CONTEXTUAL DETERMINANTS OF INFANT AND CHILD MORTALITY IN NIGERIA

By

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A Doctoral Thesis submitted to the Faculty of Humanities, University of the Witwatersrand, Johannesburg, South Africa; in fulfillment of the requirements for the award of PhD in Demography and Population Studies

September 2013

DECLARATION

I, Sunday Adepoju ADEDINI, declare that this thesis is my own original work. It is being submitted for the degree of Doctor of Philosophy in Demography and Population Studies of the University of the Witwatersrand, Johannesburg. To the best of my knowledge, it has not been submitted before in part or in full for any degree or examination at this or any other University.

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DEDICATION

I dedicate the success of this work to the glory of God

ACKNOWLEDGEMENTS

First of all, I ascribe all glory to the only wise God, the King of kings and the Lord of lords for the successful completion of this report. The achievement of this milestone can only be attributed to the grace of God. I give God all the glory.

Secondly, I owe Professor Clifford Odimegwu, my supervisor and mentor, a million thanks for his supervision, mentoring, constructive criticisms, promptness in reading my write-ups, as well as other supports too numerous to highlight. May God continue to bless him and his family!

Thirdly, I appreciate all supports, both financial and otherwise, provided by the Consortium for Advanced Research Training in Africa (CARTA)[1]. I appreciate the entire CARTA team led by Dr. Alex Ezeh of the African Population and Health Research Centre, Nairobi Kenya. The University of the Witwatersrand's Postgraduate Merit Award is also appreciated.

In addition, I am indebted to all my colleagues, both teaching and non-teaching staff in the Department of Demography and Social Statistics, Obafemi Awolowo University (OAU), Ile-Ife, Nigeria who held the forth during the period of my study leave. I particularly thank my supervisor back in OAU – Dr. Olusina Bamiwuye as well as Prof Adeyinka Adesina who worked tirelessly to secure the University approval for my study leave. I appreciate words of encouragements and supports from Drs. Ope Fadeyibi, Akanni Akinyemi and Ambrose Akinlo.

I appreciate Drs. Latifat Ibisomi, Nicole Angotti, Ms. Julia Mamabolo, Prof. Kathy Kahn, Prof. Steve Tollman, Ms. Nicole De Wet and other staff members of the Graduate Programme in Demography and Population studies, Wits University, South Africa.

[1] This research was [partially] funded by a Fellowship award provided by the Consortium for Advanced Research Training in Africa (CARTA). CARTA has been funded by the Wellcome Trust (UK) (grant: 087547/Z/08/Z), the Department for International Development under the Development Partnerships in Higher Education (DelPHE), the Carnegie Corporation of New York (grant: B 8606), the Ford Foundation (grant:1100-0399), and the Bill and Melinda Gates Foundation (grant: 51228).

I owe special thanks to Dr. Amos Chanon of the University of Southampton, UK who introduced me to multilevel analysis. I appreciate Dr. Michelle Garenne of Institut Pasteur, Paris, France, for his contributions to this study during my propositional seminar presentation. I appreciate the comments made by the two anonymous reviewers who reviewed the proposal for this study. I acknowledge the assistance from Max Petzold, a professor at the Institute of Medicine, University of Gothenburg, Sweden.

My appreciation goes to my CARTA cohort 1 colleagues. I also appreciate the companionship of my fellow PhD students at DPS, Wits University – Dorothy Ononokpono, Kojo Antobam, Eunice Imasiku, Amos Oyedokun, Nicole De Wet, Sulaimon Afolabi, Enoch Ngome, Bob Elwange, Sasha Frade, and others. I appreciate the time spent together with Jacob Ikotun and Blessing Babalola, my former roommates. Pastor Steve Agbabiaka, Dr. Gideon Fareo and Tope Adeyoju are also appreciated – the trio accommodated me at different time when I first arrived in Johannesburg. I appreciate my siblings – Rebecca, Ruth, Abel Adedini and other family members, friends and brethren for prayers and supports. I appreciate cares from Enitilo Bukola, Pastor and Mrs. Ajibade, Mr. Daramola and other friends and brethren. I particularly appreciate Mr. and Mrs. Johnson Omoyayi for their supports for my family when I was away. I also express my gratitude to many other people too numerous to mention for their supports in one way or the other.

Finally, I owe special appreciations to my supportive wife – Adeola Adedini. Her endurance, care, supports and love cannot be quantified. Her prayers and words of encouragement meant a lot for the success of this programme. What of my children – Joshua, Faith and Favour – who endured my long absence from home during the period of this PhD programme. Their endurance and sacrifice is much appreciated.

Once again, I am grateful to God who saw me through the period of this programme; and for giving me the grace to weather the challenge of being a motherless child right from the age of 10 after the death of my Mother – Mrs. Comfort Adedini. Also, despite the death of my father – Mr. John Adedini during the first year of this PhD studies, the grace of God has been sufficient to carry me through. To God be the Glory!

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LIST OF ABBREVIATIONS

AIDS	Acquired Immune Deficiency Syndrome
APA	Asian Population Association
APHRC	African Population and Health Research Council
AU	African Union
CARTA	Consortium for Advanced Research Training in Africa
CEB	Children Ever Born
DelPHE	Development Partnerships in Higher Education
DHS	Demographic and Health Survey
EAs	Enumeration Areas
ECA	Economic Commission for Africa
FCT	Federal Capital Territory, Nigeria
GLLAMM	Generalized linear latent and mixed model
HDSS	Health and Demographic Surveillance Site
HINARI	Health Inter-Network Access to Research Initiative
HR	Hazard ratios
HIV	Human Immunodeficiency Virus
ICC	Intra-class correlation coefficient
INDEPTH	International Network of field sites with continuous Demographic Evaluation of Populations and Their Health in developing countries
JSTOR	Journal Storage
LDCs	Less Developed Countries
MDG	Millennium Development Goal
NDHS	Nigeria Demographic and Health Survey
NEEDS	National Economic Empowerment and Development Strategy
NPC	National Population Commission, Nigeria
OAU	Obafemi Awolowo University
PAA	Population Association of America
PhD	Doctor of Philosophy
PSU	Primary sampling units
UAPS	Union for Africa Population Studies
UK	United Kingdom
UN	United Nations
UNDP	United Nations Development Programme
UNFPA	United Nations Population Fund
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
VPC	Variance partition coefficient
WHO	World Health Organization

ABSTRACT

Background: Despite modest improvements in child health outcomes during the 20th century, infant and child mortality rates remain unacceptably high in Nigeria. With about 1 in 6 children dying before the age of five, Nigeria, like many other countries in sub-Saharan Africa, is not on track to achieve the Millennium Development Goal 4 (MDG 4) (i.e. reducing childhood mortality by 2015). Nigeria's under-five mortality rate is among the highest in the world. Addressing poor infant and child health outcomes requires scientific evidence on how best to tackle its determinants. Literature shows that knowledge about the determinants of child mortality at the individual level is insufficient to address the problem. This is because the characteristics of the household and community context where a child is born or raised tend to modify individual-level factors and therefore affect child survival. However, there are gaps in evidence on the effects of characteristics of the community contexts on child survival in Nigeria. Hence, this study examined the contextual determinants of infant and child mortality in Nigeria with a focus on individual, household and community-level characteristics. The study addressed three specific objectives: (1) to examine the levels and magnitudes of infant and child mortality in Nigeria; (2) to identify the individual, household, and community-level factors associated with infant and child mortality in Nigeria; and (3) to determine the extent to which the contextual factors account for regional variations in infant and child mortality in Nigeria.

Methodology: The study utilized data from 2003 and 2008 Nigeria Demographic and Health Survey (NDHS). The target population for this study (women aged 15-49 years who had at least a live birth in the five years preceding the survey) were extracted from the whole 2003 and 2008 NDHS datasets. Out of the survey's total sample size of 7620 women contained in 2003 dataset, analysis was restricted to the live born children of 3775 women amounting to 6028 live births within the five years before the survey. Similarly, from a total of 33,385 women contained in 2008 dataset, analysis was restricted to the live born children of 18,028 women who were 28,647 children delivered in the five years before 2008 survey. In order to achieve the objectives of this study, analysis was restricted to births in the five years before the survey. All analyses were completely child-based. That is, child was the unit of analysis. The dependent variables in this study are: (i) infant mortality – defined as the risks of dying during the first year of life; (ii) child mortality – defined as the risk of dying between ages 12 and 59 months; and (iii) under-five mortality – defined as the risks of dying between birth and the fifth birthday. All the outcome variables were measured as the duration of survival since birth in months. Guided by the reviewed literature and the conceptual framework, relevant independent variables were selected at the individual-, household- and community-levels. Three levels of analysis – univariate, bivariate and multivariate – were conducted. At the multivariate level, Cox proportional hazards regression analysis was employed because of its suitability for analysing time-to-event data and censored observations. In addition, using generalized linear latent and mixed models (GLLAMM) implementable in Stata, multilevel survival analysis was employed to consider the hierarchical structure of the DHS mortality data; and to identify contextual factors

influencing regional variations in infant and child mortality in Nigeria. Data were analyzed using Stata software (version 11.1). Indirect estimations were obtained using MortPak-Lite, Microsoft Excel, and Model Life Tables.

Key findings addressing objective 1: Indirect techniques gave the levels of infant mortality for both sexes in 2002-2003 as 93 per 1000 live births (male: 95/1000, female: 91/1000), and 78 per 1000 live births (male: 80/1000, female: 75/1000) in 2007-2008. Probabilities of dying between ages 1 and 5 were estimated at 0.049 (male: 0.051, female: 0.047) in 2002-2003, and 0.036 (male: 0.038, females: 0.033) in 2007-2008. Indirectly computed estimates of infant/child mortality were not substantially different from the estimates obtained from direct techniques. Using INDEPTH life table, e_0 (i.e. expectation of life at birth) in 2008 was estimated at 55.6 years for females and 51.6 years for males. This suggests that the data utilized in this study are of good quality. Bivariate results indicated a slight reduction in the proportion of infant and child death over the 1999-2003 and 2004-2008 periods.

Key findings addressing objective 2: Using both 2003 and 2008 data, region of residence, place of residence, ethnic diversity, community education, community infrastructures, and community health contexts were identified as important contextual determinants of infant and child mortality in Nigeria during the periods under study. For instance, results from 2008 NDHS data showed that children of mothers residing in the North-east were having significantly higher risks of infant (hazard ratio - HR: 1.54, $p<0.05$) and child (HR: 3.19, $p<0.05$) mortality compared to children in the South-west. Residence in communities with high proportion of hospital delivery was associated with lower risks of infant (HR: 0.73, $p<0.05$) and child (HR: 0.62, $p<0.05$) mortality. In addition, residence in communities with high concentration of poor households was significantly associated with higher risks of death during childhood (HR: 1.40, $p<0.05$). Many of the selected variables remained significantly associated with infant and child mortality after adjusting for the effects of the selected important characteristics, although some to a lesser degree. Results also showed that demographic factors were more important in explaining infant mortality while socio-economic factors were more important for child mortality.

Key findings addressing objective 3: Results from both 2003 and 2008 data indicated that substantial variations in the risks of infant and child mortality exist across regions in Nigeria, and that characteristics of the community contexts were important in explaining the observed regional variations. For instance, results from 2003 data indicated that the proportional change in variance (PCV) of 43.5% in the hazards of dying during infancy, and PCV of 44.4% in the risks of dying during childhood, could be attributed to community-level contextual determinants. Also, analysis of 2008 data showed that the PCV of 43.3% in the risks of dying before age one and the PCV of 50.0% in the hazards of dying during childhood could be explained by community-level characteristics. Although, community factors appear to moderate the association between individual-level factors and death during infancy and childhood, adjusting for the effects of child-, mother- and community-levels characteristics in the final models indicated higher child mortality clustering at the community level relative to individual level. Conversely, higher infant mortality

clustering was found at the individual level compared with the community level. This result suggests that community-level attributes appear to play more important role in child survival during childhood than in infancy. Plausible explanation for this is that children's interaction with community environment or neighbourhood contexts is likely to be higher during age 12-59 months compared to the period under age one.

Conclusion: The study's findings showed that insufficient progress was made in infant and child mortality reduction over the 1999-2003 and 2004-2008 periods. Besides, increased variations in the risks of infant and child death were observed across the six regions of the country. Results demonstrated that characteristics of the community contexts tend to mitigate infant and child mortality risks in the South-west while community characteristics appear to exacerbate infant and child mortality risks in other regions, particularly in the North-east and North-west. Study's findings suggest that policies that will ensure substantial reduction in infant and child mortality in Nigeria must include strategies and programmes that rectify characteristics of the community contexts which exacerbate infant and child mortality risks, particularly in the socially and economically disadvantaged communities and regions of Nigeria.

Keywords: Infant, child, under-five, neighbourhood, community, context, mortality, demography and health survey, Nigeria

CHAPTER ONE

INTRODUCTION

1.1 Introduction and Statement of the Problem

Infant and child mortality rates remain unacceptably high in the sub-Saharan African countries. Globally, an estimated 7 million children under the age of five died in 2011 (UNICEF, 2012). Sub-Saharan African region is a major contributor to this statistics. This is basically as a result of a very high child mortality rates in the region. Although, the health outcomes of children improved dramatically worldwide during the 20th century, enormous disparities still exist between developed and developing countries. For instance, the variation in under-five mortality rates between the developing and developed nations is more than 78-fold, from a high of 180 per 1000 live births in Angola to only 2.31 per 1000 live births in Singapore (World Fact Book, 2011).

The fourth Millennium Development Goal (MDG 4) of the United Nations (2000) is to reduce the under-five mortality rates of the year 1990 by two-thirds by the year 2015. As 2015 draws near and with less than three years to the target year, leaders in Africa have realized the need to galvanize resources towards the attainment of MDG 4. A summit of the African Union in July 2010 adopted decisions to undertake actions aimed at attaining MDG 4, 5 and 6 in various member states (African Union, 2010). However, earlier Lykens and others (2009) established that during the 2000-2006 period, under-five mortality rates have only been reduced from 167 to 157 per

1000 live births in sub-Saharan Africa, and that 27 nations in sub-Saharan Africa are reported to have made no progress towards achieving MDG 4. While many countries in East Asia, Pacific, Latin America and the Caribbean are said to be on track to meeting MDG 4, sub-Saharan Africa is reportedly making insufficient progress (Shabani et al, 2010). In order to achieve MDG 4, many of the sub-Saharan African countries would have to see a 9 percent annual reduction in under-five mortality rates (Lykens et al, 2009).

Specifically in Nigeria the under-five mortality rate stood at 157 per 1000 live births, with huge variations across the various geopolitical regions (NPC & ICF Macro, 2009). Evidence from 2008 Nigeria Demographic and Health Survey shows that under-five mortality rates range between 89 per 1000 live births in the South-west, and 222 per 1000 live births in the North-East. Worse still, an increased risk of under-five mortality was reported in some regions in Nigeria (Antai 2011a).

Considering the fact that infant and child mortality remains a major public health challenge in Nigeria and other parts of the developing world, researchers have made considerable efforts to understanding factors driving the phenomenon. A number of studies have shown that infant and child mortality rates vary by socio-economic and bio-demographic characteristics (e.g.; Antai 2010; Caldwell, 1979; Feyisetan *et al.*, 1997; Griffiths et al; Harttgen & Misselhorn, 2006; Kanjala et al 2010; Kravda 2004; Madise et al., 2003; Manda 2001; Noor et al., 2006; Odimegwu, 2002; Omariba and Boyle, 2007; Orubuloye & Caldwell, 1975; Palma-Soliso et al; Sastry 1996; Sastry 1997; Sear and Mace 2008; Schell 2007; 2009; Wang, 2003).

Further, findings of previous studies have established the influence of various predictors of infant and child mortality in Nigeria and other developing countries. However, several of these studies, particularly Nigerian studies largely assumed independence between individual-, household-, and community-level factors. The studies failed to consider the hierarchical structure of mortality data; thereby ignoring the fact of heterogeneity of mortality risks across households and communities. While children nested within the same households may share similar characteristics, mortality risks are heterogeneous for children from different households and communities (Antai, 2011, Harttgen & Misselhorn, 2006). This study however, attempted to build on the findings of the previous studies by advancing the existing knowledge beyond the understanding of infant/child mortality determinants at the individual level. This is because the contextual characteristics of a community and household where children are raised tend to modify individual-level factors. But, studies have rarely addressed such contextual determinants in Nigeria.

Moreover, infant and child mortality still remains a serious issue for research and policy in Nigeria. As 2015 approaches, there is a dire need to generate new and more reliable scientific evidence on how best to tackle the key determinants of infant/child mortality in the country. Meanwhile, examination of how household and community characteristics influence a particular outcome as opposed to a mere focus on personal characteristics of individuals has made better analysis feasible. Evidence has shown that mere knowledge at the individual level is insufficient to tackle the problem of infant and child mortality (Antai, 2011a; Babalola & Fatusi, 2009; Omariba et al, 2007; Harttgen & Misselhorn, 2006; Whitworth & Stephenson, 2004). As earlier noted, household variables and community characteristics tend to influence child survival. Sastry (1996) established that much is still unknown about the relationship that exists between community characteristics and child survival in many areas of the developing world. Also, Antai (2011a:3) recently asserts that "further studies on community-levels determinants of under-five mortality are needed in Nigeria". This is because the social and environmental context where children live also affects their survival chances. The effect of community and other contextual factors on infant/child mortality has seldom received attention in Nigeria. Rather, Nigerian studies on infant and child mortality have overemphasized the influence of individual-level factors (Adeboye et al 2010, Nwokocha & Awomoyi 2009; Ekenze et al, 2009; Okoro et al; 2009). Several other studies on infant and child mortality in Nigeria are mainly hospital-based (Akinbami, et al, 2010; Okoro et al, 2009; Sadoh & Ogungbe, 2008; Brown et al, 2008; Udo et al, 2008; Oniyangi, 2006). Hence, this study extends the frontier of knowledge by examining the levels of infant and child mortality and the influences of the contextual determinants on infant and child mortality in Nigeria.

1.2 Research questions

The study answered three basic research questions:

1. What are the levels and magnitude of infant and child mortality in Nigeria?
2. What are the individual, household, and community-level factors associated with infant and child mortality in Nigeria?
3. To what extent do contextual factors account for regional variations in infant and child mortality in Nigeria?

1.3 Research objectives

1.3.1 General objective:

The general objective of this study was basically to explore the contextual determinants of infant and child mortality in Nigeria.

1.3.2 The specific objectives were to:

1. Examine the levels and magnitude of infant/child mortality in Nigeria;
2. Identify the individual, household, and community-level factors associated with infant/child mortality in Nigeria; and
3. Determine the extent to which the contextual factors account for regional variation in infant/child mortality in Nigeria.

1.4 Justification of the study

Infant and child mortality remains a daunting challenge in Nigeria. Several studies have been conducted to identify the factors accounting for high rates of under-five mortality and the best strategies to adopt in combating the problem (Antai and Moradi, 2010; Adeboye et al, 2010, Adjuik et al, 2010; Becher, 2010; Okoro et al, 2009; Ekenze, 2009; Grais et al 2007; Oniyangi et al 2006). Yet, Nigeria still falls short of Millennium Development Goal targets. In spite of the concerted international and national efforts on the undesirable levels of infant and child mortality, poor child health outcomes have continued to be a debilitating issue of concern in Nigeria.

The Millennium Development Goals (MDGs) identify the minimum requirements to be met if the general wellbeing of population is to improve (UN, 2000). One of the stated goals is the reduction of childhood deaths (MDG4), the target of which is to reduce the childhood mortality rates by two-third between 1990 and 2015. However, available statistics show that most countries in sub-Saharan Africa, including Nigeria, are not on course to achieving the MDG4. More research is thus needed to inform the formulation of policies and programmes for appropriate health intervention in Nigeria.

It is important to focus research efforts on infant and child mortality in order to generate new scientific evidence on how best to tackle its determinants. However, Nigerian studies on infant and child mortality have rarely examined the influence of key determinants of infant and child mortality at various levels (individual-, household-, and community-levels). Several studies (e.g. Akinbami et al., 201; Adeboye et al.; 2010, Ekenze, et al., 2009; Nwokocha and Awomoyi, 2009; Brown et al, 2008; Grais et al., 2007, Lawoyin, 2001, Adetunji, 1991; Adetunji 1995) have come no closer than examining the effects of individual level characteristics. Sastry (1996) opined that a study of multilevel analysis of determinants of child mortality in developing countries is important and Eberstein (1989) argued that a multilevel model is good in clarifying linkages between various characteristics and mortality levels. In his study, Wang (2003) suggested that there is need to conduct analytical studies both at the sub-national and household levels in order to produce more reliable empirical evidence to inform the design of policies and programmes that could improve child health outcomes in various countries. The need for better analysis to produce more reliable empirical evidence on how to improve child health outcomes in Nigeria underscores the importance of this study.

Several researchers have examined factors influencing infant and child mortality in Nigeria, but studies have largely focused on personal characteristics of individuals; thereby ignoring community and other contextual factors. Several infant/child mortality studies in Nigeria largely assumed independence between characteristics at various levels – individual, household and community levels. Zanini et al (2009) opined that failure to consider the correlation that exists between individuals within the same group can lead to incorrect inferences. Griffith et al (2009) also noted that it would be methodologically wrong to fit a single-level standard regression model in the analysis of child survival, because of the hierarchical nature of mortality data. Meanwhile, such studies that consider hierarchical structure of mortality data to establish the contextual factors influencing infant and child mortality are sparse in Nigeria. As earlier noted, researchers have largely assumed independence between household and community attributes thereby ignoring the fact that household and community or region where children are raised jointly impact on their survival chances. As a result, a study that considers the influence of community and other contextual factors on infant and child mortality in Nigeria will contribute significantly to the existing body of literature.

In view of this, this study aims to advance the existing knowledge by examining individual, household and community-levels determinants of infant and child mortality in Nigeria.

1.5 Study Area and Rationale for Selection

Nigeria, one of the countries with the highest level of under-five mortality in the world (UNICEF, 2012), was chosen as the study location. The country is a sub-Saharan African country located in the West African sub-region. Nigeria is bounded by Niger Republic in the North, Chad in the North-East, Cameroon in the East and Benin Republic in the West. Nigeria became an independent nation on October 1st 1960, as a federation of three regions (East, North and Western regions). The country is culturally and religiously diverse. She comprises of more than 250 different ethnic groups. At present, Nigeria is made up of 774 municipalities (local government areas), 36 states and a Federal Capital Territory (FCT) which serves as the nation's administrative capital. As shown in Figure 1.1 below, all the 36 states and the FCT are grouped into six geopolitical zones – South-East, South-South, South-West, North-Central, North-East and North-West.

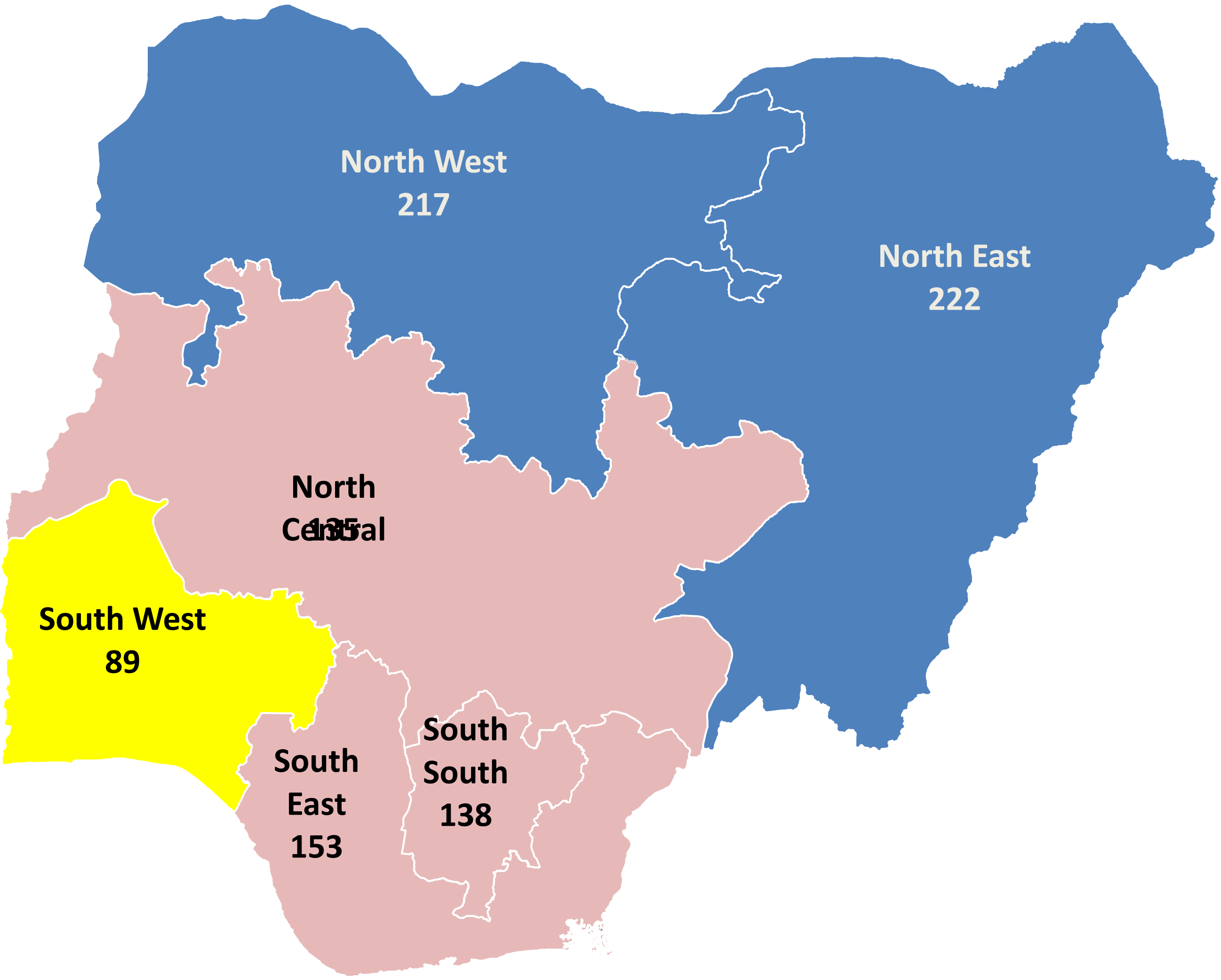

Figure 1.1 showing Nigeria map and the under-5 mortality rates in different geo-political zones of the country (Source: NPC & ICF Macro, 2009)

Thus, the rationale behind the selection of Nigeria as the study location is multifaceted. First, infant and child mortality rate in the country is very alarming and the rate is among the highest in the world. About 1 in every 6 children born in the country dies before the age of five (NPC and ICF Macro, 2009). Second, infant and child mortality rates vary substantially from one region of the country to the other. Under-five mortality rate ranges from 89 per 1000 live births in the South-west to 217 in the North-west and 222 in the North-east. Third, Nigeria is not making sufficient progress towards the achievement of MDG 4. For instance, under-five mortality rate in the country for the 1999-2003 period was 201 per 1000 live births, while the rate has marginally declined to 157 per 1000 live births during the 2004-2008 period (NPC & ORC Macro, 2004; NPC & ICF Macro, 2009). Fourth, Nigeria is by far the most populous country in Africa and she has a very huge childhood population. According to 2006 population and housing census, Nigerian's population is 140,431,790 and the population of the under-five children is 16.1% of the total population (NPC, 2008). The country's population is also estimated to be growing at 3.2% per annum (NPC and ICF Macro, 2009).

Furthermore, despite the improvement in medical technology, reports by NPC and ICF Macro, (2009) indicate that Nigeria is still being ravaged by several health challenges. These include high rates of under-five mortality (157 per 1000 live births), high teenage pregnancy (23% of young women had given birth by aged 15-19 years), many poor pregnancy outcomes such as stillbirth, spontaneous abortion, and low birth weight (Adekanmbi *et al.*, 2011), poor survival chances for the newborn, and high unmet need for family planning (20% of currently married women have an unmet need for contraception in the country). Also, the percentage of births assisted by unskilled birth attendants is 60% in the country. The list of public health problems is indeed endless in Nigeria. It is therefore momentous studying a country with such a diversity and myriad of health problems.

1.6 Definition of Terms

1.6.1 Infant mortality

In this study, infant mortality is defined as the probability of dying before the first birthday (i.e. the probability of dying between age 0 and 11 months).

1.6.2 Child mortality

Child mortality is defined in this study as the probability of dying between the first and fifth birthdays (i.e. the probability of dying between age 12 and 59 months).

1.6.3 Under-five mortality

Under-five mortality is defined in this study as the probability of dying between age 0 and five years (i.e. the probability of dying between age 0 and 59 months).

1.6.4 Infancy

Infancy was used in this study to mean the first year of life (i.e. ages 0 to 11 months)

1.6.5 Childhood

The term childhood was used in this study as the period between ages 1 and 5 years

1.6.6 Under-five

Under-five is defined in this study as the period between ages 0 and 5 years.

1.6.7 Household characteristics

Household characteristics are defined as attributes or features of a domestic unit which consists of the members of a family who live together under the same roof and who are under the control of one domestic head

1.6.8 Community variables

These are the characteristics of a community or cluster. A community comprises of people living in a particular area or in a common location. In the 2003 and 2008 Demographic and health survey programmes, the primary sampling units (PSU) are considered as proxies for communities or clusters.

1.6.9 Primary sampling units (PSU)

These are small and well-defined administrative areas having population with homogeneous background characteristics. PSUs are used as proxies for communities. A PSU contains one or more enumeration areas.

1.6.10 Cluster

A cluster consists of a minimum of 80 households.

1.6.11 Contextual characteristics

Contextual characteristics are the community or contextual-level variables that are analysed at the level of the primary sampling unit.

1.6.12 Multilevel model

"A multilevel model concerns the analysis of the relationship between variables that are measured at different hierarchical levels" (Hox 2002; cited by Harttgen & Misselhorn, 2006:7).

1.6.13 Ethnic diversity

This variable is defined as the likelihood that two individual women selected randomly from a primary sampling unit (i.e. a cluster) will not be of the same ethnic affiliation.

1.6.14 Enumeration area

An enumeration area is a geographic area that is canvassed by a set of enumerators during the census exercise.

1.6.15 Intra-class correlation coefficient

The intra-class correlation coefficient (ICC) is an important measure of the relatedness of clustered data within community or household units (Antai 2011b).

1.7 Organization of the Thesis

This thesis is organized as follows. Chapter 1 presents the background to the study. Literature review and theoretical framework is presented in chapter 2. Chapter 3 presents the methodology employed in the study. While chapter 4 presents the profile of the study sample; chapters 5, 6 and 7 address objectives 1, 2 and 3 respectively. Chapter 8 presents the hypothesis testing while chapter 9 presents the discussion, conclusion and recommendations. Other important details are presented in appendices A, B, C and D.

CHAPTER TWO

Literature Review and Theoretical Framework

2.0 Critical Review of Relevant Literature

This section presents the review of relevant literature and the theoretical framework. Important literature related to the study was collected through various sources: HINARI, JSTOR, PubMED, Google search engine, Google scholar, CAB direct, monographs, edited books and reports. Access to several articles was secured through the University of the Witwatersrand's Library, supervisor's assistance, as well as through the Information Technology and Communication Unit of the Obafemi Awolowo University, Nigeria. Keywords and mesh terms for literature search included: infant mortality, child mortality and child survival. Other search terms included: multilevel analysis of childhood mortality as well as infant and child mortality determinants.

Demographic and public health literature was found to be replete with studies on various outcomes of child health and survival. Several studies on infant and child mortality have yielded diverse findings on the causes and determinants of infant and child deaths. Literature consistently established that child health outcomes are generally poor in sub-Saharan Africa and South Asia; and that the two sub-regions are the major contributors to statistics on childhood mortality. Thus, to ensure clarity and to properly engage prior researches relevant to this study, review of literature in this chapter was presented under five sub-headings: the global overview of infant and child mortality, the overview of infant and child mortality in Africa, the overview of infant and child mortality in Nigeria, the determinants of infant and child mortality, as well as risks of childhood mortality and community contexts. Also, a tabular presentation of some of the reviewed articles was done in this section (see appendix B).

2.1 Global Overview of Infant and Child Mortality

Globally, a well above 10 million children under the age of five die annually and about half of these deaths occur in just six countries while 42 countries account for 90% of these deaths (Black et al, 2003). The authors also observed that more than 2 in 5 of child deaths occur in sub-Saharan Africa and 34% occur in the South Asia. More recently, Rutherford (2010) reported a global estimate of 9.7 million under-five deaths each year. Again, about 41% of these deaths occur in the sub-Saharan African countries. Recent estimates of the UNICEF (2012) put the 2011 global under-five deaths at around 7 million. Though childhood mortality seems to be declining, the figure still remains unacceptably high with sub-Saharan Africa remaining the major contributor to this figure.

Up till the recent time, infant and child deaths vary substantially among the regions of the world. For instance, the variation in childhood deaths between the developing and developed nations is slightly more than 78-fold from a high of 180 per 1000 live births in Angola to only 2.31 per 1000 live births in Singapore (World Fact book, 2011). Unfortunately, the vast majority of these childhood deaths are preventable by low-cost public health interventions (Jones et al 2003).

Considering factors influencing infant and child mortality, a study on maternal education and child survival in the developing countries by Cleland and others (1988) had long established the importance of maternal education in successful childrearing. The study established that maternal education has a strong effect on infant and child mortality through the influence of intervening variables like reproductive health patterns and equitable care for sons and daughters. Also emphasizing the importance of maternal education, Whitworth and Stephenson's (2002) study in India found that higher level of maternal education has the advantage of weakening the effect of short birth interval because increased female autonomy and access to resources tend to remove the competition for resources that often characterize short birth interval.

Kravdal (2004) showed that apart from the effect of maternal education on child mortality in India, the community-level of education, that is, the average education of women in an enumeration area also has strong association with child mortality. A study by Antai (2011) has attributed ethnic differentials in the risk of under-five mortality to disparities in maternal level of education among various ethnic groups in Nigeria. Uthman (2008) also observed that maternal education significantly plays a protective role against infant mortality in Nigeria. Kravdal (2004) also noted that equitable care for sons and daughters work to the advantage of children born to the educated mothers.

In a study by Zanini, et al. (2009) which analyzed the trend in infant mortality among the Brazilians using multilevel analysis, infant mortality was found to be positively associated with the proportion of low birth weight newborns and number of hospital beds per 1000 inhabitants; but, infant mortality was found to be negatively correlated with the cesarean rate and number of hospitals per 100,000 inhabitants. The authors, in addition, observed that individual and community-level characteristics have significant effects on the reduction of infant mortality rates. Griffiths et al (2004) opined that childhood malnutrition is not as prevalent as child mortality in sub-Saharan Africa; whereas, about half of the children in India alone are affected by malnutrition. The authors suggest that homogenous nutritional outcomes are found among the children in the same community "because of shared behavioural practices like cultural norms regarding food. Some of the identified covariates of child malnutrition are size of the child at birth, age of the child, maternal level of education, breastfeeding status, and last diarrhea episode. Supporting this finding, Lykens et al (2009) observed that nutrition is a significant factor in child survivability.

Furthermore, Subramanian and colleagues' (2006) study provided evidence that socio-economic effect of mortality is substantial among the Indian and that the burden of poor health outcomes disproportionately affect the economically disadvantaged. In a study by Frankenberg (1995) which examined the effects of access to health care on infant mortality in Indonesia, it was shown that just an addition of one doctor could reduce the odds of infant death by almost 2 percent while substantial reduction, that is 15 percent, could result from an addition of just one maternity clinic. The author confirmed the hypothesis that proximity to health facility significantly decreases child mortality. The study also goes on to state that a slight increase in the distance to health facility would lead to a corresponding increase in mortality risk among the children. Again, from a theoretical standpoint, increase in the availability of health personnel is expected to lead to a reduction in infant and child mortality, but Frankenberg (1995) found that increase in health personnel tend to increase mortality risk among the study population. Purdah system has been cited by Wall (1998) as a major challenge restricting wife access to health care in the Northern part of Nigeria. Antai et al (2010) also stressed the need for community-level intervention to improve access to health care services in Nigeria.

Whitworth and Stephenson (2002) established that competition for resources between the newborn and the previous sibling is the pathway through which short birth intervals increase the mortality risk among the children. The authors conclude that children of young mothers, children of high parity and children whose previous sibling died or breastfed for short durations are at greatest risks of dying if their births follow a short birth interval. Also, Schell and colleagues (2007) conducted a study on socio-economic determinants of infant mortality, using 152 low-, middle- and high-income countries' data and found that relative significance of key determinants of health varies substantially between income levels, as a result extrapolating health strategies from high- to low-income countries becomes difficult.

Further, other researchers like Omariba et al (2007), Harttgen and Misselhorn (2006), Griffiths et al, (2004), and Sastry (1996) had also employed multilevel modeling to examine the relationship between community characteristics, household attributes, and child survival in a number of countries in South Asia, Latin America and South America; and they established significant relationship between child mortality and a number of community-level variables. Studies conducted in those regions established that child health outcomes are influenced by such factors that operate at the individual level as well as those within the familial and community contextual situation in which a child is raised.

Thus, the global debate on infant and child mortality is endless. In spite of several researches that have been conducted on infant and child mortality around the world, the phenomenon still remains an issue for research and policy in the developing world. In order to contribute to the global discourse on infant and child mortality, this study attempted to build on the insights (i.e. understanding of the individual and household-level determinants of child mortality) provided in the reviewed literature. Besides, this study sought to advance the existing knowledge by taking the advantage of multilevel analytical technique (using multilevel Cox proportional hazards model) to produce more robust analysis of the determinants and levels of infant and child mortality in Nigeria.

2.2 Overview of Infant and Child Mortality in Africa

Demographic and public health literature shows that infant and child mortality remains a daunting challenge in the African continent. In particular, there exists a huge variation in infant and child mortality rates in the sub-Saharan African countries. Becher (2010) noted that about one-third of all countries in Africa show a decline of 30% or more in under-five mortality, while in contrast, a number of countries sadly show a considerable increase. Supporting this argument, Ewbank et al (2002) maintained that decades of sustained childhood mortality reductions still see the mortality levels in many parts of Africa to be relatively high. Recently, Lykens et al (2009) observed that an infant born in a less developed nation is over 13 times more likely to die before reaching fifth birthday compared to his/her counterparts in the developed world. As a result, under-five mortality is seen as a major public health issue of concern in Africa as in other developing world.

Hammer et al (2006) argued that roughly 40% of under-five deaths occur during the neonatal period and this proportion was said to be considerably lower for regions with high absolute rates such as the sub-Saharan Africa. In Africa, infant and child mortality rates vary substantially from one sub-region to the other (Lutambi et al, 2010). The rates are as high as 163.2 and 197.6 deaths per 1000 live births in Guinea and Niger republic respectively; and as low as 28.3 deaths per 1000 live birth in Egypt (Macro International Inc, 2011). It may be reasonably assumed that there is a huge variation in infant and child mortality from one country to another in the African continent because various countries are at different stages of economic development.

Also, a number of factors have been adduced for persistent high infant and child mortality in the continent. For instance, Sear and colleagues' (2002) study in rural Gambia found that presence of a living mother, maternal grandmother or an elder sister has a significant positive relationship with child's survival. The study goes on to state that it would be harmful for a child if the mother remarries to a new husband, a practice which is common in many countries. Again, stressing the significance of the mother's roles in successful childrearing, Sear et al (2000) noted that motherless children aged two years or below were 11 to 13 times more likely to die relative to those whose mothers are alive. Whereas, beyond age two, motherless children were found not to be at greater risks of dying than those whose mothers are still living.

In a related study, Berger et al (2002) stressed the importance of maternal age and breastfeeding practice for the newborn. Using Zambia 1992 DHS datasets, the authors established that maternal age at birth and breastfeeding duration are positively associated with child mortality. Corroborating this point, Sear et al (2002) noted that due to the lack of alternatives to breast milk, an infant is unlikely to survive after the death of his/her mother. All these findings point to the significance of mother's care to child's health and survival.

Also, Buor (2002) examined the effect of mothers' education on childhood mortality in Ghana and found that mothers' education is inversely related to childhood mortality. In contrast, Anderson and others' (2002) study among the African and Coloured Population in South Africa indicates that, mother's education notwithstanding, environmental factors such as source of domestic water and type of sanitation significantly influence infant and child survival.

Writing on the significance of family structure, Omariba and Boyle (2007) observed that children in polygynous settings have greater risks of dying than children whose mothers are in monogamous unions. The authors noted that factors such as education, socio-economic status and place of residence greatly influence the variations associated with polygyny. This finding, thus contrasts a study by Sear et al

(2002) which established that there is a negligible difference between the mortality rates of children in polygynous unions and those in monogamous settings. The authors also observed that "there was little difference in the mortality rates of children who were born to monogamous or polygynous fathers" (Sear et al, 2002: 43). Argeseanu (2004) threw support behind this argument by stressing that the children of married women have a greater advantage of surviving relative to the children of the unmarried women; and that children in polygynous marriages tend to have protection and higher survival chances compared to the children in monogamous unions.

Thus, the reviewed studies highlighted a number of factors associated with infant and child mortality in Africa. However, this study built on the premise established by these studies by improving on the deficiencies identified in the studies. That is, this study went beyond identifying individual-level determinants of infant and child mortality already established by the previous studies.

2.3 Overview of Infant and Child Mortality in Nigeria

Nigeria remains a major contributor to global statistics on infant and child mortality. The country's rate of under-five mortality – 156.9 per 1000 live births (ICF Macro and NPC, 2009) – is among the highest in the world. Besides, there is a substantial geographic variation in the patterns of under-five mortality rates in the country from the lowest of 89 per 1000 live births in the South-western Nigeria to the highest of 222 per 1000 live birth in the northeast. A number of reasons have been given for this enormous regional disparity. For instance, Antai's (2010) study on inequality in under-five mortality in Nigeria found that under-five death is highest among Hausa/Fulani/Kanuri in the Northern Nigeria. Basically this was because these ethnic groups have the poorest maternal and child health indicators such as access to good quality health care and availability of skilled birth attendants. Again, in a recent study, Antai (2011) established that under-five mortality rates were significantly higher in some regions compared to the others.

Thus, in another study, Antai et al (2010) stressing the relationship between migration and child health inequalities in Nigeria noted that children of rural-urban migrants tend to have significantly higher under-five mortality compared to the children of rural non-migrant mothers. The authors observed that "the disruption of family and community ties, low socio-economic position and vulnerability, and the difficulties migrants face in adapting into the new urban environment, may predispose the children of rural-urban migrants to higher mortality" (Antai et al, 2010: 1464). Also, Antai and Moradi (2010) in another study noted that under-five mortality in urban areas is positively correlated with the rate of urbanization over the 1983-2003 period in Nigeria. The authors stressed the need for further studies on community-level determinants of under-five mortality in Nigeria.

A study by Griffiths et al (2004) which analyzed the multilevel comparison of the determinants of child nutritional status using DHS data of seven countries including Nigeria emphasized the significance of individual and household-level characteristics such as age, duration of breastfeeding, recent diarrhea episodes, and the size of child at birth as well as maternal education. But, against the theoretical expectation, an earlier study in Ondo State Nigeria by Adetunji (1995) found that children of secondary school graduates experienced a higher rate of infant mortality than children of less educated mothers. In contrast however, recent findings have established that formal education as well as health education significantly improves child survival (e.g. Chirdan et al 2008). Also, Anyamele's (2009) analysis of DHS data of selected sub-Saharan African countries, including Benin and Nigeria corroborated the findings by Chirdan and colleagues by establishing that literacy is significantly associated with child mortality.

Further, several of Nigerian studies on infant and child mortality are mainly hospital-based. A number of such studies emphasized drug use, treatment and hospital admission vis-à-vis child's health outcomes. For instance, Adeboye et al (2010) conducted a hospital-based study of mortality pattern within 24-hour of emergency pediatric admission in Nigeria and found that majority of infant deaths occur within the first day of admission due to causes attributable to malaria and malnutrition. In a related clinical-based study, Okeke et al (2009) carried out an intervention to train the drug vendor with the aim of improving their drug selling and referral practices. The intervention achieved improvement in drug selling and recorded 80 percent compliance with referral cases. A hospital-based study by Oniyangi et al. (2006) on the pattern of paediatric HIV/AIDS in Abuja Nigeria showed that paediatric HIVAIDS occurs mostly through mother-to-child transmission. The authors further established that paediatric HIV/AIDS constitutes a significant cause of morbidity and mortality among children admitted at Abuja National Hospital in Nigeria. Also, a study by Grais and colleagues (2007) on child mortality in three countries including Nigeria established that preventable diseases such as measles still remain a serious killer disease in some parts of Niger, Nigeria and Chad.

Several other hospital/clinical-based studies have been conducted in Nigeria and the studies seemed to emphasize clinical-related causes of infant and child deaths (e.g. Akinbami et al 2010; Chukuezi and Nwosu, 2010; Ifesanya, 2009; Okoro, 2009; Okafor, 2009; Ekenze**,** 2009; Melliez, 2007). Many other studies that are not hospital-based, but which are community-based failed to consider the influence of contextual situation where a child is raised on his/her survival chances. The present study, however, addressed the deficiencies identified in the previous studies by exploring the influences of broad familial and community contextual factors on infant and child mortality in Nigeria.

2.4 Determinants of Infant and Child Mortality

Unraveling the determinants of childhood mortality in the developing world is rather a difficult task (Rodgers, 2002). Although, many studies have identified various determinants of infants and child mortality, it has been observed that recognizing the effects of various determinants is indeed a difficult task. It has also been contended that the pathway of influence through which the various determinants operate is rather a complex one. As a result, there is an endless debate on what constitute the determinants of infant and child mortality particularly in the developing regions of the world. Several factors ranging from bio-demographic to socio-economic have brought about huge differentials in the mortality risks among the infants and children. Zaba and David (2010) opined that risks of deaths are unevenly distributed across countries and regions. Black, et al (2003) also noted that the factors influencing child deaths vary substantially from one country to another. Hale and colleagues' (2006) study provided evidence that substantial variations in infant and child mortality exists in Bangladesh from one region to the other.

Gupta (1990) wrote that gender is a significant determinant of child mortality with boys being better-off in some places while girls are preferred in a number of other settings. Also, Subramanian and colleagues' (2006) study among the Indians lend credence to this finding by establishing that substantial mortality inequality exists between boy child and girl child with girls aged 2-5 years being at disadvantage due to differential intra-household distribution of food and access to medical treatment that favours the boys. But in contrast, Cleland et al (1988) earlier argued that the effect of preference treatment for either girls or boys is very negligible on child survival. Whitworth and Stephenson (2002) however, observed that reproductive risk factors and equitable care for sons and daughters work, though with weak impact, to the advantage of children born to the educated mothers.

Several studies have examined the effect of educational level on the rates of infant and child mortality and found that the former significantly influence the latter. However, Jamison et al (2007) did a different analysis by examining the effect of quality of education (proxied by international student achievement tests) and established that infant and child mortality rate is strongly influenced by quality of parents' education. Again, Whitworth and Stephenson (2002) noted that higher level of maternal education which is associated with greater access to household resources and improved health care could reduce the effect of sibling rivalry that characterizes short birth interval. As earlier pointed out, Uthman et al (2008) noted that maternal education plays a significant role in protecting infant against mortality.

A study by Palma-Soliso and others (2009) found that reduction in government expenditure can significantly compromise the attainment of MDG4 in many developing countries. The authors further observed that the rates of infant and child mortality are not just associated with a single characteristic but linked with several manifestations of people's living conditions. Manda (2001) supports this argument by suggesting that mortality risks of children from the same household tend to be alike and that that of the children from the same community will also be influenced by the same environmental conditions. Zanini and colleagues' study (2009) in Brazil throws weight behind this argument by establishing that about half of the variability in infant mortality rates was due largely to community-level characteristics. They concluded that individual and community characteristics have significant effects on the reduction of infant mortality rates. Meanwhile, a comparative study by Griffiths et al (2004) contrasts the foregoing by establishing that community characteristic such as place of residence is not as important as the family correlation and that the community correlation of health outcomes appears less important than the family correlation.

Also, using fixed-effects modeling, Frankenberg (1995) found that building more health facilities and adding to the number of doctors in a village would significantly reduce infant and child mortality risk. But Antai et al (2009) argued that, the number of health facilities notwithstanding, the use of maternal and child health services is largely determined by mother's indigenous religious affiliation and this significantly influences the risk of infant and child mortality.

Contributing to the debate on inter-birth interval and child survival, Sear and Mace (2008) conducted a systematic review of forty-five related studies and consistently found in all the studies that a minimum of one family member other than the mother of the newborn enhances female reproductive success and helps to improve child survival rates. The authors found that, among all the kin, presence of maternal grandmothers tend to improve child survival rates more than the presence of all other relatives, while presence of certain kin is also found to be inimical to child survival. Supporting this argument, Sear et al (2000) had found in an earlier study in rural Gambia that while paternal grandmothers and male kin, including fathers have very negligible contribution to improve child survival, maternal grandmothers are the only kin that significantly improve child’s survival apart from the mothers.

In a study by Stockwell *et al* (1995) evidence was drawn from the US data, that in spite of the decline in mortality; inverse relationship still consistently exists between income status and infant mortality. Lending credence to this finding, Rodgers (2002) established that income distribution is significantly correlated with mortality. Also corroborating this argument, Collision et al (2007) narrowed down on childhood mortality and established that a very strong relationship exists between income inequality and child mortality even in the wealthy nations.

Other relevant studies have diverse findings. For instance, women with low or no education (Kanjala et al, 2010; Schell 2007; Griffiths et al., 2003; Sastry 1996); women in lower wealth quintile (Harttgen & Misselhorn, 2006; Wang, 2003); women who reside in rural areas (Wang, 2003); women in polygynous unions (Omariba and Boyle, 2007); women who have poor or no access to electricity (Wang, 2003); women who delay initiation of breastfeeding (Harttgen and Misselhorn 2006); and women who did not complete child immunization (Wang, 2006) tend to have higher infant and child mortality. Sastry (1997) also established that higher average temperature is associated with higher child mortality in Northeastern Brazil. Kanjala et al (2010) also found that children of mothers with primary education are 18% less likely to die while children whose mothers had secondary or higher education are 47% less likely to die compared with children whose mothers had no education.

Also, emphasizing the importance of maternal education, Odimegwu (2002) observed that education is a key determinant in decision to breastfeed a baby. Meanwhile, Kravdal (2004) noted that maternal education operates through a number of community-level variables that are influenced by average educational status of mothers in a community. In a study by Manda (2001) short birth spacing, short breastfeeding duration and the death of a preceding child were found to be significantly associated with increased risk of child death. Palma-Soliso et al (2009) noted that the rates of infant and child mortality are not just associated with a single characteristic but linked with several manifestations of people's living conditions.

Furthermore, Sastry's (1997) study among the Brazilians suggests that family mortality clustering often arises from the family situations that predispose the siblings to the same mortality risks. Sear and Mace (2008) established that presence of maternal grandmothers tend to improve child survival rates, while presence of certain other kin was also found to be inimical to child survival. A study by Antai

(2010) on the relationship between migration and child health inequalities in Nigeria also established that children of rural-urban migrants tend to have significantly higher under-five mortality compared to the children of rural non-migrant mothers.

As earlier pointed out, unraveling the determinants of mortality in the developing world is seen as a difficult task (Rodgers, 2002). Though, many studies have identified various determinants of infant and child mortality, yet the determinants driving the phenomenon have not been fully explored due to the dynamic nature of the problem. As a result, the search for pathway of influence of various determinants of infant/child mortality has remained an endless search. Besides, empirical evidence is sparse on the contextual determinants of infant and child mortality in Nigeria. Hence, this study contributed to the global debate on the contextual determinants of infant and child mortality with main focus on (1) the influence of contextual factors on infant and child mortality (2) how the interplay between individual, household and community-levels characteristics influence infant and child mortality and (3) understanding the extent to which contextual factors explain regional variations in infant and child mortality in Nigeria.

2.5 Risks of Childhood Mortality and Community Contexts

From theoretical standpoint, Mosley and Chen's (1984) Model on the proximate causes of childhood mortality, as stated below, establishes a relationship between child survival and determinants at various levels of operation – individual, household, and community-levels (as published by WHO, 2003). Diez-Roux and colleagues

(2001) posited that the physical and social characteristics of neighbourhood where a person lives may affect health and health-related behaviour. Galster's (2010) work on the mechanisms of neighbourhood effects theory observed a link between residential environment and health outcomes of individual adults and children residing in such environment or community.

The effect of community context in which children are raised on their survival has been widely recognized (Sastry, 1997; Omariba et al, 2007; Antai, 2011a). Evidence suggests that living in an economically and socially deprived community or neighbourhood is associated with increased risk of under-five mortality (Antai & Moradi, 2010; Aremu et al., 2011). For instance, children born and raised in a community that lacks electricity, good drinking water and health facility are likely to suffer from the same deprivation which can directly or indirectly influence their health outcomes.

Further, Manda (2001) opined that Demographic and Health Surveys (DHS) often collect birth history data that are clustered at the household and community levels. Sastry (1997) as well maintains that most demographic surveys conducted in the developing countries often collect survival data that are clustered at both family and community-levels. Omariba and colleagues (2007) also argue that since DHS collects child survival data from mothers in sampled households, then the children of those mothers cannot be regarded as independent observations. This is as a result of natural clustering or as a result of the data collection procedures[2] used in DHS data collection (Sastry, 1997). The children from sampled households who are also nested within the same mother-level tend to share similar characteristics and common

[2] Two-stage cluster sampling design

genetic factors. This is also true of children from the same community. Individuals in the same community are likely to be more homogenous than those from different communities (Merlo, Yang*, et al.*, 2005a, 2005b). Similarities are expected in the health outcomes of children who are exposed to the same environmental conditions. In contrast, differences are expected in health outcomes of children raised in different communities due to differences in community characteristics (Harttgen & Misselhorn, 2006).

A distinction is drawn between children living in a relatively better-off neighbourhood and those living in a relatively worse-off neighbourhood (Macintyre *et al.*, 2002) Children living in two different households with similar socio-economic characteristics can suffer different mortality risks if they are from two contrasting communities. Sastry (1997) contends that community characteristics can exacerbate or mitigate mortality risks of individuals depending on the environmental context the individuals find themselves. Griffiths (2004) also argues in support that community services and levels of infrastructural development of a community are capable of amplifying or reducing mortality risks among the children. This is because an individual child resident in a household unit, which in turn is located within a community, is exposed to various levels, (within the societal hierarchy) that either directly or indirectly influence his or her survival chances.

In addition, Whitworth and Stephenson (2002) maintain that two neonates with similar characteristics may suffer a different neonatal mortality risk because of the community contextual effects. The authors argue that these differentials in mortality risks may be as a result of differences in the provision of antenatal and obstetric health care or the effects of environmental conditions the children are exposed to. Also, individuals residing in the same community tend to share similar preferences, cultural practices, values and customs. The reason is that individuals with similar tastes and values tend to cluster and live together (Sastry, 1997). All these clustering and living together of people with common norms, values, identities and cultural practices as well as spatial inequality in infrastructural development (Antai, 2011b) have a direct or indirect bearing on the health outcomes of infants and children and this often brings about variations and differentials in health outcomes between communities, particularly communities with contrasting characteristics.

Motivated by the emerging interest in the study of effects of community or neighbourhood contexts on health outcomes in developing countries, one of the objectives of this study was to examine the extent to which community contextual characteristics influence regional variations in infant and child mortality in Nigeria.

2.6 Theoretical Framework

This study has its theoretical underpinning in two theoretical models – (1) Mosley-Chen model and (2) Sastry's framework. The former is a model designed by Mosley and Chen (1984) for the study of the determinants of child survival in developing countries; while the latter is a framework developed by Sastry (1997) for interpreting the effect of factors at various levels of operation (i.e. individual, familial and community levels) on child survival. Thus, in this study, the relationship between the contextual determinants of infant and child mortality was conceptualized based on the foundation established by these two theoretical models.

2.6.1 Mosley-Chen Model

Mosley and Chen (1984) proposed an analytical framework for the study of the determinants of child survival in the developing countries. The authors considered research methods in the medical and social sciences and therefore, integrated social and biological variables into the analytical framework on the study of child survival. The framework was based on the premise that socio-economic determinants of child mortality operate through a common set of biological and proximate mechanisms to influence child mortality (Mosley and Chen, 1984:140-as published in the bulletin of WHO, 2003).

The model seeks to bridge the gap between the medical and social sciences. It was argued that traditionally, social scientists tend to focus child mortality studies on the relationship between socioeconomic status and mortality level in a population while the medical causes of deaths are left unaddressed. Conversely, the authors argued that the medical researchers only focus on the biological processes of disease; leaving socioeconomic factors that contribute to death unaddressed. The thrust of the argument however, was that both medical causes of death and socioeconomic determinants jointly influence child mortality. The authors opined that an analytical framework that adopts both social and medical science approaches in the study of child survival is highly needed in the study of childhood mortality in the developing countries.

It was also argued that several studies have identified numerous social and medical factors influencing child mortality; and that such factors that determine child health and survival are seen in various contexts: physical, socio-economic, cultural and political. It was maintained that the death of a child results from a combination of medical causes, social factors and systems failures that vary by context and culture. However, Mosley-Chen model incorporated all these factors into a framework which summarized that social and economic determinants of child mortality operate through the proximate determinants. The model established that socioeconomic variables act through proximate determinants such as maternal factors, environmental factors, nutritional status, injuries, and household behaviours.

Also, the framework takes into account a range of determinants (i.e. independent variables). These determinants were grouped into three broad categories: individual-level variables (i.e. individual productivity – at mothers or fathers' level as well as traditions/norms/attitudes); household-level variables (e.g. income and wealth) and community-level variables (i.e. ecological setting; political economy and health system). These variables operate at various levels through the proximate determinants (i.e. the intermediate factors) to influence childhood mortality. Berger et al (2002) thus observed the importance of Mosley-Chen model for the study of the determinants of child mortality at various levels of causality. Up till now, these various determinants at micro and macro levels have continued to influence infant and child mortality.

2.6.2 Sastry Framework

Sastry (1997) thus, building on the premise established by Mosley-Chen model categorized the proximate determinants into three broad categories: genetic, behavioural and environmental. He argued that these determinants can occur at three different levels of operation: child, family and community; and that the three levels provide a logical organization for the variables that are likely to influence child mortality. Emphasizing that an individual child resides within a family which is located within a community; he however noted that children belonging to the same household are exposed to the same household situation.

The framework further established that variations in household environment among children in the same community often results mainly from unobserved behavioural factors or measured socioeconomic characteristics. It was established that, "all children living in the same community are exposed to the same infrastructure, climate, physical environment, and socioeconomic and cultural setting; in addition, children are exposed to the same illnesses and diseases, which are transmitted within the community through normal patterns of contact" (Sastry, 1997:247)

Building on the foundation of Mosley-Chen model, Sastry's framework for interpreting effect of individual, family and community characteristics on child's survival provides a logical organization for the set of covariates that are likely to influence child survival at the individual (child or mother), family (i.e. household), and the community (contextual) levels. The author maintained that the actual outcome of child health depends largely on the interaction between the community attributes (like the community health systems and the infrastructures) and the individual and household characteristics. The thrust of the argument however was that child health outcomes are influenced by the determinants at the individual and household levels as well as by the attributes of the community contextual situation in which a child is raised. The Sastry framework (Figure 2.1) provides an analytical explanation of the effect of various levels of clustering of cases at the individual-, household-, and the community-level on child survival.

Form of Effect

Level of Operation	Genetic	Behavioural	Environmental
Child	Idiosyncratic genetic factor	Child specific behaviour and care	
Family	Genetic factors share among all sibling	Parental competence, care of children common to all siblings	Household environment
Community		Shared preferences, values, and cultural influences	Infrastructure, climate, physical and disease environment

Figure 2.1: A framework for interpreting factors influencing child survival at various levels (Sastry, 1997:247)

2.7 Application of Mosley-Chen Model and Sastry's Framework in the Past Studies

Mosley-Chen model has had a wide applicability in many studies of child mortality in the developing countries. Highlighting some of the studies that have applied Mosley-Chen model, first, Sastry's (1996) study on the community characteristics, individual and household attributes, and child survival in Brazil was conceptualized based on Mosley-Chen framework. Building on the Mosley-Chen model, the author opined that "although the availability of health, sanitation, and other social services is important for reducing child mortality, its interaction with individual and household characteristics determines the actual outcomes" (Sastry, 1996:213). The author established that in order to improve child survival it would be necessary to improve household living condition and community infrastructure.

Second, a work on the determinants of infant and child mortality in Kenya by Omariba and colleagues (2007) also was conceptualized based on Mosely-Chen conceptual framework. The authors established that bio-demographic factors are significant and more important in infancy than in childhood. Third, in the systematic review on the determinants of infant mortality done by Masuy-Stroobant (2001), reference was also made to Mosley-Chen analytical framework; and the author concludes that adequate statistical models are essential in the study of child mortality, particularly when many observations and sequences of causal factors are involved. Eberstein (1989) once argued that Mosley-Chen model is well suited for the study of child survival in developing countries while the framework proposed by Nam and colleagues is well suited for the study of child mortality in the developed countries.

In addition, Sastry's framework has also been widely applied in the study of child survival in developing countries. Considering some of the past studies where Sastry's framework has been applied, first, Griffiths and colleagues (2004) adapted Sastry's framework for their study on infant and child nutritional status. The authors established the significance of the effect of the contexts in which a child resides and experiences a particular nutritional outcome. The authors noted that "factors such as cultural beliefs, access to health care, community services and infrastructure, social support, and the socio-economic development of a particular community may create an environment that lowers or amplifies the risk of poor health among children of that community compared to the risk among children matched on individual characteristics but from a different community" (Griffiths et al, 2004:184). Second, Manda's (2001) study on the comparison of methods for analysing frailty model to child survival in Malawi made reference to Sastry's framework. The author opined that child survival times are clustered at the household and community levels. Third, Masuy-Stroobant's (2001) study which suggests robust statistical models in the study of child survival also made reference to Sastry's framework.

Meanwhile, what is largely missing regarding the models is their application (i.e. Mosley-Chen and Sastry's models) to the study of infant and child mortality in such a culturally and religiously diverse setting like Nigeria which has a myriad of health problems.

2.8 Relevance of Mosley-Chen Model and Sastry's framework to the study of infant and child mortality in Nigeria

As earlier stated, Nigeria is a multi-ethnic country with more than 250 identifiable ethnic groups. The country has a diverse socio-political landscape and she is home to many cultural and linguistic groups. All these diversities significantly influence the country's health indicators. From the arid northern region of the country to the savannah west, there are varied health outcomes among various categories of people – children, adult and the old. It is thus appropriate to apply Mosley-Chen model and Sastry's framework to the study of infant and child mortality in a diverse setting like Nigeria.

These theoretical models appropriately provide an analytical framework for the study of child mortality in a diverse setting with clustering of cases at the individual, household, and the community or regional levels, hence the adoption of Mosley-Chen and Sastry's models for this study. Meanwhile, for the variables to fit into the tenets of these models, the variables in the conceptual framework (figure 2.2 below) are specified at various levels of operations – individual and household and community levels. This study thus applied these models in answering the research questions to fill the identified knowledge gaps in the literature. In addition, considering that Mosley-Chen and Sastry's models do not provide for the effect of the quality of child care (prenatal, perinatal or postnatal care) on child's survival (Jain, 1985), this study addressed this missing gap by examining the effect of quality of care with which a child is brought up on his or her survival chances.

2.9 Conceptual Framework

This study was guided by both the reviewed literature and the theoretical models presented above. The Mosley-Chen (1984) model for the study of the determinants of child survival in the developing countries and the Sastry's (1997) framework for interpreting the effect of factors at various levels of operation (i.e. individual, familial and community levels) on child survival have been adapted for this study. The former, as earlier pointed out, provides the link between child mortality determinants (i.e. independent variables at individual, familial and community levels), the proximate factors (i.e. intermediate variables) and the child survival; while the latter builds on the former to provide logical framework for interpreting the effect of individual, family and community characteristics on child's survival.

The conceptual framework for this study, as earlier pointed out, was adapted from both Mosley-Chen model and Sastry's Framework. The framework (figure 2.2) below considers factors at different levels of operations and their role in influencing infant and child mortality.

As shown in the framework, the mother and her child are found at the individual level (i.e. level one). The mother together with the child resides in a household unit (i.e. level two). Also, the household unit in turn is located within a community (i.e. level three). The thrust of this argument is that the determinants at each of these levels of operation within the broad hierarchical structure are capable of influencing infant and child mortality through the interactions of attributes at various levels.

Thus, Schell et al (2007: 290) wrote that "infant or child deaths are seen as attributable to a range of hierarchical determinants". The authors also categorized these determinants into: distal, intermediate and proximate determinants (this classification was adapted in this study to logically organize the intervening variables). The framework of this study provides a logical organization of the correlates of child survival and it is also useful for the understanding of factors that are likely to influence infant and child mortality at various levels. Thus, the multi-factor conceptual framework for this study is depicted in the diagram below:

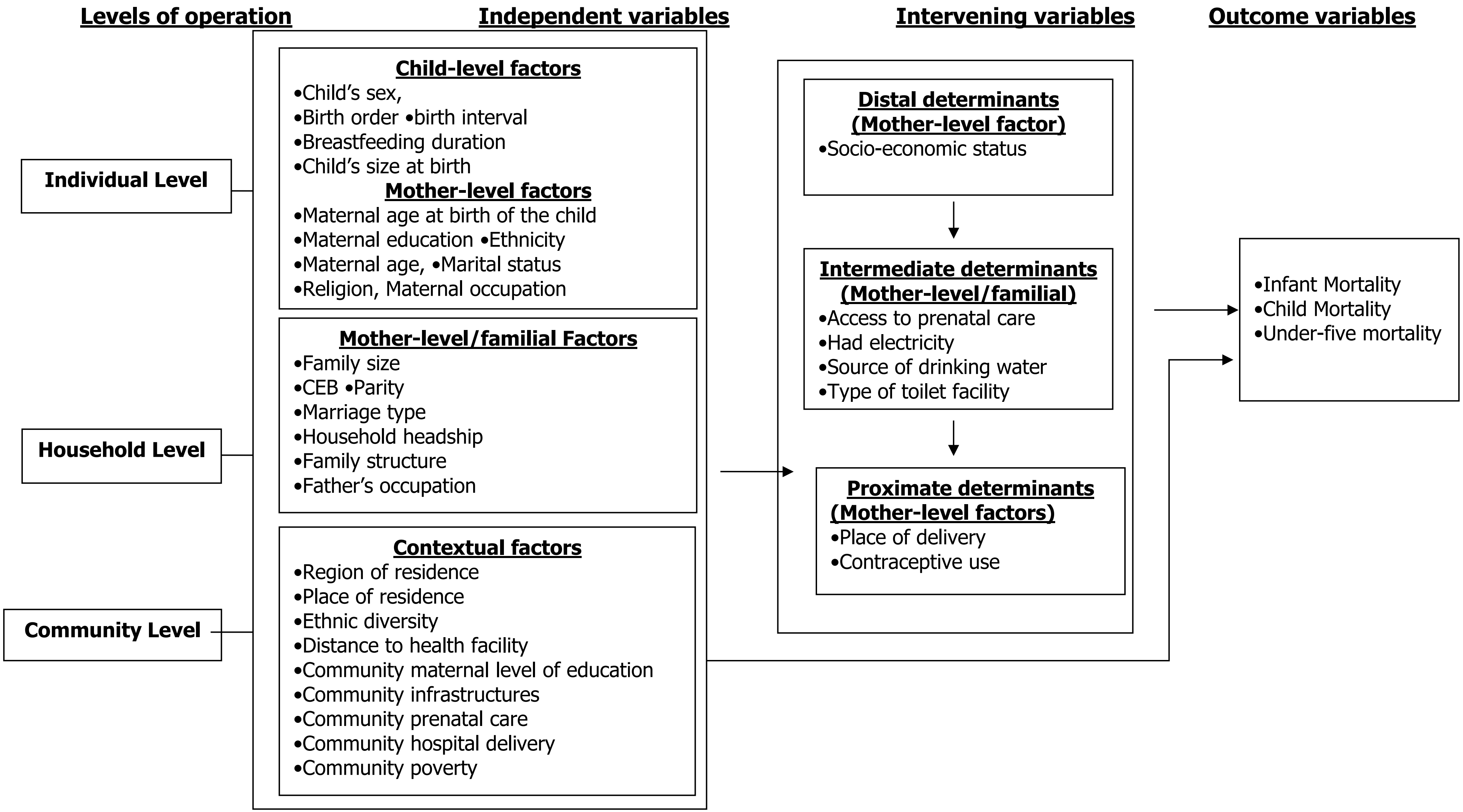

Figure 2.2: Conceptual framework on the relationship between contextual determinants and infant/child mortality (adapted from Mosley & Chen, 1984; Sastry, 1997; Schell et al, 2007)

2.9.1 Direction of relationship among variables

While a few of the independent variables in figure 2.2 above exert direct influence on the outcome variables (infant/child mortality and under-five mortality); a good number of the independent variables exert influence on the outcome variables through a set of intervening variables. Variables that have direct relationship with the outcome variables in the Figure 2.2 include: maternal age, child's sex, maternal age at first birth, maternal education, region of residence and ethnicity. The point of arrows in the figure above thus shows the direction of interrelationships among the variables.

2.9.2 Independent variables

The independent variables as shown in the conceptual framework (figure 2.2) above comprise variables at the three levels of operations: individual, household and community levels. At the individual levels, the selected mother/child level variables such as maternal age, child's sex, birth order, birth interval, breastfeeding duration, child's size at birth, maternal age at birth of the child and maternal education are all important determinants of infant and child mortality as observed in the reviewed literature.

At the household level, the variables of interest include: family size, children ever born (CEB), marriage type (polygyny or monogamy), household headship (household headed by a male or female), maternal occupation and father's occupation.

Also, at the third level of operation (community level), from where most of the study hypotheses were drawn, the important variables of interest as discovered in the reviewed literature include: region of residence (i.e. geopolitical zones of the country), place of residence (rural/urban residence), ethnicity, distance to health facility, community maternal level of education (i.e. the proportion of mothers who have at least secondary education in the community), community infrastructures (proportion having electric connection in the community and proportion having access to piped water in the community), community hospital delivery (i.e. the proportion of women who had hospital delivery in the community) and community prenatal care (i.e. the proportion of women who received prenatal care by a skilled provider in the community).

2.9.3 Intervening Variables

The intervening variables are grouped into three: distal, intermediate and proximate. According to Schell et al (2007) infant and child deaths can result from a range of hierarchical determinants that may be proximal, intermediate or distal. In the framework (figure 2.2) above, the variables regarded as distal determinants are essentially socioeconomic status characteristics. The intermediate determinants are: having/not having electricity in the household, source of drinking water in the household and access to prenatal care. The variables regarded as proximate determinants include: place of delivery and contraceptive use (whether currently using modern, traditional method or not using method).

2.9.4 Outcome Variables

This study considered infant/child and under-five mortality as the outcome variables. As shown in the figure 2.2, these are the risks of infant death and child death. The risk of infant death is defined as the probability of dying between birth and the first birthday (0-11 months); while the risk of child death is defined as the probability of dying between age one and the fifth birthday (12-59 months). Overall, under-five mortality is the probability of dying between birth and the fifth birthday (0-59 months). The risks of infant and child mortality can be influenced by characteristics at the individual, household and community levels. The variables at the various levels of operation mediate through the distal determinants, intermediate determinants and the proximate determinants to influence the risks of infant and child mortality.

2.10 Statement of Hypotheses

The hypotheses tested in this study are as follows:

1. Lower risk of infant and child mortality is associated with residence in communities that had high proportion of women who had secondary or higher education;
2. Easy access to health care facility significantly decreases the risk of infant and child mortality;

3. Residence in communities with high proportion of women who had prenatal care by skilled provider significantly lowers the risks of infant and child mortality;
4. Region of residence is a significant predictor of infant and child mortality;
5. Residence in heterogeneous communities is significantly associated with higher risks of infant and child mortality;
6. Ethnicity is a significant predictor of infant and child mortality; and
7. Polygyny is positively related to increased risks of infant and child mortality.

2.10.1 Rationale for the Hypotheses

The hypotheses above were drawn from the reviewed literature and the conceptual framework. As earlier pointed out, proximity to health care facility, access to prenatal care, educational attainment, ethnicity, region of residence and polygyny were all shown in the literature as important determinants of infant and child mortality.

CHAPTER THREE

METHODOLOGY

3.0 Introduction

This chapter presents the description of the study area and the sources of data. Also presented in this chapter are details of data collection procedures, sampling design technique, sample size, variables definition, data analysis procedures as well as the study limitations.

3.1 Data Sources

The study utilized 2003 and 2008 Nigeria Demographic and Health Survey datasets (2003 and 2008 NDHS)[3]. The 2003 and 2008 Demographic and Health Survey elicited information on demographic and health indicators both at the national and state levels. The primary sampling unit (PSU) which was regarded as a cluster for the 2003 and 2008 NDHS was defined on the basis of Enumeration Areas (EAs). While the 2003 NDHS adopted the Enumeration Areas designed for 1991 population census, the 2008 NDHS utilized the Enumeration Areas designed for Nigeria 2006 population and housing census. Samples for the two surveys were selected using stratified two-stage cluster design consisting of 365 clusters for 2003 NDHS (NPC and ORC Macro, 2004) and 888 clusters for 2008 NDHS (NPC and ICF Macro, 2009). Data were gathered from 7620 women aged 15-49 in 2003 and 33,385 women aged 15-49 women in 2008.

[3] Data from 2003 and 2008 NDHS were utilized in this study purposely to understand the influence of community contexts on child survival within a period of ten years – 1998-2008.

3.3 Organization of the 2003 and 2008 Nigeria Demographic and Health Surveys

The 2008 Nigeria Demographic and Health Survey is the most comprehensive of all the demographic and health surveys conducted in the country. Three previous ones were conducted in 1990, 1999 and 2003. Meanwhile, the 2003 and 2008 NDHS are the only Demographic and Health Surveys with data disaggregated by both the six geopolitical zones and the 36 states and FCT. The 2003 NDHS was conducted by the National Population Commission (NPC) from March to August 2003 while the 2008 NDHS fieldwork took place from June to October 2008. The financial supports for the two surveys came from United States Agency for International Development (USAID) and United Nations Population Fund (UNFPA). Technical assistance was provided by ICF Macro International. Questionnaires were administered on a nationally representative sample of 7,864 households in 2003 and 36,000 households in 2008, randomly drawn from all the 36 states and the FCT. Data were gathered from all women aged 15-49 years in all the selected households. Also, questionnaires were administered on the selected men aged 15-59 years drawn from a sub-sample of half of the households.

