0.058 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 25-29 | 3215 | 6128 | 421 | 1.91 | 0.069 | 2.393 | 0.078 | -0.725 | -0.506 | 2017.4 | 2.4 | 0.068 |
| 30-34 | 2927 | 8284 | 589 | 2.83 | 0.071 | 14.644 | 0.073 | -0.651 | -0.620 | 2018.0 | 14.6 | 0.078 |
| 35-39 | 2609 | 9707 | 795 | 3.72 | 0.082 | 35.047 | 0.089 | -0.550 | -0.615 | 2018.3 | 35.0 | 0.094 |
| 40-44 | 1713 | 7760 | 649 | 4.53 | 0.084 | 47.537 | 0.089 | -0.513 | -0.650 | 2018.3 | 47.5 | 0.100 |
| 45-49 | 1540 | 7975 | 884 | 5.18 | 0.111 | 49.904 | 0.115 | -0.455 | -0.564 | 2018.2 | 49.9 | 0.111 |
| | | | | **P1/P2=0.09** | | | | | **-0.585** | | | |
| | | | | **P2/P3=0.37** | | | | | | | | |

**Source of drinking water**

**10.** Tap water

| Age | N of women | CEB | CD | Pi | Di | Ki | qx | Standard | Alpha | Time | Tx | Adjusted qx |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15-19 | 1049 | 115 | 119 | 0.11 | 1.031 | 0.841 | 1.199 | -0.997 | -0.574 | 2017.3 | 0.8 | 0.068 |
| 20-24 | 837 | 887 | 89 | 1.06 | 0.101 | 3.632 | 0.106 | -0.805 | -0.262 | 2017.5 | 3.6 | 0.097 |
| 25-29 | 829 | 2102 | 236 | 2.54 | 0.112 | 2.311 | 0.128 | -0.725 | -0.235 | 2017.4 | 2.3 | 0.112 |
| 30-34 | 715 | 2757 | 335 | 3.86 | 0.122 | 14.078 | 0.122 | -0.651 | -0.338 | 2017.9 | 14.1 | 0.127 |
| 35-39 | 579 | 2955 | 368 | 5.10 | 0.125 | 34.581 | 0.132 | -0.550 | -0.394 | 2018.3 | 34.6 | 0.151 |
| 40-44 | 447 | 2694 | 419 | 6.03 | 0.155 | 47.460 | 0.162 | -0.513 | -0.310 | 2018.3 | 47.5 | 0.161 |
| 45-49 | 424 | 2680 | 427 | 6.33 | 0.159 | 46.966 | 0.162 | -0.455 | -0.365 | 2018.2 | 47.0 | 0.177 |
| | | | | **P1/P2=0.10** | | | | | **-0.312** | | | |
| | | | | **P2/P3=0.42** | | | | | | | | |

11. Well water

| Age | N of women | CEB | CD | Pi | Di | Ki | qx | Standard | alpha | Time | Tx | Adjusted qx |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15-19 | 3977 | 634 | 119 | 0.16 | 0.188 | 0.917 | 0.209 | -0.997 | 0.332 | 2017.4 | 0.9 | 0.072 |
| 20-24 | 3164 | 3782 | 408 | 1.20 | 0.108 | 3.878 | 0.110 | -0.805 | -0.240 | 2017.6 | 3.9 | 0.103 |
| 25-29 | 3344 | 8655 | 1036 | 2.59 | 0.120 | 2.588 | 0.135 | -0.725 | -0.205 | 2017.4 | 2.6 | 0.118 |
| 30-34 | 2910 | 11191 | 1422 | 3.85 | 0.127 | 15.822 | 0.125 | -0.651 | -0.322 | 2018.0 | 15.8 | 0.135 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35-39 | 2605 | 12244 | 1538 | 4.70 | 0.126 | 35.538 | 0.131 | -0.550 | -0.396 | 2018.3 | 35.5 | 0.160 |
| 40-44 | 1907 | 10739 | 1686 | 5.63 | 0.157 | 47.455 | 0.161 | -0.513 | -0.311 | 2018.3 | 47.5 | 0.170 |
| 45-49 | 1867 | 11573 | 2055 | 6.20 | 0.178 | 51.983 | 0.179 | -0.455 | -0.305 | 2018.3 | 52.0 | 0.187 |
| | | | | **P1/P2=0.13** | | | | | **-0.279** | | | |
| | | | | **P2/P3=0.46** | | | | | | | | |

12. Other non-portable sources

| Age | N of women | CEB | CD | Pi | Di | Ki | qx | Standard | Alpha | time | Tx | Adjusted qx |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15-19 | 3422 | 739 | 119 | 0.22 | 0.161 | 0.968 | 0.174 | -0.997 | 0.218 | 2017.4 | 1.0 | 0.082 |
| 20-24 | 2835 | 3900 | 502 | 1.38 | 0.129 | 4.101 | 0.128 | -0.805 | -0.155 | 2017.6 | 4.1 | 0.116 |
| 25-29 | 3081 | 8444 | 1072 | 2.74 | 0.127 | 2.393 | 0.141 | -0.725 | -0.177 | 2017.4 | 2.4 | 0.133 |
| 30-34 | 2554 | 10078 | 1443 | 3.95 | 0.143 | 14.644 | 0.139 | -0.651 | -0.262 | 2018.0 | 14.6 | 0.151 |
| 35-39 | 2279 | 11442 | 1777 | 5.02 | 0.155 | 35.047 | 0.160 | -0.550 | -0.280 | 2018.3 | 35.0 | 0.179 |
| 40-44 | 1586 | 9647 | 1633 | 6.08 | 0.169 | 47.537 | 0.172 | -0.513 | -0.272 | 2018.3 | 47.5 | 0.190 |
| 45-49 | 1411 | 9279 | 1854 | 6.58 | 0.200 | 49.904 | 0.200 | -0.455 | -0.239 | 2018.2 | 49.9 | 0.209 |
| | | | | **P1/P2=0.16** | | | | | **-0.211** | | | |
| | | | | **P2/P3=0.50** | | | | | | | | |

