UNIVERSITY OF THE WITWATERSRAND
DEMOGRAPHY & POPULATION STUDIES PROGRAMME

**RESEARCH THESIS**

# Antenatal Care as a Determinant of Perinatal Mortality in Nigeria: Population-Based Study

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Research Report Submitted To the Faculty of Humanities,

University of the Witwatersrand

Johannesburg, In Fulfilment of the Requirements for the Award of

Degree of Masters of Arts in Demography and Population Studies

Academic Year, 2014

# DECLARATION

I, Tukur Dahiru, declare that this research report is my original work. It is being submitted in fulfilment of the requirements for the award of the degree of Masters in Demography and Population Studies of the University of the Witwatersrand. This work has never been submitted for the award of any degree in this university or another, to the best of my knowledge.

………………….day of ……………………., 2015

# DEDICATION

I dedicate this research report to the Almighty God and my late mother and father: Sa'adatu and Dahiru. May Allah rest their souls in Al-Jannah Firdausi.

# ACKNOWLEDGEMENT

First, my appreciation is to Almighty Allah the Creator of all creatures, for giving me the opportunity and good health to begin and complete this research successfully on time. Secondly, my family will be most appreciated by being there for me in Nigeria while I am in South Africa. They endured my absence and they held on for me till the end. My ‘trophy wife’ Safiya, has been very understand and supportive despite health challenges she faced in my absence as a result of the gift of triplets from Allah. May God bless the triplets (Sa’adatu [aka Ikram], A’isha [aka Ihsan] and Hussaina [aka Eiman]) and their alder brother, Awwal; their *de facto* father. My appreciation also goes to my brother, Sani who has been very supportive in the face of family challenges during my absence. My friends who have been very concerned about my family and academic progress needs to be mentioned here: Sani (Doka), Ibrahim (Bature), Munkailu. My brothers, uncles and unties who have supported my studies in different ways.

It is also important to appreciate the company my colleagues during this programme from whom I learnt a lot: Tobi, Mercy, Thabang, Dineo, Takalani, Doreen, Harawa, Chibuye and Dhivu. Also, my PhD colleagues Busi, Loretta, Vespa, Ken, Bob, Jeremy, and Dr Adedini. Also, importantly is the programme administrator, Ma Julia Mamabolo for her wonderful welcome reception.

I will extend my appreciation to my MSA brothers and friends: Ahmad Isyaka, Moshood (Baba Addini), AbdulGafar, Mahmud, Miftah, Mustapha Sa’ad, Sima Sa’id and Ali.

My appreciation will go to MEASURE DHS project for making the data set available to me and granting me the permission to the dataset. Without the dataset, my research work would have been extremely difficult to accomplish.

For the financial sponsorship offered by Tertiary Education Fund (TETFUND), I am grateful to TETFUND and Ahmadu Bello University, Zaria for giving Study Fellowship for the programme.

Finally, my profound appreciation goes to my supervisor, Prof Clifford C. Odimegwu for his wonderful encouragement and prompt responses to my queries on the research thesis. Thank you Prof!!!.

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# List of Abbreviations

| | |
|---|---|
| ANC | Antenatal Care |
| BP | Blood pressure |
| DHS | Demographic and Health Survey |
| FANC | Focused Antenatal Care |
| NDHS | Nigeria Demographic and Health Survey |
| WHO | World Health Organization |
| MDG | Millennium Development Goal |
| MSS | Midwifery Service Scheme |
| NPC | National Population Commission |
| UNICEF | United Nations Children's Fund |

# Abstract

## Background

The World Health Organization has recommended focused antenatal care as a strategy for reducing the burden of perinatal mortality and for the overall improvement of maternal and child health. Fragmentary studies in Nigeria indicate that lack of ANC or inadequate ANC is a predictor of perinatal death. However, most of these studies are hospital-based and suffer heavily from selection bias and therefore do not adequately represent the general population. This study examined the association between focused antenatal care and perinatal mortality in Nigeria.

### Data Source and Methods

The data for this study comes from the 2013 Nigeria Demographic and Health Survey (DHS). The 2013 Nigeria DHS is the fifth round of nation-wide organized data collection system supported by USAID and implemented by the National Population Commission (NPC 2014). The 2013 survey consists of nationally representative sample of 38,945 women aged 15-49years and 17,359 men aged 15-59 years living in 38,904 households. The unique feature of the 2013 survey is the collection of information that allows the estimation of perinatal mortality possible.

The main outcome variables are stillbirth (death of fetus after 7months of pregnancy or 22weeks of gestation), early neonatal death (death within 6days of delivery) and perinatal mortality (sum of stillbirths and early neonatal death). The main exposure variable is having at least four antenatal care visits in the most recent pregnancy within the five year period preceding the survey as recommended by WHO. Cox proportional hazard models were fitted to answer the research question.

## Results

There were 396 stillbirths and 925 early neonatal deaths and use of focused ANC is 61%; perinatal mortality rate as a whole is 41 per 1000 births. About 29% of all the early neonatal deaths occurred on the day they were born while 61% within 48 hours of delivery. Use of ANC varies significantly with maternal age, geopolitical zone (North/South), place of residence (rural/urban), maternal education, wealth index, religion, and parity, sex of household head, marital status and type of marriage (polygyny/monogamy). Further, perinatal mortality rate vary according to some previously established trends: more at the extremes of maternal ages, higher in northern than in the southern geopolitical zone, highest among those with primary level of education and among lowest wealth quintile; among parity one and five or

more, male child, very small babies and small babies (<2.5Kg) and those delivered in health facility.

In the final model, factors significantly reducing the risk of perinatal mortality are use of focused ANC (HR=0.69, 95%CI: 0.65-0.73); being in the middle or rich wealth quintile (HR=0.87, 95%CI: 0.83-0.92); living in southern zone of the country (HR=0.87, 95%CI: 0.84-0.89); being of parity between two and four (HR=0.91, 95%CI: 0.83-0.99); having had a urine test (HR=0.86, 95%CI: 0.81-0.91) and receiving all the six components of antenatal care (HR=0.18, 95%CI: 0.13-0.25). Those factors found to increase the risk perinatal death include living in rural area of the country (HR=1.32, 95%CI: 1.27-1.38); having between one and three cowives (HR=1.21, 95%CI: 1.17-1.26) having had a complication during the pregnancy (HR= 1.20, 95%CI: 1.16-1.25); having a female as the head of the household (HR=1.05, 95%CI: 1.02-1.09) and taking iron tablets for more than six months (HR=1.24, 95%CI: 1.15-1.34).

## Conclusion

The results of the analysis show that use of focused ANC significantly reduces the risk of perinatal mortality by about 31%; varying between 26% (risk reduction for early neonatal death) and 28% (risk reduction for stillbirths). Other factors that are significantly associated with reduction of perinatal mortality are residing in Southern part of the country, being of parity of between two and four, being in the middle and/or rich wealth quintile, having had a urine test during ANC visits and receiving all the six elements of antenatal care.

## Policy implication

This results calls for the more investment in maternal and child health services particularly antenatal care to make it more easily accessible in the overall framework of improving maternal and child health. It specifically implies that socioeconomic development programs should target basic schooling (especially female education), economic welfare/poverty eradication, women empowerment as well as allocating more health resources in the disadvantaged rural areas and Northern part of Nigeria.

## Research implication

While this research has corroborated the recommendations of WHO it has also opened up new areas of future research. There is the need to test the validity of World Health Organization’s recommendations on the role of focused ANC on perinatal mortality using more advanced statistical methods and designs such multi-level modelling, instrumental variable and propensity score matching. To have a smooth transition from research to practice, operations research have to be conducted in specific cultural and health systems contexts to deal with issues specific to these contexts. Such operations research will involve assessing the capacity of the health system on how to implement the new model of ANC in terms infrastructure, staffing, training and re-training of staff and supplies. Attitudes and perception of providers and clients about the new model needs to be determined also. It is also important to conduct a multi-country analysis to assess the claim of WHO knowing fully that WHO conducted the trial of this model in only four countries none of which is from sub-Saharan Africa.

# Chapter 1

# Introduction

## 1.1. Background

Across sub-Saharan Africa, despite worldwide progress made in child mortality reduction in the period 1970-2013, the continent remains one with highest neonatal deaths with the least amount of progress towards achieving MDG 4(Wang et al 2014). Based on 2013 estimates of child mortality, of the 26 countries contributing over 80% of global child deaths, 18 are located in sub-Saharan Africa that include Angola, Demographic Republic of Congo, Ethiopia, Kenya and Nigeria. Again, all but one of the nine countries with neonatal mortality rate of more than 40 per 1000 live births are in sub-Saharan Africa; these are Central African Republic (40.9), Mali (41.5), DRC (43.5), Lesotho (45.3), Angola (45.5), Guinea-Bissau (45.7), Somalia (45.7) and Sierra Leone (49.5) (Lawn et al 2014;Wang et al 2014). Furthermore, 25 countries, all of which are in sub-Saharan Africa have early neonatal death rate (ENDR) of more than 20 per 1000 live births of which fifteen are in Western Africa including Nigeria (27.9) which is also home to 2 of 3 countries with early neonatal death rate of more than 30 per 1000 live births: Guinea-Bissau (30.0), Mali (31.4) and Lesotho (31.3) (Wang et al 2014). However, despite this bleak scenario of sub-Saharan Africa's progress in reducing child mortality some countries were able to make sustained and significant progress in reducing child mortality. Botswana, Namibia, Rwanda, Malawi and Tanzania are able to reduce child deaths of around 28% and 38% in the period 2000-2010 (Lawn et al 2012).

In the Nigerian context, the maternal and child health indices are among the worst globally and even by African average. The process indicators of maternal and child health care are poor: ANC coverage of at least one and four visits are 61% and 45% respectively; women with at least two doses of tetanus toxoid (TT) vaccinations of 53%; skilled attendance at delivery of only 38% and facility delivery of 36% (NPC 2009; 2014).A review of recent literature on maternal mortality in Nigeria will lead to the conclusion that Nigeria is still battling with pregnancy-related deaths and that Nigeria's contribution to the global estimate of maternal mortality remains significantly high with little decline over the past three decades. For instance, the new estimates provided by WHO and other development partners indicates that maternal mortality rates in Nigeria declined from 1100 deaths per 100,000 live births in 1990 to 840 deaths per 100,000 live births in 2008; and that Nigeria contributes around 50, 000 maternal deaths or around 14% of global burden of maternal mortality. This decline implies an annual rate of reduction of 1.5% which is far from the minimum annual rate of reduction of 5% required to achieve MDG 5 by 2015 (WHO 2010). This slow decline in maternal mortality in Nigeria is further confirmed by estimates produced from the recent 2013 Nigeria DHS. The maternal mortality rate according to 2013 Nigeria DHS is 576 deaths per 100, 000 live births which is not statistically different from that of 2008 NDHS of 545 deaths per 100, 000 live births (the confidence intervals of the two estimates overlap with one another) (NPC 2014).Further, estimates by the Countdown Strategy to achieve Millennium Development Goals among 70 low performing countries indicate that maternal mortality rate fell from 800 in 2003 to

545 in 2008(FRN 2010a).As pointed out earlier, this rate of decline is not enough to achieve the target of maternal mortality rate of 250 deaths per 100, 000 live births by 2015(FRN 2010b).

As regard child health, the indices are also poor. Quantitatively, Nigeria contributes disproportionately large numbers of child mortality globally and child mortality remains a significant public health challenge in the country. Of the total 6.6 million deaths among children less than five years estimated to have occurred in 2012, about 12.5% took place in Nigeria (You et al 2013). Going by this estimates, the under-five deaths fell from 849,000 in 1990 to 827,000 in 2012 or an annual rate of reduction of 1% or 1000 under-five deaths annually. These figures translate to under-five mortality rate of 129 per 1000 live births and infant mortality rate of 78 per 1000 live births (both for the year 2012). These figures also approximate to that produced by the 2013 Nigeria DHS where the under-five and infant mortality rates are respectively 128 and 69 deaths per 1000 live births in the five period preceding the survey (NPC 2014). A critical look at the trends in levels of child mortality within the past decade show that rate of reduction is not enough to achieve the MDG 4 by 2015, Lozano (2010) reported an annualized rate reduction of 2%. This rate is inadequate to achieve the 2015 target of 76 per 1000 live births.

Recognizing the poor performance of the Nigeria's health care systems especially in the provision of maternal and child health (MCH) care services and the consequent failure to address persistent challenge of high maternal and child mortality in the context of MDGs, the National Primary Health Care Development Agency (NPHCDA) initiated a programme called Midwives Service Scheme in 2009. The overall aim is to address the problem of shortage as well as the maldistribution health personnel based on the evidence that increasing the number of midwives improves utilization, satisfaction with services and ultimately reduction in maternal and child mortality (Abimbola et al 2011).

Important international declarations aimed at boosting the status of maternal and child health include Alma Ata Declaration on Primary Health Care in 1978 (UNICEF 1978). The Alma Ata Declaration has maternal and child health services including family planning as one of the twelve components of primary health care.  There was the Cairo International Conference on Population and Development (ICPD) in 1994 which drafted a global Plan of Action with a 'paradigm shift' describing reproductive health as a form of human right. More importantly, the ICPD calls for the improvement of maternal and child health through the provision of user-friendly reproductive health services such as accessible and affordable antenatal care, family planning services and post-abortion care. At the turn of the 21$^{st}$ century, in the year 2000 leaders of 189 countries signed the Millennium Declaration aimed at eradicating poverty, hunger, illiteracy and global inequality all enshrined in eight development goals called the Millennium Development Goals (MDGs) (UN 2000). Millennium development goals 4 and 5 are aimed at reducing child and maternal mortality respectively but MDG 1 (eradicating poverty), MDG 2 (provision of universal primary education) and MDG 3 (women's empower) all have synergistic impact on MDGs 4 and 5. The target year to achieve these goals is 2015 and based on monitoring progress report, Nigeria is unlikely to achieve these crucial goals 4 and 5(Africa MDG Report 2013). Thus, despite these international declarations of which Nigeria is a signatory, appreciable progress has not been made in this respect. Firstly, the World Health Organization in its 2000 report ranked Nigeria's health system 187 out of 191 member countries; basically performing better than war-torn countries like Democratic Republic of Congo, Central African Republic, Myanmar and Sierra Leone; Liberia was ranked 186 (WHO 2000). Secondly, indices of utilization of maternal health services such antenatal care, institutional delivery and postnatal care are also poor even by African average. Nigeria's neighbors such Benin Republic, Cameroun and Ghana all have indices better than Nigeria in terms access to antenatal care: 78.1% for Liberia 62.2% for Cameroun, and 78.3%for Ghana (ICF International, 2012).Worried by poor maternal health indices, the current Minister of Health outlined eleven priority area for action to achieve MDGs 4, 5 and 6 of which focused ANC is one of them. Strategies adopted include the establishment of maternal, newborn and child health (MNCH) task force that culminated to launching of integrated maternal, newborn and child health programme (IMNCH) in 2007 and later adopted by National Council of Health implying that the programme is binding on States and Local Governments. Further, a separate department in the Federal Ministry of Health (FMoH) was created to handle the new programme (that is IMNCH) (FMoH 2005). In 2009 Midwives Service Scheme (MSS) was also launched to address the shortage as well as the maldistribution health personnel based on the fact that the rural areas and the Northern part of country are experiencing chronic shortage of midwives and other nursing staff and with this scheme utilization and satisfaction with services will improve and ultimately reduction in maternal and child mortality (Abimbola et al, 2011). However, despite these national efforts to tackle the persistent poor maternal and child health services, the indices are deteriorating or stagnant. Antenatal care which provides an entry point for maternal and child health services and whose role in averting maternal and child death has been established is poorly utilized (NPC 2014).

Focused antenatal care has been recommended by WHO as goal-oriented intervention consisting of at least four ANC visits for pregnant women (Villar 2001; WHO 2002) and the ANC policy in Nigeria is based on this model. This new model emphasizes quality of care rather than number of visits which is beneficial in most resource-constrained and high-fertility developing countries like Nigeria (Ekele 2008); and that it is intended to take care of at least 75% of pregnant women whom are considered at low-risk of adverse outcome and therefore do not require frequent ANC visits such that resources would be diverted to deal with those women with complications or adverse conditions (Carroli G, et al 2001). However, evidence supporting the effectiveness of ANC in reducing adverse pregnancy outcome especially perinatal outcome is virtually non-existent in Nigeria. Therefore, this study seeks to explore the role of ANC in reducing perinatal mortality.

## 1.2. The Problem Statement

Recent estimates show that the overall ANC (skilled) coverage in Nigeria stood at 61% which is an abysmal three percentage points increase from 58% a decade ago (NPC 2003 and NPC 2014). Furthermore, this coverage of 61% falls short of the recommended 90% coverage required to reduce most deaths among newborn (Lawn and Kerber 2006). Additionally, this national average conceals major variations between rural and urban areas as well as between states and geopolitical zones within the country. For instance, the rural and urban ANC coverage are 47% and 86% respectively; the North

West geopolitical zone has the least of 41% while the South East has the highest coverage of 91%. Sokoto state located in North West has the least coverage of 17% while Osun located in the South West recorded the highest of 98%. This pattern of regional and rural/urban bias is similarly experienced with other indicators of maternal and child health: skilled attendance at delivery is highest in urban areas (67%) than in rural areas (23%); highest in South West zone (83%) and lowest in North West (12%); highest in Imo State (96%) and lowest in Sokoto State (5%). With regard to facility delivery urban areas had a rate of 62% while rural has 23%; South West recorded 75% while North West recorded the least of 12%. Sokoto State had the least health facility deliveries of 5% and Imo State recorded the highest facility delivery of 91% (NPC 2014).

The consequence of these differentials of ANC coverage is that both child and maternal mortality remains so high despite the co-existence of high national coverage in ANC. Past scholarships on maternal and child health have either looked at socioeconomic or demographic factors in isolation ignoring the role of antenatal care as a package of intervention that determines maternal and child health. For example, Adedini (2013) employing multi-level modelling of determinants of infant and child mortality in Nigeria reported that factors at community level such geopolitical zone, place of residence (rural versus urban), level of poverty and level of hospital delivery in the community as well as factors operating at the level of individual such as sex of child, maternal age and education, birth order and birth interval and household wealth index are the most important factors in child mortality. On the other hand, other researchers have reported on the factors influencing use of antenatal care alone. Recently, Ononokpono (2013) has identified three factors predicting maternal health care utilization: living in communities where health facility delivery is high; living in community with high level of poverty decreases likelihood of use of antenatal care use and living in community where there is high proportion of women that are educated. Her findings are to a large extent consistent with earlier studies by Babalola and Fatusi (2009), Kabir (2005), Iyaniwura (2009), Caldwell (1979), Ware (1984), Mellington and Cameron (1999), Basu and Stephenson (2005) and from a systematic review by Simkhada (2007).