3.4 Sample Design

(Summarized from NPC and ORC Macro, 2004 and NPC and ICF Macro, 2009 reports)

The 2003 NDHS program made use of the sampling frame designed for the 1991 population census while the 2008 NDHS program adopted the sampling frame designed for the 2006 population and housing census. The primary sampling unit (PSU) which was regarded as a cluster for both 2003 and 2008 NDHS was defined on the basis of Enumeration Areas (EAs) from the 1991 and 2006 EA census frames, respectively. Samples for the surveys were selected using stratified two-stage cluster design consisting of 365 clusters in 2003 NDHS (NPC and ORC Macro, 2004) and 888 clusters in 2008 NDHS (NPC and ICF, 2009).

In all, a representative sample of 7,864 households in 2003 and 36,800 households in 2008 were selected for the surveys. In 2003, the second stage of selection involved a complete listing of all households in the selected 365 clusters followed by a systematic selection of about 50 households in each cluster for participation in the survey. Similarly, the second stage of selection in 2008 DHS involved a complete listing of the 888 selected clusters followed by a selection of an average of 41 households in each cluster, using equal probability systematic sampling. In each state, a minimum of 350 and 950 completed interviews was the target in 2003 and 2008 respectively. The number of households was proportionately distributed between rural and urban areas. All women within the reproductive age 15-49 years who were either permanent residents in the selected households or visitors that slept in the selected households on the night preceding the survey were eligible to be interviewed. Thus, the 2003 NDHS had an overall response rate of 95.4% while the 2008 NDHS had an overall response rate of 96.5%, with 98.1% from South-west being the highest and 94.1% from South-East being the lowest (Macro International, 2011).

Overall, data were collected from 7,620 women age 15-49 and 2,346 men age 15-59 years in 2003; and 33,385 women age 15-49 years and 15,486 men age 15-59 years in 2008, in randomly selected households across all the 36 states and the FCT. The survey elicited information on demographic and health indicators both at the national and state levels. Also the sample design allowed for specific population and health indicators to be computed for each of the 6 geopolitical zones and 36 states and the FCT.

3.5 Study Design

This study is an analytical cross-sectional study through the analysis of secondary datasets of the 2003 and 2008 Nigerian Demographic and Health Survey.

3.6 Survey Questionnaires

Three types of questionnaires were used for the 2003 and 2008 NDHS: the household questionnaire, the women's questionnaire, and the men's questionnaire. This study utilized data generated through the women's questionnaire. The women questionnaire was used to elicit information on the whole birth history of women age 15-49 years. Other important information collected from women include: background information, fertility preferences, breastfeeding practices, nutritional status of women and children, vaccination, childhood morbidity and mortality, knowledge and use of family planning etc. Thus, the criterion for inclusion in the analyses was that a woman had at least a live birth within the five years before the survey. This reference period was chosen in order to explore happenings in the more recent time in household and community levels.

3.7 Study Population

As earlier stated, the relevant data for this study (women age 15-49 years who had at least one live birth within the five years preceding the survey) were extracted from the whole 2003 and 2008 NDHS datasets. The unit of analysis was the child born in the five years before the survey.

3.8 Study Sample Size

Out of the survey's complete sample size of 7620 women contained in 2003 dataset, the sample size for this study comprised 3775 women who had a total of 6028 live births within the five years before the survey. Similarly, from a total of 33,385 women contained in the 2008 dataset, the sample size for this study comprised 18,028 women who had a total of 28,647 live births within the five years preceding the survey. Analysis was child-based. That is, the birth recode datasets of the two surveys were utilized in the analysis, and as earlier indicated; child was the unit of analysis.

3.9 Variables and Variable Measurements

The dependent and independent variables for this study were contained in the 2003 and 2008 NDHS datasets. The relevant variables were kept while the irrelevant ones were dropped using the Stata software (Stata version 11.1).

3.9.1 Dependent Variables

The dependent variables in this study were (1) infant mortality (i.e. death before the first birthday – death during age 0 to 11 months) and (2) child mortality (i.e. death between the first and the fifth birthday – death during age 12 to 59 months). Additionally, under-five mortality (i.e. death before reaching the fifth birthday) was another outcome variable considered in this study to examine, in overall, the risks of death during the first five years of life. Infant and child mortality was measured using the information from the birth histories of women age 15-49 years. Questions were asked on the number of sons and daughters the women have had and whether the children were alive or dead. Responses – yes or no – were given to the question – 'is child alive?' Other information obtained include: child's sex, child's current age, as well as age at death if the child had died.

3.9.2 Independent variables

The independent variables in this study included such important characteristics at the individual level, familial level and community level. The selection of independent variables in this study was guided by the reviewed literature and by the theoretical foundation established from the reviewed literature. Empirically, the selected independent variables in this study (at the individual, household and community levels) are those known to have influence on child survival as established in the literature. As presented in the conceptual framework above, these variables are presented and defined as follows:

3.9.2.1 Individual-level variables

The variables at the individual level include characteristics at the child and mother level. These include: maternal age, marital status, child's sex, birth order, birth interval, breastfeeding duration, child's size at birth, maternal age at birth of the child, maternal education and ethnic affiliation.

Table 3.1: Definition of individual-level variables

S/No	Variable	Definition	Coding
1.	Maternal age at birth	Age of mother at the time of child birth	Numeric response in years
2.	Child's sex,	Sex of the child	Male (1) Female (2)
3.	Birth order	Ranking of child according to order of birth	(1) First birth (2) 2-4 birth order (3) 5+
4.	Birth interval	Number of months between preceding birth and the birth of child in question	(1) Less than 2 years (2) 2 years or longer
5.	Breastfeeding duration	Duration of breastfeeding in months	(1) less than 6 months (2) 6 months or more
6.	Birth size	Size of child at birth	(1) Very large/larger than average (2) Average (3) smaller than average/very small
7.	Maternal education	Highest educational level of the mother	None (0), Primary (1), Secondary (2), Higher (3)
8.	Maternal age at birth of the child	Age of the mother at birth of the child	Numeric response in years
9.	Mother's marital status	Current marital status of respondent	(1) never married (2) currently married (3) previously married
10.	Ethnic affiliation	Mother's ethnicity affiliation	(1) Hausa/Fulani/Kanuri, (2) Igbo (3) Yoruba (4)Others
11.	Maternal occupation	Occupational status of the mother	(1) not working (2)prof/tech/manag/clerical (3)sales/agric workers (4) Manual labour
12.	Religion	Respondent's religious affiliation	(1) Catholic (2) Other Christian (3) Islam (4) Others

3.9.2.2 Household-level variables

Important selected household-level variables which could influence child survival include: family size, children ever born, parity, marriage type, household headship, household facilities and items ownership and father's occupation. These variables are defined in Table 3.2 below:

Table 3.2: Definition of household-level variables

S/No	**Variable**	**Definition**	**Coding**
1.	CEB	Total children ever born by respondent	(1) <3 children (2) 3-4 children (3) 5+
2.	Parity	Number of living children respondent had	(1) <3 children (2) 3-4 children (3) 5+
3.	Marriage type	Polygynous or monogamous family	(1) Polygynous (2) Monogamous
4.	Household headship	The sex of household head	(1) Male (2) Female
5.	Family size	Number of household members	Numeric response
6.	Father's occupation	Occupational status of the father	(1) not working (2)prof/tech/manag/clerical (3)sales/agric workers (4) Manual labour

3. 9.2.3 Community-level variables

The selected community-level variables in this study include: region of residence, place of residence, ethnic diversity, distance to health facility, community maternal level of education, community infrastructures, community prenatal care and community hospital delivery. Apart from region of residence, place of residence and distance to health facility, all other community level characteristics were created from the individual-level and household-level variables. Using Stata software, individual and household-level variables were aggregated at the level of primary sampling unit to create the community-level variables of interest. The decision to create the community variables considered in this study was based on the understanding obtained from the reviewed literature. These variables are defined in Table 3.3 as follow:

Table 3.3: Definition of community-level variables

S/No	Variable	Definition	Coding
1.	Region of residence	Geopolitical zone where respondent lives	(1) North-central (2) Northeast (3) Northwest (4) Southeast (5) South-south (6) Southwest
2.	Type of place of residence	Rural/urban residence	(1) Urban (2) Rural
3.	Ethnic diversity	The extent of diversity in the community where respondents live in terms of ethnic composition	(1) Homogenous (2) Mixed (3) Heterogeneous
4.	Distance to health facility	Distance between respondents' house and health facility	(1) Big problem (2) Not a big problem
5.	Community maternal level of education	Proportion of women who had at least secondary education in the community	(1) Low (2) Medium (3) High
6.	Community infrastructures - electricity	Proportion in the community who had access to electricity	(1) Low (2) Medium (3) High
7	Community infrastructures – drinkable water	Proportion in the community who had access to drinkable water	(1) Low (2) Medium (3) High
8.	Community prenatal care	Proportion in the community who had prenatal care by skilled provider	(1) Low (2) Medium (3) High
9.	Community hospital delivery	Proportion in the community who had hospital delivery	(1) Low (2) Medium (3) High

3.9.2.4 Intervening variables

Intervening variables in this study include distal determinants, intermediate and proximate determinants. Distal determinants are mainly socioeconomic status characteristics for which household assets were used to represent as proxy variables. These household assets were used to generate another variable called wealth index. Using principal component analysis, each household asset such as television, car, bicycle etc., were assigned a weight and the resulting scores were standardized and summed for each household (NPC and ICF Macro, 2009). Socioeconomic status of individuals was ranked according to the household where they lived. The intermediate determinants include: access to electricity, source of drinking water, type of toilet facility and access to prenatal care. Also, the selected proximate determinants include: place of delivery and contraceptive use.

Table 3.4: Definition of intervening variables

S/No	Variable	Definition	Coding
1.	Socio-economic status	Wealth index of household where respondents lived	(1) Poorest, (2) Poorer (3) Middle (4) Richer (5) Richest
2.	Have electricity	Household has electricity	(1) Yes (2) No
3.	Source of drinking water	Household source of drinking water	(1) piped (2) protected well/spring (3) unprotected well/spring/river/stream (4) others
4.	Type of toilet facility	Type of toilet facility in the household	(1) flush toilet (2) cover pit latrine (3) open pit latrine (4) others
5.	Access to prenatal care	Received prenatal care while pregnant	(1)Yes (2) No
6.	Contraceptive use	Ever used any method[4]	(1) never used (2) used traditional method (3) used modern method
7.	Place of delivery	Place where respondent had delivery	(1) Home (2) Hospital

[4] Rather than choosing current contraceptive use, ever used any method was chosen because previous use of method is more likely to influence child death (which occurred within 5 years before the survey) than current contraceptive use.

3.10 Addressing the Study Objectives

The objectives of this study provide answers to the research questions. Hence, the study objectives were addressed as follows:

3.10.1 First objective: - to examine the levels and magnitude of infant and child mortality in Nigeria. To address this objective, appropriate descriptive statistics were employed to assess the levels and magnitude of infant and child mortality in Nigeria both at the national and the regional levels. Besides, indirect estimation technique was employed to determine the present levels of infant and child mortality in Nigeria using Mortpark-Lite software and Microsoft Excel. The indirect estimation technique is suitable in assessing the reliability of the mortality rates obtained in the DHS reports through the direct method. Thus, in order to account for various assumptions and realities such as the inconsistency of mortality pattern in sub-Saharan Africa and the impact of HIV/AIDS in the region, the Trussell's variant and the Palloni-Heligman variant of the Brass Method of indirect estimating procedures were employed. Other techniques employed are Zlotni and Hill childhood estimation technique and the indirect estimation of childhood mortality using INDEPTH[5] Life Table.

3.10.2 Second objective: - to identify the individual, familial and contextual characteristics associated with infant and child mortality in Nigeria.

This objective was addressed using appropriate inferential statistics. First, bivariate analyses were conducted and chi-square test was performed to examine the

5 INDEPTH is the abbreviation for 'International Network of field sites with continuous Demographic Evaluation of Populations and Their Health in developing countries'.

association between infant/child mortality and the selected individual-, familial- and community-level variables. Second, multivariate analyses were performed using Cox proportional hazards regression analysis. This was done to identify the determinants of infant/child mortality at various levels (i.e. individual-, familial- and community-level).

3.10.3 Third objective: - to determine the extent to which the contextual factors account for regional variations in infant/child mortality across regions in Nigeria.

To achieve this objective, multilevel Cox proportional hazards regression analysis was performed. Fixed effects (i.e. measures of associations) and random effects (i.e. measures of variations) were employed to examine the extent to which contextual factors explain variations in infant and child mortality across regions in Nigeria.

3.11 Data Analysis

To analyze the datasets, three levels of analyses were employed in this study. First, the univariate analysis presents the percentage distribution of the respondents according to the background characteristics of interest. Second, at the bivariate level, cross-tabulations of a number of important variables were done and chi-square was employed to test the association between variables. Third, at the multivariate level, further analysis was done to examine the relationship between infant/child mortality and the selected independent variables. The selection of independent variables was guided by the theoretical foundation established in the literature. At the third level of analysis, Cox proportional hazards model and multilevel Cox proportional hazards model were employed to examine the relationship between the outcome variables (infant/child and under-five mortality) and a set of selected independent variables. All analysis at the univariate, bivariate and multivariate was done using Stata statistical package (version 11.1). The multilevel Cox regression analysis was performed using the generalized linear latent and mixed models (GLLAMM) procedure downloadable and implementable in Stata. To account for oversampling of some sections of the population, weighting factor provided by Measure DHS was applied in data management and analysis, where necessary.

3.12 Multilevel Cox Proportional Hazards Regression Analysis

A number of researchers had employed multilevel analysis to identify correlates of infant and child mortality. The assumption is that "individuals (level 1) are nested within households (level 2), and households are nested within communities (level 3)",(Harttgen and Misselhorn, 2006:6). To date, with the exception of one or two studies, Nigerian studies on infant and child mortality have rarely employed multilevel model approach. The multilevel approach is good at identifying the broad social, economic and environmental contexts in which a child lives and experiences a particular health outcome (Griffith et al, 2004). This suggests that individuals with similar household characteristics can have different health outcomes when residing in different communities with different characteristics. Griffith and colleagues (2004) opined that it would be methodologically wrong to fit a single-level standard regression model in the analysis of child survival. This is because standard regression models cannot handle hierarchical structure in the datasets due to its assumption of independence. In this study, therefore, multilevel Cox proportional hazards regression analysis was undertaken to determine the extent to which the contextual determinants explain infant/child mortality in Nigeria.

Cox proportional hazards model (i.e. survival analysis) is appropriate in analyzing censored observations. This means that, using Cox proportional hazards regression analysis, both the occurrence of infant/child mortality and the time when the infant or the child died were considered as the outcome variables. Also, the hazards model analysis can be done to take care of the multilevel or hierarchical structure of the DHS data (i.e. interdependency of determinants, because individuals (level 1) are nested within households (level 2) and households are also nested within communities (level 3)). Multilevel modeling provides for better analysis that would yield more robust findings on the factors associated with infant and child mortality.

3.13 Cox proportional hazard model: methodological procedure

The Cox regression procedure (i.e. survival analysis) is a useful technique for analysis of survival data and it takes care of censoring problem in mortality data. This is because some children are not fully exposed to the mortality risk.

In social science research, censoring occurs when the value of an observation is not fully known. Cox regression analysis allows for the inclusion of censored data and it models censored time-until-event data as a dependent variable where it can be assumed that the covariates have a multiplying effect on hazard rates. The outcome variables in this study were treated as the time between birth and death of a child under age one year (in the case of infant mortality), or time between age one and death of a child under age five years (in the case of child mortality), or overall, time between birth and death of a child under age five years (in the case of under-five mortality); or until the observation is censored. Children known to have died (i.e. non-censored) were regarded as the cases (as proper for each of the three outcome variables), while children who were still alive were treated as right-censored observations (as appropriate for infant, child and under-five mortality). Each of the outcome variables takes into consideration the children's survival status as well as the month of their death or the last month that they were known to be alive.

The probability of infant and child mortality is called the hazard. The hazard was modeled using the following equations:

$$\mathrm{H(t) = H_0(t) \times exp(b_1x_1 + b_2x_2 + \cdots + b_kx_k)} \dots\dots\dots\dots\dots\dots\dots..\dots\dots\dots.(1)$$

Where $\mathrm{x_1}$ ... $\mathrm{x_k}$ are a collection of explanatory variables and $\mathrm{H_0(t)}$ is the baseline hazard at time t, representing the hazard for a person with the value 0 for all the explanatory variables. By dividing both sides of equation 1 by $\mathrm{H_0(t)}$ and taking logarithms, the equation 1 becomes:

$$\ln\left[\frac{\mathrm{H(t)}}{\mathrm{H_0(t)}}\right] = \mathrm{b_1x_1 + b_2x_2 + \cdots + b_kx_k} \dots\dots\dots\dots\dots\dots\dots..\dots\dots\dots\dots\dots\dots\dots..(2)$$

Where $H(t) / H_0(t)$ is regarded as the hazard ratio. The coefficients $b_1 ... b_k$ are estimated by Cox regression.

Assuming that T is a continuous random variable and F(t) is the probability density function, the general survival function is of the form:

$$S(t) = P([T > t]) = \int_t^{\infty} f(u)du = 1 - F(t) \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (3)$$

The Cox proportional hazard model[6] assumes that the distribution of survival time is exponential and contingent on the values of a set of explanatory variables (*Xi)* (StatSoft, 2012*).* The rate parameter of this exponential distribution can be expressed as:

$$S(X) = \exp(a + b1 * X1 + b2 * X2 + bk * Xk \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots . (4)$$

Where S(*X)* is the survival times, *a* is the constant and *bi's* are the regression parameters.

The resulting model is similar to the conventional multiple regression model (StatSoft, 2012) and this may be written as:

$$t = a + b1 * X1 + b2 * Z2 + \cdots + bk * Zk \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots . (5)$$

Where t becomes the survival times

To estimate both the fixed and random effects in the multilevel survival analysis, it could be assumed that the hazards of any two units are proportional (Rabe-Hesketh *et al.*, 2004) and this is modeled as:

$$h_{ij}\ (t) = h^0(t)\exp\left(v_{ij}\right) \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (6)$$

In the above equation, there are two levels – (the two subscripts) – *i* represents the level 1units and *j* stands for the level two units, v_{ij} denotes the linear predictor of GLLAMM.

[6] Proportional hazard tests for time-varying covariates are presented in appendix D.

Using the Cox proportional hazards model, the dependent variable was taken as the risk of death in infancy (age 0-11 months), childhood (age 12-59 months) or under-five (age 0-59 months) measured as the duration of survival since birth in months.

Further, at the multivariate level, analyses were run separately for infant mortality and separately for child mortality, and overall, separately for under-five mortality[7] to examine how and to what extent the contextual factors (particularly at the community level) affect survival chances in infancy and childhood. This is because the literature indicates that bio-demographic factors are more significant in infancy and socio-economic and cultural factors are more important in childhood (Omariba et al, 2007). As a result, besides the analyses at the univariate and bivariate levels, there were eighteen models at the multivariate level (six models for each of the 3 outcome variables). In addition to this, the multilevel analysis involved fitting of forty-two models (fourteen models for each of the outcome variables), from the empty models to the full models. These models provide understanding on the influences of contextual factors on children's survival chances.

The various models are described as follows:

Model 0 – This is the empty model which contains no explanatory variables. This model focused mainly on decomposing total variance into both individual and community components.

Model 1 – This model considered only the region of residence covariate in order to examine the independent influence of region where children were born and raised on their survival chance.

[7] Separate analysis was done for under-five mortality to examine (in the overall) the effects of the selected characteristics on child survival within the period age 0 to 5.

Model 2 - Model 2 incorporated the child-level variables into the multilevel analysis.

Model 3 – Model 3 incorporated the mother-level variables into the multilevel analysis

Model 4: - This model considered only the community-level variables in order to examine the effect of community-level factors on child survival, independent of other factors.

Model 5 – This model is the full model that incorporated all variables into the multilevel analysis.

Model 6 – This is the final model. Fitting this model involved two steps. First, stepwise survival analysis was done to determine the key variables associated with infant and child mortality. Second, all the variables selected using stepwise Cox regression analysis were incorporated into the multi-level modeling.

The seven models above were fitted for each of the three outcome variables. This means that 21 models each were fitted using 2003 NDHS and 2008 NDHS. As earlier indicated, this translates to forty-two models in all.

3.14 Limitations of the study and data quality

Generally, mortality studies are faced with data limitations, particularly in the developing countries where death is regarded as a sad event that respondents do not love to recall. The study draws on a cross-sectional secondary datasets; as a result, there is tendency for child deaths to be underreported. "Mothers may be reluctant to talk about their dead children either because it brings back sad memories or because their culture discourages mention of the dead", (NPC and ICF Macro, 2009: 118). As omission of deaths can affect levels and patterns of child deaths; so also misreporting of age at death (heaping or avoidance) can distort the age pattern of mortality. Also, because information on child's births and deaths was collected retrospectively, number of births and child deaths might have been underreported due to memory lapse. Nonetheless, it is not envisaged that the data limitations will pose a serious challenge to this study. This is because the data quality assessment done for 2003 and 2008 NDHS data indicated that both surveys yielded far more reliable mortality data compared to the surveys earlier conducted in 1990 and 1999 (NPC and ORC Macro, 2004, NPC and ICF Macro, 2009). In addition, the infant and child mortality estimates obtained through the indirect estimation techniques (in Chapter five of this report) confirmed 2003 and 2008 NDHS data as of reliable quality. This is because there was no significant difference between the directly and indirectly computed estimates of infant and childhood mortality. Further details on this could be found in Chapters five and nine of this thesis.

3.15 Ethical Considerations

This study conducted a secondary analysis of an existing datasets. No personal information or name of the respondents was identified in the dataset. As a result, anonymity and confidentiality of the study respondents were guaranteed. Besides, ethical permission for the use of the Nigeria Demographic and Health Survey had already been obtained from ICF Macro Inc., USA.

3.16 Strategies for disseminating findings

Some preliminary findings from this study have already been presented in a number of international conferences in Africa, Asia and North America. Some of the presentations extracted from this thesis could be accessed online in the abstract submission websites of Union for Africa Population Studies (UAPS), Population Association of America (PAA) and Asian Population Association (APA). A number of papers have also been drafted from this study and these are currently undergoing peer review process in accredited peer-reviewed journals in the population and public health fields. Also, in order to utilize the findings of this study for necessary actions and steps to be taken in the country included in this study, a policy brief (presented in Appendix A of this thesis) would be sent to Nigerian government through the Macro International. Besides, more findings from this study will be widely disseminated at other local and international conferences and workshops. Table 3.5 below presents the names of conferences where findings of this study have been presented. The table also presents other proposed conferences and titles of papers to be presented.

Table 3.5: Conferences for the disseminations of research findings

S/N	Proposed Conferences	Conference dates	Title of paper	Action
1.	10th International conference on Urban Health, Belo Horizonte, Brazil	November 1-5, 2011	Under-five mortality disparities between the urban poor and non-poor: evidence from Nigeria DHS	Abstract accepted but conference was not attended
2.	6th APC of Union for African Population Studies (UAPS), Burkina Faso	December 5-9, 2011	Inequality in under-five mortality in Nigeria: do ethnic values and cultural practices matter?	**Abstract accepted and paper was presented at the conference**
3.	Population Association of Nigeria (PAN) conference, Lagos, Nigeria	September 12-15, 2011	Distance to health-care facilities: implication for child mortality in Nigeria	Abstract accepted but conference was not attended
4.	2011 International Conference on Family Planning, Dakar, Senegal	November 29-December 2, 2011	Unmet needs for family planning: implication for child survival in Nigeria	Abstract accepted but conference was not attended
5.	Annual conference of Population Association of America (PAA), USA	May 3-5, 2012	Regional inequalities in under-five mortality in Nigeria: a multilevel analysis	**Abstract accepted and paper was presented at the conference**
6.	European Population Association (EPC) conference, Sweden	2012	Distance to health-care facilities: implication for child mortality in Nigeria	Abstract accepted but conference was not attended
7	2nd Asia Population Conference	Aug 26-29, 2012	Unmet needs for family planning: implication for child survival in Nigeria	**Abstract accepted and paper was presented at the conference**

8.	National Family Planning Conference, Nigeria	Nov. 28-30	Unmet needs for family planning: implication for child survival in Nigeria	Abstract accepted but conference was not attended.
9.	Annual conference of Population Association of America (PAA), USA	April 2013	Unmet needs for family planning: implication for child survival in Nigeria	**Abstract accepted and paper was presented at the conference**
10.	27th Population conference of International Union for the Scientific Study of Population (IUSSP), South Korea.	August 26-31, 2013	Sex Differentials in Under-five Mortality in Sub-Saharan Africa	**Abstract accepted and paper was presented at the conference**
11	27th Population conference of International Union for the Scientific Study of Population (IUSSP), South Korea.	August 26-31, 2013	Under-five Mortality in Nigeria: Effects of Neighbourhood Contexts	**Abstract accepted and paper was presented at the conference**

Table 3.6: Articles to be published for the dissemination of research findings

S/N	Title	Thesis Chapter(s)	submission date	Journal in focus	Status of the paper
1.	Ethnic differentials in under-five mortality in Nigeria	Chapters 4 & 6,9	December 19, 2012	Ethnicity and Health	**Accepted for publication**
2.	Unmet needs for family planning and child survival: any association?	Chapters 4, 6,9	March 24, 2013	Journal of health, population and nutrition	**Under review**
3.	Regional inequalities in infant and child mortality in Nigeria: a multilevel analysis	Chapters 4, 7,9	May 18, 2013	Journal of Biosocial Science	**Under review**
4.	Under-five mortality in Nigeria: Effects of Neighbourhood Contexts	Chapters 2,4 & 7,9	August 2013	African Population Studies (APS)	**Accepted for publication**
5.	Barriers to accessing health care in sub-Saharan Africa: implication for child survival	Chapters 4, 6 & 9- these chapters to be built upon	October 2013	Journal of Health Care for the Poor and Underserved	**Draft**
6.	Sex differentials in under-five mortality in sub-Saharan Africa	Chapters 2,4,6,9 – these chapters to be built upon	November 2013	BMC Pediatrics	**Draft**
7.	Contemporary internal migration in Nigeria: Implication for child survival	Chapters 2, 6	March, 2014	BMC Public Health	To be drafted and submitted in June 2013
8.	Under-five mortality disparities between the urban poor and non-poor: evidence from Nigeria DHS	Chapters 4, 5 & 6	May 2014	Journal of Population Research	To be finalized and submitted in November 2013
9.	Levels and patterns of childhood mortality in Nigeria: Do estimation techniques matter?	Chapter 5	August 2014	Social Science and Medicine	To be written and submitted in December 2013
10.	Effect of polygyny on child survival in Nigeria	Chapters 4, 5 & 6	October 2014	Journal of Population Research	To be written and submitted in January 2014

CHAPTER FOUR

DEMOGRAPHIC, SOCIO-ECONOMIC AND ENVIRONMENTAL CHARACTERISTICS OF STUDY POPULATION

4.0 INTRODUCTION

The demographic and socio-economic characteristics as well as the contextual attributes of the environment where children are born and raised are vital and necessary to be addressed first before embarking on the study of any component of population change (be it fertility, mortality or migration). Hence this chapter presents the distributions of the study sample by selected demographic, socio-economic and community contextual characteristics which could either directly and/or indirectly influence infant and child mortality as established in the literature.

Vivid understanding of these profiles of the study population will enhance good and clear understanding of the findings in the subsequent chapters of this study.

Essentially, these background characteristics are presented using descriptive statistics. The characteristics are divided into three sub-sections according to various levels of operation: individual-level characteristics, household-level characteristics and community-level characteristics. Individual-level characteristics are the child-level and the mother-level characteristics. Household-level characteristics are the mother-level characteristics as well as the attributes of the domestic unit where the children are born and raised. Community-level characteristics are the attributes of the community or cluster where the children are raised and experienced a particular health outcome. Descriptions of the percentage distributions of the study sample by selected characteristics are also provided by Figures 4.1 to 4.11. These figures show the distribution of children according to selected individual, household and community levels characteristics.

4.1 Individual-level characteristics

In this section, the percentage distribution of the characteristics of the study population is presented according to selected important background characteristics. Selection of key background characteristics (which could influence infant and child mortality) was guided by the theoretical foundation earlier established from the literature. At the individual level, the variables analysed include: child's sex, maternal age at birth of the child, birth order, preceding birth interval, breastfeeding duration and child's size at birth. Others are maternal education, mother's current age, mother's marital status, prenatal care and place of delivery.

The distribution of the study population by individual-level characteristics is presented in Table 4.1. Results from 2003 and 2008 datasets showed that male and female children were almost of the same proportion (51% vs. 49%). With respect to birth order, almost half of the children (43.5% in 2003 and 46.2% in 2008) were of birth order 2-4. Slightly more than one-third of the children (36.6% - 2003 and 34.7% - 2008) were of birth order 5 or higher. A consideration of preceding birth interval showed that less than 1 in 5 children (18.7% - 2003 and 19.2% - 2008) had preceding birth interval of less than 2 years, whereas, slightly more than 4 in 5 children, according to both 2003 and 2008 data, were delivered after 2 years preceding birth interval. Considering self-rated child's size at birth by mothers, about half of the respondents – 47.4% (2008) and 42.1% (2008) rated their children as very large or larger than average while only 14.7% (2003) and 14.5% (2008) described their children as smaller than average or very small.

With respect to maternal education, results showed that highest proportion of the children (50.3% in 2003 and 46.5% in 2008) belonged to mothers with no formal education while 24 percent (2003) and 23 percent (2008) were children of mothers with primary education. Slightly more than one in five of the children (i.e. 21.7% in 2003) and one-quarter of the children (in 2008) were children of mothers who had secondary education. Only 3.6% (in 2003) and 5.4% (in 2008) were children of mothers who had tertiary level of education.

Table 4.1 further showed that half of the children (49.8% in both 2003 and 2008) were children of mothers aged 25-34 years. Results from 2003 data indicated that 26.7% were children of women aged 15-24 years; while results from 2008 data indicated that one-quarter each, were children of mothers aged 15-24 years (24.8%) and 35 years or higher (25.4%). Analysis of maternal age at birth of the child indicates that majority of the children (40.7% in 2003 and 43.0% in 2008) were delivered by mothers aged 25-34 years, followed by those delivered by young mothers aged 15-24 (36% in 2003 and 34% in 2008). Results from both 2003 and 2008 data showed that 8% each were delivered by teen mothers (less than 18 years) while proportion of children delivered by mothers aged 35 years or higher was 15% (2003) and 16% (2008).

It could be observed from Table 4.1 that the mothers were predominantly married as 94.7% (2003) and 96.8% (2008) were children of currently married women. Results showed that 64.3% (2003) and 63.2% (2008) were children of mothers who received prenatal care. More than 4 in 5 children (84% each in 2003 and 2008) had breastfeeding duration of 6 months or higher. With respect to place of delivery, analysis showed that almost two-thirds of the children (64.8% in 2003 and 63.9% in 2008) were delivered at home while the remaining 35.2% (2003) and 36.1% (2008) were delivered at a health facility. Considering ethnic affiliation, the results revealed that 43.1% (2003) and about 2 in 5 children (38.3% in 2008) were children of Hausa/Fulani/Kanuri mothers. While another 35.1% (2003) and 35.7% (2008) were children of the other minority ethnic groups in the country, 12% (in both 2003 and 2008) were children of the Igbo; and 9.6% (2003) and 13.6% were children of Yoruba ethnic group.

Table 4.1: Percentage distribution of study sample by individual-level characteristics (Nigeria DHS)[8]

Characteristics	2003 (n=6028)		2008 (n=28,647)	
	Percentage	Frequency	Percentage	Frequency
Preceding birth interval				
< 2 years	18.7	1124	19.2	5375
2 years or more	81.3	4904	80.8	23272
Birth size				
Very large/larger than average	42.1	2497	47.4	8449
Average	43.2	2557	38.1	6685
Smaller than average/very small	14.7	871	14.5	2702
Maternal current age				
15-24 years	26.7	1610	24.8	7249
25-34 years	49.8	3003	49.8	14111
35+	23.5	1415	25.4	7287
Maternal age at birth of the child				
<18	8.3	503	7.5	2160
15-24	36.0	2167	34.0	9742
25-34	40.7	2456	43.0	12313
35+	15.0	902	15.5	4432
Mother's marital status				
Never married	1.81	109	1.7	506
Currently married	94.7	5707	96.8	27378
Previously married	23.5	212	1.5	446
Received prenatal care				
No	35.7	1343	36.8	7015
Yes	64.3	2420	63.2	10789
Breastfeeding duration				
<6 months	16.0	909	15.2	3279
6 months or more	84.0	4771	84.8	13857

[8] Percentage distributions of children by other individual-level factors including child's sex, birth order, maternal education, place of delivery and ethnic affiliation were presented in figures.

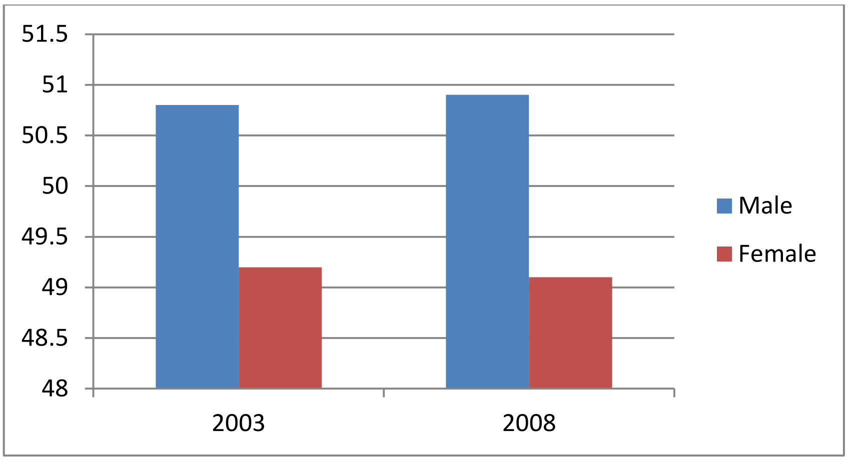

Figure 4.1: Percentage distribution of children by sex

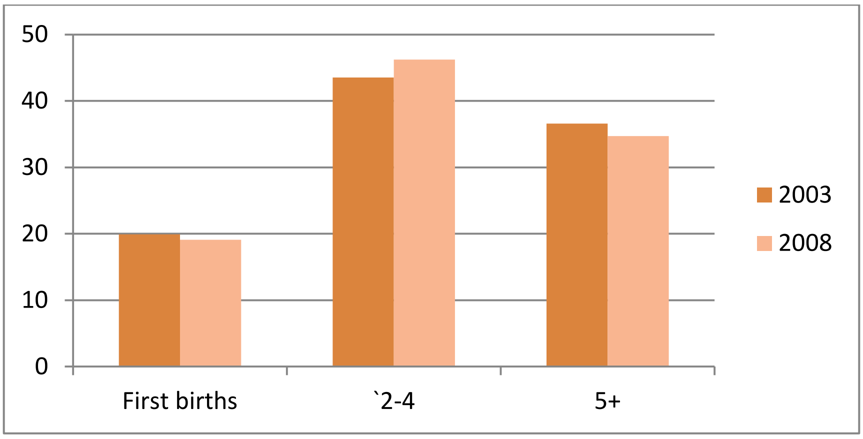

Figure 4.2: Percentage distribution of children by birth order

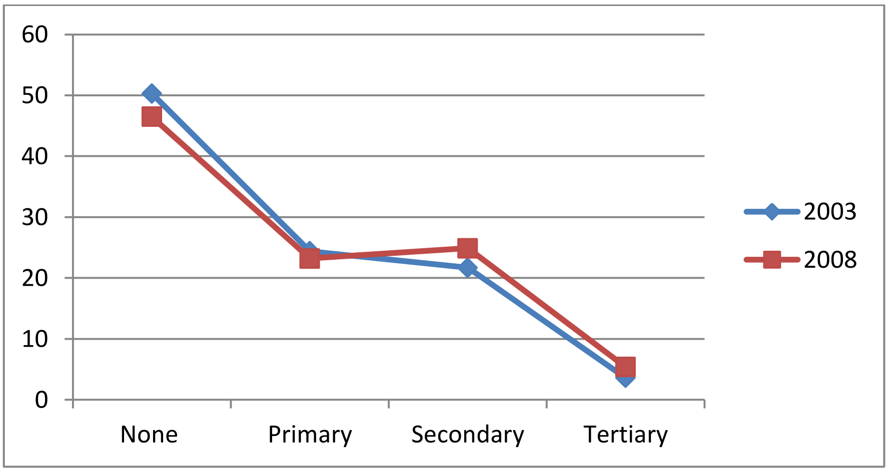

Figure 4.3: Percentage distribution of children by maternal education

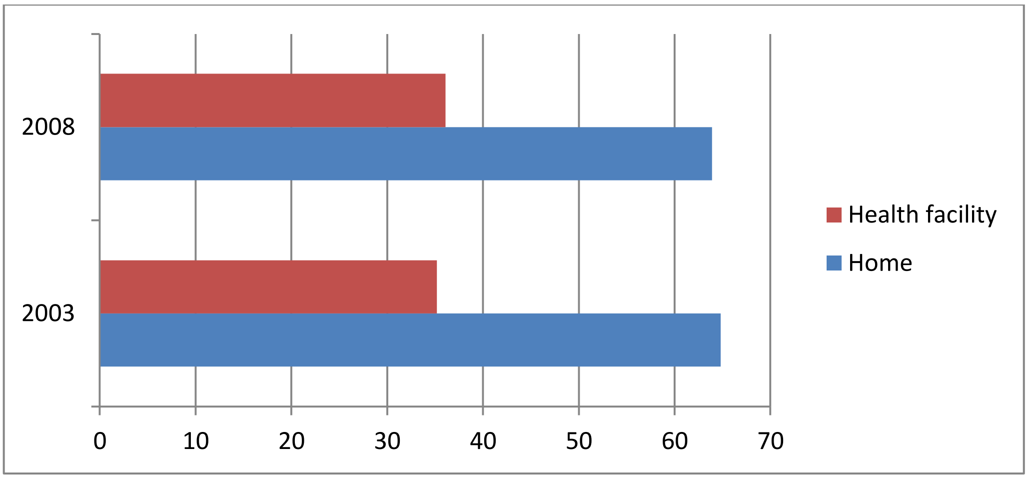

Figure 4.4: Percentage distribution of children by Place of delivery

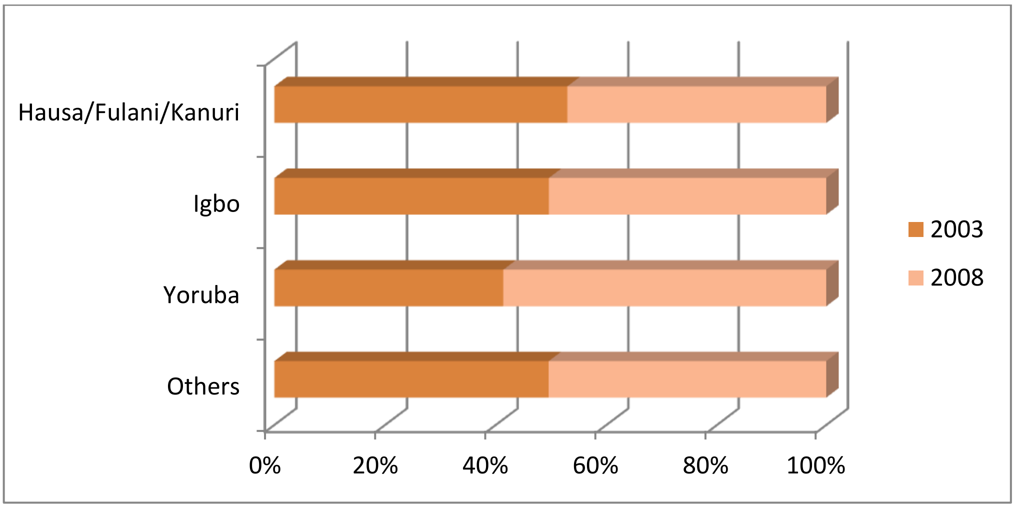

Figure 4.5: Percentage distribution of children by mother's ethnic affiliation

4.2 Household-level characteristics

At the household level, the selected characteristics are as follows: children ever born, parity, family structure, household headship, household had electricity, type of household toilet facilities, religious affiliation, family size, wealth index, mother's occupation, father's occupation and household source of drinking water.

Table 4.2 presents the percentage distribution of study sample by household characteristics. The distribution showed that 2 in 5 children (42.0% in 2003 and 40.3% in 2008) were from households with CEB[9] of 5 or more children, while about one-third (30.0% in 2003 and 31.5% in 2008) were from households having 3-4 as number of CEB.

Distribution by parity[10] showed that most of the children (38.3% in 2003 and 36.2% in 2008) were from households with parity of less than 3 children while 28.7% (2003) and 28.4% (2008) were from households with parity of 5 or more children. A consideration of family structure indicated that 65.0% (2003) and more than two-thirds of the children (67.9% in 2008) were from monogamous household while the remaining 35.0% (2003) and 32% (2008) were from polygynous family. Also, predominantly high proportion of the children (90.0% in 2003 and 90.2% in 2008) belonged to a male-headed household as against 9.0% (2003) and 9.8% (2008) belonging to a female-headed household. Results in Table 4.2 further revealed that 45.9% (2003) and 43.8% (2008) of the children were from household that lacked

[9] children ever born
[10] Number of surviving children

electricity. While 62.5% (2003) and more than half (54.4% in 2008) were from households with pit latrine, 26.0% (2003) and 30.5% (2008) were from households with no toilet facility. Only 10.0% (2003) and 12.9% (2008) of the children were from households that had flush toilet.

With respect to religious affiliation, about 7 in 10 children (59.7% in 2003) and more than half of the children (55.4% in 2008) were from Muslim family while 38.3% (2003) and 43.1% (2008) were children of Catholic/Christian mothers. A consideration of family size showed that most of the children (49.1% in 2003 and 44.1% in 2008) were from households with family size of 7 or more people. While 22.8% (2003) and 25.5% (2008) of the children were from households with 4 individuals or less, another 28.1% (2003) and 30.6% (2008) were from households that had 5 to 6 members.

Table 4.2: Percentage distribution of study sample by household-level characteristics (Nigeria DHS)[11]

Characteristics	2003 (n=6028)		2008 (n=28,647)	
	Percentage	Frequency	Percentage	Frequency
Parity				
< 3 children	38.3	2311	36.2	10263
3-4 children	33.0	1989	35.4	10001
5+	28.7	1728	28.4	8383
Family structure				
Monogamous	65.0	3688	67.9	18063
Polygynous	35.0	1989	32.1	9128
Household headship				
Male	90.0	5486	90.2	25979
Female	9.0	542	9.8	2668
Household had electricity				
No electricity	54.1	3196	56.2	17266
Has electricity	45.9	2715	43.8	11099
Type of household toilet facilities				
Flush Toilet	10.0	590	12.9	2955
Pit latrine	62.5	3700	54.4	15150
Others	1.5	91	2.2	688
None	26.0	1543	30.5	9519
Family size				
<=4	22.8	1377	25.5	7059
5-6	28.1	1693	30.6	8447
7+	49.1	2958	44.1	13141
Mother's occupation				
Not working	34.4	2074	30.4	9035
Formal employment	3.8	230	3.0	792
Informal employment	53.3	3212	55.4	15687
Manual labour	8.5	512	11.2	2976
Father's occupation				
Not working	0.3	18	0.0	0
Formal employment	16.2	957	8.9	2363
Informal employment	59.8	3537	74.8	21370
Manual labour	23.7	1407	16.3	4039
Household Source of drinking water				
Piped	15.6	921	8.6	2448
Protected well	37.3	2212	36.1	10282
River/stream	38.8	2297	49.3	14002
Others	8.3	494	6.0	1695
Contraceptive Use				
Never used	85.5	5154	84.8	24952
Used modern method	4.9	294	4.9	1072
Used traditional method	9.6	580	10.3	2623

[11] Percentage distributions of respondents by important household variables such as CEB, religion, wealth index were presented in figures.

With respect to household wealth index, the data indicated that 23.3% (2003) and 26.5% (2008) of the children were from the poorest households while the proportions from the richest households were 16.1% (2003) and 13.3% (2008). Majority of the children were children of mothers engaging in agriculture, sales or clerical works (53.3% in 2003 and 55.4% in 2008) while only 3.8% (2003) and 3.0% (2008) were children of mothers in professional or managerial works. While the proportions of children whose mothers were engaged in manual labour were 8.5% (2003) and 11.2% (2008); 34.4% (2003) and 30.4% (2008) of the children were children of mothers who were not working as at the time of the survey.

Similarly, distribution of father's occupation showed that majority were engaged in agriculture, sales or clerical as 59.8% (2003) and 74.8% (2008) of the children were children of mothers whose husbands/partners were engaged in agriculture, sales or clerical works. A consideration of household source of drinking water revealed that 38.8% (2003) and about half of the children (49.3% in 2008) were from households that fetched drinking water from a river or stream. While 37.3% (2003) and 36.1% (2008) of the children were from households that had protected well as source of drinking water; only 15.6% (2003) and 8.6% (2008) had piped borne water as their source of drinking water. Considering contraceptive use, a predominantly high proportion of the children (85.5% in 2003 and 84.8% in 2008) were children of mothers who had never used contraceptives.

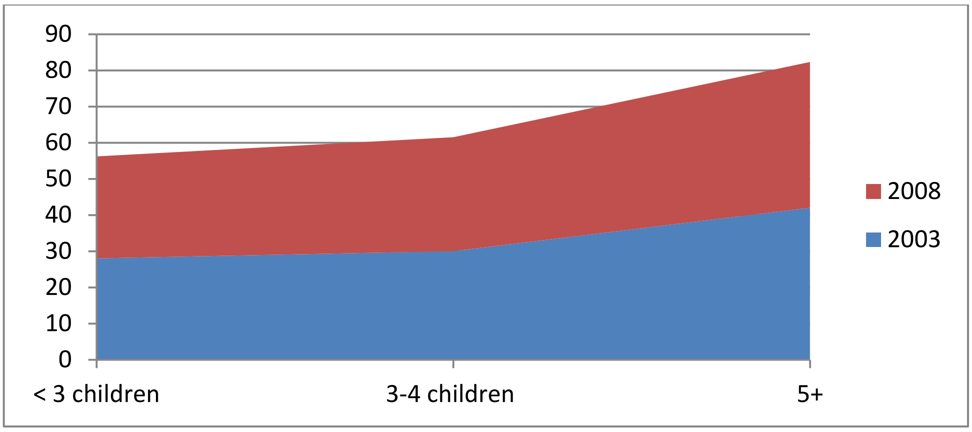

Figure 4.6: Percentage distribution by CEB

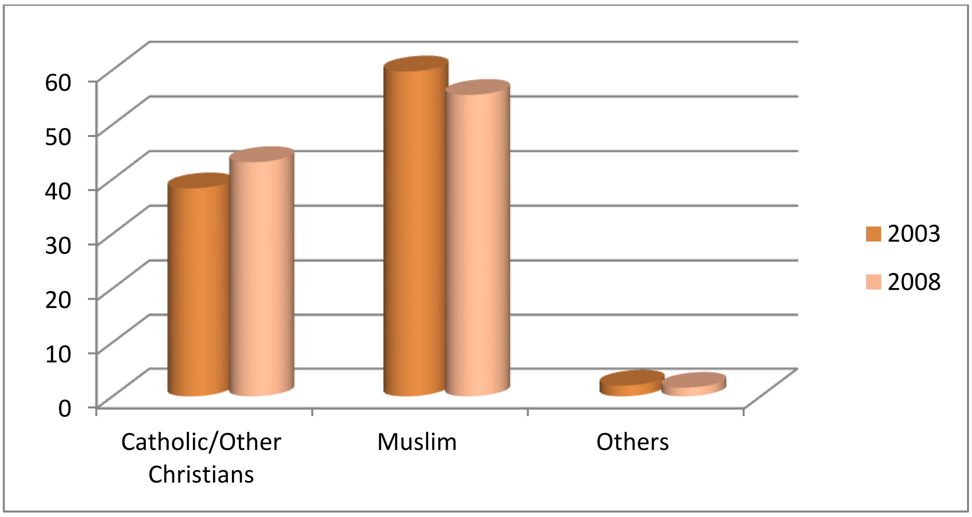

Figure 4.7: Percentage distribution of children by mother's religion

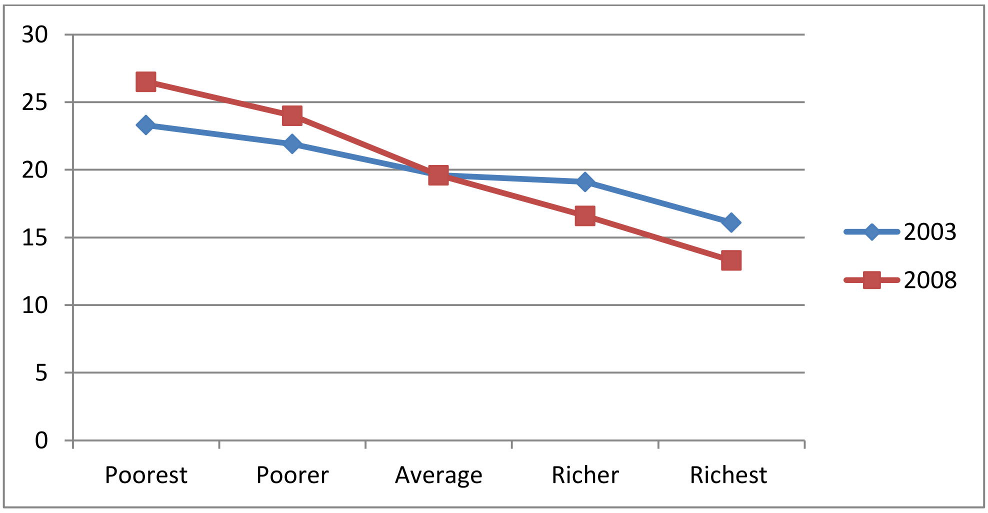

Figure 4.8: Percentage distribution children by household wealth index

4.3 Community-level characteristics

At the community level, the contextual characteristics of interest are: region of residence, type of place of residence, ethnic diversity and distance to health care facility in a community. Others are community maternal level of education, proportion with electric connection in a community, proportion with access to piped water in a community, community prenatal care by doctor, community hospital delivery and community economic status.

Percentage distribution of study sample by community-level characteristics is presented in Table 4.3. The distribution showed that 30.2% (2003) and more than one-quarter (27.7% in 2008) of the children were resident in the North-west while 24.7% (2003) and 22.9% (2008) were children of mothers residing in the North-east. Another 16.8% (2003 and 17.6% (2008) of the children were children of mothers residing in the North-central while both 2003 and 2008 datasets indicated that 9% of the children were children of mothers residing in the South-east. Also, 11.6% each were children of mothers residing in the South-south and South-west in 2008 while 2003 data indicated that 9.3% and 10.3% were children of mothers residing in South-south and South-west respectively.

A consideration of type of place of residence indicated that predominantly high proportion of the children (71.1% in 2003 and 70.3% in 2008) were children of mothers living in the rural areas while the remaining 28.9% (2003) and 29.8% (2008) were children raised in urban centres. An examination of ethnic diversity showed that the study sample was fairly heterogeneous as about 2 in 5 children

(42.2% in 2003 and 38.7% in 2008) were children of mothers residing in heterogeneous communities while 19.0% (2003) and 27.5% (2008) were children of mothers residing in homogeneous communities.

Considering proximity to health care facility in the community, the data indicated that 26.0% (2003) and about 2 in 5 children (38.7% in 2008) were children of mothers residing in communities far away from a health facility. Table 4.3 further revealed that about 2 in 5 children (37.5% in 2003 and 38.7% in 2008) were children of mothers residing in communities with low proportion of mothers who had secondary or higher level of education while 36.2% (2003) and 33.7% (2008) were children of mothers residing in communities with high proportion of mothers who had secondary or higher level of education.

It could also be seen in Table 4.3 that 30.4% (2003) and about 2 in 5 children (36.9% in 2008) were children of mothers residing in communities with low proportion of mothers who had prenatal care by a skilled provider, while 37.9% (2003) and 33.5% (2008) were children of mothers resident in communities with a high proportion of mothers who had prenatal care by a skilled provider. A consideration of community poverty indicates that 48.3% (2003) and 44.0% (2008) of the children were children of mothers residing in communities with high concentration of poor households while 18.8% (2003) and 22.9% (2008) were children of mothers residing in communities with low concentration of poor households.

Table 4.3: Percentage distribution of study sample by community-level characteristics (Nigeria DHS)[12]

Characteristics	2003 (n=6028)		2008 (n=28,647)	
	Percentage	Frequency	Percentage	Frequency
Ethnicity diversity				
Homogenous	19.0	1148	27.5	7879
Mixed	38.7	2334	33.8	9681
Heterogeneous	42.2	2546	38.7	11087
Distance to health facility in the community				
Big problem	26.0	1564	38.7	11543
Not a big problem	74.0	4464	61.3	17104
Proportion with electric connection in a community				
Low	42.3	2552	45.7	13092
Medium	18.8	1132	20.0	5725
High	38.9	2344	34.3	9830
Proportion with access to piped water in a community				
Low	60.5	3649	67.3	19289
Medium	7.5	451	3.7	1055
high	32.0	1928	29.0	8303
Community prenatal care by skilled provider				
Low	30.4	1834	36.9	10573
Medium	31.7	1910	29.6	8472
High	37.9	2284	33.5	9602
Community hospital delivery				
Low	45.2	2724	41.0	12714
Medium	27.2	1639	29.6	8326
High	27.6	1665	29.4	7607
Community poverty				
Low	18.8	1131	22.9	6628
Medium	32.9	1982	33.1	9467
High	48.3	2915	44.0	12552

12 Percentage distributions of respondents by important community-level variables including region of residence, place of residence and community maternal education were presented in figures.

Table 4.3 further presents the distribution of study sample by proportion with access to piped water and proportion with electric connection in a community. The results showed that majority of the children (60.5% in 2003 and 67.3% in 2008) were from communities that had low proportion who had access to piped water while 42.3% (2003) and about half of the children (45.7% in 2008) were children of mothers residing in communities with low proportion who had electric connection in a community.

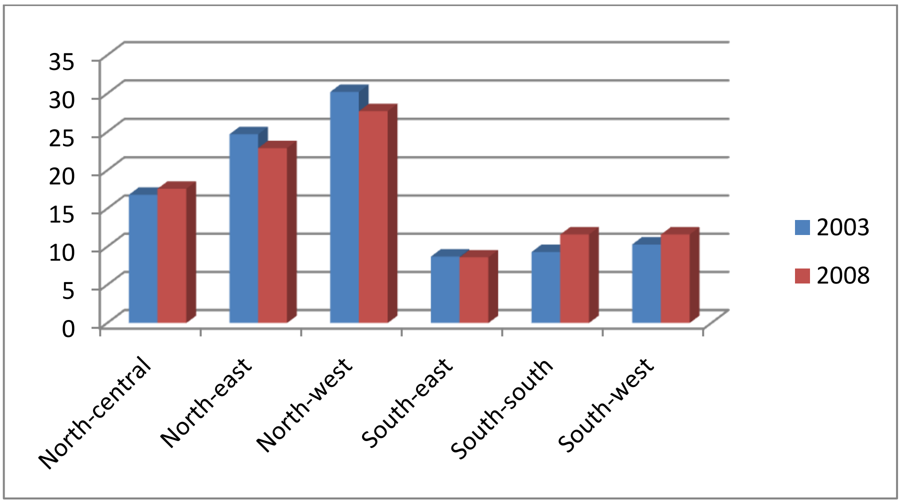

Figure 4.9: Percentage distribution of children by region of residence

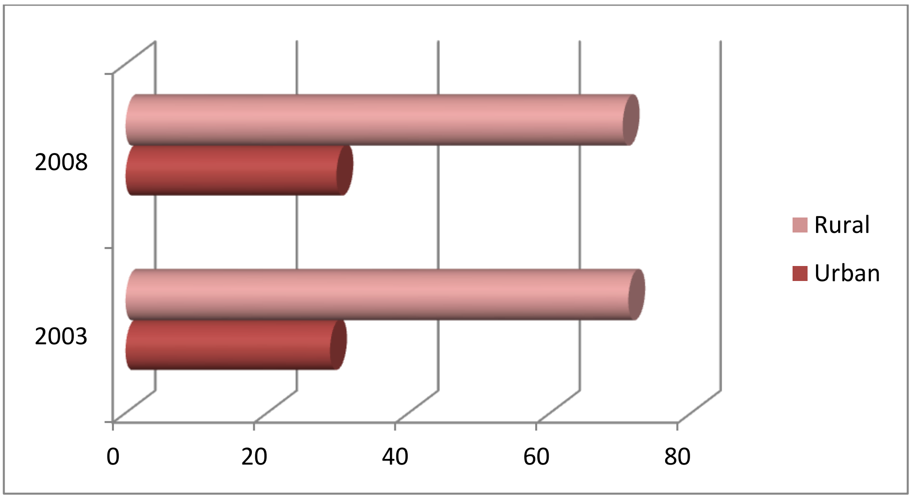

Figure 4.10: Percentage distribution of children by place of residence

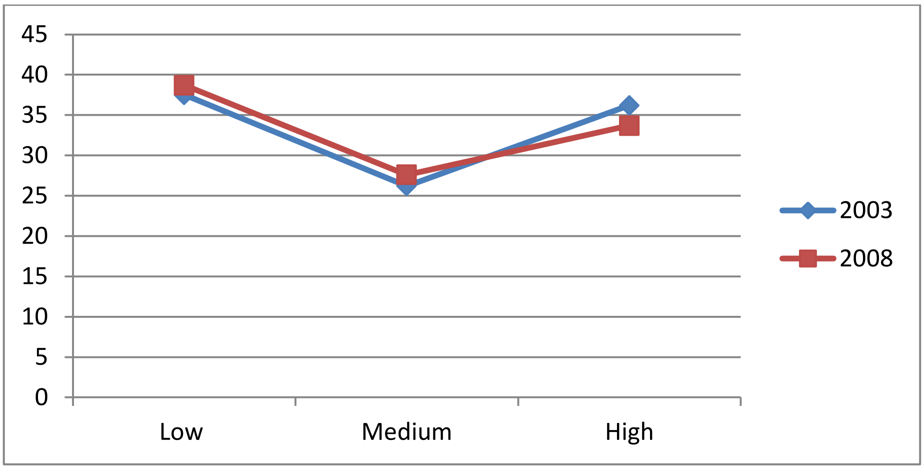

Figure 4.11: Percentage distribution of children by community maternal education

4.4 Summary of the chapter

The percentage distribution of the characteristics of the study population is presented in this chapter. As presented above, male and female children had almost similar proportion with proportion of male children slightly higher than that of their female counterparts in both 2003 and 2008. This pattern is expected as previous findings have demonstrated that sex ratio at birth is usually slightly high in favour of male children (UNFPA, 2012). However, the higher proportion of male children at birth is always counterbalanced by excess mortality among male children (Boco, 2010) thereby reducing the number of male children that would eventually survive to adulthood.

According to both datasets, the study population largely consisted of children who were of birth order 2-4 while a very high proportion of the children were also of birth order 5 or higher. The implication of birth order on child survival has been recognized (Adedini, Odimegwu Clifford*, et al.*, 2011; Antai, 2011a). Children of lower order birth are more likely to survive compared to the children of higher order birth. Similarly, birth interval between 2 births has great implication for child survival. Whitworth and Stephenson (2002) had earlier observed that sibling rivalry is a pathway, through which short birth intervals can influence child mortality. The present study indicated that the study sample comprised mainly of children delivered after 2 years of preceding birth interval.

Also presented above is the sample distribution by maternal level of education. Education has been regarded as one of the most important pillars of human development (UNDP, 2010). Uthman (2008) noted that maternal education tends to play a protective role against infant mortality. This is because education plays a very vital role in shaping opinions, customs, norms, attitudes and it also determines exposure to a range of new ideas and values. Besides, education is the only phenomenon that can loosen an individual from traditional norms and cultural practices. Also, women with little or no education tend to marry early, give births early, lack autonomy and decision-making power (McDonald., 2000; Wall, 1998). Descriptive results in this study showed that very high proportion of the study sample consisted of children whose mothers had no formal education. This suggests that Nigeria is still far from the attainment of Millennium Development Goal 2 which is to achieve universal primary education by 2015.

Distribution by mother's age showed that the highest proportion of the study children were children of mothers aged 25-34. This pattern is expected. Within the reproductive ages of 15-49 years, the age groups with highest number of children are often age groups 25-29 and 30-34. More than one-quarter of the sample were children of mothers aged 15-24. This suggests that an appreciable proportion of young people were already giving birth and a very high proportion of mothers were teenagers at the birth of their first child. Descriptive results in this chapter further showed that majority of the mothers were married. This suggests that marriage is a universal phenomenon in Nigeria and childbearing is often confined to marital union. By and large, in Nigeria as in other patriarchal societies, the primary proximate determinant of the exposure to the risk of childbearing is marital relationship, the type of marriage consummation notwithstanding.

The result which indicates that about two-thirds of the children were children of mothers who received prenatal care (according to both surveys) suggests that knowledge about the importance of prenatal care for safe motherhood and child survival was high in Nigeria. Considering such high proportion of women accessing prenatal services, one would expect that proportion of hospital delivery would be high. But, contrary to this, results from both 2003 and 2008 NDHS datasets showed that about two-thirds of the children were delivered at home.

Further, a good proportion of the children were from pronatalist households as both surveys showed that over 40 percent of the children were from households that had CEB of 5 or more children. In contrast, the distribution by parity indicated that most of the children were from households with parity of 2 children or less. This suggests that, though giving birth to so many children is still a norm in Nigeria, a good proportion of the children often die during infancy or childhood. This finding thus emphasized the replacement effect hypothesis which states that couples would continue to desire to have more children in order to replace the dead children and reach a desired number of surviving offerings (Temkin-Greener & Swedlund, 1983); thereby linking high childhood mortality to high fertility.

Descriptive results on household wealth index indicated that a good proportion of the children were from households in the richest wealth quintile while only a few were from household in poorest wealth quintile. Another result indicated that majority of the study sample were children of parents who were engaged in agriculture, sales or clerical work while very insignificant proportion were children of professionals. This suggests that majority of the parents were of low economic status as far as type of occupation was concerned. Particularly, when one considers that majorities in the study sample were farmers and farmers in Nigeria predominantly engage in subsistence farming (NPC, 2006).

An examination of the family structure showed that a good proportion of the children were from a polygynous family. It has been established that Western African region where Nigeria is situated tend to have a higher proportion of polygynous unions than the rest of the regions in Africa (Omariba, 2007). There is no law in Nigeria against polygynous unions and the phenomenon tends to transcend religion, status, culture, ethnicity and educational attainment. Polygyny can lead to high fertility and invariably competition for scarce household resources, especially if the household is poor.

The type of toilet facility vis-à-vis sanitation practice in a household can influence the health outcome of children under-5. Sastry (1996) wrote that infrastructures such as electricity and water supply are related significantly to child survival. This is because diseases such as diarrheal disease and other infectious diseases could be prevented if safe drinking water is available in the household. Also, households with electric connection could also prevent some diseases by using electrical appliances such as fridge (to preserve food stuffs) and microwaves (to keep food warm for children and other household members). Results in this chapter showed that majority of the children were from households that lacked good toilet facility and electric connection.

Religion was also selected as one of the important variables in this study because of the seeming influence of religious faith on child survival, particularly in Nigeria, a country with a great religious and denominational diversity. Descriptive findings in this chapter showed that more than half of the children were children of Muslim mothers while around 2 in 5 were children of Catholic mothers or other Christians.

One of the key community characteristics selected in this study is the region of residence. This is because one of the objectives of this study was to examine the extent to which the contextual characteristics of the community influence variations in infant and child mortality across regions in Nigeria. Evidence showed that there are substantial regional variations in under-five mortality in Nigeria (NPC & ICF Macro, 2009). As presented in Table 4.3 above, majority of the children were children of mothers residing in the North-west[13].

The descriptive findings showed that majority of the children were resident and raised in rural areas. This may not be unconnected to the fact that Nigeria is predominantly rural and more than 60 percent of Nigerians are living in rural areas (National Population Commission, 2009). In addition, descriptive results in this chapter revealed that most of the children were children of the Hausa/Fulani/Kanuri ethnic groups. Also, about 2 in 5 were children of the minority ethnic groups. This result showed that Nigeria has a great ethnic diversity. Apart from the 3 major ethnic groups[14], there are other more than 250 identifiable ethnic groups in the country.

A consideration of the distance to health care facility showed that a good proportion of the children were resident in communities far away from health care facility. This means that accessing health care facility was a big problem because of long

[13] North-west states are Kaduna, Kano, Katsina, Kebbi, Jigawa, Sokoto and Zamfara
[14] The major ethnic groups are Hausa/Fulani/Kanuri, Igbo and Yoruba.

distance. Similarly, a high proportion of the children were children of mothers residing in community with low proportion of mothers who had at least secondary level of education. While secondary education generally offers technical, vocational or college-preparatory syllabi, primary education basically offers elementary education. Straková (2010) had earlier established huge difference between primary education and secondary education. Hence, it is hypothesized in this study that a woman with at least secondary level of education would be better equipped to take care of their children. For instance, Sastry (1996) opined that maternal education and the availability of health facilities tend to complement one another and that an increase in the number of health centers in an area would only benefit more significantly the children of better educated mothers because of their knowledge that would enable them to take advantage of the new facilities. Results in this chapter showed that slightly more than one-third of the children were children of mothers residing in communities with high proportion of mothers with at least secondary level of education.

In addition, results revealed that a high proportion of children were children of mothers residing in communities with low proportion of mothers who had prenatal care by a skilled provider. This suggests that a high proportion of the mothers were resident in communities where there was poor access to prenatal care. This may be because many of the mothers were resident in communities far away from health care facility, as indicated earlier. Results also showed that almost half of the children were children of mothers residing in communities with high concentration of poor households. Distribution of study sample by the selected community-level variables suggest that majority of the children were resident in socially and economically deprived neighborhoods.

CHAPTER FIVE

LEVELS, PATTERNS AND DIFFERENTIALS OF INFANT AND CHILD MORTALITY IN NIGERIA

5.0 Introduction

This chapter presents the levels, patterns and differentials of infant and child mortality in Nigeria. The chapter is divided into four sections. The first section presents the levels of infant and child mortality in Nigeria. Application of various indirect estimation techniques of childhood mortality together with their underlying assumptions is also presented in the first section. Patterns and differentials of infant and child mortality are presented in section two. Using chi-square test, the third section of this chapter presents the bivariate relationship between infant/child mortality and the selected individual, household and community-level characteristics.

5.1 Levels of Infant and child mortality in Nigeria

This section presents the levels of infants and child mortality. First, summary statistics are presented. Second, various techniques of indirect estimation techniques for estimation of childhood mortality are presented, followed by their applications to the 2003 and 2008 Nigeria Demographic and Health Surveys.

5.1.1 Summary Statistics of infant, child and under-five mortality

The results in Table 5.1.1 presents the summary statistics of infant, child and under-five mortality in Nigeria. The table showed that of the total number of births in the 5 years preceding the 2003 survey (i.e. 6,028), 842 children died before reaching their fifth birthday. Of these 842 children, 558 children died in infancy while 284 children survived beyond age one but failed to survive beyond age five. Considering 2008 dataset, the total number of births during the five years preceding the survey was 28,647. Of this number, 3201 children had died either in infancy or childhood. The table further showed that there were more deaths in infancy[15] than in childhood[16]. While the number of death in infancy was 2042, the number of death during childhood was 1159. These results suggest that there were more deaths in infancy than in childhood.

Table 5.1: Summary Statistics for Infant, Child and Under-five Mortality, 5 years preceding the survey (Nigeria 2003 and 2008 DHS data)

Indicators	2003	2008
Total number of children (under-five)	6,028	28,647
Number of living children (under-five)	5,186	25,446
Number of dead children	842	3,201
Number of death in infancy	558	2,042
Number of death during childhood	284	1,159

5.1.2 Levels of infant and child mortality in Nigeria – application of indirect estimation techniques

Accurate estimates of levels of infant and child mortality are essential for the purpose of accurate planning and policy formulation. Such estimates of childhood mortality can be obtained through the vital registration system (Economic

[15] Death within the first year of life
[16] Death within age 12 to 59 months

Commission for Africa, 1988). However, due to the poor performance of vital registration system in Nigeria as in other sub-Saharan Africa (Adedini & Odimegwu, 2011), demographers have continued to employ the means of indirect estimation techniques to obtain the best attainable vital rates from the available data. These techniques are regarded as indirect estimation techniques because they rely on information that is only indirectly related to mortality (United Nations, 1988a). For instance, such information includes number of children ever born (CEB) and children surviving. Such information can be obtained less expensively (United Nations, 1988a) through censuses and surveys.

Using the 2003 and 2008 Nigeria Demographic and Health Surveys, this sub-section presents the levels of childhood mortality using indirect estimation techniques. Indirect estimates obtained in this section were later compared with childhood mortality estimates obtained through the direct technique. Four indirect estimation techniques were employed in this study, and where appropriate, estimates from different techniques were compared to examine whether estimation technique matter. The first and second approaches are the techniques often called "Brass method", named after William Brass who originally developed the technique in 1964; and further developed with and by his associates – Sullivan in 1972 and Trussell in 1975. The Brass method had undergone further refinement and hence, has performed well under various circumstances (UN, 1988a).

Two versions of the Brass method employed in this study are Trussell version and Palloni-Heligman version of the Brass method. While the third technique employed in this study is Zlotnik and Hill childhood indirect estimation technique; the fourth method is indirect estimation of childhood mortality using INDEPTH life table. The underlying assumptions and limitations of each technique are also discussed.

5.1.2.1 Trussel version of the Brass Method – its computational procedure and application to 2003 and 2008 Nigeria Demography and Health Survey

Trussell version of the Brass method relies on the Coale-Demeny model life tables. Although, it has its own assumptions and limitations[17], this variant of the Brass methods has some advantage over the earlier versions. This version is an ingenious technique that permits conversion of mortality statistics D(x) (i.e. the proportion of children dead among children ever born to women of age x) into probabilities of dying before age i, q(i) (ECA, 1988). The technique uses a set of multipliers that converts D(x) to q(i)

Let D(x)	=	the ratio of children dead to all children ever born to women of age x in completed year
$C_X(t)$	=	the proportion of children born t years before the survey (whether alive or not) to mothers of age x
q(t)	=	the proportion of children who died among those born t-years before the survey

If s represents the earliest age of child-bearing,

$$D(x) = \sum_{t-1}^{X-S} Cx(t)q(t) \qquad \text{5.1}$$

[17] The underlying assumption of this technique is the assumption of constant fertility and mortality

If the underlying assumption is satisfied, a life table satisfying equation 1 can be determined for a given $C_X(t)$ distribution. Let q'(t) be such a life table.

Equation (1) then changes to:

$$D(x) = \sum_{t-1}^{X-S} Cx(t)q'(t) \qquad \text{5.2}$$

From the equation (2) above, it then follows that the proportion of children dead is a weighted average of the probability of dying with $C_X(t)$ as weights. By mean value theorem, v exists within the range: 1<v<x-s; such that

$$D(x) = q'(v) \qquad \text{5.3}$$

Supposing the mortality pattern is known, in such a life table system;

$$q`(t) = k \,.\, q'_S(t)$$

where $q`_S(t)$ is the survival probability which can be selected from among the one parameter life table systems which is regarded as a standard. K is independent of age and it measures the level of mortality. From this, equation (3) becomes

$$D(x) = K \,.q'_S(v) \qquad \text{5.4}$$

Since integer and non-integer values can be assumed depending on the distribution of children by age, a set of conversion factors was developed to convert the proportions dead, D(x), to probabilities of dying at specific ages, $q`_S(i)$.

Conversion factors were developed using the formula below:

$$K(i) = \frac{q'(i)}{D(X)} = \frac{k\,.\ q'\mathrm{s(i)}}{k\,.q'\mathrm{s(v)}} = \frac{q'\mathrm{s(i)}}{q'S(v)} \qquad \text{5.5}$$

A set of multipliers was developed for various values of *S*.

To apply the Trussell variant of Brass' indirect estimation technique, the required data are: (i) number of children ever born in each age group, (ii) number of children surviving or dead among those ever born in each age group, and (iii) women in the reproductive age group by age.

Further, average parity per woman is calculated using the formula:

$$P(i) \quad = \frac{\boldsymbol{CEB}(i)}{\boldsymbol{FP}(i)} \text{...} 5.6$$

Where *P(i)* is the average parity of women of age group *i, CEB(i)* is the total number of children ever born by those women, *FP(i)* is the total number of women in the age group.

Proportion dead is computed using:

$$D(i) \quad = \frac{\boldsymbol{CD}\ (\boldsymbol{i})}{\boldsymbol{CEB}\ (\boldsymbol{i})} \text{...} 5.7$$

Where *D(i)* is the proportion of children dead for women age group *i, CD(i)* is the number of children dead reported by the women.

Multiplying factors are calculated using the formula:

$$k(i) = a(i)+b(i)\frac{P(1)}{P(2)}+c(i)\frac{P(2)}{P(3)} \text{...} 5.8$$

Where *k(i)* denotes multipliers and p(1)/P(2), P(2)/P(3) are parity ratios while *a(i), b(i)* and *c(i)* are multipliers coefficients.

Probabilities of dying by age *x* are calculated thus:

$$q(x) = k(i)\ D(i) \text{...} 5.9$$

Assuming that mortality has been constant over time, a reference time for each q(x) can be computed thus:

$$t(i) = e(i) + f(i)\frac{P(1)}{P(2)} + g(i)\frac{P(2)}{(P3)} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 5.10$$

Thus, United Nations (1988b) developed a mortality software package called Mortpark. The software is suitable for demographic measurement in developing countries where demographic data are mostly deficient or unreliable. The version 4.2 of the Mortpark software is used in this analysis, and the software provides childhood estimates for both Trussell and Palloni-Heligman variants of the Brass childhood indirect estimation technique.

5.1.2.2 Interpretation of mortality estimates from Trussell and Palloni-Heligman variants

A tabulation of the results of childhood estimations from applying Trussell variant and Palloni-Heligman version of Brass method (using Mortpark software) is presented in Tables 5.2 to 5.13. Graphical representation of the childhood mortality estimates is provided by Figures 5.1 to 5.5 (for Trussell variant) and Figures 5.6 to 5.9 (for Palloni-Heligman variant). While column 6 contains the exact ages of the child (in years) to which the probabilities of dying refers, column 7 contains the probabilities of dying.