**Appendix two: estimating under five mortality for Sierra Leone by selected variables**

Highest level of education

1. No education

| Age | N of women | CEB | CD | Pi | Di | Ki | qx | Standard | alpha | Time | Tx | Adjusted qx |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15-19 | 477 | 191 | 16 | 0.40 | 0.082 | 1.405 | 0.069 | -0.997 | -0.305 | 2017.7 | 1.4 | 0.074 |
| 20-24 | 645 | 992 | 94 | 1.54 | 0.094 | 4.495 | 0.085 | -0.805 | -0.382 | 2017.7 | 4.5 | 0.105 |
| 25-29 | 1062 | 2854 | 365 | 2.69 | 0.128 | 2.503 | 0.136 | -0.725 | -0.198 | 2017.4 | 2.5 | 0.121 |
| 30-34 | 1203 | 4634 | 663 | 3.85 | 0.143 | 19.508 | 0.137 | -0.651 | -0.267 | 2018.2 | 19.5 | 0.265 |
| 35-39 | 1658 | 7594 | 1183 | 4.58 | 0.156 | 33.775 | 0.161 | -0.550 | -0.277 | 2018.2 | 33.8 | 0.163 |
| 40-44 | 1032 | 5402 | 983 | 5.26 | 0.182 | 40.740 | 0.186 | -0.513 | -0.225 | 2018.1 | 40.7 | 0.173 |
| 45-49 | 1010 | 5674 | 1234 | 5.62 | 0.217 | 37.278 | 0.218 | -0.455 | -0.183 | 2017.9 | 37.3 | 0.191 |
| | | | | **P1/P2=0.26** | | | | | **-0.268** | | | |
| | | | | **P2/P3=0.57** | | | | | | | | |

2. Primary

| **Age** | **N of women** | **CEB** | **CD** | **Pi** | **Di** | **Ki** | **qx** | **Standard** | **Alpha** | **Time** | **Tx** | **Adjusted qx** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15-19 | 636 | 126 | 19 | 0.20 | 0.153 | 0.514 | 0.198 | -0.997 | 0.299 | 2017.2 | 0.5 | 0.088 |
| 20-24 | 338 | 584 | 91 | 1.73 | 0.157 | 4.721 | 0.155 | -0.805 | -0.042 | 2017.7 | 4.7 | 0.124 |
| 25-29 | 383 | 1079 | 140 | 2.81 | 0.129 | 2.310 | 0.147 | -0.725 | -0.155 | 2017.4 | 2.3 | 0.142 |
| 30-34 | 245 | 896 | 125 | 3.66 | 0.140 | 10.969 | 0.125 | -0.651 | -0.322 | 2017.8 | 11.0 | 0.180 |
| 35-39 | 240 | 981 | 154 | 4.08 | 0.157 | 25.494 | 0.148 | -0.550 | -0.324 | 2018.0 | 25.5 | 0.190 |
| 40-44 | 129 | 659 | 116 | 5.11 | 0.176 | 30.107 | 0.165 | -0.513 | -0.298 | 2017.9 | 30.1 | 0.202 |
| 45-49 | 130 | 715 | 161 | 5.49 | 0.225 | 39.483 | 0.211 | -0.455 | -0.206 | 2018.0 | 39.5 | 0.221 |
| | | | | **P1/P2=0.12** | | | | | **-0.174** | | | |
| | | | | **P2/P3=0.61** | | | | | | | | |

3. Secondary

| **Age** | **N of women** | **CEB** | **CD** | **Pi** | **Di** | **Ki** | **qx** | **Standard** | **Alpha** | **Time** | **Tx** | **Adjusted qx** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15-19 | 2300 | 366 | 36 | 0.16 | 0.099 | 1.128 | 0.099 | -0.997 | -0.106 | 2017.5 | 1.1 | 0.062 |
| 20-24 | 1510 | 1355 | 124 | 0.90 | 0.092 | 3.976 | 0.091 | -0.805 | -0.348 | 2017.6 | 4.0 | 0.088 |
| 25-29 | 1077 | 2016 | 224 | 1.87 | 0.111 | 2.079 | 0.123 | -0.725 | -0.258 | 2017.4 | 2.1 | 0.102 |
| 30-34 | 347 | 871 | 90 | 2.51 | 0.103 | 5.171 | 0.102 | -0.651 | -0.437 | 2017.4 | 5.2 | 0.117 |
| 35-39 | 251 | 857 | 95 | 3.38 | 0.112 | 17.841 | 0.118 | -0.550 | -0.456 | 2017.8 | 17.8 | 0.139 |
| 40-44 | 133 | 516 | 88 | 3.88 | 0.170 | 21.865 | 0.176 | -0.513 | -0.258 | 2017.7 | 21.9 | 0.148 |
| 45-49 | 107 | 476 | 85 | 4.46 | 0.178 | 28.937 | 0.181 | -0.455 | -0.299 | 2017.8 | 28.9 | 0.163 |
| | | | | **P1/P2=0.18** | | | | | **-0.362** | | | |
| | | | | **P2/P3=0.48** | | | | | | | | |