In the light of the above, it is clear that researchers in Nigeria pay less attention on the association between antennal care utilization and maternal and child health outcomes despite large body of empirical studies showing its positive effect on improving child and maternal health (Titaley et al., 2011; Singh et al., 2013 and Zeng et al., 2008). This research is an attempt to fill up this gap in knowledge primarily and secondarily to provide empirically-driven policy recommendations on the association between antenatal care utilization and perinatal mortality in Nigeria.

While poor or lack of ANC has been established as a risk factor for perinatal mortality (Lawn et al 2005; Singh et al 2012) its role in reducing maternal and child morbidity and mortality has also been established through an evidence-based process undertaken by the World Health Organization (Villar et al, 2001). The World Health Organization conducted a randomized control trial of a new model of antenatal care that is later known as “focused” or “basic” antenatal care which is “goal-oriented” that outlines specific interventions/services to be provided to all pregnant women classified as "low-risk". Following this field trial, WHO recommended this package of care as a strategy to reduce the adverse outcomes of pregnancy in developing countries (Villar et al 2001). Focused antenatal care (FANC) is a package of care given to eligible pregnant women during antenatal care. It involves a total of four ANC visits for those pregnant women found to be eligible for the package. During the first visit, which should be as early in pregnancy as possible (preferably within the first three months of pregnancy), a pregnant woman is screened to ascertain her eligibility for the care based on certain laid down criteria by the World Health Organization using the Basic Antenatal Care Checklist Form. The subsequent visits are at 26 weeks (or 6 months), then at 32 weeks (or 7.5 months) and at 38 weeks (or 8.5 months). At each visit, the pregnant woman is offered a range services that include clinical/physical body examination (blood pressure measurement, abdominal examination for fetal heart sound) and laboratory tests (such as blood test for detect anaemia and malaria parasite as well as HIV, syphilis, sickle cell disease, urine test to test for urine protein and infection) to assess the health status of the fetus and herself. It is assumed that under normal situation, about 75% of the pregnant women would qualify for this intervention and would be required to make only four visits since they are considered 'normal'; the remaining 25% would make more visits depending on their conditions. The separation of pregnant women into two groups based on this packaged has been argued by WHO that it will make the health system more efficient in terms of use of resources and time spent with each pregnant women since not all the women have to make at least between 8 and 12 visits under the old model of ANC (Villar et., 2001; WHO 2002).

Fragmentary studies in Nigeria indicate that lack of ANC or inadequate ANC is a predictor of perinatal death (Lawoyin et al., 2010; Aisen et al., 2000 and Kuti et al., 2003; Fawole et al., 2011). However, with the exception of study by Lawoyin et al (which has a small sample, though) all others are hospital-based and therefore suffer heavily from selection bias. Hospital-based studies are biased in terms of sample size and selection and are therefore not nationally-representative, hence the need for a nationally-representative sample survey to examine the association between ANC and perinatal mortality. Hospital-based studies are more likely to give exaggerated estimates of the perinatal mortality since in most situations only when pregnancy/delivery is complicated and beyond the capability of the traditional birth attendant that professional medical assistance is sought as a last resort; Lawoyin (2010) has demonstrated that births occurring outside hospital or attended by a TBA or after a pregnancy with no ANC have increased risk of perinatal/early neonatal death. More so, hospital-based studies focus their attention on the clinical causes/risk factors for perinatal mortality ignoring other important risk factors such age of mother, her parity, educational attainment and household wealth; place of residence (rural/urban) as well as region of residence, birth order and sex of the child and importantly use of antenatal care (and components of ANC services received) and place of delivery. Based on 2013 Africa MDG Report, Nigeria is unlikely to achieve MDG 4 by 2015 and as countries and agencies plan for post-2015, Nigeria's health policy makers should look at factors/deterrents responsible for not achieving the desired reduction in perinatal mortality knowing fully that early neonatal mortality contributes around 29-33% of under-5 mortality (MDG Africa Report 2013; Ezugu et al., 2011; Lawn et al.,2014).

### 1.3. The Purpose Statement

The purpose of this study is to examine the association between antenatal care and perinatal mortality in Nigeria using data from the Nigeria Demographic and Health Survey. The dependent variable is perinatal death which is an umbrella term referring to death of fetus after 22weeks (or seven months) and death within 6 days after delivery (WHO 1993). The primary independent variable is ANC (whether or not women had four ANC visits during the most recent pregnancy/birth) and the secondary independent variables are the various interventions women received during such ANC visits: iron and folic acid supplements (IFA), information about danger signs in pregnancy, body weighing, blood pressure measurement, HIV counseling and testing, malaria prophylaxis suing intermittent preventive regimen with sulphadoxine-pyrimethamine, two doses of tetanus toxoid (TT) injections, urine and blood samples taken for laboratory test such as haemoglobin estimation and proteinuria. The intervening variables are a number of socio-economic and socio- demographic factors known to have significant impact on perinatal mortality. These include maternal age, education, parity, and religion, and household wealth status, sex of newborn, rural/urban residence and region of residence. These variables would be statistically controlled in the study.

The theoretical model utilized here is the adapted versions of the conceptual frameworks of Mosley and Chen (1984) and Malqvist (2011). These frameworks are essentially displaying the roles played by two important groups of determinants of health outcomes in biomedical research: socioeconomic factors (or distal or indirect factors) and proximate determinants (proximate or intermediate or direct factors); and that the distal factors operate via the proximate or intermediate factors to directly influence child survival. The proximate determinants are also the controlling factors and provide a final common pathway through which the distal factors exert their influence to predict the final health outcomes. Mosley grouped these into five categories: maternal factors, environmental contaminants; nutrient deficiency; injury and personal illness control. They argued that socio-economic (distal factors) factors influence health outcomes (child survival in their example) via the intermediary of proximate factors such as household wealth or maternal level of education.

The investigation utilized the 2013 Nigeria DHS data. It used two recode files during analysis, the individual and birth recode. The individual recode was used to generate simple frequencies of ANC use while the birth recode was used for generating stillbirth and perinatal mortality rates as well as the multivariate analysis.

An important limitation of this study as a consequent of the study design (that is cross-sectional design) is that one cannot be able to make causal inference between exposure (ANC) and health outcome (perinatal mortality). Instead, one can generate relationships or associations between the exposure and outcome using measures of association that is hazard ratios.

### 1.4. Main Research Question:

The study will attempt to answer the following main research question:

1) What is the relationship between utilization of focused ANC and perinatal mortality?

#### 1.4.1. Sub-research questions:

1) What is the level of perinatal mortality rate in Nigeria based on 2013 Nigeria DHS?

2) What are the sociodemographic and socioeconomic factors associated with perinatal mortality in Nigeria?

3) Does utilization of focused ANC influence perinatal mortality in Nigeria?

## 1.5. Definitions of Terms

The following definitions of terms are used in this report:

1. **Antenatal care (ANC):** preventive care offered to pregnant women from conception to birth. This form of ANC have different focus, contents or range of services offered and number of visits; it is also referred to as traditional ANC.

2. **Focused antenatal care (FANC**): a form of antenatal care that is goal-oriented or focused consisting of a minimum four visits with specific ranges of tests, clinical procedure, follow-up actions that has been scientifically proven to be effective in improving maternal and newborn outcome recommended for implementation in developing countries (Villar et al., 2001).

3. **Perinatal mortality**: defined as defined the sum of stillbirths that occur after 22 weeks of pregnancy plus the number of deaths occurring in newborns in the first six days of life (WHO 2006).

4. **Early neonatal mortality:** defined as the death of live borne occurring within six days of life.

5. **Stillbirth:** death of a fetus after 22 weeks or seven months of pregnancy

# Chapter 2

## Literature Review and Theoretical/ Conceptual Models

## 2.1. Literature Review

Globally, there are over 135 million births every year distributed in the four regions of the world: 11 million newborns in high-income countries (HICs); 34 million in middle-income countries (MICs); 90 million in low-income countries (LICs) of which 40 million newborns are delivered in health facilities while the remaining 50 million are delivered at home and described as the "most invisible world" (Lawn et al., 2013).In 2000,more than 10 million newborn died before the age of five years of which 8 million did not celebrate their first birth day indicating a reduction compared to 1990 when there were 11.9million under-5 deaths (WHR., 2005). However, for the year 2010, the figure has reduced to 7.7million deaths among children less than 5years consisting of 3.1 million neonatal deaths, 2.3million post-neonatal deaths and child deaths of 2.3million. Worldwide, the distribution of under-5 deaths shows that 49.6% occurring in sub-Saharan Africa and 33% in South Asia; only about 1% occurring in high income countries (Rajaratnam et al., 2010). Recent estimates for the Global Burden of Disease Study 2013 show that child mortality has been on gradual downward trend from the 1970 level of 17.6million to 12.2million deaths in 1990 and 6.3million deaths in 2013 indicating an overall reduction of 64% in about 43years translating to average annual reduction of 2.3% even though there were periods of accelerations and decelerations especially in the period 1985-1994 (Wang et al., 2014).

Perinatal mortality is an umbrella term that combines both deaths after 22weeks of gestation (or stillbirths) and deaths occurring within the first six days of life (or early neonatal death). However, for international comparison, stillbirths are deaths occurring after 28weeks of gestation. While deaths among children less than 5years are decreasing, proportion of deaths within the neonatal period (38% in 2000) is increasing. In 2004, it was estimated that about 4million newborn die within the neonatal period and 75% of these in the early neonatal period (first 6 days of life) or about 3million and yet they are unaccounted for in the official mortality statistics or in the international health agendas such as the Millennium Development Goals; it is estimated that for every stillbirth, there occurs an early neonatal death (Aahman and Zupan., 2007). Further, the risk of dying within the early neonatal period is highest around time of labour and on the day of birth when between 25% and 45% of all neonatal deaths occur (Lawn et al., 2011).  By world regions, 99% of these deaths happened in low- and middle-income countries and only about 1% was in high-income countries. In 2013, of 6.3 million deaths among under-5 years old, about 31.9% occurred within the early neonatal period (0-6days) that is about 2 million early neonatal deaths. This represents a reduction of about 1.88 million deaths since 1970 or a 48% reduction or an average annual reduction of 2.3%. However, it is important to note that despite reduction in overall child mortality, the proportion of neonatal mortality (both early and late) in child mortality has increased gradually from 33% in 1970 to around 42% in 2013 while the proportion of early neonatal death in neonatal mortality has remained relatively stable at around 75% (WHO 2006; Wang et al., 2013).

The three major causes of early neonatal deaths in order of magnitude are intra-partum-related conditions formerly called birth asphyxia (29%), prematurity also called preterm birth (44%) and infections (14%).These causes are related to the extent and quality of care provided at the time of labour (about 12hours' duration) and the immediate hours following delivery (the first 24hours). Therefore, for those newborns especially the preterm babies that are vulnerable to complications such as hypothermia, hypoglycaemia, respiratory distress and infection, immediate intervention in the first minute of life means either survival or death. Because of nature of survival during labour and immediately after birth, the ability of newborn to survive this fragile period of life (perinatal period) is often used as an index of quality of both obstetric and neonatal care (Lee et al., 2014; Fauveau et al., 2007).

The other half of perinatal mortality is stillbirth and refers to the death of a fetus in the third trimester of pregnancy. The statistics is equally staggering with estimates of 3million stillborn dying out of 133million live births as of 2004 and virtually all of those deaths occurring in developing countries. By these estimates, global stillbirth rate was 22/1000 births; 4/1000 in HICs, 24/1000 in MICs and 31/1000 in LICs (Aahman and Zupan, 2007). In 2000, estimates by WHO showed that there were about 3.2million stillbirths annually and over 98% taking place in low-and middle-income countries (Stanton et al., 2006).However, a new estimate for 2008 indicates a reduction to 2.65 million but the regional distribution remains virtually same where 98% of deaths are still concentrated in LICs and MICs and more than 75% in sub-Saharan Africa and south Asia (Cousens et al., 2011). The burden of stillbirths can be compared to that of deaths due to other conditions: about 3.8million neonatal deaths; 3.2million child deaths; 0.8million child deaths from malaria (UNICEF, 2009; Lawn et al., 2005).

Causes of stillbirths mirror closely the causes of early neonatal death, but in this case the causes can conveniently be grouped into antepartum (61%) and intrapartum (39%) i.e. either before onset of labour or during labour. Lawn (2005) reported that about 15-40% of stillbirths occur during intrapartum period while 40-60% during intrapartum period. Similar results were obtained by Bhutta (2008) in Pakistan where 42% of stillbirths occurred during intrapartum period while 58% during antepartum period. This categorization has provided a specific point of intervention as described by Lawn and colleagues: 'To prevent antepartum stillbirths, improved maternal health and care during pregnancy is needed, whereas better obstetric care is needed to avoid intrapartum stillbirths (Lawn et al., 2011). The causes of stillbirths can also be classified as those related to maternal conditions or those related to fetal conditions. Causes related to maternal conditions include maternal hypertension, chorioamnionitis (infection of the amniotic fluid), antepartum haemorrhage form abruptio placenta (sudden dislocation of placenta), maternal diabetes, pre-existing disease especially affecting the heart, abnormal labour and rupture of the uterus, maternal infection such as syphilis and malaria. Causes of stillbirths related to fetal conditions include congenital abnormalities, infection such as malaria and syphilis and fetal growth retardation. However, the single largest cause of stillbirths in both cases is unexplained cause where it accounts for 62% in maternal-related factors and 88% in fetal-related factors (MRC SA., 2009).

### 2.1.1. Sub-Saharan Africa Reviews

Across the sub-Saharan Africa (SSA), perinatal mortality is a major public health challenge both in terms of numbers and distribution of risk factors. It has been earlier stated that both stillbirths and early neonatal deaths occur disproportionately in developing countries of South Asia and sub-Saharan Africa (WHO 2006). In 2001, according to the Global Burden of Diseases and Risk Factors Study (GBD Study), perinatal conditions accounted for 5.1% of all deaths in LMICs equivalent to 2.489 million deaths or 89 million DALYs. Further, perinatal conditions are the fifth leading cause of death in these countries (as well as in in sub-Saharan Africa) but not even among the leading ten causes of death in HICs (Lopez et al., 2006).

Africa contributes about 28% of neonatal deaths (about 1,128,000 neonatal deaths) in 2005 (UNICEF, 2005; WHO, 1996); where over 28million births takes place annually out of which 1.16million (about 4.1%) newborn babies die within the first four weeks of their lives and additional one million are born dead; up to half (0.5million) of those dying within the first four weeks will die on the day they are born. These deaths are preventable, if proven interventions reach about 90% of African mothers and about 800,000 newborn would be saved annually. About 25% of under-5 deaths happened within the neonatal period and it is logical that if MDG 4 would be achieved, first neonatal deaths must first be prevented. Six countries in Africa have made remarkable progress in reducing neonatal morality rates between 24 and 32per 1000 live births: Eritrea, Malawi, Burkina Faso, Madagascar, Tanzania and Uganda. While Africa is home to only 11% of world’s populations, it contributes about 25% of neonatal deaths; of the 20 countries in the world with highest risk of neonatal death, 15 are in Africa. Of the 1million stillborn, about 30% occur during labour; 30-50% of newborn death happens on the first day of life (Lawn and Kerber 2006; WHO 2006; Lawn et al., 2005). Highest perinatal mortality rates are found in sub-Saharan Africa with figures ranging from 104 and 95 in Liberia and Lesotho respectively to lowest in the region of 28 and 18 in South Africa and Mauritius respectively (Ahman and Zupan, 2007).

A recent estimate for the trends in child mortality indicates that eight of nine countries with neonatal mortality rate of forty or more are situated in sub-Saharan Africa but most have passed through period of civil or armed conflicts; five of ten countries with the highest neonatal deaths are in sub-Saharan Africa: Nigeria, Democratic Republic of Congo, Ethiopia, Angola and Kenya. Despite this gloomy picture some countries in the continent are able to make progress in reducing neonatal deaths: Malawi and Rwanda (Lawn et al., 2014).

**2.1.2. Country-specific reviews: Nigeria**

Both at global and continental level, Nigeria contribute large numbers of perinatal mortality. Nigeria, with an estimated population of 166million has an estimated annual birth of 5.3million, stillbirths of 0.16million and neonatal deaths of 0.26million contributing about 22% of Africa's burden of newborn deaths (Lawn and Kerber 2006; UNDP HDR 2012). An earlier estimate of perinatal mortality rate in Nigeria was 30 per 1000 live birhs (in 1990) which rose to around 86 per 1000live births in the year 2000 (WHO 1996; WHO 2000).Nigeria's perinatal mortality rate in 2000 was only surpassed by those countries that have either experienced war or political instability such as Afghanistan, Angola, Cote d'Ivoire, Liberia, Mauritania and Sierra Leone; the stillbirth rate stood at 30 per births in 2000. However, despite some declines in perinatal mortality rate between 2000 and 2004; and further decline in neonatal mortality rate from 52 in 1990 to 39 in 2012 and that of early neonatal death rate, the absolute number of perinatal deaths as well neonatal deaths increased between 2000 and 2013 as a result of increase in births. Total perinatal death in Nigeria in 1990 was estimated at 207000 which rose to 267000 by 2012 (UNICEF 2013; Ahman and Zupan 2007; WHO 2006). Oji and Odimegwu (2011) recently estimated perinatal mortality rate of 72.4 per 1000 births for Nigeria which is a close approximation to WHO's estimate of 76 per 1000 births in 2004 (Ahman and Zupan 2007).The 2013 Nigeria Demographic and Health Survey indicate the perinatal mortality in Nigeria of 41 per 1000 births representing a 46% reduction within a decade; associated with stillbirth rate of 12 and early neonatal death rate of 29 (NPC 2014).

Previous studies in Nigeria reported rates of perinatal mortality of which, majority are hospital-based. Ameh and colleagues (Ameh et al., 2012) in an assessment of obstetric care services in six developing countries including Nigeria reported a hospital-based stillbirth rate of 28 per 1000 births. This study involved 106 health facilities providing maternity care in three northern states of Katsina, Yobe and Zamfara that have some of the worse maternal and child health indicators in the country (NPC 2014). In these health facilities, none was found to provide life-saving interventions such as neonatal resuscitation, caesarean section and blood transfusion; these interventions constitute three of the nine "signal functions" of obstetric care. Adetola (2011) reported a neonatal mortality rate of 32 per 1000 live births in their hospital-based study in urban Ibadan. Risk factors identified include lack of ANC utilization, being a single mother, birth asphyxia, prematurity and low birth weight. Maternal conditions such as maternal diabetes, hypertension (or pre-eclampsia), and infections such malaria and syphilis have been identified as risk factors for perinatal (McCurdy et al., 2011). To assess the risk perinatal mortality among pregnant women with eclampsia (a high-risk pregnancy), Yakasai and Gaya reported a perinatal mortality rate of 132/1000 births, though this study lacked a control group it shows the increased risk of perinatal mortality with eclampsia (Yakasai and Gaya 2011).