The results of the estimates derived from the two variants showed that the probabilities of dying before exact age *X* (from age 1 through exact age 20) increase consistently as children's exposure to mortality risks increases. This also suggests that probabilities of surviving to age *X* falls consistently with increase in age, which also amounts to increase in exposure to mortality risks. For instance, results from 2003 data presented in Table 5.2 (column 7) indicated that probabilities of surviving to age 1 through 20 decrease consistently from 0.956 (for age 1) to 0.708 (for age 20). Comparing results from 2003 and 2008 data, Tables 5.2 and 5.5 (column 8) indicate a slight increase in probability of survival to age 1 (from 0.956 to 0.960) through 20 (from 0.708 to 0.726) over the 1999-2003 and 2004-2008 periods.

Considering infant mortality estimates, the first figure in column 10 (Tables 5.2 to 5.7) is a measure of infant mortality while the last figure in the same column 10 (Tables 5.2-5.7) represents cumulative mortality from infancy to exact age 20. Column 9 contains the reference date to which the estimated mortality levels apply. Thus, the calendar year to which infant mortality rate in column 10 (Tables 5.2-5.7) refers is May 2000. The result in Table 5.2 (column 9) suggests that infant mortality in 2000 was approximately 44 per 1000 live births, with 68.1 as the expectation of life at birth in the same year.

However, using the same information from 2003 and 2008 NDHS, Palloni-Heligman variant of Brass technique seems to give better estimates than the Trussell variant. For instance, results presented in Table 5.8 (column 8) indicated that infant mortality estimate in Nigeria, for both sexes in 2002 was 93 per 1000 live births (males: 95/1000, female: 91/1000) while the expectation of life at birth was 54.5 years for both sexes (55.6 years for females and 51.6 years for males) (column 12).

Results from analysis of both 2003 and 2008 datasets (using both Trussell and Palloni-Heligman variants), as presented in Figures 5.2, 5.5, 5.8 and 5.9, showed that infant mortality rates and probabilities of dying between ages 1 and 5 were slightly higher for males than for females. However, these figures suggest a wider male-female childhood mortality differentials in 2003 than in 2008. Figures 5.3 and 5.6 indicated that probabilities of dying in childhood had declined over the 1999-2003 and 2004-2008 periods.

Table 5.2: Application of the Trussell variant of the Brass Method to Data from 2003 NDHS (Both sexes)

Age group of mothers	Age group index	Average number of CEB	Average number of children surviving	Proportion dead	Exact age of the child in years (X)	Probability of Dying Before Age X (***qx***)	Probability of surviving to Age X (**px**)	Reference date	Infant mortalit y rate (1q0)	Probability of dying between ages 1and 5 (4q1)	Expectation of Life at birth (ex)
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
15-19	1	1.495	1.222	0.183	1	0.044	0.956	May 2000	0.044	0.008	68.1
20-24	2	2.587	2.057	0.205	2	0.171	0.829	Sep 1998	0.147	0.059	50.5
25-29	3	4.085	3.223	0.211	3	0.205	0.795	May 1997	0.163	0.069	48
30-34	4	5.656	4.301	0.240	5	0.248	0.752	Apr 1996	0.182	0.08	45.4
35-39	5	7.11	5.387	0.242	10	0.261	0.739	Apr 1995	0.179	0.078	45.9
40-44	6	7.938	5.837	0.265	15	0.282	0.718	Dec 1993	0.186	0.082	44.9
45-49	7	8.389	6.053	0.278	20	0.292	0.708	Jun 1991	0.183	0.081	45.3

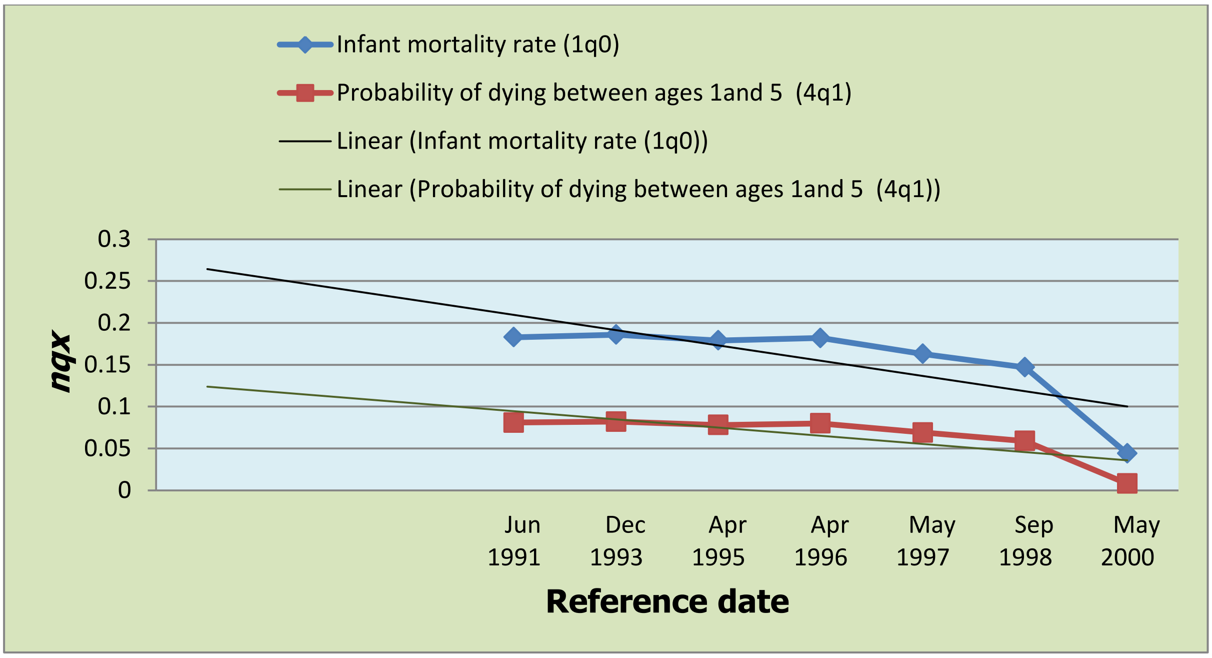

Figure 5.1: Infant mortality (1q0) and child mortality (4q1) for both sexes, estimated using Coale-Demeny Model West and the Trussell version of the Brass method, 2003 NDHS

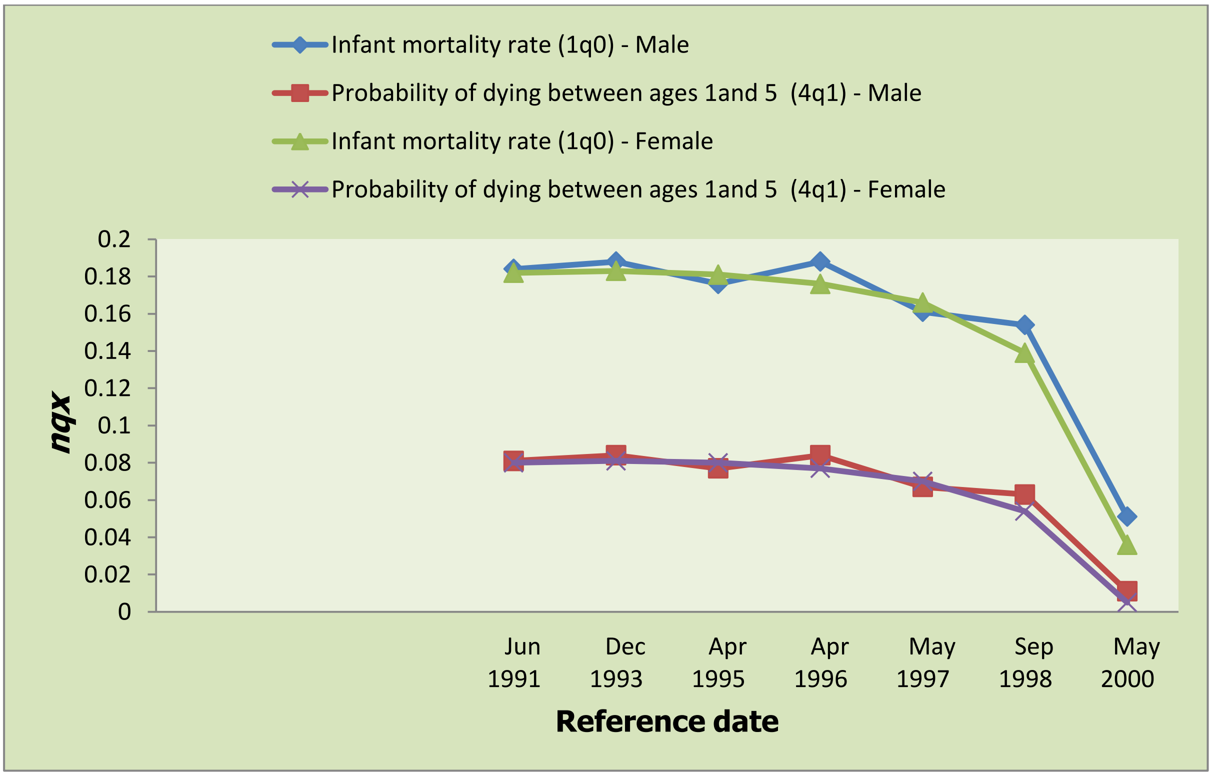

Figure 5.2: Infant mortality (1q0) and child mortality (4q1) for males and females, estimated using Coale-Demeny Model West and the Trussell version of the Brass method, 2003 NDHS

Table 5.3: Application of the Trussell variant of the Brass Method to Data from 2003 NDHS (Males)

Age group of mothers	Age group index	Average number of CEB	Average number of children surviving	Proportion dead	Exact age of the child in years (X)	Probability of Dying Before Age X (***qx***)	Probability of surviving to age X (***Px***)	Reference date	Infant mortality rate (1q0)	Probability of dying between ages 1and 5 (4q1)	Expectation of Life at birth (ex)
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
15-19	1	1.423	1.175	0.174	1	0.051	0.949	May 2000	0.051	0.011	66.5
20-24	2	2.573	2.025	0.213	2	0.180	0.820	Sep 1998	0.154	0.063	49.4
25-29	3	4.07	3.222	0.208	3	0.202	0.798	May 1997	0.161	0.067	48.3
30-34	4	5.672	4.263	0.248	5	0.256	0.744	Apr 1996	0.188	0.084	44.6
35-39	5	7.048	5.353	0.240	10	0.258	0.742	Apr 1995	0.176	0.077	46.2
40-44	6	7.856	5.74	0.269	15	0.285	0.715	Dec 1993	0.188	0.084	44.6
45-49	7	8.358	6.009	0.281	20	0.293	0.707	Jun 1991	0.184	0.081	45.2

Table 5.4: Application of the Trussell variant of the Brass Method to Data from 2003 NDHS (Females)

Age group of mothers	Age group index	Average number of CEB	Average number of children surviving	Proportion dead	Exact age of the child in years (X)	Probability of Dying Before Age X (***qx***)	Probability of surviving to Age X (***Px***)	Reference date	Infant mortality rate (1q0)	Probability of dying between ages 1and 5 (4q1)	Expectation of Life at birth (ex)
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
15-19	1	1.564	1.267	0.190	1	0.036	0.964	May 2000	0.036	0.005	69.9
20-24	2	2.601	2.09	0.196	2	0.162	0.838	Sep 1998	0.139	0.054	51.6
25-29	3	4.101	3.224	0.214	3	0.208	0.792	May 1997	0.166	0.07	47.7
30-34	4	5.641	4.341	0.230	5	0.239	0.761	Apr 1996	0.176	0.077	46.2
35-39	5	7.177	5.424	0.244	10	0.264	0.736	Apr 1995	0.181	0.08	45.6
40-44	6	8.026	5.939	0.260	15	0.278	0.722	Dec 1993	0.183	0.081	45.2
45-49	7	8.424	6.102	0.276	20	0.291	0.709	Jun 1991	0.182	0.08	45.4

Table 5.5: Application of the Trussell variant of the Brass Method to Data from 2008 NDHS (both sexes)

Age group of mothers	Age group index	Average number of CEB	Average number of children surviving	Proportion dead	Exact age of the child in years (X)	Probability of Dying Before Age X (***qx***)	Probability of surviving to Age X (**px**)	Reference date	Infant mortality rate (1q0)	Probability of dying between ages 1and 5 (4q1)	Expectation of Life at birth (ex)
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
15-19	1	1.547	1.313	0.151	1	0.040	0.960	Aug 2005	0.04	0.007	69
20-24	2	2.671	2.174	0.186	2	0.153	0.847	Nov 2003	0.132	0.051	52.6
25-29	3	3.972	3.258	0.180	3	0.172	0.828	Apr 2002	0.139	0.054	51.7
30-34	4	5.372	4.278	0.204	5	0.208	0.792	Jan 2001	0.154	0.063	49.3
35-39	5	6.694	5.219	0.220	10	0.234	0.766	Nov 1999	0.161	0.068	48.3
40-44	6	7.674	5.854	0.237	15	0.249	0.751	May 1998	0.165	0.07	47.8
45-49	7	8.357	6.146	0.265	20	0.274	0.726	Nov 1995	0.172	0.074	46.8

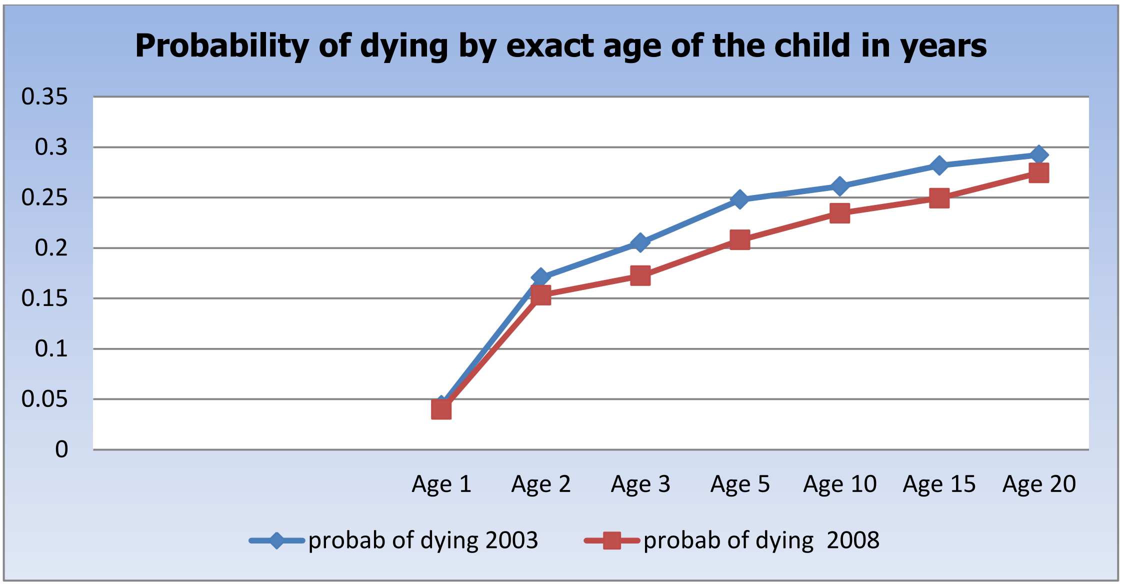

Figure 5.3: Probability of dying by exact age of the child in years estimated using Coale-Demeny Model West and the Trussell version of the Brass method (for both sexes), 2003 and 2008 NDHS

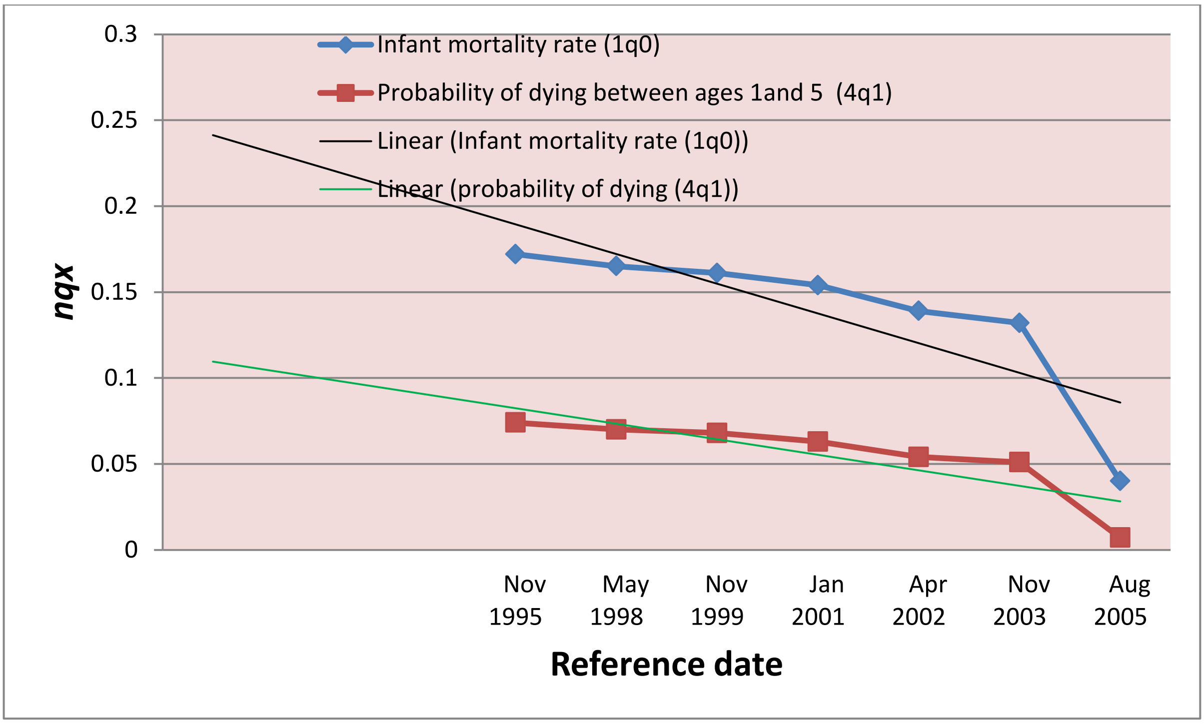

Figure 5.4: Infant mortality (1q0) and child mortality (4q1) for both sexes, estimated using Coale-Demeny Model West and the Trussell version of the Brass method, 2008 NDHS

Table 5.6: Application of the Trussell variant of the Brass Method to Data from 2008 NDHS (Males)

Age group of mothers	Age group index	Average number of CEB	Average number of children surviving	Proportion dead	Exact age of the child in years (X)	Probability of Dying Before age X (***qx***)	Probability of surviving to age X (***Px***)	Reference date	Infant mortality rate (1q0)	Probability of dying between ages 1and 5 (4q1)	Expectation of Life at birth (ex)
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
15-19	1	1.563	1.318	0.157	1	0.040	0.960	Aug 2005	0.04	0.007	69
20-24	2	2.678	2.181	0.186	2	0.152	0.848	Nov 2003	0.132	0.05	52.7
25-29	3	3.97	3.254	0.180	3	0.173	0.827	Apr 2002	0.139	0.054	51.6
30-34	4	5.372	4.277	0.204	5	0.208	0.792	Jan 2001	0.154	0.063	49.3
35-39	5	6.685	5.2	0.222	10	0.236	0.764	Nov 1999	0.163	0.068	48.1
40-44	6	7.683	5.852	0.238	15	0.251	0.749	May 1998	0.166	0.07	47.7
45-49	7	8.32	6.105	0.266	20	0.276	0.724	Nov 1995	0.173	0.075	46.7

Table 5.7: Application of the Trussell variant of the Brass Method to Data from 2008 NDHS (Females)

Age group of mothers	Age group index	Average number of CEB	Average number of children surviving	Proportion dead	Exact age of the child in years (X)	Probability of Dying Before age X (***qx***)	Probability of surviving to age X (***Px***)	Reference date	Infant mortality rate (1q0)	Probability of dying between ages 1and 5 (4q1)	Expectation of Life at birth (ex)
1	2	3	4	5	6	7	8	9	10	11	12
15-19	1	1.529	1.309	0.144	1	0.039	0.961	Aug 2005	0.039	0.006	69.1
20-24	2	2.662	2.167	0.186	2	0.154	0.846	Nov 2003	0.133	0.051	52.6
25-29	3	3.974	3.262	0.179	3	0.172	0.828	Apr 2002	0.138	0.054	51.7
30-34	4	5.372	4.279	0.203	5	0.208	0.792	Jan 2001	0.154	0.063	49.3
35-39	5	6.705	5.239	0.219	10	0.232	0.768	Nov 1999	0.16	0.067	48.5
40-44	6	7.666	5.857	0.236	15	0.248	0.752	May 1998	0.164	0.069	47.9
45-49	7	8.397	6.189	0.263	20	0.273	0.727	Nov 1995	0.171	0.073	47

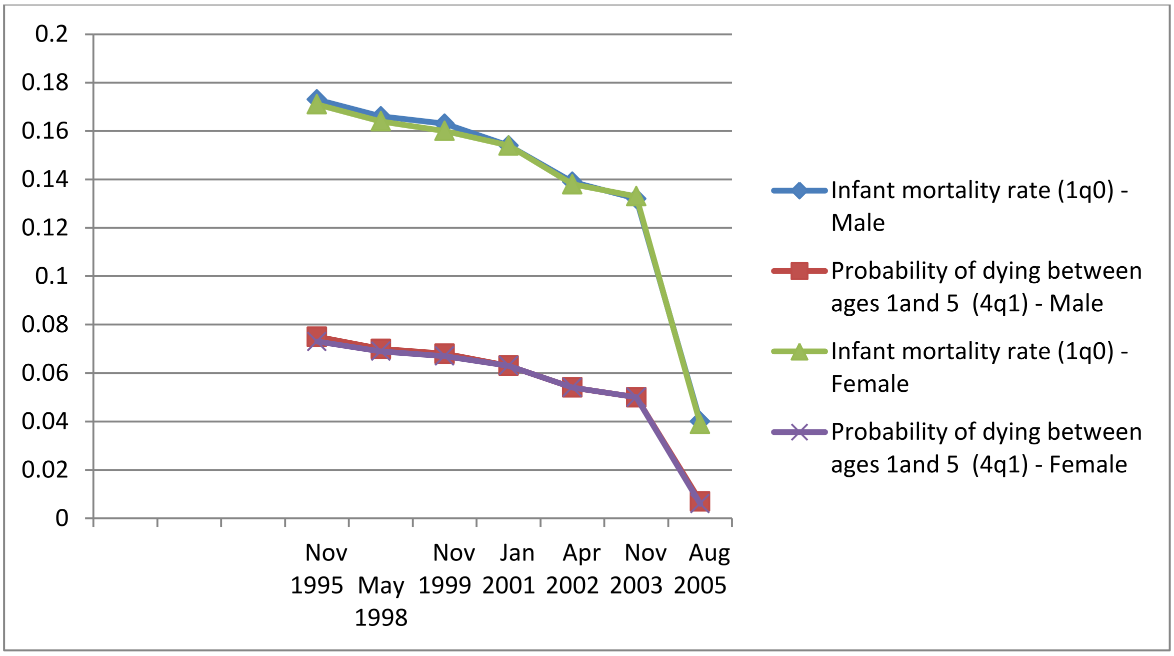

Figure 5.5: Infant mortality rate (1q0) and probability of dying between ages 1 and 5 (4q1) for males and females, estimated using Coale-Demeny Model East and the Trussell version of the Brass method, 2008 NDHS

5.1.2.3 Palloni-Heligman version of the Brass Method – Computational procedure and application to 2003 and 2008 NDHS

The Palloni-Heligman version of the Brass indirect estimation technique (developed in the early 1980s by Palloni and Heligman) relies on the United Nations model life tables for developing nations (United Nations, 1988a). Like the Trussell version, this version of Brass method yields estimates of the probabilities of dying. The Palloni-Heligman version is different from Trussell's version in that it utilizes information on births as part of data required for computation (United Nations, 1988a). This information is used for the computation of the value of the mean age at maternity, M (i.e. the mean age of the mothers of the children born in a given time)

In addition to the computational procedure given above under Trussell variant, *M* is calculated using:

$$M \qquad = \frac{\sum_{i=1}^{7}(B(i)mp(i)}{\sum_{i=1}^{7}B(i)} \text{...}5.11$$

Where *B(i)* is the number of births to women in age group *i* and *mp(i)* is the midpoint in years of age group i.

The basic estimation equation for the two versions of the Brass technique is the same except that computation of multipliers, *k(i)* now includes *M* as shown below:

$$k(i) = a(i)+b(i)\frac{P(1)}{P(2)}+c(i)\frac{P(2)}{P(3)}+d(i)\,M\text{...}5.12$$

where *a(i), b(i), c(i)* and *d(i)* are the coefficients for the estimation of the multipliers.

Childhood estimates using Palloni-Heligman variant of Brass technique were obtained using Mortpark software package (United Nations, 1988b), and results are presented in Tables 5.8 to 5.13. As earlier indicated, graphical representations of results from Palloni-Heligman version are presented in Figures 5.6 to 5.9. Interpretations of the results are presented in section 5.1.2.2 above

Table 5.8: Application of the Palloni-Heligman variant of the Brass Method to Data from 2003 NDHS (Both sexes)

Age group of mothers	Age group index	Average number of CEB	Average number of children surviving	Proportion dead	Exact age of the child in years (X)	Probability of Dying Before Age X (***qx***)	Probability of surviving to age X (***Px***)	Reference date	Infant mortality rate (1q0)	Probability of dying between ages 1and 5 (4q1)	Expectation of Life at birth (ex)
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
15-19	1	1.495	1.222	0.183	1	0.093	0.907	Jan 2002	0.093	0.049	54.5
20-24	2	2.587	2.057	0.205	2	0.177	0.823	Jun 1999	0.138	0.095	44.0
25-29	3	4.085	3.223	0.211	3	0.205	0.795	Sep 1997	0.143	0.101	43.0
30-34	4	5.656	4.301	0.240	5	0.246	0.754	Dec 1996	0.152	0.111	41.1
35-39	5	7.11	5.387	0.242	10	0.258	0.742	Sep 1996	0.145	0.103	42.6
40-44	6	7.938	5.837	0.265	15	0.272	0.728	Nov 1995	0.145	0.102	42.6
45-49	7	8.389	6.053	0.278	20	0.290	0.710	Sep 1992	0.144	0.101	42.9

Table 5.9: Application of the Palloni-Heligman variant of the Brass Method to Data from 2003 NDHS (Males)

Age group of mothers	Age group index	Average number of CEB	Average number of children surviving	Proportion dead	Exact age of the child in years (X)	Probability of Dying Before Age X (***qx***)	Probability of surviving to age X (***Px***)	Reference date	Infant mortality rate (1q0)	Probability of dying between ages 1and 5 (4q1)	Expectation of Life at birth (ex)
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
15-19	1	1.423	1.175	0.174	1	0.095	0.905	Jan 2002	0.095	0.051	54.0
20-24	2	2.573	2.025	0.213	2	0.186	0.814	Jun 1999	0.144	0.103	42.6
25-29	3	4.07	3.222	0.208	3	0.203	0.797	Sep 1997	0.141	0.099	43.3
30-34	4	5.672	4.263	0.248	5	0.255	0.745	Dec 1996	0.156	0.116	40.2
35-39	5	7.048	5.353	0.240	10	0.256	0.744	Sep 1996	0.144	0.101	42.8
40-44	6	7.856	5.74	0.269	15	0.276	0.724	Nov 1995	0.147	0.105	42.2
45-49	7	8.358	6.009	0.281	20	0.292	0.708	Sep 1992	0.145	0.102	42.8

Table 5.10: Application of the Palloni-Heligman variant of the Brass Method to Data from 2003 NDHS (Females)

Age group of mothers	Age group index	Average number of CEB	Average number of children surviving	Proportion dead	Exact age of the child in years (X)	Probability of Dying Before Age X (***qx***)	Probability of surviving to age X (***Px***)	Reference date	Infant mortality rate (1q0)	Probability of dying between ages 1and 5 (4q1)	Expectation of Life at birth (ex)
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
15-19	1	1.564	1.267	0.190	1	0.091	0.909	Jan 2002	0.091	0.047	55.1
20-24	2	2.601	2.09	0.196	2	0.168	0.832	Jun 1999	0.132	0.088	45.4
25-29	3	4.101	3.224	0.214	3	0.208	0.792	Sep 1997	0.145	0.103	42.6
30-34	4	5.641	4.341	0.230	5	0.237	0.763	Dec 1996	0.147	0.105	42.1
35-39	5	7.177	5.424	0.244	10	0.261	0.739	Sep 1996	0.147	0.104	42.3
40-44	6	8.026	5.939	0.260	15	0.268	0.732	Nov 1995	0.143	0.1	43
45-49	7	8.424	6.102	0.276	20	0.288	0.712	Sep 1992	0.143	0.1	43.1

Table 5.11: Application of the Palloni_Heligman variant of the Brass Method to Data from 2008 NDHS (both sexes)

Age group of mothers	Age group index	Average number of CEB	Average number of children surviving	Proportion dead	Age X	Probability of Dying Before Age X (*qx*)	Probability of surviving to age X (*Px*)	Reference date	Infant mortality rate (1q0)	Probability of dying between ages 1and 5 (4q1)	Expectation of Life at birth (ex)
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
15-19	1	1.547	1.313	0.151	1	0.078	0.922	Mar 2007	0.078	0.036	58.6
20-24	2	2.671	2.174	0.186	2	0.160	0.840	Aug 2004	0.126	0.082	46.7
25-29	3	3.972	3.258	0.180	3	0.172	0.828	Oct 2002	0.123	0.078	47.5
30-34	4	5.372	4.278	0.204	5	0.204	0.796	Oct 2001	0.13	0.085	46
35-39	5	6.694	5.219	0.220	10	0.228	0.772	Apr 2001	0.131	0.086	45.7
40-44	6	7.674	5.854	0.237	15	0.236	0.764	Apr 2000	0.129	0.084	46.2
45-49	7	8.357	6.146	0.265	20	0.266	0.734	Jan 1997	0.134	0.089	45.1

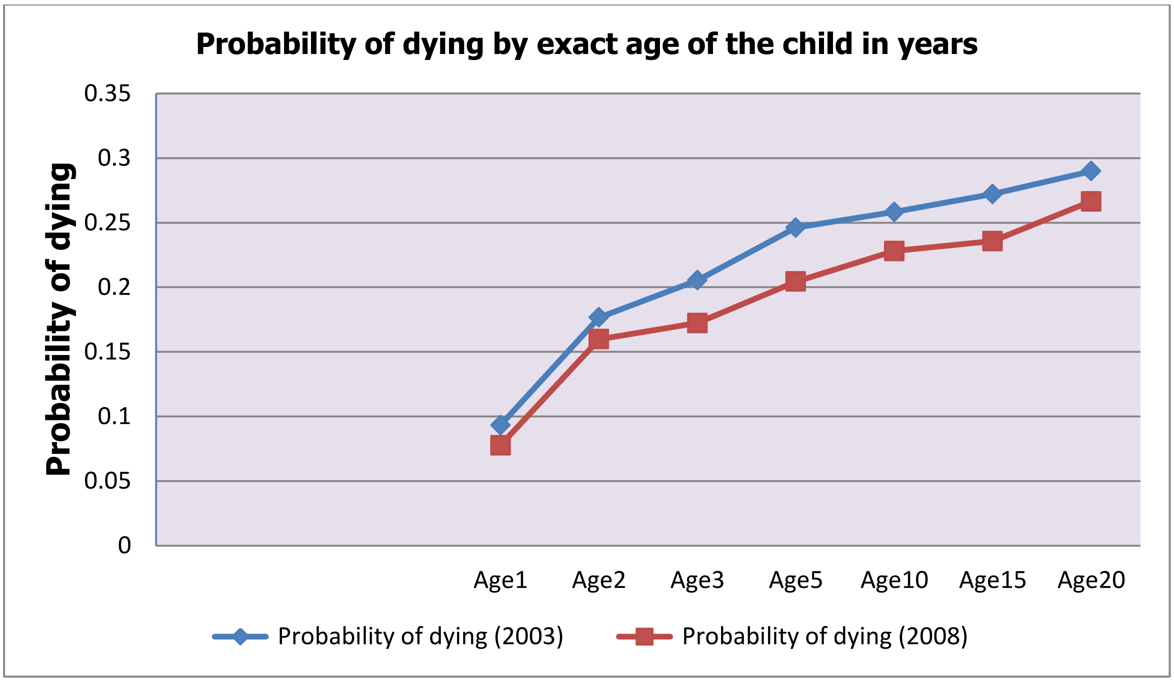

Figure 5.6: Probability of dying by exact age of the child in years (for both sexes), estimated using UN General Model and the Palloni-Heligman version of the Brass method, 2003 and 2008 NDHS

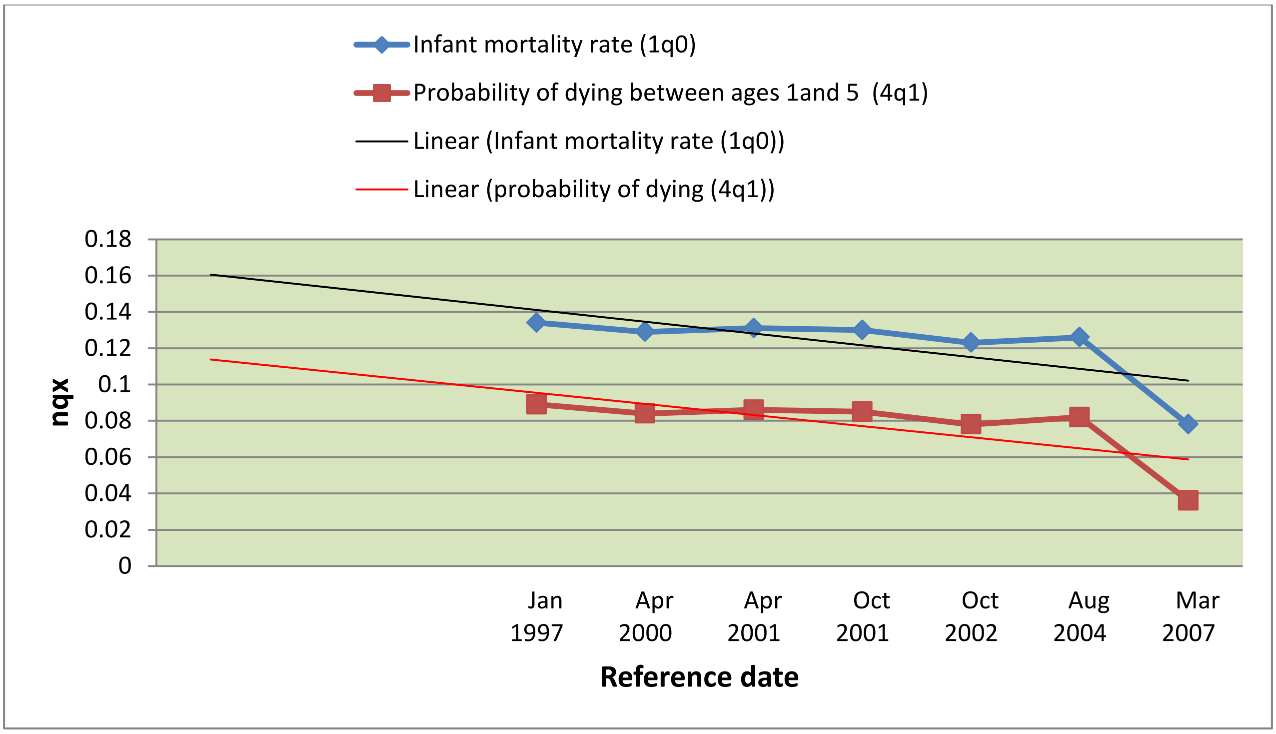

Figure 5.7: Infant mortality (1q0) and probability of surviving between ages 1 and 5 (4q1) for both sexes, estimated using UN General Model and the Palloni-Heligman version of the Brass method, 2008 NDHS

Table 5.12: Application of the Palloni-Heligman variant of the Brass Method to Data from 2008 NDHS (Males)

Age group of mothers	Age group index	Average number of CEB	Average number of children surviving	Proportion dead	Exact age of the child in years (X)	Probability of Dying Before Age X (***qx***)	Probability of surviving to age X (***Px***)	Reference date	Infant mortality rate (1q0)	Probability of dying between ages 1and 5 (4q1)	Expectation of Life at birth (e0)
1	2	3	4	5	6	7	8	9	10	11	12
15-19	1	1.563	1.318	0.157	1	0.080	0.920	Mar 2007	0.08	0.038	58.1
20-24	2	2.678	2.181	0.186	2	0.159	0.841	Jul 2004	0.126	0.081	46.8
25-29	3	3.97	3.254	0.180	3	0.173	0.827	Sep 2002	0.123	0.078	47.5
30-34	4	5.372	4.277	0.204	5	0.205	0.795	Oct 2001	0.13	0.085	45.9
35-39	5	6.685	5.200	0.222	10	0.230	0.770	May 2001	0.132	0.087	45.5
40-44	6	7.683	5.852	0.238	15	0.237	0.763	Apr 2000	0.13	0.084	46.1
45-49	7	8.32	6.105	0.266	20	0.268	0.732	Jan 1997	0.135	0.09	44.9

Table 5.13: Application of the Palloni-Heligman variant of the Brass Method to Data from 2008 NDHS (Females)

Age group of mothers	Age group index	Average number of CEB	Average number of children surviving	Proportion dead	Exact age of the child in years (X)	Probability of Dying Before Age X (***qx***)	Probability of surviving to age X (***Px***)	Reference date	Infant mortality rate (1q0)	Probability of dying between ages 1and 5 (4q1)	Expectation of Life at birth (ex)
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
15-19	1	1.529	1.309	0.144	1	0.075	0.925	Mar 2007	0.075	0.033	59.4
20-24	2	2.662	2.167	0.186	2	0.160	0.840	Aug 2004	0.126	0.082	46.6
25-29	3	3.974	3.262	0.179	3	0.172	0.828	Oct 2002	0.123	0.078	47.6
30-34	4	5.372	4.279	0.203	5	0.204	0.796	Oct 2001	0.13	0.085	46
35-39	5	6.705	5.239	0.219	10	0.226	0.774	Apr 2001	0.13	0.086	45.9
40-44	6	7.666	5.857	0.236	15	0.235	0.765	Apr 2000	0.129	0.083	46.4
45-49	7	8.397	6.189	0.263	20	0.265	0.735	Dec 1996	0.134	0.089	45.2

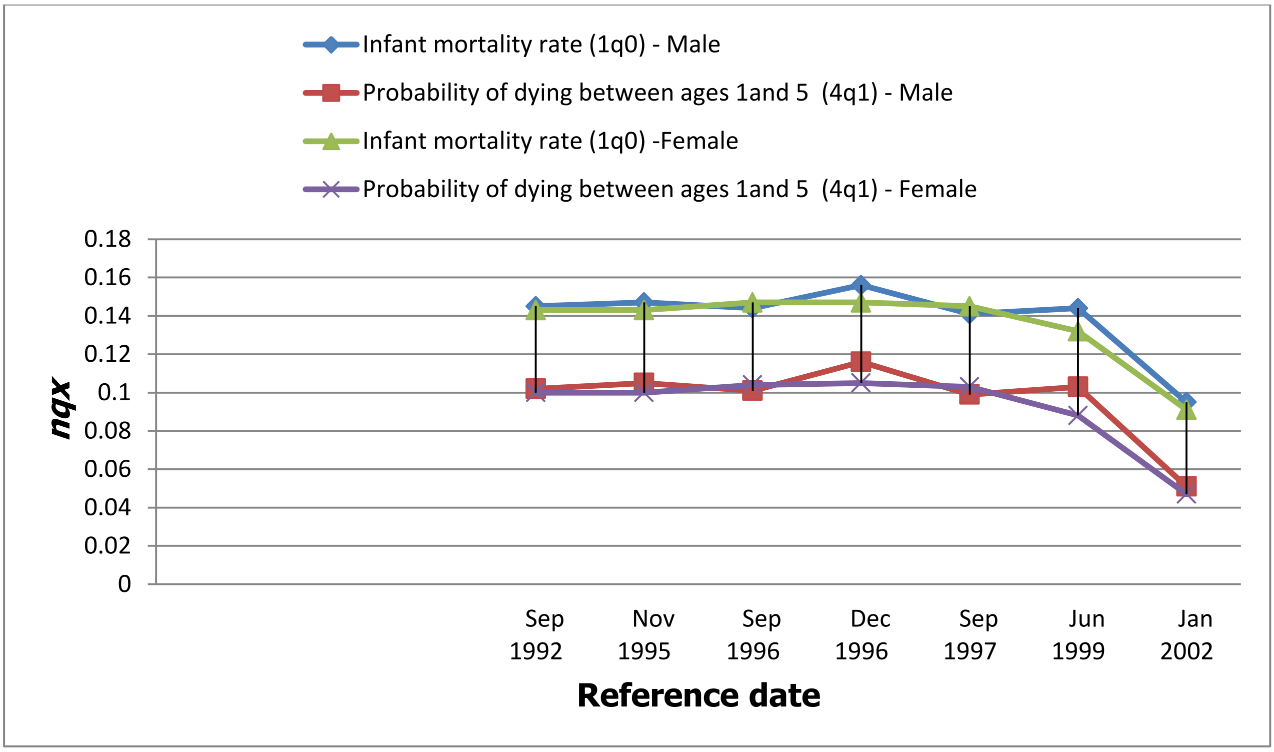

Figure 5.8: Infant mortality rate (1q0) and probability of dying between ages 1 and 5 (4q1) for males and females, estimated using UN General Model and the Palloni-Heligman version of the Brass method, 2003 NDHS

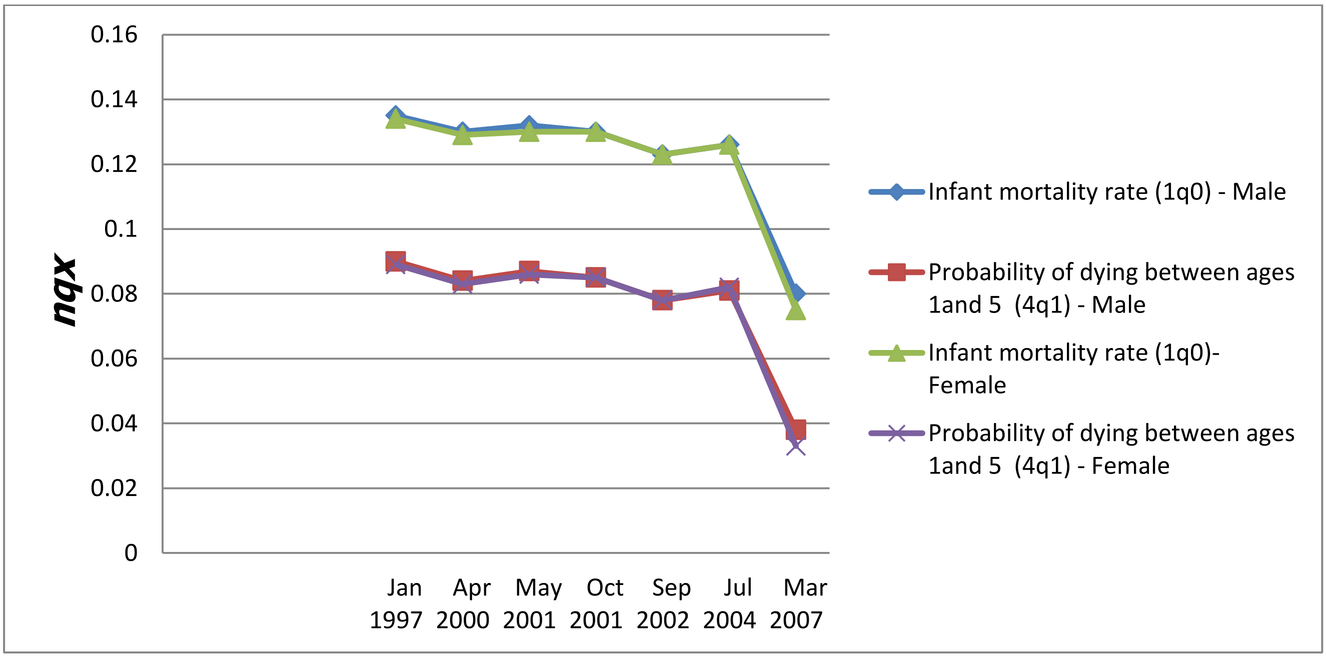

Figure 5.9: Infant mortality rate (1q0) and probability of dying between ages 1 and 5 (4q1) for males and females, estimated using UN General Model and the Palloni-Heligman version of the Brass method, 2008 NDHS

5.1.2.4 Zlotnik and Hill childhood indirect estimation technique – Computational procedure and application to 2003 and 2008 NDHS

Zlotnik and Hill developed an indirect technique for the estimation of childhood mortality in 1981. The method is applicable to countries that have collected information on children ever born and children dead or surviving from two censuses or surveys separated by five or ten years (ECA, 1988). The method is useful in determining inter-censal or inter-survey mortality levels (i.e. mortality levels between two censuses or surveys). The major assumption of this technique is that fertility does not change rapidly and that female population aged 15-19 is partially closed (ECA, 1988). The technique essentially generates a mean number of CEB and children dead for hypothetical cohort and this cohort is assumed to be exposed to the inter-survey vital rates (ECA, 1988). This is defined as:

$$Ph(i) = p2(i) \text{ for } i=1; \text{ and}$$
$$Ph(i-1) + [p2(i) - p1(i-1)] \text{ for } 2 \leq i \leq 7 \ldots\ldots 5.15$$

Where *ph(i)* is the mean number of CEB for a hypothetical cohort, *p1 and p2* are the mean number of CEB for survey 1 and survey 2 respectively.

Also, the mean number of children dead to the hypothetical cohort is computed using:

$$Dh(i) = D2(i) \text{ for } i=1,2$$
$$Dh(i-1) + [D2(i) - D1(i-1)] \text{ for } 2 \leq i \leq 7 \ldots\ldots 5.16$$

Where *Dh(i)* is the mean number of children dead to the hypothetical cohort, *D1 and D2* are the mean number of children dead for survey 1 and survey 2 respectively.

If *P1(i), D1(i), P2(i), D2(i), Ph(i)* and *Dh(i)* are defined as given above, then to estimate for both sexes, mean number of CEB to hypothetical cohort, for i = 1,2,…,7 is given as:

For $i = 1$, *for instance,*

$Ph(1) = P2(1) =$1.547 (shown in column 6 Table 5.14 below)

For $i = 2;$

$Ph(2) = Ph(1)+[P2(2)-P1(1)] =$ [1.547+(2.671-1.495)]

$Ph(2) = 2.732$

Also to compute mean number of children dead to hypothetical cohort,

for $i =$ 1,2,…,7; this is given as:

For $i=1;$

$Dh(1)=D2(1) =$ 0.234 (shown in column 7 Table 5.14 below)

$Dh(2) = Dh(1)+[D2(2)-D1(1)] =$ [0.234+(0.497-0.273)]

$Dh(2) =$ 0.458

Similarly, *Ph(3)* to *Ph(7)* and *Dh(3)* to *Dh(7)* are calculated accordingly and presented in columns 6 and 7 of Tables 5.14 to 5.16 below.

The proportions dead for the hypothetical cohort and Trussell multipliers (using the Coale-Demeny Model Life Tables) (ECA, 1988) are then computed to arrive at the probabilities of dying before exact ages 1,2,3,5,…20 in the inter-survey period of 2003 to 2008. The probabilities of surviving from birth to exact ages 1, 2, 3,…,20 are given in the last column of Tables 5.14 to 5.16.

The results in Tables 5.14 (for both sexes) indicated that the probabilities of surviving to age 1 and through to age 20 were respectively 0.997 and 0.827 over the 2004-2008 inter-survey period. Figure 5.10 indicates that, for all ages except for age 1, probabilities of dying were higher for males than for females during the inter-survey period of 2003 to 2008.

Table 5.14: Application of Zlotnik and Hill Method to Estimate Inter-Survey Infant and Child Mortality, (Inter-survey period between 2003 and 2008), both sexes

Age Group	Mean number of CEB and Children Dead for 2003		Mean number of CEB and Children Dead for 2008		Mean number of CEB and Children Dead to Hypothetical Cohort		Proportion Dead for hypothetical Cohort	Trussel Multipliers	Index to which Probability of dying refers	Probability of Dying before age X	Probability of Surviving to Exact Age X
	P1(i)	D1(i)	P2(i)	D2(i)	Ph(i)	Dh(i)	dh(i)	M(k)	X	nqx	npx
1	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***	***10***	***11***	***12***
15-19	1.495	0.273	1.547	0.234	1.547	0.234	0.151	0.019	1	0.003	0.997
20-24	2.587	0.53	2.671	0.497	2.723	0.458	0.168	0.667	2	0.112	0.888
25-29	4.085	0.862	3.972	0.714	4.108	0.642	0.156	0.871	3	0.136	0.864
30-34	5.656	1.356	5.372	1.094	5.395	0.874	0.162	1.002	5	0.162	0.838
35-39	7.11	1.723	6.694	1.476	6.433	0.994	0.155	1.108	10	0.171	0.829
40-44	7.938	2.102	7.674	1.821	6.997	1.092	0.156	1.102	15	0.172	0.828
45-49	8.389	2.336	8.357	2.211	7.416	1.201	0.162	1.069	20	0.173	0.827

Table 5.15: Application of Zlotnik and Hill Method to Estimate Inter-Survey Infant and Child Mortality, (Inter-survey period between 2003 and 2008), Males

Age Group	Mean number of CEB and Children Dead for 2003		Mean number of CEB and Children Dead for 2008		Mean number of CEB and Children Dead to Hyphothetical Cohort		Proportion Dead for hypothetical Cohort	Trussel Multipliers	Index to which Probability of dying refers	Probability of Dying before age X	Probability of Surviving to Exact Age X
	P1(i)	**D1(i)**	**P2(i)**	**D2(i)**	**Ph(i)**	**Dh(i)**	**dh(i)**	**M(k)**	**X**	**nqx**	**npx**
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
15-19	1.423	0.106	1.563	0.139	1.547	0.234	0.151	0.047	1	0.007	0.993
20-24	2.573	0.285	2.678	0.274	2.818	0.402	0.143	0.654	2	0.093	0.907
25-29	4.07	0.447	3.97	0.377	4.215	0.494	0.117	0.875	3	0.103	0.897
30-34	5.672	0.747	5.372	0.574	5.517	0.621	0.113	1.012	5	0.114	0.886
35-39	7.048	0.912	6.685	0.786	6.53	0.66	0.101	1.121	10	0.113	0.887
40-44	7.856	1.11	7.683	0.961	7.165	0.709	0.099	1.114	15	0.110	0.890
45-49	8.358	1.251	8.32	1.159	7.629	0.758	0.099	1.079	20	0.107	0.893

Table 5.16: Application of Zlotnik and Hill Method to Estimate Inter-Survey Infant and Child Mortality, (Inter-survey period between 2003 and 2008), Females

Age Group	Mean number of CEB and Children Dead for 2003		Mean number of CEB and Children Dead for 2008		Mean number of CEB and Children Dead to Hyphothetical Cohort		Proportion Dead for hypothetical Cohort	Trussel Multipliers	Index to which Probability of dying refers	Probability of Dying before age X	Probability of Surviving to Exact Age X
	P1(i)	**D1(i)**	**P2(i)**	**D2(i)**	**Ph(i)**	**Dh(i)**	**dh(i)**	**M(k)**	**X**	**nqx**	**npx**
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
15-19	1.564	0.167	1.529	0.095	1.547	0.234	0.151	0.047	1	0.007	0.993
20-24	2.601	0.245	2.662	0.223	2.627	0.29	0.110	0.654	2	0.072	0.928
25-29	4.101	0.415	3.974	0.337	4	0.382	0.096	0.875	3	0.084	0.916
30-34	5.641	0.608	5.372	0.52	5.271	0.487	0.092	1.012	5	0.093	0.907
35-39	7.177	0.81	6.705	0.67	6.335	0.549	0.087	1.121	10	0.097	0.903
40-44	8.026	0.992	7.666	0.86	6.824	0.599	0.088	1.114	15	0.098	0.902
45-49	8.424	1.085	8.397	1.052	7.195	0.659	0.092	1.079	20	0.099	0.901

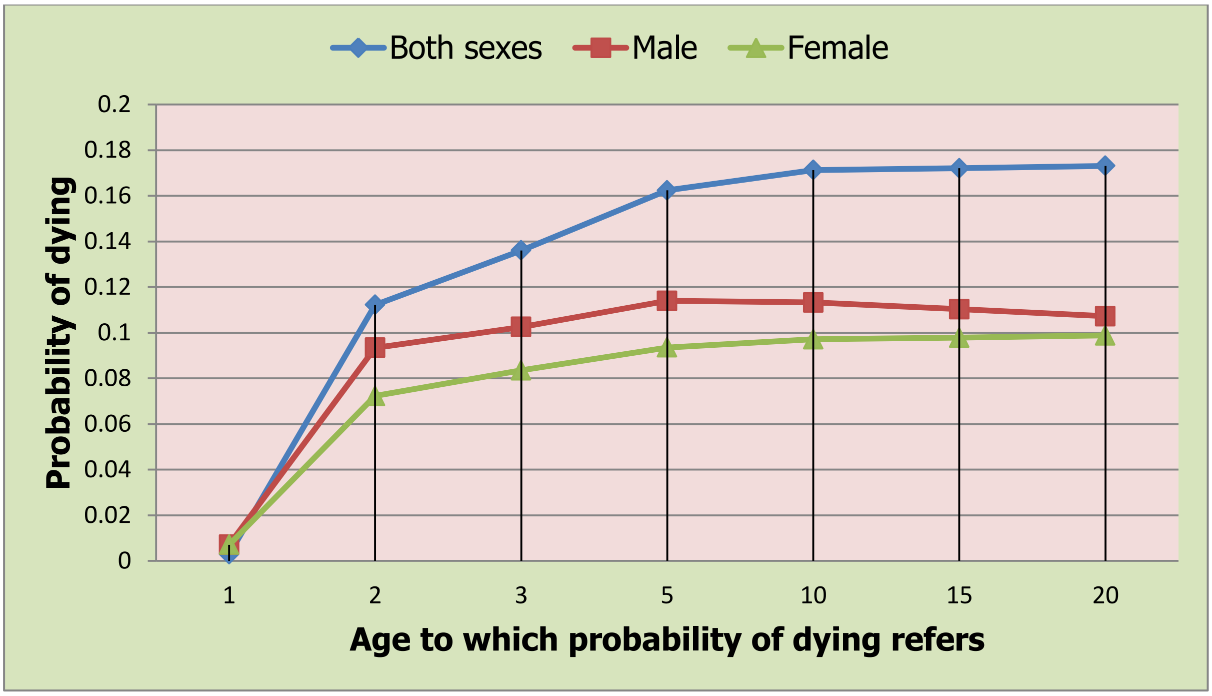

Figure 5.10: Inter-Survey Probability of Dying (period between 2003 and 2008 survey), Application of Zlotnik and Hill Method to 2003 and 2008 NDHS

5.1.2.5 Indirect estimation of childhood mortality using INDEPTH Model life table – Computational procedure and application to 2003 and 2008 NDHS

The basic data required for this technique are not different from those required for the application of Trussel variant of Brass Technique. However, rather than using Coale-Demeny model life table, INDEPTH Model life table was utilized.

Essentially, the data sources for generating the model life tables by Coale-Demeny, the United Nations, Lederman and others were mainly civil registrations which are generally lacking in the sub-Saharan Africa; whereas such model life tables have been mostly utilized in the sub-Saharan Africa (INDEPTH, 2004). Hence, the INDEPTH Model life tables were developed using data from demographic surveillance sites across sub-Saharan African countries. Data from these surveillance sites are unique datasets for the entire sub-Saharan Africa because, using the data, it was possible to estimate mortality levels and patterns of all the regions – East, West, Central and Southern Africa – which were hitherto characterized as data-poor settings. To compute the INDEPTH Model life tables, data were sourced from 17 INDEPTH sites across sub-Saharan African countries (INDEPTH, 2004). Specifically, the significance of the INDEPTH Model life tables is that the tables basically took into account the effect of HIV/AIDS on the mortality levels and patterns in the sub-Saharan Africa. The detailed computational procedures, assumptions and full reports on the INDEPTH Model life tables have been given elsewhere (INDEPTH, 2004).

The INDEPTH model life table is basically estimated using:

$$\frac{1}{1+^{e2\alpha+2\beta Y}} \quad \text{..........} 5.17$$

Equation 5.17 above is derived from the Brass logit relationship given below:

$$Y=\text{logit}(l^F{}_x)= \alpha+\beta y^F{}_{SX}= \alpha +\beta\text{logit}(1^F{}_{SX}) \quad \text{..........} 5.18$$

Using the INDEPTH Model Life Tables survival functions, probabilities of dying by exact age *X* were estimated for males and females, using both data points – i.e. NDHS 2003 and 2008. The estimates are presented in Tables 5.17 to 5.20 below.

Table 5.17: INDEPTH Model Life Table estimates of the male survival function by exact age *X* (estimated using *1q0* and *5q0* from 2003 Nigeria DHS)

Age	**lx**	Correction factor, yx	lx/yx= col (2)/(3)	(col5)=Logit of col (4)	INDEPTH Pattern1, male	(col7)=Logit of col (6)	**INDEPTH Estimates (px)**	**lx**	**ndx**	**nax**	**nmx**	**nLx**	**Tx**	**ex**
1	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***	***10***	***11***	***12***	***13***	***14***	***15***
0	1	1	1	--	1	--	--	100000	6989.816	0.35	0.073	95456.6	5097717	51.0
1	0.988	1	0.988	-2.223	0.915	-1.186	0.930	93010.2	7613.8	0.34	0.022	351940.2	5002261	53.8
5	0.972	1	0.972	-1.774	0.835	-0.812	0.854	85396.4	1898.1	0.5	0.004	422236.5	4650320	54.5
10	0.967	1	0.967	-1.695	0.816	-0.746	0.835	83498.3	1116.5	0.5	0.003	414700.1	4228084	50.6
15	0.965	1	0.965	-1.652	0.805	-0.710	0.824	82381.8	1042.4	0.5	0.003	409303.0	3813384	46.3
20	0.962	1	0.962	-1.614	0.795	-0.678	0.813	81339.4	1389.6	0.5	0.003	403223.0	3404081	41.9
25	0.958	1	0.958	-1.565	0.782	-0.638	0.799	79949.8	2192.7	0.5	0.006	394267.4	3000858	37.5
30	0.952	1	0.952	-1.494	0.761	-0.578	0.778	77757.1	3039.8	0.5	0.008	381186.1	2606590	33.5
35	0.943	1.1	0.857	-0.896	0.732	-0.502	0.747	74717.3	3761.6	0.5	0.010	364182.6	2225404	29.8
40	0.931	1.1	0.846	-0.852	0.696	-0.415	0.710	70955.7	4498.4	0.5	0.013	343532.5	1861222	26.2
45	0.914	1.2	0.762	-0.582	0.655	-0.320	0.665	66457.3	5352.0	0.5	0.017	318906.4	1517689	22.8
50	0.892	1.2	0.744	-0.532	0.606	-0.214	0.611	61105.3	6070.6	0.5	0.021	290349.8	1198783	19.6
55	0.863	1.2	0.719	-0.471	0.550	-0.101	0.550	55034.7	7392.6	0.5	0.029	256691.8	908433	16.5
60	0.820	1.3	0.631	-0.268	0.483	0.034	0.476	47642.0	8151.3	0.5	0.037	217831.9	651741	13.7
65	0.761	1.3	0.585	-0.172	0.409	0.185	0.395	39490.7	9519.0	0.5	0.055	173656.1	433909	11.0
70	0.667	1.4	0.477	0.047	0.320	0.377	0.300	29971.8	8627.4	0.5	0.067	128290.2	260253	8.7
75	0.550	1.7	0.323	0.369	0.237	0.584	0.213	21344.3	8810.2	0.5	0.104	84696.1	131963	6.2
80	0.378	1.9	0.199	0.696	0.148	0.874	0.125	12534.1	6161.4	0.5	0.130	47267.0	47267	3.8

Tx= total person's years lived, ex= expectation of life

Table 5.18: INDEPTH Model Life Table estimates of the female survival function by exact age *X* (estimated using *1q0* and *5q0* from 2003 Nigeria DHS)

1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
Age	**lx**	Correction factor, yx	lx/yx= col (2)/(3)	(col5)=Logit of col (4)	INDEPTH Pattern1, female	(col7)=Logit of col (6)	INDEPTH Estimates (px)	**lx**	**ndx**	**nax**	**nmx**	**nLx**	**Tx**	**ex**
0	1	1	1	--	1	--	--	100000	6443.0	0.35	0.067	95812.1	5497962	55.0
1	0.881	1	0.881	-1.003	0.921	-1.225	0.936	93557.0	7325.9	0.34	0.021	354887.8	5402150	57.7
5	0.789	1	0.789	-0.659	0.844	-0.843	0.862	86231.1	1675.1	0.5	0.004	426967.9	5047262	58.5
10	0.770	1	0.770	-0.604	0.827	-0.782	0.846	84556.0	916.3	0.5	0.002	420489.4	4620294	54.6
15	0.760	1	0.760	-0.576	0.818	-0.751	0.836	83639.8	1095.0	0.5	0.003	415461.1	4199799	50.2
20	0.748	1	0.748	-0.544	0.807	-0.715	0.825	82544.7	1482.3	0.5	0.004	409017.7	3784338	45.8
25	0.732	1	0.732	-0.503	0.793	-0.670	0.811	81062.4	1951.4	0.5	0.005	400433.3	3375321	41.6
30	0.712	1	0.712	-0.453	0.774	-0.614	0.791	79111.0	2327.7	0.5	0.006	389735.6	2974887	37.6
35	0.689	1	0.689	-0.397	0.751	-0.553	0.768	76783.3	2087.1	0.5	0.006	378698.5	2585152	33.7
40	0.669	1	0.669	-0.351	0.732	-0.501	0.747	74696.1	2691.3	0.5	0.007	366752.3	2206453	29.5
45	0.643	1.1	0.585	-0.171	0.706	-0.439	0.720	72004.8	3210.9	0.5	0.009	351996.7	1839701	25.5
50	0.614	1.1	0.558	-0.116	0.676	-0.368	0.688	68793.9	4728.6	0.5	0.014	332148.0	1487704	21.6
55	0.572	1.1	0.520	-0.040	0.633	-0.272	0.641	64065.3	6458.3	0.5	0.021	304180.7	1155556	18.0
60	0.517	1.1	0.470	0.060	0.574	-0.148	0.576	57607.0	7579.0	0.5	0.028	269087.5	851376	14.8
65	0.454	1.2	0.379	0.248	0.505	-0.010	0.500	50028.0	9993.2	0.5	0.044	225157.2	582288	11.6
70	0.374	1.3	0.288	0.453	0.414	0.175	0.400	40034.9	11428.2	0.5	0.067	171603.7	357131	8.9
75	0.283	1.5	0.188	0.730	0.307	0.407	0.286	28606.6	10655.5	0.5	0.092	116394.5	185527	6.5
80	0.194	1.7	0.114	1.026	0.204	0.682	0.180	17951.2	8247.1	0.5	0.119	69138.1	69133	3.9

Tx= total person's years lived, ex= expectation of life

Table 5.19: INDEPTH Model Life Table estimates of the male survival function by exact age *X* (estimated using *1q0* and *5q0* from 2008 Nigeria DHS)

Age (X)	**lx**	Correction factor, yx	lx/yx= col (2)/(3)	(col5)=Logit of col (4)	INDEPTH Pattern1, male	(col7)=Logit of col (6)	**INDEPTH Estimates px**	lx	Ndx	nax	nmx	nLx	**Tx**	**ex**
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
0	1	1	1	--	1	--	--	100000	6734.2	0.33	0.071	95488.1	5157972.8	51.6
1	0.917	1	0.917	-1.204	0.915	-1.186	0.933	93265.8	7377.6	0.34	0.021	353586.2	5062484.7	54.3
5	0.830	1	0.830	-0.793	0.835	-0.812	0.859	85888.2	1846.1	0.5	0.004	424825.5	4708898.5	54.8
10	0.809	1	0.809	-0.721	0.816	-0.746	0.840	84042.0	1087.2	0.5	0.003	417492.3	4284073.0	51.0
15	0.796	1	0.796	-0.681	0.805	-0.710	0.830	82954.9	1015.9	0.5	0.002	412234.5	3866580.7	46.6
20	0.785	1	0.785	-0.646	0.795	-0.678	0.819	81938.9	1355.6	0.5	0.003	406305.7	3454346.2	42.2
25	0.769	1	0.769	-0.602	0.782	-0.638	0.806	80583.3	2142.1	0.5	0.005	397561.5	3048040.5	37.8
30	0.745	0.9	0.828	-0.785	0.761	-0.578	0.784	78441.3	2975.8	0.5	0.008	384766.7	2650479.0	33.8
35	0.712	0.9	0.791	-0.665	0.732	-0.502	0.755	75465.4	3692.3	0.5	0.010	368096.3	2265712.2	30.0
40	0.671	0.9	0.746	-0.538	0.696	-0.415	0.718	71773.1	4430.1	0.5	0.013	347790.3	1897615.9	26.4
45	0.623	0.9	0.693	-0.406	0.655	-0.320	0.673	67343.0	5291.4	0.5	0.016	323486.5	1549825.6	23.0
50	0.568	0.9	0.631	-0.267	0.606	-0.214	0.621	62051.6	6029.2	0.5	0.020	295185.0	1226339.1	19.8
55	0.506	0.9	0.562	-0.124	0.550	-0.101	0.560	56022.4	7381.8	0.5	0.028	261657.6	931154.1	16.6
60	0.432	0.9	0.480	0.040	0.483	0.034	0.486	48640.6	8190.2	0.5	0.037	222727.7	669496.5	13.8
65	0.353	0.9	0.392	0.219	0.409	0.185	0.405	40450.4	9632.5	0.5	0.054	178171.0	446768.9	11.0
70	0.263	0.9	0.293	0.441	0.320	0.377	0.308	30818.0	8794.4	0.5	0.067	132103.8	268597.9	8.7
75	0.185	0.8	0.231	0.601	0.237	0.584	0.220	22023.6	9044.3	0.5	0.103	87507.0	136494.0	6.2
80	0.107	0.9	0.119	1.002	0.148	0.874	0.130	12979.2	6363.6	0.5	0.130	48987.0	48987.0	3.8

Tx= total person’s years lived, ex= expectation of life

Table 5.20: INDEPTH Model Life Table estimates of the female survival function by exact age *X* (estimated using *1q0* and *5q0* from 2008 Nigeria DHS)

Age	**lx**	Correction factor, yx	lx/yx= col (2)/(3)	(col5)=Logit of col (4)	INDEPTH Pattern1, female	(col7)=Logit of col (6)	**INDEPTH Estimates (px)**	**lx**	**Ndx**	**nax**	**nmx**	**nLx**	**T_x**	**e_x**
1	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***	***10***	***11***	***12***	***13***	***14***	***15***
0	1	1	1	--	1	--	--	100000	6206.0	0.35	0.065	95966.1	5558049	55.6
1	0.924	1	0.924	-1.248	0.921	-1.225	0.938	93794.0	7094.8	0.34	0.020	356445.7	5462083	58.2
5	0.840	1	0.840	-0.827	0.844	-0.843	0.867	86699.2	1628.0	0.5	0.004	429426.0	5105637	58.9
10	0.821	1	0.821	-0.760	0.827	-0.782	0.851	85071.2	891.4	0.5	0.002	423127.4	4676211	55.0
15	0.810	1	0.810	-0.726	0.818	-0.751	0.842	84179.8	1066.2	0.5	0.003	418233.3	4253084	50.5
20	0.798	1	0.798	-0.687	0.807	-0.715	0.831	83113.6	1444.8	0.5	0.004	411955.9	3834851	46.1
25	0.781	1	0.781	-0.637	0.793	-0.670	0.817	81668.8	1904.5	0.5	0.005	403582.7	3422895	41.9
30	0.760	0.9	0.844	-0.845	0.774	-0.614	0.798	79764.3	2275.6	0.5	0.006	393132.4	3019312	37.9
35	0.734	0.9	0.816	-0.744	0.751	-0.553	0.775	77488.7	2044.0	0.5	0.005	382333.4	2626180	33.9
40	0.711	0.9	0.791	-0.664	0.732	-0.501	0.754	75444.7	2640.7	0.5	0.007	370621.6	2243846	29.7
45	0.682	0.9	0.758	-0.571	0.706	-0.439	0.728	72804.0	3157.9	0.5	0.009	356125.2	1873225	25.7
50	0.648	0.9	0.720	-0.472	0.676	-0.368	0.696	69646.1	4665.2	0.5	0.014	336567.5	1517099	21.8
55	0.598	0.9	0.665	-0.342	0.633	-0.272	0.650	64980.9	6400.2	0.5	0.021	308904.0	1180532	18.2
60	0.513	0.9	0.570	-0.141	0.574	-0.148	0.586	58580.7	7552.9	0.5	0.028	274021.5	871628	14.9
65	0.455	0.9	0.506	-0.012	0.505	-0.010	0.510	51027.9	10029.0	0.5	0.044	230066.8	597606	11.7
70	0.358	0.9	0.398	0.207	0.414	0.175	0.410	40998.9	11568.4	0.5	0.066	176073.4	367540	9.0
75	0.251	0.8	0.313	0.392	0.307	0.407	0.294	29430.5	10882.6	0.5	0.091	119945.9	191466	6.5
80	0.155	0.9	0.172	0.787	0.204	0.682	0.185	18547.9	8487.6	0.5	0.119	71520.4	71520.4	3.9

T_x= total person's years lived, e_x= expectation of life

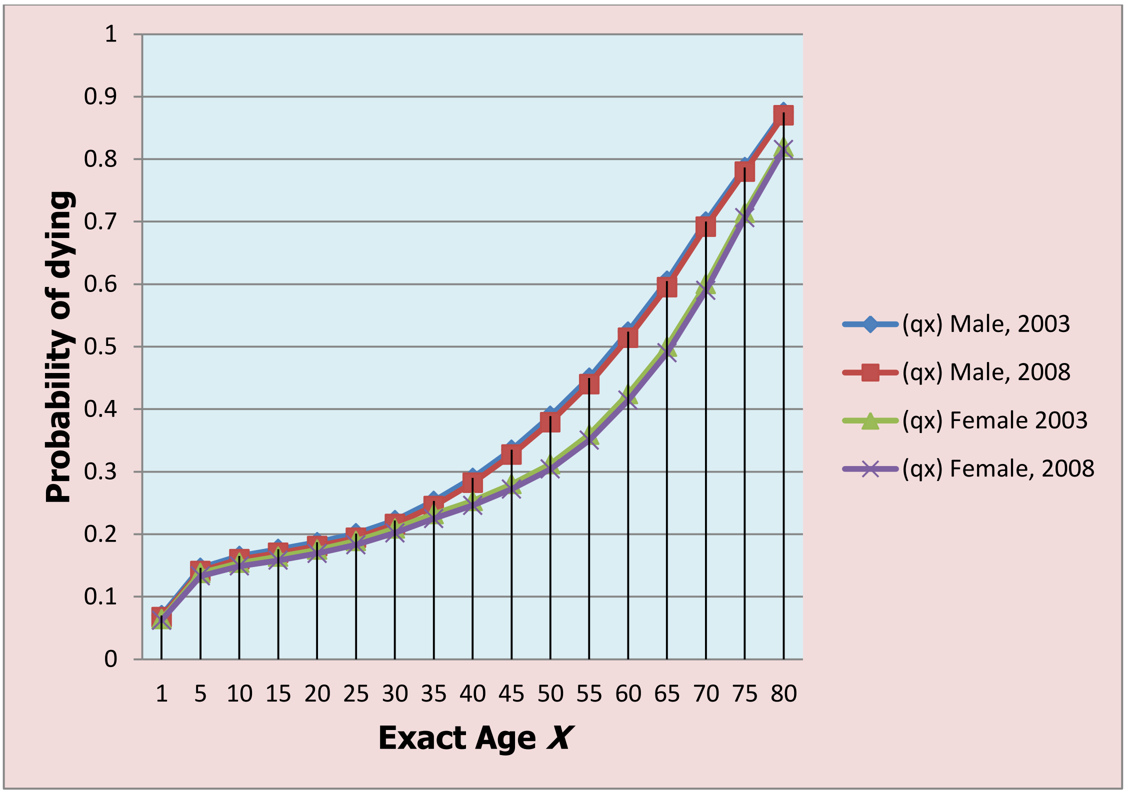

Figure 5.11: INDEPTH Estimates of probabilities of dying by exact age *X* (in years) according to sex, NDHS 2003 and 2008

The results of the survival function by exact age *X* derived from the INDEPTH Life Tables yielded estimates for probabilities of surviving and expectation of life at birth; amongst other life table functions. The INDEPTH estimates, as presented in Tables 5.17 to 5.20, showed that the probabilities of surviving to age 1 through age 80 declines consistently with increase in age. For instance, results from analysis of 2003 data for males as presented in Table 5.17 (column 8) indicated that probabilities of surviving to age 1 through 80 decrease consistently from 0.930 (for age 1) to 0.125 (for age 80). The corresponding life expectancy at birth (in Table 5.17 column 15) is 51.0 years. Also, INDEPTH estimate of the life expectancy at birth for female is 55.0 years. These results indicated a higher expectation of life at birth for females than for males. Figure 5.11 also indicated higher probabilities of dying for males than for females with these gaps becoming wider as age increases. Comparing results from 2003 and 2008 data, Tables 5.17 to 5.20 (column 15) indicated a slight increase in expectation of life at birth for both males and females during the period under study.

5.2 Patterns and differentials of infant and child mortality in Nigeria

This section presents the patterns and differentials of infant and child mortality in Nigeria. The first sub-section of this section presents the patterns and differentials of infant and child mortality by individual-level characteristics. While the patterns and differentials of infant and child mortality by household-level characteristics are presented in the second sub-section; the third sub-section presents the patterns and differentials of infant and child mortality by community-level characteristics.

5.2.1 Patterns and differentials of infant and child mortality by individual-level characteristics

Infant and child mortality rates per 1000 live births according to individual-level characteristics are presented in Tables 5.2.1 to 5.2.3. The results in Table 5.2.1 indicated that infant mortality rate was higher for males than for females, both in 2003 and 2008. A closer look at Table 5.2.1 and 5.2.2 suggests that during childhood, the gap in mortality experience between male and female children became closer compared with the mortality pattern during infancy. With respect to birth order, the results showed that the infant mortality rate was highest for children of fifth or higher order birth. Comparing the results in Tables 5.2.1 and 5.2.2 for both datasets, the pattern of deaths by birth order showed that the proportion of first born who died within age 12 to 59 months was lower compared to proportion who died during infancy. Tables 5.2.1 and 5.2.2 revealed that, for both datasets, women who have no education tend to suffer more children's death both in infancy and childhood. The result suggests that the higher the level of education the lower the infant and child death. This means that deaths during infancy or childhood tend to reduce with increase in the level of education. A consideration of place of delivery indicated that there was higher rate of infant and child deaths among children delivered at home compared with those delivered at a health facility in both surveys. Pattern of infant and child death by ethnic affiliation as shown in Tables 5.2.1 to 5.2.3 for both 2003 and 2008 datasets indicated that infant and child mortality rate was highest for Hausa/Fulani/Kanuri ethnic groups and lowest for Yoruba. The distribution of infant and child death by mother's age at child's birth for both surveys showed that the rates of infant and child death were highest for children of teen mothers and lowest for children of women aged 25-34 years. Overall, comparing results for the two surveys (2003 and 2008 NDHS) in Tables 5.2.1-5.2.3, there was a slight reduction in infant/child mortality during the inter-survey period.