4. Higher

| **Age** | **N of women** | **CEB** | **CD** | **Pi** | **Di** | **Ki** | **qx** | **Standard** | **Alpha** | **Time** | **Tx** | **Adjusted qx** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15-19 | 14 | 2 | 0 | 0.11 | 0.000 | 2.386 | 0.000 | -0.997 | 0.000 | 2018.1 | 2.4 | 0.050 |
| 20-24 | 136 | 45 | 3 | 0.33 | 0.068 | 2.972 | 0.063 | -0.805 | -0.547 | 2017.5 | 3.0 | 0.071 |
| 25-29 | 205 | 226 | 26 | 1.10 | 0.114 | 2.510 | 0.117 | -0.725 | -0.285 | 2017.4 | 2.5 | 0.083 |
| 30-34 | 148 | 236 | 17 | 1.60 | 0.072 | 13.320 | 0.082 | -0.651 | -0.560 | 2017.9 | 13.3 | 0.094 |
| 35-39 | 75 | 165 | 15 | 2.20 | 0.091 | 29.873 | 0.112 | -0.550 | -0.486 | 2018.1 | 29.9 | 0.113 |
| 40-44 | 48 | 133 | 11 | 2.80 | 0.079 | 43.122 | 0.095 | -0.513 | -0.612 | 2018.2 | 43.1 | 0.121 |
| 45-49 | 40 | 126 | 14 | 3.13 | 0.115 | 45.286 | 0.133 | -0.455 | -0.484 | 2018.1 | 45.3 | 0.134 |
| | | | | **P1/P2=0.34** | | | | | **-0.479** | | | |
| | | | | **P2/P3=0.30** | | | | | | | | |

**Type of place of residence**

5. Urban

| Age | N of women | CEB | CD | Pi | Di | Ki | qx | Standard | alpha | time | Tx | Adjusted qx |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15-19 | 1814 | 253 | 32 | 0.14 | 0.128 | 1.160 | 0.127 | -0.997 | 0.032 | 2017.5 | 1.2 | 0.062 |
| 20-24 | 1387 | 1148 | 92 | 0.83 | 0.080 | 3.744 | 0.080 | -0.805 | -0.416 | 2017.6 | 3.7 | 0.088 |
| 25-29 | 1368 | 2586 | 293 | 1.89 | 0.113 | 2.845 | 0.126 | -0.725 | -0.244 | 2017.4 | 2.8 | 0.102 |
| 30-34 | 808 | 2197 | 252 | 2.72 | 0.114 | 16.701 | 0.115 | -0.651 | -0.367 | 2018.0 | 16.7 | 0.116 |
| 35-39 | 850 | 3178 | 414 | 3.74 | 0.130 | 33.090 | 0.140 | -0.550 | -0.359 | 2018.2 | 33.1 | 0.139 |
| 40-44 | 507 | 2215 | 350 | 4.37 | 0.158 | 48.150 | 0.167 | -0.513 | -0.291 | 2018.3 | 48.1 | 0.148 |
| 45-49 | 430 | 2027 | 398 | 4.72 | 0.196 | 45.312 | 0.203 | -0.455 | -0.229 | 2018.1 | 45.3 | 0.163 |
| | | | | **P1/P2=0.17** | | | | | **-0.364** | | | |
| | | | | **P2/P3=0.44** | | | | | | | | |

6. Rural

| Age | N of women | CEB | CD | Pi | Di | Ki | qx | Standard | alpha | time | Tx | Adjusted qx |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15-19 | 1613 | 433 | 39 | 0.27 | 0.091 | 0.998 | 0.095 | -0.997 | -0.128 | 2017.4 | 1.0 | 0.081 |
| 20-24 | 1241 | 1828 | 221 | 1.47 | 0.121 | 4.412 | 0.116 | -0.805 | -0.210 | 2017.6 | 4.4 | 0.114 |
| 25-29 | 1360 | 3589 | 461 | 2.64 | 0.129 | 2.510 | 0.142 | -0.725 | -0.175 | 2017.4 | 2.5 | 0.132 |
| 30-34 | 1134 | 4441 | 644 | 3.91 | 0.145 | 13.320 | 0.137 | -0.651 | -0.269 | 2017.9 | 13.3 | 0.149 |
| 35-39 | 1374 | 6410 | 1033 | 4.67 | 0.161 | 29.873 | 0.162 | -0.550 | -0.271 | 2018.1 | 29.9 | 0.177 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 40-44 | 830 | 4495 | 848 | 5.41 | 0.189 | 43.122 | 0.188 | -0.513 | -0.218 | 2018.2 | 43.1 | 0.188 |
| 45-49 | 858 | 4964 | 1096 | 5.79 | 0.221 | 45.286 | 0.217 | -0.455 | -0.187 | 2018.1 | 45.3 | 0.206 |
| | | | | **P1/P2=0.18** | | | | | **-0.218** | | | |
| | | | | **P2/P3-0.56** | | | | | | | | |

**Wealth Index combined**

7. Poor

| Age | N of women | CEB | CD | Pi | Di | Ki | qx | Standard | alpha | time | Tx | Adjusted qx |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15-19 | 971 | 289 | 26 | 0.30 | 0.089 | 0.987 | 0.093 | -0.997 | -0.139 | 2017.4 | 1.0 | 0.079 |
| 20-24 | 795 | 1259 | 144 | 1.58 | 0.114 | 4.531 | 0.109 | -0.805 | -0.247 | 2017.7 | 4.5 | 0.112 |
| 25-29 | 916 | 2505 | 320 | 2.74 | 0.128 | 2.688 | 0.141 | -0.725 | -0.180 | 2017.4 | 2.7 | 0.129 |
| 30-34 | 796 | 3168 | 459 | 3.98 | 0.145 | 15.335 | 0.135 | -0.651 | -0.276 | 2018.0 | 15.3 | 0.147 |
| 35-39 | 943 | 4484 | 766 | 4.76 | 0.171 | 33.347 | 0.170 | -0.550 | -0.242 | 2018.2 | 33.3 | 0.174 |
| 40-44 | 562 | 3096 | 570 | 5.51 | 0.184 | 48.724 | 0.182 | -0.513 | -0.239 | 2018.3 | 48.7 | 0.185 |
| 45-49 | 588 | 3358 | 761 | 5.71 | 0.227 | 42.811 | 0.221 | -0.455 | -0.175 | 2018.1 | 42.8 | 0.203 |
| | | | | **P1/P2=0.19** | | | | | **-0.230** | | | |
| | | | | **P2/P3=0.58** | | | | | | | | |