## 2.2. Risk factors for Perinatal Mortality

Studies across the globe have identified several risk factors for perinatal mortality. The researchers employed different study designs in their investigations such as case-control, prospective or cross-sectional or community-based cohort study. Some other investigators undertook a secondary analysis of collected data especially using the data from demographic and health surveys while others used hospital-based case-control. However, adapting the framework as proposed by Di Mario (Mario et al., 2007) of classifying risk factors for stillbirths, the following classification has been proposed here for use: clinical conditions (related to mother or fetus) and contextual factors (such as socioeconomic, maternal education, utilization of antenatal care services). In this systematic review, Di Mario and his colleagues arrived at a list of risk factors for stillbirths with population attributable fraction (PAF) of at least 50%. These risk factors include: maternal syphilis, maternal malnutrition, low maternal educational attainment of less than six years of schooling, lack of or low prenatal care services defined as less than three antenatal care visits and chorioamnionitis.

The study by Di Mario cited above involves studies in developing countries only. Flenady (2011) conducted a systematic review of risk factors associated with stillbirths in five high-income countries and identified eight major risk factors: maternal overweight and obesity, maternal smoking, advancing maternal age older than 35years, primiparity, small size for gestational age, pre-existing diabetes mellitus and hypertension, abruption placenta. From these two reviews, it can be summarized that risk factors for stillbirths in developing are closely associated with poor socio-economic development while those in the high-income countries are closely related to diseases of affluence. Obesity is the single most important risk factor for stillbirth in high-income nations while in low-income countries maternal syphilis, maternal malnutrition and chorioamnionitis (infection of the placenta) are the three leading risk factors for stillbirths.

Ngoc (2006) using the data of WHO's trial of calcium supplementation in six countries identified risk factors/causes of both stillbirths and early neonatal deaths in these collaborating centers. Factors responsible for perinatal deaths are spontaneous preterm delivery (28.7%), hypertensive disorders in pregnancy (23.6%) and fetal abnormalities (14%). As for early neonatal deaths, three major risk factors were identified: prematurity (60%), asphyxia and birth trauma (23%) and congenital anomalies (13%). Engmann (2009) broadly identified the risk factors for perinatal mortality into two: (1) maternal factors (such single marital status, lack of antenatal care utilization, and lack of formal education); (2) neonatal factors (such as male sex, prematurity, multiple births, low birth weight and preterm [gestational age less than 37weeks]). After multivariate analysis, they concluded that all these factors remained significantly associated with perinatal mortality except advanced maternal age, primiparity, skilled attendance during delivery, location of delivery (home/facility) supporting the finding of Oti in Nigeria (Oti and Odimegwu, 2011). This result may not be a surprising drawing from the findings of Ameh (2012) where majority of health facilities in sub-Saharan Africa lack the basic and essential life-saving interventions to prevent both maternal and neonatal death at around labour and delivery. However, in a systematic review and meta-analysis by some Ethiopian researchers they concluded that 'Health facility delivery is found to reduce the risk of neonatal mortality by 29% in low and middle income countries' (Tura G et al., 2013).Fawole (2011) reported in a multi-center study of the determinants of perinatal mortality in Nigeria the following factors (in order of association) as predictors of perinatal mortality: asphyxia, lack prenatal care, prematurity, unbooked status, advanced maternal age of more than 35years and short duration of schooling. They reported stillbirth rate, early neonatal death rate of perinatal death rate of 71, 78 and 70 per 1000 live births. Other studies from Nigeria reported similar risk factors for perinatal mortality: lack of ANC, hypertensive disease, labour complications such birth asphyxia, prematurity and infection (Ezugu et al., 2011; Etuk et al., 2000 and Guerrier et al., 2013).

McClure (2006) provided a summary of risk factors for stillbirths both in developing and developed countries. In developing countries the risk factors include: obstructed labour, birth asphyxia, congenital infections, hypertensive disease, poor maternal nutrition, previous stillbirth, congenital anomalies, malaria and sickle cell disease. In developed countries the risk factors include congenital anomalies, fetal growth retardation, medical conditions e.g. diabetes, hypertensive disease, congenital infections, smoking and multiple gestation.

## 2.3. ANC and perinatal mortality: the relationship

Historically, antenatal care or prenatal care (or ANC) started in the United Kingdom around the early 1900s following the proposal by Ballantyne calling for an organized prenatal care system (Ballantyne 1901). J. Whitridge Williams in 1915 (Williams 1915) added the impetus for justifying prenatal care arguing, “prenatal care and instruction offer great opportunities for the diminution in the number of deaths [due to prematurity]”. Organization of ANC services and its constituent elements/components continued on both sides of the Atlantic. However, the modern day ANC schedule could be traced to the practice by Dr Janet Campbell in 1929(Oakley 1982): ANC visit every 4 weeks until 28 weeks; every 2 weeks until 36 weeks and weekly thereafter. This practice spread across the globe and as a former British colony, Nigeria adopted the schedule.

Even though ANC has been demonstrated to reduce morbidity and mortality among the mother and baby, the organization, content, frequency and timing has been a matter of rituals rather than based on scientific evidence or its effectiveness. Thus, Cochrane lamented (Cochrane 1989): “By some curious chance, antenatal care has escaped the critical assessment to which most screening procedures have been subjected”. An attempt was made by Kessner in 1974 to develop an adequacy index for antenatal care and its utility in predicting birth outcome (Kessner et al., 1973). This index was refined and modified by Gortmaker (Gortmaker 1979) on account that the outcome variable in Kessner’s index was narrowed to low birth weight only rather than other adverse pregnancy outcomes such pre-term delivery.

While these controversies were going on in the USA and Europe, the World Health Organization (WHO) embarked on trial to assess the effectiveness of ANC in detecting and treating adverse perinatal outcome on both the mother and the newborn. In a landmark trial comparing a standard ANC package with reduced number of visits, the researchers concluded that despite slight excess of stillbirth rates (1.4% against 1.1%) and perinatal death rates (2.0% by 1.7%) that “Provision of routine antenatal care by the new model seems not to affect maternal and perinatal outcomes. It could be implemented without major resistance from women and providers and may reduce cost” (Villar et al., 2001). The publication of this trial was immediately followed by a systematic review of randomized trial conducted to assess the effectiveness of the new package of ANC against the standard. Again, the reviewers came to a similar conclusion that a model of care based on reduced number of ANC visits that may or may not be goal-oriented does not impose additional risk to either the mother or the new born but that mothers may be dissatisfied with the service (Carrolli et al., 2001). Thus, based on the results of these two investigations, the World Health Organization recommended what is now called “focused” or “basic” antenatal care as the standard model of care for pregnant women (Villar, J., and Bergsjo. P., 2002). In its design, the focused ANC consists basically of four ANC visits: during the first visit pregnant women are screened based on certain criteria and clinical conditions to determine their eligibility for the focused care where it is anticipated that as much as 75% of pregnant women would be eligible for the focused care. Under this model, initiation of ANC begins within the first trimester (first three months of pregnancy). The subsequent three visits under this model will be at 26, 32 and between 36-38 weeks of pregnancy or roughly at 6, 7.5 and 8.5 months respectively. Those pregnant women who are not eligible for this model are seen more frequently, presumably because they have conditions requiring frequent medical attention (WHO 2002).

Since this recommendation by WHO, several studies were conducted to determine the relationship between antenatal care utilization and perinatal mortality. Such studies include those by Orvos in Szeged, Hungary (Orvos et al., 2002) using a matched case-control design demonstrated a reduction in preterm labour, low birth weight and more tendencies for mothers whom did not attend ANC give up their babies for adoption. Petrou (2003) employed a population-based study among nine representative maternity units in Northern England and North Wales in which they showed an inverse relationship between ANC utilization and delivery of low birth weight, infant admission to special care baby unit and perinatal mortality. Lin in Taiwan (2004) using a national survey of reproductive health among married women showed positive influence of pre-natal care on birth outcome. Pervin and colleagues (Pervin et al., 2012) using before-after study design determined the association between use of ANC and health facility delivery and perinatal outcome and found that utilization of ANC services increased health facility delivery and better perinatal outcome. Perinatal mortality was about twice higher among women who had ≤1 ANC visits compare to women who had received ≥3 visits; and that health facility delivery and skilled attendance at delivery are two secondary benefits derived from ANC visits. In India, Singh and colleagues reported that risk of neonatal mortality is reduced by at least 31% among infants of mothers who attended at least 4 ANC visits, took iron/folic (IFA) acid supplement and had at least 2 doses of tetanus toxoid injections (Singh et al., 2013). Another study from Latvia also established the association between lack of ANC utilization and increased perinatal death. This study by Jansone (Jansone et al., 2001) showed that 19% of mothers that experienced perinatal death had not received any form ANC and that they are more likely to be smokers, alcohol abusers, and high parity and have advanced maternal age of above 35years.

The role of ANC in improving both maternal and fetal outcomes has long being established; one of the benefits is reduction of perinatal death (Salina set al., 1997). The ANC provides a platform for interaction between the expectant mothers and health professionals during which information is passed to the women on how to maintain good health and for their babies. Antenatal care as package provides these benefits by delivering some specific services to the pregnant women: screening for ill-heath in the mother that could jeopardize both the mother and the baby, monitoring the health of baby through fetal heart sounds using fetoscope, tetanus toxoid injection to the mother to provide passive protection for the fragile newborn against, blood pressure measurement and screening to detect pre-eclampsia, blood analysis to detect and treat anaemia, malaria, syphilis and HIV infection. Therefore, when ANC is given asa complete package of care it is expected to reduce the adverse pregnancy outcomes; it is also expected that every pregnant women who attends at least 4 ANC visits during the pregnancy should get the whole package. In Nigeria, an assessment of health facilities providing such ANC services was conducted in 642 MSS (Midwives Service Scheme) PHC facilities. While 97% of the PHC facilities provide some element of ANC services, provision of specific element was low: 47% provide IFA supplements, 61% provide blood test for anaemia, 60% provide urine test for pre-eclampsia, 73% provide prophylaxis for malaria, 48% distribute free ITNs to pregnant and 37% provide PMTCT (prevention of mother-child transmission of HIV) services(Okoli et al., 2012).

## 2.4. Theoretical framework

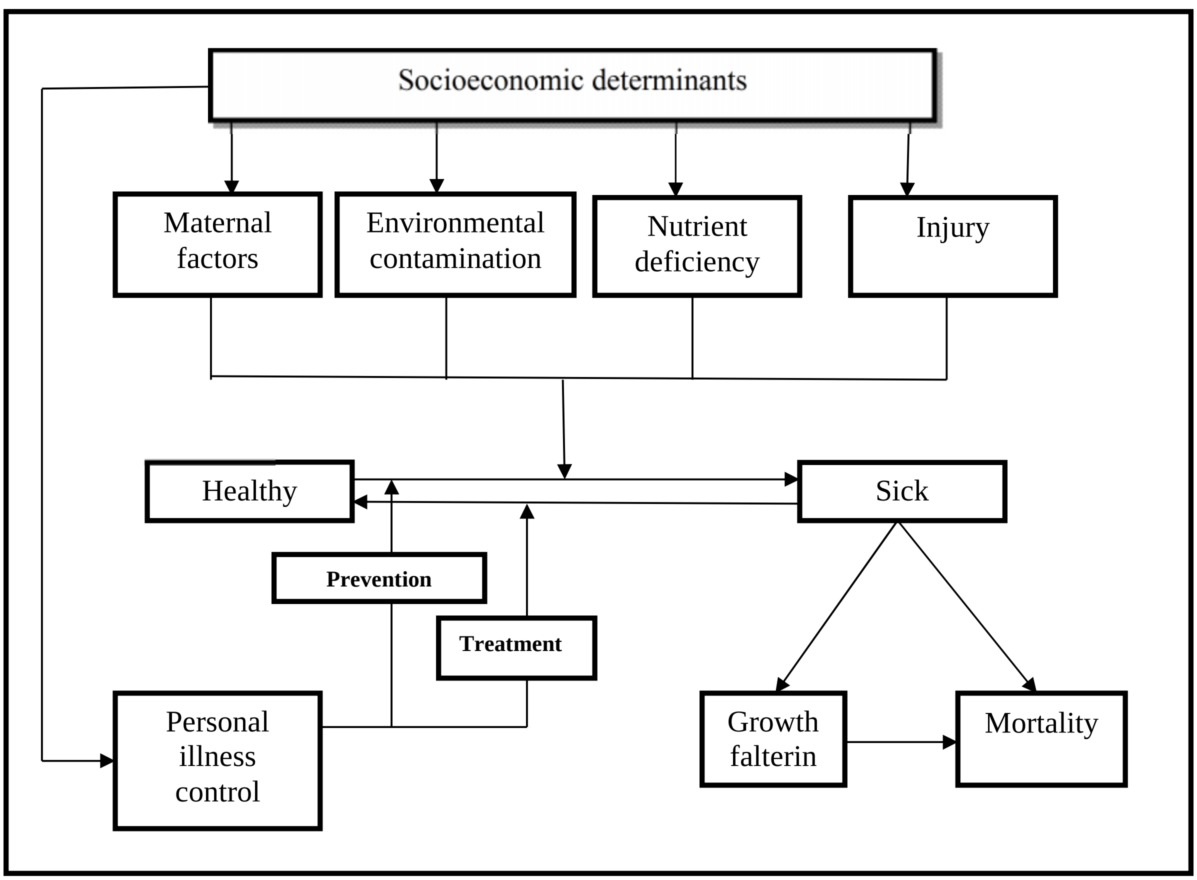
The theoretical framework proposed here is the product of the review of frameworks of Mosley and Chen (1984) and Malqvist (Malqvist 2011). The fundamental theory behind this research is that women who availed themselves to focused ANC (i.e. four ANC visits as recommended by the WHO and received the complete package of care) in a facility offering focused ANC are less likely to have either a stillbirth or perinatal death compared to those women who have less or none of focused ANC at all; perinatal death among women with at least four ANC visits is expected to be significantly lower than among those women with less than four ANC visits. The reason is that focused ANC visits will offer a woman the chance to have some specific medical interventions such as screening of diseases condition such as symptomless hypertension that is known to increase the risk of stillbirth and perinatal death. Further, by attending ANC she will be informed of signs and symptoms that denote complications/danger signs and to seek immediate care when such signs appear like leg swelling which is associated with high blood pressure that is deleterious to both mother and child and one of the leading causes of stillbirth and pre-mature babies (McCarthy and Maine 1992). If high blood pressure is detected it can be treated and controlled such that she can have a normal baby and delivery. However, utilization of ANC are modified by other factors termed distal factors or indirect factors. For instance, maternal education is not directly acting to improve maternal and child health outcomes but via the intermediary of increased use of ANC. A woman’s educational level dictates to her to attend ANC (through knowledge of its beneficial effects on herself and her newborn) and because of her relative income position (she might be employed) she can afford the health care needed if it is not provided free. Thus, the maternal education acts via the intervening variable of ANC to determine the pregnancy outcome.

The present study will explore how socio-economic and socio-demographic variables at individual and household levels acting via the intermediary of proximate determinants of use of focused ANC services. The framework proposed here has two hierarchical levels of operations: (1) socio-demographic factors (or distal factors) and (2) proximate determinants. The socio-demographic variables include mother's and father's levels of formal education, maternal age at marriage, household wealth index, ethnicity, religion, rural/urban location, region of residence, sex of child, maternal parity, family structure and type of marital union. The proximate determinants are ANC-related factors such as the timing of first ANC visit, number of ANC visits, type of services received during ANC like TT injections, IFA supplements, and information on danger signs in pregnancy, weighing, blood pressure measurement, HIV counseling and testing, malaria prophylaxis, urine and blood samples taken. In this framework, it is proposed that underlying factors such as maternal education will act by increasing household income and (or wealth index) and positive health-seeking behavior of mother (which is more important) to attend ANC while pregnant. This is premise on which the underlying socio-demographic factors affect perinatal outcome through their actions on the proximate factors which in turn influence the outcome of pregnancy in perinatal period. The conceptual framework for this study is shown in figure 1 below. It shows a hierarchical relationship between the underlying socio-economic factors (maternal and paternal education, religion, ethnicity, wealth index, family type, and household structure) linearly related with proximate variables (ANC factors, maternal factors related to pregnancy, neonatal factors, delivery and post-natal factors) to influence perinatal outcome.