Table 5.2.1: Infant mortality rate (IMR per 1000 live births) by individual-level characteristics, 2003 and 2008 DHS

Characteristics	2003		2008	
	IMR	Number of deaths	IMR	Number of deaths
Child's sex				
Male	98.3	301	77.8	1136
Female	86.6	257	64.5	906
Birth order				
First birth	105.8	127	76.8	411
2-4	74.8	196	61.3	801
5+	106.5	235	81.2	830
Preceding birth interval				
<2 years	130.8	147	114.8	617
2 years & higher	83.8	411	61.2	1425
Birth size				
Very large/larger than average	76.1	190	91.1	770
Average	85.3	218	107.0	715
Smaller than average/very small	126.3	110	149.9	405
Maternal education				
None	105.5	320	77.6	1119
Primary	99.8	147	72.3	474
Secondary	59.6	78	62.6	397
Tertiary	60.5	13	38.8	52
Current age of mother				
15-24	97.5	157	81.4	590
25-34	84.2	253	62.9	888
35+	104.6	148	77.4	564
Maternal age at birth of the child				
<18	123.3	62	106.0	229
15-24	92.3	200	69.4	676
25-34	83.1	204	63.3	779
35+	102.0	92	80.8	358
Mother's marital status				
Never married	64.2	7	57.3	29
Currently married	92.7	529	71.0	1943
Previously married	103.8	22	98.7	44
Received prenatal care				
No	77.4	104	52.7	370
Yes	88.6	119	46.1	497
Place of delivery				
Home	100.4	387	114.2	1347
Health facility	67.3	141	98.0	579
Breastfeeding duration				
<6 months	284.9	259	280.0	918
6 months or more	24.9	119	24.8	343
Ethnicity				
Hausa/Fulani/Kanuri	97.3	252	119.6	787
Igbo	87.6	64	125.8	225
Yoruba	53.7	31	64.5	138
Others	98.6	208	118.0	876

Table 5.2.2: Child mortality rate (CMR per 1000 live births) by individual-level characteristics

Characteristics	2003		2008	
	CMR (per 1000)	Number of deaths	CMR (per 1000)	Number of deaths
Child's sex				
Male	52.9	146	44.3	596
Female	50.9	138	42.9	563
Birth order				
First births	48.5	52	35.0	173
2-4 birth order	44.9	109	37.7	462
5+	62.4	123	55.8	524
Preceding birth interval				
< 2 years	73.7	72	69.6	331
2 years	47.2	212	37.9	828
Birth size				
Very large/larger than average	50.3	116	62.9	483
Average	47.0	110	69.5	415
Smaller than average/very small	52.6	40	83.2	191
Maternal education				
None	71.9	195	56.2	748
Primary	43.7	58	40.7	247
Secondary	22.0	27	26.3	156
Tertiary	19.8	4	6.2	8
Maternal current age				
15-24 years	50.9	74	40.8	272
25-34 years	45.8	126	40.8	539
35+	66.3	84	51.8	348
Maternal age at birth of the child				
<18	70.3	31	58.0	112
15-24	50.8	100	43.0	390
25-34	44.0	99	40.5	467
35+	66.7	54	46.6	190
Mother's marital status				
Never married	29.4	3	27.3	13
Currently married	51.2	265	43.1	1097
Previously married	84.2	16	82.1	33
Received prenatal care				
No	42.8	53	32.1	213
Yes	17.4	40	15.0	154
Place of delivery				
Home	64.6	224	88.2	921
Health facility	23.6	46	34.5	184
Breastfeeding duration				
<6 months	15.4	10	14.8	35
6 months or more	52.7	245	71.3	963
Ethnicity				
Hausa/Fulani	75.3	176	105.7	612
Igbo	18.0	12	53.1	83
Yoruba	23.8	13	24.5	49
Others	43.6	83	62.1	407

Table 5.2.3: Under-five mortality rate (UMR per 1000 live births) by individual-level characteristics

Characteristics	2003		2008	
	UMR (per 1000)	Number of deaths	UMR (per 1000)	Number of deaths
Child's sex				
Male	143.4	439	118.6	1732
Female	135.8	403	104.6	1469
Birth order				
First births	149.2	179	109.1	584
2-4 birth order	116.4	305	96.6	1263
5+	162.2	358	132.4	1354
Preceding birth interval				
< 2 years	194.8	219	176.4	948
2 years	127.0	623	96.8	2253
Birth size				
Very large/larger than average	122.5	306	148.3	1253
Average	128.3	328	169.0	1130
Smaller than average/very small	178.0	155	220.6	596
Maternal education				
None	169.9	515	129.5	1867
Primary	139.2	205	110.0	721
Secondary	80.3	105	87.3	553
Tertiary	79.1	17	44.8	60
Maternal current age				
15-24 years	143.5	231	118.9	862
25-34 years	126.2	379	101.1	1427
35+	164.0	232	125.2	912
Maternal age at birth of the child				
<18	184.9	93	157.9	341
15-24	138.4	300	108.3	1066
25-34	123.4	303	101.2	1246
35+	161.9	146	123.6	548
Mother's marital status				
Never married	91.7	10	83.0	42
Currently married	139.1	794	111.0	3040
Previously married	179.2	38	172.6	77
Received prenatal care				
No	116.9	157	83.1	583
Yes	65.7	159	60.3	651
Place of delivery				
Home	158.6	611	192.3	2268
Health facility	89.3	187	129.1	763
Breastfeeding duration				
<6 months	295.9	269	290.6	953
6 months or more	76.3	364	94.2	1306
Ethnicity				
Hausa/Fulani/Kanuri	165.3	428	212.7	1399
Igbo	104.0	76	172.3	308
Yoruba	76.3	44	87.5	187
Others	137.9	291	172.8	1283

5.2.2 Patterns and differentials of infant and child mortality by household-level characteristics

Patterns differentials of infant and child mortality according to household-level variables are presented in Tables 5.3.1 to 5.3.3. It could be seen in the tables that household with more CEB tend to experience higher mortality relative to household with fewer number of CEB. Similarly, the patterns of infant and child mortality, for both 2003 and 2008 surveys, as presented in the tables and figures below showed that households without electricity tend to experience higher infant and child deaths compared to households with electric connection. For both survey years, households that had pit latrine as a form of toilet facility predominantly had higher proportion of infant and child deaths when compared with households that had a flush toilet.

A consideration of religious affiliation showed that infant and child mortality rate was higher for Muslims than for Christians. With respect to wealth index, the pattern showed that the poorer a household is, the higher the rate of infant and child mortality. Pattern of infant and child death by household source of drinking water showed that proportion of infant and child death was lowest for children from households whose source of water was piped borne water. Pattern of childhood deaths by contraceptive use indicated that infant and child mortality rate was highest for children whose mothers had never used contraception. Overall, comparing results for the two survey years (2003 and 2008) in Tables 5.2.1-5.2.3, a slight reduction in infant and child mortality (according to various selected household-level characteristics) was observed during the inter-survey period.

Table 5.3.1: Infant mortality rate (IMR per 1000 live births) by household-level characteristics

Characteristics	2003		2008	
	IMR (per 1000)	Number of deaths	IMR (per 1000)	Number of deaths
Children ever born				
< 3 children	72.2	122	62.0	493
3-4 children	86.4	156	63.3	561
5+	110.6	280	83.5	988
Parity				
< 3 children	118.6	274	105.1	1079
3-4 children	68.4	139	51.4	514
5+	83.9	145	53.6	449
Family structure				
Monogamous	87.6	323	67.1	1212
Polygynous	102.1	203	79.0	721
Household headship				
Male	92.6	508	70.9	1842
Female	92.3	50	75.0	200
Household had electricity				
No electricity	114.8	367	78.6	1357
Has electricity	65.2	177	59.9	665
Type of household toilet facilities				
Flush toilet	40.7	24	50.7	150
Pit latrine	88.1	326	74.8	1133
Others	208.8	19	74.1	51
None	114.7	177	71.8	683
Religion				
Catholic/Other Christians	86.3	199	70.0	822
Muslim	92.6	333	71.4	1154
Others	211.4	26	85.9	47
Family size				
<=4	122.7	169	98.9	698
5-6	85.1	144	62.0	524
7+	82.8	245	62.4	820
Mother's occupation				
Not working	97.9	203	68.8	622
Formal employment	73.9	17	49.2	39
Informal employment	91.8	295	73.8	1157
Manual labour	84.0	43	71.2	212
Father's occupation				
Not working	55.6	1	0	0

Formal employment	78.4	75	58.8	139
Informal employment	98.7	349	8.2	175
Manual labour	89.6	126	69.6	281
Household Source of drinking water				
Piped	66.2	61	55.1	135
Protected well	94.5	209	63.8	656
River/stream	105.4	242	79.5	1113
Others	68.8	34	71.4	121
Wealth quintile				
Poorest	118.1	166	78.9	600
Poorer	124.9	165	80.6	554
Average	89.6	106	71.8	403
Richer	64.4	74	63.1	300
Richest	48.5	47	48.6	185
Contraceptive Use				
Never used	99.5	513	74.7	1865
Used traditional method	51.0	15	42.9	46
Used modern method	51.7	30	49.9	131

Table 5.3.2: Child mortality rate (CMR per 1000 live births) by household-level characteristics

Characteristics	2003		2008	
	CMR (per 1000)	Number of deaths	CMR (per 1000)	Number of deaths
Children ever born				
< 3 children	34.4	54	26.3	196
3-4 children	51.5	85	38.5	320
5+	64.4	145	59.3	643
Parity				
< 3 children	64.3	131	58.0	533
3-4 children	50.8	94	37.3	354
5+	37.3	59	34.3	272
Family structure				
Polygynous	42.5	143	36.0	607
Monogamous	66.6	119	56.7	477
Household headship				
Male	52.6	262	44.5	1074
Female	44.7	22	34.4	85
Household had electricity				
Yes	61.5	174	50.9	810
No electricity	40.6	103	32.6	340
Type of household toilet facilities				
Flush toilet	15.9	9	12.8	36
Pit latrine	58.4	197	52.7	739
Others	83.3	6	34.5	22
None	48.3	66	38.9	344
Religion				
Catholic/Other Christians	30.8	65	29.9	326
Muslim	66.2	216	53.5	803
Others	30.9	3	117.6	16
Family size				
<=4	56.3	68	53.8	342
5-6	49.7	77	35.0	277
7+	51.2	139	43.8	540
Mother’s occupation				
Not working	56.1	105	47.0	395
Formal employment	14.1	3	19.9	15
Informal employment	51.8	151	41.4	602
Manual labour	53.3	25	51.7	143
Father’s occupation				
Not working	0	0	0	0

Formal employment	27.7	43	35.1	78
Informal employment	65.7	188	42.6	903
Manual labour	129.5	50	39.6	149
Household Source of drinking water				
Piped	48.8	42	31.1	72
Protected well	63.4	127	39.9	384
River/stream	46.7	96	49.8	642
Others	28.3	13	33.7	53
Wealth quintile				
Poorest	62.1	77	57.5	403
Poorer	70.1	81	51.1	323
Average	57.6	62	44.8	233
Richer	42.8	46	30.8	137
Richest	19.5	18	17.4	63
Contraceptive Use				
Never used	55.6	258	47.6	1098
Used traditional method	32.3	9	14.6	15
Used modern method	30.9	17	20.5	51

Table 5.3.3: Under-five Mortality Rate (UMR per 1000 live births) by household-level characteristics

Characteristics	2003		2008	
	UMR (per 1000)	Number of deaths	UMR (per 1000)	Number of deaths
Children ever born				
< 3 children	104.1	176	86.6	689
3-4 children	133.4	241	99.4	881
5+	167.9	425	137.9	1631
Parity				
< 3 children	175.3	405	157.1	1612
3-4 children	117.1	233	86.8	868
5+	118.1	204	86.0	721
Family structure				
Polygynous	126.4	466	100.7	1819
Monogamous	162.9	324	131.2	1198
Household headship				
Male	140.4	770	112.2	2916
Female	132.8	72	106.8	285
Household had electricity				
Yes	169.2	541	125.5	2167
No electricity	103.1	280	90.5	1005
Type of household toilet facilities				
Flush toilet	55.9	33	62.9	186
Pit latrine	141.4	523	123.6	1872
Others	274.7	25	106.1	73
None	157.5	243	107.9	1027
Religion				
Catholic/Other Christians	114.4	264	97.8	1148
Muslim	152.6	549	121.2	1957
Others	235.8	29	115.2	63
Family size				
<=4	172.1	237	147.3	1040
5-6	130.5	221	94.8	801
7+	129.8	384	103.5	1360
Mother's occupation				
Not working	148.5	308	112.6	1017
Formal employment	87.0	20	68.2	54
Informal employment	138.9	446	112.1	1759
Manual labour	132.8	68	119.3	355
Father's occupation				
Not working	55.6	1	0	0
Formal employment	123.3	118	91.8	217
Informal employment	151.8	537	116.0	2478
Manual labour	125.1	176	106.5	430
Household Source of drinking water				

Piped	111.8	103	84.6	207
Protected well	151.9	336	101.1	1040
River/stream	147.1	338	125.3	1755
Others	95.1	47	102.7	174
Wealth quintile				
Poorest	173.0	243	131.9	1003
Poorer	186.2	246	127.6	877
Average	142.0	168	113.4	636
Richer	104.4	120	91.9	437
Richest	67.0	65	65.1	248
Contraceptive Use				
Never used	149.6	771	118.5	2958
Used traditional method	81.6	24	56.9	61
Used modern method	81.0	47	69.4	182

5.2.3 Patterns and differentials of infant and child mortality by community-level characteristics

The distributions of infant and child death according to community-level characteristics are presented in Tables 5.4.1 to 5.4.3. The patterns of infant mortality for both survey years – 2003 and 2008, as shown in the Tables below, indicated that the proportion of infant and child deaths was highest in the North-east and North-west and lowest in the South-east and South-west. Pattern of infant and child death according to place of residence indicated that higher proportion of death during infancy was found in the rural areas relative to urban areas. Considering death within age 12 to 59 months for the two survey years, the picture becomes more appalling as child mortality rate was predominantly higher for women residing in rural areas compared with those in urban centers (Table 5.4.2).

A consideration of ethnic diversity as shown in Tables 5.4.1 to 5.4.3 revealed that the more heterogeneous a community was in terms of ethnic diversity the higher the rate of infant and child death. For instance, there were higher proportions of infant, child and under-five deaths for children whose mothers were resident in highly heterogeneous communities compared with mortality experience of children in homogeneous communities.

Tables 5.4.1 and 5.4.2 further indicated a higher proportion of infant and child deaths for children of mothers residing in community that had a low proportion of women who had secondary or higher level of education. The same thing was true of community hospital delivery and community prenatal care by a skilled provider. The results indicated a higher infant and child mortality rates for children of mothers residing in community that had a low proportion of mothers who had hospital delivery or who had prenatal care by a skilled provider. There was also a higher proportion of infant and child mortality for children of mothers resident in communities with high concentration of poor households compared with children of mothers in the communities with low concentration of poor households.

The patterns of infant and child mortality by proportions with electric connection in a community and proportions with piped water in a community showed that the rates of infant and child deaths were highest for children in the communities with low proportion with electric connection and low proportion with piped water.

Table 5.4.1: Infant Mortality Rate (IMR per 1000 live births) by community-level characteristics

Characteristics	2003		2008	
	IMR (per 1000)	Number of deaths	IMR (per 1000)	Number of deaths
Region of residence				
North-central	103.5	88	69.0	348
Northeast	149.8	152	77.5	508
Northwest	136.0	180	72.5	576
Southeast	66.3	46	83.3	204
South-south	120.2	55	71.5	238
Southwest	66.1	37	50.6	168
Type of place of residence				
Urban	81.0	146	57.1	435
Rural	121.3	412	76.4	1607
Ethnicity diversity				
Homogenous	74.9	86	71.2	561
Mixed	84.4	197	64.7	626
Heterogeneous	108.0	275	77.1	855
Community maternal level of education				
Low	115.8	262	77.6	908
Medium	78.4	124	67.4	520
High	78.8	172	66.5	614
Proportion with electric connection in a community				
Low	117.6	300	77.1	1010
Medium	78.4	89	71.3	408
High	72.1	169	63.5	624
Proportion with piped water in a community				
Low	100.8	368	78.1	1506
Medium	102.0	46	50.2	53
high	74.7	144	58.1	483
Community prenatal care by				
skilled provider	118.9	218	73.0	772
Low	73.8	141	72.8	617
Medium	87.1	199	68.0	653
High				
Community hospital delivery				
Low	111.6	304	79.2	1007
Medium	83.0	136	71.9	599
High	70.9	118	57.3	436
Community poverty				
low	96.4	109	69.9	463
Medium	87.3	173	70.7	669
High	94.7	276	72.5	910
Distance to health facility				
Big problem	123.4	193	75.5	872
Not a big problem	81.8	365	68.4	1170

Table 5.4.2: Child Mortality Rate (CMR per 1000 live births) by community-level characteristics

Characteristics	2003		2008	
	CMR (per 1000)	Number of deaths	CMR (per 1000)	Number of deaths
Region of residence				
North-central	70.4	32	31.9	156
Northeast	154.2	96	50.3	314
Northwest	176.0	112	63.1	472
Southeast	40.1	11	30.7	73
South-south	63.2	21	28.4	92
Southwest	47.4	12	15.9	52
Type of place of residence				
Urban	78.0	69	26.7	198
Rural	139.4	215	47.9	961
Ethnic diversity				
Homogenous				
Mixed	43.3	46	45.2	341
Heterogeneous	52.9	113	43.5	404
Community maternal level of education	55.0	125	38.8	414
Low				
Medium	75.5	151	55.6	616
High	47.3	69	37.4	278
Proportion with electric connection in a community	31.8	64	29.6	265
Low				
Medium	59.1	133	48.8	609
High	46.0	48	36.2	200
Proportion with piped water in a community	47.4	103	36.9	350
Low				
Medium	53.9	177	45.4	837
high	54.3	22	43.5	44
Community prenatal care by skilled provider	47.6	85	34.6	278
Low	76.1	123	54.3	545
Medium	44.7	79	35.7	292
High	39.3	82	34.7	322
Community hospital delivery				
Low	73.6	178	58.3	700
Medium	31.9	48	36.0	289
High	37.5	58	22.9	170
Community poverty				
Low	39.1	40	35.6	228
Medium	49.2	89	40.0	364
High	58.7	155	47.3	567
Distance to health facility				
Big problem	58.4	80	43.2	478
Not a big problem	49.8	204	41.5	681

Table 5.4.3: Under-five Mortality Rate (UMR per 1000 live births) by community-level characteristics

Characteristics	2003		2008	
	UMR (per 1000)	Number of deaths	UMR (per 1000)	Number of deaths
Region of residence				
North-central	122.1	76	99.9	504
Northeast	118.2	120	125.3	822
Northwest	166.8	248	131.9	1048
Southeast	160.4	292	113.1	277
South-south	109.0	57	99.2	330
Southwest	87.5	49	66.3	220
Type of place of residence				
Urban	101.6	215	83.1	633
Rural	160.3	627	122.1	2568
Ethnic diversity				
Homogenous	115.0	132	114.5	902
Mixed	132.8	310	106.4	1030
Heterogeneous	157.1	400	114.5	1269
Community maternal level of education				
Low	182.6	413	130.2	1524
Medium	122.0	193	103.4	798
High	108.1	236	95.3	879
Proportion with electric connection in a community				
Low	169.7	433	123.7	1619
Medium	121.0	137	106.2	608
High	116.0	272	99.1	974
Proportion with piped water in a community				
Low	149.4	545	121.5	2343
Medium	150.8	68	91.9	97
High	118.8	229	91.7	761
Community prenatal care by skilled provider				
Low	185.9	341	124.6	1317
Medium	115.2	220	107.3	909
High	123.0	281	101.5	975
Community hospital delivery				
Low	176.9	482	134.3	1707
Medium	112.3	184	106.7	888
High	105.7	176	79.7	606
Community poverty				
Low	131.7	149	55	691
Medium	132.2	262	109	1033
High	147.9	431	222	1477
Distance to health facility				
Big problem	174.6	273	117.0	1350
Not a big problem	127.5	569	108.2	1851

5.3 Bivariate Analysis

This section presents the results of the bivariate analysis of this study. The first sub-section presents the bivariate relationship between infant/child mortality and the selected individual-level characteristics. The results of bivariate relationship between infant/child mortality are presented in the second sub-section, while the third sub-section presents the bivariate association between infant/child mortality and the selected characteristics at the community level.

5.3.1 Bivariate relationship between infant/child mortality and individual-level characteristics

Results of bivariate association between infant/child mortality and individual-level characteristics, for both survey years, are presented in Tables 5.5.1 to 5.5.3. Comparing Tables 5.5.1 and 5.5.2, a slightly higher proportion of the children died in infancy among the male children than among females (9.8% vs. 8.7% in 2003); (7.7% vs. 6.5% in 2008; $p<0.05$); whereas, about the same proportion of male and female children died between ages 12 and 59 months (5% in 2003 and 4% in 2008). Table 5.5.3 indicates that, overall, 14% each of both male and female children died before their fifth birthday in 2003 as against 12 percent of the males and 11 percent of females who died before age five in 2008 ($p<0.05$). The results suggest that there was a slight reduction in the proportion of infant and child death over the 1999-2003 and 2004-2008 periods.

Examination of relationship between infant/child mortality and birth order as presented in Tables 5.5.1 to 5.5.3 indicated a slightly higher percentage of death in infancy for children of first-order births (10.6% in 2003, 7.4% in 2008) and higher-order births (5^{th} or higher) (10.7% in 2003, 8.2% in 2008) than for children of middle-order (i.e. 2nd-4th order) births (7.5% in 2003, 6.2% in 2008), ($p<0.05$). However, the proportion who died between ages 1 and 5 significantly reduced for children of first-order birth (4.9% in 2003, 3.2% in 2008), ($p<0.05$).

Considering the relationship between infant/child mortality and preceding birth interval, 2008 data indicated that slightly more than 1 in 10 of all the children born after the preceding birth interval of less than 24 months died during the first year of life as against only 6 percent of their counterparts that were born after the birth interval of 24 months or higher ($p<0.05$). Results from 2003 data also indicated higher proportion of death for children with short birth interval when compared to mortality experience of children with longer birth interval (13.1% vs. 6.1%). Table 5.5.2 indicates that as children survive beyond age 1, the proportion of death among those with too short birth interval tend to decline (7.4% in 2003, 6.9% in 2008). Overall, the data indicated that 1 in 5 (in 2003), and 17.5% (in 2008) of all the children born with short preceding birth interval of less than 24 months died before reaching their fifth birthday ($p<0.05$).

Table 5.5.1: Bivariate association between infant mortality and individual-level characteristics

Characteristics	(2003)			(2008)		
	Survival Status		P-value (χ^2)	Survival Status		P-value (χ^2)
	Alive (n=5186)	Dead (n=842)		Alive (n=26605)	Dead (n=2042)	
Child's sex			0.117(2.4)			0.0 (12.0)
Male	90.2	9.8		92.3	7.7	
Female	91.3	8.7		93.5	6.5	
Birth order			0.0 (17.5)			0.0 (14.2)
First birth	89.4	10.6		92.6	7.4	
2-4 birth order	92.5	7.5		93.8	6.2	
5+	89.4	10.7		91.8	8.2	
Preceding birth interval			0.0 (24.0)			0.0(130.7)
<2 years	86.9	13.1		88.7	11.3	
2 years or more	91.6	8.4		93.9	6.1	
Birth size			0.0 (20.7)			0.0 (32.4)
Very large/larger than average	92.4	7.6		94.2	5.6	
Average	91.5	8.5		93.4	6.6	
Smaller than average/very small	87.4	12.6		90.1	9.9	
Maternal education			0.0 (26.5)			0.0 (9.1)
None	89.5	10.6		92.1	7.9	
Primary	90.0	10.0		92.8	7.2	
Secondary	94.0	6.0		93.7	6.3	
Tertiary	94.0	6.0		96.0	4.0	
Maternal current age			0.07 (5.4)			0.0 (14.6)
15-24 years	90.3	9.8		91.8	8.2	
25-34 years	91.6	8.4		93.8	6.2	
35+	89.5	10.5		92.1	7.9	
Mother's marital status			0.5 (1.4)			0.01 (5.1)
Never married	93.6	6.4		94.3	5.7	
Currently married	90.7	9.3		92.9	7.0	
Previously married	89.6	10.4		88.8	11.2	
Received prenatal care			0.0(12.4)			0.032 (4.6)
No	92.3	7.7		94.7	5.3	
Yes	95.1	4.9		95.5	4.5	
Place of delivery			0.0(18.4)			0.067 (3.3)
Home	90.0	10.0		92.9	7.1	
Health facility	93.3	6.7		93.1	6.4	
Ethnicity			0.01(12.2)			0.0 (8.7)
Hausa/Fulani/Kanuri	90.3	9.7		92.5	7.5	
Igbo	91.2	8.8		92.8	7.2	
Yoruba	94.6	5.4		95.4	4.6	
Others	90.1	9.9		92.4	7.6	

With respect to child's size at birth, both 2003 and 2008 data indicates that the smaller the size at birth the higher the proportion of death during infancy. For instance, 13% in 2003 and 1 out of 10 (in 2008) of all children whose size at birth was very small/smaller than average did not reach their first birthday; whereas 7.6% (in 2003) and 5.6% (in 2008) of very large/larger than average children died during infancy ($p<0.05$). However, child's size at birth became a non-significant variable as children survive beyond the first year of life.

A consideration of relationship between infant/child mortality and maternal education showed that infant and child mortality significantly decreases with increase in maternal level of education ($p<0.05$). Table 5.5.1 indicates that while 11% (in 2003) 8% (in 2008) of all children whose mothers had no former education died during infancy, 6% (in 2003) and 4% (in 2008) of the children whose mothers had tertiary education did not survive beyond age one. Thus, as children survive beyond age one; virtually all the children of mothers with tertiary education tend to survive beyond age 5 as only 2% (in 2003) and 0.6% (in 2008) of children in this category died during childhood ($p<0.05$). In contrast, 7 percent (2003) and 6 percent (2008) of children of illiterate mothers died during childhood. Overall, while 17 percent (in 2003) and 13 percent (in 2008) of all children of uneducated mothers died between ages 0 and 5, 7.9% (in 2003) and 4.2% (in 2008) of the children of mothers with tertiary education died under the age of 5 years ($p<0.05$).

Table 5.5.1 further revealed that proportion of infant mortality tend to be significantly higher for children of younger mothers (mothers aged 15-24 years) than for the children of middle aged mothers (women aged 25-34 years) ($p<0.05$). Thus, results in Table 5.5.2 indicated that as children survive beyond age one, the proportion of deaths tend to be slightly higher for children of mothers aged 35 and above compared with the children of younger mothers aged 15-24 (6.6% vs. 5.1% in 2003, 5.2% vs. 4.1% in 2008, $p<0.05$).

An examination of bivariate relationship between infant/child mortality and mother's marital status as presented in Table 5.5.3 showed that about 2 in 5 (18% in both 2003 and 2008) of the children of previously married mothers[18] died before reaching their fifth birthday as against 14% (2003) and 11% (2008) of children of currently married women who died before age five ($p<0.05$). Results from 2008 data showed that the proportion of children of previously married mothers who died in infancy (11.2%) was almost twice the proportion of children of the currently married mothers who died during infancy (5.7%), ($p<0.05$). In the same vein, the proportion of children of previously married mothers who died in childhood (8.1% in 2008) was twice the proportion of children of the currently married mothers (4.3%) that died within the same reference period ($p<0.05$).

[18] previously married mothers are widowed or divorced women

Table 5.5.2: Bivariate association between child mortality and individual-level characteristics, 2003 and 2008 DHS

Characteristics	(2003) Survival Status		P-value (χ^2)	(2008) Survival Status		P-value (χ^2)
	Alive (n=5186)	**Dead** (n=284)		**Alive** (n=25446)	**Dead** (n=1159)	
Child's sex			0.52 (0.4)			0.71 (0.1)
Male	95.0	5.0		95.6	4.4	
Female	94.6	5.4		95.7	4.3	
Birth order			0.03 (7.0)			0.0 (30.0)
First birth	95.2	4.9		96.8	3.2	
2-4 birth order	95.5	4.5		96.3	3.7	
5+	93.8	6.2		94.3	5.7	
Preceding birth interval			0.0 (11.5)			0.0 (80.1)
<2 years	92.6	7.4		93.1	6.9	
2 years or more	95.3	4.7		96.3	3.7	
Birth size			0.41 (1.8)			0.13 (2.1)
Very large/larger than average	95.0	5.0		96.0	4.0	
Average	95.3	4.7		95.9	4.1	
Smaller than average/very small	94.1	5.9		95.2	4.8	
Maternal education			0.0(50.5)			0.0 (41.4)
None	92.8	7.2		94.2	5.8	
Primary	95.6	4.4		95.9	4.1	
Secondary	97.8	2.2		97.4	2.6	
Tertiary	98.0	2.0		99.4	0.6	
Maternal current age			0.02(7.4)			0.0 (6.3)
15-24 years	94.9	5.1		95.9	4.1	
25-34 years	95.4	4.6		96.0	4.0	
35+	93.4	6.6		94.9	5.2	
Mother's marital status			0.08 (5.1)			0.0 (6.6)
Never married	97.1	2.9		96.8	3.2	
Currently married	94.9	5.1		95.7	4.3	
Previously married	91.6	8.4		91.9	8.1	
Received prenatal care			0.0 (20.3)			0.0 (61.4)
No	95.7	4.3		96.6	3.4	
Yes	98.3	1.7		98.5	1.5	
Place of delivery			0.0 (44.5)			0.0 (111.0)
Home	93.5	6.5		94.6	5.4	
Health facility	97.6	2.4		97.8	2.2	
Ethnicity			0.0 (52.8)			0.0 (48.6)
Hausa/Fulani/Kanuri	92.5	7.5		93.6	6.4	
Igbo	98.2	1.8		97.0	3.0	
Yoruba	97.6	2.4		98.4	1.6	
Others	95.6	4.4		96.4	3.6	

Both 2003 and 2008 data, as presented in Tables 5.5.1-5.5.3, further indicated a significantly higher proportion of deaths for children that were delivered at home ($p<0.05$) and for children whose mothers received no prenatal care ($p<0.05$). For instance, results indicated that 8 percent (2003) and 5 percent (2008) of the children whose mothers received no prenatal care died before age one as against 4.3% (2003) and 3.4% (2008) who died in childhood. Overall, 12 percent (2003) and 9 percent (2008) of children whose mothers received no prenatal care died before age five. Similarly, 7 percent of all children delivered at home died in infancy while 6.5 percent (2003) and 5.4 percent (2008) died in childhood; and overall, 16 percent (2003) and 12 percent (2008) died before reaching the age of five ($p<0.05$).

An examination of the relationship between ethnicity and infant/child mortality indicated that the proportion of infant death was significantly lowest for Yoruba ethnic group (5.4% in 2003, 4.6% in 2008) and highest for Hausa/Fulani/Kanuri ethnic groups (9.7% in 2003, 7.5% in 2008), ($p<0.05$). The proportions of infant death for the other minority ethnic groups were 9.9% (in 2003), and 7.6% (in 2008) while those of Igbo ethnic group were 8.8% (in 2003) and 7.2% (in 2008), ($p<0.05$). The 2008 data indicated that the proportion of deaths during childhood among Hausa/Fulani/Kanuri ethnic groups was twice that of Igbo ethnic group and more than fourfold that of Yoruba ethnic group. A closer look at Table 5.5.3 showed that, overall, 17% (in 2003) and 13.4% (in 2008) of children of Hausa/Fulani mothers died before reaching age five while 8% (in 2003) and 6% (in 2008) of the children of Yoruba mothers and 10% of children of Igbo mothers (in both 2003 and 2008) died before age five ($p<0.05$).

Table 5.5.3: Bivariate association between under-five mortality and individual-level characteristics, 2003 and 2008 DHS

Characteristics	(2003) Survival Status		P-value (χ²)	(2008) Survival Status		P-value (χ²)
	Alive (n=5186)	Dead (n=842)		Alive (n=28647)	Dead (n=3201)	
Child's sex			0.4 (0.7)			0.0 (8.7)
Male	85.7	14.3		88.3	11.7	
Female	86.4	13.6		89.5	10.5	
Birth order			0.0 (22.0)			0.0 (34.9)
First birth	85.1	14.9		89.6	10.4	
2-4 birth order	88.4	11.6		90.3	9.7	
5+	83.8	16.2		86.5	13.5	
Preceding birth interval			0.0 (35.0)			0.0 (212)
<2 years	80.5	19.5		82.5	17.5	
2 years or more	87.3	12.7		90.4	9.6	
Birth size			0.0 (18.1)			0.0 (27.2)
Very large/larger than average	87.8	12.3		90.5	9.5	
Average	87.2	12.8		89.6	10.4	
Smaller than average/very small	82.2	17.8		85.8	14.2	
Maternal education			0.0(68.0)			0.0 (35.7)
None	83.0	17.0		86.8	13.2	
Primary	86.1	13.9		89.0	11.0	
Secondary	92.0	8.0		91.3	8.7	
Tertiary	92.1	7.9		95.4	4.6	
Maternal current age			0.0(11.7)			0.0 (16.2)
15-24 years	85.7	14.4		88.0	12.0	
25-34 years	87.4	12.6		90.1	9.9	
35+	83.6	16.4		87.4	12.6	
Mother's marital status			0.1 (4.9)			0.0 (10.3)
Never married	90.8	9.2		91.3	8.7	
Currently married	86.1	13.9		89.0	11.0	
Previously married	82.1	17.9		81.7	18.3	
Received prenatal care			0.0 (29.4)			0.0 (34.9)
No	88.3	11.7		91.5	8.5	
Yes	93.4	6.6		94.1	5.9	
Place of delivery			0.0 (56.0)			0.0 (56.2)
Home	84.1	15.9		87.9	12.1	
Health facility	91.1	8.9		91.5	8.5	
Ethnicity			0.0 (41.3)			0.0 (33.7)
Hausa/Fulani/Kanuri	83.5	16.5		86.7	13.4	
Igbo	89.6	10.4		90.0	10.0	
Yoruba	92.4	7.6		93.9	6.1	
Others	86.2	13.8		89.1	10.9	

5.3.2 Bivariate relationship between infant/child mortality and household-level characteristics

The results of chi square test and the bivariate association between infant/child mortality and household-level characteristics are presented in Tables 5.6.1 to 5.6.3. As shown in the tables, the results indicated that the higher the number of CEB in a household, the higher the proportion of death during infancy and childhood ($p<0.05$). For instance, for both 2003 and 2008 datasets, there was twice as much as the proportion of children from households with CEB of 5 or more that died during childhood (6%) when compared with the children from household with CEB of less than 3 (3%), ($p<0.05$). Table 5.6.3 showed that, overall, 16.8% (in 2003) and 14.0% (in 2008) of all children from households with CEB of 5 or more died before reaching the age of five as against 10.4% (2003) and 8.4% (2008) of those from households with CEB of less than 3 ($p<0.05$).

Family structure showed a statistical significant bivariate relationship for infant/child mortality ($p<0.05$), and there was slightly a higher proportion of death during infancy (10.3% in 2003, 7.9% in 2008) and childhood (6.8% in 2003, 5.9% in 2008) for children in the polygynous households compared with children in the monogamous family. Sex of household head showed no statistical significance for infant and child mortality for both survey years.

Presence of electricity in a household as well as type of household toilet facilities showed a statistical significance for infant and child mortality ($p<0.05$). For instance, there was a higher percentage of death in infancy (11.5% in 2003, 7.3% in 2008) for children from households that had no toilet facilities compared with children from households that had a flush toilet (4.1% in 2003, 5.2% in 2008).

Table 5.6.1: Bivariate association between infant mortality and household-level characteristics

Characteristics	(2003) Survival Status Alive	(2003) Survival Status Dead	P-value (X^2)	(2008) Survival Status Alive	(2008) Survival Status Dead	P-value (X^2)
CEB			0.0 (19.0)			0.0 (20.4)
< 3 children	92.8	7.2		94.0	6.0	
3-4 children	91.4	8.6		93.7	6.3	
5+	88.9	11.1		91.5	8.5	
Parity			0.0 (32.3)			0.0(85.2)
< 3 children	88.1	11.9		89.7	10.3	
3-4 children	93.0	7.0		94.9	5.1	
5+	91.6	8.4		94.4	5.6	
Family structure			0.05 (3.7)			0.0 (8.9)
Monogamous	91.2	8.8		93.3	6.7	
Polygynous	90.0	10.3		92.1	7.9	
Household headship			0.0 (1.0)			0.27(1.2)
Male	90.7	9.3		93.0	7.0	
Female	90.8	9.2		92.2	7.8	
Household had electricity			0.0 (43.3)			0.0(22.2)
No electricity	88.5	11.5		92.1	7.9	
Has electricity	93.5	6.5		93.9	6.1	
Type of household toilet facilities			0.0 (43.6)			0.0 (4.7)
Flush toilet	95.9	4.1		94.8	5.2	
Pit latrine	91.2	8.8		92.5	7.5	
Others	79.1	20.9		93.2	6.8	
None	88.5	11.5		92.7	7.3	
Religion			0.0 (21.8)			0.55 (0.6)
Catholic/Other Christians	91.4	8.6		93.1	6.9	
Muslim	90.7	9.3		92.8	7.2	
Others	78.9	21.1		91.8	8.2	
Number of under-five children in household			0.0 (53.7)			0.0 (70.7)
<=2	88.9	11.1		91.5	8.5	
3-4	95.0	5.0		96.0	4.0	
5+	93.9	6.1		95.7	4.3	
Family size			0.0 (19.4)			0.0(36.0)
<=4	87.7	12.3		90.3	9.7	
5-6	91.5	8.5		94.1	5.9	
7+	91.7	8.3		93.6	6.4	
Mother's occupation			0.5 (2.1)			0.06(2.4)
Not working	90.2	9.8		93.1	6.9	
Formal employment	92.6	7.4		95.5	4.5	
Informal employment	90.8	9.2		92.7	7.3	
Manual	91.6	8.4		92.5	7.5	
Father's occupation			0.2 (4.3)			0.05(3.1)
Not working	94.4	5.6		0.0	0	
Formal employment	92.2	7.8		94.1	5.9	
Informal employment	90.1	9.9		92.6	7.3	
Manual labour	91.0	9.0		93.2	6.8	

Household Source of drinking water			0.0 (15.5)			0.0(6.8)
Piped	93.4	6.6		94.3	5.7	
Protected well	90.6	9.5		93.5	6.5	
River/stream	89.5	10.5		92.0	8.0	
Others	93.1	6.9		93.5	6.5	
Wealth quintile			0.0 (60.8)			0.0(8.9)
Poorest	88.2	11.8		92.0	8.0	
Poorer	87.5	12.5		92.0	8.0	
Average	91.0	9.0		92.5	7.5	
Richer	93.6	6.4		93.6	6.4	
Richest	95.1	4.9		95.1	4.9	
Contraceptive Use			0.0 (20.5)			0.0(14.3)
Never used	90.0	10.0		92.4	7.6	
Used traditional method	94.9	5.1		95.7	4.3	
Used modern method	94.8	5.2		95.2	4.8	

In the same vein, proportion of death was higher in infancy (8.8% in 2003, 7.5% in 2008) and childhood (5.8 in 2003, 5.4 in 2008) for children raised in households that had a pit latrine as toilet facility when compared with household that had a flush toilet. There was almost no death during childhood in the households that had a flush toilet; as the percentage of child death in such households was just 1 percent in 2008 and slightly above 1 percent in 2003 ($p<0.05$). In addition, there was slightly a higher proportion of death in infancy (11.5% in 2003, 7.9% in 2008) and in childhood (6.2 in 2003, 5.2% in 2008) for children raised in household that had no electric connection when compared with household that had electric connection. In Table 5.6.3, 2008 data indicated that the overall proportion of children that died before the fifth birthday was 13% each for the households that lacked electric connection and households that had pit latrine as toilet facility.

A consideration of bivariate association between religious affiliation and infant/child mortality as shown in Tables 5.6.1 to 5.6.3 revealed that while the percentage of death during infancy for children from Muslim and Christian households was the same in 2003 (9%) and 2008 (7%), results for both surveys showed that the proportion of death in childhood was higher for Muslim mothers than for Christian mothers in 2003 (6.6% vs. 3.1%) and in 2008 (5.4% vs. 2.9%), ($p<0.05$).

Table 5.6.2: Bivariate association between child mortality and household-level characteristics

Characteristics	(2003)			(2008)		
	Survival Status		P-value (χ^2)	Survival Status		P-value (χ^2)
	Alive	Dead		Alive	Dead	
CEB			0.0 (16.9)			0.0 (56.1)
< 3 children	96.6	3.4		97.5	2.5	
3-4 children	94.9	5.2		96.2	3.8	
5+	93.6	6.4		94.0	6.0	
Parity			0.0 (13.3)			0.0(27.3)
< 3 children	93.6	6.4		94.3	5.7	
3-4 children	94.9	5.1		96.3	3.7	
5+	96.3	3.7		96.6	3.4	
Family structure			0.0 (14.1)			0.0 (58.0)
Monogamous	95.8	4.3		96.5	3.4	
Polygynous	93.3	6.8		94.1	5.9	
Household headship			0.45(0.6)			0.15 (2.1)
Male	94.7	5.3		95.6	4.4	
Female	95.5	4.5		96.4	3.6	
Household had electricity			0.0 (12.0)			0.0 (38.8)
No electricity	93.9	6.2		94.8	5.2	
Has electricity	95.9	4.1		96.8	3.2	
Type of household toilet facilities			0.0 (19.7)			0.0 (38.3)
Flush toilet	98.4	1.6		98.9	1.1	
Pit latrine	94.2	5.8		94.6	5.4	
Others	91.7	8.3		97.2	2.8	
None	95.2	4.8		96.2	3.8	
Religion			0.0 (33.4)			0.0 (50.8)
Catholic/Other Christians	96.9	3.1		97.1	2.9	
Muslim	93.4	6.6		94.6	5.4	
Others	96.9	3.1		97.5	2.5	
Number of under-five children in household			0.0 (26.4)			0.0 (30.8)
<=2	93.8	6.3		94.9	5.1	
3-4	97.2	2.8		97.3	2.7	
5+	96.0	4.0		97.5	2.5	
Family size			0.72 (0.6)			0.0 (9.5)
<=4	94.4	5.6		95.0	5.0	
5-6	95.0	5.0		96.6	3.4	
7+	94.9	5.1		95.5	4.5	
Mother's occupation			0.08 (6.9)			0.009(4.0)
Not working	94.4	5.6		95.4	4.6	
Formal employment	98.6	1.4		98.0	2.0	
Informal employment	94.8	5.2		95.9	4.1	
Manual	94.7	5.3		94.8	5.2	
Father's occupation			0.04 (5.2)			0.046(3.1)

Not working	100.0	0.0		100.0	0.0	
Formal employment	95.1	4.9		96.4	3.6	
Informal employment	94.1	5.9		95.5	4.5	
Manual labour	96.1	3.9		96.2	3.8	
Household Source of drinking water			8.6 (8.6)			0.0 (8.7)
Piped	95.1	4.9		96.7	3.3	
Protected well	93.7	6.3		96.2	3.8	
River/stream	95.3	4.7		94.8	5.2	
Others	97.2	2.8		96.9	3.1	
Wealth quintile			0.0 (0.0)			0.0 (30.0)
Poorest	93.1	6.2		93.9	6.1	
Poorer	93.7	7.0		94.6	5.4	
Average	95.3	5.8		95.6	4.4	
Richer	97.1	4.3		96.8	3.2	
Richest	97.2	2.0		98.4	1.6	
Contraceptive Use			0.01(8.4)			0.0 (32.2)
Never used	94.4	5.5		95.2	4.8	
Used traditional method	96.8	3.2		98.7	1.3	
Used modern method	96.9	3.1		98.1	1.9	

Overall, the percentage of children from Muslim households that died before reaching the fifth birthday was 15.3 percent (2003) and 12.3 percent (2008) while the proportion for children from Christian households was 11.4 percent (2003) and 9.6 percent (2008), ($p<0.05$).

Results in Tables 5.6.1 and 5.6.2 revealed that the children whose mothers were engaged in formal employment had the least percentage of death in infancy (7.4% - in 2003, 4.5% - in 2008) and in childhood (1.4% - in 2003, 2.0% - in 2008); whereas, the proportion of death in infancy for children whose mothers were engaged in manual labour was 8.4 percent (2003) and 7.5 percent (2008), ($p<0.05$). As presented in Table 5.6.3, overall, while 8.7 percent (in 2003) and 6.4 percent (in 2008) of children whose mothers were engaged in formal employment died before age 5, both 2003 and 2008 data indicated that more than 1 in 10 of the children whose mothers were engaged in manual labour died before their fifth birthday ($p<0.05$).

Table 5.6.3: Bivariate association between under-five mortality and household-level characteristics

Characteristics	(2003)			(2008)		
	Survival Status		P-value (X^2)	Survival Status		P-value (X^2)
	Alive	Dead		Alive	Dead	
CEB			0.0 (35.1)			0.0 (65.2)
< 3 children	89.6	10.4		91.6	8.4	
3-4 children	86.7	13.3		90.1	9.9	
5+	83.2	16.8		86.0	14.0	
Parity			0.0 (39.5)			0.0(105.3)
< 3 children	82.5	17.5		84.6	15.4	
3-4 children	88.3	11.7		91.3	8.7	
5+	88.2	11.8		91.2	8.8	
Family structure			0.0 (14.4)			0.0 (45.3)
Monogamous	87.4	12.6		90.0	10.0	
Polygynous	83.7	16.3		86.7	13.3	
Household headship			0.6 (0.2)			0.98(0.001)
Male	86.0	14.0		88.9	11.1	
Female	86.7	13.3		88.9	11.1	
Household had electricity			0.0 (53.7)			0.0 (48.6)
No electricity	83.1	16.9		87.3	12.7	
Has electricity	89.7	10.3		90.9	9.1	
Type of household toilet facilities			0.0 (52.6)			0.0 (23.6)
Flush toilet	94.4	5.6		93.7	6.3	
Pit latrine	85.9	14.1		87.5	12.5	
Others	72.5	27.5		90.7	9.3	
None	84.3	15.8		89.2	10.8	
Religion			0.0 (26.7)			0.0 (18.2)
Catholic/Other Christians	88.6	11.4		90.4	9.6	
Muslim	84.7	15.3		87.7	12.3	
Others	76.4	23.6		89.5	10.5	
Number of under-five children in household			0.0 (80.5)			0.0 (99.1)
<=2	83.4	16.6		86.8	13.2	
3-4	92.3	7.7		93.4	6.6	
5+	90.2	9.8		93.3	6.7	
Family size			0.0 (15.6)			0.0 (38.8)
<=4	82.8	17.2		85.8	14.2	
5-6	87.0	13.0		90.8	9.2	
7+	87.0	13.0		89.3	10.7	
Mother's occupation			0.08 (6.9)			0.006 (4.3)
Not working	85.1	14.9		88.8	11.2	
Formal employment	91.3	8.7		93.6	6.4	
Informal employment	86.1	13.9		88.9	11.1	
Manual	86.7	13.3		87.8	12.2	
Father's occupation			0.02 (9.9)			0.005(5.4)
Not working	94.4	5.6		0.0	0.0	
Formal employment	87.7	12.3		90.7	9.3	
Informal employment	84.8	15.2		88.4	11.6	
Manual labour	87.5	12.5		89.7	10.3	
Household Source of drinking water			0.0 (18.0)			0.0 (13.6)
Piped	88.8	11.2		91.2	8.8	
Protected well	84.8	15.2		90.0	10.0	
River/stream	85.3	14.7		87.2	12.8	
Others	90.5	9.5		90.6	9.4	

Wealth quintile			0.0 (91.3)			0.0 (31.3)
Poorest	82.7	17.3		86.3	13.7	
Poorer	81.4	18.6		87.0	13.0	
Average	85.8	14.2		88.4	11.6	
Richer	89.6	10.4		90.6	9.4	
Richest	93.3	6.7		93.6	6.4	
Contraceptive Use			0.0 (29.1)			0.0 (38.3)
Never used	85.0	15.0		88.0	12.0	
Used traditional method	91.8	8.2		94.4	5.6	
Used modern method	91.9	8.1		93.4	6.6	

A significant bivariate relationship exists between household source of drinking water and infant/child mortality ($p<0.05$). The results as presented in Tables 5.6.1 to 5.6.3 indicated a higher percentage of death in infancy (10.5% - in 2003, 8.0% - in 2008) and childhood (4.7% – in 2003, 5.2% - in 2008) for children raised in households whose source of drinking water was river/stream compared with children in households with piped water which had 6.6% (2003) and 5.7% (2008) as percentage of infant death. Table 5.6.3 revealed that, overall, 14.2% (in 2003) and 12.8 percent (in 2008) of children in households that drew drinking water from river/stream died before reaching their fifth birthday as against 11.2% (2003) and 8.8% (2008) of children from households whose source of drinking water was piped water, ($p<0.05$).

With respect to the bivariate relationship between wealth index and infant/child mortality, the results in Tables 5.6.1 to 5.6.3 indicated that the poorer a household was the higher the percentage of infant and child mortality ($p<0.05$). For instance, it could be seen in Table 5.6.4 that the proportion of death during infancy in the households in the poorest wealth quintile was more than twice (11.8% in 2003), and almost twice (8.0% in 2008) that of infant death in the households in the richest wealth quintile (i.e. 4.9% each for both years). Thus, 2003 and 2008 data indicated that the gap in the proportion of death within ages 12 to 59 months between the poorest and the richest households was almost fourfold. In addition, the overall percentage of children in the poorest households that died before reaching age 5 was 17.3% (in 2003) and 13.7% (in 2008) as against 6.7% (in 2003) and 6.4% (in 2008) of their counterparts in the richest households.

Results also revealed a significantly higher proportion of death in infancy (10% in 2003, 7.6% in 2008) and in childhood (5% each for both 2003 and 2008) for children whose mothers had never used contraceptives ($p<0.05$) when compared with children of mothers that used either traditional or modern contraceptive methods. Results indicated that while 15% (in 2003) and 12% (in 2008) of children whose mothers had never used contraceptive died before the fifth birthday, 8.1% (2003) and 6.6% (2008) of children whose mothers used modern methods died before age five.

5.3.3 Bivariate relationship between infant/child mortality and community-level characteristics

The results of the bivariate association between infant/child mortality and the selected community-level characteristics are presented in Tables 5.7.1 to 5.7.3. The tables indicated a significant relationship between infant/child mortality and regions of residence in 2003 ($p<0.05$) and 2008 ($p<0.05$). A consideration of survival status within each region revealed that proportion of death was significantly lowest in Southwest both in infancy (6% in 2003, 5% in 2008) and in childhood (2.0% in 2003, 1.6% in 2008). Results also showed that 8.8% (in 2003) and 8.3% (in 2008) of the children born in the South-east region died in infancy while only 2.3% (in 2003) and 3% (in 2008) died during childhood.

In the North-east, 10.2% (in 2003) 7.8% (in 2008) of children from the North-east died in infancy while 7.2% (in 2003) and 4.8% (in 2008) of the children died in childhood. Also, 2008 data indicated that 7 percent each died in infancy in each of the North-central, North-west and South-south regions, while 3 percent each died during childhood in North-central, South-east and South-south. Overall, 2008 data indicated that proportion of under-five death in various regions as presented in Table 5.7.3 showed that the proportion of under-five death was significantly highest in the North-east and North-west (13%), followed by South-east (11.3%), North-central and South-south (10%) ; and lowest in South-west (6.6%), ($p<0.05$).

Table 5.7.1: Bivariate association between infant mortality and community-level characteristics

Characteristics	(2003)			(2008)		
	Survival Status		P-value (χ^2)	Survival Status		P-value (χ^2)
	Alive	Dead		Alive	Dead	
Region of residence			0.045(11.4)			0.0 (31.0)
North-central	91.3	8.7		93.1	6.9	
Northeast	89.8	10.2		92.2	7.8	
Northwest	90.1	9.9		92.8	7.2	
Southeast	91.2	8.8		91.7	8.3	
South-south	90.2	9.8		92.9	7.1	
Southwest	94.0	6.0		94.9	5.1	
Type of place of residence			0.0 (21.6)			0.0 (25.7)
Urban	93.1	6.9		94.4	5.6	
Rural	89.5	10.5		92.2	7.8	
Ethnic diversity			0.0 (13.3)			0.0 (12.1)
Homogenous	92.5	7.5		92.9	7.1	
Mixed	91.6	8.4		93.5	6.5	
Heterogeneous	89.2	10.8		92.3	7.7	
Community maternal level of education			0.0 (23.3)			0.005(5.3)
Low	88.4	11.6		92.1	7.9	
Medium	92.1	7.8		93.3	6.7	
High	92.1	7.9		93.5	6.5	
Proportion with electric connection in a community			0.0 (33.3)			0.0 (4.6)
Low	88.2	11.8		92.2	7.8	
Medium	92.1	7.9		93.1	6.9	
High	92.1	7.2		93.6	6.4	
Proportion with piped water in a community			0.005)			0.0 (12.8)
Low	89.9	10.1		92.1	7.9	
Medium	89.8	10.2		95.2	4.8	
high	92.5	7.5		94.2	5.8	
Community prenatal care by skilled provider			0.0 (23.9)			0.43 (0.8)
Low	88.1	11.9		92.6	7.4	
Medium	92.6	7.4		92.8	7.2	
High	91.3	8.7		93.2	6.8	
Community hospital delivery			0.0 (22.9)			0.0 (11.7)
Low	88.8	11.2		91.9	8.1	
Medium	91.7	8.3		92.9	7.1	
High	92.9	7.1		94.2	5.8	
Community poverty			0.6 (1.0)			0.64 (0.4)
Low	90.4	9.6		92.9		
Medium	91.3	8.7		93.1		
High	90.5	9.5		92.7		
Distance to health facility			0.0 (23.9)			0.03 (4.7)
Big problem	87.7	12.3		92.4	7.6	
Not a big problem	91.8	8.2		93.2	6.8	

Considering the bivariate relationship between place of residence and infant/child mortality, the data indicated a significantly higher proportion of death in infancy (10.5% in 2003, 7.8% in 2008) for children of mothers residing in rural areas when compared with children in the urban centers (6.9% in 2003, 5.6% in 2008), ($p<0.05$). Table 5.7.2 showed that 6.1% (in 2003) and 5.1% (in 2008) of the children in rural areas died during childhood while 3.5% (in 2003) and 2.6% (in 2008) of the children in the urban centers died during childhood ($p<0.05$). Table 5.7.3 showed that, overall, proportions of death between ages 0 and 5 were 16% (2003) and 12% (2008) in rural areas compared to 10% (2003) and 8% (2008) in the urban centers ($p<0.05$).

Considering the relationship between ethnic diversity and infant/child mortality, the results as presented in Table 5.7.1 indicated that percentage of death in infancy (10.8% in 2003, 7.7% in 2008) was slightly higher for children raised in heterogeneous communities when compared with the experience of children in homogenous communities (7.5% - 2003, 7.1% - 2008), ($p<0.05$). Meanwhile, a closer look at Tables 5.7.2 and 5.7.3 revealed that once a child survives beyond the first year of life, there exists no significant difference between the mortality experience of children in homogenous communities and those in heterogeneous communities.

Table 5.7.2: Bivariate association between child mortality and community-level characteristics

Characteristics	(2003)			(2008)		
	Survival Status		P-value (χ^2)	Survival Status		P-value (χ^2)
	Alive	Dead		Alive	Dead	
Region of residence			0.0 (46.3)			0.0 (30.5)
North-central	96.6	3.4		96.9	3.1	
Northeast	92.8	7.2		95.2	4.8	
Northwest	93.2	6.8		94.1	5.9	
Southeast	97.7	2.3		97.0	3.0	
South-south	95.8	4.2		97.2	2.8	
Southwest	98.0	2.0		98.4	1.6	
Type of place of residence			0.0 (17.9)			0.0 (55.1)
Urban	96.5	3.5		97.4	2.6	
Rural	93.9	6.1		94.9	5.1	
Ethnic diversity			0.352(2.1)			0.091(4.8)
Homogenous	95.7	4.3		95.7	4.3	
Mixed	94.7	5.3		95.8	4.2	
Heterogeneous	94.5	5.5		96.3	3.7	
Community maternal level of education			0.0 (39.7)			0.0 (33.7)
Low	92.4	7.6		94.1	5.9	
Medium	95.3	4.7		96.1	3.9	
High	96.8	3.2		97.1	2.9	
Proportion with electric connection the a community			0.136(4.0)			0.0 (10.9)
Low	94.1	5.9		94.8	5.2	
Medium	95.4	4.6		96.4	3.6	
High	95.3	4.7		96.3	3.7	
Proportion with piped water in the community			0.612(1.0)			0.002(6.2)
Low	94.6	5.4		95.6	4.4	
Medium	94.6	5.4		95.8	4.2	
high	95.2	4.8		96.8	3.2	
Community prenatal care by skilled provider			0.0 (27.8)			0.0 (18.3)
Low	92.4	7.6		94.7	5.3	
Medium	95.5	4.5		96.6	3.4	
High	96.1	3.9		96.7	3.3	
Community hospital delivery			0.0 (41.7)			0.0 (58.6)
Low	92.6	7.4		93.7	6.3	
Medium	96.8	3.2		96.3	3.7	
High	96.2	3.8		97.7	2.3	
Community poverty			0.046(6.1)			0.002(6.5)
Low	96.1	3.9		96.5	3.5	
Medium	95.1	4.9		96.0	4.0	
High	94.1	5.9		95.1	4.9	
Distance to health facility			0.215(1.5)			0.065(3.4)
Big problem	94.2	5.8		95.4	4.6	
Not a big problem	95.0	5.0		95.9	4.1	

A comparison of Tables 5.7.1 and 5.7.2 showed that proportions of death in infancy (11.6 in 2003, 7.9% in 2008) and childhood (7.6 in 2003, 5.9%n in 2008) were significantly higher for children of mothers residing in communities that had a low proportion of mothers with at least secondary level of education when compared with those residing in communities that had a high proportion of mothers with at least secondary education ($p<0.05$). As shown in Table 5.7.3, overall, 18 percent (in 2003) and 13 percent (in 2008) of children of mothers residing in communities that had a low proportion of mothers with at least secondary education died under the age of five while 11 percent (in 2003) and 9 percent (in 2008) of their counterparts in community that had high proportion of mothers with at least secondary level of education died before their fifth birthday ($p<0.05$).

A closer look at Tables 5.7.1 and 5.7.2 revealed that percentages of death in infancy (11.2% in 2003, 8.1% in 2008) and childhood (7.4% in 2003, 6.3% in 2008) were highest for children whose mothers were resident in communities with a low proportion of mothers who had hospital deliveries when compared with survival experience of children in communities that had a medium or high proportion of mothers who had hospital deliveries ($p<0.05$). Table 5.7.3 also indicated that, overall, percentage of death under the age of five was highest (17.7% in 2003, 13.9% in 2008) for children of mothers residing in communities with a low proportion of mothers who had hospital deliveries ($p<0.05$).

A consideration of bivariate relationship between community poverty level and infant/child mortality (Tables 5.7.1 to 5.7.3) showed that percentages of death in childhood (5.9% in 2003, 4.9% in 2008) were slightly higher for children of mothers residing in communities with high proportion of poor households, when compared with children raised in communities with low proportion of poor households. The bivariate relationship between community poverty and death in infancy does not reach statistical significance (Table 5.7.1); but, there exists a significant relationship between community poverty level and death in childhood ($p<0.05$).

The percentages of death in infancy (11.9% in 2003, 7.4% in 2008), childhood (7.6% in 2003, 5.3% in 2008, $p<0.05$) and between ages 0 and 5 (18.6% in 2003, 12.7% in 2008, $p<0.05$) were highest for children raised in communities with a low proportion of mothers who had prenatal care by a skilled provider. Unexpectedly, the relationship between community prenatal care by skilled provider and infant survival does not reach statistical significance; whereas it became significant once the child survives beyond age one.

With respect to proximity to health-care facility in the community, the data for both survey years indicated a slightly higher proportion of death (12.3% in 2003 and 7.6% in 2008) during the first year of life for children raised in communities that were far from a health facility ($p<0.05$). Table 5.7.2 showed that, overall, 17.5 percent (2003) and 12 percent (2008) of all children raised in communities far from a health facility died before the age of five ($p<0.05$).

Considering the relationship between the community infrastructure and infant and child survival, the results as presented in Tables 5.7.1 to 5.7.3 showed a significantly higher percentages of infant (11.8% in 2003, 7.8% in 2008), child (5.9% in 2003, 5.2% in 2008) and under-five deaths (17.0% in 2003, 12.6% in 2008), for children raised in communities with a low proportion of households with electric connection

($p<0.05$). In the same vein, a consideration of the relationship between infant/child survival and the proportion of households with piped water (as a source of drinking water) in a community revealed a higher percentage of infant (11.6% in 2003, 7.9% in 2008) and child death (5.4% in 2003, 4.4% in 2008) for children raised in communities with a low proportion of households with piped water ($p<0.05$). Table 5.7.3 showed that overall percentages of death for children raised in communities that had low proportion of households with piped water were 14.9 percent (2003) and 12.3 percent (2008) as against 10 percent (2003) and 9 percent (2008) for those raised in communities with a high proportion who had piped water in the community.

Table 5.7.3: Bivariate association between under-five mortality and community-level characteristics

Characteristics	(2003)			(2008)		
	Survival Status		P-value (χ^2)	Survival Status		P-value (χ^2)
	Alive	Dead		Alive	Dead	
Region of residence			0.0 (42.8)			0.0 (21.2)
North-central	88.2	11.8		90.0	10.0	
Northeast	83.3	16.7		87.5	12.5	
Northwest	84.0	16.0		86.8	13.2	
Southeast	89.1	10.9		88.7	11.3	
South-south	86.4	13.6		90.1	9.9	
Southwest	92.1	7.9		93.4	6.6	
Type of place of residence			0.0 (39.4)			0.0 (64.0)
Urban	89.8	10.2		92.0	8.0	
Rural	84.0	16.0		87.6	12.4	
Ethnic diversity			0.0 (13.2)			0.299 (1.2)
Homogenous	88.5	11.5		88.6	11.4	
Mixed	86.7	13.3		89.4	10.6	
Heterogeneous	84.3	15.7		88.5	11.5	
Community maternal level of education			0.0 (56.9)			0.0 (25.4)
Low	81.7	18.3		86.7	13.3	
Medium	87.8	12.2		89.7	10.3	
High	89.2	10.8		90.7	9.3	
Proportion with electric connection in the community			0.0 (33.3)			0.0 (11.8)
Low	83.0	17.0		87.4	12.6	
Medium	87.9	12.1		89.7	10.3	
High	88.4	11.6		90.1	9.9	
Proportion with piped water in the community			0.006(10.3)			0.0 (13.1)
Low	85.1	14.9		87.7	12.3	
Medium	84.9	15.1		91.0	9.0	
High	88.1	11.9		91.0	9.0	
Community prenatal care by skilled provider			0.0 (47.5)			0.0 (9.6)
Low	81.4	18.6		87.3	12.7	
Medium	88.5	11.5		89.5	10.5	
High	87.7	12.3		89.9	10.1	
Community hospital delivery			0.0 (57.7)			0.0 (49.7)
Low	82.3	17.7		86.2	13.9	
Medium	88.8	11.2		89.5	10.5	
High	89.4	10.6		92.1	7.9	
Community poverty			0.208(3.1)			0.032(3.5)
Low	86.8	13.2		89.7	10.3	
Medium	86.8	13.2		89.4	10.6	
High	85.2	14.8		88.1	11.9	
Distance to health facility			0.0 (21.4)			0.006 (7.5)
Big problem	82.5	17.5		88.1	11.9	
Not a big problem	87.2	12.8		89.4	10.6	

5.4 Summary of the chapter

This chapter addressed the levels, patterns and differentials of infant and child mortality in Nigeria. Generally, there were not substantial differences in infant and child mortality levels and patterns between 1999-2003 and 2004-2008 periods. Results from both datasets indicated that there were more deaths in infancy than in childhood. To estimate the levels of infant and child mortality, indirect estimation techniques were employed. Comparing Trussell and Palloni-Heligman variants of the Brass indirect estimation method, the latter variant seemed to yield a more plausible estimate than the former. This is because the estimates derived from the Palloni-Heligman variants were comparable to the directly calculated infant and child mortality rates. Besides, Palloni-Heligman variant of Brass technique seemed to yield more plausible expectation of life at birth.

Both variants indicated that infant and child mortality rates were generally higher for males than for females. Results suggest a reduction in mortality differentials between male and female children during the 1999-2003 and 2004-2008 periods. The estimated rates also suggest a decline in the probabilities of dying in childhood during the period under study. Both methods indicated that information collected on childhood mortality in both 2003 and 2008 NDHS were of reliable quality. This was confirmed by the pattern observed in the estimated rates. For instance, the probabilities of dying consistently increased with age of the child.

The INDEPTH estimates showed a consistent decrease in the probabilities of surviving as children's age increases and the probabilities of dying were generally higher for males than for females with gaps becoming wider as age increases.

Results also indicated a higher expectation of life at birth for females than for males. The results indicated a slight increase in expectation of life at birth for both males and females over the 1999-2003 and 2004-2008 periods.

The pattern of deaths by birth order showed that the proportion of first born children that died during childhood was lower compared to proportion that died during infancy. The results suggest that the survival chances of first order children tend to increase as children survive beyond age one.

As one would expect, women who had no formal education tend to suffer more children's death. As children survive beyond age one; virtually all the children of mothers who had tertiary education survived beyond age five. The pattern of infant and child deaths by place of delivery indicated a higher proportion of death in infancy and childhood for children delivered at home compared with those delivered at a health facility. Proportion of infant and child deaths was highest for Hausa/Fulani/Kanuri ethnic groups and lowest for Yoruba ethnic group.

Further, households with more CEB tend to have higher mortality relative to households with fewer CEB. Results in this chapter revealed the importance of household facilities such as toilet facility and electric connection and drinkable water, as households that lacked these facilities tend to experience higher infant and child deaths than the households that possessed such facilities. As expected, proportion of infant and child mortality was highest for households in the poorest wealth quintile and lowest for households in the richest wealth quintile. Percentage of infant and child death was highest for children whose mothers had never used contraception and lowest for children whose mothers were using modern contraceptive methods.

The proportion of infant and child deaths was highest in the North-east and North-west, and lowest in the South-east and South-west.

Findings suggest that the more heterogeneous a community was in terms of ethnic diversity the higher the proportion of infant and child death. This may be adduced to lack or less cohesion among residents in a heterogeneous community as opposed to much cohesion and togetherness in a homogenous community. However, a closer look at the results revealed that once a child survives beyond the first year of life, there exists no difference between the mortality experience of children in homogenous communities and those in heterogeneous communities.

A higher proportion of infant and child death was found among children of mothers residing in communities that had a low proportion of women who had at least secondary education. Uneducated mother who is surrounded by well educated women is likely to be positively influenced to use health-care facilities to enhance her children's survival chances.

Percentages of infant and child deaths were highest for children in the communities with low proportion with electric connection and low proportion with piped water. This finding suggests the importance of community infrastructure on children's survival. Percentages of infant and child death were also highest for children in communities that had low proportion of mothers who had prenatal care by a skilled provider and children in communities that had low proportion of mothers who had hospital delivery.

A careful look at the results of bivariate analyses suggests that there was a slight reduction in the proportion of infant and child death over the 1999-2003 and 2004-

2008 periods. Bivariate results also suggest that birth order, birth interval, child's size at birth (demographic factors) were more important in infancy than in childhood.

CHAPTER SIX

DETERMINANTS OF INFANT AND CHILD MORTALITY IN NIGERIA: A SURVIVAL ANALYSIS

6.0 Introduction

This chapter presents the determinants of infant and child mortality in Nigeria. The children survival curves (i.e. Kaplan-Meier estimates) are presented in this chapter. Also the effects of the individual-level, household-level and community-level factors on infant and child mortality (in the five years preceding the two surveys – NDHS 2003 and NDHS 2008) are presented in this chapter. To achieve this objective, Cox proportional hazard regression analysis was employed. Unadjusted and adjusted models are presented in Tables 6.1.1 to 6.1.6. To avoid repetition of analysis, further adjustments for the effects of variables at various levels are presented in Tables 7.1 to 7.6 (Chapter 7). Finally, summaries of findings from the multivariate analyses in this chapter are discussed.

6.1 Children survival functions

As presented in Table 5.1 (in Chapter 5), results from 2003 data indicated 842 under-five deaths (558 infant deaths, 284 childhood deaths) out of a total of 6,028 children analyzed. Similarly, out of a total sample of 28,647 children analyzed for 2008 dataset, 3,201 children died before reaching age five; with 2,042 and 1159 of these children dying in infancy and childhood respectively. Figure 6.1 (below) presents the child survival plots, showing the duration of survival since birth for all the children who died during the first 5 years of life. The figures showed the survival functions of the children between ages 0 and 59 months. The Kaplan-Meier estimates suggest that mortality risks within age 0 to 59 months were slightly higher and more profound in 2003 than in 2008. Comparing the two curves in Figures 5.1; while most under-five deaths occurred within the first year of life according to both 2003 and 2008 datasets, occurrence of under-five death was higher in 2003 than in 2008 as depicted by the frequent drops in the survival curves. It is also important to note that while Kaplan-Meier estimates from 2008 data indicated that under-five deaths spread over the entire period of 0 to 59 months, Kaplan-Meier estimates from 2003 data showed that the last under-five death reported in 2003 occurred at 52nd months. Further descriptions of the mortality risks among the children by selected characteristics are provided in Figures C1 to C40 in the appendix C. In addition, results of the proportional hazard tests for time-varying covariates are presented in appendix D

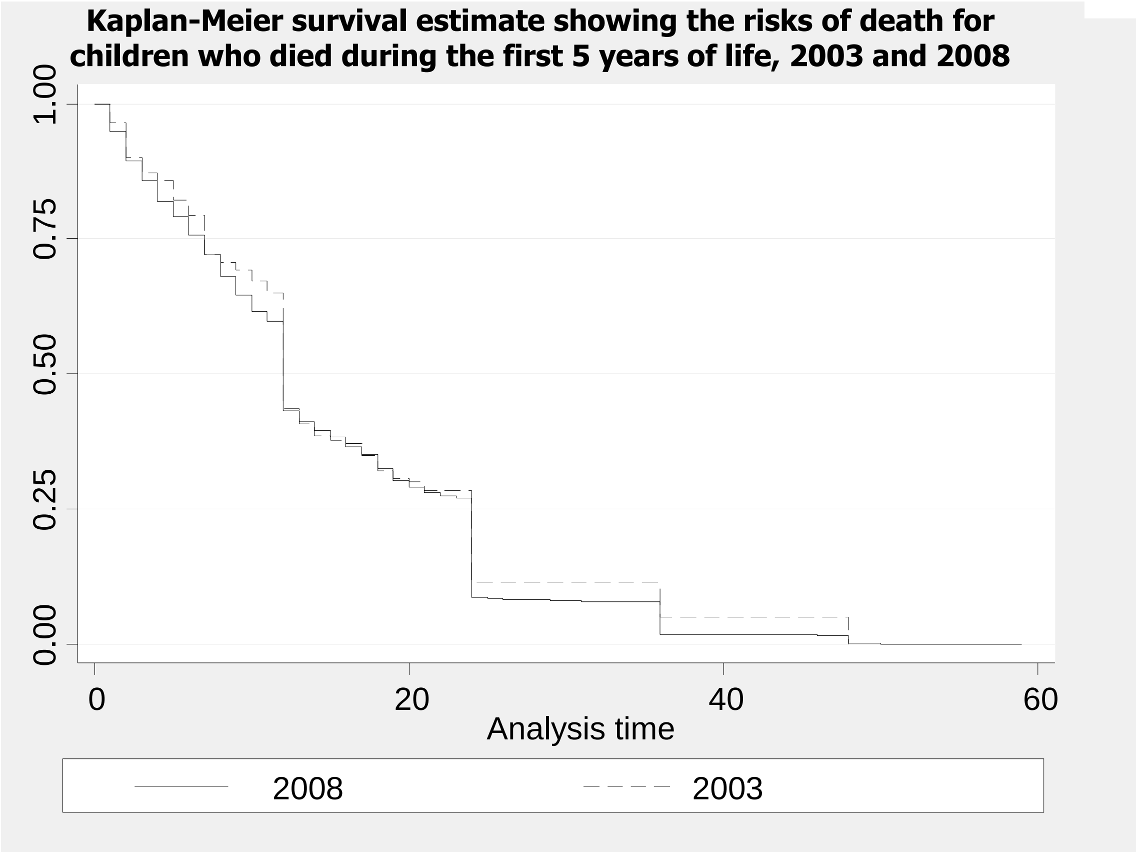

Figure 6.1: Children survival plots, Nigeria DHS 2003 and 2008

6.2 Effects of individual-level factors on infant and child mortality

The results of survival analysis are presented in Tables 6.1.1-6.1.6. In all, eighteen models were fitted to examine the risk factors of infant and child mortality at various levels of operation. Six models each were fitted for each of the 3 outcome variables. In sub-section 6.2, six models were fitted to examine the effects of individual-level factors on infant and child mortality. The first Model presents univariate hazard ratio examining relationship between individual-level factors and infant mortality. While Model 2 achieves similar purpose, it adjusted for the effects of various selected factors. Models 3 and 4 present the unadjusted and adjusted hazard ratios examining relationship between individual-level factors and child mortality. Finally, Models 5 and 6 respectively presents the univariate (i.e. unadjusted) and adjusted hazard ratios of under-five mortality

Model 1 in Table 6.1.2 (2008 NDHS) indicated a significant relationship between infant mortality and child's sex; as risks of death were 18% significantly lower for female infants when compared with their male counterparts ($p<0.05$). This result was consistent after adjusting for the effects of other variables. Models 4, 5, 6 indicated similar results; as risks of death were about 20% significantly lower for female children when compared with males ($p<0.05$). Although, 2003 data also indicated a lower risk of death for female children than for males, the result is not statistically significant.