8. Middle

| Age | N of women | CEB | CD | Pi | Di | Ki | qx | Standard | alpha | time | Tx | Adjusted qx |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15-19 | 682 | 161 | 14 | 0.24 | 0.084 | 1.053 | 0.086 | -0.997 | -0.182 | 2017.5 | 1.1 | 0.080 |
| 20-24 | 466 | 621 | 77 | 1.33 | 0.125 | 4.181 | 0.122 | -0.805 | -0.184 | 2017.6 | 4.2 | 0.113 |
| 25-29 | 432 | 1116 | 130 | 2.58 | 0.116 | 2.180 | 0.129 | -0.725 | -0.231 | 2017.4 | 2.2 | 0.130 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30-34 | 346 | 1350 | 200 | 3.91 | 0.148 | 10.028 | 0.143 | -0.651 | -0.243 | 2017.7 | 10.0 | 0.147 |
| 35-39 | 452 | 2048 | 302 | 4.53 | 0.148 | 25.978 | 0.152 | -0.550 | -0.310 | 2018.0 | 26.0 | 0.175 |
| 40-44 | 287 | 1563 | 308 | 5.44 | 0.197 | 33.115 | 0.201 | -0.513 | -0.178 | 2017.9 | 33.1 | 0.185 |
| 45-49 | 289 | 1751 | 385 | 6.05 | 0.220 | 43.666 | 0.220 | -0.455 | -0.179 | 2018.1 | 43.7 | 0.204 |
| | | | | **P1/P2=0.18** | | | | | **-0.227** | | | |
| | | | | **P2/P3=0.52** | | | | | | | | |

9. Rich

| **Age** | **N of women** | **CEB** | **CD** | **Pi** | **Di** | **Ki** | **qx** | **Standard** | **alpha** | **time** | **Tx** | **Adjusted qx** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15-19 | 1774 | 235 | 32 | 0.13 | 0.137 | 1.155 | 0.137 | -0.997 | 0.076 | 2017.5 | 1.2 | 0.063 |
| 20-24 | 1368 | 1096 | 91 | 0.80 | 0.083 | 3.715 | 0.084 | -0.805 | -0.391 | 2017.6 | 3.7 | 0.090 |
| 25-29 | 1380 | 2555 | 305 | 1.85 | 0.119 | 2.510 | 0.132 | -0.725 | -0.215 | 2017.4 | 2.5 | 0.104 |
| 30-34 | 801 | 2121 | 236 | 2.65 | 0.111 | 13.320 | 0.113 | -0.651 | -0.381 | 2017.9 | 13.3 | 0.119 |
| 35-39 | 829 | 3056 | 378 | 3.68 | 0.124 | 29.873 | 0.133 | -0.550 | -0.388 | 2018.1 | 29.9 | 0.141 |
| 40-44 | 488 | 2051 | 320 | 4.20 | 0.156 | 43.122 | 0.165 | -0.513 | -0.298 | 2018.2 | 43.1 | 0.151 |
| 45-49 | 410 | 1882 | 348 | 4.59 | 0.185 | 45.286 | 0.192 | -0.455 | -0.265 | 2018.1 | 45.3 | 0.166 |
| | | | | **P1/P2=0.17** | | | | | **-0.352** | | | |
| | | | | **P2/P3=0.43** | | | | | | | | |

**Source of drinking water**

10. Tap water

| **Age** | **N of women** | **CEB** | **CD** | **Pi** | **Di** | **Ki** | **qx** | **Standard** | **alpha** | **time** | **Tx** | **Adjusted qx** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15-19 | 672 | 109 | 14 | 0.16 | 0.130 | 1.016 | 0.138 | -0.997 | 0.081 | 2017.4 | 1.0 | 0.067 |
| 20-24 | 499 | 508 | 37 | 1.02 | 0.072 | 3.999 | 0.072 | -0.805 | -0.475 | 2017.6 | 4.0 | 0.096 |
| 25-29 | 574 | 1208 | 166 | 2.11 | 0.137 | 2.438 | 0.153 | -0.725 | -0.131 | 2017.4 | 2.4 | 0.111 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30-34 | 339 | 1091 | 146 | 3.22 | 0.134 | 13.086 | 0.131 | -0.651 | -0.294 | 2017.9 | 13.1 | 0.126 |
| 35-39 | 370 | 1523 | 237 | 4.12 | 0.156 | 30.499 | 0.162 | -0.550 | -0.272 | 2018.1 | 30.5 | 0.150 |
| 40-44 | 255 | 1132 | 157 | 4.43 | 0.139 | 43.036 | 0.143 | -0.513 | -0.383 | 2018.2 | 43.0 | 0.160 |
| 45-49 | 183 | 895 | 182 | 4.88 | 0.203 | 43.839 | 0.205 | -0.455 | -0.222 | 2018.1 | 43.8 | 0.176 |
| | | | | **P1/P2=0.16** | | | | | **-0.316** | | | |
| | | | | **P2/P3=0.48** | | | | | | | | |