## 2.5. Conceptual Framework

The conceptual framework for this research would be an adaptation of that developed by Mosley and Chen in determining the factors responsible for child survival in developing countries (Mosley and Chen 1984). In its classic form Mosley and Chen integrate both the sociological and biomedical approaches in the study of child survival in developing countries. In their argument they posit that sociologists overlook the medical processes in child survival while the medical experts also on the other hand downplay the role of socio-economic and cultural contexts in child survival. Mosley and Chen came up with broadly two groups of determinants: (1) socioeconomic factors (or distal or indirect factors) and (2) proximate determinants (proximate or intermediate or direct factors); and that the distal factors operate via the proximate or intermediate factors to directly influence child survival. The proximate determinants are further grouped into five categories: maternal factors (age, parity, and birth interval), environmental contaminants (air, food, water, fingers, skin); nutrient deficiency (protein, calories); injury (accidental, intentional) and personal illness control (use of personal preventive measures or devices). They argued that socio-economic factors influence child survival via the intermediary of proximate factors: for instance socio-economic factors like household wealth or maternal/paternal educational level will determine the type of food (i.e. quality) and how to feed the child (i.e. infant feeding practices such as withholding of colostrum or giving pre-lacteal feeds or force-feeding or observing food taboos) and amount (quantity) of food nutrient available to the child which will in turn influence his/her nutritional status either underweight or stunting or wasting or normal which has a direct effect on the survival or otherwise of the child. Further, they argued that the distal factors or indirect factors do not always act directly to determine the child's survival but via some intervening variables. By integrating both the sociological and biomedical approaches into a coherently linked system they allow both the sociologists and medical experts to analyse child survival from biological as well as from medical point of view and be able to appreciate the roles played by both the biological/medical processes and socio-cultural processes. Figure 1 shows the framework how these five groups of proximate determinants operate on the health dynamics of a population

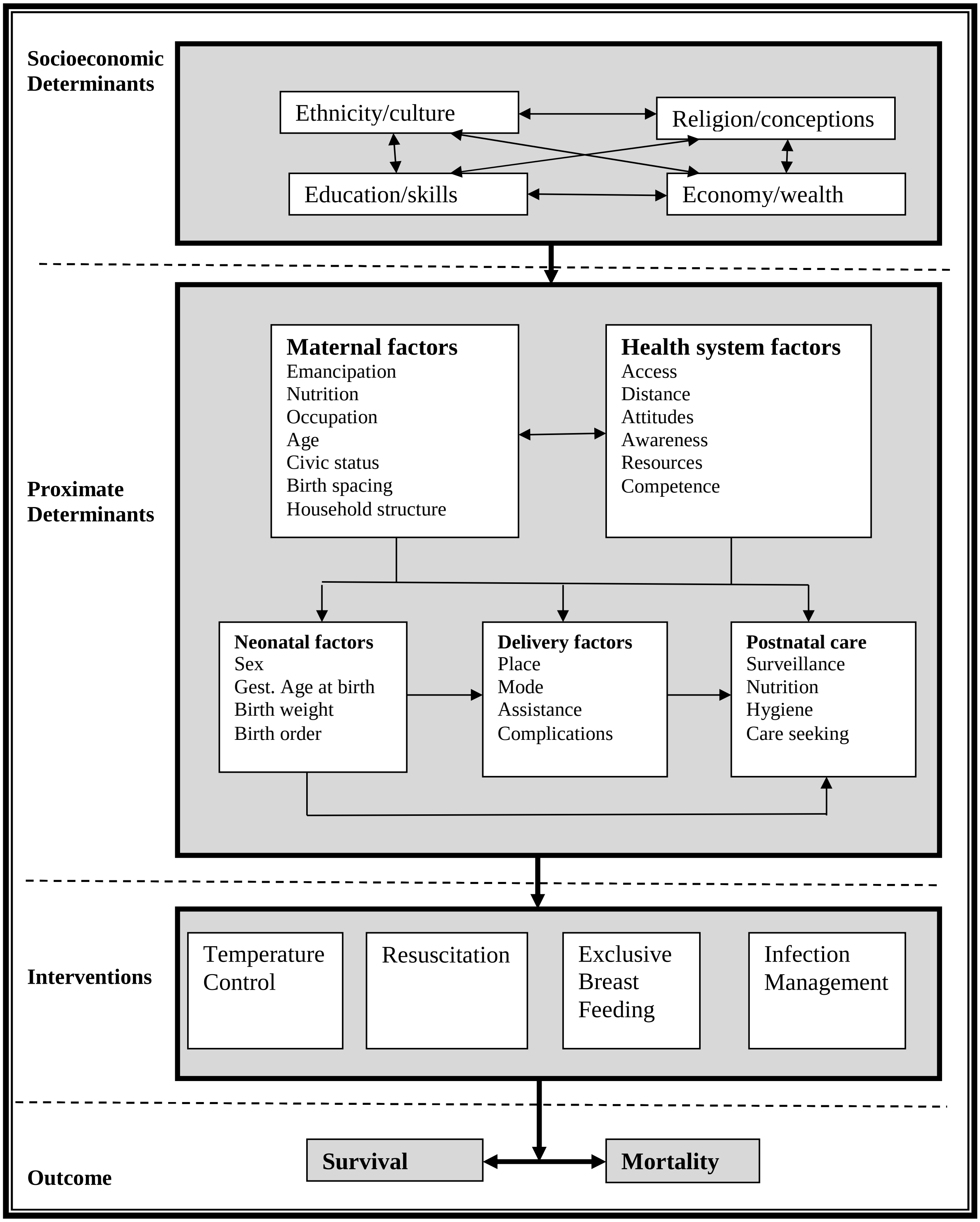
Figure 1. Operation of the five groups of proximate determinants on the health dynamics of a population (Mosley and Chen, 1984)



Firstly, UNICEF adapted and expanded the framework in explaining the factors associated with malnutrition (UNICEF, 1998). The conceptual framework developed by UNICEF integrated the large number of already identified factors by Mosley and Chen interacting in a complex manner show that the causes of malnutrition are multi-sectoral involving food supply, health and child feeding and child care practices. The UNICEF's framework also operates via a hierarchy of factors: immediate (individual level); underlying (household or family level) and basic causes (societal level). Further, the framework can be applied at district, sub-national and national levels. Like with other frameworks, it allows policy makers and researchers identify points of interventions or research areas or priority area in research.

The Mosley-Chen framework was also adapted by several researchers in biomedical field of research. Titaley and colleagues (Titaley et al., 2008) in their study of the determinants of neonatal mortality in Indonesia adapted this model in the hierarchy of factors that begins with community-level factors i.e. the socio-cultural context and socio-economic status both of which are described as distal or indirect factors. The proximate determinants are divided into maternal factors (age at birth); neonatal factors (sex, birth size); pre-delivery factors (desire for pregnancy); delivery factors (delivery assistance, delivery complications, mode and place of delivery) and post-delivery (postnatal care). The main outcome variable is neonatal death and the explanatory variables are those listed above categorized into community-level contextual factors, socio-economic factors at household level and proximate determinants at individual level. Finally, Singh (2013) in their study of the determinants of neonatal mortality in rural India utilized an adapted version of the classical Mosley and Chen framework. The framework consists of community contextual factors such as community-level infrastructures: distance to public and private health facilities, availability of auxiliary nurse-midwife, implementation of Safe Motherhood programme in the community and proportion of mothers with secondary level of education. These factors influence the socio-economic factors at individual (mother education, father education, religion and caste) and household environment (access to social services such as water, electricity, improved sanitation and type of house). The proximate determinants are grouped into: mother factors; neonatal factors; pre-delivery factors and delivery-related factors) that are directly linked to child's survival.

Figure 2. Conceptual framework for factors influencing neonatal mortality, adapted from Malqvist (2011)

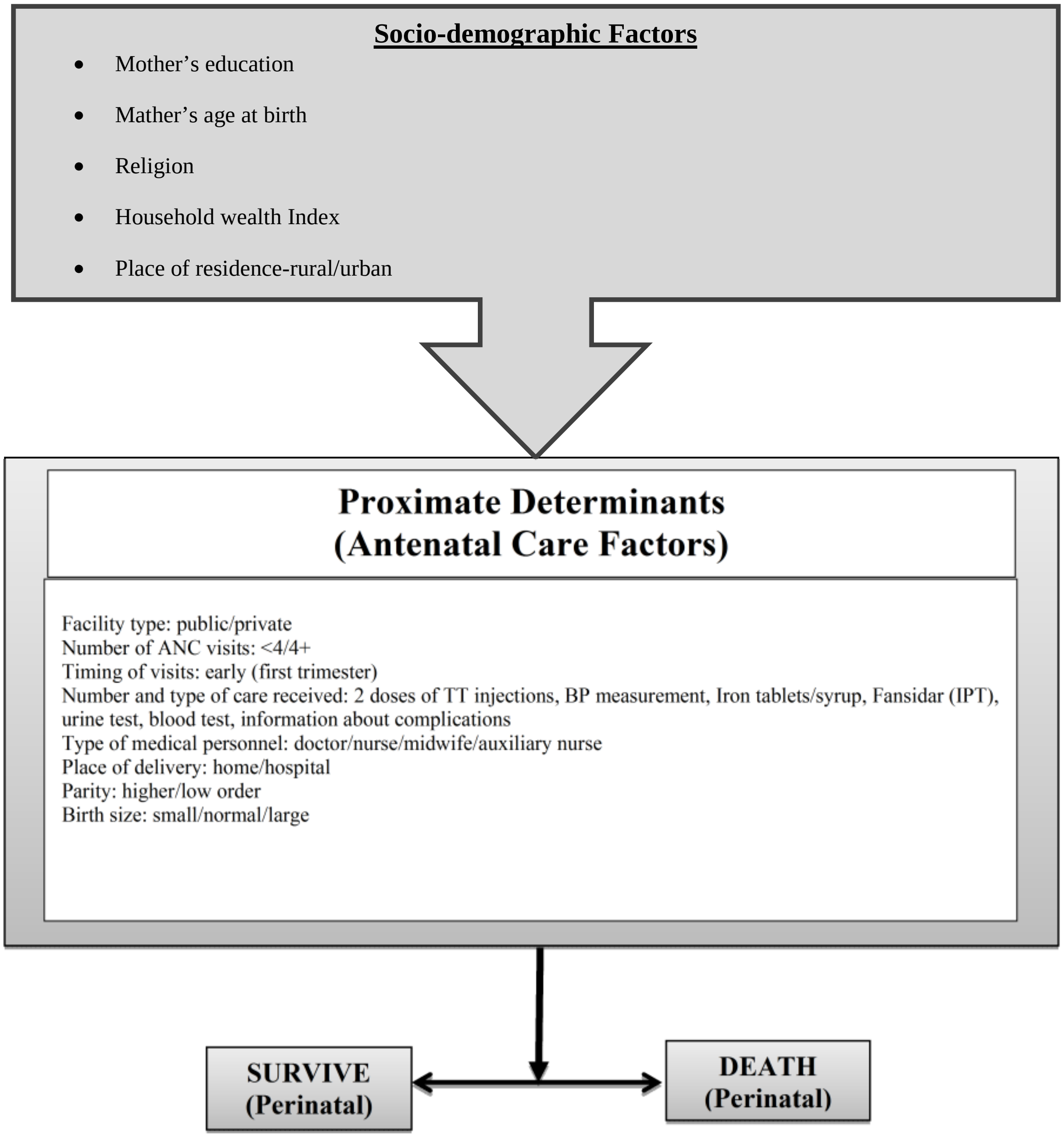


The Mosley and Chen’s framework was adapted and modified by Malqvist (2011) in the study of neonatal mortality in Vietnam. In this framework, the distal factors (or underlying factors/ socioeconomic) include ethnicity/culture, religion/conceptions, education/skills and economy/wealth. The proximate determinants are grouped into maternal and health system factors on one level and neonatal, delivery and postnatal care on the other level in which they both interact with one another.  For instance, the health system factors (access, distance of health facility, attitudes of staff, awareness of services, resources and competence of medical staff) can influence maternal factors such birth spacing.  Both the health system and maternal factors can influence the other proximate determinants such as place and mode of delivery as well as postnatal factors (e.g. care seeking in postnatal period). The proximate determinants do directly influence survival of newborn, but do so via some interventions that have been proven to improve child survival: temperature control (including kangaroo mother care for preterm babies, resuscitation for asphyxiated babies, exclusive breastfeeding, and treatment and management of infections). According to Malqvist, these interventions can directly influence the survival or otherwise of a newborn.

The ingenuity demonstrated by Mosley and Chen in 1984 through the development of the conceptual framework can be measured in terms of it wide applicability in other related medical fields: maternal health, HIV/AIDS (McCarthy, J., and Maine, D., 1992); the framework provided the basis for the analysis of factors related to child survival, generally.

**Figure 3. Conceptual framework for factors influencing perinatal mortality in Nigeria**

(Adapted from Mosley and Chen (1984) and Malqvist (2011))



## 2.6. Research Hypotheses

From the review of relevant literature above as well as conceptual framework, the following hypotheses are put forward to be tested in this study:

1. Lower risk of perinatal mortality is associated with use of focused antenatal care;
2. Lower risk of perinatal mortality is associated with use of all the six elements of antenatal care;
3. Residing in Northern Nigeria significantly increases the likelihood of perinatal mortality;

# Chapter 3

## Methodology

### 3.1. Study Setting

The study setting is Nigeria, located in the West African sub-region. It lies between between latitudes 4º16' and 13º53' north and longitudes 2º40' and 14º41' east. It is bounded to the North by Niger Republic, on the East by Benin Republic, on the East/North-East by Cameroun and Chad Republics and to the South by the Atlantic Ocean that stretches for over 850km and Gulf of Guinea. Nigeria is the most populous Black African nation with a population of over 140 million people according to 2006 census (FGN, 2007); currently its estimated population is about 162.5million people with per capita income of $2290 based on 2011 statistics (WDI, 2013). Politically and administratively, the country is divided into 774 local government areas (or municipalities) distributed in 36 states and a Federal capital Territory. It has six geopolitical zones: North-West, North-East, North-Central, South-West, South-East and South-South. According to the results of 2008 and 2013 Nigeria Demographic and Health Surveys, the neonatal, post-neonatal, infant, child and under-five mortality rates are unacceptably high even by African average. These rates are shown in the table below (NPC 2009; 2014):

Table I. Neonatal, post-neonatal, infant, child, and under-five mortality rates per 1000 live births for five year periods preceding the survey, Nigeria 2008 and 2013.

| Year of survey | Neonatal Mortality | Post-neonatal Mortality | Infant Mortality | Child Mortality | Under-5 Mortality |
|---|---|---|---|---|---|
| 2008 | 40 | 35 | 75 | 88 | 157 |
| 2013 | 37 | 31 | 69 | 64 | 128 |

### 3.2. Survey Design

The study utilized a cross-sectional design using the 2013 Nigeria DHS data sets. The survey utilized a stratified three-cluster sampling technique to select a respondent. Nigeria is administrative divided into 36 states with a Federal Capital Territory (FCT). The 36 states including the FCT are further divided into local government areas (LGA) which are the smallest administrative units in the country. In addition to these administrative units, each locality was sub-divided into census enumeration areas (or EAs) that was used for the 2006 population census. The EAs provided the primary sampling units for the both the census and for the 2013 Nigeria DHS. These EAs are referred also to as clusters in the 2013 Nigeria DHS (2013 NDHS). A total of 904 clusters were sampled during the 2013 NDHS; 372 in urban areas and 532 in rural areas. A representative sample of 40, 680 households was sampled for the survey allowing a minimum of 943 completed interviews in each state and 45 households in each cluster. All women aged 15-49years present, either permanent resident or a visitor in the household the night before the survey were eligible for the interview. Further, in a subsample of half of the households, all men aged 15-49years present either as permanent residents or visitors were also eligible for the interview. The survey used basically three types of structured questionnaires on the respondents: the Household Questionnaire, Woman's Questionnaire and Man's Questionnaire. The Household Questionnaire listed all usual members and visitors to the selected households; additional basic information collected was on the characteristics of each person listed, including age, sex, marital status, education, and relationship to the head of the household. The Woman's Questionnaire collected information on background characteristics, reproductive history and childhood mortality, family planning methods, fertility preferences, antenatal, delivery, and postnatal care and host of other health issues relating to specific diseases and disease-prevention programmes/interventions. The Man's Questionnaire is similar to the Woman's Questionnaire except that it is shorter. At the end of the exercise, 99.0%, 97.6% and 95.2% response rates were recorded for the households, women's and men's responses [NPC 2014]. Information collected from these questionnaires were transformed into Stata data files for statistical analysis.

## 3.3. The Population and Sample

The 2013 NDHS is the fifth in the series of nation-wide organized data collection project supported by USAID and implemented by the National Population Commission with technical assistance from ICF Macro International (NPC 2014). The 2013 survey consists of nationally representative sample of 38,945 women aged 15-49years and 17,359 men aged 15-59 years living in 38,904 households. The purpose of the survey is to provide policy makers and researchers with "updated estimates of basic demographic and health indicators" for planning, policy-making and programming.  Therefore, it collected information on various demographic and health issues and indicators such fertility levels, trends and preferences, nuptiality, sexual activity, awareness and use of contraception, child nutrition and feeding practices including nutritional statuses, child morbidity and mortality, health seeking behaviors among mothers. The 2013 NDHS has additional modules on malaria treatment, neglected tropical diseases, domestic violence, women empowerment and female genital cutting.

The study population composed of the following:

1. All the most recent births within the 5-year period prior to the survey in 2013 (28,467)

The sample however will include the following. The sample is different from study population since not all of the respondents (that is the women aged 15-49 years) experienced event of interest (that is perinatal mortality). Therefore, the analysis was restricted to the sample that included:

1. All pregnancies of 7months or more duration not ending in live birth within the 5-year period prior the survey in 2013. There were 27,777 pregnancies of 7 months or more duration and 396 of these ended up as stillbirths.

2. All early neonatal deaths (deaths within 6 days of birth) within the 5-year period prior the survey in 2013 (925).

## 3.4. The instruments

The instruments used to collect the data for the 2013 NDHS consisted of six questionnaires; for the purpose of this research the women’s questionnaire remains the most important. From this questionnaire two data files (in Stata format) are utilized for the analysis: the birth recode (NGBR6AFL) and the individual recode (NGIR6AFL).For data on live births and stillbirths occurring in the five year period preceding the survey and for the purpose of generating early neonatal mortality rate the birth record (NGBR6AFL) was used since it refers to all births as the universe, however for stillbirths, the individual records (NGIR6AFL)was used since the women represent the universe for the analysis (Rutstein and Rojas., 2006)

## 3.5. Variables in the analysis

The variables of interest in this study are broadly divided into dependent (or outcome) and independent (or explanatory) variable. These variables with their operational definitions and coding are shown in Table I.

### 3.5.1 Independent variables.

The independent variables are two: stillbirths and early neonatal deaths. For regression analyses, stillbirth and early neonatal death were used as the dependent variables separately. For early neonatal death, the independent variable of at least four ANC visits was used, but for stillbirths this was not case. Instead, the variable of at least one skilled ANC visit use as one of the explanatory variables. This was necessary since by definition, stillbirth refers to pregnancy of at least seven months not resulting in a live birth and since by seven months of pregnancy most women have not had all the required four antenatal care visits. In fact, based on this data set, about 62% of women began ANC during the second trimester (between the fourth and the sixth months) of their pregnancies. The secondary outcome variable is perinatal death which is the sum of stillbirths and early neonatal mortality. This variable was created by merging the two separate data files (Birth and Individual recode files).

### 3.5.1. The dependent variables:

The dependent variables are classified into two:

1. Those acting distally or the socio-economic factors such as mother's, household wealth index, religion, rural/urban location, region of residence; and household structure (sex of the household head)

2. Those acting proximally: maternal factors (maternal age, parity); neonatal factors (birth weight); pre-natal factors or ANC factors (type of health facility used to obtain ANC, timing of first ANC visit, number of ANC visits, number of tetanus toxoid injections received, number and type of services received such as BP measurement, urine test, blood test, information about complication); delivery-related factors (place of delivery).Table I below gives a summary of these variables.

These variables were selected based on review of empirical research and theoretical framework. Sociodemographic factors have been documented to predict use of antenatal care such as maternal age, maternal education, sex of household head, place of residence, household wealth index, religious affiliation, region of residence and parity. For instance, Ahmed (2010) reported that women with complete primary education are 2.89 times more likely to have at least four antenatal care visits than those with less than primary education. Singh (2013), also reporting their work in India show that utilization of maternal health care services is low in rural areas compared to urban areas and in communities with low level of literacy and high levels of poverty. Matsumura and Gubhaju (2001), working in Nepal indicated that use of antenatal care is significantly low in households where men are the heads.

The influence of maternal age on utilization of maternal health care (MCH) services is inconsistent. McCaw-Binns (1995) documented that young maternal age (teenage) is associated with decreased use of MCH services but Miles-Doan and Brewster (1998) reported that maternal age group of 25-34 is associated with increased chance of using MCH services. In Ethiopia, Mekonnen and Mekonnen (2003) showed that women of parity 2-4 have increased odds (OR=1.1, 95%CI: 0.9-1.4) of using maternal health services compared to women of other parity. He further reported that affiliated to Islam and residing in Addis Ababa both have increased odds of utilization of MCH services of 1.33 (OR=1.33; 1.1-16.0) and 9.9 (OR=9.9; 7.1-13.8) respectively. Consistent with Mekonnen and Mekonnen's findings is the report of the finding by Nielsen et al (2001) where they reported that higher order parity decreased the propensity to use MCH services in India.