A consideration of birth order in Models 1 and 5 showed that risks of death were about 20% significantly lower for children of birth order 2-4 compared to children of first birth order ($p<0.05$). Once adjustments were made for the effects of other factors in Models 2 and 6, the significance disappeared. Thus, adjusted and unadjusted hazard ratio using 2003 data (Table 6.1.1) indicated a significantly lower risk of death for children of birth order 2-4 compared to children of first order birth ($p<0.05$). Results from 2008 data revealed that all Models 1-6 (adjusted and unadjusted models) showed that the risks of death were about 50% significantly lower for children with preceding birth interval of 2 years or more compared with those with short birth interval of less than 2 years ($p<0.05$). Analysis of 2003 data also showed similar results as Models 1, 3, 5 and 6 indicated that risks of death were about 40% significantly lower for children who had preceding birth interval of 2 years or more compared to those with shorter birth intervals ($p<0.05$).

The results from 2003 and 2008 data showed a systematically higher risk of death for children whose size at birth was very small compared to children with larger size (Tables 6.1.1-6.1.2). This risk was more pronounced in infancy than in childhood as both 2003 and 2008 data indicated that the risks of dying for infants with very small size at birth was almost two-fold higher compared to their counterparts with larger size at birth ($p<0.05$). Unadjusted hazard ratios (both 2003 NDHS and 2008 NDHS data) indicated that increase in maternal education systematically reduces the risks of death both in infancy and in childhood ($p<0.05$). The more education a woman has, the lower the risks of her child dying young. For instance, Model 3 revealed that risks of death were 70% (2003 NDHS) and 60% (2008 NDHS) significantly lower for children whose mothers had secondary or higher education compared to the children of uneducated mothers ($p<0.05$). The adjusted hazard models showed similar results, but the significant association became attenuated or weakened.

Regarding the effects of mother's ethnic affiliation, unadjusted hazard ratio from 2003 NDHS data indicated the children of Yoruba mothers as significantly having the least hazards of dying either in infancy (HR: 0.54, $p<0.05$) or childhood (HR: 0.61, $p<0.05$). Both adjusted and unadjusted hazard ratio from 2008 NDHS data revealed that risks of death were significantly lower for children of Yoruba ethnic group (Hazard ratio ranging from 0.27 to 0.75) when compared with children of Hausa/Fulani/Kanuri mothers. Models 3-6 (Table 6.1.2) also showed that risks of deaths were significantly lower for children of Igbo mothers (HR ranging from 0.27-

0.60) and children of minority ethnic groups (HR ranging from 0.61-0.95) when compared with children of Hausa/Fulani/Kanuri ethnic groups ($p<0.05$).

Mother's older age at birth tend to reduce the hazards of the child dying either in infancy or during the first five years of life. For instance, 2008 NDHS data (Models 1, 2, 5 and 6; Table 6.1.2) showed that children born to mothers aged 25-34 years have on average 20-40% lower risks of dying in infancy (Models 1 and 2) or before age five (Models 5 and 6) compared to children born to younger mother's aged 15-24 ($p<0.05$). Results in Table 6.1.2 also showed that children born to mothers aged 35 years or older were having lower risks of dying in infancy (HR: 0.58, $p<0.05$) (Model 2). Analysis showed similar results with respect to mother's age at birth of the child with the risks of death basically reducing with increase in mother's age at birth of the child.

Table 6.1.1: Effects of individual-level factors on infant and child mortality among children who were born in the five-year period preceding the surveys, (2003 NDHS)

Characteristics	Model 1 (UHR)	Model 2 (MHR)	Model 3 (UHR)	Model 4 (MHR)	Model 5 (UHR)	Model 6 (MHR)
Child's sex						
Male	1	1	1	1	1	1
Female	0.87	0.89	1.08	0.96	0.94	0.91
Birth order						
First birth	1	1	1	1	1	1
2-4	0.70*	0.44*	0.92	0.72	0.76*	0.52*
5+	1.01	0.62	1.29	0.76	1.09	0.67
Preceding birth interval						
< 2 years	1	1	1	1	1	1
2 years	0.63*	0.70	0.63*	0.62	0.63*	0.68*
Birth size						
Very large/larger than average	1	1	1	1	1	1
Average	1.13	1.01	0.94	0.93	1.05	0.98
Smaller than average/very small	1.69*	1.70*	1.19	1.01	1.51*	1.48*
Maternal education						
None	1	1	1	1	1	1
Primary	0.94	1.33	0.60*	1.30	0.81*	1.33*
Secondary/Tertiary	0.56*	0.77	0.30*	0.54	0.46*	0.72
Maternal current age						
15-24 years	1	1	1	1	1	1
25-34 years	0.86	0.82	0.90	1.11	0.87	0.91
35+	1.08	1.18	1.31	1.38	1.15	1.21
Maternal age at first birth						
<18 years	1	1	1	1	1	1
18+	0.85	1.18	0.54*	0.76	0.74*	1.08
Mothers' age at birth						
<18	1	1	1	1	1	1
18-34	0.70*	0.77	0.66*	1.24	0.69*	0.91
35+	0.82	0.81	0.95	1.68	0.87	1.05
Mother's marital status						
Never married	1	1	1	1	1	1
Currently married	1.46	1.40	1.76	0.48	1.55	1.55
Previously married	1.63	1.61	2.93	2.41	2.01*	2.01*
Received prenatal care						
No	1	1	1	1	1	1
Yes	0.63*	0.56*	0.40*	0.50*	0.55*	0.54*
Place of delivery						
Home	1	1	1	1	1	1
Health facility	0.66*	1.01	0.38*	1.18	0.55*	1.04
Ethnicity						
Hausa/Fulani/Kanuri	1	1	1	1	1	1
Igbo	0.90	1.47	0.23*	0.33	0.62*	1.02
Yoruba	0.54*	1.14	0.31*	1.11	0.46*	1.09
Others	1.01	1.82*	0.57*	0.80	0.83*	1.40*

Religion						
Catholic/Other Christians	1	1	1	1	1	1
Muslim	0.96	1.06	1.39	1.35	1.06	1.12
Others	1.06	0.96	2.49*	2.17*	1.37*	1.22
Mother's occupation						
Not working	1	1	1	1	1	1
Professional	0.75	1.07	0.25*	0.32	0.57*	0.86
Sales	0.93	0.84	0.92	0.98	0.93	0.89
Manual	0.85	0.95	0.95	1.02	0.89	0.97
Contraceptive Use						
Never used	1	1	1	1	1	1
Used traditional method	0.50*	0.51*	0.58	0.04	0.53*	0.66
Used modern method	0.51*	0.50*	0.55*	0.84	0.52*	0.60*

UHR- univariate hazard ratio, MHR –multivariate hazard ratio, *p<0.05

The effect of mother's marital status is relevant, according to NDHS 2003 and NDHS 2008 data, as children of the previously married mothers were having a risk of dying young that is about two-fold (hazard ratio ranging from 1.51 to 2.63) higher than the risk of death for children of the unmarried mothers. The effect of marital status was more pronounced during childhood, as analysis of 2008 data (Models 3 and 4) revealed that the risks of dying between ages 1 and 5 were 3 times (HR: 3.08, $p<0.05$) higher for children of the previously married mothers compared to children of the unmarried ($p<0.05$). Table 6.1.2 showed that the risks of infant and child mortality were not statistically significant for the children of the currently married women.

As regards the effects of the use of health care services, accessing a prenatal care was significantly associated with child survival. For instance, analysis of 2003 and 2008 data revealed that children whose mothers received prenatal health care were having hazards of dying in infancy or childhood that was about 30-60% lower than those of their counterparts whose mothers received no prenatal care ($p<0.05$). In the same vein, Tables 6.1.1 and 6.1.2 revealed that children delivered at a health facility were on average having 34-62% lower hazards of dying in infancy or childhood compared to children delivered at home ($p<0.05$).

Regarding the effects of religious affiliation, results from 2008 data (Table 6.1.4) indicated a higher risk (HR: 1.81, $p<0.05$) of dying during childhood for children from Muslim households compared to children from Christian households. This risk became attenuated after adjusting for the effects of other factors in Model 4 Table 6.1.4, though the risks remained significant (HR: 1.18, $p<0.05$). Analysis of 2003 data showed different results as there was no significant difference in the risks of death between children from Muslim households and children from Christian households; rather 2003 data showed that the risks of dying in childhood were more than two-folds higher for children from households whose religious affiliation was traditional or other religions.

With respect to the effects of contraceptive use on child survival, analysis of both 2003 and 2008 data indicated that the risks of death were on average 40-50% (Table 6.1.3) and 30-57% (Table 6.14) significantly lower for children whose mothers were using modern contraceptives relative to children whose mothers were using no method ($p<0.05$). This result remained consistently significant after adjusting for the effects of other factors.

Table 6.1.2: Effects of individual-level factors on infant and child mortality among children who were born in the five-year period preceding the surveys, (2008 NDHS)

Characteristics	Model 1 (UHR)	Model 2 (MHR)	Model 3 (UHR)	Model 4 (MHR)	Model 5 (UHR)	Model 6 (MHR)
Child's sex						
Male	1	1	1	1	1	1
Female	0.82*	0.81*	0.97	0.75*	0.87*	0.79*
Birth order						
First birth	1	1	1	1	1	1
2-4	0.79*	0.91	1.08	1.00	0.88*	0.92
5+	1.06	1.24	1.61*	1.07	1.21*	1.17
Preceding birth interval						
< 2 years	1	1	1	1	1	1
2 years	0.52*	0.51*	0.54*	0.65*	0.53*	0.55*
Birth size						
Very large/larger than average	1	1	1	1	1	1
Average	1.13*	1.09	1.05	1.03	1.10*	1.07
Smaller than average/very small	1.64*	1.48*	1.27*	0.93	1.50*	1.30*
Maternal education						
None	1	1	1	1	1	1
Primary	0.93	0.91	0.72*	1.15	0.85*	0.97
Secondary/Tertiary	0.75*	0.86	0.40*	1.06	0.61*	0.92*
Maternal current age						
15-24 years	1	1	1	1	1	1
25-34 years	0.77*	0.61*	1.00	1.56*	0.84*	0.78*
35+	0.95	0.58*	1.27*	2.41*	1.05	0.90
Maternal age at first birth						
<18 years	1	1	1	1	1	1
18+	0.83*	1.04	0.69*	0.85	0.78*	0.97
Mothers' age at birth						
<18	1	1	1	1	1	1
18-34	0.61*	0.79	0.71*	1.07	0.64*	0.87
35+	0.76*	1.15	0.80	0.95	0.77*	1.05
Mother's marital status						
Never married	1	1	1	1	1	1
Currently married	1.25	0.96	1.59	0.65	1.35	0.86
Previously married	1.74*	1.51	3.08*	2.63*	2.15*	1.88*
Received prenatal care						
No	1	1	1	1	1	1
Yes	0.87*	0.91	0.46*	0.65*	0.72*	0.81*
Place of delivery						
Home	1	1	1	1	1	1
Health facility	0.91	0.91	0.42*	0.65*	0.71*	1.14
Ethnicity						
Hausa/Fulani/Kanuri	1	1	1	1	1	1
Igbo	1.03	1.12	0.48*	0.65	0.79*	0.95
Yoruba	0.61*	0.75	0.27*	0.34*	0.46*	0.60*
Others	1.03	1.12	0.61*	0.67*	0.85*	0.95*
Religion						
Catholic/Other Christians	1	1	1	1	1	1
Muslim	1.02	0.85*	1.81*	1.18*	1.24*	0.95
Others	1.23	0.99	1.07	0.72	1.19	0.90
Mother's occupation						
Not working	1	1	1	1	1	1

Professional	0.75	0.91	0.42*	1.00	0.62*	0.93
Sales	1.01	1.03	0.99	1.04	1.00	1.04
Manual	1.13*	1.08	0.85*	0.89	1.02	1.01
Contraceptive Use						
Never used	1	1	1	1	1	1
Used traditional method	0.57*	0.63*	0.30*	0.54*	0.47*	0.60*
Used modern method	0.66*	0.70*	0.43*	0.59*	0.57*	0.66*

UHR- univariate hazard ratio, MHR –multivariate hazard ratio, *p<0.05

6.3 Effects of household-level factors on infant and child mortality

Considering the importance of household-level factors on child survival, this sub-section presents the effects of household-level factors on infant and child mortality in Nigeria. Six models (Tables 6.1.3 and 6.1.4) were fitted to examine the effects of household-level factors on infant and child mortality. First Model contains the univariate hazard ratios of the effects of household-level factors on infant mortality. Model 2 presents the adjusted hazard ratios of the effects of household-level factors on infant mortality. While Model 3 presents the univariate hazard ratios examining relationship between household-level factors and child mortality, Model 4 achieves the same objective as in Model 3, but adjusted for the effect of various selected household-level factors. Models 5 and 6 respectively present the unadjusted and adjusted hazard ratios examining relationship between under-five mortality and selected household-level factors.

At the household level, analysis of 2003 NDHS and 2008 NDHS data showed that number of CEB was significantly associated with infant and child mortality ($p<0.05$). It is also shown that risks of dying in infancy or childhood tend to significantly increase with increasing number of CEB in a household. For instance, children from households that had CEB of 5 or more children were on average having 47-66% (2003) and 29-93% (2008) higher risks of dying young when compared to children from households with CEB of 2 or less ($p<0.05$).

Table 6.1.3: Effects of household-level factors on infant and child mortality among children who were born in the five-year period preceding the surveys, (2003 NDHS)

Characteristics	Model 1 (UHR)	Model 2 (MHR)	Model 3 (UHR)	Model 4 (MHR)	Model 5 (UHR)	Model 6 (MHR)
Children ever born						
< 3 children	1	1	1	1	1	1
3-4 children	1.20	1.17	1.50*	1.48*	1.29*	1.26*
5+	1.56*	1.47*	1.89*	1.62*	1.66*	1.52*
Family structure						
Monogamous	1	1	1	1	1	1
Polygynous	1.19	1.09	1.59*	1.22	1.30*	1.14
Household had electricity						
No electricity	1	1	1	1	1	1
Has electricity	0.56*	0.81	0.65*	0.91	0.59*	0.85
Type of household toilet facilities						
Flush toilet	1	1	1	1	1	1
Pit latrine	2.20*	1.48	3.73*	1.36	2.62*	1.44
Others	5.48*	4.35*	5.42*	3.56*	5.53*	4.19*
None	2.90*	1.60	3.07*	1.04	2.96*	1.39
Household Source of drinking water						
Piped	1	1	1	1	1	1
Protected well	1.44*	0.90	1.31	0.83	1.39*	0.88
River/stream	1.62*	1.02	0.96	0.89	1.35*	0.98
Others	1.04	0.81	0.58	0.55	0.85	0.71
Wealth quintile						
Poorest	1	1	1	1	1	1
Poorer	1.06	1.08	1.13	0.95	1.08	1.04
Average	0.75*	0.92	0.92	0.82	0.81*	0.88
Richer	0.53*	0.73	0.68*	0.63	0.58*	0.69*
Richest	0.40*	0.78	0.31*	0.37*	0.37*	0.61*
UHR- univariate hazard ratio, MHR –multivariate hazard ratio, *p<0.05						

The results showed a significantly higher risk of death for children of mothers from polygynous households compared to those from monogamous families. Results from 2003 data indicated higher hazards of dying in childhood (H.R: 1.59, $p<0.05$, in Model 3 Table 6.1.3) or before age five (HR: 1.30, $p<0.05$, in Model 5 Table 6.1.3) for children of mothers in a polygynous union, relative to mortality risks of children from monogamous households. Analysis of 2003 NDHS data indicated insignificant relationship between family structure and infant and child mortality after adjusting for the effects of other covariates. However, results from analysis of 2008 data revealed that both adjusted and unadjusted models (Table 6.1.4) indicated that risks of death in infancy or childhood were on average 12-59% higher for children of mothers in polygynous unions compared with those from monogamous marriages.

Findings from analysis of 2003 and 2008 NDHS data showed that hazards of dying in infancy or childhood for children raised in households that had electric connection were on average 15-44% (Table 6.1.3) and 8-37% (Table 6.1.4) lower relative to children from households that lacked electric connection. Similarly, type of household toilet facility showed statistical significance for the risks of infant and child mortality; as the risks of death were on average two to three-folds (2003 NDHS data in Table 6.1.3) and about two to four-folds (2008 NDHS data in Table 6.1.4) significantly higher for children from households that had a pit toilet as type of toilet facility, relative to children whose households had a flush toilet.

In the same vein, risks of death were higher for children from households that had well or stream as source of drinking water when compared to mortality experience of children from households whose source of drinking water was piped borne water.

This risk was more pronounced in infancy than in childhood. For instance, results showed that risks of dying in infancy were 62% (Model 1 Table 6.1.3) and 45% (Model 1 Table 6.1.4) significantly higher for children from households whose source of drinking water was river/stream relative to children from households with piped borne water. This significant effect disappeared once adjustments for other factors were made in the analysis.

Analysis of both 2003 and 2008 NDHS data showed that the effect of household wealth quintile on child survival seems to be more profound during childhood than in infancy. For instance, risks of dying in infancy were 60% (Model 1 Table 6.1.3), 39% (Model 1 Table 6.1.4) lower for children from the richest household compared to those from the poorest households. Adjusted hazard ratios in Model 2 Table 6.1.3 and Model 2 Table 6.1.4 indicated consistent significant results, though the risks became reduced. On the other hand, 2003 and 2008 data showed that the risks of dying during childhood were 69% (Model 3 Table 6.1.3 – 2003 data), 63% (Model 4 Table 6.1.3 – 2003 data) 70% (Model 3 Table 6.1.4 – 2008 data), and 48% (Model 4 Table 6.1.4 – 2008 data) lower for children from of mothers in households in the richest wealth quintile relative to children from households in poorest wealth quintile.

Table 6.1.4: Effects of household-level factors on infant and child mortality among children who were born in the five-year period preceding the surveys, 2008 NDHS

Characteristics	Model 1 (UHR)	Model 2 (MHR)	Model 3 (UHR)	Model 4 (MHR)	Model 5 (UHR)	Model 6 (MHR)
Children ever born						
< 3 children	1	1	1	1	1	1
3-4 children	1.02	1.03	1.47*	1.41*	1.15*	1.14*
5+	1.36*	1.29*	2.29*	1.93*	1.62*	1.48*
Family structure						
Monogamous	1	1	1	1	1	1
Polygynous	1.18*	1.07	1.59*	1.20*	1.32*	1.12*
Household had electricity						
No electricity	1	1	1	1	1	1
Has electricity	0.76*	0.91	0.63*	0.94	0.71*	0.92
Type of household toilet facilities						
Flush toilet	1	1	1	1	1	1
Pit latrine	1.48*	0.91	0.42*	1.00	0.62*	1.18
Others	1.47*	1.03	0.99	1.04	1.00	1.02
None	1.42*	1.08	0.85*	0.89	1.02	0.94
Household Source of drinking water						
Piped	1	1	1	1	1	1
Protected well	1.16	1.06	1.29	1.11	1.20*	1.08
River/stream	1.45*	1.18	1.61*	1.11	1.51*	1.16
Others	1.30*	1.29	1.09	1.18	1.23*	1.26*
Wealth quintile						
Poorest	1	1	1	1	1	1
Poorer	1.02	1.03	0.89	0.84*	0.97	0.95
Average	0.91	0.95	0.77*	0.78*	0.85*	0.88*
Richer	0.80*	0.89	0.53*	0.60*	0.69*	0.77*
Richest	0.61*	0.75*	0.30*	0.52*	0.48*	0.66*

UHR- univariate hazard ratio, MHR –multivariate hazard ratio, *p<0.05

6.4 Effects of community-level compositional factors on infant and child mortality

Having established in the literature that community-level compositional factors tend to influence child survival, this sub-section presents the influences of community contextual factors on infant and child mortality in Nigeria. The results of the six models (Tables 6.1.5 and 6.1.6) fitted purposely to examine the effects of community-level factors on infant and child mortality, are presented in this sub-section. Model 1 presents the univariate hazard ratio – that is the unadjusted hazard ratios of the effects of community-level factors on infant mortality. Model 2 achieves similar purpose, but adjusted for the effect of the various selected community-level factors. Model 3 presents the univariate hazard ratios examining the effect of community-level factors on child mortality while Model 4 presents the adjusted hazard ratios examining the effects of community-level factors on child mortality. While Model 5 presents the univariate hazard ratio examining the relationship between under-five mortality and the selected community-level factors, Model 6 achieves similar objective after adjusting for the effect of the selected community-level factors.

Tables 6.1.5 and 6.1.6 show that the risks of dying in infancy or childhood were lowest in the South-west and highest in the North-east. Analysis of 2003 NDHS data indicated that hazards of dying in the first year of life were 75% (North-east), 69% (North-west), 67% (South-south), and 47% (North-central) significantly higher relative to children of mothers residing in South-west region ($p<0.05$). After adjusting for the effects of other community-level factors in Model 2 (Table 6.1.5), the significance disappeared. Analysis of 2008 data (Model 1 Table 6.1.6) also showed similar results, and the risks of dying in infancy had reduced in all the regions over the 1999-2003 and 2004-2008 periods. A closer look at Tables 6.1.5 and 6.1.6 revealed that the variations in the risks of death across regions were more pronounced during childhood. For instance, analysis of 2003 and 2008 data indicated that risks of death during childhood were about four-fold higher for children of mothers residing in the North-east and North-west compared to children of mothers in the South-west ($p<0.05$). Even, after adjusting for the effect of other community-level factors the risks of death during childhood remained as high as two-fold higher for children of mothers in the North-east and North-west compared to children of mothers residing in the South-west ($p<0.05$).

The results further showed consistently higher risks of death for children of mothers residing in rural areas compared to those in the urban centers. Results of unadjusted model from 2003 data (Models 1 and 3 Table 6.1.5) indicated that risks of dying in infancy (HR: 1.55, $p<0.05$) or childhood (HR: 1.78, $p<0.05$) were significantly higher for children of mothers resident in rural areas relative to children of mothers in the urban centers ($p<0.05$). These significant effects disappeared after adjusting for the effects of other community-level variables. Although, the variation in the risks of infant and child mortality between rural and urban areas had reduced according to 2008 data, the analysis still showed consistently significantly higher risk of death for children in the rural areas than for those in the urban centers. For instance, adjusted and unadjusted Model (Table 6.1.6) showed that children from rural areas were having 32-49% higher hazards of dying before the age of five relative to children in the urban centers ($p<0.05$).

Table 6.1.5: Effects of community-level factors on infant and child mortality among children who were born in the five-year period preceding the surveys, (2003 NDHS)

Characteristics	Model 1 (UHR)	Model 2 (MHR)	Model 3 (UHR)	Model 4 (MHR)	Model 5 (UHR)	Model 6 (MHR)
Region of residence						
Southwest	1	1	1	1	1	1
North-central	1.47*	1.04	1.70	1.23	1.53*	1.09
Northeast	1.75*	1.10	3.60*	2.33*	2.19*	1.39
Northwest	1.69*	1.15	3.40*	2.11*	2.10*	1.37
Southeast	1.50	1.50	1.13	1.09	1.41	1.43
South-south	1.67*	1.31	2.06*	1.85	1.77*	1.45*
Type of place of residence						
Urban	1	1	1	1	1	1
Rural	1.55*	1.01	1.78*	1.36	1.60*	1.12
Ethnic diversity						
Homogenous	1	1	1	1	1	1
Mixed	1.13	1.17	1.23	0.97	1.16	1.10
Heterogeneous	1.46*	1.66*	1.28	1.31	1.40*	1.53*
Community maternal level of education						
Low	1	1	1	1	1	1
Medium	0.67*	0.78	0.62*	0.84	0.65*	0.80*
High	0.67*	0.78	0.41*	0.55*	0.57*	0.70*
Proportion with electric connection in the community						
Low	1	1	1	1	1	1
Medium	0.66*	0.78	0.77	0.98	0.69*	0.83
High	0.60*	0.65*	0.80	0.94	0.66*	0.74*
Proportion with piped water in the community						
Low	1	1	1	1	1	1
Medium	1.01	1.14	1.01	1.05	1.01	1.10
High	0.73*	0.98	0.88	1.14	0.78*	1.03
Community prenatal care by skilled provider						
Low	1	1	1	1	1	1
Medium	0.61*	0.73*	0.58*	0.72	0.69*	0.73*
High	0.72*	0.83	0.51*	0.56*	0.65*	0.74*
Community hospital delivery						
Low	1	1	1	1	1	1
Medium	0.74*	1.04	0.43*	0.90	0.62*	0.99
High	0.62*	0.86	0.50*	1.32	0.58*	0.96
Community poverty						
Low	1	1	1	1	1	1
Medium	0.90	1.05	1.26	1.37	1.00	1.15
High	0.98	1.40*	1.52*	1.65*	1.12	1.50*
Distance to health facility						
Big problem	1	1	1	1	1	1
Not a big problem	0.65*	0.84	0.85	1.10	0.71*	0.91

UHR- univariate hazard ratio, MHR –multivariate hazard ratio, *p<0.05

According to NDHS 2003 data, ethnic diversity showed a significant effect for the risks of infant and child mortality. Results as shown in Table 6.1.5 indicated that children born or raised in an ethnically heterogeneous community were having elevated risks of dying in the first year of life (i.e. 46-66% higher risks of death) compared to mortality risks of children in an ethnically homogenous community ($p<0.05$). Also, children in heterogeneous communities were having around 40-53% higher risk of dying before age five compared to children in homogenous communities (Table 6.1.5), ($p<0.05$). Thus, results from NDHS 2008 data indicated no significant difference in the risks of death for children living in heterogeneous communities and those living in homogenous ones.

Community level of education appears to play a significant role in child survival according to 2003 data, as risks of dying in infancy or childhood were on average 33-59% significantly lower for children whose mothers were residing in communities with a high proportion of mothers who had secondary or higher education (Table 6.1.5), ($p<0.05$). Analysis of 2008 NDHS data (Table 6.1.6) showed a similar result, but the significant effects of community education disappeared after adjustments were made for other community-level factors.

Effects of neighborhood infrastructures such as electricity and drinkable water seem more pronounced in infancy than in childhood. For instance, results from 2003 data (Table 6.1.5) indicated about 40% lower hazards of dying in the first year of life (HR: 0.60, $p<0.05$) for children of mothers residing in communities that had a high proportion of households with electric connection relative to children of mothers in communities with a low proportion of households with electric connection. Results from 2008 data showed a similar result, but became statistically insignificant after adjusting for the effects of other factors. In the same vein, 2008 data indicated that risks of dying during the first year of life were 16-26% lower for children of mothers resident in communities that had a high proportion of households with piped borne water ($p<0.05$).

Health care context seemed to play a key role in child survival, both during infancy and childhood. Analysis of 2003 and 2008 data (Models 1, 3, 5, Tables 6.1.5 and 6.1.6) showed that children of mothers residing in a community with a high proportion of mothers who had hospital delivery were having 28-61% lower risks of dying in infancy or childhood when compared with children whose mothers were residing in communities with a low proportion of mothers who had hospital delivery ($p<0.05$). After adjusting for the effects of other factors, the results remained significant according to 2008 data; but using 2003 data, the significant effect disappeared. Similarly, living in a community with a high proportion of mothers who had a prenatal care by a skilled provider tends to significantly reduce the risks of dying during infancy or childhood (Tables 6.1.5 and 6.1.6), ($p<0.05$). In addition, living in a community where distance to a health facility was not a problem was significantly associated with lower risks of dying particularly during infancy (Model 1, Tables 6.1.5 and 6.1.6), ($p<0.05$). The results further showed that the effect of community poverty was more pronounced in childhood than in infancy. Communities with a high proportion of mothers living in poor households were having significantly increased risks of child mortality. For instance, analysis of 2003 and 2008 data indicated that the risks of dying during childhood were 52-65% (Models 3 and 4, Table 6.1.5 – 2003 data), and 32-40% (Models 3 and 4, Table 6.1.6 – 2008 data) higher for children whose mothers were residing in communities with a high proportion of mothers in poor households ($p<0.05$).

Table 6.1.6: Effects of community-level factors on infant and child mortality among children who were born in the five-year period preceding the surveys, 2008 NDHS

Characteristics	Model 1 (UHR)	Model 2 (MHR)	Model 3 (UHR)	Model 4 (MHR)	Model 5 (UHR)	Model 6 (MHR)
Region of residence						
Southwest	1	1	1	1	1	1
North-central	1.37*	1.10	2.03*	1.65*	1.53*	1.23*
Northeast	1.54*	1.16	3.19*	2.29*	1.93*	1.42*
Northwest	1.44*	1.12	4.00*	2.48*	2.03*	1.46*
Southeast	1.66*	1.57*	1.99*	1.83*	1.74*	1.6*
South-south	1.42*	1.26*	1.82*	1.53*	1.52*	1.32*
Type of place of residence						
Urban	1	1	1	1	1	1
Rural	1.35*	1.12	1.81*	1.32*	1.49*	1.32*
Ethnic diversity						
Homogenous	1	1	1	1	1	1
Mixed	0.91	0.95	0.96	1.03	0.92	0.98
Heterogeneous	1.09	1.03	0.87*	0.95	1.00	1.00
Community maternal level of education						
Low	1	1	1	1	1	1
Medium	0.87*	0.90	0.67*	1.05	0.79*	0.95
High	0.86*	0.92	0.53*	0.96	0.72*	0.93
Proportion with electric connection in the community						
Low	1	1	1	1	1	1
Medium	0.92	1.04	0.74*	1.06	0.85*	1.04
High	0.82*	0.94	0.75*	0.97	0.79*	0.95
Proportion with piped water in the community						
Low	1	1	1	1	1	1
Medium	0.64*	0.71*	0.93	1.29	0.74*	0.89
high	0.74*	0.84*	0.75*	0.87	0.74*	0.85
Community prenatal care by skilled provider						
Low	1	1	1	1	1	1
Medium	1.00	1.19*	0.66*	0.98	0.86*	1.10*
High	0.93	0.89*	0.64*	0.97	0.81*	0.88*
Community hospital delivery						
Low	1	1	1	1	1	1
Medium	0.91	1.89	0.62*	0.82*	0.79*	0.87*
High	0.72*	0.73*	0.39*	0.62*	0.58*	0.69*
Community poverty						
Low	1	1	1	1	1	1
Medium	1.01	1.08	1.12	1.17	1.04	1.12*
High	1.04	1.15	1.32*	1.40*	1.13*	1.24*
Distance to health facility						
Big problem	1	1	1	1	1	1
Not a big problem	0.90*	1.00	0.95	1.07	0.92*	1.02

UHR- univariate hazard ratio, MHR –multivariate hazard ratio, *p<0.05

6.5 Summary of the Chapter

This chapter examined the determinants of infant and child mortality at individual-, household-, and community-levels in Nigeria over the 1999-2003 and 2004-2008 periods. Cox proportional hazard regression analysis was employed to achieve this objective. Also, using Kaplan-Meir survival estimates, graphical representations of children's survival functions were presented for the study samples in 2003 and 2008 NDHS data; and by important selected characteristics (in appendix C).

This chapter found that risks of dying during infancy or childhood were significantly lower for females than for males. This finding confirms the biological theory that stresses male disadvantage in early life (Boco, 2010). Children of birth order 2-4 had lower risks of death compared to children of first order birth. This indicates higher risks of dying young for first born children. As expected, findings indicated lower risks of death in infancy or childhood for children with preceding birth interval of 2 years or longer. Results from both datasets showed a systematically higher risk of death for children whose size at birth was very small compared to children with larger size at birth. Low birth weight has been regarded as one of the strongest predictor of infant mortality (Hack *et al.*, 2002; Horbar *et al.*, 2002; Stoll *et al.*, 2004).

Results revealed that the risks of death in infancy and childhood tend to reduce with increasing maternal education. This is an expected result, considering that as maternal education increases there is likelihood for increased or enhanced social and economic opportunities that could lead to better health outcomes for women and their children. Results also showed that children of Yoruba mothers were having the lowest risks of dying in infancy or childhood while children of Hausa/Fulani/Kanuri ethnic groups had the highest risks of infant and child mortality.

Further, findings in this chapter confirmed the negative hypothesis of polygyny, as results revealed that children of mothers from polygynous unions were having significantly higher risk of infant and child death than their counterparts from monogamous unions.

Household amenities such as electricity, drinkable water and type of toilet facility were established in this chapter as important determinants of infant and child mortality in Nigeria; with risks of death in infancy or childhood significantly higher for children raised in the households that lacked such facilitates. Meanwhile, once adjustments for other factors were made, the significance of these items seemed to wane; thereby suggesting that the presence of other factors such as improved wealth, education etc., may offset for non-availability of electricity and good drinking water.

Results also indicated a negative relationship between household wealth quintile and infant and child mortality, with children of mothers in the poorest households having the highest risks of death in infancy or childhood and children in the richest households having the lowest risks. The results suggest that the effect of household wealth on child survival seemed to be more profound during childhood than in infancy.

Children of Muslim mothers had higher risks of dying during childhood relative to children of Catholic/Christian mothers. Though results from 2003 data revealed that there was no significant difference in the risks of death between Muslim and

Christian children, results from both datasets indicated lower risks of death for children of Christian mothers compared to other religions.

Results further indicated contraceptive use as an important predictor of children survival. Results from both datasets indicated that the risks of death were significantly lower for children whose mothers were using modern contraceptive method compared to their counterparts whose mothers were using no method. This suggests the importance of contraceptive use for the purpose of child spacing or limiting.

Considering the community contextual factors, findings from both 2003 and 2008 surveys indicated the region of residence as an important community-level covariate. Results revealed that variations in the risks of death across regions were more pronounced during childhood than in infancy. Results also revealed that, between 2003 and 2008, the risks of dying young had slightly reduced in all the regions. Although, in term of infant and child mortality reduction, findings suggest that not much progress was made during the period under study. Previous study by Lyken et al (2009) had earlier established that countries in the sub-Saharan Africa are not making sufficient progress towards the attainment of Millennium Development Goal four.

As would be expected, risks of death were higher in rural areas compared to urban settings. The significant effects of place of residence on children survival disappeared after adjusting for the effects of other community-level variables such as community education, community infrastructures etc. This suggests the importance of factors such as community education, access to drinkable water in the community, access to health care services etc., in reducing infant and child mortality risks even in the rural areas. Results further revealed that living in an ethnically heterogeneous community tends to increase the risks of dying in the first year of life compared to living in an ethnically homogenous community.

Community level of education appears to play an important role in child survival. Risks of dying in infancy or childhood were significantly lower for children whose mothers were residing in communities with a high proportion of mothers who had at least secondary education compared to those in communities that had a low proportion of mothers who had at least secondary education.

Neighbourhood infrastructures such as electricity and drinkable water were established as important covariates influencing infant and child mortality. Findings suggest that neighbourhood infrastructures were more important in infancy than in childhood during the 1999-2003 and 2004-2008 periods.

Results established health care context as important predictor of infant and child mortality during the period under study. Children of mothers who reside in communities with a high proportion of mothers who had hospital delivery were having lower risks of death in infancy and childhood compared with their counterparts whose mothers were residing in communities with a low proportion of mothers who had a hospital delivery. In the same vein, living in communities with a high proportion of mothers who had a prenatal care by skilled medical personnel lowers the risks of infant and child mortality. Proximity to a health-care facility was also found to significantly increase children's survival chances, particularly during infancy.

Findings in this chapter further established that poverty concentration within a community was an important predictor of infant and child mortality. Communities with a high proportion of mothers living in poor households had higher risks of infant and child mortality compared to communities with a low concentration of poor households.

Further adjustments for the effects of variables at various levels of operation were done and presented in the next chapter (Chapter 7).

CHAPTER SEVEN

EFFECTS OF CONTEXTUAL DETERMINANTS ON REGIONAL VARIATIONS IN INFANT AND CHILD MORTALITY IN NIGERIA – A MULTILEVEL ANALYSIS

7.0 Introduction

Having observed variations in infants and child mortality across the six regions of Nigeria in the previous chapters, the extent to which the contextual determinants explain these variations was examined in this chapter. Using multilevel Cox proportional hazards analysis, the distributions of the child-level, mother-level and community-level characteristics were examined by region of residence in order to assess how much of the observed regional variations in infant and child mortality were attributed to the individual-level compositional and community-level factors.

To examine how regional variation was built up from variations arising from various levels (child-level, mother-level and community-level); separate analysis was done examining the relationships among infant/child mortality and characteristics at various levels of operations. Generalized linear and latent mixed models (GLLAMM, downloadable program and implementable in Stata version 11.1) were used to conduct all the multilevel analyses. Fixed effects and random effects which are important concepts in multilevel analysis were employed in results interpretation. While fixed effects are used to model associations, random effects are useful in modeling variations (Merlo, Chaix, Ohlsson*, et al.*, 2005; Merlo, Chaix, Yang*, et al.*, 2005). Conventionally, measures such as regression coefficients, odds ratios, and hazard ratios are useful measures of association, but these give no information on the health variations within and between populations. Thus in multilevel modeling, measures of variations such as variance partition coefficient (or intra-class correlation) and proportional change in variance are good measures that provide good understanding of contextual determinants of individual health (Merlo, Chaix, Yang, et al., 2005). In this study, measures of variation represent the extent to which children raised in the same neighbourhood or community are exposed to the same situations such as availability (or non-availability) of health services, medical personnel, electricity, drinkable water, good sanitary conditions and others.

Measures of association (i.e. fixed effects) were expressed in this study as hazard ratios (HR) and p-value. The random effects which were regarded as measures of variations in infant and child mortality across communities were expressed in this study as intra-class correlation (ICC)[19] (or variance partition coefficient (VPC)), and proportional change in variance (PCV). The precision of random effects was determined by the standard error (SE) of the covariates. To determine the goodness of fit of the consecutive models, regression diagnostic was done using Akaike Information Criteria (AIC). Introduced by Hitrotugu Akaike in 1971, AIC measures the relative goodness of fit of statistical model ("Book Reviews," 1988). Boco (2010) noted that the lower value of AIC indicates a better fit.

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[19] The intra-class correlation (ICC) is an important measure of the relatedness of clustered data within community or household units (Antai 2011). ICC is the proportion of the total variance that is at the community (Pillinger, 2011). The VPC was calculated in this study using the linear threshold model method whereby VPC corresponds to the intra-class correlation (ICC) (Merlo *et al.,* 2006).
Hence, the VPC was computed using:

$$\rho = (\delta^2\mu/(\delta^2\mu + (\pi^2/3))$$

Where, ρ is the ICC, $\delta^2\mu$ is the variance at the community level, $\pi^2/3$ = 3.29 and represents the fixed variance at individual level (Merlo *et al*, 2006).

Seven models were fitted for each of the three outcome variables, hence twenty-one models each were fitted using 2003 and 2008 datasets. This translated to forty-two models in all. The first model (Model 0 or empty model) contained no explanatory variable, but focused on decomposing the total variance into individual- and community-level components; and to determine whether clustering of infant and child mortality within communities or neighbourhoods was large enough to justify assessing random effects at the community level (Babalola & Fatusi, 2009; Merlo, Chaix, Ohlsson, et al., 2005). The second model (Model 1) contains the region of residence as the only covariate to examine the independent effects of region of residence in the multilevel analysis on infant and child mortality. While the third model (Model 2) considered the child-level factors, Model 3 incorporated the mother-level factors; and these were all regarded as factors at the individual level since no clear-cut difference could be established between individual-level and household-level for the purpose of fitting multilevel models.

Additionally, since the objective of this chapter was to examine the effects of community contextual determinants on regional variations in infant and child mortality, the fifth model (Model 4) separately considered the effects of region of residence and all the selected community-level variables on the outcome variables. While the sixth model (Model 5) was the full model containing all covariates at various levels, the seventh model which was the final model (Model 6) incorporated only variables that were significant and selected by the stepwise regression analysis (with forward selection at 5% significance level).

7.1 Results – fixed effects and random effects

The results presented in the empty model, which contains no explanatory variables, (Model 0, Tables 7.1 to 7.6) indicated a significant variation in infant and child mortality with variances ranging from 0.14 to 0.35 across child and mother levels, and variances ranging from 0.13 to 0.30 across communities; thereby justifying the use of multilevel modeling in this chapter. The results from analysis of 2003 data (Model 0 Tables 7.1 to 7.3) indicated that the between communities variance (expressed as variance partition coefficient – VPC or intra-class correlation coefficient – ICC) in child mortality was larger than the between communities variance estimated for infant mortality. This suggests that intra-community variations associated with risk of dying during the first year of life (i.e. 6.5%) was smaller than the observed variations associated with risk of dying between ages 1 and 5 (i.e. 7.6%). Overall, the intra-community variation (i.e. PVC) associated with the risk of dying before the fifth birth day was estimated at 7.1%.

Similarly, the results from analysis of 2008 data as presented in Model 0 Tables 7.4 to 7.6 indicated that variation (i.e. ICC) in child mortality across communities (10.4%) was slightly larger than the intra-community variation associated with infant mortality, which was estimated at 8.4%. Comparing the results from 2003 and 2008 NDHS datasets, the observed intra-community variations in infant and child mortality appear to be larger in 2008 than in 2003. Plausible reason for this was provided in chapter 9 in the discussion section.

Table 7.1: Child and mother-level compositional and community contextual factors associated with regional variations in infant mortality in Nigeria, 2003

Characteristics	Model 0	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Fixed effects	Empty Model (HR)	Region covariate (HR)	Child-level variables (HR)	Mother-level variables (HR)	Community-level variables (HR)	Full model (HR)	Final Model (HR)
Region of residence							
South-west		1	1	1	1	1	1
North-central		1.39	1.42	0.86	1.01	0.67	1.02
North-east		1.70*	1.60*	0.96	1.09	0.66	0.90
North-west		1.65*	1.48	0.95	1.17	0.70	0.82
South-east		1.45	1.08	0.71	1.44	0.66	0.96
South-south		1.60	1.65*	1.56	1.29	1.39	1.85*
Child's sex							
Male			1			1	
Female			0.87			0.88	
Birth order							
First birth			1			1	
2-4			0.94			0.53*	
5+			2.51*			0.65	
Birth interval							
<24 months			1			1	1
24+			0.65*			0.74	0.83
Child size at birth							
Large			1			1	
Average			1.09			1.16	
Small			1.60*			1.87*	
Maternal education							
None				1		1	1
Primary				1.30		1.42	1.37
Secondary or higher				1.00		1.04	0.97
Mother's age							
15-24				1		1	1
25-34				0.66		0.84	0.78
35+				0.99		1.37	1.20
CEB							
<3				1		1	
3-4				2.32*		2.05*	
5+				4.38*		4.18*	
Family structure							
Monogamous				1		1	
Polygynous				1.13		1.11	
Religion							
Christianity				1		1	
Islam				0.83		0.85	
Others				0.60		0.53*	
Wealth index							
Poorest				1		1	
Poorer				1.17		1.23	
Middle				0.96		1.10	
Richer				0.67*		0.87	
Richest				0.68		0.93	
Contraceptive use							
No method				1		1	
Traditional				0.60		0.54	
Modern				0.52*		0.36*	
Had Prenatal care							
No				1		1	1
Yes				0.64*		0.71	0.64*
Place of delivery							

Home				1		1	
Health facility				0.65		0.72	
Place of residence							
Urban					1	1	
Rural					1.00	0.80	
Ethnic diversity							
Homogenous					1	1	
Mixed					1.18	1.10	
Heterogeneous					1.64*	1.62	
Community maternal level of education							
Low					1	1	
Medium					0.77	0.66	
High					0.77	0.61	
Community prenatal care by skilled provider							
Low					1	1	
Medium					0.75*	0.82	
High					0.86	1.08	
Proportion with electric connection in the community							
Low					1	1	1
Medium					0.81	0.67	0.67
High					0.67*	0.63	0.49*
Proportion with piped water in the community							
Low					1	1	
Medium					1.14	1.14	
High					0.95	1.09	
Community hospital delivery							
Low					1	1	
Medium					1.03	0.87	
High					0.87	0.67	
Community poverty							
Low					1	1	1
Medium					1.06	1.02	1.03
High					1.38	1.79	1.85*
Distance to health facility in community							
Big problem					1	1	
Not a big problem					0.86	0.89	
Random effects	**Empty**	**Region**	**Child**	**Mother**	**Community**	**Full model**	**Final model**
Community-level							
Variance (SE)	0.23(0.16)*	0.18(0.12)*	0.17(0.10)*	0.15(0.09)*	0.10(0.05)*	0.13(0.07)*	0.13(0.08)*
VPC (%)	6.5	5.2	4.9	4.4	2.9	3.8	3.8
Explained variation (PCV) %	Reference	21.7	26.1	34.8	56.5	43.5	43.5
Child/Mother-level							
Variance (SE)	0.22(0.14)*	0.21(0.13)*	0.20(0.11)*	0.12(0.07)*	0.10(0.05)*	0.09(0.03)	0.07(0.03)
Explained variation (PCV) %	Reference	4.5	9.1	45.5	54.5	59.1	68.2
Log likelihood	-1872.3	-1867.9	-1701.1	-1552.3	-1841	-695.8	-832.4
Model fit statistics							
AIC	3750.5	3752	3434	3162.6	3731.5	1481.7	1686.8

Abbreviation:- HR: Hazard ratio, SE: standard error, VPC: variance partition coefficient, PCV: proportional change in variance, AIC: Akaike information criterion, *p<0.05

According to the results from 2003 data presented in Model 1 (Table 7.1), inclusion of region of residence as the only covariate in the multilevel analysis resulted in almost two-fold significantly higher risks of dying during the first year of life for children in the North-east (HR: 1.70, $p<0.05$) and North-west (HR: 1.65, $p<0.05$), compared to children in the South-west. Although, inclusion of region of residence in the multilevel model, according to 2008 data, yielded similar results, a careful comparison of results from the two datasets indicated that regional variations in the risks of death during the first year of life has slightly reduced during the 1999-2003 and 2004-2008 periods, though with more variations across communities. For instance, Tables 7.1 and 7.4 showed that hazards of dying in infancy were 1.70 (in 2003) and 1.54 (in 2008) in the North-east; and 1.65 (in 2003) and 1.43 (in 2008) in the North-west.

Results from Tables 7.2 and 7.5 showed that the regional variations in the risks of death were more pronounced in childhood than in infancy. For instance, Model 1 (Table 7.5) which examines the effect of region of residence (in the multilevel analysis) on child mortality indicated that the risks of dying during childhood were more than three-fold significantly higher for children of mothers residing in the North-east (HR: 3.29, $p<0.05$) and North-west (HR: 3.14, $p<0.05$) compared to children of mothers in the South-west. Results from Table 7.5 showed that while there was a slight decrease in the risks of death during childhood in North-east (HR: 3.04, $p<0.05$) and South-south (HR: 1.75, $p<0.05$); there was an increase in the risks of death in childhood in the North-central (HR:1.91, $p<0.05$), North-west

(HR:3.74, $p<0.05$) and South-east (HR:1.89, $p<0.05$) over the 1999-2003 and 2004-2008 periods.

Considering measures of variation in Model 1, fitting region of residence covariate into Model 1 (in Tables 7.1 to 7.6) yielded significant variance across mothers (with variance ranging from 0.12 to 0.34) and across communities (with variance ranging from 0.14 to 0.31). The proportional change in variance (PCV) in Model 1 (Tables 7.1 and 7.4) indicated that 21.7% (2003) and 16.7% (2008) of the variance associated with the risks of dying in infancy across communities were explained by regions of residence (that is being born or raised in a particular region). In the same vein, Model 1 in Tables 7.2 and 7.5 indicated that 14.8% (2003) and 18.4% (2008) of the variance associated with the risks of dying during childhood across communities were explained by region of residence. The estimated PCV suggests that more variations in the risks of dying in infancy were explained by region of residence in 2003 compared to 2008; whereas more variations associated with the risks of dying in childhood were explained by region of residence in 2008 compared to 2003. Overall, the estimated PCV in Model 1 (Tables 7.3 and 7.6) indicated that 16% (in 2003) and 33.3% (in 2008) of the variance associated with under-five mortality across communities were explained by regions where children were raised. This also shows that more variations in under-five mortality across communities were explained by region of residence in 2008 compared to 2003.

Table 7.2: Child and mother-level compositional and community contextual factors associated with regional variations in child mortality in Nigeria, 2003

Characteristics	Model 0	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Fixed effects	Empty Model (HR)	Region covariate (HR)	Child-level variables (HR)	Mother-level variables (HR)	Community-level variables (HR)	Full model (HR)	Final Model (HR)
Region of residence							
South-west		1	1	1	1	1	1
North-central		1.62	1.76	1.62	1.22	0.61	1.67
North-east		3.29*	3.32*	2.43*	2.26*	1.20	3.45*
North-west		3.14*	2.97*	2.29*	2.08*	0.87	3.28*
South-east		1.08	0.49	0.50	1.05	0.45	1.11
South-south		1.93	2.11*	2.15	1.79	1.44	2.01
Child's sex							
Male			1			1	
Female			1.08			0.98	
Birth order							
First birth			1			1	
2-4			1.15			0.89	
5+			3.08*			0.99	
Birth interval							
<24 months			1			1	
24+			0.76			0.75	
Child size at birth							
Large			1			1	
Average			0.92			0.85	
Small			1.03			0.95	
Maternal education							
None				1		1	
Primary				0.82		1.37	
Secondary or higher				0.48*		0.69	
Mother's age							
15-24				1		1	
25-34				0.99		1.03	
35+				1.42		1.60	
CEB							
<3				1		1	
3-4				2.34*		2.30*	
5+				3.38*		3.14*	
Family structure							
Monogamous				1		1	
Polygynous				1.44		1.43	
Religion							
Christianity				1		1	
Islam				1.70		1.66	
Others				1.60		1.40	
Wealth index							
Poorest				1		1	
Poorer				1.04		1.22	
Middle				0.92		1.32	
Richer				0.78		0.99	
Richest				0.59		1.31	
Contraceptive use							
No method				1		1	
Traditional				0.63		0.65	
Modern				0.34		0.35	
Had Prenatal care							
No				1		1	
Yes				0.50*		0.55	
Place of delivery				1		1	

Home				0.71		0.74	
Health facility							
Place of residence							
Urban					1	1	
Rural					1.34	1.42	
Ethnic diversity							
Homogenous					1	1	
Mixed					0.95	0.80	
Heterogeneous					1.26	0.91	
Community maternal level of education							
Low					1	1	
Medium					0.85	0.99	
High					0.56*	0.49	
Community prenatal care by skilled provider							
Low					1	1	
Medium					0.77	1.08	
High					0.59*	0.92	
Proportion with electric connection in the community							
Low					1	1	
Medium					1.00	0.92	
High					0.97	1.37	
Proportion with piped water in the community							
Low					1	1	
Medium					1.03	1.27	
High					1.13	0.94	
Community hospital delivery							
Low					1	1	
Medium					0.91	0.60	
High					1.32	1.99	
Community poverty							
Low					1	1	
Medium					1.36	0.85	
High					1.59	0.83	
Distance to health facility in community							
Big problem					1	1	
Not a big problem					1.12	0.98	
Random effects	**Empty**	**Region**	**Child**	**Mother**	**Community**	**Full model**	**Final model**
Community-level							
Variance (SE)	0.27(0.15)*	0.23(0.10)*	0.19(0.08)*	0.17(0.08)*	0.15(0.06)*	0.10(0.06)	0.09(0.03)*
VPC (%)	7.6	6.5	5.5	4.9	4.4	2.9	2.7
Explained variation (PCV) %	Reference	14.8	29.6	37.0	44.4	63.0	66.7
Child/Mother-level							
Variance (SE)	0.25(0.12)*	0.15(0.08)*	0.11(0.06)	0.09(0.03)	0.08(0.06)	0.05(0.03)	0.03(0.01)
Explained variation (PCV) %	Reference	40.0	56.0	64.0	68.0	80.0	88.0
Log likelihood	-1145.8	-1127.0	-1050.2	-955.3	-1110	-361.7	-1098.1
Model fit statistics							
AIC	2297.7	2270.0	2132.4	1968.6	2268.4	2223.7	2212.2

Abbreviation:- HR: Hazard ratio, SE: standard error, VPC: variance partition coefficient, PCV: proportional change in variance, AIC: Akaike information criterion, *p<0.05.

Multilevel analysis models in Tables 7.3 and 7.6 (Model 1) indicated that, generally there were reductions in the risks of dying before reaching the firth birthday in all the regions during the period under study – 1999-2003 and 2004-2008.

Results from analysis of 2003 data as presented in Tables 7.1 and 7.2 indicated that adding child-level variables into the multilevel models (Model 2 Tables 7.1 and 7.2) did not significantly change the regional variations in the risks of dying in infancy or childhood. For instance, while the risks of dying in infancy were 70% significantly higher in the North-east and 65% higher in the North-west compared to South-west (in Model 1); adding child-level variables into the multilevel models (in Model 2 Table 7.1) resulted in 60% (North-east) and 48% (North-west) significantly higher risks of dying in infancy compared to risks of infant death in the South-west. Results from Tables 7.4 and 7.5 (2008 dataset) also showed that inclusion of child-level variables did not yield much difference between Models 1 and 2. For instance, hazards of dying in infancy slightly declined in the North-central from 1.35 (Model 1) to 1.29 (Model 2); from 1.65 (Model 1) to 1.49 (Model 2) in the South-east; and from 1.41 (Model 1) to 1.33 (Model 2) in the South-south. This suggests that the effect of region of residence on child's survival was independent of child-level characteristics.

In contrast, incorporating the mother-level variables into the multilevel analysis in Model 3 (Tables 7.1 and 7.4) indicated mother's attributes as important characteristics in the multilevel modeling, as the regional variations in the risks of dying during the first year of life became insignificant. This suggests that mother-level variables included in the multilevel analysis; such as maternal education, wealth index, contraceptive use, number of children ever born and maternal age are important factors that influence regional variations in the risks of dying during infancy. Table 7.3 showed that, overall, being a child of an educated woman with at least secondary education (HR: 0.70, $p<0.05$); being a child of a woman from households in the richest wealth quintile (HR: 0.64, $p<0.05$); and being a child of woman that used modern contraceptives (HR: 0.67, $p<0.05$) was associated with lower risks of under-five mortality, irrespective of the region of residence a child came from.

Similarly, considering mother-level characteristics in the multilevel analysis in Model 3 (2003 and 2008 NDHS results in Tables 7.2 and 7.5 respectively), the regional variations in the risks of death during childhood slightly reduced. For instance, while Models 2 and 3 in Table 7.2 showed that the hazards of dying in childhood had significantly reduced from 3.32 to 2.43 in the North-east and from 2.97 to 2.29 in the North-west, Model 3 (Table 7.2) indicated that the hazards of dying young were insignificant in other regions. This may also be due to the importance of mother-level characteristics. For instance, overall, results from Model 3 (Table 7.6) indicated that being a child of mother aged 25-34 (HR: 0.77, $p<0.05$); being a child of mother from the richest households (HR: 0.73, $p<0.05$); being a child of mother who used modern contraceptives (HR: 0.42, $p<0.05$); and being a child of mother who attended a prenatal care by a skilled provider (HR:0.85, $p<0.05$), was associated with lower risks of dying before the fifth birthday.

Considering measures of variations in Models 2 and 3, after incorporating child-level covariates into Model 2 and mother-level variables into Model 3, the measures of variations remained significant across communities (in Tables 7.1 to 7.6), with intra-class correlation (ICC) associated with risks of death in infancy estimated at 4.4% (Model 3 Table 7.1 – 2003) and 5.7% (Model 3 Table 7.4 – 2008); and intra-class correlation associated with risks of dying in childhood estimated at 4.9% (Model 3 Table 7.2 – 2003) and 6.5% (Model 3 Table 7.5 in – 2008). According to results from the analysis of 2003 data, the proportional change in variance (PCV) of 34.8% in the hazards of dying during the first year of life; and PCV of 37.0% in the hazards of dying between ages 1 and 5, across communities, could be explained by mother-level characteristics. Also results from 2008 data indicated that PCV of 33.3% in the risks of dying during infancy and PCV of 39.5% associated with risks of dying during childhood, across communities, could be explained by the characteristics at the mother level.

Table 7.3: Child and mother-level compositional and community contextual factors associated with regional variations in under-five mortality in Nigeria, 2003

Characteristics	Model 0	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Fixed effects	Empty Model (HR)	Region covariate (HR)	Child-level variables (HR)	Mother-level variables (HR)	Community-level variables (HR)	Full model (HR)	Final Model (HR)
Region of residence							
South-west		1	1	1	1	1	1
North-central		1.45*	1.52*	1.14	1.08	0.92	0.80
North-east		2.09*	2.00*	1.43	1.37	1.24	0.80
North-west		2.00*	1.83*	1.46	1.38	1.22	0.72
South-east		1.36*	0.95	0.66	1.37	0.74	0.68
South-south		1.68*	1.78*	1.54*	1.42	1.98	1.64
Child's sex							
Male			1			1	
Female			0.94			0.95	
Birth order							
First birth			1			1	1
2-4			1.00			0.73	0.59*
5+			2.73*			2.30*	0.73
Birth interval							
<24 months			1			1	1
24+			0.68*			0.76	0.74
Child size at birth							
Large			1			1	1
Average			1.03			1.03	1.04
Small			1.38*			1.47*	1.45*
Maternal education							
None				1		1	1
Primary				0.97		1.36	1.37*
Secondary or higher				0.70*		0.82	0.91
Mother's age							
15-24				1		1	1
25-34				0.83		1.03	0.90
35+				1.04		2.00*	1.36
CEB							
<3				1		1	1
3-4				2.33*		2.30*	1.96*
5+				4.02*		3.29*	3.10*
Family structure							
Monogamous				1		1	1
Polygynous				1.23*		1.23	1.22
Religion							
Christianity				1		1	
Islam				1.10		0.96	
Others				0.92		0.78	
Wealth index							
Poorest				1		1	
Poorer				1.06		1.27	
Middle				0.91		1.20	
Richer				0.71*		0.92	
Richest				0.64*		1.02	
Contraceptive use							
No method				1		1	1
Traditional				0.56		0.59	0.56
Modern				0.38*		0.39*	0.35*
Had Prenatal care							
No				1		1	1
Yes				0.60*		0.69*	0.61*

Place of delivery				1		1	
Home				0.89		0.90	
Health facility							
Place of residence							
Urban					1	1	
Rural					1.11	0.95	
Ethnic diversity							
Homogenous					1	1	
Mixed					1.09	1.11	
Heterogeneous					1.49*	1.57	
Community maternal level of education							
Low					1	1	
Medium					0.81*	0.82	
High					0.71*	0.68	
Community prenatal care by skilled provider							
Low					1	1	
Medium					0.76*	0.86	
High					0.76*	1.08	
Proportion with electric connection in the community							
Low					1	1	1
Medium					0.85	0.83	0.74
High					0.75*	0.97	0.64*
Proportion with piped water in the community							
Low					1	1	
Medium					1.09	1.12	
High					1.02	0.99	
Community hospital delivery							
Low					1	1	
Medium					0.99	0.82	
High					0.97	0.85	
Community poverty							
Low					1	1	1
Medium					1.15	1.14	0.95
High					1.46*	1.41	1.54*
Distance to health facility in community							
Big problem					1	1	
Not a big problem					0.93	0.97	
Random effects	**Empty**	**Region**	**Child**	**Mother**	**Community**	**Full model**	**Final model**
Community-level							
Variance (SE)	0.25(0.12)*	0.21(0.09)*	0.18(0.09)	0.15 (0.08)*	0.14 (0.06)*	0.11 (0.04)	0.09 (0.04)*
VPC (%)	7.1	6.0	5.2	4.4	4.1	3.2	2.7
Explained variation (PCV) %	Reference	16.0	28.0	40.0	44.0	56.0	64.0
Child/Mother-level							
Variance (SE)	0.20(0.10)*	0.15(0.08)*	0.12(0.09)	0.09(0.04)*	0.07(0.04)	0.05(0.02)	0.08(0.06)
Explained variation (PCV) %	Reference	25.0	40.0	55.0	65.0	75.0	60.0
Log likelihood	-2486.9	-2471.8	-2266.1	-2070.2	-2436.5	-879.4	-941.6
Model fit statistics							
AIC	4979.8	4959.5	4564.2	4198.4	4921.1	1860.8	1933.2

Abbreviation:- HR: Hazard ratio, SE: standard error, VPC: variance partition coefficient, PCV: proportional change in variance, AIC: Akaike information criterion, *p<0.05.

Further, while results from incorporating only community-level contextual factors into the multilevel models in Model 4 (2003 results in Table 7.1) indicated that regional variations in the risks of dying in infancy were insignificant across all regions, adding only community-level contextual factors into the multilevel analysis in Model 4 (2008 results in Table 7.2) indicated further reductions in the risks of dying during childhood across regions. For example, hazards of dying in childhood as presented in Models 3 and 4 (Table 7.2) significantly reduced from 2.43 to 2.26 in North-east ($p<0.05$) and from 2.29 to 2.08 in the North-west ($p<0.05$). Results similar to that of Model 4 (Table 7.1) were obtained from the inclusion of community-level contextual factors into multilevel analysis in Model 4 Table 7.3, as regional variations in the risks of under-five mortality became insignificant across all regions.

Results presented in Models 3 and 4 Table 7.5 (2008 data) showed that the inclusion of community-level factors in the multilevel analysis in Model 4 resulted in reduction in the risks of dying during childhood across all regions, except North-east (HR: 2.24, $p<0.05$) and South-south (HR: 1.49, $p<0.05$) where some increase was observed. While the characteristics of the community tend to mitigate the risks of dying in childhood in other regions, there were increased risks of childhood death in North-east and South-south. Models 3 and 4 in Table 7.6 showed similar results.

Considering measures of variations (random effects), variances that resulted from inclusion of only community-level characteristics in the multilevel modeling were significant across communities (Model 4 Tables 7.1 to 7.6). Intra-class correlations of 2.9% (in 2003 – Model 4 Table 7.1) and 4.9% (in 2008 – Model 4 Table 7.4) were found to be associated with risks of dying before age one. Intra-class correlation of 4.4% (in 2003, Model 4 Table 7.2) and 5.5% (in 2008 – Model 4 Table 7.5) were associated with risks of dying in childhood. Results from 2003 dataset showed that, the proportional change in variance (PCV) of 43.5% (Model 4 Table 7.1) in the hazards of dying during infancy; and PCV of 44.4% (Model 4 Table 7.2) in the risks of dying during childhood, across communities, could be attributed to community-level characteristics. Analysis of 2008 data showed that PCV of 43.3% (Model 4 Table 7.4) in the risks of dying before age one and PCV of 50.0% (Model 4 Table 7.5) in the hazards of dying during childhood; and across communities, could be explained by community-level characteristics.

Furthermore, results from Model 5 (full model) which incorporated all covariates at various levels as presented in Tables 7.3 and 7.6 indicated some significant increase in the risks of under-five mortality during the period under study in the North-central (hazard ratio increased from 0.92 to 1.39, $p<0.05$); North-east (hazard ratio increased from 1.24 to 1.45, $p<0.05$) and North-west (hazard ratio increased from 1.22 to 1.44, $p<0.05$). This was also true of risks of death during childhood as shown in Model 5 in Tables 7.2 and 7.5).

Further results from the full model (Model 5 Table 7.1, 2003 data) showed that child-level variables (such as birth order and child's size at birth) and mother-level variables (including number of CEB and mother's religious affiliation) were significantly associated with regional variations in the risks of dying during infancy. Results from 2008 dataset (Model 5 Table 7.4) indicated that being a female child (HR: 0.78, $p<0.05$), being born after a preceding birth interval of 2 years or more

(HR: 0.50, $p<0.05$) and being born in a health facility (HR: 0.55, $p<0.05$) was associated with lower risks of death in infancy, while having a small size at birth (HR: 1.53, $p<0.05$) was associated with increased risks of death during infancy.

In comparison to model 4, the measures of variations between communities were found to be significant in model 5 (Tables 7.1 to 7.6), with variances ranging from 0.10 to 0.13 (in Tables 7.1 to 7.3) and from 0.07 to 0.14 (Tables 7.4 to 7.6). Comparing Models 4 and 5, results from 2003 data showed that the intra-community correlation (i.e. ICC or VPC) associated with risks of infant mortality increased from 2.9% to 3.8% (Table 7.1), while the intra-community correlation associated with child mortality decreased from 4.4% to 2.9% (Table 7.2). Results from 2008 data indicated a slight decrease in VPC associated with hazards of dying in infancy from 4.9% (Model 4 Table 7.4) to 4.1% (Model 5 Table 7.4), while VPC associated with death in childhood also decreased from 5.5% (Model 4 Table 7.5) to 2.9% (Model 5 Table 7.5).

Results of the final model from 2003 data (i.e. Model 6 in Table 7.1, which included only the variables selected in the stepwise Cox regression analysis in the multilevel modeling) indicated significantly higher risks of dying in infancy for children of mothers residing in the South-south (HR: 1.85, $p<0.05$), and children of mothers residing in communities with high proportion of poor households (HR: 1.85, $p<0.05$) compared to children in the reference groups. Results from Model 6 (Table 7.1) also showed lower risks of dying in infancy for children whose mothers had prenatal care by a skilled provider (HR: 0.64, $p<0.05$), and for children of mothers residing in communities that had a high proportion of households with electric connection (HR: 0.49, p<0.05).

Results of final model from analysis of 2008 data (Model 6 in Table 7.4) indicated higher risks of dying during the first year of life for children with small size at birth (HR: 1.53, p<0.05) and children of mothers residing in rural areas (HR: 1.22, p<0.05), relative to children in the reference categories. Results from Model 6 (Table 7.4) further indicated lower risks of dying before age one for female children (HR: 0.78, p<0.05), children who had preceding birth interval of 24 months or longer (HR: 0.51, p<0.05), children of mothers aged 25-34 years (HR: 0.57, p<0.05), children whose mothers were using modern contraceptives (HR: 0.47, p<0.05) and children born in a health facility (HR: 0.41, p<0.05); compared to children in the reference categories. Model 6 in Table 7.5 revealed almost similar results compared to results in Model 6 Table 7.4.

Overall, Model 6 Table 7.3 showed that being a child with birth order 2-4 (HR: 0.59, p<0.05), being a child of mother using modern contraceptives (HR: 0.35, p<0.05), being a child whose mother had prenatal care by a skilled provider (HR: 0.61, p<0.05) and being a child raised in community with high proportion of households with electric connection (HR: 0.64, p<0.05) was significantly associated with lower risks of dying before the fifth birthday, compared to their counterparts in the reference groups. Results from Model 6 (Table 7.3) further indicated significantly higher risks of death before age five for children with small size at birth (HR: 1.45, p<0.05) and for children residing in communities with high proportion of poor households (HR: 1.54, p<0.05).

Results from final model (Model 6 Table 7.6 – 2008 data) showed that the risks of dying before reaching the fifth year were significantly higher for children raised in North-central (HR: 1.43, $p<0.05$), North-east (HR: 1.56, $p<0.05$) and North-west (HR: 1.55, $p<0.05$); and also for children with small size at birth (HR: 1.32, $p<0.05$), children of mothers in polygynous union (HR: 1.15, $p<0.05$), and children of mothers living in rural areas (HR: 1.25, $p<0.05$). Results from Model 6 (Table 7.6) further indicated lower risks of dying before age five for female children (HR: 0.76, $p<0.05$), children with preceding birth interval of 24 months or longer (HR: 0.55, $p<0.05$) and children from ethnically heterogeneous communities (HR: 0.82, $p<0.05$), compared with children in the reference groups.

Considering the measures of variations in comparison with Model 5, variations in Model 6 (Table 7.1 to 7.6) remained significant but decreased slightly, with variances ranging from 0.04 to 0.13. Results from 2003 data (Model 6 Table 1) showed that the intra-community correlation associated with risks of infant mortality remained at 3.8%, while the intra-community correlation associated with child mortality slightly decreased from 2.9% to 2.7% (Model 6 Table 7.2). Results of analysis from 2008 data indicated a decrease in ICC associated with risks of dying in infancy from 4.1% (Model 5 Table 7.4) to 2.9% (Model 6 Table 7.4), while ICC associated with death during childhood slightly decreased from 3.2% (Model 5 Table 7.5) to 2.4% (Model 6 Table 7.5).

According to results from 2003 data, the proportional change in variance (PCV) of 43.5% in the risks of dying before age one, and PCV of 66.7% in the hazards of dying during childhood, across communities, were partly due to the individual and community level characteristics incorporated into the final model (Model 6), and partly due to unobserved characteristics not included in the model. Results from 2008 data indicated that PCV of 66.7% in the risks of dying in infancy and PCV of 78.9% associated with risks of dying in childhood, across communities, were partly due to individual- and community-level factors in the final model (Model 6) and partly to unobserved factors other than those incorporated into the model.

Finally, the decreasing values of AIC with each successive model indicated a good fit of the multilevel models with each successive model signifying a significant improvement of the previous model.

Table 7.4: Child and mother-level compositional and community contextual factors associated with regional variations in infant mortality in Nigeria, 2008

Characteristics	Model 0	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	Empty Model	Region covariate	Child-level variables	Mother-level variables	Community-level variables	Full model	Final Model
Fixed effects	(HR)	(HR)	(HR)	(HR)	(HR)	(HR)	(HR)
South-west		1	1	1	1	1	1
North-central		1.35*	1.29*	1.23	1.10	1.22	1.28
North-east		1.54*	1.35*	1.30	1.17	1.27	1.37
North-west		1.43*	1.22*	1.18	1.12	1.09	1.19
South-east		1.65*	1.49*	1.43*	1.56*	1.29	1.30
South-south		1.41*	1.33*	1.26*	1.27*	1.32	1.29
Child's sex							
Male			1			1	1
Female			0.79*			0.78*	0.78*
Birth order							
First birth			1			1	1
2-4			1.23*			0.90	0.90
5+			4.06*			1.20	1.23
Birth interval							
<24 months			1			1	1
24+			0.56*			0.50*	0.51*
Child size at birth							
Large			1			1	1
Average			1.12*			1.10	1.11
Small			1.58*			1.53*	1.53*
Maternal education							
None				1		1	
Primary				0.87		0.88	
Secondary or higher				0.90		0.90	
Mother's age							
15-24				1		1	1
25-34				0.57*		0.58*	0.57*
35+				0.60*		0.73*	0.72*
CEB							
<3				1		1	1
3-4				2.10*		1.61*	1.60*
5+				3.65*		2.13*	2.11*
Family structure							
Monogamous				1		1	1
Polygynous				1.13		1.12	1.15
Religion							
Christianity				1		1	1
Islam				0.88		0.78*	0.82
Others				0.95		1.03	1.08
Wealth index							
Poorest				1		1	
Poorer				1.03		0.98	
Middle				0.95		1.06	
Richer				0.89		1.05	
Richest				0.82*		0.80	
Contraceptive use							
No method				1		1	1
Traditional				0.63*		0.45*	0.43*
Modern				0.71*		0.49*	0.47*
Had Prenatal							
No				1		1	1
Yes				0.94		0.91	0.93
Place of delivery							

Home				1		1	1
Health facility				0.47*		0.55*	0.41*
Place of residence							
Urban					1	1	1
Rural					1.12	1.10	1.22*
Ethnic diversity							
Homogenous					1	1	1
Mixed					0.95	0.81*	0.83
Heterogeneous					1.03	0.84	0.91
Community maternal level of education							
Low					1	1	
Medium					0.90	0.96	
High					0.92	0.10	
Community prenatal care by skilled provider							
Low					1	1	
Medium					0.79*	1.13	
High					0.75*	1.25	
Proportion with electric connection in the community							
Low					1	1	
Medium					1.03	0.97	
High					0.94	0.91	
Proportion with piped water in the community							
Low					1	1	
Medium					0.70*	0.79	
High					0.84*	0.93	
Community hospital delivery							
Low					1	1	
Medium					0.90	0.90	
High					0.74*	0.80	
Community poverty							
Low					1	1	
Medium					1.08	1.05	
High					1.15	1.06	
Distance to health facility in community							
Big problem					1	1	
Not a big problem					1.00	1.05	
Random effects	**Empty**	**Region**	**Child**	**Mother**	**Community**	**Full model**	**Final model**
Community-level							
Variance (SE)	0.30(0.13)*	0.25(0.09)*	0.22(0.10)	0.20(0.08)*	0.17(0.08)*	0.14 (0.06)*	0.10(0.06)*
VPC (%)	8.4	7.1	6.3	5.7	4.9	4.1	2.9
Explained variation (PCV) %	Reference	16.7	26.7	33.3	43.3	53.3	66.7
Child/Mother-level							
Variance (SE)	0.35(0.14)*	0.34(0.14)*	0.24(0.11)*	0.23(0.14)*	0.23(0.15)	0.15(0.08)	0.12(0.07)*
Explained variation (PCV) %	Reference	2.9	28.6	34.3	34.3	57.1	65.7
Log likelihood	-7400.2	-7387.5	-6557.2	-2984.6	-7359.4	-2978.6	-2985.0
Model fit statistics							
AIC	14806.3	14790.9	13146.5	6027.3	14766.8	6047.1	6022.1

Abbreviation:- HR: Hazard ratio, SE: standard error, VPC: variance partition coefficient, PCV: proportional change in variance, AIC: Akaike information criterion, *p<0.05.