11. Well water

| **Age** | **N of women** | **CEB** | **CD** | **Pi** | **Di** | **Ki** | **qx** | **Standard** | **Alpha** | **time** | **Tx** | **Adjusted** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15-19 | 1543 | 286 | 33 | 0.19 | 0.114 | 1.065 | 0.117 | -0.997 | -0.011 | 2017.5 | 1.1 | 0.073 |
| 20-24 | 1076 | 1190 | 131 | 1.11 | 0.111 | 3.997 | 0.110 | -0.805 | -0.242 | 2017.6 | 4.0 | 0.104 |
| 25-29 | 1083 | 2480 | 306 | 2.29 | 0.123 | 2.706 | 0.137 | -0.725 | -0.195 | 2017.4 | 2.7 | 0.120 |
| 30-34 | 727 | 2492 | 310 | 3.43 | 0.124 | 14.061 | 0.122 | -0.651 | -0.336 | 2017.9 | 14.1 | 0.136 |
| 35-39 | 877 | 3727 | 540 | 4.25 | 0.145 | 30.159 | 0.151 | -0.550 | -0.312 | 2018.1 | 30.2 | 0.162 |
| 40-44 | 509 | 2608 | 497 | 5.13 | 0.190 | 43.663 | 0.196 | -0.513 | -0.191 | 2018.2 | 43.7 | 0.172 |
| 45-49 | 536 | 3061 | 694 | 5.71 | 0.227 | 46.958 | 0.229 | -0.455 | -0.151 | 2018.2 | 47.0 | 0.189 |
| | | | | **P1/P2=0.17** | | | | | **-0.272** | | | |
| | | | | **P2/P3=0.48** | | | | | | | | |

12. Other non-portable sources

| **Age** | **N of women** | **CEB** | **CD** | **Pi** | **Di** | **Ki** | **qx** | **Standard** | **alpha** | **time** | **Tx** | **Adjusted qx** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15-19 | 1213 | 291 | 25 | 0.24 | 0.085 | 1.157 | 0.083 | -0.997 | -0.203 | 2017.5 | 1.2 | 0.075 |
| 20-24 | 1054 | 1278 | 144 | 1.21 | 0.113 | 4.212 | 0.108 | -0.805 | -0.248 | 2017.6 | 4.2 | 0.107 |
| 25-29 | 1071 | 2488 | 283 | 2.32 | 0.114 | 2.510 | 0.124 | -0.725 | -0.250 | 2017.4 | 2.5 | 0.123 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30-34 | 877 | 3055 | 440 | 3.48 | 0.144 | 13.320 | 0.140 | -0.651 | -0.258 | 2017.9 | 13.3 | 0.140 |
| 35-39 | 977 | 4338 | 670 | 4.44 | 0.154 | 29.873 | 0.160 | -0.550 | -0.280 | 2018.1 | 29.9 | 0.166 |
| 40-44 | 573 | 2971 | 544 | 5.19 | 0.183 | 43.122 | 0.187 | -0.513 | -0.221 | 2018.2 | 43.1 | 0.177 |
| 45-49 | 568 | 3035 | 619 | 5.34 | 0.204 | 45.286 | 0.205 | -0.455 | -0.223 | 2018.1 | 45.3 | 0.194 |
| | | | | **P1/P2=0.20** | | | | | **-0.256** | | | |
| | | | | **P2/P3=0.52** | | | | | | | | |

**Appendix Three: estimating under five mortality for Guinea by selected variables**

Highest level of education

1. No education

| **Age** | **N of women** | **CEB** | **CD** | **Pi** | **Di** | **Ki** | **qx** | **Standard** | **alpha** | **Time** | **Tx** | **Adjusted qx** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15-19 | 1259 | 430 | 37 | 0.34 | 0.087 | 1.239 | 0.081 | -0.997 | -0.218 | 2017.6 | 1.2 | 0.066 |
| 20-24 | 994 | 1522 | 153 | 1.53 | 0.101 | 4.366 | 0.094 | -0.805 | -0.326 | 2017.6 | 4.4 | 0.094 |
| 25-29 | 1304 | 3634 | 417 | 2.79 | 0.115 | 2.920 | 0.124 | -0.725 | -0.251 | 2017.5 | 2.9 | 0.108 |
| 30-34 | 1133 | 4314 | 471 | 3.81 | 0.109 | 18.209 | 0.105 | -0.651 | -0.420 | 2018.1 | 18.2 | 0.170 |
| 35-39 | 1127 | 5256 | 670 | 4.66 | 0.127 | 30.911 | 0.131 | -0.550 | -0.396 | 2018.1 | 30.9 | 0.147 |
| 40-44 | 847 | 4397 | 653 | 5.19 | 0.148 | 41.134 | 0.151 | -0.513 | -0.350 | 2018.1 | 41.1 | 0.157 |
| 45-49 | 826 | 4300 | 679 | 5.20 | 0.158 | 36.030 | 0.158 | -0.455 | -0.382 | 2017.9 | 36.0 | 0.173 |
| | | | | **P1/P2=0.22** | | | | | **-0.328** | | | |
| | | | | **P2/P3=0.55** | | | | | | | | |

2. Primary

| Age | N of women | CEB | CD | Pi | Di | Ki | qx | Standard | alpha | Time | Tx | Adjusted qx |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15-19 | 563 | 160 | 15 | 0.28 | 0.093 | 0.819 | 0.105 | -0.997 | -0.073 | 2017.4 | 0.8 | 0.071 |
| 20-24 | 211 | 341 | 39 | 1.62 | 0.115 | 4.801 | 0.108 | -0.805 | -0.248 | 2017.7 | 4.8 | 0.102 |
| 25-29 | 198 | 511 | 50 | 2.58 | 0.098 | 2.106 | 0.108 | -0.725 | -0.329 | 2017.4 | 2.1 | 0.117 |
| 30-34 | 107 | 379 | 53 | 3.53 | 0.141 | 9.548 | 0.127 | -0.651 | -0.311 | 2017.7 | 9.5 | 0.145 |
| 35-39 | 86 | 336 | 23 | 3.93 | 0.068 | 30.071 | 0.065 | -0.550 | -0.780 | 2018.1 | 30.1 | 0.158 |
| 40-44 | 45 | 215 | 34 | 4.74 | 0.157 | 29.388 | 0.150 | -0.513 | -0.353 | 2017.8 | 29.4 | 0.169 |
| 45-49 | 45 | 217 | 34 | 4.83 | 0.157 | 40.200 | 0.149 | -0.455 | -0.416 | 2018.0 | 40.2 | 0.185 |
| | | | | **P1/P2=0.18** | | | | | **-0.285** | | | |
| | | | | **P2/P3=0.63** | | | | | | | | |