The other variables selected are related to the utilization of ANC. These elements or components of ANC are critical in determining the outcome of the pregnancy. These elements are receiving two or more tetanus vaccine injection, blood pressure measurement/ screening, blood test, taking drug to prevent malaria in pregnancy (Fansidar), taking iron/folic acid supplements to prevent anaemia in pregnancy, type provider of care during ANC, type facility used for ANC, place of delivery and birth weight of baby. Some of these variables represent the content of ANC and provide the basis for assessing the role of antenatal care with regard to perinatal mortality. These variables are linked to the conceptual framework; the sociodemographic factors in themselves predict perinatal mortality but their effect on perinatal survival is modified by the use of these elements of care during ANC. For a particular case of woman with secondary level of education and living in urban area with available health facilities and with adequate knowledge of benefits of ANC either from reading pamphlet or from exposure to mass media is more likely to attend at least four ANC visits and to obtain all the components of the ANC. This woman, is also more likely to deliver in presence of a health professional and in clean and medically-controlled environment that can prevent adverse pregnancy outcomes such as neonatal death or maternal death.

### 3.5.1. Index of ANC adequacy

An index of ANC adequacy was created to using six elements of ANC services. These elements are having blood pressure measurement, having at least two doses of tetanus toxoid vaccination, consuming iron tablets supplements, taking two doses of Fansidar tablets to prevent malaria and having done urine and blood tests. This index is dichotomous, that is either a pregnant woman received all of these elements or not receiving any at all. This index is constructed in this way to optimize the benefit of ANC since all the elements are important components of the ANC service; receiving one element less means not having the optimum benefit and can lead to adverse pregnancy outcome.

## 3.6. Steps in data analysis

The first step in the data analysis was identification of all the relevant variables required for the analysis; the list is presented in the Table II below. Next was the recoding of some these variables into appropriate categories such as age of mother, region of residence, household headships (male versus female), educational attainment of the mother, wealth index, early neonatal death, stillbirth, categories of birth weight, use of focused ANC, blood pressure (BP) measurement, urine test, blood test, tetanus toxoid injections and index of ANC adequacy. Then descriptive statistics were generated in terms of utilization of focused ANC across background characteristics of the respondents. Numbers of live births, early neonatal deaths and stillbirths were generated with subsequent estimation of perinatal mortality rates by background characteristics and by use of ANC.

The Cox model was finally fitted to answer the research question. The Cox model was fitted first for the early neonatal death, then stillbirth and finally the combined stillbirth and early neonatal death (perinatal death) by merging the two separate files used for early neonatal mortality (Birth Recode File) and stillbirth (Individual Recode File) to derive the perinatal mortality. In all situations, unadjusted models were fitted first (univariate analysis) then adjusted models fitted to control for the background variables.

Table II. List of variables, variable definition and variable coding

| S/No | Variable | Variable definition | Coding |
|---|---|---|---|
| **Main outcome variables** | | | |
| 1 | Still birth | Death of fetus after 28 weeks gestation (or seven months and above) | Death (1); live birth (0) |
| 2 | Early neonatal death | Death of live born within 6 days of delivery | Died within 6days(0); alive after 6days (1) |
| 3 | Perinatal mortality | Death after 28weeks gestation and within 6days of delivery | Perinatal death(0); survival (1) |
| **Main Explanatory variables (ANC-related factors)** | | | |
| 4 | ANC visit/attendance | Attending antenatal care while pregnant in the last pregnancy | <4(0); 4+ (1) |
| 5 | Timing of ANC visit | Number of months pregnant at time of first ANC visit | First trimester (1); Second Trimester (2); Third Trimester (3) |
| 6 | TT injections | 2 doses of TT injections received in last pregnancy | <2 (0); 2+(1) |
| 7 | Blood pressure | Blood pressure measured | None(0); Yes (1) |
| 8 | Urinalysis | Test of urine (Urinalysis) done | None(0); Yes (1) |
| 9 | Blood test | Blood test done | None(0); Yes (1) |
| 10 | Antimalarial | Took antimalarial drug (Fansidar) | None(0); Yes (1) |
| 11 | Iron/Folic acid | Took iron and folic acid supplements | None(0); Yes (1) |
| 12 | Complications | Informed of pregnancy complications | None(0); Yes (1) |
| 13 | Skilled provider of care at ANC | Qualified medical personnel providing care during ANC | None(0); Doctor/Nurses/midwife/auxiliary staff (1) |
| 14 | ANC Adequacy | Receiving all the six components of antenatal care | Received all (1); received none (0) |
| **Bio-demographic variables (Maternal and neonatal factors)** | | | |
| 15 | Maternal age | Maternal age at the time of interview | Numerical values in years |
| 16 | Maternal education | Highest level of formal education attained by mother | None (0); primary (1); secondary (2); tertiary (3) |
| 17 | Sex of household | Sex of Household | Male(1); female(2) |
| 18 | Place of residence | Place of residence either rural or urban | Urban(1); rural(2) |
| 19 | Household Wealth Index | Measure of household wealth in quintiles | Poor (1); Middle (2): Rich (3) |
| 20 | Religion | Religious affiliation of mother | Christianity(1); Islam (2) Traditional/Others (3) |
| 21 | Regional of residence | Geopolitical zone of residence | South (1);North (2) |
| 22 | Parity | Total children ever born by mother | One(1); 2-4(2); 5+(3) |
| 23 | Birth size | Perceived size of baby at birth by mother without birth weight recording | Small/very small (1); smaller than average (2); average/large (3) |
| 24 | Birth weight | Accurate weight of baby at birth in kilograms (for facility deliveries since birth weights were taken at the time of delivery using weighing scale ) | <2.5Kg(1); 2.5-4.5Kg (2);>4.5 (3) |
| **Delivery-related factors** | | | |
| 25 | Place of delivery | Place where delivery took place | Home (0); Health facility (1) |

### 3.7. Statistical Method

First, descriptive statistics were generated in order to provide a general understanding of the characteristics of the respondents and their associated background factors in relation to utilization of focused ANC. Bivariate analyses were conducted to establish any statistical association between the outcome variables early neonatal death, stillbirth and perinatal deaths (sum of early neonatal death and stillbirths) and the explanatory variables as listed in Table 1. The bivariate analyses are the unadjusted regression models ignoring the influencing of distal (background) factors.

The statistical model for the analysis of the influence of ANC on perinatal mortality is the Cox proportional hazards regression model (Cox 1972). The Cox was chosen for this analysis since it represents the typical "time-to-event" pattern or "failure data" or "time-to-failure" data we are dealing with. Early neonatal death and stillbirth are forms of failure data in which we are trying to estimate the risk or probability of a stillbirth from conception or that of death within 6 days after delivery. Thus, Cox provides the most appropriate analytical model as it provides an estimate of the treatment effect on survival after adjustment for other explanatory variables. In addition, it allows us to estimate the hazard (or risk) of death for an individual, given their prognostic variables. In this model, it is proposed that the hazard or risk or probability for a subject j in the data experiencing the event is given by the semi-parametric relationship:

$$h(t|x_j) = h_0(t).\exp(x_j\beta_x);$$

the $h_0$ component represents the survival or the hazard function while the β component stand for the multivariate component or the regressions coefficients to be estimated from the data and the x's multiplied by β are the explanatory variables i=1, 2, 3, …….n; n denotes the number of the explanatory variables in the model. The $h_0$ represents that baseline hazard function when all the explanatory variables are zero.

A model with one explanatory (independent) variable looks like this:

$$h_j(t|x_j) = h_0(t).\exp(x_1\beta_{1j});$$

and if the individual (pregnancy in this case) is exposed (i.e.the pregnancy is exposed to at least four ANC visits), the model is of the form: (i.e. x=1)

$$h_j(t|x_j=1) = h_0(t).\exp(\beta_1*1) = h_0(t).\exp(\beta_1).$$

However if the individual is not exposed, then the model takes the form of: (i.e. x=0)

$$h_j(t|x_j=0) = h_0(t).\exp(\beta_1*0) = h_0(t).$$

In this model the risk or probability of either early neonatal death or stillbirth was measured in terms hazard ratio; representing increased (or decreased) risk of perinatal death between those births/pregnancies that were exposed to focused ANC compared to those not exposed. Hazard ratio of more than one indicates increased risk of perinatal death while hazard ratio of less than one indicates reduced risk of perinatal death; hazard ratio of one means the exposure (focused ANC) has no effect on perinatal death or risk of perinatal death is similar between those with focused ANC and those without it.

Cox model is implemented in Stata v13 using the Stata's ***stcox*** command that fits the Cox proportional hazard models. However, the data was first ***stset*** that is 'telling' the Stata to treat the data as a form of 'time-to-event' or survival analysis. Further, because the data for the analysis was collected using complex multistage sampling techniques, the analyses were conducted incorporating this sampling design and also applying the sampling weight (wgt) generated by dividing v005 by 1,000,000. The Stata survey command ***svy*** was utilized to 'inform' Stata about the nature of the data in terms sampling design and by so doing, Stata handles the data appropriately. The sampling weight was also ***stset***, as usual to 'tell' Stata to handle this weight as survival data.

After the preliminary preparation of the data into the form to allow Cox modelling, the analyses were ran; first univariate (or unadjusted models) and then the multivariate (adjusted models). The adjusted models took the form of three models:

1. Model 1: only focused ANC was the explanatory variable.
2. Model 2: focused ANC plus sociodemographic variables were included.
3. Model 3: focused ANC plus sociodemographic variables plus ANC-related factors such as timing of first visit or elements of ANC service received during the pregnancy such as TT injection, blood pressure measurement, urine test and blood test.
4. Model 4: sociodemographic factors were included only together with stillbirths, early neonatal death and perianal death.

All these models were implemented for the three outcome variables: stillbirth, early neonatal death and perinatal death. However, before running the multivariate Cox hazard models, backward stepwise elimination process was conducted to eliminate highly correlated variables before they are entered in the final models and only potential factors with $p<0.20$ were used in the final model. Factors that showed collinearity were not included in the final model. After generating the final model, graphs of Kaplan-Meier survival estimated were plotted represent these estimates graphically to aid interpretation and discussion.

Perinatal mortality rate is estimated using the formula provided by the WHO (WHO 2006). The WHO method states that perinatal mortality rate is the sum of early neonatal death and stillbirths divided by the total of all births (that is sum of live births and stillbirths). This definition is represented mathematically as follows:

Perinatal mortality rate= (Early neonatal deaths + Stillbirths) ÷Total births *1000

## 3.8. Ethical Issues

Permission to use the data sets was obtained from the owner that is ICF Macro International. Ethical clearance for this survey was obtained by the primary data collected (ICF Macro International) from the National Health Research Ethics Committee (NHREC) of the Federal Ministry of Health (FMoH) of Nigeria prior to the commencement of the survey. Further, the data collection process as well as all instruments used for survey remained anonymized and consent from each participants was obtained before interview.

## 3.9. Study limitations

The study used the 2013 Nigeria Demographic and Health Survey which is a cross-sectional study design; and therefore this design is limited in trying to establishing temporality. It is not possible to establish causal relationship between exposure and outcome; or more specifically it is not possible to establish conclusively that rural residence causes perinatal death as seen in this analysis; one can only generate association/relationship. This limitation can be overcome by being careful about making definite inferences and also being careful about interpretations and conclusions.

Secondly, by its cultural nature, stillbirths and early neonatal deaths are not often reported as they should and this often leads to under-reporting of their occurrences (Frederik et al., 2011). If these deaths are not as accurately reported as possible it can lead to biased estimates of their rates; thus WHO assesses the accuracy of their report by taking the ratio of early neonatal deaths and all neonatal deaths. If this percentage is abnormally low, it indicates some under-reporting of perinatal deaths. From the data sets, there were 925 early neonatal deaths and 1189 neonatal deaths and the ratio of the two is 77.8% which indicates good level of reporting and the estimates generated can be accepted as being reasonable. Oti and Odimegwu (2011) in a similar analysis reported a ratio of 74%.

Thirdly, because of its retrospective nature of the data and based on the design of the survey, it is not possible to assess the causes of either stillbirth or early neonatal deaths. Knowledge of this will help significantly in proposing recommendation in addressing the issue of perinatal mortality. The data set does not capture information on probable cause of either stillbirth or early neonatal death; thus this limitation is not feasible to manage.

Fourthly, stillbirths occurs to pregnant women whose pregnancies have attained the age of at least seven months. However, majority of the women initiated their ANC visit during the second trimester which falls between the fourth and end of seventh month of pregnancy. It is therefore not possible for majority of these women to have had at least four ANC visit before experiencing stillbirth. Because of this inability to attain at least four ANC visits, the Cox model for stillbirth was implemented using at least one ANC visit as one of the main explanatory variable rather than four visit as the case for early neonatal death.

Fifthly, measuring the effect of ANC on pregnancy outcomes faces problem of how to measure or adjust for the unobserved variables (i.e. endogeneity) especially that the data used here is inherently suffering from selection bias. Adjiwanou (2013) has pointed out that the characteristics of the woman will make her more likely to utilize skilled ANC as well as to deliver under skilled conditions. For instance, educated as well employed women or women living in highest wealth quintile households are more likely to use both skilled ANC and delivery. There is also the possibility that unmeasured individual characteristics or ANC factors such as quality of service received may be associated both with the dependent and independent variables in the estimated models. This sorts of selective biases has also being highlighted by Babalola and Fatusi (2009) whom recommended other more robust estimating models such propensity score matching, bivariate probit regression, multivariate probit regression and instrumental variable regression. Adjiwanou (2013) implemented the recursive biprobit model (Adjiwanou 2013) to take account of endogeneity and concluded that the usual commoner methods (such as regression methods) of testing the effect of ANC on pregnancy outcomes under-estimate its effect. Thus, there is the possibility that our estimates in this models underestimated the effects of ANC on perinatal mortality as the models did not account for the potential selectivity bias and endogeneity.

The role of household and community characteristics as well as policy environment (such as free maternal and child health services or distribution of insecticide treated nets to pregnant women and children and anti-malaria drugs that has been going as part of intervention to achieve MDG 4 and 5 in Nigeria) in shaping the pattern of usage of ANC has not been captured by this study despite their growing importance in this regard. These factors have a strong influence on the use of maternal and child health services including ANC which has been demonstrated by earlier investigators (Stephenson et al., 2006; Babalola and Fatusi 2009; Ononokpono et al., 2013).

The quality of ANC or the perception of pregnant women was not assessed. It is important to do this since we are measuring the relationship between use of ANC and a particular outcome (perinatal mortality). Many women may or may not use because of their experience with the previous use and this perception shape future use or non-use.

Finally, on developing adequacy of ANC index, it will have been best developed using either principal component analysis (PCA) or factor analysis (FA). However, as pointed out by many other researchers that principal components are artificially constructed indices and the technique is arbitrary, that the method of choosing the number of components and the variables to include is not well defined. Further, assigning proper weights (eigenvalues) to each element will require extensive empirical research to assess each weight's predictive power which will open a new area of research that is not the intent of this research.

# Chapter 4

# Results

## 4.1. Profile of respondents

This chapter highlights the sociodemographic characteristics of the women respondents age 15-49 years, utilization of antenatal care (focused ANC; at least four ANC visits during the most recent pregnancy in the five years period preceding the survey), levels of perinatal mortality rates by various sociodemographic variables and the determinants/correlates of perinatal mortality.

The sociodemographic profiles of the women respondents are shown in Table 1. The profile indicates that more than one-third (37.5%) of the respondents are in the age group of 15-24years while about 58% are located in the North geopolitical zone; 60% are in rural residences. Furthermore, more than one-third (35%) have no formal education and a similar proportion (40%) of the husbands/partners of these respondents also do not have formal education. As for the household wealth, majority (43.2%) are in the rich quintile (rich and richest) while those in the middle quintile constitute the least proportion of 20.5%; slightly more than 36% are in the poor quintile. The sample of respondents show that those with Christian faith constitute over half of the sample (51.2%), around 48% are of Islamic faith while the remaining belong to the traditional or other faiths. About 30% of women have never had child (parity zero) while those with two or four and those with five or more are f equal proportions (30%). Overwhelming majority of the households are headed by males (82%); female-headed households are only 18%. About 70% of the respondents are currently married or in some form of marital unions while one-quarter (25%) are not married or not in any form of marital union and the remaining (5%) were formerly in union. Among those respondents who are in some form of union, one-third (34%) had other wives or mates while two-thirds (66%) are the only female partners or wives.

Results of use of antenatal care indicates that about 67% had some form of ANC care (at least one ANC visit); and that majority started ANC visits during the second trimester (between the fourth and sixth months of pregnancy). Home is the predominant place of delivery as close to two-thirds (61%) delivered at home with around 39% delivering in a health facility. Majority (89%) of the respondents indicated that their last pregnancies were timely, 8% desired that it would have been later than then while the remaining (2.4%) wanted no more childbirth.

Table 1. Sociodemographic profile of women 15-49years, Nigeria DHS, 2013.