Table 7.5: Child and mother-level compositional and community contextual factors associated with regional variations in child mortality in Nigeria, 2008

Characteristics	Model 0	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	Empty Model	Region covariate	Child-level variables	Mother-level variables	Community-level variables	Full model	Final Model
Fixed effects	(HR)	(HR)	(HR)	(HR)	(HR)	(HR)	(HR)
Region of residence							
South-west		1	1	1	1	1	1
North-central		1.91*	1.86*	1.82	1.62*	2.14*	1.38*
North-east		3.04*	2.80*	2.13*	2.24*	2.38*	1.52*
North-west		3.74*	3.46*	3.32*	2.43*	2.99*	1.12
South-east		1.89*	1.88*	1.94	1.76*	1.52	1.01
South-south		1.75*	1.72*	1.26	1.49*	1.26	0.62*
Child's sex							
Male			1			1	1
Female			0.97			0.73*	0.97
Birth order							
First birth			1			1	
2-4			1.53*			1.15	
5+			5.00*			1.31	
Birth interval							
<24 months			1			1	1
24+			0.66*			0.68*	0.57*
Child size at birth							
Large			1			1	
Average			1.03			0.99	
Small			1.10			0.91	
Maternal education							
None				1		1	
Primary				1.17		1.11	
Secondary or higher				1.14		1.07	
Mother's age							
15-24				1		1	1
25-34				1.26		1.25	1.10
35+				1.74*		1.71*	1.36*
CEB							
<3				1		1	1
3-4				1.75*		1.64*	1.32*
5+				1.93*		1.77*	1.74*
Family structure							
Monogamous				1		1	
Polygynous				1.13		1.14	
Religion							
Christianity				1		1	
Islam				0.90		0.80	
Others				0.56		0.63	
Wealth index							
Poorest				1		1	
Poorer				0.87		0.85	
Middle				1.02		0.97	
Richer				0.82		0.80	
Richest				0.76		0.76	
Contraceptive use							
No method				1		1	
Traditional				0.88		0.87	
Modern				0.05		0.05*	
Had Prenatal							
No				1		1	
Yes				0.75*		0.74*	

Place of delivery							
Home				1		1	1
Health facility				0.68		0.68	0.67*
Place of residence							
Urban					1	1	1
Rural					1.30*	1.33	1.40*
Ethnic diversity							
Homogenous					1	1	1
Mixed					1.05	0.79	1.04
Heterogeneous					0.97	0.59*	0.90
Community maternal level of education							
Low					1	1	
Medium					1.06	1.28	
High					0.97	1.31	
Community prenatal care by skilled provider							
Low					1	1	
Medium					0.96	1.05	
High					0.95	1.12	
Proportion with electric connection in the community							
Low					1	1	
Medium					1.06	1.26	
High					0.98	1.16	
Proportion with piped water in the community							
Low					1	1	
Medium					1.30	1.00	
High					0.88	0.85	
Community hospital delivery							
Low					1	1	
Medium					0.83	0.82	
High					0.64*	0.83	
Community poverty							
Low					1	1	
Medium					1.16	0.87	
High					1.37*	1.01	
Distance to health facility in community							
Big problem					1	1	
Not a big problem					1.06	1.12	
Random effects	**Empty**	**Region**	**Child**	**Mother**	**Community**	**Full model**	**Final model**
Community-level							
Variance (SE)	0.38 (0.12)*	0.31 (0.10)*	0.27 (0.07)*	0.23 (0.09)*	0. 19 (0.08)*	0.11 (0.02)	0.08(0.03)*
VPC (%)	10.4	8.6	7.6	6.5	5.5	3.2	2.4
Explained variation (PCV) %	Reference	18.4	28.9	39.5	50.0	71.1	78.9
Child/Mother-level							
Variance (SE)	0.17(0.08)*	0.15(0.07)*	0.15(0.08)	0.12(0.07)*	0.09(0.04)*	0.09(0.06)	0.06(0.04)
Explained variation (PCV) %	Reference	11.8	11.8	29.4	47.1	47.1	64.7
Log likelihood	-4856.6	-4786.7	-4362.6	-1477.9	-4758.4	-1469.5	-1476.2
Model fit statistics							
AIC	9719.1	9589.4	8757.1	3013.8	9564.7	3029.0	3142.3

Abbreviation:- HR: Hazard ratio, SE: standard error, VPC: variance partition coefficient, PCV: proportional change in variance, AIC: Akaike information criterion, *p<0.05.

Table 7.6: Child and mother-level compositional and community contextual factors associated with regional variations in under-five mortality in Nigeria, 2008

Characteristics	Model 0	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	Empty Model	Region covariate	Child-level variables	Mother-level variables	Community-level variables	Full model	Final Model
Fixed effects	(HR)	(HR)	(HR)	(HR)	(HR)	(HR)	(HR)
Region of residence							
South-west		1	1	1	1	1	1
North-central		1.49*	1.42*	1.33*	1.21*	1.39*	1.43*
North-east		1.85*	1.73*	1.41*	1.42*	1.45*	1.56*
North-west		1.90*	1.80*	1.57*	1.44*	1.44*	1.55*
South-east		1.61*	1.52*	1.63*	1.59*	1.28	1.36
South-south		1.38*	1.40*	1.29	1.30*	1.30	1.31
Child's sex							
Male			1			1	1
Female			0.88*			0.78*	0.76*
Birth order							
First birth			1			1	1
2-4			0.73*			0.95	0.96
5+			0.95			1.20	1.24
Birth interval							
<24 months			1			1	1
24+			0.54*			0.55*	0.55*
Child size at birth							
Large			1			1	1
Average			1.22*			1.07	1.07
Small			1.46*			1.31*	1.32*
Maternal education							
None				1		1	
Primary				0.96		0.95	
Secondary or higher				0.98		0.96	
Mother's age							
15-24				1		1	
25-34				0.77*		0.77*	
35+				1.01		1.01	
CEB							
<3				1		1	1
3-4				1.98*		1.76*	1.76*
5+				2.37*		2.34*	2.32*
Family structure							
Monogamous				1		1	1
Polygynous				1.20*		1.15*	1.15*
Religion							
Christianity				1		1	1
Islam				0.85		0.82	0.81*
Others				0.90		0.95	0.93
Wealth index							
Poorest				1		1	
Poorer				0.98		0.97	
Middle				1.03		1.04	
Richer				0.99		1.06	
Richest				0.73*		0.82	
Contraceptive use							
No method				1		1	
Traditional				0.53*		0.53*	
Modern				0.42*		0.43*	
Had Prenatal							
No				1		1	
Yes				0.85*		0.84*	

Place of delivery							
Home				1		1	
Health facility				1.21		1.27	
Place of residence							
Urban					1	1	1
Rural					1.19*	1.17	1.25*
Ethnic diversity							
Homogenous					1	1	1
Mixed					0.98	0.81*	0.82*
Heterogeneous					1.01	0.74*	0.82*
Community maternal level of education							
Low					1	1	
Medium					0.96	1.03	
High					0.94	1.11	
Community prenatal care by skilled provider							
Low					1	1	
Medium					1.11	1.11	
High					1.11	1.20	
Proportion with electric connection in the community							
Low					1	1	
Medium					1.04	1.04	
High					0.95	0.97	
Proportion with piped water in the community							
Low					1	1	
Medium					0.88	0.85	
High					0.85*	0.88	
Community hospital delivery							
Low					1	1	
Medium					0.87*	0.88	
High					0.71*	0.77*	
Community poverty							
Low					1	1	
Medium					1.11	1.01	
High					1.23*	1.07	
Distance to health facility in community							
Big problem					1	1	
Not a big problem					1.02	1.10	
Random effects	**Empty**	**Region**	**Child**	**Mother**	**Community**	**Full model**	**Final model**
Community-level							
Variance (SE)	0.21 (0.09)*	0.14(0.06)*	0.14(0.07)	0.12(0.05)*	0.09 (0.05)*	0.07(0.04)	0.04(0.02)*
VPC (%)	6.0	4.1	4.1	3.5	2.7	2.1	1.2
Explained variation (PCV) %	Reference	33.3	33.3	42.9	57.1	66.7	81.0
Child/Mother-level							
Variance (SE)	0.14 (0.08)*	0.12 (0.06)*	0.11(0.09)	0.09(0.07)	0.06 (0.03)	0.04(0.03)	0.04(0.02)
Explained variation (PCV) %	Reference	14.3	21.4	35.7	57.1	71.4	71.4
Log likelihood	-10179.8	-10139	-10004	-1433.5	-10090.8	-4121	-3870.2
Model fit statistics							
AIC	20365.5	20294.0	20032.1	8327.0	20229.5	8334.4	7792.3

Abbreviation:- HR: Hazard ratio, SE: standard error, VPC: variance partition coefficient, PCV: proportional change in variance, AIC: Akaike information criterion, *p<0.05.

7.2 Summary of the Chapter

This chapter addressed the extent to which the contextual factors account for variations in infant and child mortality across the six regions of Nigeria. Using multilevel Cox proportional regression analysis, the chapter examines the effects of child-level, mother-level and community-level characteristics on regional variations in infant and child mortality in Nigeria. Fixed effects which models associations and random effects which models variations in multilevel analysis (Merlo, Chaix, Yang, et al., 2005) were employed to interpret findings.

Results in this chapter demonstrated the importance of individual and community contexts in the risks of infant and child mortality across regions. For instance, results from the null model indicated a significant variation in infant and child mortality across communities. This result could be interpreted as evidence of variations in infant and child mortality between communities. Findings suggest that conditions of community contexts where children are born or raised contribute significantly to the variations in infant and child mortality across regions of the country. This suggests the need to take community contexts into consideration (Aremu, 2011, Boco, 2010) in the efforts to address high infant and child mortality in Nigeria.

Results from the null model further revealed that the between communities variance expressed as VPC or ICC estimated for child mortality was larger than the between communities variance estimated for infant mortality during the 1999-2003 and 2004-2008 periods. This suggests that intra-community variations associated with risk of dying in infancy was smaller than the observed variations associated with risk of dying in childhood. Results also showed that the observed intra-community variations in infant and child mortality appear to be larger in 2008 than in 2003. This suggests increase in variations associated with risks of infant and child mortality across communities in Nigeria in 2008. Findings also established a strong association between region of residence and infant/child mortality during the period under study. A careful comparison of findings from 2003 and 2008 NDHS datasets indicated that regional variations in the risks of death in infancy had slightly reduced during the period under study. Results suggest that the variation associated with childhood mortality was higher than the variation in infant mortality across regions of the country.

Results from multilevel analysis from both surveys indicated that child-level variables were not so important in explaining regional variations in the risks of death in infancy or childhood. This suggests that the effect of region where children were born or raised on their survival is independent of child-level characteristics. In contrast, findings indicated that mother-level characteristics were considerably important. This is because the variations in infant and child mortality explained by mother-level characteristics were significantly large across communities. This results suggest that the mother-level variables incorporated into the multilevel analysis – such as maternal education, wealth index, contraceptive use, number of children ever born and maternal age are important factors that influence regional variations in the risks of dying during infancy or childhood. For instance, overall for under-five mortality, findings suggest that being a child of an educated woman with at least secondary education, being a child of woman from households in the richest wealth quintile and being a child of woman that used modern contraceptives was associated with lower risks of under-five mortality, irrespective of the region of residence a child comes from.

Results further suggest that community-level factors were more important in explaining death during childhood compared to death during infancy. Inclusion of community-level factors in the multilevel analysis resulted in reduction in the risks of dying during childhood across in all regions, except North-east and South-south where some increase was observed. This suggests that while the characteristics of the community tend to mitigate the risks of death in childhood in other regions, the risks of childhood death seemed to be amplified in the North-east and South-south. Literature established that characteristics of the community context can either mitigate or exacerbate mortality risks of individuals depending on the environmental context the individuals find themselves (Sastry, 2007).

Results from the final model, using 2003 NDHS dataset, indicated that region of residence, place of residence, community poverty, community infrastructure, prenatal care by a skilled provider, child's size at birth, birth interval, maternal age and contraceptive use were found to be significantly associated with infant and child mortality. Similarly, results from the final model, using 2008 dataset, showed that region of residence, place of residence, ethnic diversity, family structure, birth interval, child's sex and child's size at birth were significant covariates influencing risks of infant and child mortality.

Finally, results of the measure of variations from the final model suggest that the estimated explained variations in infant and child mortality across communities were partly due to the individual and community level characteristics included in the final model and partly due to unobserved characteristics not included in the model. This means that there are unmeasured characteristics that were not included in the multilevel analysis but which also influence clustering of infant and child mortality at the individual, household and community levels.

CHAPTER EIGHT

HYPOTHESES TESTING

8.0 Introduction

The purpose of this chapter is to test the study's hypotheses, most of which focused on the relationship between contextual independent variables and outcome variables. Seven research hypotheses were tested:

(1) lower risk of infant and child mortality is associated with residence in communities with a high proportion of women who had secondary or higher education;

(2) easy access to health care facility significantly decreases the risk of infant and child mortality;

(3) residence in communities with a high proportion of women who had prenatal care by a skilled provider significantly lowers the risks of infant and child mortality;

(4) region of residence is a significant predictor of infant and child mortality;

(5) residence in heterogeneous communities is significantly associated with higher risks of infant and child mortality;

(6) ethnicity is a significant predictor of infant and child mortality; and

(7) polygyny is positively related to increased risks of infant and child mortality.

Out of the three objectives examined in this study, objective one was addressed using descriptive statistics (i.e. direct and indirect techniques), while inferential statistics (i.e. Cox proportional regression analysis) was employed to addressed the second and the third objectives. These last two objectives were addressed by testing the hypotheses listed above.

8.1 Theoretical and empirical background for the research hypotheses

This section provides some theoretical and empirical background for the hypotheses tested. The first posits that lower risk of infant and child mortality is significantly associated with residence in communities that had a high proportion of women with secondary or higher education. Literature has established a huge difference between primary and secondary levels of education (Straková, 2010), hence, it was hypothesised that women with at least a secondary level of education would be better equipped to take care of their children. Literature furthermore has shown that secondary or higher education contexts tend to provide social capital that increases the survival chances of the children of mothers who themselves have little or no education but reside in communities that had a high proportion of people with secondary or higher education.

As earlier noted, Diez-Roux et al (2001) posited that the physical and social characteristics of communities where individuals live could affect their health and health-related behaviour. For instance, an uneducated woman who lives in a community predominantly occupied by well-educated people is likely to be positively influenced towards adopting appropriate health-seeking behaviour for her own health and that of her children. Neighbourhood effects theory has established a link between residential environment and an individual's health outcome (Galster, 2010).

This theory also provides background and justification for hypotheses 2 to 5. It is established in the literature that residence in a poor neighbourhood tends to influence health outcomes (Aremu, et al., 2011). Relating different community-level characteristics to children's survival chances, as indicated in hypotheses 1 to 5, posit that residence in an economically and socially deprived community significantly influences children's survival chances. For instance, hypothesis 2 posits that easy access to a health care facility significantly decreases the risk of infant and child mortality. This is because children raised in communities that lack a health facility are likely to suffer poorer health outcomes than those children from communities where good health facilities are available. Harttgen & Misselhorn, (2006) argued that there would be differences in health outcomes of children from two communities that have contrasting characteristics.

The first five hypotheses were based on the Mosley-Chen model, Sastry's framework and neighbourhood effects model, which provide the theoretical foundation that community attributes can amplify or diminish mortality risks depending on the characteristics of the contexts where individuals live (Sastry, 1997; Macintyre *et al.*, 2002). The models maintained that health outcomes of individuals largely depend on the interaction between attributes of the community, the individual and household characteristics.

Hypotheses 6, which postulates that ethnic affiliation is a significant predictor of infant and child mortality rests on the premise that the socio-economic determinants of child mortality operate through a set of biological and proximate mechanisms (Mosley and Chen, 1984, as published in the bulletin of WHO, 2003). In Sastry's framework for interpreting determinants of mortality, the proximate factors which could influence child mortality due to ethnic affiliation were categorised as shared preferences, values and cultural influences. These are basically considered as behavioural factors. Nigeria is a multi-ethnic country and various ethnic groups have different behavioural factors, shared preferences, values and cultural practices that can directly or indirectly influence children's health outcomes, hence hypothesis 6 posits that ethnic affiliation is a significant predictor of infant and child mortality in Nigeria.

Hypothesis 7, which posits that polygyny is positively related to increased risks of infant and child mortality also rests on the Mosley-Chen model and Sastry's framework. Practice such as plural marriage is a behavioural factor that can directly or indirectly influence child survival and literature has established negative hypothesis of polygyny (Amankwaa, 1996; Amey, 2002; Desai, 1992; Omariba. & Boyle, 2007; Strassmann, 1997).

8.2 Testing of hypotheses

8.2.1 Hypothesis one

H_0: Lower risk of infant and child mortality is not associated with residence in communities with a high proportion of women who had secondary or higher education.

H_1: Lower risk of infant and child mortality is associated with residence in communities with a high proportion of women who had secondary or higher education.

The hypothesis stated above examines the relationship between community-level maternal education and infant/child mortality in Nigeria. It was tested by conducting multilevel Cox proportional regression analysis. The significance of this relationship was tested by examining the p-value corresponding to the estimated hazard ratios, with the p-value set at 95% significance level (α=0.05). Multilevel Cox proportional hazard models were fitted to examine the effects of community maternal education on regional variations in infant and child mortality in Nigeria. To do this, community-level variables were first considered separately in the multilevel analysis, followed by inclusion of variables at various levels of operation into the multilevel analysis. Results from analysis of both 2003 and 2008 data (Tables 7.1-7.6) indicated that residence in communities with a high proportion of women who had secondary or higher education was significantly associated with lower risks of infant and child mortality at 5% level of significance (thereby leading rejection of null hypothesis), with community education having significant effects for regional variations in child mortality and overall for under-five mortality, but not for infant mortality.

Generally, it could be said that the findings of this study confirmed the hypothesis 1 - that a lower risk of infant and child mortality is significantly associated with residence in communities that had a high proportion of women with secondary or higher education. However, results of this hypothesis testing showed that community maternal education was more important in explaining regional variation in child mortality than infant mortality.

8.2.2 Hypothesis two

H_0: Easy access to a health care facility does not significantly decrease the risk of infant and child mortality.

H_1: Easy access to a health care facility significantly decreases the risk of infant and child mortality.

Hypothesis 2 tests the association between access to health care facility and infant and child mortality. The testing of this hypothesis involved fitting multilevel Cox proportional hazard models and examination of the corresponding p-value set at 95% significance level (α=0.05). The results of this test indicate that easy access to a health care facility was not significantly associated with regional variations in infant and child mortality, thereby leading to the acceptance of null hypothesis. Results from analysis of both 2003 and 2008 NDHS did not provide sufficient evidence that would enable the acceptance of research hypothesis that easy access to a health care facility is significantly associated with infant and child mortality in Nigeria. This means that the study data could not confirm this hypothesis.

8.2.3 Hypothesis three

H_0: Residence in communities with a high proportion of women who had prenatal care by a skilled provider does not lower the risks of infant and child mortality.

H_1: Residence in communities with a high proportion of women who had prenatal care by a skilled provider significantly lowers the risks of infant and child mortality.

Hypothesis 3 examines the relationship between community-level prenatal care by a skilled provider and infant/child mortality. To test this hypothesis, the significance of the relationship between community prenatal care and infant and child mortality was tested by examining the p-value associated with the estimated hazard ratio, with significance level of p-value set at 95% alpha level ($\alpha=0.05$).

Results from testing this hypothesis, from analysis of 2003 data, showed that residence in communities that had a high proportion of women who received prenatal care by a skilled provider was significantly associated with lower risks of infant and child mortality in Nigeria ($p<0.05$). This relationship became insignificant after adjusting for the effects of other variables at different levels of operation. Results from 2008 data indicated that residence in communities with a high proportion of women who received prenatal care by a skilled provider was only significantly related with lower risks of infant mortality, but not associated with lower risks of child mortality. The results of the test for hypothesis 3 could be regarded as mixed; suggesting that hypothesis 3 could not be sufficiently confirmed by results from the analysis of 2003 and 2008 NDHS datasets.

8.2.4 Hypothesis four

H_0: Region of residence is a significant predictor of infant and child mortality.

H_1: Region of residence is a significant predictor of infant and child mortality.

Hypothesis 4 examines the association between region of residence and infant/child mortality in Nigeria. This hypothesis posits that residence in a particular region of the country significantly influences the risks of infant and child mortality. The testing of this hypothesis involved fitting of multilevel Cox regression models and examination of the significance of the association between the predictor and the outcome variables, with the p-value set at 95% confidence level ($\alpha=0.05$).

Results from the analysis of both 2003 and 2008 data revealed a significant association between region of residence and infant and child mortality in Nigeria ($p<0.05$). Findings indicated region of residence as a significant predictor of the outcome variables, ($p<0.05$), thereby leading to rejection of the null hypothesis (H_0). As specified in the alternative hypothesis (H_1), evidence from both datasets confirmed region of residence as an important contextual factor that influences infant and child mortality across communities in Nigeria. This suggests that residence in a particular region in Nigeria is significantly associated with variations in infant and child mortality across the country. For instance, residence in the South-western part of Nigeria is associated with the lowest risks of infant and child mortality while residence in the North-east is associated with the highest risks of infant/child mortality.

8.2.5 Hypothesis five

H_0: Residence in heterogeneous communities is not associated with higher risks of infant and child mortality.

H_1: Residence in heterogeneous communities is significantly associated with higher risks of infant and child mortality

Hypothesis 5 focuses on the relationship between ethnic diversity and infant and child mortality. It is hypothesised that living in an ethnically heterogeneous community significantly increases the risks of death in infancy or childhood. This hypothesis was tested using multilevel Cox proportional hazard models. The significant association between the independent and the outcome variables was tested by examining the corresponding p-value of the estimated hazard ratio which was set at 95% level of significance ($\alpha=0.05$).

Results from the analysis of 2003 NDHS data revealed that residence in heterogeneous communities was significantly associated only with infant mortality but not with child mortality. This result suggests that a child born or raised in a heterogeneous community had an elevated risk of dying during the first year of life relative to children in homogeneous community. This suggests that ethnic diversity was more important in explaining infant mortality than child mortality. Results from the analysis of 2008 NDHS data did not provide enough evidence to confirm hypothesis 5. Even evidence from 2003 data suggests that ethnic diversity was only an important predictor of child survival during the first year of life. Furthermore, once the child survives beyond age 1, the positive effects of community cohesion and togetherness on child survival (which results from residence in homogeneous communities) tend to disappear.

8.2.6 Hypothesis six

H_0: Ethnicity is not a significant predictor of infant and child mortality.

H_1: Ethnicity is a significant predictor of infant and child mortality.

Hypothesis 6, which examined the relationship between mother's ethnic affiliation and infant and child mortality, was tested by fitting adjusted and unadjusted hazard ratio. Ethnicity covariate was not included in the multilevel analysis due to its correlation with region of residence covariate; hence hypothesis 6 was not tested using multilevel Cox proportional hazard models.

The results of Cox proportional hazard analysis showed that ethnicity was a significant predictor of infant and child mortality in Nigeria, with the children of Hausa/Fulani/Kanuri ethnic groups generally having the highest risks of infant and child mortality while the children of the Yoruba ethnic group had the lowest risks of infant and child mortality in Nigeria. An examination of the corresponding p-value of the measures of association between ethnic affiliation and child survival which was set at 95% level of significance (α=0.05) revealed a significant relationship between the predictor and the outcome variables, thereby leading to the rejection of the null hypothesis. This means that evidence from both 2003 and 2008 NDHS confirmed hypothesis 6 - that ethnic affiliation is a significant predictor of infant and child mortality in Nigeria.

8.2.7 Hypothesis seven

H_0: Polygyny is not related to increased risks of infant and child mortality.

H_1: Polygyny is positively related to increased risks of infant and child mortality.

Hypothesis 7 posits that residence in a household where there are co-wives significantly increases the risks of infant and child mortality. The testing of this hypothesis was done using the results from the multilevel analysis. The test also involved examination of the corresponding p-value of the test statistic set at 95% level of significance ($\alpha=0.05$).

Results from analysis of both 2003 and 2008 data using multilevel Cox proportional hazard models indicated that the association between polygyny and infant/child mortality was not statistically significant, thereby leading to the acceptance of null hypothesis (which states that polygyny is not related to increased risks of infant and child mortality). Findings from analysis of both datasets did not provide sufficient evidence that would enable the acceptance of research hypothesis - that polygyny is positively related to increased risks of infant and child mortality in Nigeria. Although unadjusted hazard ratios confirmed the negative influence of polygyny on child survival, results from the adjusted hazard ratios and the multilevel analysis could not confirm this hypothesis.

8.3 Summary of the chapter

In all, seven hypotheses were tested in this study. Hypotheses 1 to 5 focused on the influences of community contextual determinants on infant and child mortality.

Results from the study data confirmed hypothesis 1 - that lower risk of infant and child mortality is significantly associated with residence in communities with a high proportion of women who had secondary or higher education. Results showed that community education was more important in explaining regional variations in child mortality than infant mortality. Results from the study data could not confirm hypothesis 2. Findings showed that easy access to a health care facility was not significantly associated with lower risks of infant and child mortality.

Results of the hypothesis 3 testing could be regarded as mixed. This suggests that evidence from 2003 and 2008 data could not sufficiently confirm that residence in communities with a high proportion of women who received prenatal care by a skilled provider significantly lowers the risks of infant and child mortality in Nigeria. Considering hypothesis 4, evidence from both 2003 and 2008 NDHS data confirmed hypothesis 4 that region of residence is a significant predictor of infant and child mortality in Nigeria. The study data also confirmed hypothesis 5 that residence in heterogeneous communities is significantly associated with higher risks of infant and child mortality in Nigeria.

In addition, hypotheses 6 and 7 stated above focused on individual-level compositional factors of ethnicity and polygyny. The former posited that children's survival chances could be influenced by such characteristic as ethnic affiliation of the parents while the latter postulated that polygynous context could exacerbate the risks of infant and child mortality. Evidence from this study confirmed hypothesis 6 that ethnic affiliation is a significant predictor of infant and child mortality. However, there was insufficient evidence from the study data to confirm hypothesis 7 – that polygyny is significantly associated with increased risks of infant and child mortality in Nigeria.

CHAPTER NINE

DISCUSSION, CONCLUSION AND RECOMMENDATIONS

9.0 Introduction

This study has addressed three specific objectives. First, it examined the levels and magnitudes of infant and child mortality in Nigeria. Second, it identified the individual, household, and community-level factors associated with infant and child mortality there. Third, it determined the extent to which the contextual factors account for regional variations in infant and child mortality in Nigeria.

The purpose of the ninth chapter is to present the discussion of findings of this study. Furthermore, it presents the study's conclusion and recommendations. Summaries of the findings presented in the fourth to seventh chapters were drawn,, expatiated and discussed in the light of the existing literature.

This chapter is divided into seven sections. The first section presents the discussion on the levels and magnitudes of infant and child mortality in Nigeria, and discusses the quality assessment of the data. Section two presents the discussion on the individual, household and community-level factors which influence infant and child mortality in Nigeria. The third section discusses the extent to which contextual factors explain regional variations in infant and child mortality in Nigeria. Some contributions to theory are discussed in section four. Section five presents the strengths and weaknesses of the study while section six presents the conclusions, recommendations and policy implications of the findings. Some frontiers for future research are identified in section seven.

9.1 Discussion on levels and magnitudes of infant and child mortality in Nigeria and quality of 2003 and 2008 NDHS data

A careful comparison of direct and indirect estimates from both 2003 and 2008 NDHS indicates some decline in mortality level over the 1999-2003 and 2004-2008 periods. However, generally the decline seems minimal as the findings of the study suggest that there were no substantial differences in the levels and patterns of infant and child mortality from both datasets. Previous study had established that countries in sub-Saharan Africa are not making sufficient progress towards the United Nations' goal of achieving a two-third's reduction in childhood mortality (Lyken et al; 2009). The implication of this finding is that much still needs to be done by the National and State Governments if appreciable reduction in infant and child mortality is to be achieved in Nigeria. Besides, the efforts of the international organisations and donor communities need to be re-doubled in order to ensure considerable reduction in infant and child mortality in Nigeria; and perhaps the country could be placed back on course towards achieving the Millennium Development Goal four.

A recent finding by the UNICEF (2012) indicates that the number of children dying before their fifth birthday has declined significantly over the past two decades, from over 12 million under-five deaths in 1990 down to 6.9 million in year 2011. This reduction was largely attributed to the fact that some poorer countries are getting richer through foreign aid that targets programmess such as immunisations against childhood killer diseases, like measles, polio, and pneumonia. The situation of under-five deaths is still considered fragile in India, Nigeria, the Democratic Republic of Congo, Pakistan and China where half of the global under-five deaths were reported to have occurred in 2011 (UNICEF 2012). Findings of this study suggest that much still needs to be done in Nigeria considering that progress made in infant and child mortality reduction during the period under study was minimal.

Results of this study established that the levels of infant mortality were higher than levels of child mortality during the period studied. This result suggests that children below the age of one tend to be more predisposed to higher mortality risks than older children. It has been established that the probability of death during the first year of life, particularly during the neo-natal period, is higher compared to the probability of death after the period beyond age one (Black *et al.*, 2003; Kaldwei, 2010).

Results from both variants of Brass indirect estimation technique and the INDEPTH estimates showed that infant and child mortality rates were generally higher for males than for females. Findings from INDEPTH estimates also indicated a higher expectation of life at birth for females than for males. This is an expected finding as the gender gap in mortality differentials between males and females is often determined by excess male mortality of all ages (Kaldwei, 2010; UNFPA, 2012). The only exception is the period of childbearing (age 15-49) particularly in countries that have a high maternal mortality ratio. Although results on the male-female mortality differentials depict a reduction of the gender gap in mortality differentials during the period under study, the reduction seems negligible.

Results from both Trussel and Palloni-Heligman variants of the Brass estimation technique suggest that mortality information obtained from the women's birth histories provided in the 2003 and 2008 NDHS could be accepted as reliable. NPC and ICF Macro's (2009) assessment of NDHS data quality confirmed that 2003 and 2008 NDHS yielded reliable estimates of the true mortality levels in the country while the data quality assessment for the previous survey, specifically 1999 NDHS data, indicates that the reported rates seem to underestimate the true mortality levels in Nigeria. This could be regarded as one of the strengths of this study, considering the results of the data quality assessment done in this study and elsewhere (NPC and ICF Macro, 2009).

It is noteworthy to mention that the expectations of life obtained in this study using the INDEPTH model life table are consistent with those obtained elsewhere (UNDP, 2011; World Bank, 2011). This also serves to strengthen confidence in the results coming from the analyses of 2003 and 2008 NDHS data.

Results from the INDEPTH estimates indicated some increase in expectation of life at birth for both males and females over the 1999-2003 and 2004-2008 periods. This increase may be due partly to the slight reduction in infant and child mortality rates during the period under study; and partly due to the drop in Nigeria HIV prevalence rate (NACA, 2012).

As established elsewhere (Omariba et al, 2007), results of this study suggest that demographic factors, such as birth order, child's size at birth and preceding birth interval were more important in explaining infant mortality while socio-economic factors, such as wealth index and maternal education were more important in explaining childhood mortality.

9.2 Discussion – individual, household and community-level factors influencing infant and child mortality in Nigeria.

The second objective of this study was to identify the individual, household, and community-level factors associated with infant/child mortality in Nigeria. First, Kaplan-Meir survival estimates were employed to give the graphical descriptions of the risks of death for children who died within ages 0 to 59 months. The Kaplan-Meier estimates showed a different picture for 2003 and 2008 NDHS data. Although estimates from both surveys showed that most under-five deaths occurred within the first year of life, the survival plots for the 2003 survey suggest more frequent drops in the survival curves compared to those for the 2008 survey. This suggests higher mortality risks in 2003 than in 2008. Kaplan-Meier estimates were also presented by selected characteristics. It is noteworthy to mention that the Kaplan-Meir curve by maternal education revealed that childhood mortality between ages 12 and 59 months was a rare phenomenon among the women with tertiary education. All the survival plots by characteristics of interest could be found in appendix C.

Second, Cox proportional hazard regression analysis was employed to identify the individual, household and community-level factors associated with infant and child mortality in Nigeria. The study identified individual-level factors, such as child's sex, birth order, preceding birth interval, child's size at birth, maternal education, ethnic affiliation and family structure as important factors associated with both infant and child mortality in Nigeria. As previously discussed, most of these variables remained significantly associated with infant and child mortality even after adjusting for the effects of other important factors, although some to a lesser degree.

Considering a child's sex, as indicated earlier, the results of multivariate analysis confirmed this as an important predictor of infant and child mortality. Previous studies suggest that globally, death rates of males generally exceed those of females, except in parts of South Asia, the Middle East and North Africa (Basu, 1989). For instance, Boco's (2010) study on twenty-eight (28) sub-Saharan African countries established higher mortality for male children than for females in 27 out of the 28 countries. Conversely, Muhuri and Preston (1991) noted that child mortality rates are generally higher for girls than for boys throughout South Asia. Pebley and Amin (1991) observed excess mortality among female children in rural Punjab in India. Hill and Upchurch (1995) noted that child mortality has been the main driver of excess female mortality among the Chinese population due to excess female mortality risks right from early ages. However, girl child disadvantage, which is largest during childhood, particularly during ages 1 to 4, is mostly driven not by genetic factors but by discrimination in child care in favour of boys (Basu, 1989; Muhuri & Preston, 1991; Okojie, 1994; Svedberg, 1990). In the absence of sex discrimination in child care, child immunization and food provision against a particular sex, child mortality risks are generally higher for males than for females (Basu, 1989; Koenig & D'Souza, 1986), due to genetic factors (Muhuri & Preston, 1991). The present study established higher mortality risks for male children than for females in Nigeria.

Further, as previously found in Nigeria (Uthman, 2008) and elsewhere (Bolstad & Manda, 2001), this study established birth order and preceding birth interval as important predictors of infant and child mortality in Nigeria. Children of first birth and fifth or higher order birth were having higher risks of dying young than children of second to fourth order birth. Similarly**,** children with a short birth interval had higher risks of death than their counterparts with a birth interval of 24 months or longer. This could be due to the maternal depletion syndrome as a result of having births too close and too many births, and because of competition for household resources that often characterize short birth intervals (Boco, 2010, Whitworth & Stephenson, 2002; Yohannes, *et al*., 2011).

This study found that the child's size at birth was significantly associated with infant mortality. The results showed that size at birth was not so important once a child survives beyond the first year of life. Serious and timely intervention in the form of promoting breastfeeding and micronutrient interventions is recommended for stunted and underweight children, particularly during the neonatal period and late infancy (Bhutta *et al.*, 2009; Black *et al.*, 2008; Imdad *et al.*, 2011). Uthman (2008) noted that underweight children are more vulnerable to infections and diseases.

As has been found before (Antai, 2011a; Aremu*, et al.*, 2011; Fuchs *et al.*, 2010; George & Boerma, 1993; Hobcraft, 1993; Odimegwu, 2002; Uthman, 2008; Whitworth & Stephenson, 2002), this study established that maternal education is an important predictor of infant and child mortality. It found that maternal education was most important for child survival, both in infancy and childhood. A possible explanation for this is that higher maternal education could alter a woman's approach to such practices as poor health-seeking behaviour and having too frequent and too many births. Even if an educated woman experiences births that are too close or too many births, maternal education has the advantage of weakening the effect of a short birth interval and higher order birth through increased female autonomy and economic empowerment that guarantees access to resources, which could eliminate competition for household resources among siblings (Whitworth and Stephenson, 2002). Maternal education also has a strong effect on child survival through the influence of reproductive health patterns and equitable care for sons and daughters (Cleland, *et al*, 1988, Kravdal, 2004).

Further, ethnic affiliation was established in this study as an important explanatory factor, which influences infant and child mortality in Nigeria. Moreover, previous studies have established the relationship between ethnicity and health outcomes in Nigeria (Antai, 2011b, Fayeun & Omololu 2011, Wall, 1998) and elsewhere (Anand, 1999; Braun, 2002; Collins., 2004; Culley, 2006; Macbeth & Shetty, 2001). Culley (2006) noted that ethnicity is contextual. Ethnicity cannot be regarded as positive or negative, although ethnic disparities in health tend to have more to do with differences in socio-cultural practices than with genetics (Collins, 2004). Ethnic groups that have developed good health-seeking behaviours are expected to have better child health outcomes than the ethnic groups that hold persistently to poor health-seeking behaviour (Adedini*, et al.*, 2011).

Results of this study established that the Yoruba ethnic group had the lowest risks of infant and child mortality, followed by the Igbo ethnic group, while the Hausa/Fulani/Kanuri ethnic groups had significantly the highest risks of infant and child mortality in Nigeria. Some of the possible reasons for these ethnic disparities in infant and child mortality include disparities in educational attainment and health-seeking practices. For instance, studies have established that the Igbo and Yoruba ethnic groups are the most educated ethnic groups in Nigeria (Adedini*, et al.*, 2011; Antai, 2011a). Hence practices such as poor health-seeking and high-fertility related behaviours, such as having high parity and frequent births are becoming less fashionable among Igbo and Yoruba ethnic groups. Besides, the practices of postponing marriage and child-bearing seemed well entrenched in their culture. In contrast, the Hausa/Fulani/Kanuri ethnic groups have the highest risks of infant and child mortality, perhaps because they are mostly uneducated, as established in this study. Other reasons that could be attributed to higher infant and child mortality risks among Hausa/Fulani/Kanuri ethnic groups are poor health-seeking behaviour as well as early motherhood (Wall, 1998).

It was found that the risks of infant and child mortality were significantly lower if children are raised in households that had electric connection, drinkable water and a flush toilet. Sastry (1996) noted that water connections, access to health facilities and toilet facilities are important predictors of child health outcomes, with the health problem becoming more severe for children of uneducated women who also lack access to such household facilities. The present analysis also revealed that once adjustments were made for other important covariates such as maternal education and wealth status, the significance of these household facilities waned to a lesser degree. This suggests that the importance of access to drinkable water, electric connection and a good toilet facility tends to be negligible for children of better-educated and better-off women while the effect is significant for the children of less-educated and poorer women.

Wealth index covariate is another important determinant of infant and child mortality that was established in this study, which indicated an inverse relationship between household wealth and infant and child mortality. This showed that risks of infant and child mortality tend to increase with decreasing household wealth. As one would expect, children from households in poor wealth quintile are likely to suffer from resource constraints due to limited access to household resources. This study established that children of women with improved wealth status had reduced risks of under-five mortality, both in the economically advantaged areas as well as in socially and economically deprived settings, such as rural areas. This establishes the significance of household wealth as a strong predictor of infant and child mortality, although its significance seems to be more felt in childhood than in infancy. This corroborates previous findings by Omariba *et al.,* (2007), which established that socio-economic factors such as education, occupation and wealth index are more important in childhood than in infancy.

The findings of this study further provide empirical support that uptake of modern contraceptive methods helps in increasing children's survival chances. These analyses, using both datasets, indicates a significantly lower risk of dying young for children whose mothers were using modern contraceptive methods compared to children whose mothers were using no method. Previous studies had stressed the importance of family planning as the pillar of safe motherhood and improved child health outcomes. For instance, Cleland *et al.,* (2006) projected that increasing contraceptive use in countries with high fertility rates has the potential of averting about 32% of all maternal deaths and 10% of childhood deaths.

Since high fertility is seen as issue of public health concern (Bongaarts & Sinding, 2009; Moreland *et al.*, 2010; Odimegwu., 1999; Sinding *et al.*, 1994) due to its implication for maternal and child health (Kotb *et al.*, 2011; Kuhlmann *et al.*, 2010), the present analysis suggests that uptake of modern contraceptive methods will help to accelerate speed towards a significant reduction in under-five mortality in Nigeria. Nigeria's contraceptive prevalence rate currently stands at 10% (NPC & ICF Macro, 2009). Considering the importance of modern contraceptive methods for child survival through adequate births spacing and limiting (Adedini, Odimegwu, Ononokpono, & Imasiku, 2012), such commonly-cited reasons for non-use of contraception like fear of side effects (Oye-Adeniran *et al.*, 2006), religious prohibition (Avong, 2000; Srikanthan & Robert, 2008), and husband rejection (Bongaarts & Bruce, 1995; Duze & Mohammed, 2006; Onwuzurike & Uzochukwu, 2001) must be addressed if Nigeria's quest for the attainment of MDG 4 will be a reality.

Furthermore, various characteristics of community contexts were found to exhibit significant effects on children's survival chances. Most importantly, the study's findings showed that region of residence was significantly associated with infant and child mortality in Nigeria.

Comparing the risks of death in the northern regions with the risks of death in the southern regions of the country, generally the former had elevated risks of infant and child death compared to the latter. Juxtaposing the risks of death in all the six regions of the country, the North-east and North-west, both in Northern Nigeria, are the two regions with the highest risks of infant and child mortality. The North-central region, which is also in the northern part of Nigeria, had a far lower risk of infant and child death than the rest of the regions in the north. A possible explanation is that while the other two regions of the north comprise the states predominantly occupied by Hausa, Fulani, and Kanuri ethnic groups, the North-central region of the country is mainly occupied by the minority ethnic groups. Furthermore, the Nation's Federal Capital Territory (FCT) is located in the North-Central, and the FCT has brought a lot of development to this region. Such development is expected to have a positive implication for child survival, possibly through regular immunization campaigns, improved access to health care facility, better attitude towards health seeking and improved well-being among the people through increased access to economic opportunities and resources.

While the characteristics of community context tend to mitigate infant and child mortality in some regions, those contextual characteristics tend to exacerbate mortality risks in some others. Results of this study suggest that the former scenario represents the situation in the southern regions of the country while the latter scenario is reminiscent of the situation in the North-east and North-west. Other reasons for regional disparities in infant and child mortality across regions in Nigeria are diverse. For instance, North-east and North-west regions are regions where children were mostly of higher order birth – i.e. fifth order or higher, mothers were mostly uneducated, mainly unemployed and in poor households, and were mostly teenagers at the time of their first birth (Adedini*, et al.*, 2011).

It is noteworthy to mention that some progress, though very minimal, was made in infant and child mortality reduction across the six regions of the country during the 1999-2003 and 2004-2008 periods.

As has been previously established (Adetunji, 1994, Brockerhoff, 1990), the present study established place of residence as an important contextual predictor of infant and child mortality in Nigeria. It is not an unexpected result that children of mothers residing in rural areas had significantly higher risks of infant and child death compared to children of mothers in the urban centres. This is because access to good health care services is likely to be limited in rural areas compared to urban centres. Besides, women in the rural areas are likely to be less educated compared with their counterparts in the urban centres.

Adjusting for the effects of other important factors made the effect of place of residence on children survival to be statistically insignificant. This suggests that contextual characteristics, such as community-level maternal education, access to drinkable water in the community, easy access to health- care services by members of the community could lead to reduced risks of infant and child mortality even in socially and economically deprived areas like rural settings.

Juxtaposing the results from analysis of 2003 and 2008 data, findings revealed a reduction in urban-rural differentials in infant and child mortality over the 1999-2003 and 2004-2008 periods. However, the decline in rural and urban mortality differential seems minimal. This suggests that efforts to achieve significant under-five mortality reduction in Nigeria should include policies that address urban-rural differentials in the distribution of health facilities (Adetunji, 1994) as well as other factors that worsen the urban-rural mortality differentials.

Results from 2003 NDHS data showed that ethnic diversity was significantly associated with infant mortality but not with child mortality. This finding suggests that infants in an ethnically heterogeneous community were having an elevated risk of dying during the first year of life. Once a child survives beyond the first year of life there exists no significant difference between the mortality experience of children in homogenous communities and those in heterogeneous communities. Results from 2008 NDHS data suggest that the importance of neighbourhood ethnic composition may have waned between 2003 and 2008, as there was no significant difference in the risks of infant and child mortality in a heterogeneous community and homogenous community. Also, because of higher ethnic diversity in Nigeria as in many other countries of sub-Saharan Africa, the effects of community ethnic composition on child survival appear complex, and the effects may be difficult to understand (Boco, 2010).

Furthermore, as earlier indicated, maternal education at an individual level was important in explaining infant and child mortality in Nigeria during the period under study. In addition , at the contextual level the community-level maternal education was found to be an important predictor of child survival. The study's findings indicated lower risks of death for children of mothers who were resident in communities where there were many educated women. The results indicate that individual-level and community-level maternal education are important for child survival in Nigeria and that children whose mothers had little or no education appear to benefit from the social capital contexts provided by the educational attainment of other women within the same neigbourhood. A plausible explanation for this is that an uneducated woman who resides in a community that is predominated by educated people may learn such behaviours and practices that go with acquisition of formal education, and which could have a positive influence on children's health and survival.

As Kravdal (2004:177) puts it: "…the effect of community education, like that of individual education, operates through the use of maternity services and other preventive health services, the child's nutrition's and the mother's care for a sick child". He noted that a high average community-level of education tends to increase women's use of preventive health care during pregnancy, increase chances that children get vaccinated and receive vitamin A supplements as well as breast milk and complementary food to enhance their survival chances. The present study has established that the effect of social capital provided by the education of other women in the community is of substantial benefit for the health and survival of children of mothers who had little or no education.

It was further established that neighbourhood infrastructures, such as access to electricity and portable water in a community were important predictors of infant and child mortality in Nigeria during the period under study. This result points to the importance of good infrastructural contexts for child survival. Availability and access to drinkable water within the neighbourhood could prevent children from contacting avoidable infections and water-borne diseases, such as diarrheal disease and other forms of infections.

This study has established that health care contexts are important predictors of infant and child mortality in Nigeria. It was found that living in communities that had a high percentage of mothers who delivered their children in hospital was associated with lower risks of infant and child mortality. Moreover, residence in communities with a high percentage of mothers who had prenatal care by skilled medical workers was associated with lower risks of infant and child mortality. These findings suggest that children born or raised in communities where the uptake of prenatal care services and hospital delivery is high had higher survival chances, perhaps because of good health care contexts provided by the availability of health facilities and skilled birth attendants within such communities. In addition, it was found that living in communities close to a health-care facility tend to increase children's survival chances, particularly during the first year of life.

The socio-economic context of the community where children are born or raised was another important predictor of infant and child mortality in Nigeria. It was established that poverty concentration within a community tends to significantly increase risks of infant and child mortality. Nigeria is one of the sub-Saharan African countries that face most critical infrastructure challenges (Akinwale, 2010; Foster & Pushak, 2011). Factors that contribute to poor socio-economic contexts in Nigeria include poor infrastructure (National Planning Commission, 2004). The negative effect of a poor socio-economic context on child survival is therefore expected to be severe in a country like Nigeria that is highly infrastructural deficient.

A long period of military rule and corrupt practices at various levels of governance in Nigeria had led to attendant economic hardship and non-availability of good infrastructures in the country (National Planning Commission, 2004; Osoba, 1996). Since successive Nigeria governments have failed in their roles to provide social services, such as good roads, electricity, piped-borne water, health facilities as well as adequate securities among others, the usual practice at present is for the relatively better-off communities to make communal arrangements to provide services such as bore-holes, dispensaries, motorable roads and even vigilante groups for their communal use. While these activities may be affordable for very rich and relatively better-off communities, poor communities would find it difficult to make provision for such services. This study has established an elevated risk of infant and child mortality for communities that had poor socio-economic contexts, perhaps because young children are likely to be highly vulnerable to unfavorable community contexts arising from lack of essential social services. This establishes one of the reasons why poor neigbourhoods like slums tend to have poorer child health outcomes than the better-off neigbourhoods.

9.3 Discussion on the influence of contextual determinants on regional variations in infant and child mortality in Nigeria

The third objective of this study was to determine the extent to which the contextual factors explain the variations in infant and child mortality across regions in Nigeria. Considering that substantial variations in infant and child mortality exist across regions in Nigeria, the third objective attempted to determine the extent to which the characteristics of the community contexts explain variations in infant and child mortality across regions.

The study's findings demonstrated that characteristics of the neighbourhood or community contexts are important factors which influence regional variations in infant and child mortality in Nigeria. It has shown that variations in the risks of infant and child mortality across Nigeria's communities and regions were jointly determined by the observed child-level, mother-level and community contextual determinants, as well as by unobserved effects at various levels. Considering the relative contribution of the community contextual factors to the regional variations in infant and child mortality in Nigeria, this study indicated that the measures of variations expressed as intra-community coefficient were significant and large enough to influence variations in infant and child mortality risks across communities and regions. This result suggests that there is a need to take the influences of community contexts into consideration if enough progress is to be achieved in infant and child mortality reduction.

Results showed that the between-communities variance associated with mortality during childhood was larger than the between-communities variance associated with infant mortality during the period under study. This suggests that community contextual factors are more important in explaining death during ages 12 to 59 months compared to death during the first year of life. This indicates a higher community-level clustering of death during childhood than in infancy. The plausible explanation for this is that children are likely to have a limited contact with the community environments during the first year of life, as children's exposure to unfavourable conditions in the neighbourhood tend to increase with increasing age (Boco, 2010).

In addition, a comparison of the measures of variations from the analysis of 2003 and 2008 NDHS datasets indicated that the intra-community variations in infant and child mortality was larger in 2008 than in 2003. This suggests an increased gap in infant and child mortality variations between and across communities and regions during the 2004-2008 periods.

After adding the region of residence covariate into the multilevel model, results revealed that infant and child mortality was significantly associated with region of residence during the period under study. The associated measures of variations suggest that substantial variations in infant and child mortality between and across communities could be partly explained by region of residence. This result suggests that residence in a particular region of Nigeria is a major determinant of variations in the risks of infant and child mortality. This finding may be attributed to spatial inequality in social and economic development between regions (Antai, 2011b), inequality in the distribution and use of health facilities (Adetunji, 1994; Pradhan *et al.*, 2003; Say & Raine, 2007; Stock, 1983), differences in maternal education between and across regions, differences in hygiene practices (Ladusingh & Singh, 2006), differences in age at first marriage (Wall, 1998) as well as differences in community education and use of preventive health care services (Kravdal, 2004; Ladusingh & Singh, 2006).

A comparison of results from the analysis of 2003 and 2008 data indicated that the regional variations in the risks of death in childhood were higher than those associated with infant mortality across the six regions of the country. While there were declines in the risks of infant mortality across regions between 2003 and 2008, results indicated some increase in the risks of death during childhood in the North-central, North-west and South-east. This suggests that characteristics of community contexts appear to amplify childhood mortality risks in those regions during the period under study.

Also, more variations in under-five mortality were explained by regions of residence in 2008 than in 2003. A possible explanation for this is that characteristics of the community contexts, which could influence child survival (such as health contexts, education contexts, community infrastructures etc.), perhaps improved in some regions while they grew worse in others; thereby widening the gap in child mortality risks between regions.

This study suggests that child-level characteristics were not as important as mother-level and community-level characteristics in explaining variations in infant and child mortality across regions. This is because multilevel analysis showed that regional variations in infant and child mortality were found to be independent of child-level characteristics, such as birth order, child's sex, and child's size at birth.

In contrast, the variations in mortality risks explained by the mother-level characteristics were significantly large across communities. Mother-level characteristics, such as maternal education, maternal age, mother's religious affiliation, wealth status, and contraceptive use were established as important factors influencing variations in infant and child mortality across regions in Nigeria.

Differences in these mother-level characteristics between regions partly accounted for variations in infant and child mortality across the six regions of the country.

Further, the explained variations in infant and child mortality associated with the community-level contextual determinants were significantly large. This suggests that characteristics of the community contexts, such as place of residence, region of residence, ethnic diversity, community maternal education, community prenatal care by a skilled provider, community hospital delivery, and community infrastructures were very important in explaining variations in infant and child mortality across the regions of Nigeria.

Considering place of residence, for instance, infant and child mortality is likely to be higher in the regions that are predominantly rural compared to the more urbanized regions. This is possibly partly due to the differentials in the distribution of health care facilities between rural and urban communities (Adetunji, 1994; Stock, 1983), with urban residents having easier access to health care facilities than their rural counterparts. Evidence showed that more than half of the people in the regions of the south were resident in urban areas, while between 75 and 80 percent of the people in the northern regions were residing in the rural areas (Adedini, Odimegwu, Ononokpono, Ibisomi*, et al.*, 2012). This huge differential in the composition of rural-urban population between the north and the south tend to contribute to regional variations in infant and child mortality in Nigeria.

Considering the significance of ethnic diversity in influencing regional variations in infant and child mortality in Nigeria, the study's finding established elevated risks of infant and child mortality for children of mothers residing in the ethnically heterogeneous communities. The South-south region is the most heterogeneous region in the southern part of Nigeria. This may partly explain the reason why the South-south region has a relatively high risk of infant and child mortality when compared to the South-west region, which is highly homogeneous. Boco's (2010) study established the protective role of ethnic concentration or homogeneity for child survival in some countries in sub-Saharan Africa.

In addition, the role of community-level maternal education in explaining regional variations in child survival cannot be overemphasized. The role of the education context is manifested through the development of communal attitude towards the use of child care services and other preventive health care, such as immunization (Kravdal, 2004, Sastry, 1996). This indicates the beneficial effect of the educational attainment of other educated women within the community to the advantage of the child of an uneducated mother. A higher level of education has been linked with selection of medical centres for prompt treatment of childhood disease (Aremu *et al*, 2011). The substantial variations in infant and child mortality between the northern and Southern regions could be partly attributed to variations in the community-level of education between the North and the South. Results of the 2006 Nigeria population and housing census indicate huge disparities in the proportion of educated people between the North and the South, with the latter having a higher proportion of uneducated people than the former (NPC, 2006). The community context of predominantly uneducated people in the North as opposed to community context filled with relatively more educated people in the South is a key factor that contributes to regional variations in infant and child mortality in Nigeria.

In addition, the variation in infant and child mortality across the regions of Nigeria is attributable partly to the disparities in health care contexts between regions. Results of this study established that substantial disparities exist across regions in the use of health facilities for prenatal care and delivery. The finding that risks of infant and child death were highest in the North-east and North-west and lowest in the South-west is partly a reflection of disparities in the health care contexts between the Northern and the Southern regions. For instance, the percentage of children born or raised in communities that had a high proportion of mothers who received prenatal care by a skilled provider, and who had hospital delivery was significantly highest in the South-west and lowest in the North-east and North-west.

Studies have established that living in communities with a good health care context is associated with increased survival chances for children through proximity to health facilities (Adedini, Odimegwu*, et al.*, 2011), utilization of maternal and child health care, use of preventive health care and full immunization (Kravda, 2004). The present study showed that the regions of the South appear to have better health care contexts than those in the North, which has led to substantial variations in infant and child mortality between the Southern regions and Northern regions.

The study's findings further established community infrastructures as an important contextual determinant of regional variations in infant and child mortality in Nigeria. Generally, urban centres tend to have their better share of infrastructures, such as electricity, drinkable water, health facilities, etc., than the rural communities (Adetunji, 1994). As earlier indicated, regions of the South are more urbanized than those in the North (Adedini*, et al.*, 2012), hence the huge differential in infant and child mortality between these regions is partly driven by the disparities in the distribution of community infrastructures.

Stressing the importance of contextual factors for infant and child mortality, the inclusion of all the selected community-level factors into the multilevel analysis resulted in reduction in the risks of child mortality in North-central, North-west and South-east, while some increase was observed in the North-east and South-south (South-west region is the reference category). This suggests that the characteristics of community contexts tend to help in mitigating child mortality risks in the North-central, North-west and South-east while the contextual characteristics seem to exacerbate child mortality risks in the North-east and the South-south. The increased risks of childhood mortality explained by community contextual factors in the region like South-south is possibly due to environmental degradation emanating from crude oil spillage as well as geographical deprivation due to inadequate provision of community infrastructure (Antai, 2011b, Sastry, 2004).

Finally, as earlier indicated, the multilevel analysis suggests the presence of unobserved heterogeneity due to unmeasured characteristics that were not included in this analysis but which may also account for variations in infant and child mortality across communities and regions in Nigeria. This suggests that variations in infant and child mortality across communities and regions are not only due to child-level, mother-level, and community-level variables measured in this study, but are also partly due to other unmeasured or unobserved characteristics. Sastry (1997) classified these unobserved factors as genetic, environmental and behavioural. Some of the unmeasured characteristics not included in this analysis which may also account for regional variations in infant and child mortality in Nigeria are feeding practice, hygienic practice as well as specific ethnic taboos relating to feeding practice and child care. Other unmeasured factors are socio-cultural practices, such as female genital mutilation (FGM), purdah practice (i.e. wife seclusion) and child marriage among Hausa, Fulani and Kanuri ethnic groups (Wall, 1998).

9.4 Neighbourhood Contexts: Some Contribution to theory

This study was conducted with theoretical foundation on the Mosley-Chen model and Sastry's framework. While the former construct was developed for the study of the determinants of child survival in developing countries, the latter was designed to provide basis for interpretation of the effect of factors at various levels of operation on child survival. The hypotheses expressing relationship between the selected characteristics of the neighbourhood context and infant/child mortality as tested in this study were conceptualized and based on the theoretical foundation established by the Mosely-Chen model and Sastry's framework. Contributions of the findings of this study to neighbourhood theory will be considered under three elements: *what, how, why,* as proposed by Whetten (1989)

'WHAT' – The first component of a good theory 'what', refers to the identified and specified concepts or variables. As earlier indicated, Mosley-Chen (1984) proposed that socio-economic determinants of child mortality operate through a set of biological and proximate mechanisms (Mosley and Chen, 1984:140 - as published in the bulletin of WHO, 2003). Sastry (1997) attempted to build on the premise

established by the Mosley-Chen model by categorizing the proximate determinants identified by Mosley and Chen into three groups: genetic, behavioural and environmental. The third category of Sastry framework – environmental, as shown in Figure 2.1 (in Chapter 2) was further divided into family-level factor (i.e. household environment) and community-level factors (i.e. infrastructure, climate, and physical and disease environment).

Essentially, the focus of the present study was to examine the contextual determinants of infant and child mortality. As a result, most of the hypotheses tested focused on the relationship between contextual factors and infant/child mortality. The selected characteristics of the neighbourhood contexts, such as community education context, community health context, socio-economic context, region of residence, and community infrastructure exhibited significant influence on infant and child mortality. The results of the hypotheses test in this study seem to be in consonance with Sastry's framework, particularly with respect to the characteristics outlined in the third level and third category of the framework (i.e. community and environmental) (Figure 2.1). For instance, the framework posits that infrastructure and climate are important community-level factors influencing child survival. The results of the present study also established community infrastructure as a significant predictor of infant and child mortality in Nigeria.

The present study makes some theoretical contribution by adding factors, such as community education contexts and community health contexts to the predictors of children survival chances outlined in the Sastry framework. For instance, the results of the hypothesis test in this study showed that a lower risk of infant and child mortality was significantly associated with residence in communities that had a high proportion of women with secondary or higher education.

'HOW' and 'WHY' components are employed to justify and provide brief explanation of the contributions to theory. While the second component of a good theory – 'how' refers to the relationship between variables or concepts, the third component – 'why' refers to the explanations for the theorized relationship (Whetten, 1989). Having built on the Mosley-Chen model, Sastry's framework posits that physical and disease environment can influence child survival. However, the relationship between physical/disease environment and child survival can be altered through the mechanism of good health contexts and good education contexts. For instance, even if a child is born or raised in a poor disease environment, availability of good health contexts (in terms of good health facilities and proximity to health facilities) and living in a community predominated by educated people, as the present study suggests, will lead to an increase in children survival chances. Residence in a community that had a good health context and a community predominated by a high proportion of educated people could increase child survival chances through the mechanisms of promptly seeking medical attention and accepting referral (Claeson & Waldman, 2000).

WHO/WHERE/WHEN – The fourth element of a good theory involved the three questions of 'who, where and when'. This refers to the bounding contextual conditions or situations under which the theory operates (Whetten, 1989). Results of the present study provide empirical explanations for why there are variations in infant and child mortality across regions in Nigeria. It could be reasonably argued that irrespective of persons involved, location or period, high infant and child mortality is expected in any community or region that has poor health care contexts and where quality care from mothers is lacking due to little maternal education and poor education contexts.

9.5 Strengths and weaknesses of the study

This study utilized nationally representative data, which offers some advantages. First, Demographic and Health Survey data allow for the generalization of findings across the whole country. Second, the Demographic and Health Survey programme often adopts similar sampling methodology and comparable survey instruments over time; hence results from analysis of two or more DHS data points are comparable over time. In addition, the use of similar methodology can make results comparable across countries.

Strengths of this study include the use of the Cox proportional hazard model employed to tease out the determinants of infant and child mortality in Nigeria. In modeling infant and child mortality, there is a censoring issue that other statistical techniques like logistic regression could not address. For instance, comparing a child who died at age 24 months with a child who died at age 30 months may not be well analyzed using logistic regression. In addition, information on children who are not fully exposed to the mortality risk cannot be correctly analyzed using logistic regression, due to a censoring problem. The Cox regression procedure, which is useful in analyzing both the uncensored and censored observations, was employed in this study.

Furthermore, both Trussel and Palloni-Heligman variants of the Brass estimation technique as well as the Zlotnik and Hill estimation technique were employed to obtain the indirect estimates of infant and child mortality. As earlier discussed, these techniques shed some light on the reliability of the 2003 and 2008 NDHS data. The data quality assessment done in this study could strengthen confidence in the study's findings. Strengths of this study also include the use of INDEPTH model life tables. In the process of computing mortality level and expectation of life, INDEPTH life table accounts for the effects of HIV/AIDS on mortality levels in sub-Saharan Africa (INDEPTH, 2004)

The use of multilevel analysis could also be regarded as a strength of this study. As earlier indicated, many previous studies on infant and child mortality in Nigeria did not account for the hierarchical structure of the mortality data. Such studies attempted fitting a single-level regression modeling and ignored the fact that children are nested within families and families are nested within neighbourhoods or communities (Harttgen & Misselhorn, 2006). Specifically, multilevel survival analysis was employed, using Generalized Linear Latent and Mixed Models (GLLAMM) to tease out the regional variations in infant and child mortality in Nigeria. GLLAMMs is a class of multilevel procedure, which is very robust in analyzing a mixed type of responses, such as survival data, counts data, dichotomous variables as well as ordered and unordered categorical responses (Rabe-Hesketh*, et al.*, 2004). Using GLLAMM, this study provides empirical evidence that community contexts are important factors for a better understanding of regional variations in infant and child mortality in Nigeria.

However, there are a number of limitations that must be considered when interpreting the results of this study. First, a primary sampling unit was used as a proxy for cluster or community. These administratively defined boundaries may misclassify individuals into inappropriate communities or clusters, and this could possibly introduce some bias (Antai, 2011a). Second, with the exception of region of residence and place of residence covariates, other community-level variables in this study were generated by aggregating the individual-level and household-level variables at the level of PSUs. This process could yield multicollinearity, although this problem was minimized by testing for correlation between variables and by conducting stepwise regression before fitting the final Model. Third, information on household income was not available in the DHS data; hence wealth index which was generated from household assets was used as a proxy indicator for household income. However, wealth index may not yield the same results that could be obtained from direct information on household income. Being a cross-sectional data, a cause-effect relationship could not be established in this study. In addition, although Cox models are useful for modeling time-to-event data, the technique may present some biases in the interrelationships between the outcome variables and some time-varying covariates.

Another major limitation of this study concerns the issue of unobserved heterogeneity, which could result from non-inclusion of other important contextual characteristics in the analysis. Such factors include information on various socio-cultural practices as well as important information on quality of health care service, measurable distance to health care facilities and others. These were not measured because of the absence of such relevant information in the DHS datasets. Further studies on the socio-cultural and other contextual factors influencing infant and child mortality are needed in Nigeria.

9.6 Conclusions, recommendations and policy implications

9.6.1 Conclusions

This study set out to answer three basic research questions: (1) what are the levels and magnitude of infant and child mortality in Nigeria? (2) What are the individual, household, and community-level factors associated with infant and child mortality in Nigeria? (3) To what extent do the contextual factors account for variations in regional patterns of infant and child mortality in Nigeria?

These research questions were answered by addressing the three specific objectives of the study. In summary, analytical results from both 2003 and 2008 NDHS data indicated diverse findings and contributions to knowledge:

1) Indirect estimation techniques indicated slightly higher levels of infant mortality compared to the directly calculated rates. As observed by Adetunji (1995b), this suggests that estimation techniques employed in computation of mortality levels matter; hence rates from direct and indirect techniques should not be combined to form trend lines.

2) Overall, some decline was recorded in the levels of infant and child mortality in Nigeria over the 1999-2003 and 2004-2008 periods. However, the decline was minimal.
3) Infant and child deaths were higher in the Northern regions than in the Southern regions, with the overall proportion of under-five deaths highest in the North-east and North-west and lowest in the South-west.
4) Both the levels and the risks of infant and child mortality were higher for males than for females.
5) Slight reduction was observed in the gender gap in mortality differentials between male and female children during the period under study.
6) INDEPTH estimates indicated some increase in the expectation of life for the general population during 1999-2003 and 2004-2008 periods.
7) The risks of death in infancy (age 0-11 months) were higher than the risks of death during childhood (period between ages 12 and 59 months).
8) Demographic factors were more important in explaining infant mortality while socio-economic factors were more important in explaining child mortality.
9) Substantial ethnic disparities in infant and child mortality exist in Nigeria.
10) Uptake of modern contraceptive methods could increase children's survival chances.
11) Rural-area disadvantage was associated with increased risks of infant and child mortality.
12) There are substantial regional variations in infant and child mortality in Nigeria. Hence living in different regions of the country appears to

significantly influence variations in infant and child mortality between and across communities and regions.

13) Results of this study established that the high under-five mortality rate in Nigeria is mainly driven by level of under-five mortality in the North-east and North-west.
14) Disparities in health care contexts are an important contextual determinant of regional variations in infant and child mortality in Nigeria.
15) Community infrastructures are important contextual factors that could influence children's survival chances.
16) Infant and child mortality risks were found to be higher in ethnically heterogeneous communities than in the homogeneous ones, hence ethnic diversity is an important contextual factor influencing variations in infant and child mortality across regions in Nigeria.
17) Higher education contexts tend to provide social capital that increases the survival chances of the children of mothers who themselves have little or no education but reside in the communities that have well-educated people.
18) During the period under study, characteristics of the community contexts appear to amplify child mortality risks in some regions while community contexts seemed to mitigate the child mortality risks in some other regions.

9.6.2 Policy Implications

A number of findings of this study have important policy implications. First, both direct and indirect methods indicated high levels of infant and child mortality in

Nigeria. With the present levels of infant and child mortality in the country, Nigeria is not on course to achieve Millennium Development Goal four. Without scaling up necessary and timely interventions, achievement of the MDG 4 by 2015 is unrealistic in Nigeria.

Second, infant and child mortality levels as well as risks of dying young were found to be higher in some regions than in others. As a result, under-five mortality levels will continue to remain high in Nigeria if interventions and policies are not formulated and implemented to address the regional variations in infant and child mortality in the country.

Third, there is need for governments at various levels to scale up strategies to fast track socio-economic development in the socially and economic deprived communities and regions, otherwise infant and child mortality will continue to increase in some regions in Nigeria, while it may be declining in some other regions.

Fourth, the current infrastructural deficiencies (in terms of lack of drinkable water and electric connections in many communities in Nigeria); which impact negatively on child survival, (as established in this study), need to be urgently addressed. Without this, significant reductions in infant and child mortality seem unachievable.

Fifth, efforts that will reduce infant and child mortality differentials between rural and urban areas must include policies that address rural area-disadvantage through equitable distributions of community infrastructures, such as health facilities, drinkable water and electricity.

Sixth, the implication of the observed ethnic variations in infant and child mortality in Nigeria is that infant and child mortality rates may continue to decline among some ethnic groups while the rates may continue to increase among others if their practices, such as early childbearing, polygyny and high fertility-related norms persist.

Seventh, better understanding of the importance of characteristics of the community contexts is necessary for a reasonable reduction in infant and child mortality to be achieved. Strategies must be scaled up to address the contextual factors that amplify children’s mortality risks.

Eighth, this study established that the high rate of under-five mortality is mainly driven by high mortality during the first year of life. There is therefore the need to scale up interventions that will address poor health outcomes among children during the first year of life. As the results of this study suggest, the policies that will achieve substantial reduction in mortality during the first year of life must include strategies that address high-fertility behaviours, such as early childbearing, frequent births that normally result in short-interval births, and too many births that often result in higher order births.

Ninth, risks of death was found to be higher for children whose mothers were using no contraceptive methods compared to those whose mothers were using contraception. Therefore, without concerted efforts to address the present levels of low contraceptive prevalence which currently stands at 14.6% in Nigeria (NPC & ICF Macro, 2009); infant and child mortality will continue to remain high in the country.

Finally, ethnically heterogeneous communities and regions such as South-south and North-east were high-risk areas, with respects to infant and child mortality; there is need, therefore, to scale up interventions in those communities and regions. Failure to achieve this, higher under-five mortality from those regions will continue to drive up the level of under-five mortality in the country.

9.6.3 Recommendations

The recommendations emanating from this research work are as follows:

1) Policies and programmes aimed at addressing regional variations in infant and child mortality must be formulated and their implementation must be vigorously pursued. To achieve this, while under-five mortality reduction measures which have worked to some extent in the Southern regions of Nigeria must be strengthened to achieve more results in the south, these measures could be extrapolated and applied in the Northern regions of the country. Such measures include having hospital delivery and attending prenatal care.
2) To rectify the current situation of infrastructural deficiencies in many communities in Nigeria, it is recommended that there should be increased budgetary allocation towards the provision of essential amenities like drinkable water, electricity, health facilities, and good toilet facilities.
3) To ensure proximity to health facilities in all communities across the country, the current imbalance in the distribution of health facilities between the rural areas and the urban centers must be rectified through equitable distribution of facilities across communities and regions.

4) It is recommended that strategies to address poor community contexts that amplify under-five mortality risks in the disadvantaged communities and regions be scaled up. Such community contexts include poor health contexts and poor education contexts. Poor community contexts could be addressed through proper public-private partnership initiatives. A multi-sector approach could also be adopted to address poor neighbourhood contexts.
5) In order to achieve enough reductions in under-five mortality, strategies aimed at increasing the proportion of children who survive beyond the first birthday must be adopted. This is because risks of under-five death were higher in infancy than in childhood.
6) The current family planning programme in the country must be strengthened and expanded to ensure that all men and women who wish to space or limit the number of their children have the means to do so. This will bring about adequate spacing between births. Behavioural change communication could be used as a strategy to promote acceptance of family planning.
7) There is a need for all tiers of government to provide adequate funding to address poor community contexts that exacerbate infant and child mortality risks, particularly in the socially and economically deprived neighbourhoods and regions.
8) Behavioural change communication (BCC) programmes targeting high-risk fertility behaviours, such as having short birth intervals and higher order birth must be vigorously pursued.
9) There must be strong political and financial commitments from governments at various levels towards achieving increase in the enrolment and retention

rates of female children in schools. Increasing the number of years that female children spend in school will most likely lead to postponement of childbearing, which will eventually lead to reduction in early childbearing that is prevalent in some regions in the country.

9.7 Frontiers for further research

- Further studies on other contextual factors such as socio-cultural factors influencing infant and child mortality are needed in Nigeria.
- The influences of contextual determinants on infant and child mortality need to be further explored with the use of qualitative data.
- Contraceptive uptake was established in this study as an important factor that could increase children's survival chances. Hence both qualitative and quantitative studies need to be carried out to explore the barriers to the utilisation of family planning methods in Nigeria.
- Although effects of HIV/AIDS were factored into derivation of INDEPTH estimates, other techniques used for indirect estimations of infant and child mortality in this study need to be refined in order for their assumptions to be in tune with the current reality.

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Appendix A: Policy Brief

(To be sent to Nigerian government through the ICF Macro International)

<u>Regional Variations in Infant and Child Mortality in Nigeria: A Policy Brief</u>

Background and Statement of the problem

Evidence indicates that about 1 in every 6 children dies before the age of five in Nigeria. This rate of under-five mortality at the national level tends to mask the variation that exists across the six regions of the country. Evidence shows a huge regional variation in under-five mortality in Nigeria, with the rate ranging from 89 per 1000 live births in the South-west to 222 per 1000 live births in the North-East. This means that 1 in about 12 children will die before reaching age five in South-west, while 1 out of every 4 children will die before their fifth birthday in the North-east. This variation is huge and studies suggest worsening variation in the rate of under-five mortality in the country (Adedini et al, 2012, Antai 2011a).
Considering the fact that infant and child mortality remains a major public health challenge in Nigeria and other parts of the developing world, researchers have made considerable efforts to understanding factors driving the phenomenon. A number of studies have shown that infant and child mortality rates vary by socio-economic and bio-demographic characteristics. However, evidence is sparse on the influences of contextual determinants on infant and child mortality in Nigeria. By contextual determinants, we mean the characteristics of the community contexts where children are born, raised and experienced a particular health outcome.
Sastry (1997) contends that community characteristics can exacerbate or mitigate mortality risks of individuals depending on the environmental context the individuals find themselves. Griffiths (2004) also argues that community services and levels of infrastructural development of a community are capable of amplifying or reducing mortality risks among the children. This is because an individual child is resident in a household unit, and the household in turn is located within a community. Hence, an individual child is exposed to various levels, within the societal hierarchy, that either directly or indirectly influences his or her survival chances.

Policy Context

Giving the above background, this study was conducted to examine the influences of the characteristics of the community contexts (where children are born or reared) on children survival chances. The study utilized the 2003 and 2008 Nigeria Demographic and Health survey data. Both surveys solicited demographic and health information from samples that were selected across the country using multi-stage sampling technique. Analysis for this study covered the live births within the five years before the surveys (i.e. 1999-2003 and 2004-2008). Out of the survey's total sample size of 7620 women contained in 2003 dataset, analysis was restricted to 6028 live born children of 3775 women. Similarly, from a total of 33,385 women contained in 2008 dataset, analysis was restricted to 28,647 live born children of 18,028 women. Multilevel Survival analysis was used to determine the extent to which the contextual characteristics influence regional variations in infant and child mortality in Nigeria.

Although, the results showed that the risks of death during infancy[20] or childhood[21] were high in the North-central, South-east and South-south, the North-east and North-west had the highest risks of under-five mortality in the country. For instance, the results indicate that the risks or hazards of death were almost two-fold higher (during infancy) and more than four-fold higher (during childhood) for children in the North-east and North-west, compared to children in the South-west.
Results further showed that characteristics of the community contexts were important in explaining the observed variations in the risks of infant and child mortality across the country, as shown by a high intra-community correlation. Some of the contextual characteristics influencing regional variations in infant and child mortality in Nigeria, as established by this study include: community health contexts (such as access to and utilization of health facilities in the community), community education contexts (i.e. average number of people with at least secondary education in the community), community infrastructures (i.e. availability and access to drinkable water, electricity and toilet facility in the community), and place of residence (whether the community is rural or urban).

Implications of Findings and Policy Recommendations

The high under-five mortality rate at the national level in Nigeria is mainly driven by level of under-five mortality in the North-east, North-west, and to a lesser degree, South-south and South-east. Characteristics of the community context play a significant role in amplifying the risks of under-five death in these regions, while community characteristics seemed to mitigate the risks of under-five mortality in the South-west. Nigeria is not on track to achieving Millennium Development Goal four. Without scaling up necessary and timely interventions, achievement of the MDG 4 by 2015 is unrealistic in Nigeria.
In view of the importance of the contextual determinants on child survival, the following recommendations are suggested for policy actions to be taken by government and the community people:

Recommendations for Government

1) To rectify the current poor community contexts that exacerbate infant and child mortality risks in many communities and regions in Nigeria, it is recommended that there should be increased budgetary allocation towards the provision of essential amenities like drinkable water, electricity, health facilities, and good toilet facilities.
2) To ensure proximity to health facilities in all communities across the country, the current imbalance in the distribution of health facilities between the rural

[20] Deaths within ages 0 to 11 months
[21] Deaths that occur between ages 12 and 59 months

areas and the urban centers must be rectified through equitable distribution of facilities across communities and regions.

3) There must be strong political and financial commitments from governments at various levels towards achieving increase in the enrolment and retention rates of female children in schools. Increased female education tends to work through the mechanisms of postponement of childbearing, adequate birth-spacing, quality care for children and improved health-seeking behaviour to bring about reduction in infant and child mortality.

Recommendation for Community People

Measures aimed at addressing regional variations in infant and child mortality must be vigorously pursued. To achieve this, while the under-five mortality reduction measures which have worked to some extent in the South-west must be strengthened to achieve more results, these measures could be extrapolated and applied in other regions of the country. As established in this study, such measures include having hospital delivery and attending prenatal care.