3. Secondary

| Age | N of women | CEB | CD | Pi | Di | Ki | qx | Standard | alpha | Time | Tx | Adjusted qx |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15-19 | 771 | 91 | 7 | 0.12 | 0.078 | 1.246 | 0.075 | -0.997 | -0.256 | 2017.5 | 1.2 | 0.035 |
| 20-24 | 399 | 299 | 14 | 0.75 | 0.047 | 3.319 | 0.049 | -0.805 | -0.680 | 2017.5 | 3.3 | 0.051 |
| 25-29 | 266 | 553 | 37 | 2.08 | 0.068 | 1.531 | 0.075 | -0.725 | -0.528 | 2017.3 | 1.5 | 0.060 |
| 30-34 | 138 | 359 | 23 | 2.61 | 0.065 | 5.541 | 0.068 | -0.651 | -0.654 | 2017.5 | 5.5 | 0.000 |
| 35-39 | 63 | 220 | 11 | 3.49 | 0.049 | 12.541 | 0.055 | -0.550 | -0.872 | 2017.6 | 12.5 | 0.083 |
| 40-44 | 41 | 132 | 9 | 3.25 | 0.068 | 22.748 | 0.075 | -0.513 | -0.745 | 2017.7 | 22.7 | 0.088 |
| 45-49 | 29 | 134 | 7 | 4.58 | 0.050 | 28.808 | 0.054 | -0.455 | -0.981 | 2017.8 | 28.8 | 0.098 |
| | | | | **P1/P2=0.16** | | | | | **-0.654** | | | |
| | | | | **P2/P3=0.36** | | | | | | | | |

4. Higher

| Age | N of women | CEB | CD | Pi | Di | Ki | qx | Standard | alpha | Time | Tx | Adjusted qx |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15-19 | 12 | 0 | 0 | 0.00 | 0.000 | 0.229 | 0.000 | -0.997 | 0.000 | 2017.0 | 0.2 | 0.018 |
| 20-24 | 155 | 53 | 2 | 0.34 | 0.029 | 3.728 | 0.033 | -0.805 | -0.887 | 2017.6 | 3.7 | 0.026 |
| 25-29 | 140 | 110 | 5 | 0.78 | 0.041 | 2.808 | 0.049 | -0.725 | -0.755 | 2017.4 | 2.8 | 0.031 |
| 30-34 | 59 | 84 | 2 | 1.43 | 0.024 | 14.511 | 0.023 | -0.651 | -1.232 | 2017.9 | 14.5 | 0.161 |
| 35-39 | 36 | 75 | 3 | 2.08 | 0.041 | 32.933 | 0.041 | -0.550 | -1.021 | 2018.2 | 32.9 | 0.043 |
| 40-44 | 14 | 43 | 1 | 3.15 | 0.016 | 42.901 | 0.015 | -0.513 | -1.565 | 2018.2 | 42.9 | 0.046 |
| 45-49 | 7 | 25 | 1 | 3.40 | 0.027 | 46.594 | 0.026 | -0.455 | -1.347 | 2018.2 | 46.6 | 0.052 |
| | | | | **P1/P2=0.00** | | | | | **-1.000** | | | |
| | | | | **P2/P3=0.44** | | | | | | | | |

Type of place of residence

5. Urban

| Age | N of women | CEB | CD | Pi | Di | Ki | qx | Standard | alpha | Time | Tx | Adjusted qx |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15-19 | 1126 | 180 | 5 | 0.16 | 0.030 | 1.332 | 0.028 | -0.997 | -0.785 | 2017.6 | 1.3 | 0.039 |
| 20-24 | 789 | 650 | 34 | 0.82 | 0.053 | 3.656 | 0.052 | -0.805 | -0.644 | 2017.6 | 3.7 | 0.056 |
| 25-29 | 747 | 1455 | 103 | 1.95 | 0.071 | 3.187 | 0.078 | -0.725 | -0.512 | 2017.5 | 3.2 | 0.066 |
| 30-34 | 503 | 1431 | 107 | 2.85 | 0.075 | 18.044 | 0.077 | -0.651 | -0.593 | 2018.1 | 18.0 | 0.194 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35-39 | 406 | 1543 | 119 | 3.81 | 0.077 | 35.865 | 0.084 | -0.550 | -0.646 | 2018.3 | 35.9 | 0.091 |
| 40-44 | 264 | 1176 | 97 | 4.46 | 0.082 | 45.915 | 0.088 | -0.513 | -0.653 | 2018.2 | 45.9 | 0.097 |
| 45-49 | 257 | 1240 | 138 | 4.83 | 0.111 | 47.159 | 0.117 | -0.455 | -0.557 | 2018.2 | 47.2 | 0.108 |
| | | | | **P1/P2=0.19** | | | | | **-0.602** | | | |
| | | | | **P2/P3=0.42** | | | | | | | | |