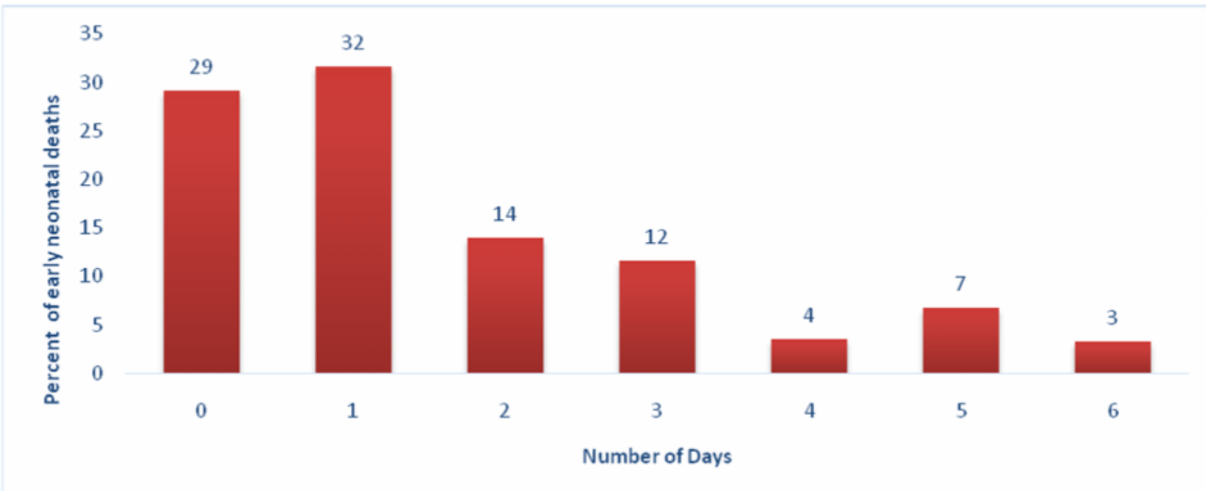
| **Variable** | **Number of women** | **Percentage (%)** |
|---|---|---|
| **Maternal age** | | |
| 15-24 | 14619 | 37.5 |
| 25-34 | 12410 | 31.9 |
| 35+ | 11919 | 30.6 |
| **Total** | **38948** | **100.0** |
| **Geopolitical zone** | | |
| North | 22554 | 57.9 |
| South | 16394 | 42.1 |
| **Total** | **38948** | **100.0** |
| **Place of residence** | | |
| Urban | 15545 | 39.9 |
| Rural | 23403 | 60.1 |
| **Total** | **38948** | **100.0** |
| **Maternal level of education** | | |
| No formal education | 13740 | 35.3 |
| Primary | 7104 | 18.2 |
| Secondary and above | 18104 | 46.5 |
| **Total** | **38948** | **100.0** |
| **Husband's level of education** | | |
| No formal education | 10566 | 36.9 |
| Primary | 5570 | 19.5 |
| Secondary and above | 12466 | 43.6 |
| **Total** | **28602** | **100.0** |
| **Wealth index** | | |
| Poor | 14117 | 36.3 |
| Middle | 8001 | 20.5 |
| Rich | 16830 | 43.2 |
| **Total** | **38948** | **100.0** |
| **Religion** | | |
| Christianity | 19838 | 51.2 |
| Islam | 18578 | 47.9 |
| Traditional/other | 366 | 0.9 |
| **Total** | **38782** | **100.0** |
| **Parity** | | |
| None | 11457 | 29.6 |
| One | 4363 | 11.3 |
| 2-4 | 11397 | 29.5 |
| 5+ | 11446 | 29.6 |
| **Total** | **38663** | **100.0** |
| **Sex of household head** | | |
| Male | 31581 | 81.7 |
| Female | 7082 | 18.3 |
| **Total** | **38663** | **100.0** |
| **Marital status of mother** | | |
| Not in union (single) | 9783 | 25.3 |
| Currently in union (married) | 27033 | 69.9 |
| Formerly in union | 1847 | 4.8 |
| **Total** | **38663** | **100.0** |
| Table 1 continued | | |
| **Cowives wives** | | |
| None | 17959 | 66.4 |
| 1-3 | 8828 | 32.7 |
| 4+ | | |

| | | |
|---|---|---|
| **Total** | 246 | 0.9 |
| **ANC utilization (at least one visit)** | **27033** | **100.0** |
| Yes | | |
| No | 13206 | 67.2 |
| **Total** | 6458 | 32.8 |
| **Initiation of ANC visits** | **38948** | **100.0** |
| First trimester | | |
| Second trimester | 3682 | 27.6 |
| Third trimester | 8242 | 61.7 |
| **Total** | 1428 | 10.7 |
| **Place of delivery** | **13352** | **100.0** |
| Home | | |
| Health facility | 12124 | 61.4 |
| **Total** | 7627 | 38.6 |
| **Pregnancy desire** | **19751** | **100.0** |
| Then | | |
| Later | 17587 | 89.3 |
| No more | 1629 | 8.3 |
| **Total** | 476 | 2.4 |
| **Blood pressure measured** | **19692** | **100.0** |
| Yes | | |
| No | 12010 | 90.4 |
| **Total** | 1275 | 9.6 |
| **Urine test done** | **13285** | **100.0** |
| Yes | | |
| No | 10766 | 81.1 |
| **Total** | 2510 | 18.9 |
| **Blood test done** | **13276** | **100.0** |
| Yes | | |
| No | 10806 | 81.4 |
| **Total** | 2466 | 18.6 |
| **Told of complications** | **13272** | **100.0** |
| Yes | | |
| No | 9200 | 69.3 |
| **Total** | 4072 | 30.7 |
| **Took iron tablets** | **13272** | **100.0** |
| Yes (≥180 days) | | |
| No (<180 days) | 963 | 7.6 |
| **Total** | 10984 | 92.4 |
| **Two doses of TT injections** | **11947** | **100.0** |
| Yes | | |
| No | 9086 | 48.5 |
| **Total** | 9643 | 51.5 |
| **Took Fansidar** | **18729** | **100.0** |
| Yes | | |
| No | 4742 | 25.7 |
| **Total** | 13711 | 74.3 |
| **ANC Adequate** | **18453** | **100.0** |
| No | | |
| Yes | | |
| **Total** | 17205 | 55.1 |
| | 14039 | 44.9 |
| | **31244** | **100.0** |

## 4.2. Perinatal mortality

In the five years preceding the survey, there were 28,467 most recent births, 925 early neonatal deaths and 396 stillbirths. The distribution of the early neonatal deaths by age at death is shown in Figure 4. About 29% of the early neonatal deaths occurred on the day in which the newborns were delivered; two-thirds (or 61%) of these deaths occurring within the first 48hours of. About 2.4% of women had their newborn dying within the first six days of life and around 1.9% of women experienced stillbirths. Overall perinatal mortality rate for the country is 41 per 1000births.

**Figure 4. Percent distribution of early neonatal deaths day of death, 2013 Nigeria DHS**




## 4.3. Focused ANC and Sociodemographic characteristics

Table 2 shows the distribution of focused ANC by sociodemographic factors. It also indicates any statistically significant difference in the use of ANC by the various sociodemographic variables under study by means of chi-squared test.

Overall, 54% of women with live births in the five years preceding the survey had at least four focused ANC. Disaggregated by age group of respondents, it is discernible that those in the age group 25-34 years (middle) are more likely to have had at least four ANC visits compared to other age groups likewise those respondents living in urban areas are almost twice as likely to attend four ANC visits as those in the rural areas. Education of respondents is seemingly playing a role on use of ANC, there is a clear increasing trend in utilization of ANC with increasing level of education; about 30% of those with no formal education are making use of ANC compared to 62% with primary level of education and 83% of those with secondary or higher levels of education. Living in a the rich wealth gives a comparative advantage to use

ANC (83%) as opposed to living in poor wealth quintile (29%). Christianity (73%) gives a similar comparative advantage in the use of ANC compared to other religious affiliations; Islam (41%) and traditional (34%). There is clear significant difference between women with one child (parity one) and higher parity women with respect to ANC use; women with one children are more likely to have used ANC (66%) compared with higher parity. In fact, grand multiparous (parity 5+) women use ANC the least (27%). Women in female-headed households also have better use of ANC (71%) as opposed to women in male-headed households (52%) possibly due to less autonomy and the need to seek permission as well as possible financial dependence on the male head. Similar reasons may be operating among the single women (women not in union) in explaining why they have better rates of utilization of ANC (65%) in comparison to those who are married (54%) or those formerly married (62%).

Table 2. Percent distribution of women 15-49 by focused ANC by background characteristics, 2013 Nigeria DHS.

| **Variable** | **Focused ANC visits (%)** | | **Number of women** | **P value ($\chi^2$)** |
|---|---|---|---|---|
| | **No(less than 4 visits)** | **Yes (4 or more visits)** | | |
| **Maternal age** | | | | **<0.001** |
| 15-24 | 52.4 | 47.6 | 4910 | |
| 25-34 | 42.9 | 57.1 | 9015 | |
| 35+ | 44.3 | 55.7 | 9275 | |
| **Geopolitical zone** | | | | **<0.001** |
| North | 58.5 | 41.5 | 12617 | |
| South | 21.2 | 78.8 | 6583 | |
| **Place of residence** | | | | **<0.001** |
| Urban | 21.2 | 78.8 | 6463 | |
| Rural | 58.2 | 41.8 | 12737 | |
| **Maternal level of education** | | | | **<0.001** |
| No formal education | 70.8 | 29.2 | 8694 | |
| Primary | 37.9 | 62.1 | 3900 | |
| Secondary and above | 17.4 | 82.6 | 6606 | |
| **Wealth index** | | | | **<0.001** |
| Poor | 71.2 | 28.8 | 8544 | |
| Middle | 39.3 | 60.7 | 3844 | |
| Rich | 17.4 | 82.6 | 6812 | |
| **Religion** | | | | **<0.001** |
| Christianity | 26.8 | 73.2 | 7968 | |
| Islam | 59.0 | 41.0 | 11033 | |
| Traditional/other | 65.8 | 34.2 | 199 | |
| **Parity** | | | | **<0.001** |
| One | 33.6 | 66.4 | 3446 | |
| 2-4 | 62.1 | 37.9 | 8455 | |
| 5+ | 73.5 | 26.5 | 7269 | |
| **Sex of household head** | | | | **<0.001** |
| Male | 47.9 | 52.1 | 16974 | |
| Female | 29.2 | 70.8 | 2226 | |
| **Marital status of mother** | | | | **<0.001** |
| Not in union (single) | 35.4 | 64.6 | 508 | |
| Currently in union (married) | 46.3 | 53.7 | 18062 | |

| | | | | |
|---|---|---|---|---|
| Formerly in union | 38.4 | 61.6 | 630 | |
| **Total** | **46.0** | **54.0** | **19200** | |

## 4.4. Levels of Perinatal Mortality Rate

The number of live births, early neonatal deaths, stillbirths and perinatal mortality rates by sociodemographic characteristics are shown in Table 3**;** early neonatal death rate is 28.7 per live birhs, perinatal mortality rate is 12 per births and overall perinatal mortality rate is 41 per 1000 births. Some of these results corroborates what has already been known from existing literature such as the differentials with age, urban-rural residence, North-South geopolitical zone, level of education, wealth, parity, sex of child, size of child at birth based on mother's assessment, birth weight (in kilogramme), utilization of ANC and number of ANC visits.

Thus, expectedly, perinatal mortality rate is highest among the youngest women (15-24years) followed by rate among the oldest women (35years and above); so also is the rate between the North and South showing bias against the North (42 per 1000). Those living in rural areas have higher rate of perinatal mortality (45 per 1000) compared to those in urban areas (34 per 1000). Perinatal mortality rates by educational level showed that women with primary education have the highest (46.8 per 1000) followed by those with no formal education and finally those with secondary and tertiary education equally with 36 per 1000. Women in the poor wealth quintile have the highest rates of perinatal mortality of 45.9 per 1000 while those in the rich quintile have the least rate of 36.4 per 1000. Perinatal mortality rates by religious affiliation does not seem to vary around 41 per 1000. Perinatal mortality by parity show marked variations in the expected direction: low and high parity have higher rates of perinatal mortality. The low and high parity pregnancies are prone to several pregnancy complications that can lead to either stillbirths or early neonatal death such high blood pressure, excessive bleeding, and birth complications. The sex of the child has a bearing on the perinatal survival: male child has perinatal survival disadvantage compared to the female counterpart.

The result here indicates such survival advantage of female child (34.9 per 1000) over the male child (43.5 per 1000). For deliveries that did not take place in health facilities and the birth weight not recoded, babies' size at birth are based on mother's perception and recorded accordingly. Newborns considered large by their mothers experienced the smallest perinatal mortality rate of 27 per 1000; smaller and very small have the highest perinatal mortality rates of 47.9 and 80.4 per 1000 respectively. This pattern of perinatal mortality risk by birth size show similar pattern with birth weight: newborn with birth weight less than 2.5kg (small) have the highest perinatal mortality rate compared to those with normal (2.5-4.5kg) or large birth weight (>4.5kg). Again, small babies are prone to a barrage of complications (such as prematurity, infection, bleeding into the brain, hypothermia and hypoglycemia) that makes them vulnerable to succumb to perinatal death.

Regarding use of focused ANC, an unexpected findings appears here that pregnant women with at least four ANC have higher perinatal mortality rate (48 per 1000) than those who had less than four ANC visits (30 per 1000 births). Similarly, those with only one visit have the lowest perinatal mortality rate (19 per 1000 births) compared to those with at least four visits (30 per 1000). Early timing of ANC care does not seem to confer advantage to perinatal survival: those that began ANC care in the first trimester (within three months of pregnancy) do not have better survival advantage than those that started in the second trimester (34 against 27 per 1000 births). Regarding place of delivery, expectedly perinatal mortality is highest among hospital deliveries (36 per 1000 births) as opposed to home deliveries (33 per 1000 births).

During ANC visits, pregnant women are subjected to various laboratory test to screen and detect infection (such as malaria) and ill-conditions that can jeopardize their health and that of the unborn baby. These elements of care include blood pressure measurement to detect elevated blood pressure which is one of leading causes of maternal mortality as well neonatal death; urine test to detect infection of the urinary track that cause stillbirth, taking preventive medicine (Fansidar) against malaria and taking iron tablets supplements to prevent anaemia which is also a cause of stillbirth. The levels of perinatal mortality disaggregated by these elements of ANC services does not provide consistent results as shown in table 3. There appears to be little variation in terms utilization of these elements and level of perinatal mortality except in the case of urine test and adequacy of focused ANC. For those pregnant women who had urine test the perinatal mortality is 42 as against 28 per 1000 births for those without urine test. However, for those who had all the six elements of ANC, the perinatal mortality rate is lower compared to those whom did not have all the six elements (17 versus 54 per 1000 births).

Table 3. Number of live births, early neonatal deaths, stillbirths and perinatal mortality rates (per 1000 births) by sociodemographic characteristics and ANC-related factors, Nigeria DHS 2013¶.

| Characteristic | Live birth | Early neonatal death | Stillbirth | Perinatal mortality rate (PNMR) |
|---|---|---|---|---|
| **Maternal age** | | | | |
| 15-24 | 7771 | 265 | 106 | 47.09 |
| 25-34 | 15751 | 405 | 161 | 35.60 |
| 35+ | 8047 | 253 | 129 | 46.56 |
| **Total** | **31569** | **923** | **396** | **41.78** |
| **Geopolitical zone** | | | | |
| North | 21693 | 633 | 291 | 42.01 |
| South | 10136 | 293 | 105 | 40.90 |
| **Total** | **31829** | **926** | **396** | **41.53** |
| **Place of residence** | | | | |
| Urban | 11126 | 263 | 115 | 33.65 |
| Rural | 20702 | 659 | 281 | 44.79 |
| **Total** | **31828** | **922** | **396** | **41.41** |
| **Maternal level of education** | | | | |
| No formal education | 15521 | 459 | 199 | 41.80 |
| Primary | 6064 | 200 | 88 | 46.84 |
| Secondary | 8160 | 217 | 87 | 36.90 |
| Tertiary | 1826 | 47 | 20 | 36.06 |
| **Total** | **31571** | **923** | **394** | **41.71** |
| **Wealth index** | | | | |
| Poor | 14734 | 466 | 221 | 45.92 |
| Middle | 5937 | 170 | 58 | 38.05 |
| Rich | 10902 | 287 | 114 | 36.39 |
| **Total** | **31573** | **923** | **393** | **41.68** |
| **Religion** | | | | |
| Christianity | 11560 | 346 | 131 | 40.82 |
| Islam | 19523 | 564 | 259 | 41.58 |
| Traditional/other | 295 | 9 | 3 | 40.29 |
| **Total** | **31378** | **919** | **393** | **41.81** |
| **Parity** | | | | |
| One | 3640 | 110 | 69 | 48.16 |
| 2-4 | 15196 | 410 | 148 | 36.35 |
| 5+ | 12735 | 403 | 121 | 40.78 |
| **Total** | **31571** | **923** | **338** | **39.94** |
| **Sex of child** | | | | |
| Male | 15944 | 529 | 173 | 43.53 |
| Female | 15627 | 394 | 157 | 34.90 |
| **Total** | **31571** | **923** | **330** | **39.68** |
| **Size of baby at birth** | | | | |
| Very large | 4272 | 102 | 25 | 29.58 |
| Larger | 9216 | 181 | 71 | 27.11 |
| Average | 12764 | 324 | 84 | 31.75 |
| Smaller | 3315 | 145 | 15 | 47.96 |
| Very small | 1409 | 100 | 14 | 80.36 |
| **Total** | **30976** | **852** | **209** | **34.25** |
| **Birth weight** | | | | |
| Small (<2.5Kg) | 4724 | 245 | 29 | 57.66 |
| Normal (2.5-4.5Kg) | 12764 | 324 | 84 | 31.75 |
| Large(>4.5Kg) | 13488 | 283 | 95 | 27.82 |
| **Total** | | | | |

| | | | | |
|---|---|---|---|---|
| | **30976** | **852** | **208** | **34.22** |
| **Focused ANC utilization** | | | | |
| Yes | 19375 | 680 | 265 | 48.12 |
| No | 12196 | 242 | 129 | 30.11 |
| **Total** | **31571** | **922** | **394** | **41.68** |
| **Number of ANC Visits** | | | | |
| None | 6990 | 166 | 71 | 33.47 |
| One | 351 | 2 | 5 | 18.90 |
| 2-3 | 2078 | 55 | 23 | 37.09 |
| 4+ | 10322 | 203 | 110 | 29.76 |
| **Total** | **19741** | **426** | **209** | **32.17** |
| **Timing of first ANC visit** | | | | |
| First trimester | 3565 | 83 | 41 | 34.33 |
| Second trimester | 8182 | 144 | 83 | 27.51 |
| Third trimester | 1416 | 32 | 14 | 32.17 |
| **Total** | **13163** | **259** | **138** | **30.16** |
| **BP measurement** | | | | |
| Yes | 1190 | 26 | 14 | 33.23 |
| No | 12024 | 246 | 125 | 30.57 |
| **Total** | **13214** | **272** | **139** | **31.10** |
| **Urine test** | | | | |
| Yes | 2370 | 63 | 38 | 42.11 |
| No | 10837 | 208 | 208 | 28.34 |
| **Total** | **13207** | **271** | **246** | **39.15** |
| **Two doses of TT injections** | | | | |
| Yes | 10281 | 227 | 109 | 32.30 |
| No | 9749 | 192 | 100 | 29.61 |
| **Total** | **20030** | **419** | **209** | **31.35** |
| **Took Iron tablets** | | | | |
| Yes | 7293 | 159 | 77 | 31.96 |
| No | 12765 | 259 | 131 | 30.23 |
| **Total** | **20058** | **418** | **208** | **31.21** |
| **Had complications** | | | | |
| Yes | 4188 | 87 | 38 | 29.72 |
| No | 9032 | 184 | 100 | 31.12 |
| **Total** | **13220** | **271** | **138** | **30.93** |
| **Took Fansidar tablets** | | | | |
| Yes | 14531 | 162 | 323 | 33.02 |
| No | 5245 | 43 | 89 | 25.01 |
| **Total** | **19776** | **205** | **412** | **31.20** |
| **ANC Adequate** | | | | |
| No | 14256 | 642 | 233 | 61.38 |
| Yes | 24692 | 298 | 154 | 18.31 |
| **Total** | **38948** | **940** | **387** | **34.07** |
| **Place of delivery** | | | | |
| Home | 19899 | 534 | 132 | 33.72 |
| Health facility | 11346 | 335 | 78 | 36.15 |
| **Total** | **31245** | **869** | **210** | **34.53** |

¶ The variables are not adding up to total because of missing and not all respondents experienced the outcomes of either stillbirth or early neonatal death

## 4.5. Correlates of Perinatal Mortality

This sub-section is about the predictors or correlates of perinatal mortality. The statistical analysis employed is the Cox proportional hazard model to model the survival pattern of live births up to the sixth day of life as well as the survival of fetus after the seventh month of pregnancy (or stillbirth).