Appendix B

Tabular presentation of some of the reviewed articles

S/N	Title & Source	Author(s) & year	Data Source	Method	Level of Analysis	Findings	Missing Gaps
1	Mortality pattern within twenty-four hours of emergency paediatric admission in a resource-poor nation health facility.	Adeboye et al (2010)	Records of diagnosis and outcome of management	Logistic regression	Individual-level	Malaria is the major cause of death among emergency pediatric admission	The study is not population based, but mainly hospital-based
2	Infant mortality and mother's education in Ondo State, Nigeria.	Adetunji et al (1995)	Demographic and Health Survey, Ondo state, Nigeria, 1986-1987	Logistic regression	Individual-level	Significant relationship exists between mother's education and infant mortality	Level of analysis restricted only to individual-level. Household & community levels not considered
3	Clustering of under-five mortality in the Navrongo HDSS in the Kassena-Nankana District of northern Ghana.	Adjuik et al (2010)	Data from Navrongo Health & Demographic Surveillance Site (HDSS), Ghana	Spatial analysis	Community level	More than average under-5 mortality clustering found in many of the study locations	Clustering of under-5 mortality considered only in HDSS, nationally representative population not used

4	Regional inequalities in under-5 mortality in Nigeria: a population-based analysis of individual- and community-level determinants	Antai (2011a)	Nigeria Demographic & Health Survey (DHS), 2003 dataset	Cox proportional hazards model	Individual and community levels	Region has a significant relationship with under-5 mortality	Region is the main focus, other key determinants of child mortality not covered
5	Inequalities in under-5 mortality in Nigeria: do ethnicity and socioeconomic position matter?	Antai (2011b)	Nigeria Demographic & Health Survey, 2003 dataset	Multilevel logistic regression	Individual and community levels	Under-5 mortality differentials were attributed to differences in socioeconomic characteristics.	The study considered only ethnicity and socioeconomic status
6	Migration and child immunization in Nigeria: individual- and community-level contexts	Antai (2010)	Nigeria Demographic & Health Survey, 2003 dataset	Multilevel logistic regression	Individual and community levels	The study stressed the importance of migration in child's immunization uptake.	Study is restricted to migration and child's immunization uptake
7	Urban Area Disadvantage and Under-5 Mortality in Nigeria: The Effect of Rapid Urbanization	Antai & Moradi (2010)	Nigeria Demographic & Health Survey, 2003 dataset	Multilevel logistic regression	Individual and community levels	Significant relationship exists between urban area disadvantage and under-5 mortality	Study limited to relationship between under-5 mortality and urban area disadvantage
8	Migration and child health inequities in Nigeria: a multilevel analysis of contextual- and individual-level factors.	Antai et al (2010)	Nigeria Demographic & Health Survey, 2003 dataset	Multilevel Cox regression analysis	Individual and community levels	Under-five death was higher among children of rural-urban migrant mothers compared to rural non-migrant mothers	Study limited to the relationship between migration and child mortality, other determinants not covered
9	Inequities in under-five mortality in Nigeria: differentials by religious	Antai et al (2009)	Nigeria Demographic & Health Survey,	Multilevel regression	Individual level	Religious affiliation explained the differential use of	Focused on under-5 mortality and religious affiliation, other under-five

	affiliation of the mother.		2003 dataset			maternal and child health service	determinants not addressed
10	Urban and rural differences across countries in child mortality in sub-Saharan Africa	Anyamele (2009)	DHS datasets of 11 countries	Logit regression	Country level	Urban residents have higher survival chances than their rural counterparts	Only a comparative study of rural-urban under-5 differentials, key determinants not covered
11	Determinants of use of maternal health services in Nigeria - looking beyond individual and household factors.	Babalola & Fatusi (2009)	2005 Nigeria National HIV/AIDS and Reproductive Health Survey	Multilevel analysis	Individual, household and communit y level	Predictors of maternal health services utilization were found at various levels	Study focused only on utilization of maternal care services, child mortality determinants not considered
12	Dynamic modelling of child mortality in developing countries: application for Zambia	Berger et al (2002)	1992 Zambia Demographic and health Survey.	Bayesian dynamic logit model	---	The study found many factors whose effects exhibit distinct age-dependencies	It is not a study of child mortality determinants, but a study on modeling of child mortality
13	Where and why are 10 million children dying every year?	Black et al (2003)	Systematic review	----	----	Causes of under-5 death differ from one country to another; and under-nutrition is the major cause	The article only reviewed the existing literature, and was not a study on child mortality determinants
14	Mothers' education and childhood mortality in Ghana.	Buor (2002)	1998 Ghana DHS datasets & 2000 World Bank datasets	Regression model	Individual-level	Inverse relationship exists between mothers’ education and child survival	The study focused on one out of several determinants of child survival
15	Impact of health education on home treatment and prevention of malaria in Jengre, North Central	Chirdan et al (2008)	Community based intervention	Chi-square test	Individual-level	Health education is effective in increasing caregivers' knowledge of malaria	The study did not go beyond the analysis of health education impact on home treatment of malaria

	Nigeria						
16	Maternal education and child survival in developing countries: the search for pathways of influence	Cleland et al (1988)	Systematic review	-----	----	Reproductive health patterns and equitable treatment of sons and daughters were established as intervening factors between mothers' education and child survival	Focus was only on the relationship between mothers' education and child survival
17	Income inequality and child mortality in wealth nations	Collison et al (2007)	2003-2006 UNICEF reports on children	Correlation analysis	Country-level	Strong associations exist between child mortality and income inequality	The study relates income inequality to child mortality, several other determinants were not considered.
18	Death Clustering, Mothers' Education and the Determinants of Child Mortality in Rural Punjab, India	Gupta (1990)	Data from Ludhiana District, Punjab survey	Multilevel analysis	Community-level	Gender and mothers' education are significantly related to child mortality	Missing gaps include addressing key determinants of child mortality other than mothers' education
19	Demographic Research on Infant Mortality	Eberstein (1989)	Overview of research on infant mortality	----	----	Diverse associations exist between social inequality and mortality	The article is a review, but not a study of child mortality determinants
20	Childhood trauma in Owerri (south eastern) Nigeria	Ekenze et al (2009)	Hospital record of children managed for trauma	Chi-square test	Individual-level	Delay in presentation of trauma case is a problem	Mainly hospital-based study
21	The effects of access to health care on infant	Frankenberg (1995)	1987 Indonesia DHS and village-level	Logistic regression	Individual and communit	Increase in access to health care services decreases mortality	Relationship between child mortality and access to health care considered,

	mortality in Indonesia		censuses of infrastructure		y levels	risks	other key factors not considered
22	Unacceptably high mortality related to measles epidemics in Niger, Nigeria, and Chad	Grais et al (2007)	Household retrospective survey	Frequency distributio n	Individual-level	Children still face very high mortality from a vaccine-preventable disease	hospital/clinical-based study, determinants of child mortality not covered
23	A tale of two continents: a multilevel comparison of the determinants of child nutritional status from selected African and Indian regions	Griffiths et al (2004)	Demographic and Health Survey datasets of 7 countries	Multilevel modeling	Individual and household levels	The study stressed the importance of individual and household level predictors of underweight	The study focused only on child's nutritional status, child mortality determinants not considered
24	Pattern of cause-specific childhood mortality in a malaria endemic area of Burkina Faso	Hammer et al (2006)	1999-2003 datasets of Nouna Health Research Centre DSS	Multivariat e logistic regression .	Individual and communit y levels	Malaria is the most important cause of death in the study locations	Childhood mortality determinants not considered, only causes of childhood mortality were considered
25	A multilevel approach to explian child mortality and undernutrition in South Asia and sub-Saharan Africa.	Harttgen et al (2006)	DHS data sets of five countries	Multilevel approach	Individual, household & communit y-levels	The determinants of child mortality are different from those of undernutrition	The study did not consider other key determinants of child mortality
26	The effects of education quality on income growth and mortality decline	Jamison et al (2007)	Datasets of 62 countries from various sources	Regression analysis	Country-level	Rates of mortality complement the income levels as indicators of national well-being	The study linked education quality with income growth & mortality decline, child mortality decline not covered

27	How many child deaths can we prevent this year?	Jones et al (2003)	Systematic review	----	----	About two-thirds of child deaths could be prevented by simple interventions	The article reviews the existing literature, gaps include addressing key determinants of child mortality
28	Spatial and Temporal Clustering of Mortality in Digkale HDSS in rural northern South Africa.	Kanjala et al. (2010)	Data from Digale HDSS, South Africa.	Poison regression and space-time clustering	Village-level	The high clustering of mortality was observed and attributed to HIV/AIDS	The study's focus was not specific on child mortality, but on the mortality experience of the whole population
29	Child Mortality in India: The Community-Level Effect of Education	Kravdal (2004)	Indian National Family Health Survey II	Multilevel discrete-time hazard model	Community-level	The community average level of education of women has a strong effect on child mortality	Identified gaps include addressing impact of familial and other community factors on child mortality.
30	Social, Economic, and Political Factors in Progress Towards Improving Child Survival in Developing Nations	Lykens et al (2009).	Data from UN database	Multiple regression analysis	Region-level	External resources, and per capita income were established as factors influencing child survival	Study conducted not to address child mortality determinants, but to track MDG4 progress in developing countries
31	Risk factors for infant mortality in a rural community in Nigeria	Lawoyin (2001).	Prospective community based study	Logistic regression	Individual level	Neonatal death mainly results from low birth weight while post-neonatal death mainly results from infection	Analysis restricted to individual-level determinants of infant mortality
32	A comparison of methods for analysing a nested frailty model to child survival in Malawi	Manda (2001)	Malawi 1992 Demographic and Health Survey	Cox proportional hazards model	Family and community levels	The two methods examined leads to similar estimates	The study basically compared analytical methods but not a study on child mortality determinants

33	State downsizing as a determinant of infant mortality and achievement of Millennium Development Goal 4.	Palma-Solís et al. (2009)	Ecological retrospective cohort study of 161 countries, (1978-2002)	Multiple logistic regression	Country-level	Non-achievement of MDG4 is linked with reductions in government expenditure (GE) and increase in income inequality	Focus was on the effect of income inequality & reduction in GE, other key determinants of child mortality not addressed
34	The determinants of infant mortality: how far are conceptual frameworks really modelled?	Masuy-Stroobant (2001)	Systematic review of articles	Systematic compilation of articles	-----	Use of more adequate statistical models is suggested, particularly if many observations are involved in the analysis	Systematic review of existing articles, identified gaps include consideration of key determinants of child mortality risk
35	Effectiveness of childhood vaccination against rotavirus in sub-Saharan Africa: the case of Nigeria.	Melliez et al. (2007)	Estimates derived from published data	Regression analysis	Individual-level	Rotavirus vaccination can substantially reduce the number of deaths from rotavirus diarrhea	Identified gaps include consideration of child mortality determinants
36	Factors influencing mothers' role in convulsion treatment among under-five children in Ibadan, Nigeria.	Nwokocha & Awomoyi. (2009)	Community-based Qualitative study	Qualitative study analysis	Qualitative study	Respondents' socio-demographic factors influence their choice of remedies for convulsion	The study focused only on convulsion treatment among under-5 children
37	Determinants of Breast-Feeding Status in Eastern Nigeria	Odimegwu (2002)	Community-based study in Imo state Nigeria	Logistic regression	Individual-level	determinants of decision to breastfeed a baby include education, age & working status	Study mainly focused on breastfeeding status, determinants of child mortality not addressed
38	Family Structure and Child Mortality in Sub-Saharan Africa: Cross-National	Omariba & Boyle (2007)	DHS datasets of 22 sub-Saharan African	Multilevel logistic regression	Individual, family & country-	Children in polygynous union have higher mortality risk than those in monogamous	The study established one of the determinants of child mortality, there is a missing

	Effects of Polygyny		countries		levels	union	gap regarding other factors
39	The pattern of paediatric HIV/AIDS as seen at the National Hospital Abuja, Nigeria	Oniyangi & Iregbu (2006)	A retrospective study of children with HIV/AIDS	Chi square test	Individual-level	Pediatric HIVAIDS occurs mainly by mother to child transmission	Analysis restricted to pediatric HIV/AIDS, determinants of child mortality not covered
40	The Effects of Kin on Child Mortality in Rural Gambia	Sear et al (2002)	Rural Gambia surveys of 1950-1974	Multilevel analysis	Individual and familial levels	Presence of some kin positively influence child survival	Study restricted to one determinant of child survival, other factors are gaps to address
41	Who keeps children alive? A review of the effects of kin on child survival.	Sear & Mace (2008)	Review of articles	Systematic review	----	At least one relative apart from the mother help to improve child survival	The review focused on one out of several determinants of child survival, leaving the rest as gaps to fill
42	Maternal grandmothers improve nutritional status and survival of children in rural Gambia	Sear et al (2000)	Longitudinal database from Rural Gambia (1950-1974)	Multilevel analysis & analysis of variance	Individual and familial levels	Maternal grandmother significantly helps to improve the nutritional status of children.	Focus was on the child's nutritional status, there are lots of gaps to address on child mortality determinants
43	Income and inequality as determinants of mortality: an international cross-section analysis	Rodgers (2002)	Cross-sectional data from 56 countries	Regression analysis	Country-level	Income distribution found to be consistently significant across countries	Study restricted to income distribution, other determinants of child mortality are gaps to address
44	How Access to Health Care Relates to Under-Five Mortality in sub-Saharan Africa	Rutherford et al (2010)	Review of literature	Systematic review	-----	If child mortality rates are to be reduced, access to health care must be seen as multidimensional	This is a systematic review of access to health care, gaps are identified on key determinants of child mortality

45	Family-level clustering of childhood mortality risk in Northeast Brazil	Sastry (1997)	1986 Brazil household survey	Multilevel modeling	Family and communit y levels	Parental competence and shared genetic factors are unimportant in child mortality outcome	Missing gaps regarding the determinants of child mortality are identified
46	Community Characteristics, Individual and Household Attributes, and Child Survival in Brazil.	Sastry (1996)	1986 Brazil household survey	Multilevel modeling	Individual, household & communit y levels	Relationships between child mortality risks and community characteristics vary by maternal level of education	Interaction of community covariates with maternal education considered, interaction with other key covariates not considered
47	Socioeconomic determinants of infant mortality: A worldwide study of 152 low-, middle-, and high-income countries.	Schell et al (2007)	National level data of 152 countries	Multivariat e linear regression	Country level	Relative importance of child mortality determinants varies by income levels	The analysis was done at country level. Gap identified include analysis on regional variation which is masked in this study.
48	Clustering of under-five mortality in Rufiji Health and Demographic Surveillance System in rural Tanzania.	Shabani et al. (2010)	Datasets from Rufiji HDSS, Tanzania	Spatial analysis	Cluster-level	Child mortality decline recorded in the Surveillance site and a number of significant clusters were identified	The study population is not nationally representative and therefore cannot be generalized
49	The mortality divide in India: the differential contributions of gender, caste, and standard of living across the life course	Subramania n et al (2006)	1998-1999 Indian National Family Health Survey datasets	Multilevel logistic regression	Multilevel – from individual to state level	The economically disadvantaged disproportionately bear the mortality burden across life course in India	Gender, social class and living standard were considered, missing gaps include consideration of other child mortality determinants
50	Neonatal morbidity and mortality in Calabar,	Udo et al (2008)	Hospital records of neonates	Frequency distributio	Individual level	Infection is the major cause of death among	Mainly hospital-based study

	Nigeria: a hospital-based study		admitted into the ward	n		the neonates	
51	Determinants of child mortality in LDCs: Empirical findings from demographic and health surveys.	Wang (2003)	DHS datasets of 60 countries	Regression analysis (ordinary/ weighted least square	National and regional levels	The decline in child mortality leads to a widening gap in mortality between the rich and the poor	There is tendency to mask household and community variations in an international cross-sectional study as this
52	Birth spacing, sibling rivalry and child mortality in India.	Whitworth & Stephenson (2002)	1992 Indian National Family Health Survey.	Multilevel modeling approach	Individual, household and communit y levels	Short preceding birth intervals are significantly associated with an increased risk of child mortality	The study's focus is only the birth intervals influence on child mortality, other determinants are not considered
53	Dead Mothers and Injured Wives: The Social Context of Maternal Morbidity and Mortality among the Hausa of Northern Nigeria	Wall (1998)	Anthropological field research (175-1977)	Review	----	Hausas of Northern Nigeria has the worst records of female reproductive health	The review was basically on the context of maternal morbidity and mortality, identified gaps include addressing the context of infant/child mortality
54	An analytical framework for the study of child survival in developing countries by Mosley W.H and Chen L.C.	WHO (2003)	----	Analytical model	----	Proposed appropriate theory for the study of child survival in developing countries	-----
55	Fertility and the distribution of child mortality risk among women: an illustrative analysis.	Zaba & David (1996)	5% sample of Kenya 1979 census	Regression analysis	Individual-level	Families of women with high fertility tend to have the greatest risk of child mortality	Relationship between fertility and child mortality risk was examined, gap still exits on the examination of key determinants of child

							mortality
56	Infant mortality trends in the State of Rio Grande do Sul, Brazil, 1994-2004: a multilevl analysis and community risk factors.	Zanini et al (2009)	1994-2004 Brazil longitudinal ecological study	Panel data analysis & multilevel linear regression	Individual and communit y levels	Individual and community factors have significant effects on the reduction of infant mortality rates	Analysis restricted to infant mortality, missing gaps include consideration of child mortality risk determinants.
57	Determinants of Regional Variations in Infant Mortality in Rural India	Jain (1985)	India sample registration system (SRS)	Multiple regression analysis & path analysis.	Individual household and village-levels.	Maternal literacy as a proxy for women's autonomy affects infant mortality through its association with indicators of better medical care before birth, at birth and after birth.	Study mainly focused on quality of child care, many other determinants of child survival not addressed.

Appendix C: Child survival plots for children that died before age five, by selected characteristics

Fig C1: Kaplan-Meier survival estimates, by maternal education, 2003

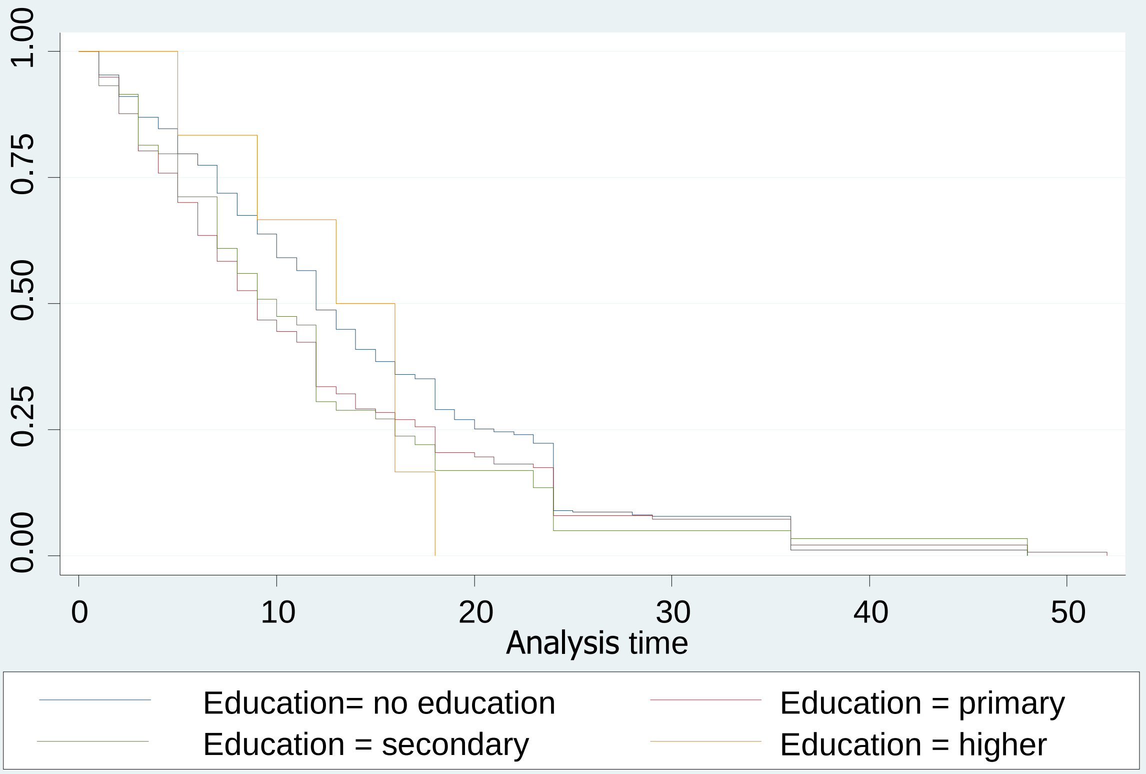


Fig C2: Kaplan-Meier survival estimates, by maternal education, 2008

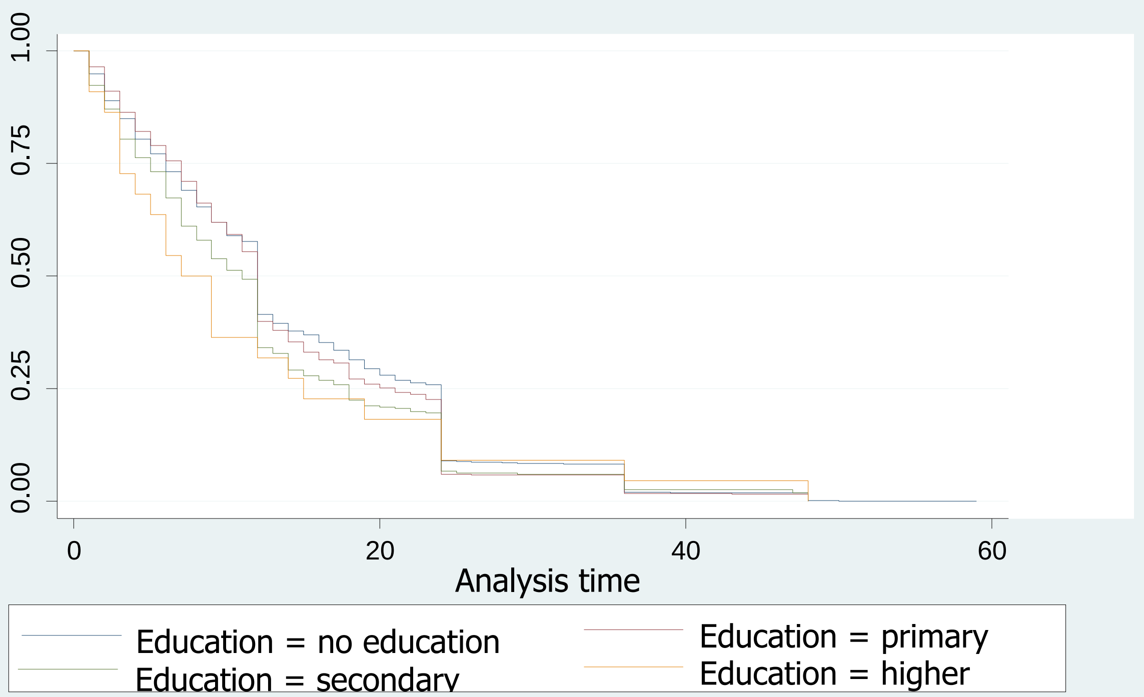


Fig C3: Kaplan-Meier survival estimates, by child sex, 2003

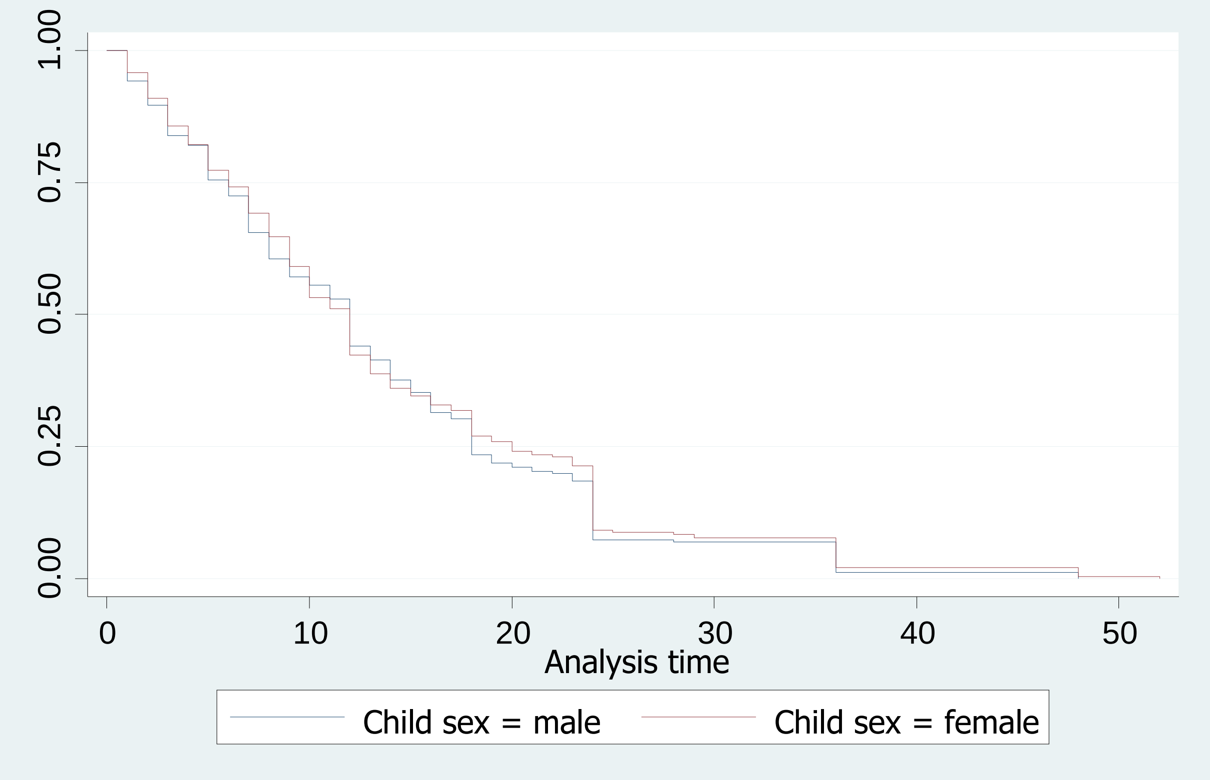


Fig C4: Kaplan-Meier survival estimates, by child sex, 2008

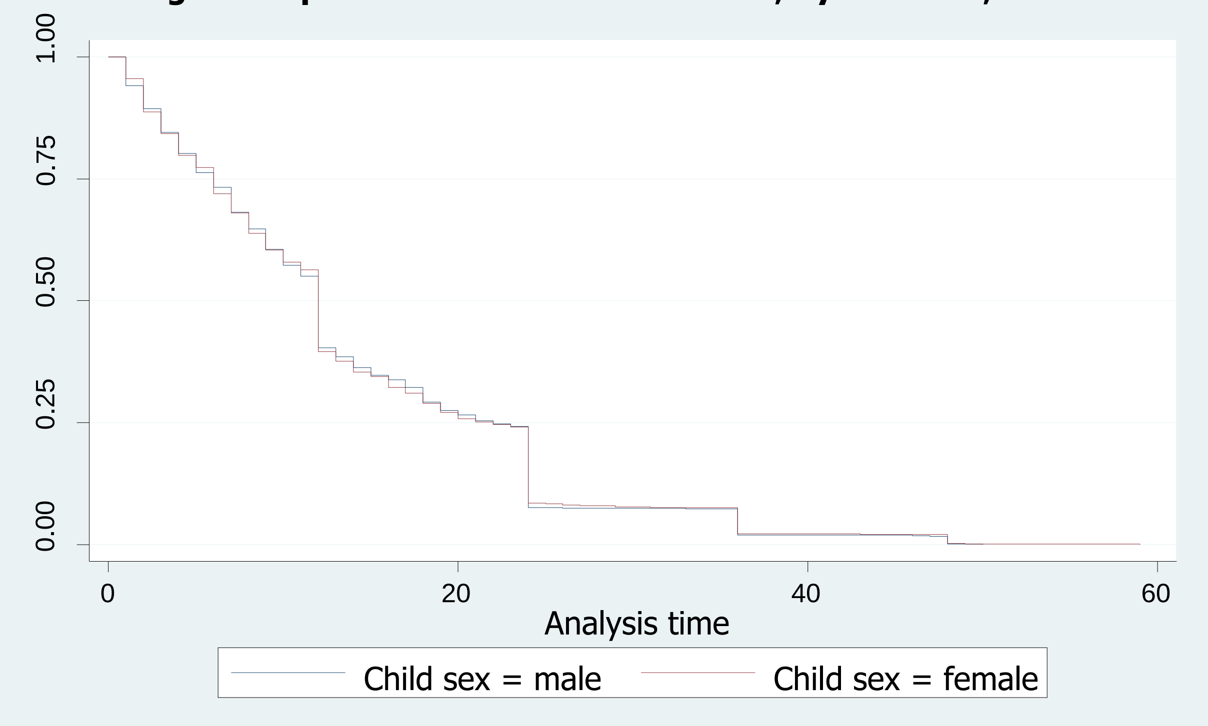


Fig C5: Kaplan-Meier survival estimates, by birth order, 2003

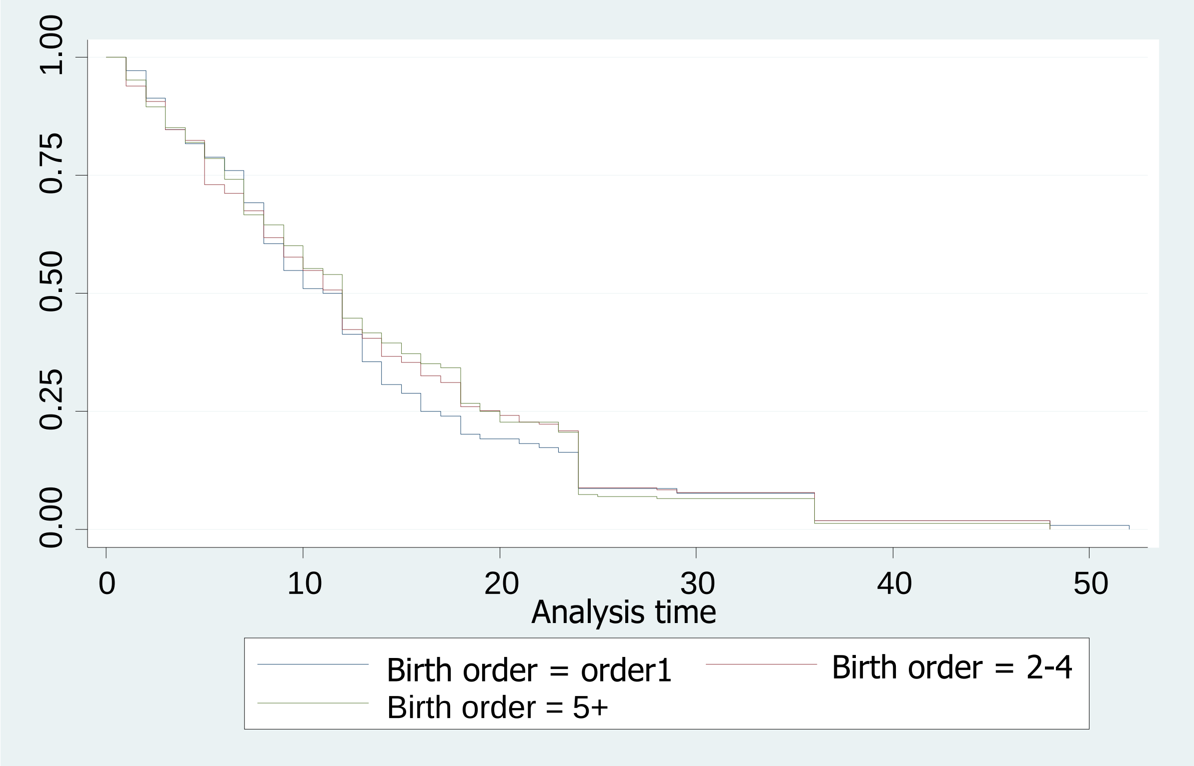


Fig C6: Kaplan-Meier survival estimates, by birth order, 2008

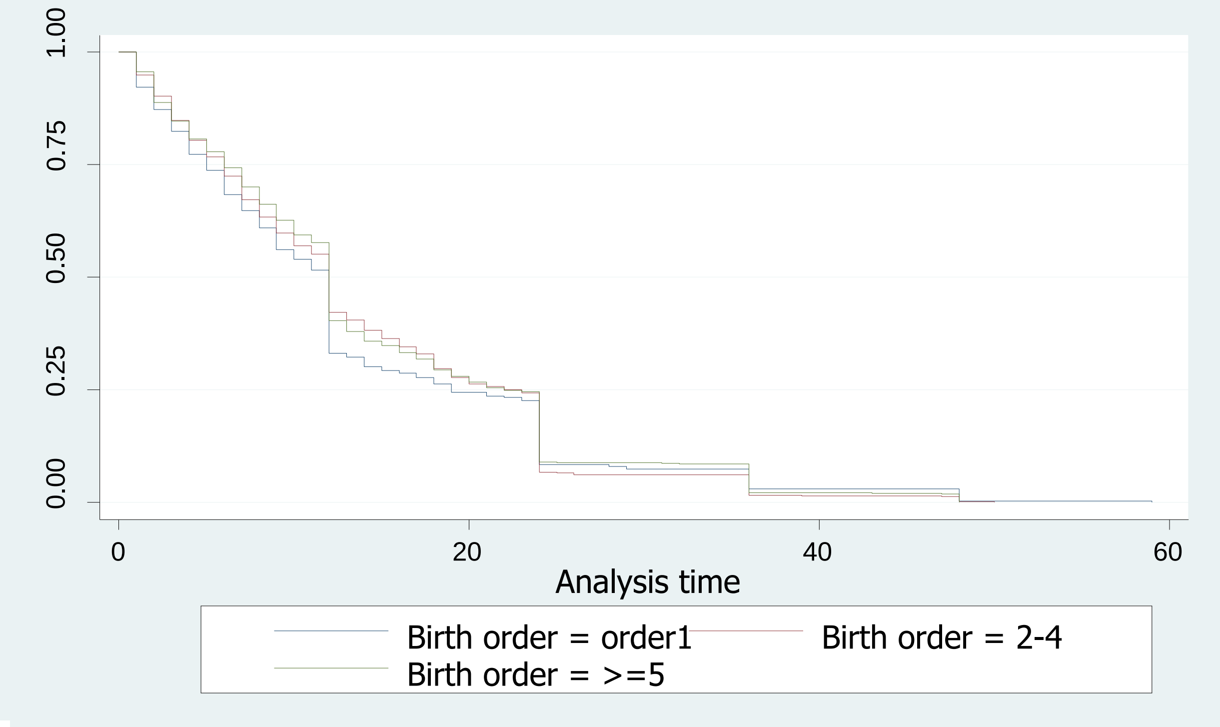


Fig C7: Kaplan-Meier survival estimates, by preceding birth interval, 2003

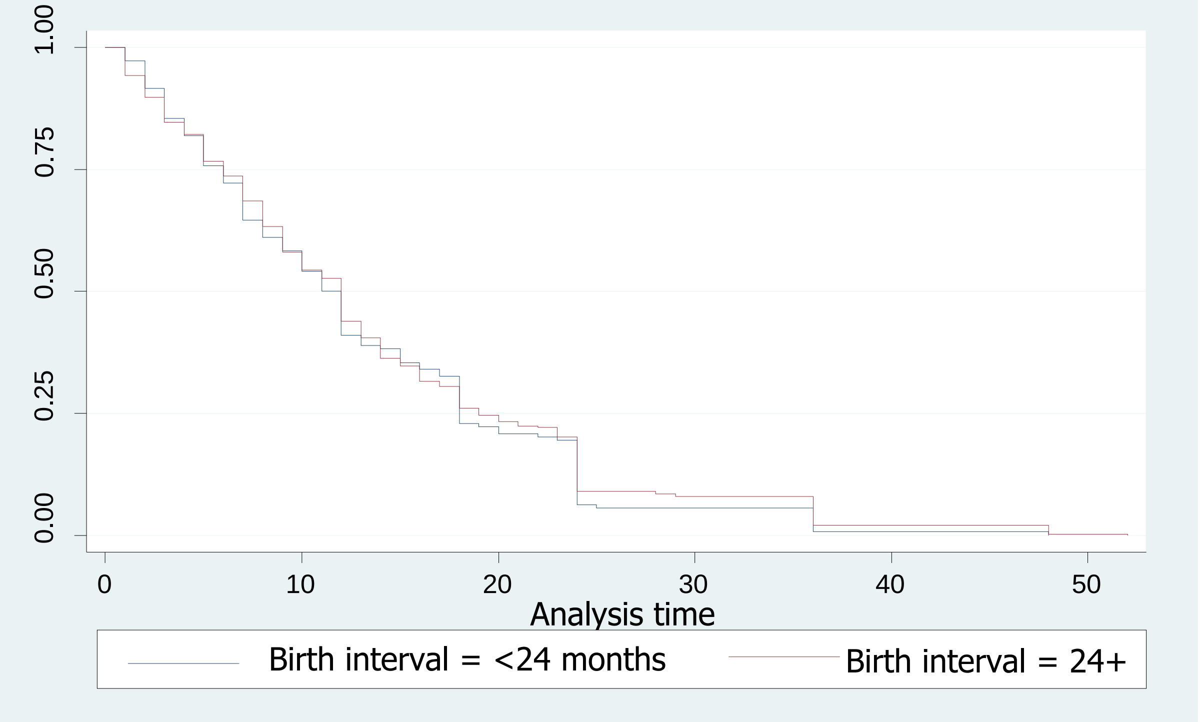


Fig C8: Kaplan-Meier survival estimates, by preceding birth interval, 2008

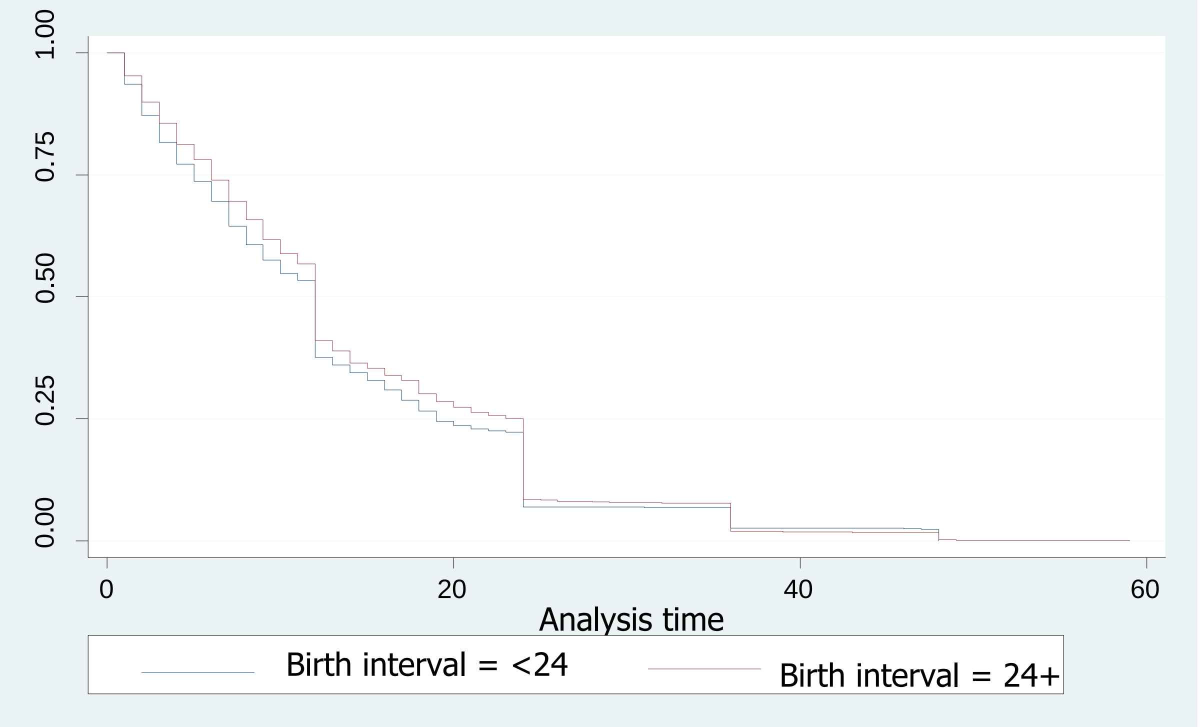


Fig C9: Kaplan-Meier survival estimates, by child's size at birth, 2003

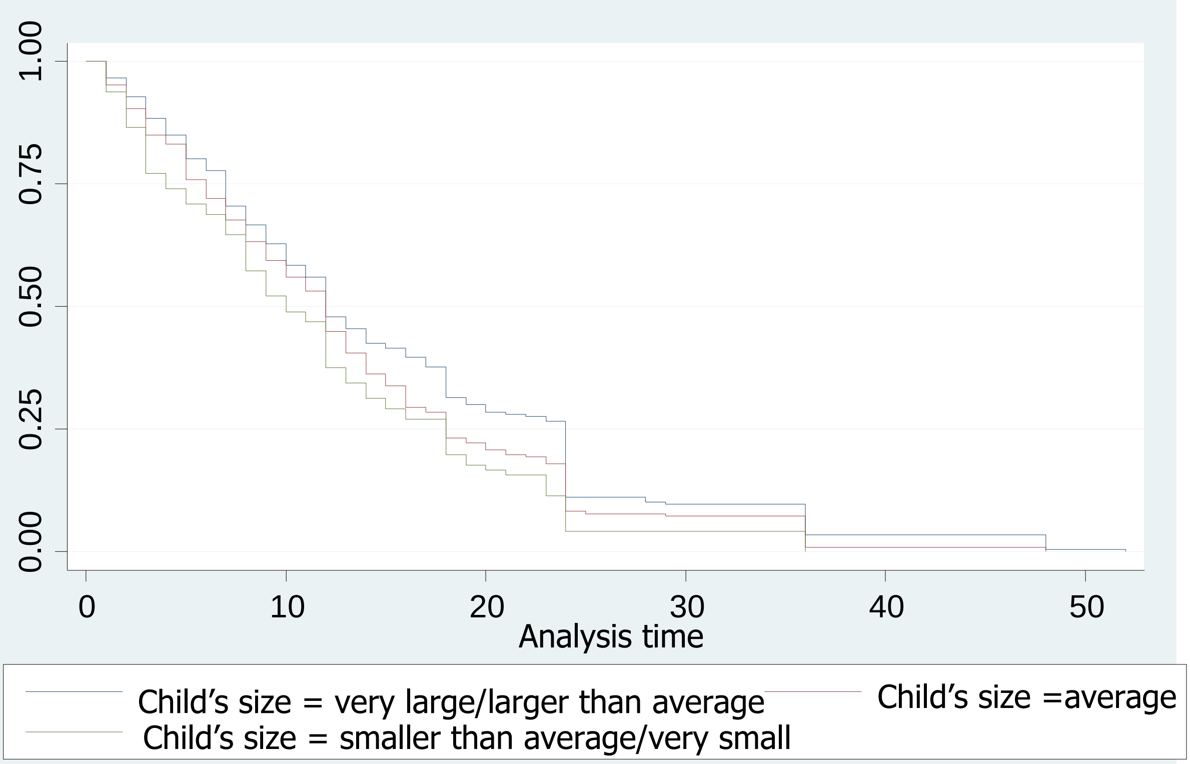


Fig C10: Kaplan-Meier survival estimates, by child's size at birth, 2008

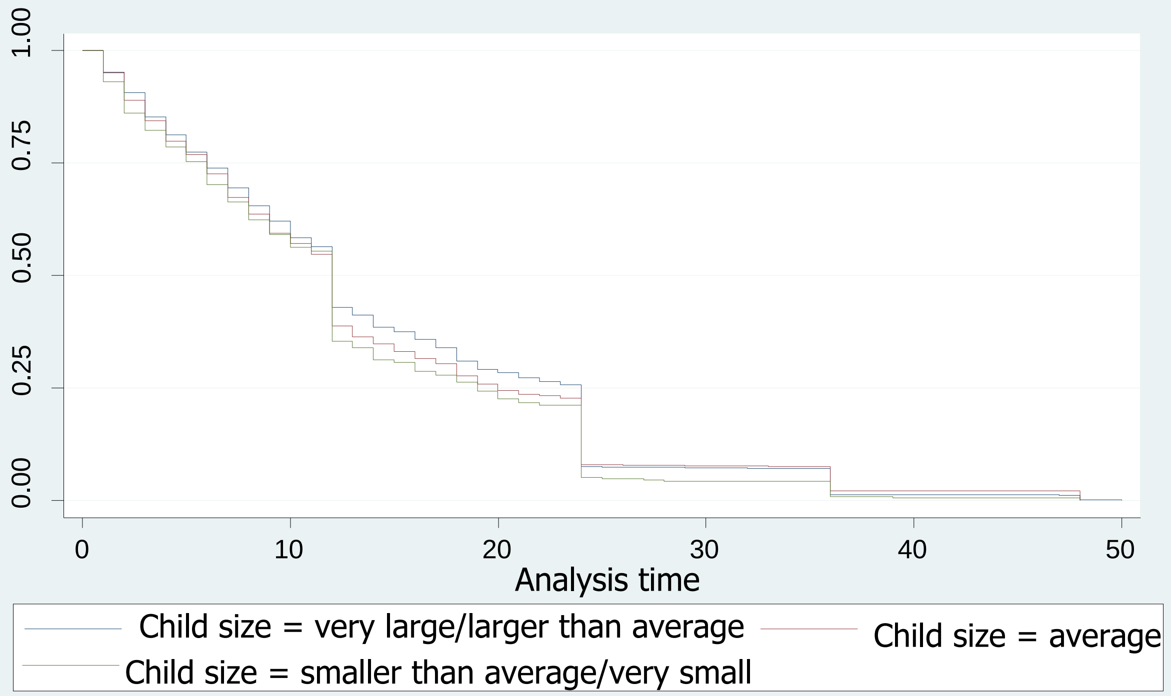


Fig C11: Kaplan-Meier survival estimates, by maternal age at birth, 2003

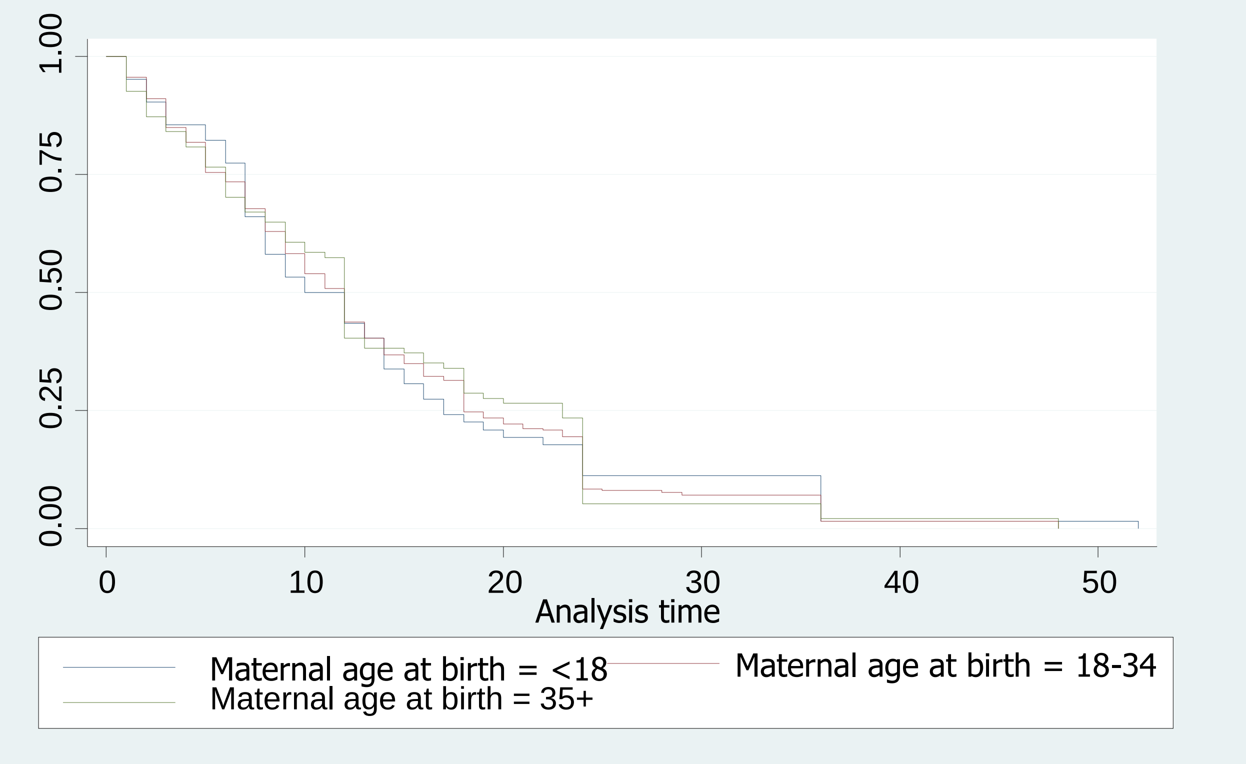


Fig C12: Kaplan-Meier survival estimates, by maternal age at birth, 2008

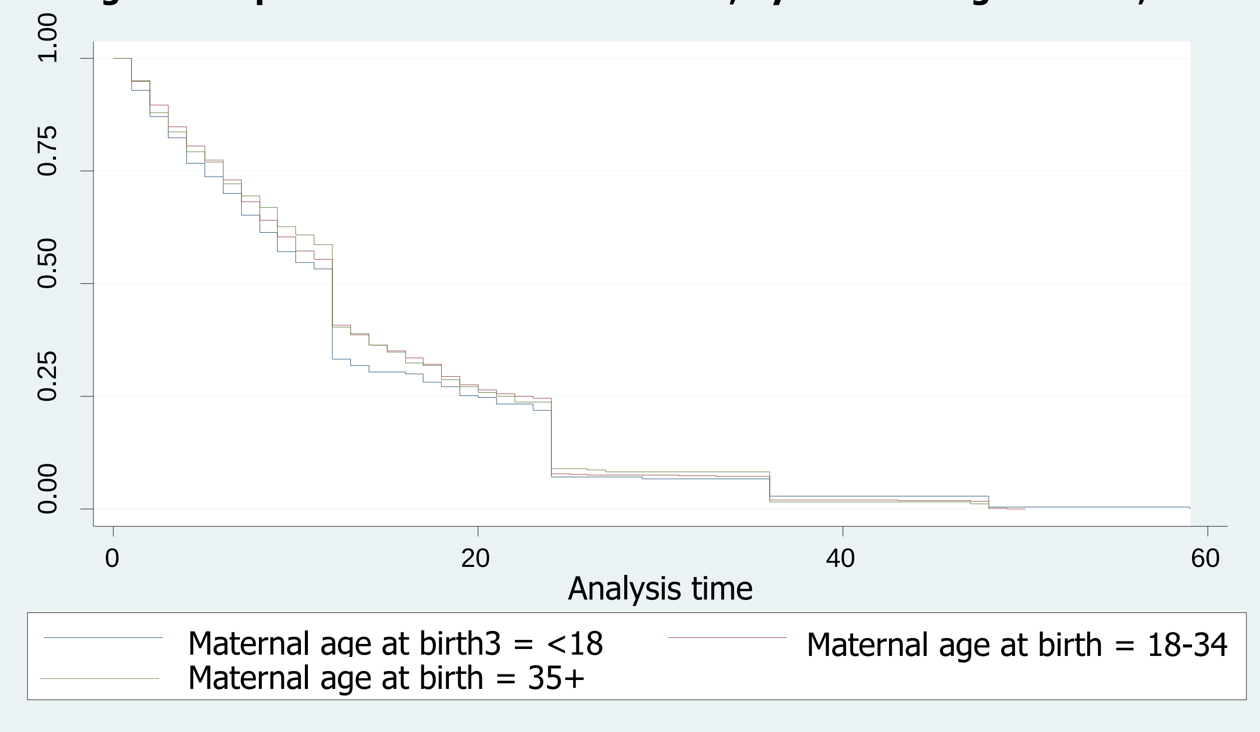


Fig C13: Kaplan-Meier survival estimates, by mother's marital status, 2003

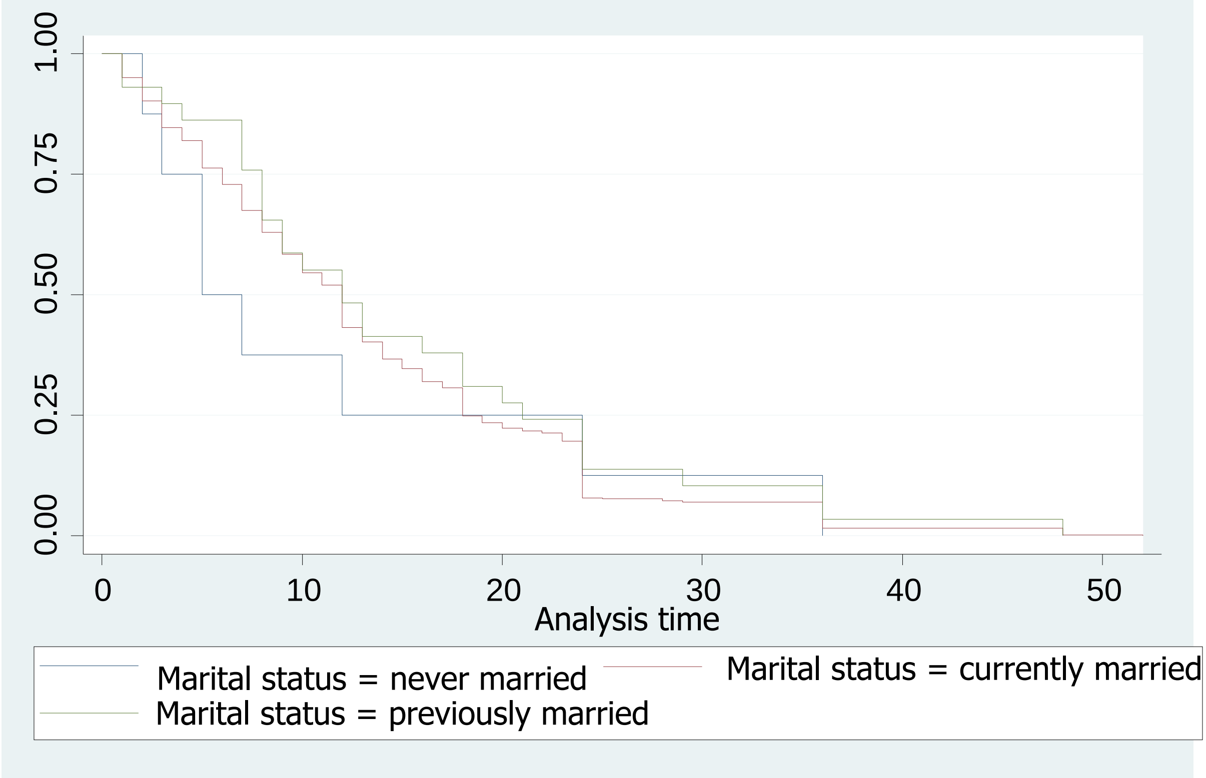


Fig C14: Kaplan-Meier survival estimates, by mother's marital status, 2008

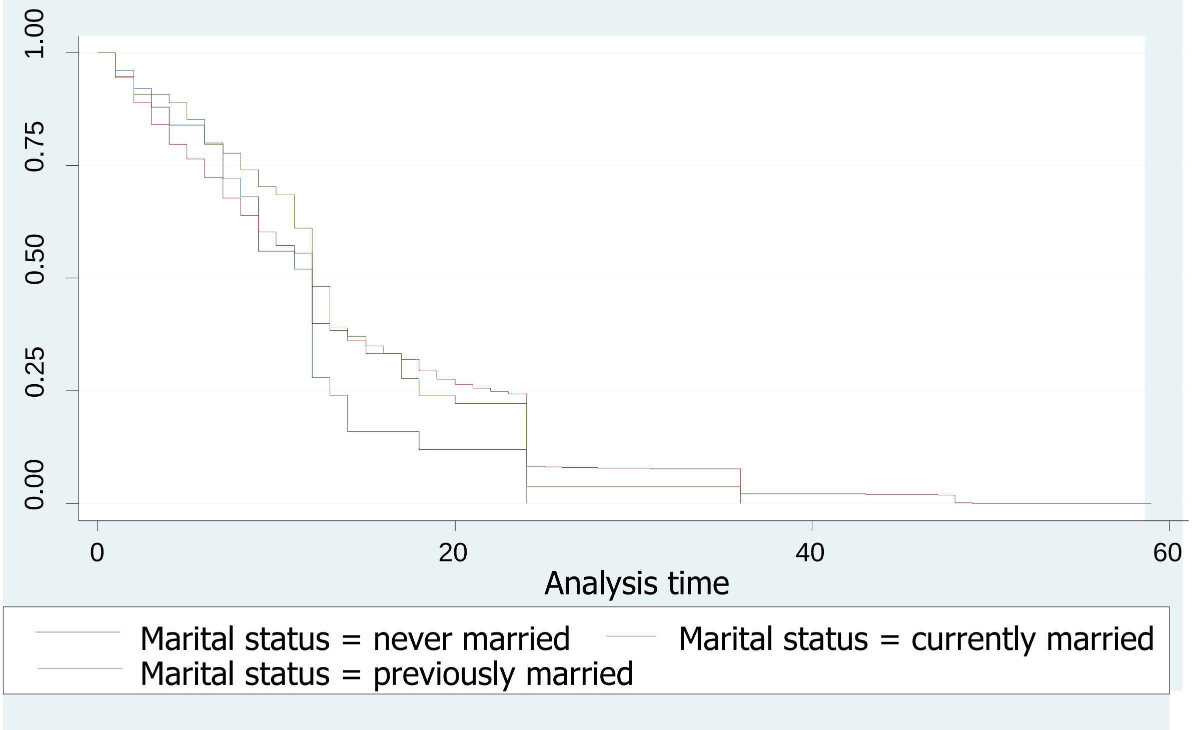


Fig C15: Kaplan-Meier survival estimates, by place of delivery, 2003

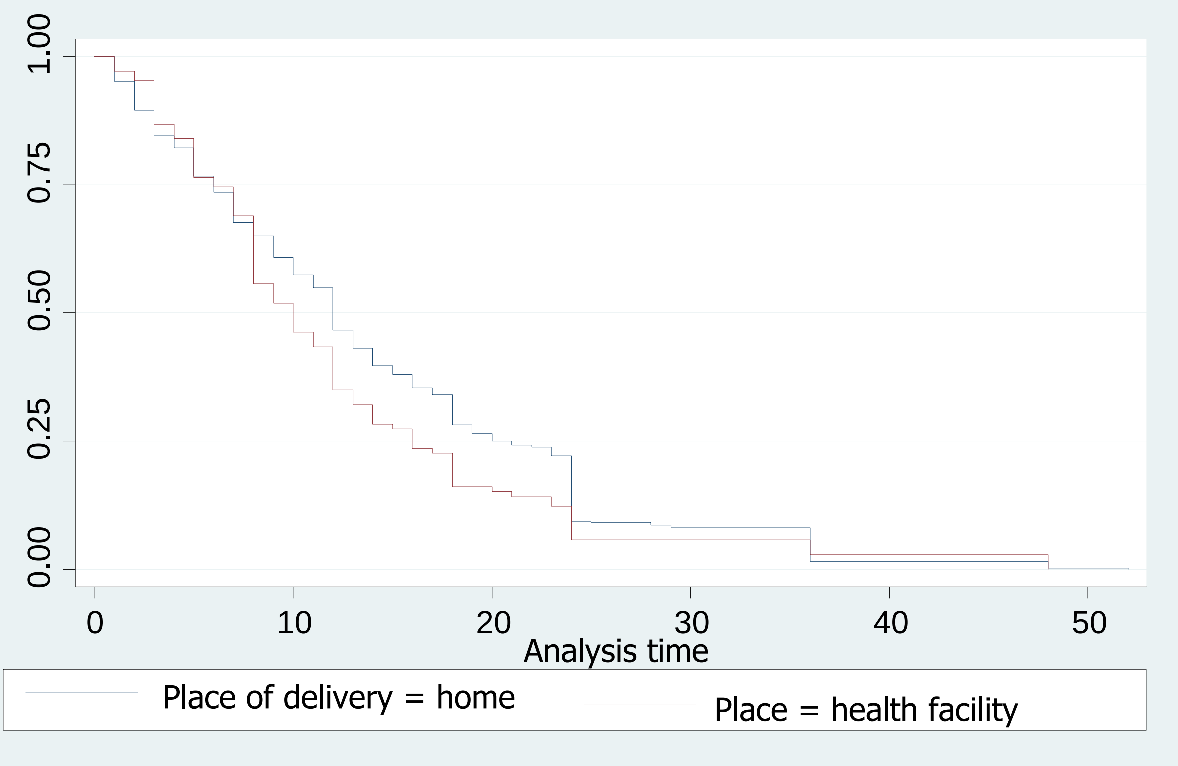
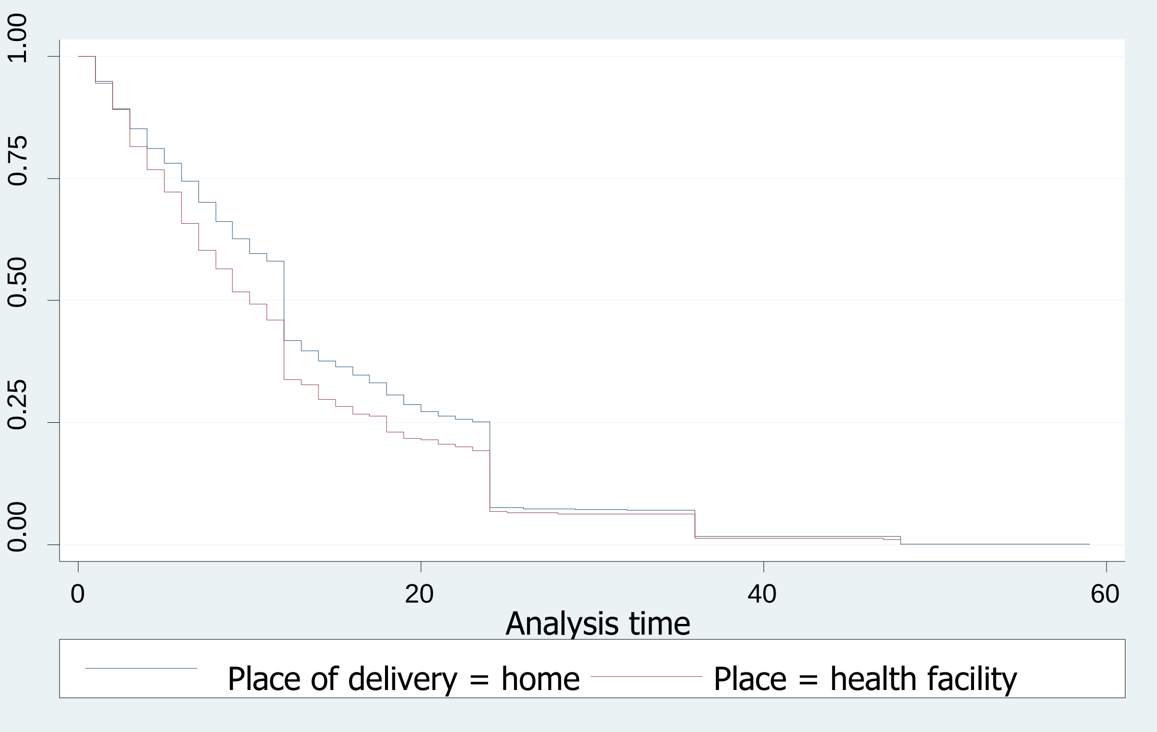


Fig C16: Kaplan-Meier survival estimates, by place of delivery, 2008



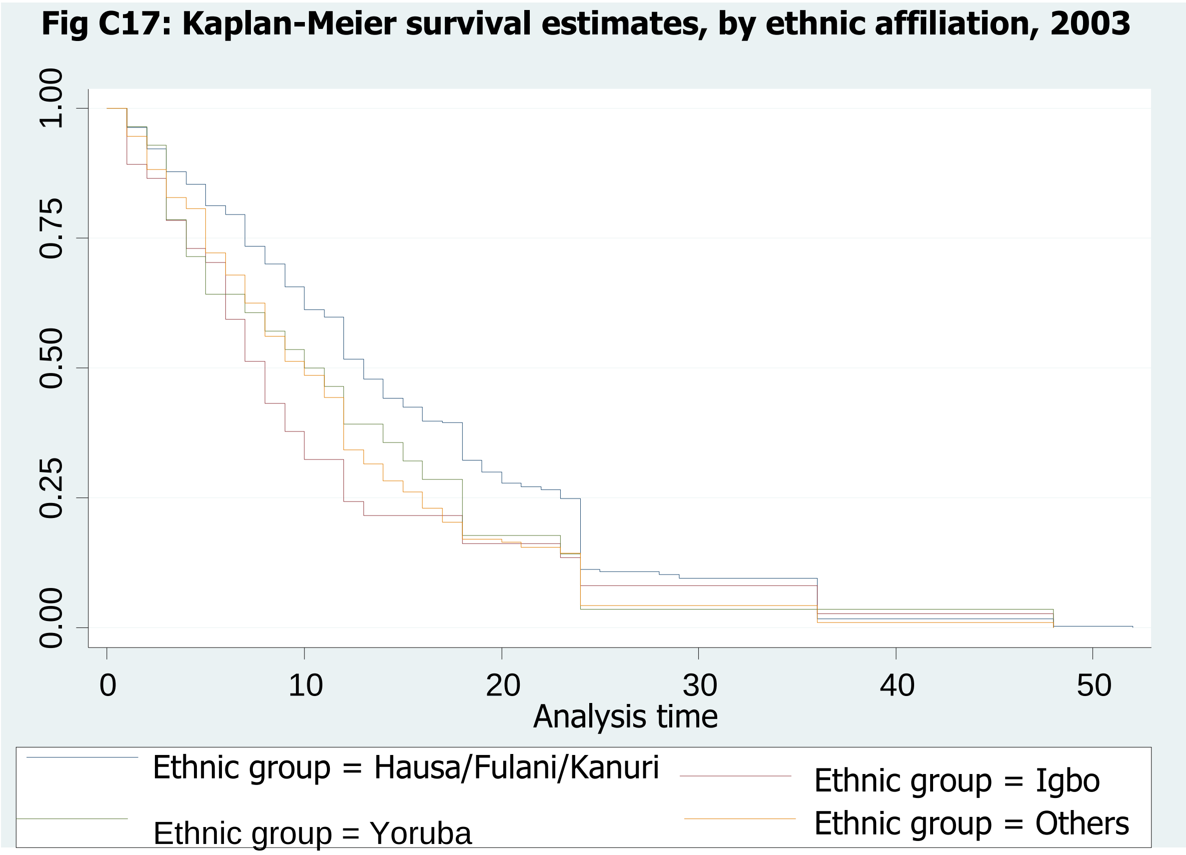


Fig C17: Kaplan-Meier survival estimates, by ethnic affiliation, 2003
0.00
0.25
0.50
0.75
1.00
0
10
20
30
40
50
Analysis time
Ethnic group = Hausa/Fulani/Kanuri
Ethnic group = Igbo
Ethnic group = Yoruba
Ethnic group = Others

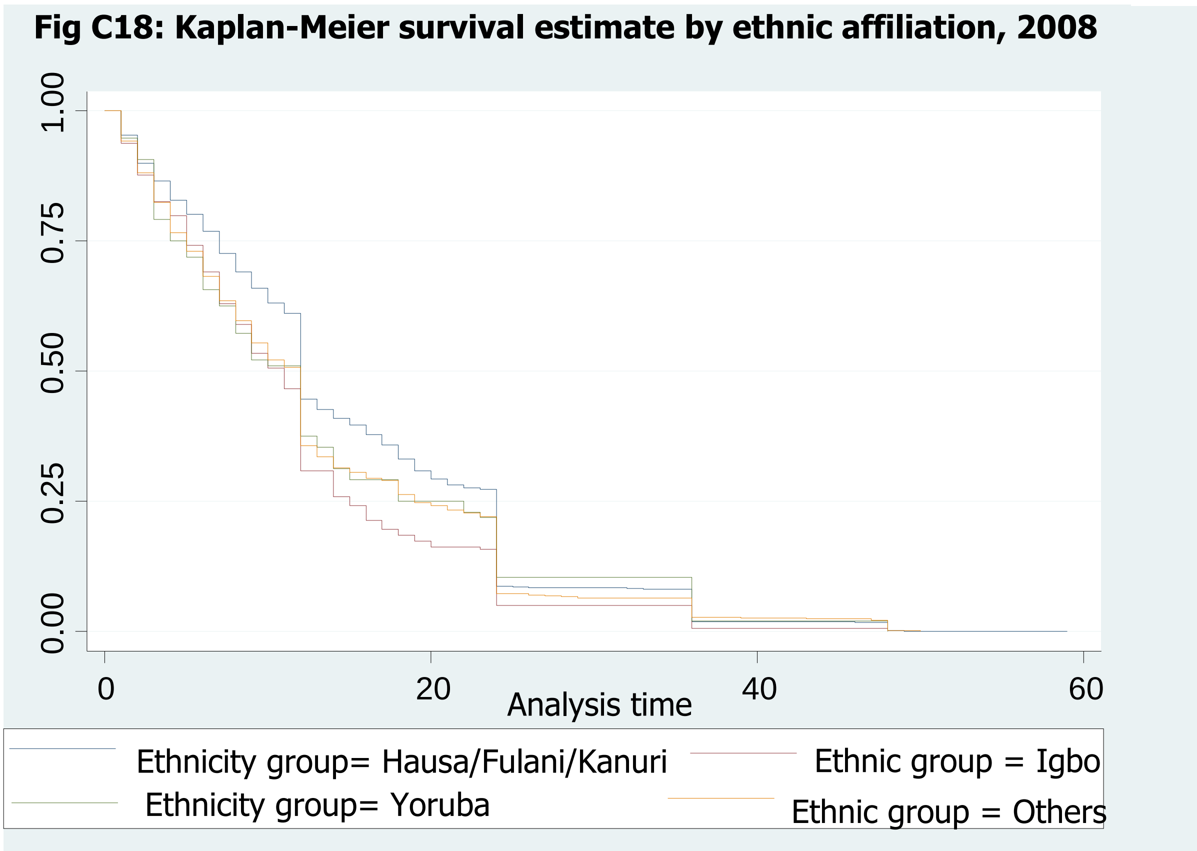


Fig C18: Kaplan-Meier survival estimate by ethnic affiliation, 2008
0.00
0.25
0.50
0.75
1.00
0
20
40
60
Analysis time
Ethnicity group= Hausa/Fulani/Kanuri
Ethnic group = Igbo
Ethnicity group= Yoruba
Ethnic group = Others