6. Rural

| **Age** | **N of women** | **CEB** | **CD** | **Pi** | **Di** | **Ki** | **qx** | **Standard** | **alpha** | **Time** | **Tx** | **Adjusted qx** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15-19 | 1479 | 500 | 54 | 0.34 | 0.108 | 1.142 | 0.105 | -0.997 | -0.073 | 2017.5 | 1.1 | 0.072 |
| 20-24 | 968 | 1566 | 174 | 1.62 | 0.111 | 4.426 | 0.105 | -0.805 | -0.268 | 2017.6 | 4.4 | 0.102 |
| 25-29 | 1161 | 3352 | 406 | 2.89 | 0.121 | 2.808 | 0.132 | -0.725 | -0.217 | 2017.4 | 2.8 | 0.118 |
| 30-34 | 934 | 3705 | 443 | 3.97 | 0.119 | 14.511 | 0.114 | -0.651 | -0.376 | 2017.9 | 14.5 | 0.161 |
| 35-39 | 906 | 4344 | 588 | 4.79 | 0.135 | 32.933 | 0.138 | -0.550 | -0.368 | 2018.2 | 32.9 | 0.159 |
| 40-44 | 683 | 3610 | 599 | 5.29 | 0.166 | 42.901 | 0.167 | -0.513 | -0.290 | 2018.2 | 42.9 | 0.169 |
| 45-49 | 651 | 3436 | 582 | 5.28 | 0.169 | 46.594 | 0.168 | -0.455 | -0.345 | 2018.2 | 46.6 | 0.186 |
| | | | | **P1/P2=0.21** | | | | | **-0.282** | | | |
| | | | | **P2/P3=0.56** | | | | | | | | |

Wealth Index combined

7. Poor

| **Age** | **N of women** | **CEB** | **CD** | **Pi** | **Di** | **Ki** | **qx** | **Standard** | **alpha** | **Time** | **Tx** | **Adjusted qx** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15-19 | 867 | 321 | 42 | 0.37 | 0.131 | 1.237 | 0.122 | -0.997 | 0.010 | 2017.6 | 1.2 | 0.073 |
| 20-24 | 591 | 974 | 95 | 1.65 | 0.098 | 4.398 | 0.091 | -0.805 | -0.344 | 2017.6 | 4.4 | 0.104 |
| 25-29 | 725 | 2151 | 284 | 2.97 | 0.132 | 2.812 | 0.143 | -0.725 | -0.169 | 2017.4 | 2.8 | 0.119 |
| 30-34 | 594 | 2415 | 314 | 4.06 | 0.130 | 17.161 | 0.125 | -0.651 | -0.324 | 2018.1 | 17.2 | 0.143 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35-39 | 570 | 2717 | 370 | 4.77 | 0.136 | 35.879 | 0.140 | -0.550 | -0.360 | 2018.3 | 35.9 | 0.162 |
| 40-44 | 421 | 2257 | 401 | 5.37 | 0.177 | 42.320 | 0.180 | -0.513 | -0.244 | 2018.1 | 42.3 | 0.172 |
| 45-49 | 423 | 2207 | 405 | 5.22 | 0.184 | 52.541 | 0.184 | -0.455 | -0.291 | 2018.3 | 52.5 | 0.189 |
| | | | | **P1/P2=0.22** | | | | | **-0.273** | | | |
| | | | | **P2/P3=0.56** | | | | | | | | |

8. Middle

| **Age** | **N of women** | **CEB** | **CD** | **Pi** | **Di** | **Ki** | **qx** | **Standard** | **Alpha** | **Time** | **Tx** | **Adjusted qx** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15-19 | 489 | 123 | 10 | 0.26 | 0.077 | 0.992 | 0.082 | -0.997 | -0.214 | 2017.4 | 1.0 | 0.071 |
| 20-24 | 293 | 445 | 56 | 1.51 | 0.125 | 4.282 | 0.122 | -0.805 | -0.183 | 2017.6 | 4.3 | 0.100 |
| 25-29 | 347 | 985 | 111 | 2.83 | 0.113 | 2.436 | 0.125 | -0.725 | -0.247 | 2017.4 | 2.4 | 0.116 |
| 30-34 | 268 | 1006 | 109 | 3.75 | 0.108 | 11.065 | 0.103 | -0.651 | -0.429 | 2017.8 | 11.1 | 0.062 |
| 35-39 | 276 | 1355 | 181 | 4.91 | 0.133 | 27.452 | 0.135 | -0.550 | -0.377 | 2018.0 | 27.5 | 0.157 |
| 40-44 | 205 | 1068 | 163 | 5.21 | 0.153 | 37.925 | 0.154 | -0.513 | -0.339 | 2018.1 | 37.9 | 0.167 |
| 45-49 | 179 | 973 | 145 | 5.43 | 0.149 | 43.062 | 0.148 | -0.455 | -0.420 | 2018.1 | 43.1 | 0.183 |
| | | | | **P1/P2=0.17** | | | | | **-0.292** | | | |
| | | | | **P2/P3=0.53** | | | | | | | | |

9. Rich

| **Age** | **N of women** | **CEB** | **CD** | **Pi** | **Di** | **Ki** | **qx** | **Standard** | **alpha** | **Time** | **Tx** | **Adjusted** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15-19 | 1249 | 231 | 7 | 0.18 | 0.032 | 1.314 | 0.029 | -0.997 | -0.759 | 2017.6 | 1.3 | 0.043 |
| 20-24 | 873 | 797 | 57 | 0.91 | 0.072 | 3.923 | 0.070 | -0.805 | -0.487 | 2017.6 | 3.9 | 0.062 |
| 25-29 | 836 | 1672 | 113 | 2.00 | 0.068 | 8.368 | 0.074 | -0.725 | -0.539 | 2018.0 | 8.4 | 0.071 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30-34 | 574 | 1715 | 127 | 2.99 | 0.074 | 25.217 | 0.075 | -0.651 | -0.606 | 2018.3 | 25.2 | 0.124 |
| 35-39 | 466 | 1815 | 157 | 3.89 | 0.086 | 39.419 | 0.093 | -0.550 | -0.590 | 2018.3 | 39.4 | 0.099 |
| 40-44 | 321 | 1461 | 132 | 4.56 | 0.090 | 47.301 | 0.096 | -0.513 | -0.609 | 2018.2 | 47.3 | 0.105 |
| 45-49 | 306 | 1497 | 169 | 4.89 | 0.113 | 45.008 | 0.117 | -0.455 | -0.554 | 2018.1 | 45.0 | 0.117 |
| | | | | **P1/P2=0.20** | | | | | **-0.557** | | | |
| | | | | **P2/P3=0.46** | | | | | | | | |