### 4.5.1. Correlates of Early Neonatal Mortality

Table 4 represents the unadjusted model fitting early neonatal mortality as the outcome variable with various sociodemographic and ANC-related factors. Results of this analysis show some of the expected relationships and some uncommon findings. Expected findings include the role of ANC use as significantly reducing the probability of early neonatal death by about 2% and that residing in Northern part of the country as well as living in rural area both of which increase the risk of early neonatal death by between 14% and 18% respectively. Higher parity (5 and more) as well as living in a household with four other cowives (4 and more) increases the risk of newborn dying within six days of life. Unplanned or unintended pregnancies increases the chance of early neonatal death by between 11% and 17% so also is living in female-headed household. Home delivery has a disadvantage on early neonatal death as well as not taking iron tablets for at least six months.

One of the negative findings is that education increases the chance of early neonatal mortality. Specifically, having primary education or more confers survival disadvantage in the early neonatal period. Similarly, initiating ANC in the second trimester is associated with decreased risk of early neonatal mortality.

The adjusted model, Model 4 (Table 5) indicates that use of ANC (HR=0.76, 95%CI: 0.71-0.81), residing in southern part of Nigeria (HR=0.83, 95%CI: 0.79-0.87) belonging to Islamic religion (HR=0.84, 95%CI: 0.79-0.88) and having utilized all the six elements of ANC (HR=0.41, 95%CI: 0.30-0.56) significantly reduces the risk early neonatal death. Factors found to increase the risk of early neonatal mortality are: living in rural area (HR=1.24, 95%CI: 1.19-1.30), having 1-3 cowives (HR=1.09, 95%CI: 1.04-1.14), being in the middle wealth quintile (HR=1.08, 95%CI: 1.02-1.14), and wanting no more pregnancy (HR=1.10, 95%CI: 0.99-1.23), delivering in health facility (HR=1.07, 95%CI: 1.02-1.12), having pregnancy complication (HR=1.14, 95%CI: 1.09-1.19) and not taking iron tablets as supplements (HR=1.14, 95%CI: 1.07-1.22). These factors increase the hazard of early neonatal death by between 7% and 24%.

The summary results of these models (Models 2, 3 and 4) is that three factors are associated with increased risk of early neonatal mortality. These are residing in Southern part of Nigeria, rural residence and having between one and three cowives. Conversely, Models 1, 3 and 4 (in Table 5) show that focused ANC and receiving complete package of six elements consistently reduces the risk of early neonatal mortality. Of note, is that focused ANC alone, without controlling for other covariates significantly reduces the hazard of early neonatal mortality (Model 1) (HR=0.98, 95%CI: 0.96-0.99) but this finding is not enough to draw conclusion but adds to the strength of the argument for making a case for focused ANC as a strategy in reducing risk of early neonatal mortality.

Table 4. Unadjusted hazard ratios and 95% confidence interval for variables associated with early neonatal death, Nigeria DHS 2013.

| Covariate | Unadjusted hazard ratios, 95% CI and p values | | |
|---|---|---|---|
| | HR | (95% CI) | P values |
| ***Antenatal care*** | | | |
| Yes | 0.98 | (0.96-0.99) | 0.024 |
| No | 1.00 | - | |
| ***Maternal age*** | | | |
| 15-24 | 1.00 | - | |
| 25-34 | 1.02 | (1.00-1.05 | 0.043 |
| 35+ | 1.08 | (1.06-1.10) | <0.001 |
| ***Geopolitical region*** | | | |
| North | 1.14 | (1.12-1.15) | <0.001 |
| South | 1.00 | - | |
| ***Place of residence*** | | | |
| Rural | 1.18 | (1.17-1.20) | <0.001 |
| Urban | 1.00 | - | |
| ***Educational attainment*** | | | |
| None | 1.00 | - | |
| Primary | 1.16 | (1.15-1.18) | <0.001 |
| Secondary | 1.11 | (1.09-1.13) | <0.001 |
| Tertiary | 1.17 | (1.14-1.20) | <0.001 |
| ***Religion*** | | | |
| Christianity | 1.00 | - | |
| Islam | 0.97 | (0.78-0.79) | <0.001 |
| Traditional/other | 0.92 | (0.87-0.96) | 0.001 |
| ***Parity*** | | | |
| One | 1.00 | - | |
| 2-4 | 0.96 | (0.93-0.99) | 0.028 |
| 5+ | 1.03 | (1.00-1.07) | 0.032 |
| ***Number of cowives*** | | | |
| None | 1.00 | - | |
| 1-3 | 1.04 | (1.03-1.06) | <0.001 |
| 4+ | 1.12 | (1.04-1.19) | 0.001 |
| ***Wealth index*** | | | |
| Poor | 1.00 | - | |
| Middle | 1.11 | (1.09-1.13) | <0.001 |
| Rich | 0.99 | (0.98-1.01) | 0.241 |
| ***Timing of ANC*** | | | |
| 1$^{st}$ trimester | 1.00 | - | |

| | | | |
|---|---|---|---|
| 2nd trimester | 0.95 | (0.91-0.99) | 0.015 |
| 3rd trimester | 0.95 | (0.89-1.01) | 0.122 |
| ***Pregnancy Wanted*** | | | |
| Then | 1.00 | - | |
| Later | 1.11 | (1.08-1.15) | <0.001 |
| No more | 1.17 | (1.13-1.21) | <0.001 |
| ***Sex of Household head*** | | | |
| Male | 1.00 | - | |
| Female | 1.15 | (1.13-1.17) | <0.001 |
| ***Place of delivery*** | | | |
| Home | 1.04 | (1.01-1.06) | 0.001 |
| Health facility | 1.00 | - | |
| ***BP measurement*** | | | |
| No | 1.00 | - | |
| Yes | 0.89 | (0.84-0.94) | <0.001 |
| ***Urine test*** | | | |
| No | 1.00 | - | |
| Yes | 0.90 | (0.86-0.94) | <0.001 |
| ***Blood test*** | | | |
| No | 1.00 | - | |
| Yes | 0.91 | (0.87-0.95) | <0.001 |
| ***Had complications*** | | | |
| No | 1.00 | - | |
| Yes | 1.07 | (1.03-1.11) | <0.001 |
| ***Took iron tablets(>180days)*** | | | |
| No | 1.08 | (1.05-1.12) | <0.001 |
| Yes | 1.00 | - | |
| ***Took Fansidar tablets*** | | | |
| No | 1.00 | - | |
| Yes | 0.96 | (0.93-0.99) | 0.027 |
| ***TT injections (2+ doses)*** | | | |
| No | 1.00 | - | |
| Yes | 1.06 | (1.03-1.09) | <0.001 |
| **ANC Adequate** | | | |
| No | 1.00 | | |
| Yes | 0.95 | (0.92-0.98) | <0.001 |

Table 5. Adjusted hazard ratios and 95% confidence interval for variables associated with early neonatal death.

| Covariate | Model 1 (ANC) | Model 2 (Sociodemographic variables and stillbirths) | Model 3 (ANC plus sociodemographic variables) | Model 4 (ANC plus sociodemographic plus ANC elements) |
|---|---|---|---|---|
| | HR (95% CI) | | HR (95% CI) | HR (95% CI) |
| ***Antenatal care*** | | | | |
| No | 1.00 | - | 1.00 | 1.00 |
| Yes | 0.98 (0.96-0.99)* | - | 0.76 (0.72-0.82)** | 0.76 (0.71-0.81)** |
| ***Age at birth*** | | | | |
| 15-24 | | 1.00 | 1.00 | 1.00 |
| 25-34 | | 1.01 (0.92-1.10) | 1.04 (0.99-1.09) | 1.03 (0.98-1.09) |
| 35+ | | 1.03 (0.92-1.14) | 1.07 (0.99-1.14) | 1.06 (0.98-1.13) |
| ***Geopolitical region*** | | | | |
| North | | 1.00 | 1.00 | 1.00 |
| South | | 0.90 (0.84-0.99)* | 0.85(0.81-0.90)** | 0.83 (0.79-0.87)** |
| ***Place of residence*** | | | | |
| Rural | | 1.00 | 1.23(1.12-1.29)** | 1.24 (1.19-1.30)** |
| Urban | | 1.29 (1.20-1.38)** | 1.00 | 1.00 |
| ***Educational attainment*** | | | | |
| None | | 1.00 | 1.00 | 1.00 |
| Primary | | 1.01 (0.93-1.10) | 1.10(1.04-.16)** | 1.08 (1.02-1.14)* |
| Secondary | | 0.94 (0.85-1.03) | 1.09(1.03-1.16)* | 1.07 (1.00-1.13)* |
| Tertiary | | 1.13 (0.99-1.29) | 1.22(1.13-1.33)** | 1.19 (1.09-1.29)** |
| ***Religion*** | | | | |
| Christianity | | 1.00 | 1.00 | 1.00 |
| Islam | | 0.94 (0.86-1.02) | 0.82(0.78-0.86)** | 0.84 (0.79-0.88)** |
| Traditional/other | | 0.69 (0.41-1.17) | 0.87 (0.70-1.09) | 0.88 (0.71-1.09) |
| ***Parity*** | | | | |
| One | | 1.00 | 1.00 | 1.00 |
| 2-4 | | 0.92 (0.84-1.00) | 0.94(0.89-0.99)* | 0.95 (0.89-1.00) |
| 5+ | | 0.95 (0.85-1.06) | 0.96 (0.90-1.03) | 0.97 (0.90-1.04) |
| ***Number of cowives*** | | | | |
| None | | 1.00 | 1.00 | 1.00 |
| 1-3 | | 1.14 (1.07-1.23)** | 1.09(1.04-1.14)** | 1.09 (1.04-1.14)** |
| 4+ | | 1.16 (0.89-1.53) | 1.06 (0.88-1.29) | 1.06 (0.87-1.28) |
| ***Wealth index*** | | | | |
| Poor | | 1.00 | 1.00 | 1.00 |
| Middle | | 0.95 (0.87-1.04) | 1.07(1.02-1.13)* | 1.08 (1.02-1.14)* |
| Rich | | 0.91 (0.83-0.99) | 1.00(0.95-1.07) | 1.00 (0.94-1.07) |
| ***Timing of ANC*** | | | | |
| 1st trimester | | 1.00 | 1.00 | 1.00 |
| 2nd trimester | | 0.96 (0.89-1.02) | 0.98(0.94-1.03) | 0.99 (0.95-1.03) |
| 3rd trimester | | 0.96 (0.86-1.06) | 0.99(0.93-1.06) | 1.01 (.94-1.08) |
| ***Pregnancy Wanted*** | | | | |
| Then | | 1.00 | 1.00 | 1.00 |
| Later | | 1.04 (0.92-1.17) | 1.03(0.96-1.10) | 1.04 (0.97-1.11) |
| No more | | 1.05 (0.84-1.32) | 1.10(0.99-1.23) | 1.10 (0.99-1.23)* |
| ***Sex of Household head*** | | | | |
| Male | | 1.00 | 1.00 | 1.00 |
| Female | | 1.07 (0.96-1.19) | 1.06(1.00-1.13)* | 1.06 (0.99-1.12) |
| ***Place of delivery*** | | | | |
| Home | | | | 1.00 |

| | |
|---|---|
| Health facility | 1.07 (1.02-1.12)* |
| ***BP measurement*** | |
| No | 1.00 |
| Yes | 0.95 (0.88-1.03) |
| ***Urine test*** | |
| No | 1.00 |
| Yes | 0.94 (0.88-1.01) |
| ***Blood test*** | |
| No | 1.00 |
| Yes | 0.97 (0.90-1.04) |
| ***Told of complications*** | |
| No | 1.00 |
| Yes | 1.14 (1.09-1.19)** |
| ***Took iron tablets(>180ds)*** | |
| No | 1.00 |
| Yes | 1.14 (1.07-1.22)** |
| ***Took Fansidar tablets*** | |
| No | 1.00 |
| Yes | 0.94 (0.90-0.98)* |
| ***TT injections (2+ doses)*** | |
| No | 1.00 |
| Yes | 1.02 (0.97-1.06) |
| **ANC Adequate** | |
| No | 1.00 |
| Yes | 0.41 (0.30-0.56)** |

*Significant at 0.05; ** significant at 0.001

**4.5.2. Correlates of Stillbirths**

Table 6 displays the results of unadjusted analysis of the factors associated with stillbirths. These factors mirror that of early neonatal mortality except that utilization of focused ANC no longer have a significant advantage in reducing the risk of stillbirth. Factors associated with reducing the risk of stillbirth include maternal age of 25-34years (HR=0.97, 95%CI: 0.95-0.99), belonging to either Islamic (HR=0.79,95%CI: 0.78-0.81) or traditional religion (HR=0.79, 95%CI: 0.79-0.98), parity of 2-4 (HR=0.97, 95%CI: 0.93-1.00), initiating ANC in the second trimester (HR=0.96, 95%CI: 0.92-0.99), having had blood pressure measured (HR=0.88, 95%CI: 0.83-0.93), having done a urine test (HR=0.89, 95%CI: 0.85-0.93), having a blood test performed (HR=0.89, 95%CI: 0.86-0.94) and taking Fansidar® tablets against malaria (0.96, 95%CI: 0.93-0.99). Factors found to significantly increase risk of stillbirths are: living in Northern part of Nigeria (HR=1.09, 95%CI: 1.07-1.11) as well as residing in rural area (HR=1.17, 95%CI: 1.15-1.19), having either primary level of education (HR=1.18, 95%CI: 1.15-1.22) or secondary level of education (HR=1.14, 95%CI: 1.12-1.17), having between 1-3 cowives (HR=1.04, 95%CI: 1.01-1.06), being in the middle wealth quintile (HR+1.13, 95%CI:

1.09-11.16), mistimed pregnancy (HR=1.06, 95%CI: 1.06-1.19) or unintended/unwanted pregnancy (HR=1.17, 95%CI: 1.06-1.26), living in a female-headed household (HR=1.14, 95%CI: 1.10-1.19), having complication in pregnancy (HR=1.07, 95%CI: 1.03-1.11), taking iron tablets for more than six months (HR=1.18, 95%CI: 1.09-1.27) and having at least two doses of tetanus injections (HR=1.06, 95%CI: 1.03-1.09).

However, after adjusting for the potential confounders, the adjusted Model (Model 4) in Table 7 show that at focused ANC utilization(HR=0.72, 95%CI: 0.67-0.77), living in Southern part of Nigeria (HR=0.82, 95%CI: 0.77-0.87), belonging to Islamic religion (HR=0.87, 95%CI: 0.82-0.92), being of parity 2-4 (HR=0.94, 95%CI: 0.88-0.99), taking Fansidar tablets (HR=0.93, 95%CI: 0.89-0.97) and receiving all the six elements of focused ANC (HR=0.20, 95%CI: 0.14-0.27) are all significantly protective against stillbirths. It is to be noted from Table 7, that utilization of focused ANC alone (that is Model 1) does not have any significant influence of stillbirth in contrast to what was obtained with early neonatal mortality in Table 5. Factors conferring disadvantage on the hazard of stillbirths are rural residence (HR=1.25, 95%CI: 1.19-1.32), having any formal education (primary [HR=1.10, 95%CI: 1.03-1.16]; secondary [HR=1.07, 95%CI: 1.00-1.14] and tertiary [HR=1.20, 95%CI: 1.10-1.31]), having 1-3 cowives (HR=1.08, 95%CI: 1.04-1.13), living in a female-headed household (HR=1.08, 95%CI: 1.01-1.15), having had complications in pregnancy (HR=1.15, 95%CI: 1.10-1.21), taking iron tablets (HR=1.23, 95%CI: 1.14-1.33). In contrast what has been obtained in Table 5, where focused ANC is an independent determinant of early neonatal survival this effect of focused ANC on stillbirth is not obtainable (HR=0.99, 95%CI: 0.96-1.01).

Overall, these models (Models 2, 3 and 4) suggest that the common factors associated with decreased risk of stillbirths are utilization of focused ANC, residing in Southern part of Nigeria and having parity between two and four. While the common factors increasing hazard of stillbirth are having primary education and 1-3 cowives.