Fig C19: Kaplan-Meier survival estimate by parity, 2003

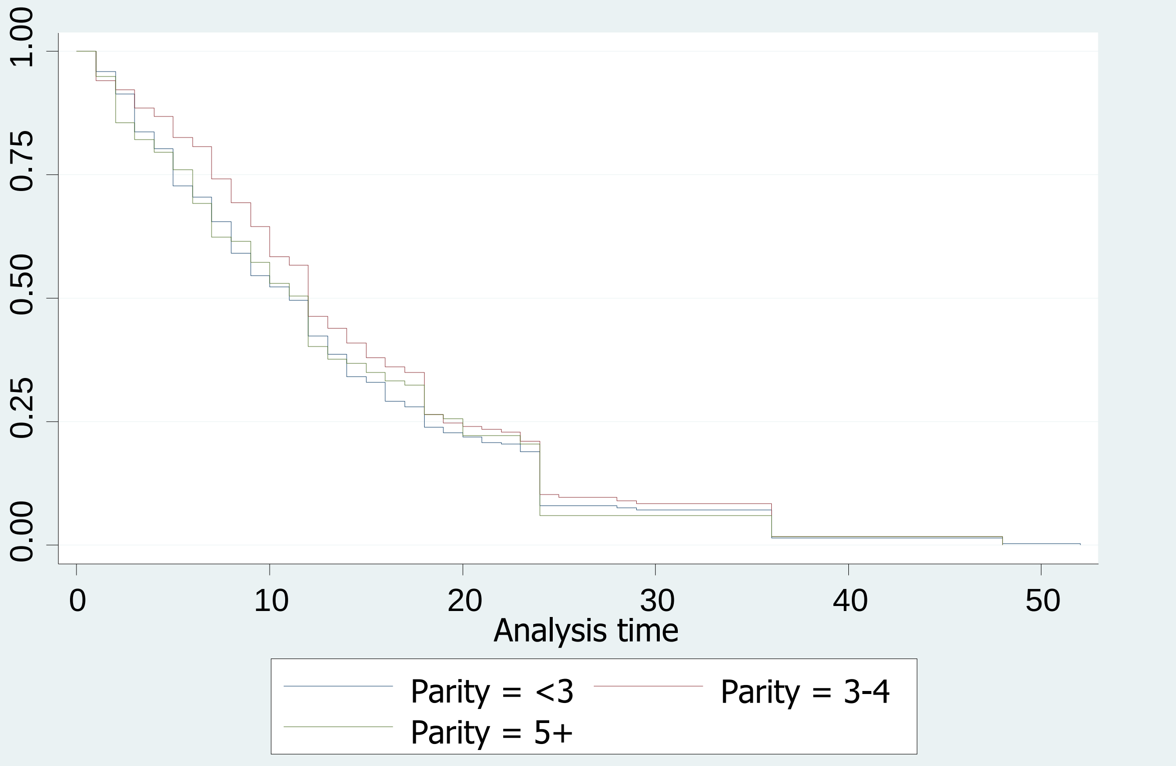


Fig C20: Kaplan-Meier survival estimate by parity, 2008

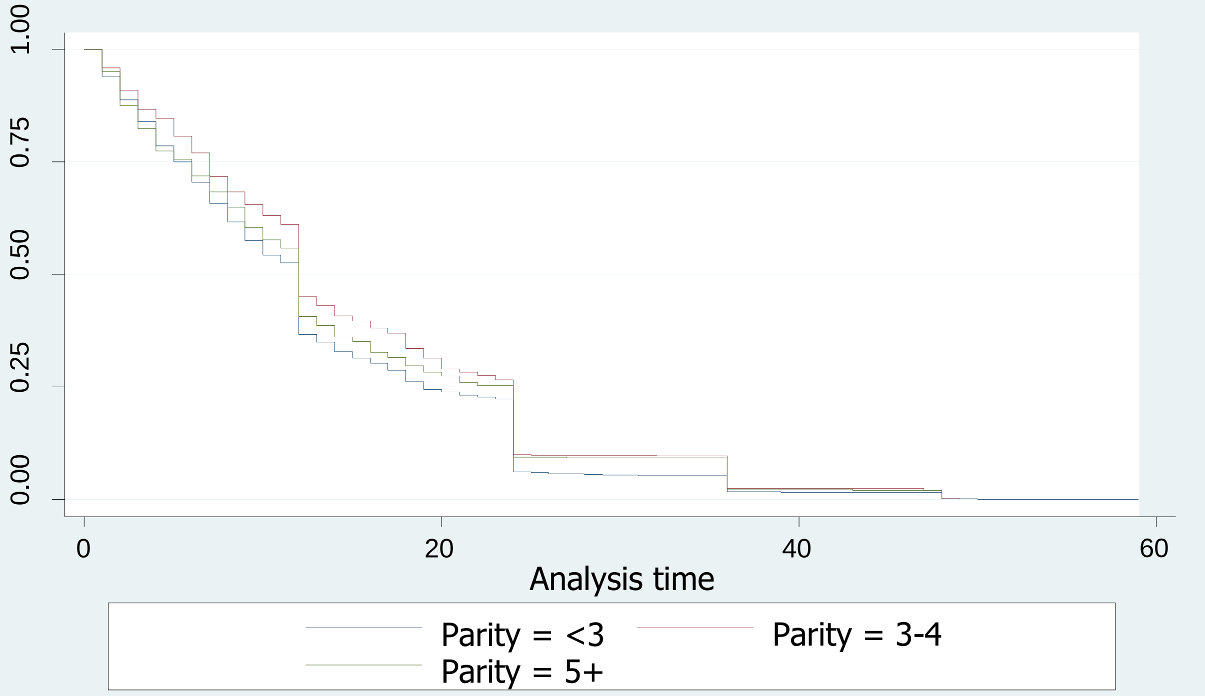


Fig C21: Kaplan-Meier survival estimate by family structure, 2003

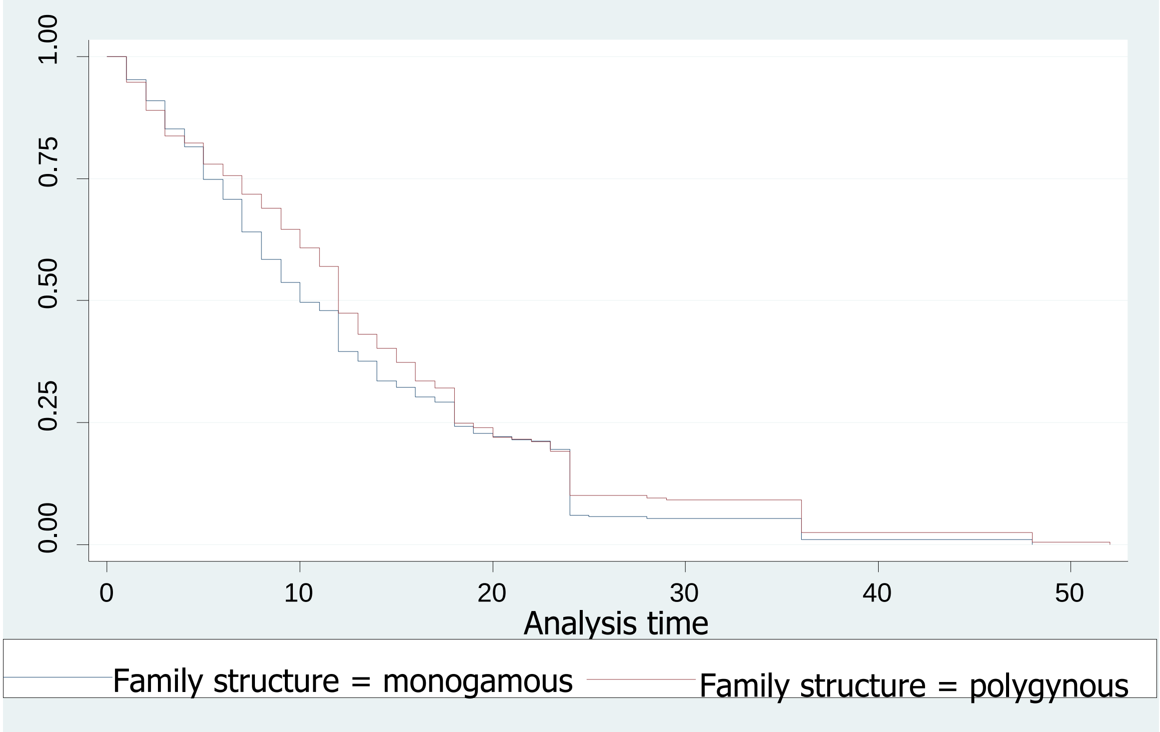


Fig C22: Kaplan-Meier survival estimate by family structure, 2008

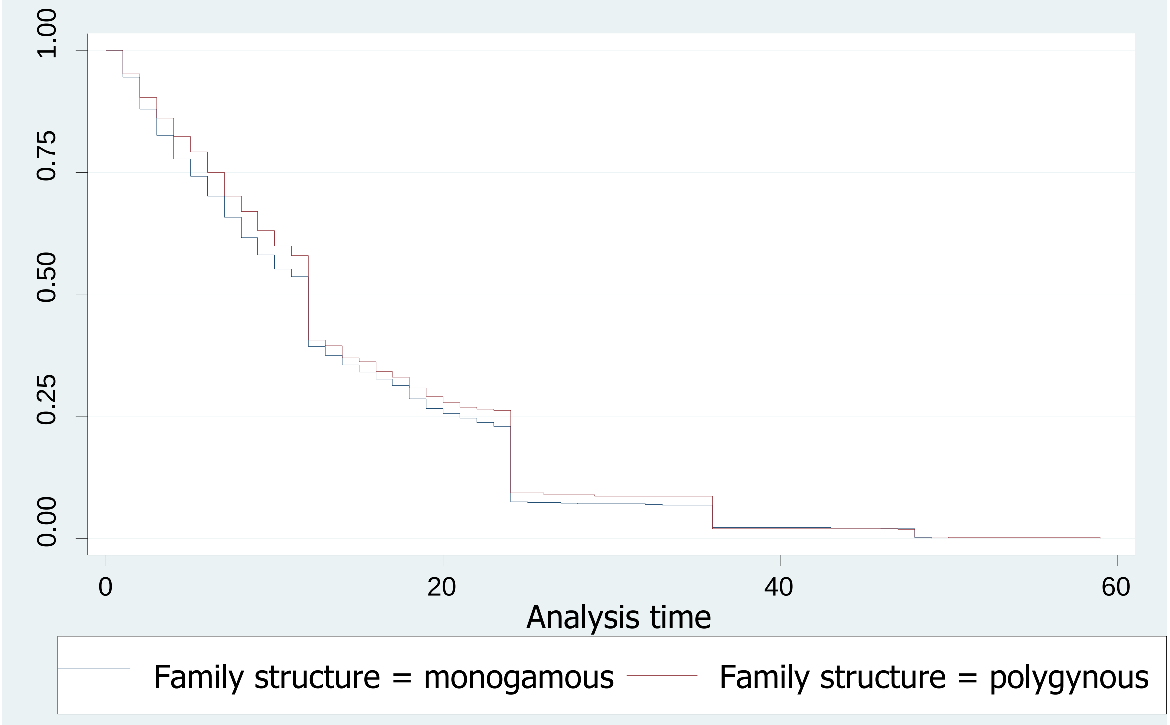


Fig C23: Kaplan-Meier survival estimate by religion, 2003

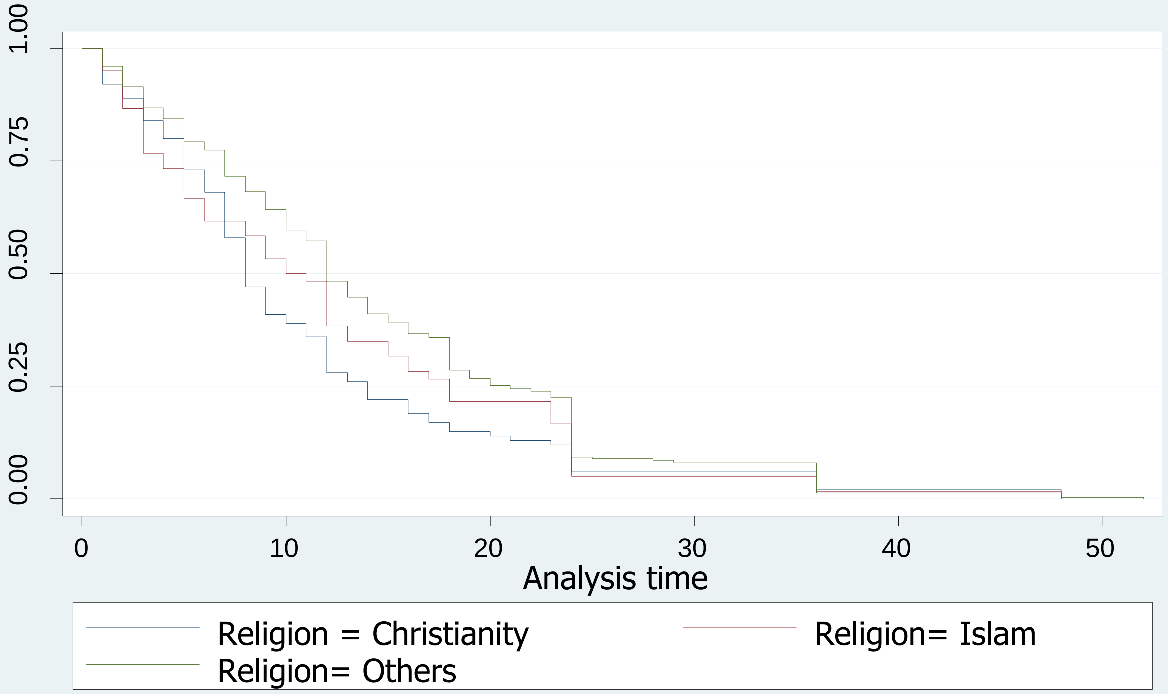


Fig C24: Kaplan-Meier survival estimate by religion, 2008

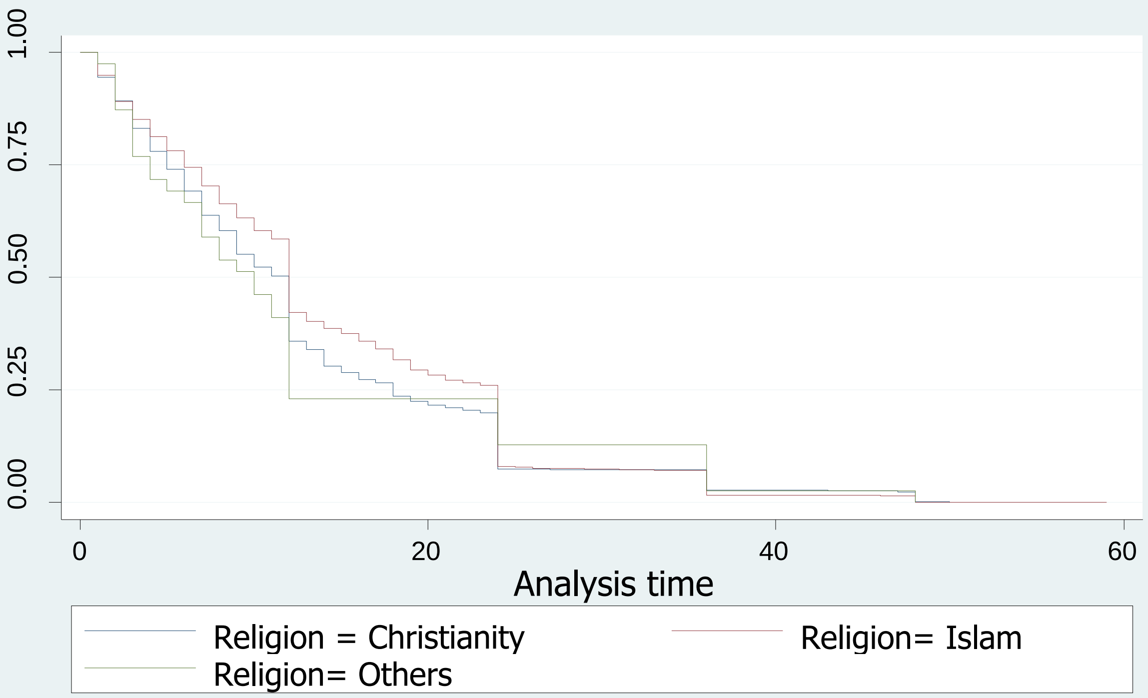


Fig C25: Kaplan-Meier survival estimate by mother's occupation, 2003

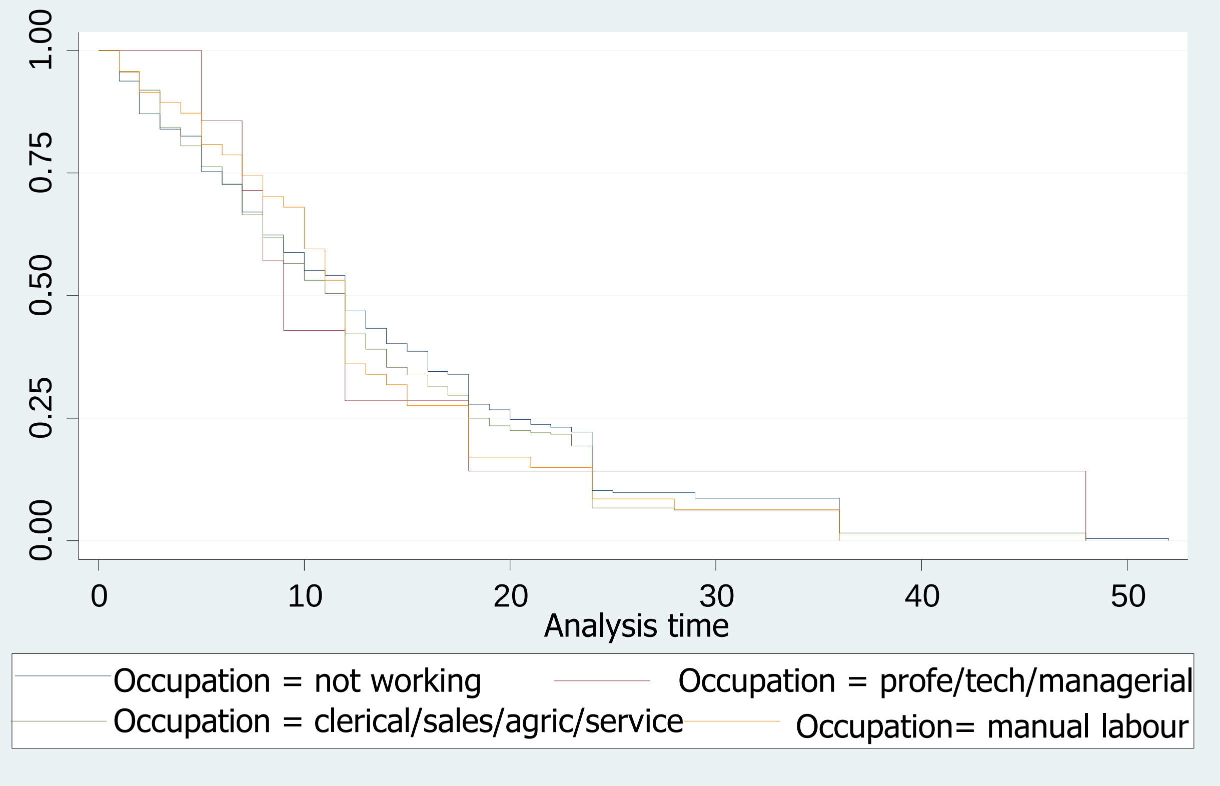
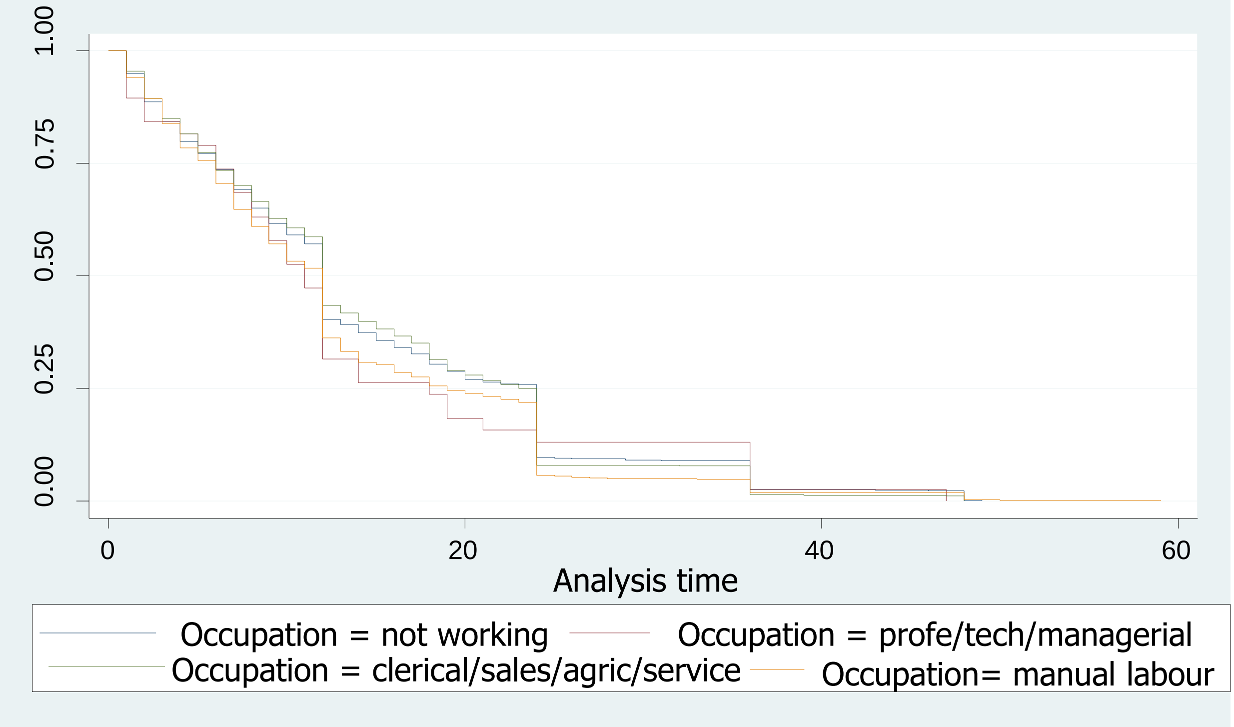


Fig C26: Kaplan-Meier survival estimate by mother's occupation, 2008



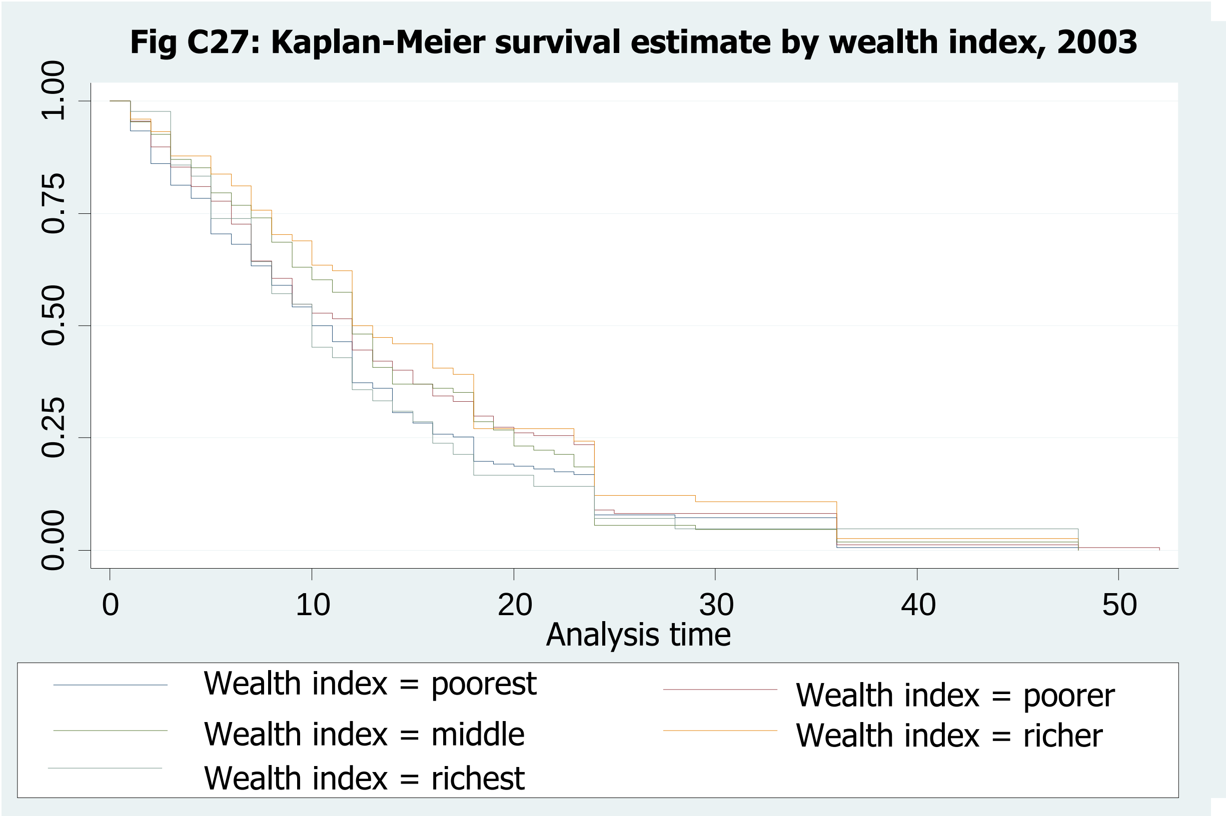


Fig C27: Kaplan-Meier survival estimate by wealth index, 2003
0.00
0.25
0.50
0.75
1.00
0
10
20
30
40
50
Analysis time
Wealth index = poorest
Wealth index = middle
Wealth index = richest
Wealth index = poorer
Wealth index = richer

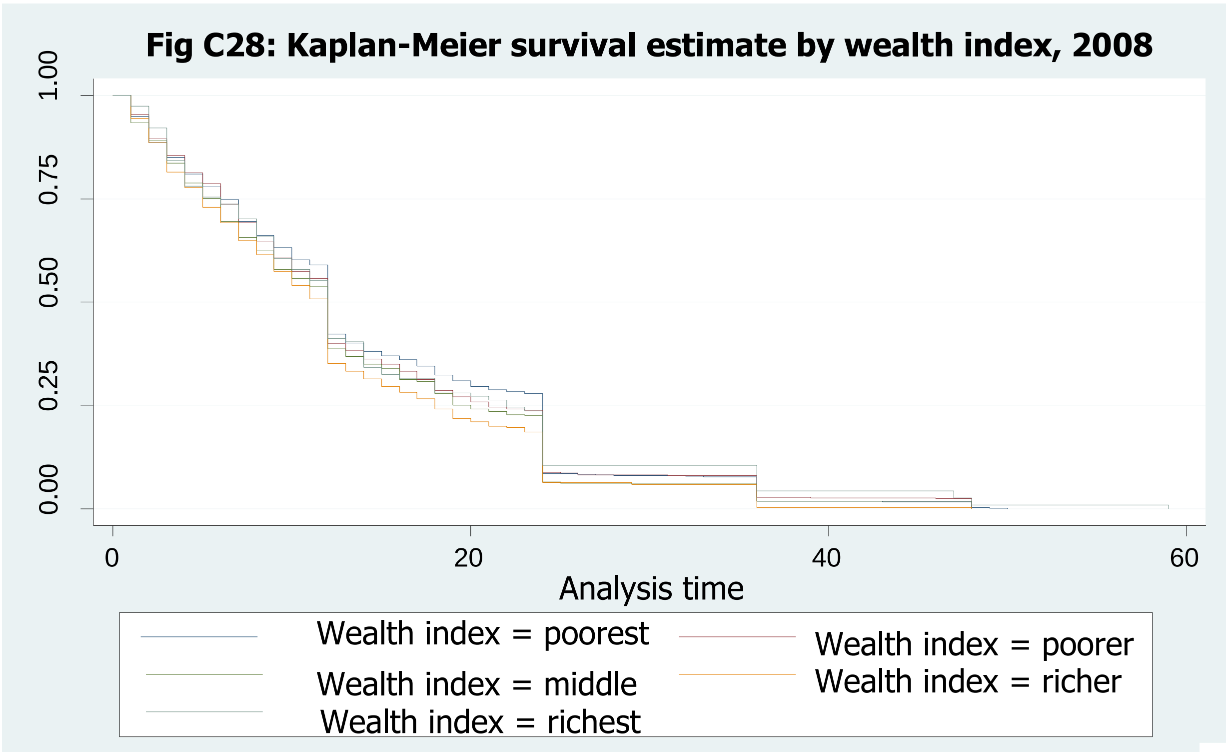


Fig C28: Kaplan-Meier survival estimate by wealth index, 2008
0.00
0.25
0.50
0.75
1.00
0
20
40
60
Analysis time
Wealth index = poorest
Wealth index = middle
Wealth index = richest
Wealth index = poorer
Wealth index = richer

Fig C29: Kaplan-Meier survival estimate by contraceptive use, 2003

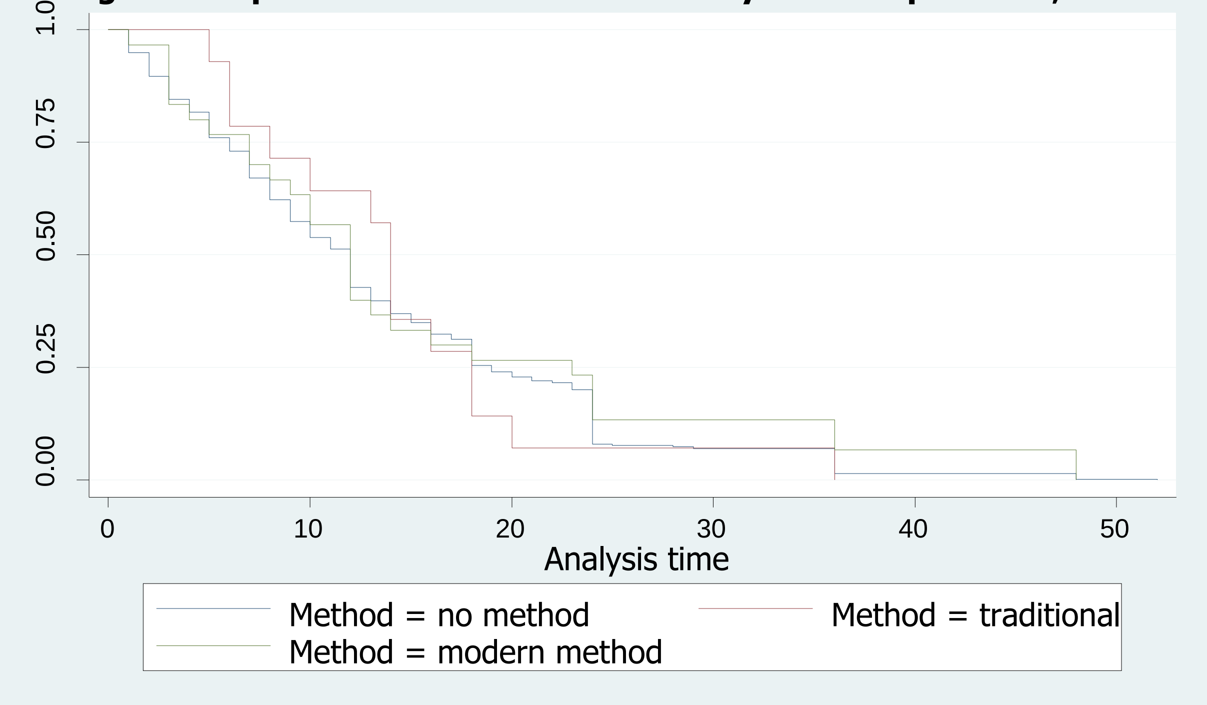


Fig C30: Kaplan-Meier survival estimate by contraceptive use, 2008

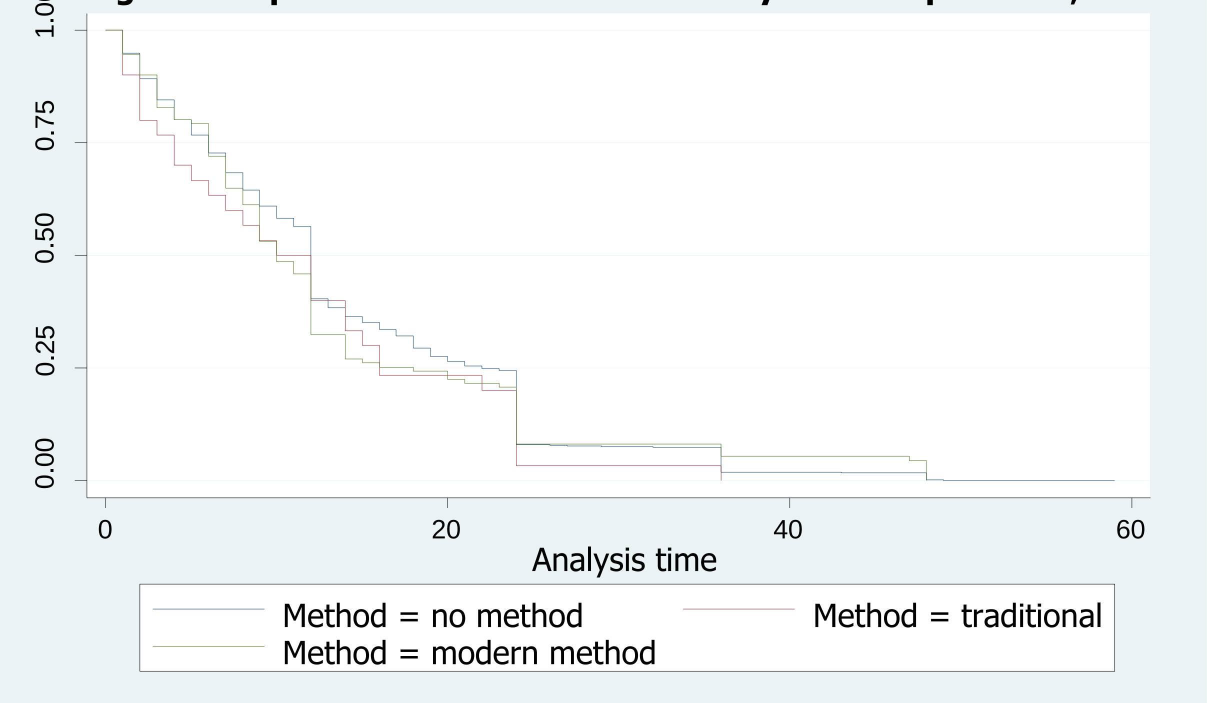


Fig C31: Kaplan-Meier survival estimates, by region of residence, 2003

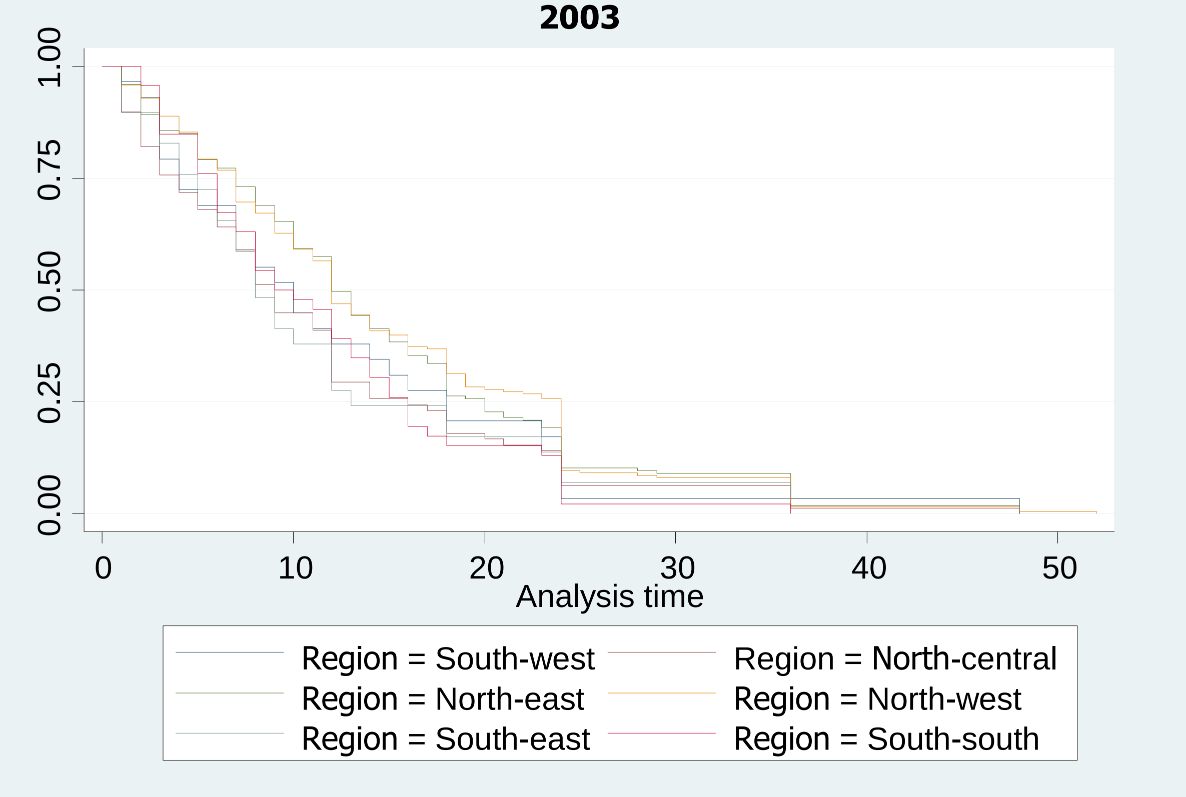


Fig C32: Kaplan-Meier survival estimates, by region of residence, 2008

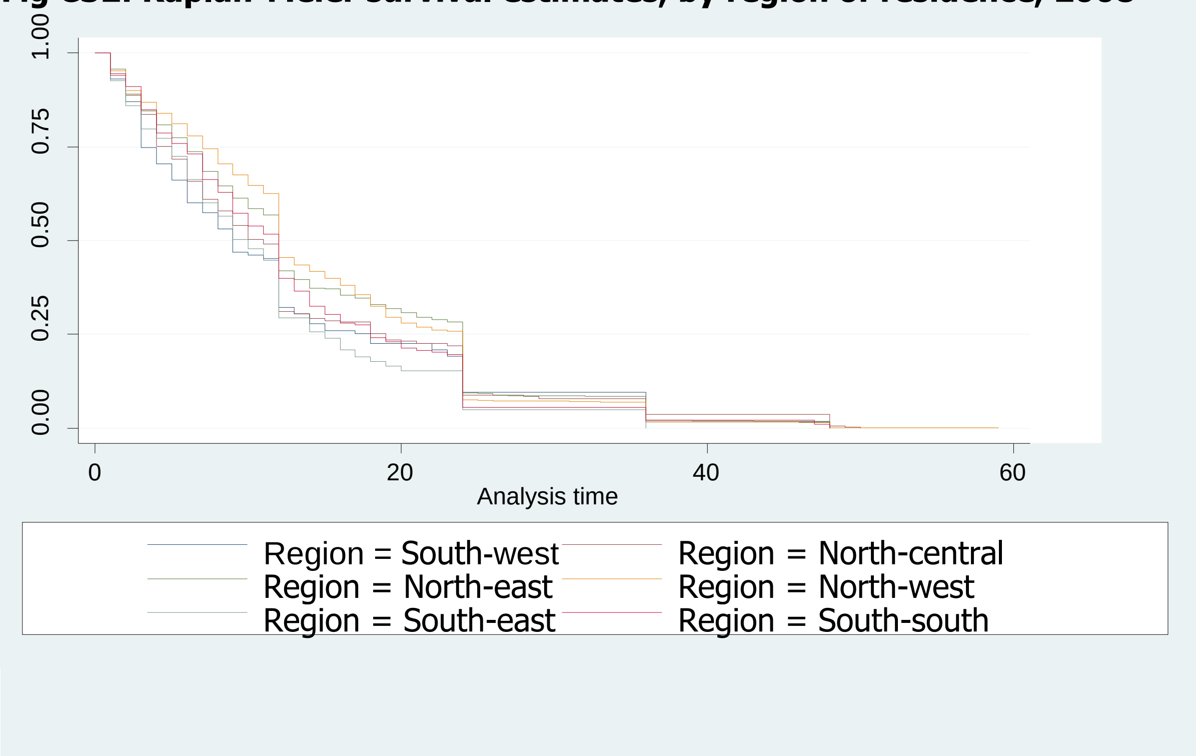


Fig C33: Kaplan-Meier survival estimate by place of residence, 2003

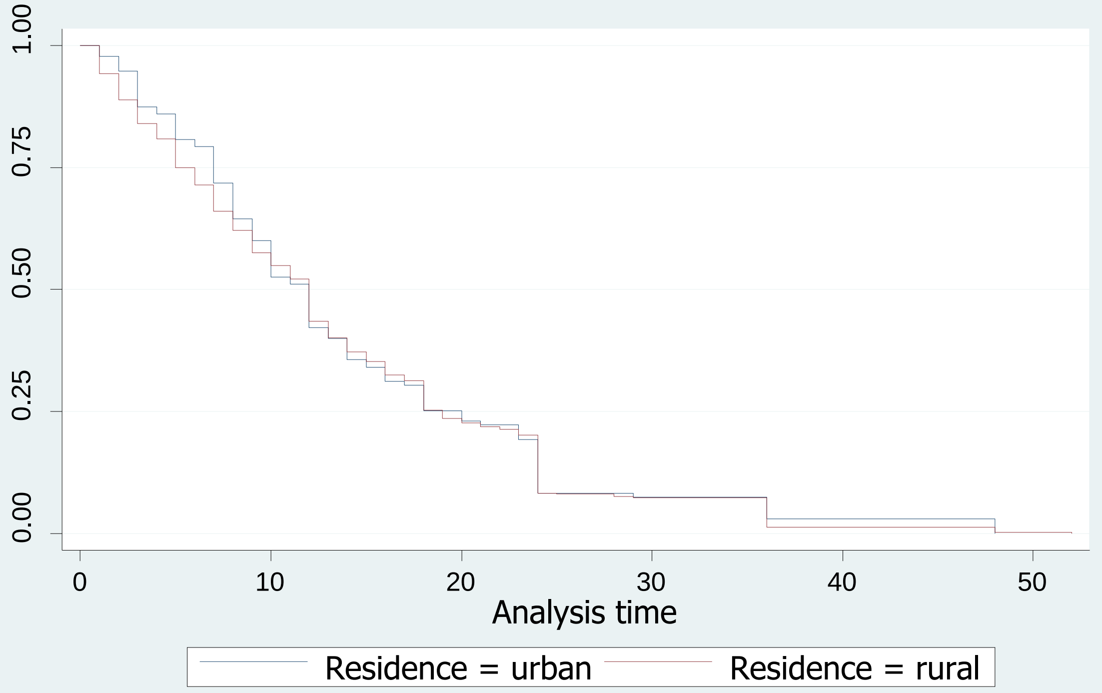


Fig C34: Kaplan-Meier survival estimate by place of residence, 2008

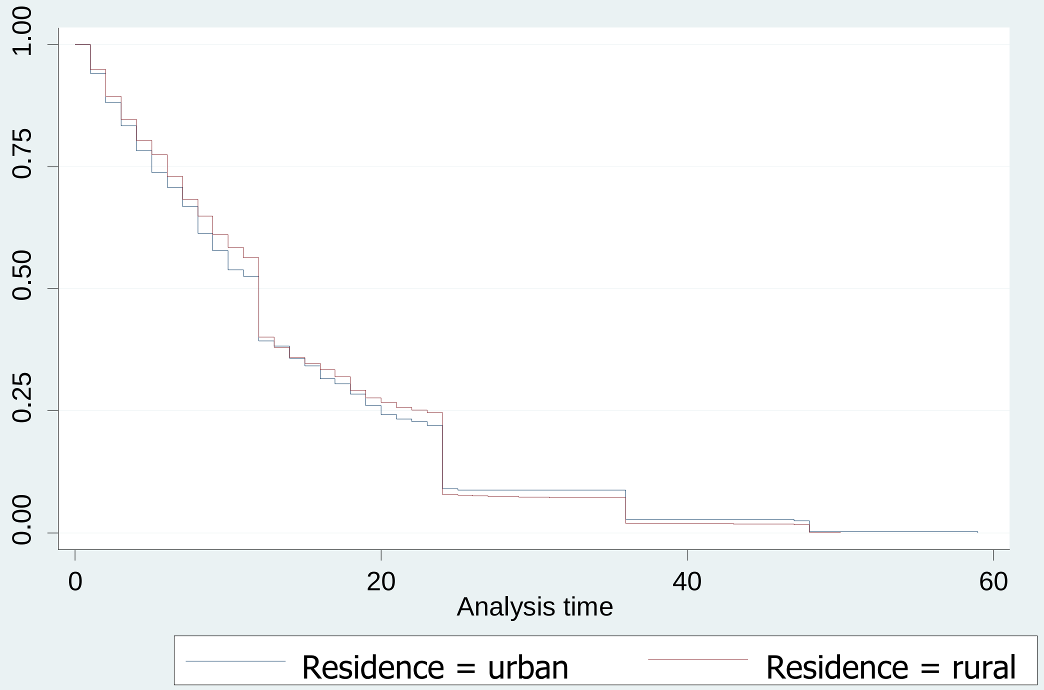


Fig C35: Kaplan-Meier survival estimate by community prenatal care, 2003

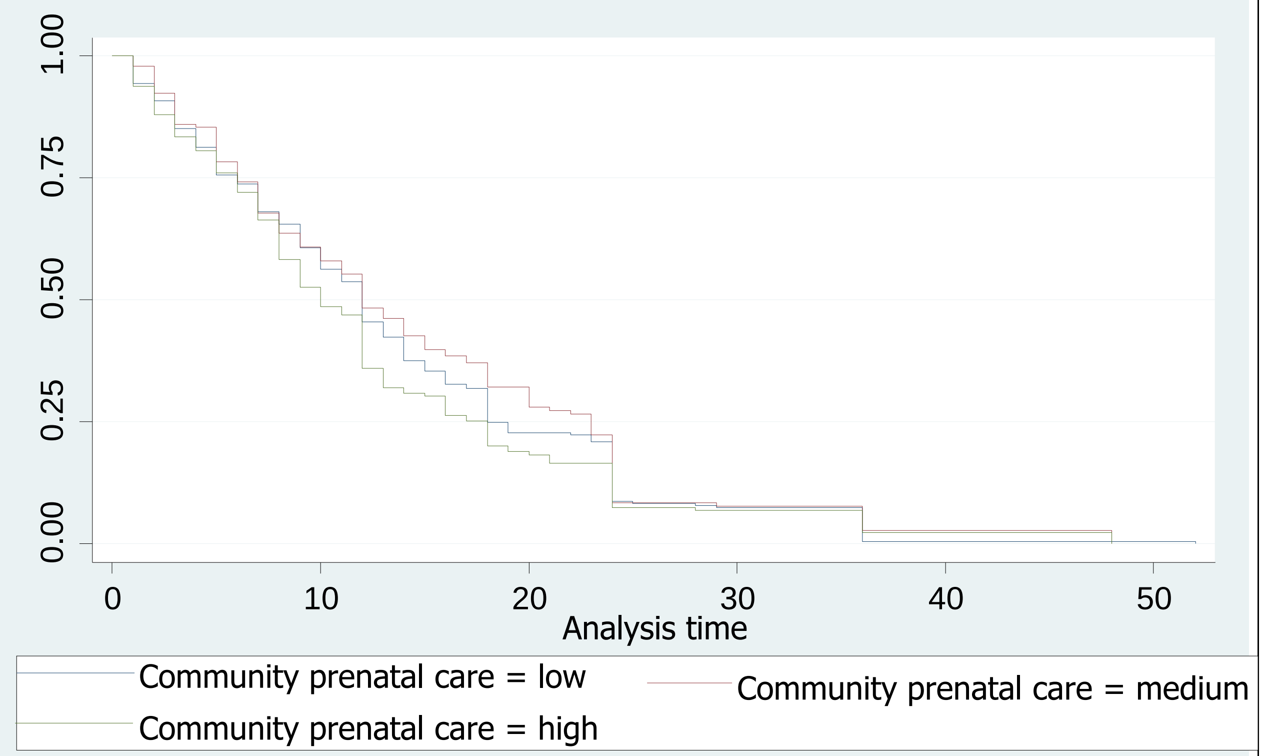


Fig C36: Kaplan-Meier survival estimate by community prenatal care, 2008

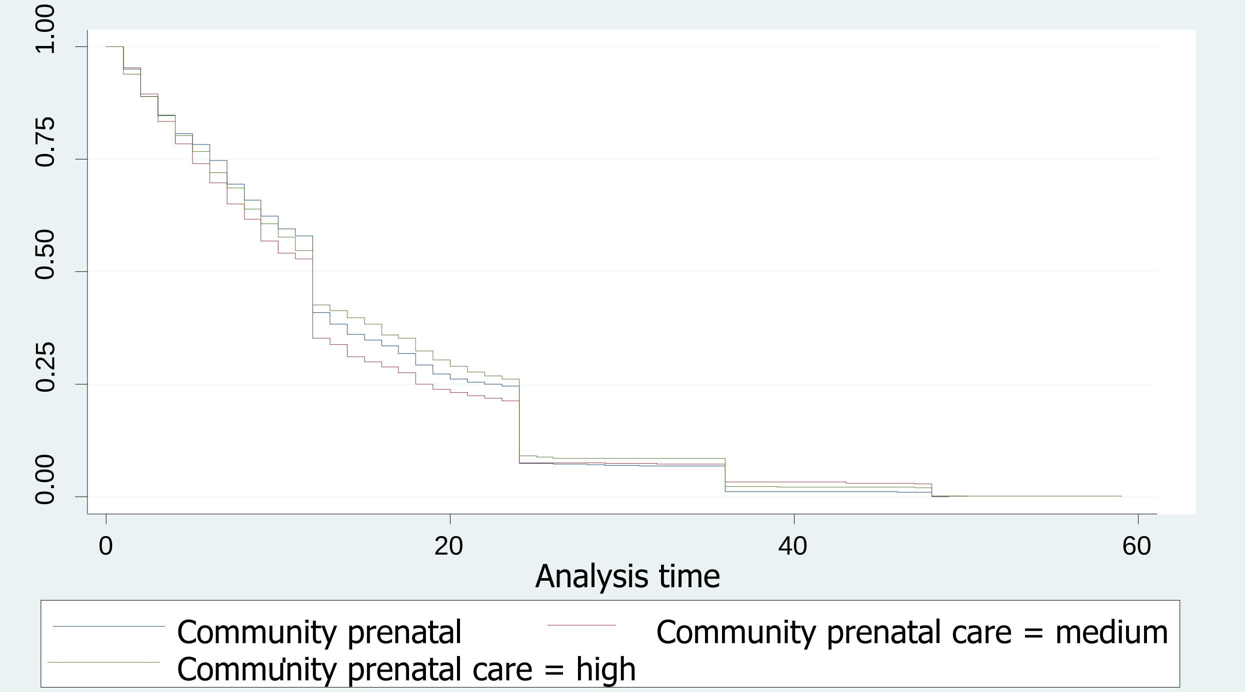


Fig C37: Kaplan-Meier survival estimate by community level of education, 2003

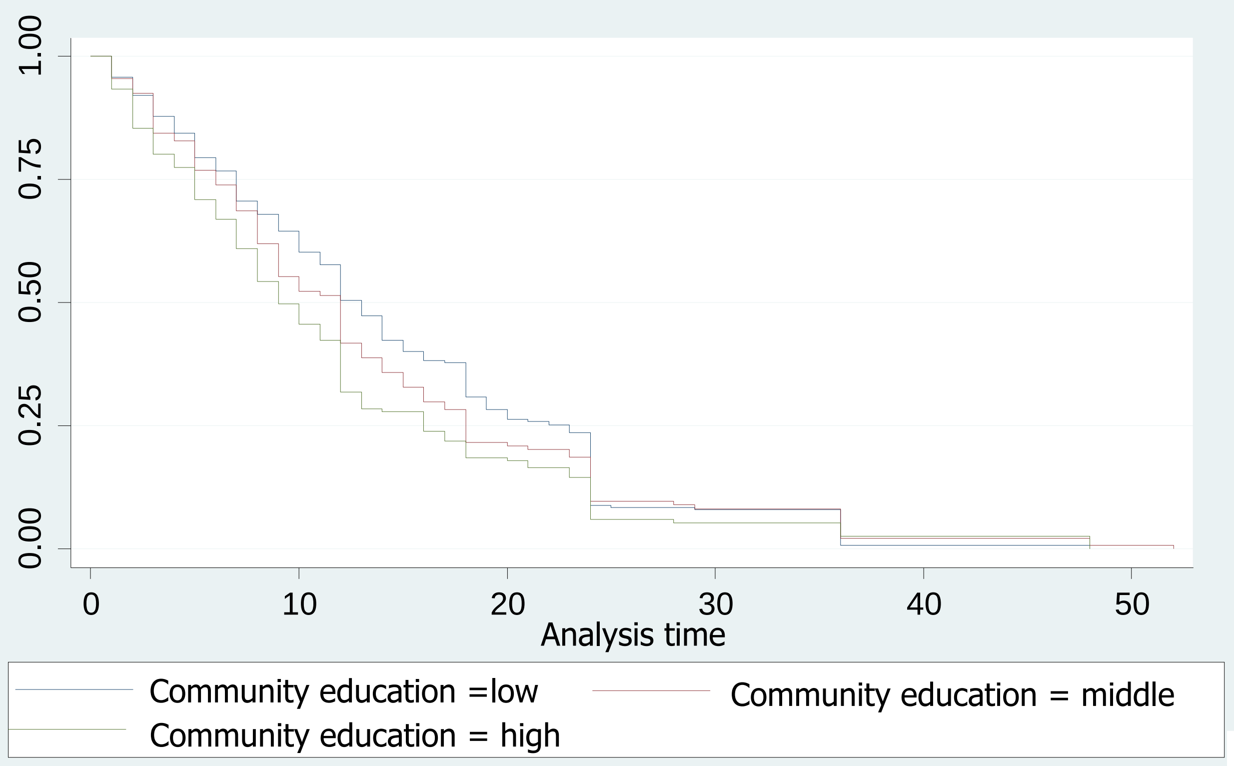


Fig C38: Kaplan-Meier survival estimate by community level of education, 2008

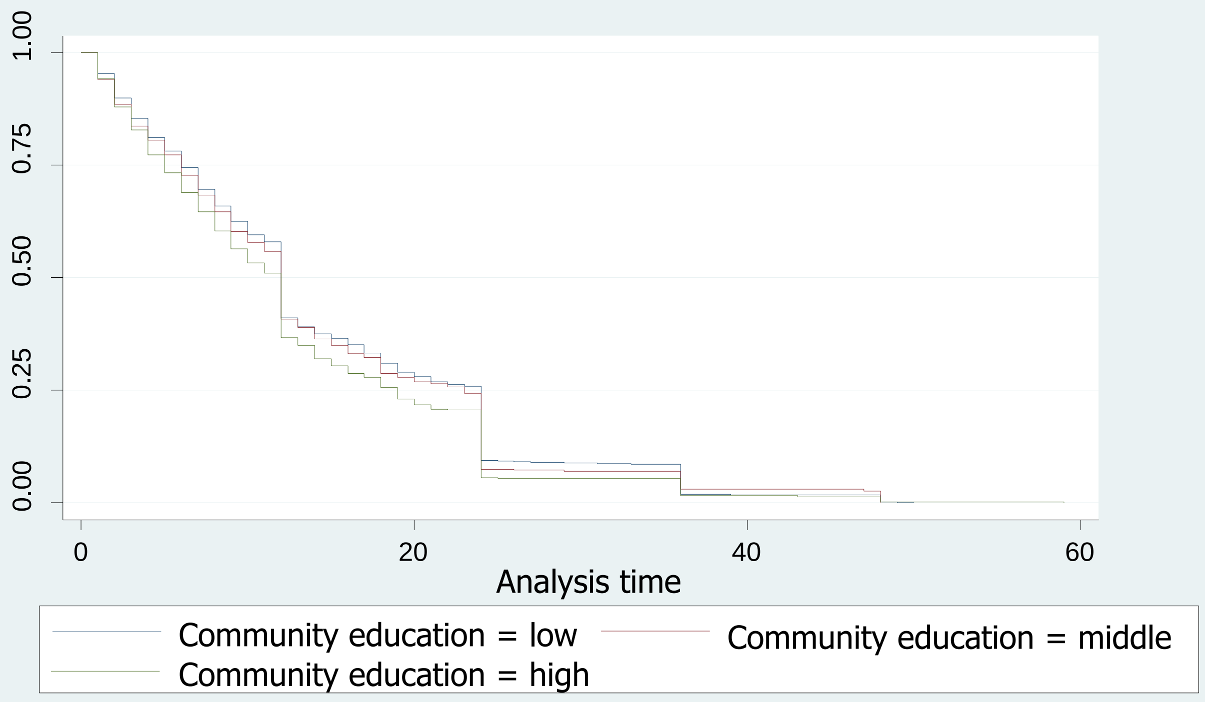


Fig C39: Kaplan-Meier survival estimate by community hospital delivery, 2003

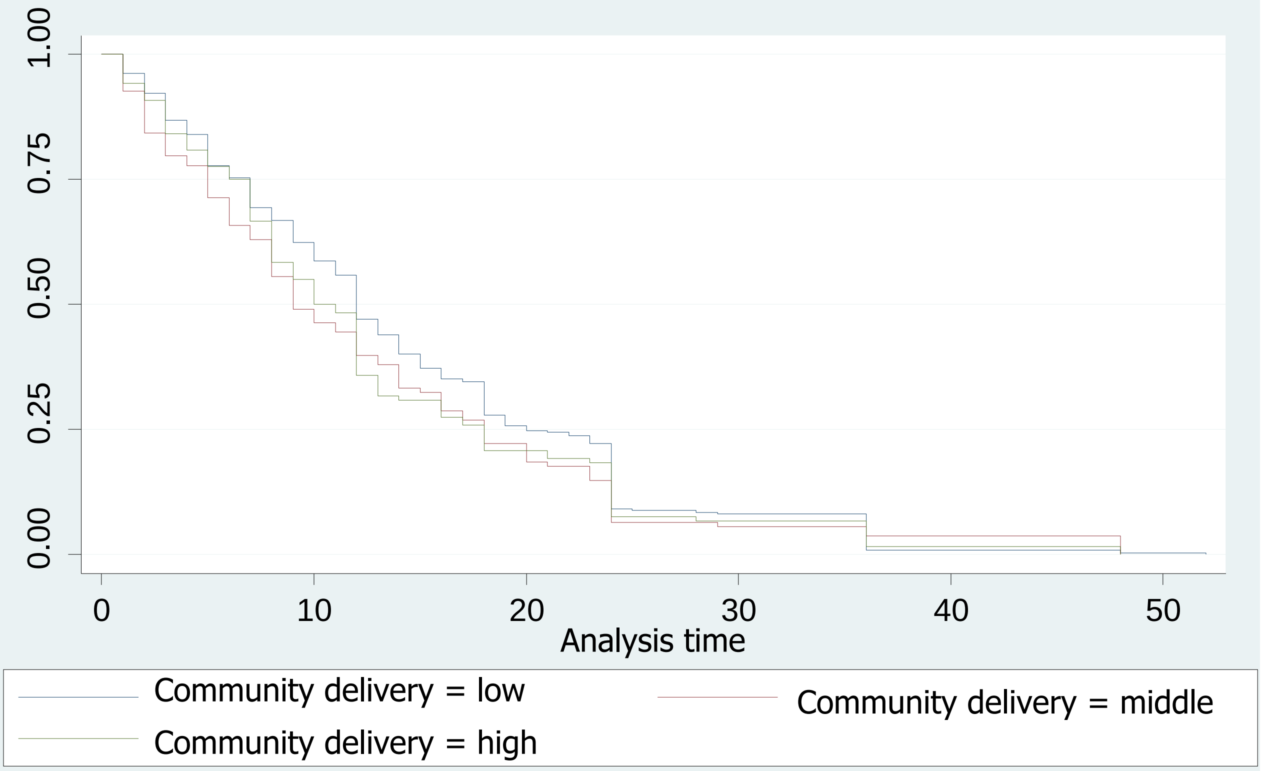
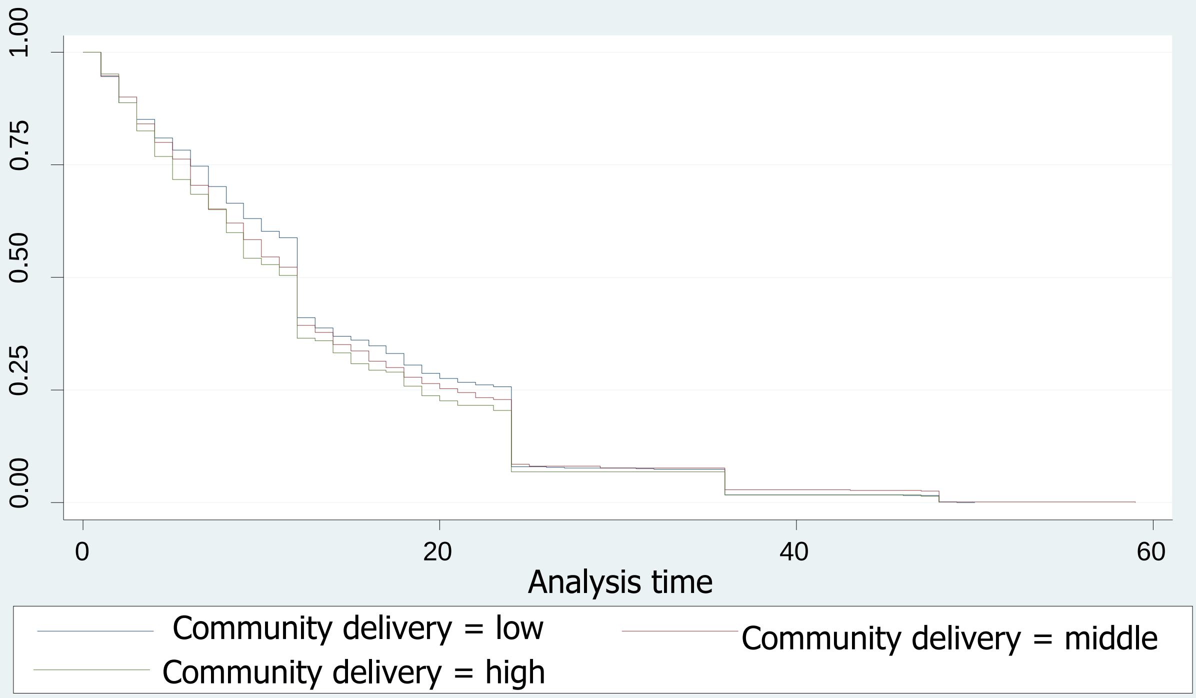


Fig C40: Kaplan-Meier survival estimate by community hospital delivery, 2008

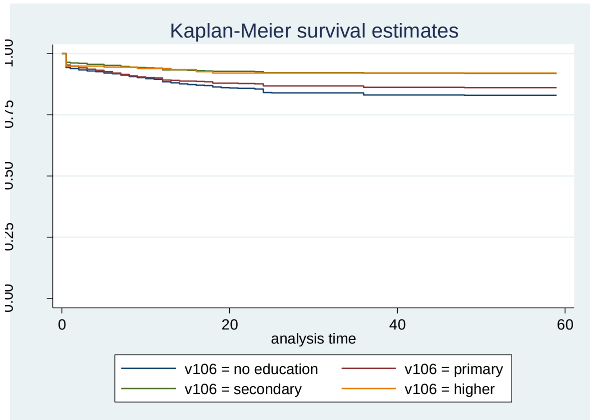


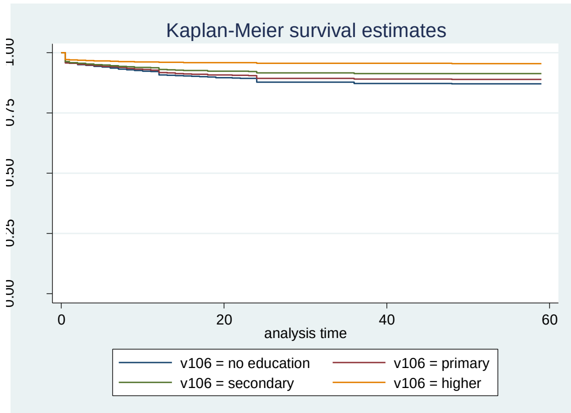
Appendix D: Proportional hazard tests for time-varying covariates

(A parallel curve of the survival functions is a confirmation that the proportional hazard assumption is satisfied for the selected time-varying covariates)

Maternal education

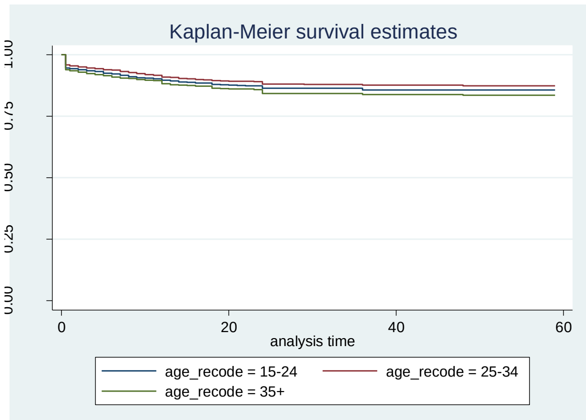
2003 **2008**

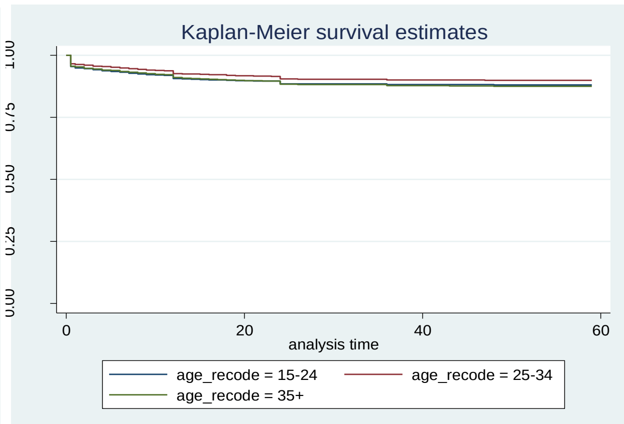




Maternal age

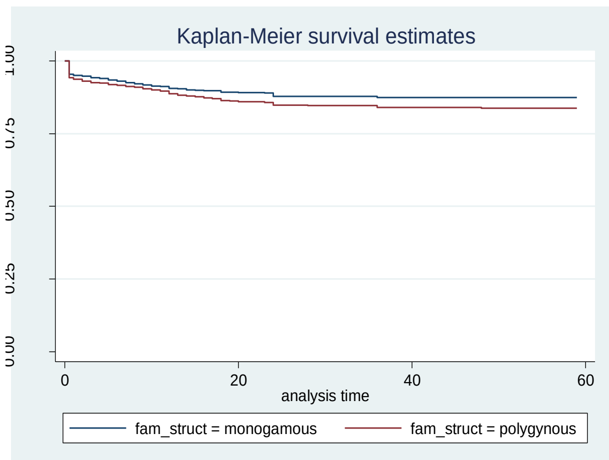
2003 **2008**

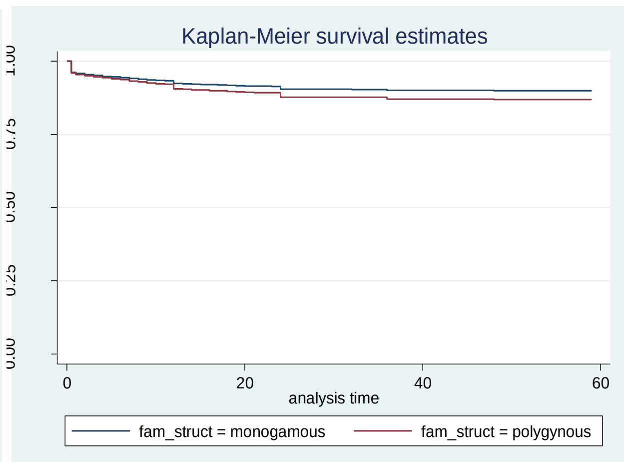




Family structure

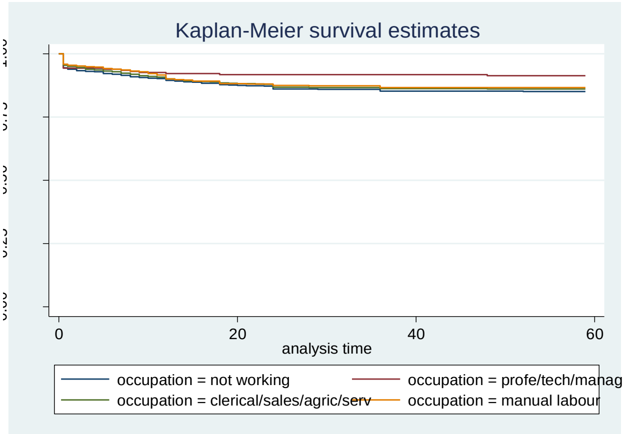
2003 **2008**

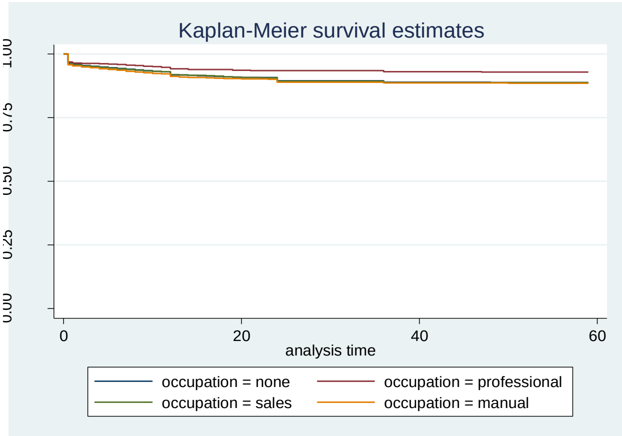




Occupation

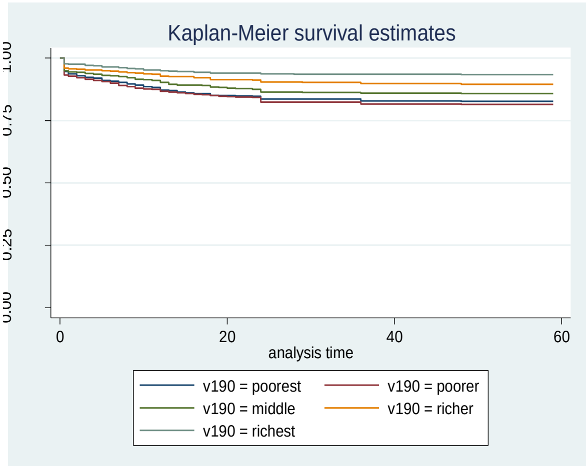
2003 | 2008

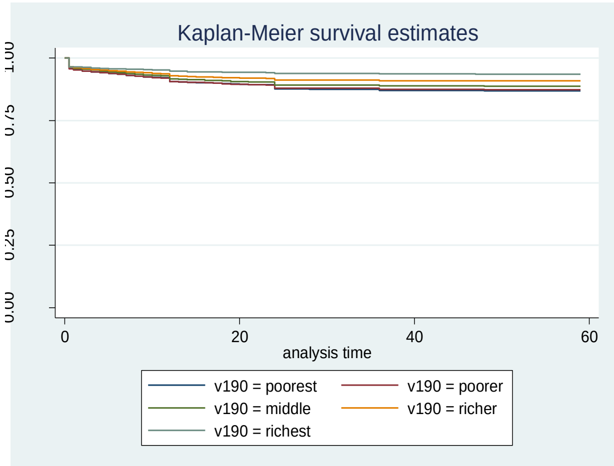




Wealth index

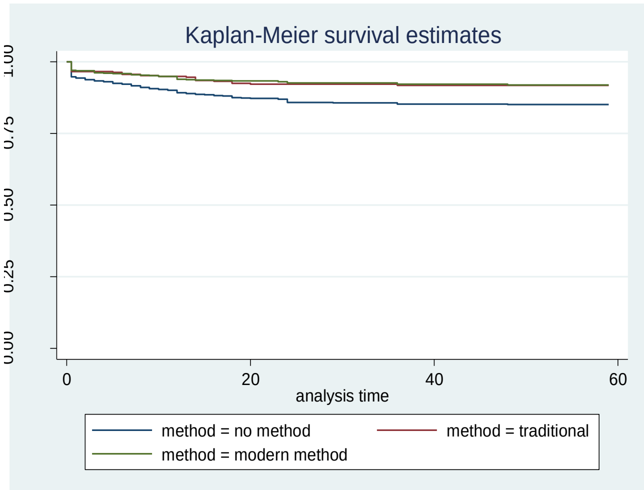
2003 | 2008

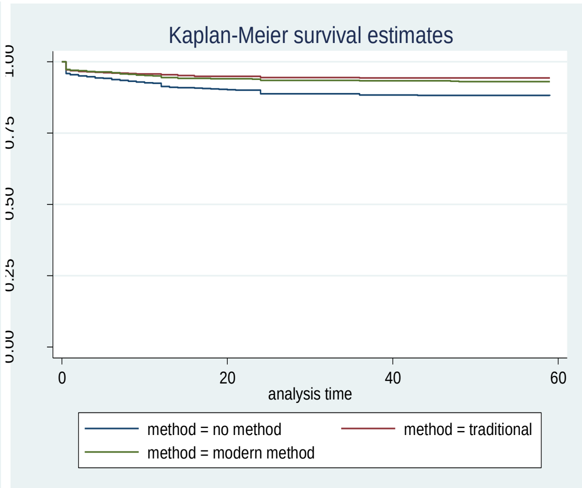




Contraceptive use

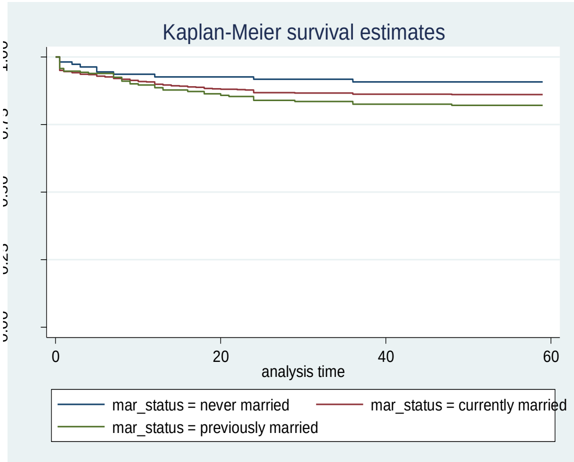
2003 | 2008



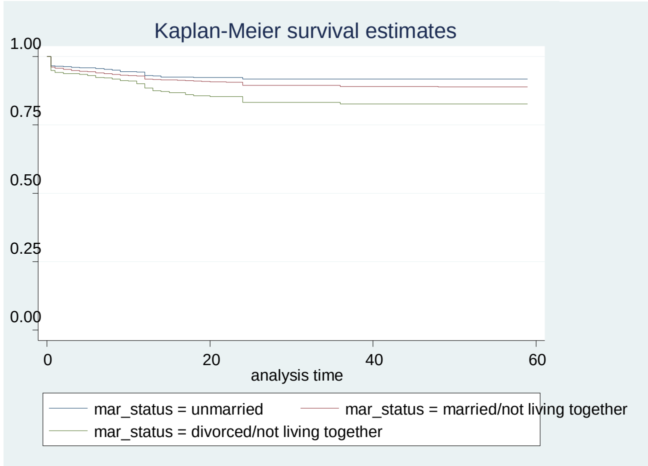


Marital status

2003

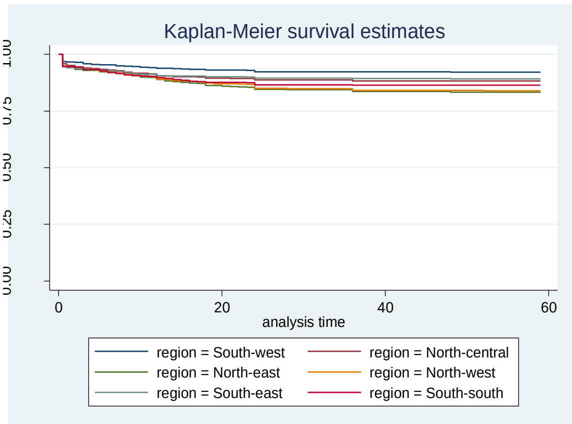


2008

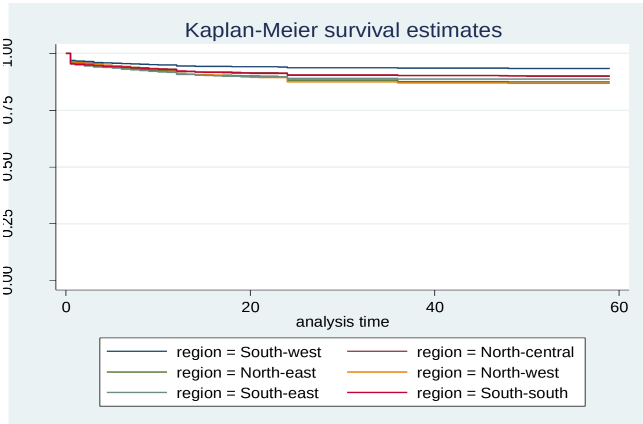


Region of residence

2003

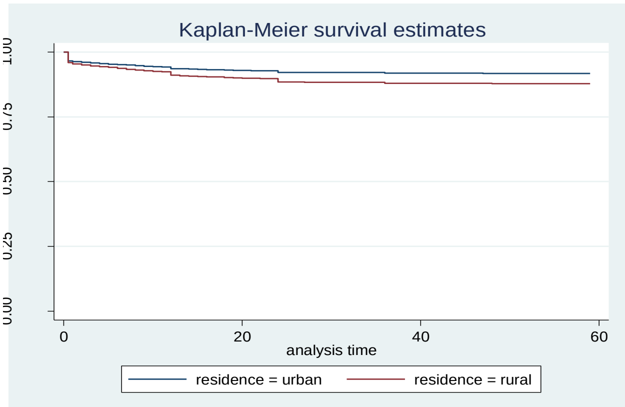


2008



Place of residence

2003



2008