Source of drinking water

10. Tap water

| **Age** | **N of women** | **CEB** | **CD** | **Pi** | **Di** | **Ki** | **qx** | **Standard** | **alpha** | **Time** | **Tx** | **Adjusted qx** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15-19 | 701 | 106 | 4 | 0.15 | 0.042 | 1.294 | 0.039 | -0.997 | -0.604 | 2017.6 | 1.3 | 0.047 |
| 20-24 | 520 | 426 | 31 | 0.82 | 0.073 | 3.614 | 0.073 | -0.805 | -0.469 | 2017.5 | 3.6 | 0.068 |
| 25-29 | 478 | 944 | 81 | 1.98 | 0.086 | 2.854 | 0.095 | -0.725 | -0.402 | 2017.5 | 2.9 | 0.078 |
| 30-34 | 336 | 1016 | 78 | 3.02 | 0.076 | 15.915 | 0.078 | -0.651 | -0.581 | 2018.0 | 15.9 | 0.140 |
| 35-39 | 267 | 1057 | 95 | 3.95 | 0.090 | 33.995 | 0.098 | -0.550 | -0.560 | 2018.2 | 34.0 | 0.108 |
| 40-44 | 199 | 888 | 103 | 4.46 | 0.115 | 42.380 | 0.124 | -0.513 | -0.464 | 2018.1 | 42.4 | 0.115 |
| 45-49 | 167 | 855 | 110 | 5.13 | 0.129 | 46.178 | 0.135 | -0.455 | -0.473 | 2018.1 | 46.2 | 0.128 |
| | | | | **P1/P2=0.18** | | | | | **-0.506** | | | |
| | | | | **P2/P3=0.41** | | | | | | | | |

11. Well water

| **Age** | **N of women** | **CEB** | **CD** | **Pi** | **Di** | **Ki** | **qx** | **Standard** | **alpha** | **Time** | **Tx** | **Adjusted qx** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15-19 | 1378 | 372 | 28 | 0.27 | 0.076 | 1.123 | 0.075 | -0.997 | -0.259 | 2017.5 | 1.1 | 0.060 |
| 20-24 | 847 | 1184 | 107 | 1.40 | 0.090 | 4.235 | 0.087 | -0.805 | -0.371 | 2017.6 | 4.2 | 0.086 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 25-29 | 971 | 2579 | 264 | 2.66 | 0.102 | 3.407 | 0.112 | -0.725 | -0.309 | 2017.5 | 3.4 | 0.099 |
| 30-34 | 728 | 2650 | 278 | 3.64 | 0.105 | 17.254 | 0.101 | -0.651 | -0.440 | 2018.1 | 17.3 | 0.234 |
| 35-39 | 678 | 3060 | 341 | 4.51 | 0.112 | 34.938 | 0.115 | -0.550 | -0.471 | 2018.2 | 34.9 | 0.135 |
| 40-44 | 491 | 2585 | 366 | 5.26 | 0.142 | 46.748 | 0.144 | -0.513 | -0.377 | 2018.2 | 46.7 | 0.144 |
| 45-49 | 488 | 2451 | 352 | 5.02 | 0.144 | 48.182 | 0.144 | -0.455 | -0.437 | 2018.2 | 48.2 | 0.159 |
| | | | | **P1/P2=0.19** | | | | | **-0.377** | | | |
| | | | | **P2/P3=0.53** | | | | | | | | |

12. Other non-portable sources

| **Age** | **N of women** | **CEB** | **CD** | **Pi** | **Di** | **Ki** | **qx** | **Standard** | **alpha** | **Time** | **Tx** | **Adjusted qx** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15-19 | 526 | 202 | 27 | 0.38 | 0.133 | 1.363 | 0.114 | -0.997 | -0.026 | 2017.6 | 1.4 | 0.077 |
| 20-24 | 390 | 605 | 70 | 1.55 | 0.116 | 4.398 | 0.106 | -0.805 | -0.258 | 2017.6 | 4.4 | 0.109 |
| 25-29 | 459 | 1284 | 164 | 2.80 | 0.128 | 2.808 | 0.137 | -0.725 | -0.196 | 2017.4 | 2.8 | 0.125 |
| 30-34 | 373 | 1471 | 194 | 3.95 | 0.132 | 14.511 | 0.127 | -0.651 | -0.310 | 2017.9 | 14.5 | 0.161 |
| 35-39 | 366 | 1770 | 270 | 4.83 | 0.153 | 32.933 | 0.158 | -0.550 | -0.286 | 2018.2 | 32.9 | 0.169 |
| 40-44 | 256 | 1314 | 227 | 5.13 | 0.173 | 42.901 | 0.177 | -0.513 | -0.254 | 2018.2 | 42.9 | 0.180 |
| 45-49 | 253 | 1370 | 258 | 5.41 | 0.188 | 46.594 | 0.190 | -0.455 | -0.271 | 2018.2 | 46.6 | 0.198 |
| | | | | **P1/P2=0.25** | | | | | **-0.245** | | | |
| | | | | **P2/P3=0.56** | | | | | | | | |