Table 6. Unadjusted hazard ratios and 95% confidence interval for variables associated with stillbirths, Nigeria DHS 2013.

| Covariate | Unadjusted hazard ratios, 95% CI and p values | | |
|---|---|---|---|
| | HR | (95% CI) | P values |
| ***Antenatal care*** | | | |
| Yes | 0.98 | (0.96-1.00) | 0.065 |
| No | 1.00 | | |
| ***Maternal age*** | | | |
| 15-24 | 1.00 | - | |
| 25-34 | 0.97 | (0.95-0.99) | 0.031 |
| 35+ | 1.02 | (0.99-1.05) | 0.100 |
| ***Geopolitical region*** | | | |
| North | 1.09 | (1.07-1.11) | <0.001 |
| South | 1.00 | - | |
| ***Place of residence*** | | | |
| Rural | 1.17 | (1.15-1.19) | <0.001 |
| Urban | 1.00 | - | |
| ***Educational attainment*** | | | |
| None | 1.00 | - | |
| Primary | 1.18 | (1.15-1.22) | <0.001 |
| Secondary | 1.14 | (1.12-1.17) | <0.001 |
| Tertiary | 1.14 | (1.10-1.19) | <0.001 |
| ***Religion*** | | | |
| Christianity | 1.00 | - | |
| Islam | 0.79 | (0.78-0.81) | <0.001 |
| Traditional/other | 0.88 | (0.79-0.98) | 0.024 |
| ***Parity*** | | | |
| One | 1.00 | - | |
| 2-4 | 0.97 | (0.93-1.00) | 0.052 |
| 5+ | 1.03 | (0.99-1.07) | 0.057 |
| ***Number of cowives*** | | | |
| None | 1.00 | - | |
| 1-3 | 1.04 | (1.01-1.06) | 0.004 |
| 4+ | 1.12 | (0.98-1.29) | 0.087 |
| ***Wealth index*** | | | |
| Poor | 1.00 | 1.00 | <0.001 |
| Middle | 1.13 | (1.09-1.16) | 0.982 |
| Rich | 1.00 | (0.97-1.03) | |
| ***Timing of ANC*** | | | |
| 1st trimester | 1.00 | - | |
| 2nd trimester | 0.96 | (0.92-0.99) | 0.024 |
| 3rd trimester | 0.95 | (0.89-1.01) | 0.111 |
| ***Pregnancy Wanted*** | | | |
| Then | 1.00 | - | |
| Later | 1.12 | (1.06-1.19) | <0.001 |
| No more | 1.17 | (1.06-1.26) | 0.002 |
| ***Sex of Household head*** | | | |
| Male | 1.00 | - | |
| Female | 1.14 | (1.10-1.19) | <0.001 |
| ***BP measurement*** | | | |

| | | | |
|---|---|---|---|
| No | 1.00 | - | |
| Yes | 0.88 | (0.83-0.93) | <0.001 |
| ***Urine test*** | | | |
| No | 1.00 | - | |
| Yes | 0.89 | (0.85-0.93) | <0.001 |
| ***Blood test*** | | | |
| No | 1.00 | - | |
| Yes | 0.89 | (0.86-0.94) | <0.001 |
| ***Had complications*** | | | |
| No | 1.00 | - | |
| Yes | 1.07 | (1.03-1.11) | <0.001 |
| ***Took iron tablets(>180days)*** | | | |
| No | 1.00 | - | |
| Yes | 1.18 | (1.09-1.27) | <0.001 |
| ***Took Fansidar tablets*** | | | |
| No | 1.00 | - | |
| Yes | 0.96 | (0.93-0.99) | 0.020 |
| ***TT injections (2+ doses)*** | | | |
| No | 1.00 | - | |
| Yes | 1.06 | (1.03-1.09) | <0.001 |
| **ANC Adequate** | | | |
| No | 1.00 | | |
| Yes | 1.04 | (1.02-1.06) | <0.001 |

Table 7. Adjusted hazard ratios and 95% confidence interval for variables associated with stillbirths, Nigeria DHS 2013.

| Covariate | Model 1 (ANC) | Model 2 (Sociodemographic variables and stillbirths) | Model 3 (ANC plus sociodemographic variables) | Model 4 (ANC plus sociodemographic plus ANC elements) |
|---|---|---|---|---|
| | HR (95% CI) | | HR (95% CI) | HR (95% CI) |
| ***Antenatal care*** | | | | |
| No | 1.00 | - | 1.00 | 1.00 |
| Yes | 0.99 (0.96-1.01) | - | 0.76 (0.71-0.81)** | 0.72 (0.67-0.77)** |
| ***Age at birth*** | | | | |
| 15-24 | | 1.00 | 1.00 | 1.00 |
| 25-34 | | 1.15 (1.12-1.86)** | 1.05 (0.99-1.11) | 1.04 (0.99-1.14) |
| 35+ | | 1.62 (1.56-1.68)** | 1.08 (1.00-1.16)* | 1.06 (0.98-1.14) |
| ***Geopolitical region*** | | | | |
| North | | 1.00 | 1.00 | 1.00 |
| South | | 0.96 (0.93-0.99)* | 0.85 (0.80-0.90)** | 0.82 (0.77-0.87)** |
| ***Place of residence*** | | | | |
| Urban | | 1.00 | 1.00 | 1.00 |
| Rural | | 1.03 (1.00-1.05) | 1.25 (1.19-1.31) | 1.25 (1.19-1.32)** |
| ***Educational attainment*** | | | | |
| None | | 1.00 | 1.00 | 1.00 |
| Primary | | 1.05 (1.01-1.08)* | 1.10 (1.04-1.16)* | 1.10 (1.03-1.16)* |
| Secondary | | 1.01 (0.98-1.05) | 1.09 (1.02-1.15)* | 1.07 (1.00-1.14)* |
| Tertiary | | 0.98 (0.93-1.03) | 1.23 (1.13-1.34)** | 1.20 (1.10-1.31)** |
| ***Religion*** | | | | |
| Christianity | | 1.00 | 1.00 | 1.00 |
| Islam | | 1.00 (0.97-1.03) | 0.83 (0.79-0.88)** | 0.87 (0.82-0.92)** |
| Traditional/other | | 1.31 (1.14-1.49)** | 0.86 (0.66-1.14) | 0.83 (0.59-1.16) |
| ***Parity*** | | | | |
| One | | 1.00 | 1.00 | 1.00 |
| 2-4 | | 0.38 (0.37-0.39)** | 0.94 (0.89-0.99)* | 0.94 (0.88-0.99)* |
| 5+ | | 0.32 (0.30-0.33)** | 0.95 (0.89-1.02) | 0.95 (0.88-1.03) |
| ***Number of cowives*** | | | | |
| None | | 1.00 | 1.00 | 1.00 |
| 1-3 | | 1.04 (1.01-1.06)* | 1.09 (1.04-1.13)** | 1.08 (1.04-1.13)** |
| 4+ | | 0.97 (0.85-1.09) | 1.05 (0.86-1.28) | 1.02 (0.83-1.26) |
| ***Wealth index*** | | | | |
| Poor | | 1.00 | 1.00 | 1.00 |
| Middle | | 1.05 (1.02-1.08)* | 1.08 (1.02-1.14)* | 1.05 (0.97-1.13) |
| Rich | | 1.07 (1.02-1.10)** | 1.02 (0.96-1.08) | 1.11 (0.98-1.27) |
| ***Timing of ANC*** | | | | |
| 1$^{st}$ trimester | | 1.00 | 1.00 | 1.00 |
| 2$^{nd}$ trimester | | 0.98 (0.96-1.01) | 0.99 (0.94-1.03) | 1.01 (0.96-1.06) |
| 3$^{rd}$ trimester | | 0.91 (0.88-0.95)** | 0.98 (0.91-1.04) | 1.02 (0.95-1.10) |
| ***Pregnancy Wanted*** | | | | |
| Then | | 1.00 | 1.00 | 1.00 |
| Later | | 0.85 (0.82-0.88)** | 1.04 (0.96-1.12) | 1.05 (0.97-1.13) |
| No more | | 1.07 (0.96-1.20) | 1.09 (0.96-1.23) | 1.11 (0.98-1.27) |
| ***Sex of Household head*** | | | | |
| Male | | 1.00 | 1.00 | 1.00 |
| Female | | 1.03 (1.00-1.07) | 1.07 (1.00-1.07)* | 1.08 (1.01-1.15)* |
| ***Place of delivery*** | | | | |
| Health facility | | | | 1.00 |

| | |
|---|---|
| Home | 1.07 (1.02-1.13)* |
| ***BP measurement*** | |
| No | 1.00 |
| Yes | 0.94 (0.86-1.02) |
| ***Urine test*** | |
| No | 1.00 |
| Yes | 0.95 (0.87-1.03) |
| ***Blood test*** | |
| No | 1.00 |
| Yes | 0.96 (0.89-1.04) |
| ***Told of complications*** | 1.00 |
| No | 1.15 (1.10-1.21)** |
| Yes | |
| ***Took iron tablets(>180ds)*** | 1.00 |
| No | 1.23 (1.14-1.33)** |
| Yes | |
| ***Took Fansidar tablets*** | 1.00 |
| No | 0.93 (0.89-0.97)** |
| Yes | |
| ***TT injections (2+ doses)*** | 1.00 |
| No | 1.02 (0.97-1.07) |
| Yes | |
| **ANC Adequacy** | 1.00 |
| No | 0.20 (0.14-0.27)** |
| Yes | |

*Significant at 0.05; ** significant at 0.001

## 4.6. Correlates of Perinatal Mortality Rate

Perinatal mortality is a composite index of the sum of fetus dying from seven months (or 22weeks) of pregnancy and death of live birth within six days of life. In the unadjusted model (Table 8) several factors have been found to predict the occurrence of perinatal mortality. As shown in Table 8, those that reduce the risk of perinatal mortality include use of ANC (at least one visit) with a hazard ratio of 0.90 (95%CI: 0.88-0.91); residing in southern geopolitical of the country (HR=0.97, 95%CI: 0.95-0.99); having formal education: primary (HR=0.96, 95%CI: 0.94-0.98), secondary and more level of education (HR=0.88, 95%CI: 0.86-0.90); parity 1-3 (HR=0.95, 95%CI: 0.90-1.00); being in the middle or rich wealth quintile (HR=0.93, 95%CI: 0.87-0.92); home delivery (HR=0.90, 95%CI: 0.87-0.92); blood pressure measured (HR=0.79, 95%CI: 0.75-0.83); having had a urine test done (HR=0.78, 95%CI: 0.75-0.80); having done a blood test (HR=0.80,95%CI: 0.77-0.83); taking Fansidar tablets (0.92, 95%CI: 0.90-0.94) and having two or more doses of tetanus injections (HR=0.92, 95%CI: 0.90-0.94). Maternal age above 35years (HR=1.06, 95%CI: 1.03-1.09); rural residence (HR= 1.32,95%CI: 1.29-1.35); parity five or more (HR=1.10, 95%CI: 1.05-1.16); one or more cowives (HR=1.17, 95%CI: 1.15-1.19); parity five or more (HR=1.10, 95%CI: 1.05-1.16); having female as the head of the household (HR=1.07, 95%CI: 1.04-1.10), having complications during pregnancy (HR=1.05, 95%CI: 1.02-1.08), taking iron tablets for more than six months (HR=1.16, 95%CI: 1.08-1.24) and having all the components of focused ANC (HR=1.04, 95%CI: 1.03-1.06) all increase the hazard rate of perinatal mortality.

Table 9 show the adjusted models, of particular importance is Model 4 which controls for all other background factors. This model show that ANC utilization (HR=0.69, 95%CI: 0.65-0.73); living in Southern geopolitical zone of the country (HR=0.87, 95%CI: 0.84-0.89); being in middle (HR=0.94, 95%CI: 0.90-0.98) or rich wealth quintile (HR=0.87, 95%CI: 0.83-0.92), having done urine test (HR=0.86, 95%CI: 0.81-0.91) and receiving all the six elements of focused ANC (HR=0.18,95%CI: 0.13-0.25) all significantly reduce the hazard of perinatal death. The models in Table 9 (Models 2,3 and 4), they suggests that living in the Southern part of Nigeria and having parity between 2 and 4 protects against perinatal death and conversely living in rural Nigeria with 1-3 cowives increases prospects of perinatal mortality. Summary of models in Tables 5, 7 and 9 show that focused ANC is more potent in reducing the hazard of early neonatal death and perinatal death than it has on stillbirths.

Kaplan-Meier survival estimates of perinatal mortality by some selected background factors were plotted and presented in Appendix A. Figure A1 show the baseline survivorship estimates for perinatal mortality. The survivorship estimates rapidly decline from births to around 48hours of life which also coincides with the period of highest perinatal death (around 61% of all early neonatal deaths occurred within 48hours as shown in Figure 1). Figure A2 is the perinatal survivorship with receipt of focused ANC. Figure A3 plots the survivorship disaggregated by place of residence (rural/urban) and it clearly indicate the urban advantage in perinatal survival: the plot of urban survivorship (the blues line) is consistently above that of rural survivorship (the maroon line). Figure A4 is that of perinatal survivorship by geopolitical zone. As already obtained from hazard ratios, the South geopolitical zone has better perinatal survivorship compared to North geopolitical zone and this is also corroborated by this plot where the blue plot (South geopolitical zone) is above the maroon (North geopolitical zone) indicating better survival chance. Figures A5 and A6 refer to perinatal survival estimates by maternal educational attainment; Figure A6 provides a better graphical representation of the influence of maternal education on perinatal mortality. In Figure A6 only two categories of maternal education are used (formal/none) while in Figure A5 three categories are used: none; primary and secondary and above and this difference in categorization has brought out differences. Figure A7 show the survivorship by maternal age.

Table 8. Unadjusted hazard ratios and 95% confidence interval for variables associated with perinatal deaths, Nigeria DHS 2013.

| Covariate | Unadjusted hazard ratios, 95% CI and p values | | |
|---|---|---|---|
| | HR | (95% CI) | P values |
| ***Antenatal care*** | | | |
| No | 1.00 | - | |
| Yes | 0.90 | (0.88-0.91) | <0.001 |
| ***Maternal age*** | | | |
| 15-24 | 1.00 | - | |
| 25-34 | 1.01 | (0.98-1.05) | 0.400 |
| 35+ | 1.06 | (1.03-1.09) | 0.001 |
| ***Geopolitical region*** | | | |
| North | 1.00 | - | |
| South | 0.97 | (0.95-0.99) | 0.002 |
| ***Place of residence*** | | | |
| Urban | 1.00 | - | |
| Rural | 1.32 | (1.29-1.35) | <0.001 |
| ***Educational attainment*** | | | |
| None | 1.00 | - | |
| Primary | 0.96 | (0.94-0.98) | <0.001 |
| Secondary+ | 0.88 | (0.86-0.90) | <0.001 |
| ***Religion*** | | | |
| Christianity | 1.00 | - | |
| Islam | 0.98 | (0.96-1.00) | 0.067 |
| Traditional/other | 1.12 | (1.01-1.25) | 0.030 |
| ***Parity*** | | | |
| One | 1.00 | - | |
| 2-4 | 0.95 | (0.90-1.00) | <0.001 |
| 5+ | 1.10 | (1.05-1.16) | <0.001 |
| ***Number of cowives*** | | | |
| None | 1.00 | - | |
| 1-3 | 1.17 | (1.15-1.19) | <0.001 |
| 4+ | 1.18 | (1.02-1.36) | 0.022 |
| ***Wealth index*** | | | |
| Poor | 1.00 | - | |
| Middle | 0.90 | (0.87-0.92) | <0.001 |
| Rich | 0.80 | (0.78-0.81) | <0.001 |
| ***Timing of ANC*** | | | |
| 1$^{st}$ trimester | 1.00 | - | |
| 2$^{nd}$ trimester | 0.93 | (0.90-0.96) | <0.001 |
| 3$^{rd}$ trimester | 0.93 | (0.88-0.98) | 0.004 |
| ***Pregnancy Wanted*** | | | |
| Then | 1.00 | - | |
| Later | 1.03 | (0.98-1.09) | 0.227 |
| No more | 1.05 | (0.96-1.13) | 0.285 |
| ***Sex of Household head*** | | | |
| Male | 1.00 | - | |
| Female | 1.07 | (1.04-1.10) | <0.001 |
| ***Place of delivery*** | | | |
| Health facility | 1.00 | - | |

| | | | |
|---|---|---|---|
| Home | 0.90 | (0.87-0.92) | <0.001 |
| ***BP measurement*** | | | |
| No | 1.00 | - | |
| Yes | 0.79 | (0.75-0.83) | <0.001 |
| ***Urine test*** | | | |
| No | 1.00 | - | |
| Yes | 0.78 | (0.75-0.80) | <0.001 |
| ***Blood test*** | | | |
| No | 1.00 | - | |
| Yes | 0.80 | (0.77-0.83) | <0.001 |
| ***Had complications*** | | | |
| No | 1.00 | - | |
| Yes | 1.05 | (1.02-1.08) | 0.003 |
| ***Took iron tablets(>180days)*** | | | |
| No | 1.00 | - | <0.001 |
| Yes | 1.16 | (1.08-1.24) | |
| ***Took Fansidar tablets*** | | | |
| No | 1.00 | - | |
| Yes | 0.92 | (0.90-0.94) | <0.001 |
| ***TT injections (2+ doses)*** | | | |
| No | 1.00 | - | |
| Yes | 0.92 | (0.90-0.94) | <0.001 |
| **ANC Adequacy** | | | |
| No | 1.00 | | |
| Yes | 1.04 | (1.03-1.06) | <0.001 |

Table 9. Adjusted hazard ratios and 95% confidence interval for variables associated with perinatal mortality, Nigeria DHS 2013.

| Covariate | Model 1 (ANC) | Model 2 (Sociodemographic variables and perinatal mortality) | Model 3 (ANC plus sociodemographic variables) | Model 4 (ANC plus sociodemographic plus ANC elements) |
|---|---|---|---|---|
| | HR (95% CI) | HR (95% CI) | HR (95% CI) | HR (95% CI) |
| ***Antenatal care*** | | | | |
| No | 1.00 | - | 1.00 | 1.00 |
| Yes | 0.90 (0.88-91)** | - | 0.72 (0.68-0.76) | 0.69 (0.65-0.73)** |
| ***Age at birth*** | | | | |
| 15-24 | | 1.00 | 1.00 | 1.00 |
| 25-34 | | 1.02 (0.93-1.11) | 1.00 (0.95-1.06) | 1.01 (0.95-1.07) |
| 35+ | | 1.04 (0.93-1.16) | 1.00 (0.94-1.06) | 1.01 (0.94-1.08) |
| ***Geopolitical region*** | | | | |
| North | | 1.00 | 1.00 | 1.00 |
| South | | 0.96 (0.93-0.99)* | 0.90 (0.88-0.93)** | 0.87 (0.84-0.89)** |
| ***Place of residence*** | | | | |
| Urban | | 1.00 | 1.00 | 1.00 |
| Rural | | 1.03 (1.00-1.06)* | 1.28 (1.25-1.31)** | 1.32 (1.27-1.38)** |
| ***Educational attainment*** | | | | |
| None | | 1.00 | 1.00 | 1.00 |
| Primary | | 1.05 (1.01-1.09)* | 0.99 (0.95-1.03) | 0.99 (0.94-1.03) |
| Secondary+ | | 1.01 (0.98-1.05) | 0.98 (0.93-1.03) | 0.98 (0.93-1.03) |
| ***Religion*** | | | | |
| Christianity | | 1.00 | 1.00 | 1.00 |
| Islam | | 1.00 (0.97-1.03) | 0.92 (0.88-0.96)** | 0.96 (0.92-1.01) |
| Traditional/other | | 1.27 (1.11-1.47)** | 0.83 (0.64-1.08) | 0.74 (0.56-0.99)* |
| ***Parity*** | | | | |
| One | | 1.00 | 1.00 | 1.00 |
| 2-4 | | 0.38 (0.37-0.39)** | 0.91 (0.84-0.99)* | 0.91 (0.83-0.99)* |
| 5+ | | 0.32 (0.30-0.33)** | 0.97 (0.89-1.06) | 0.95 (0.87-1.05) |
| ***Number of cowives*** | | | | |
| None | | 1.00 | 1.00 | 1.00 |
| 1-3 | | 1.04 (1.01-1.07)* | 1.20 (1.16-1.24)** | 1.21 (1.17-1.26)** |
| 4+ | | 0.92 (0.80-1.05) | 1.13 (0.98-1.29) | 1.07 (0.93-1.23) |
| ***Wealth index*** | | | | |
| Poor | | 1.00 | 1.00 | 1.00 |
| Middle | | 1.05 (1.02-1.08)* | 0.94 (0.90-0.98)* | 0.94 (0.90-0.98)* |
| Rich | | 1.06 (1.03-1.10) | 0.91 (0.87-0.95)** | 0.87 (0.83-0.92)** |
| ***Timing of ANC*** | | | | |
| 1$^{st}$ trimester | | 1.00 | 1.00 | 1.00 |
| 2$^{nd}$ trimester | | 0.99 (0.96-1.01) | 0.96 (0.93-1.00)* | 0.98 (0.94-1.02) |
| 3$^{rd}$ trimester | | 0.91 (0.87-0.94)** | 0.94 (0.89-0.99)* | 0.96 (0.91-1.02) |
| ***Pregnancy Wanted*** | | | | |
| Then | | 1.00 | 1.00 | 1.00 |
| Later | | 0.85 (0.82-0.88)** | 1.01 (0.95-1.08) | 1.02 (0.96-1.09) |
| No more | | 1.08 (0.96-1.23) | 1.04 (0.95-1.14) | 1.07 (0.98-1.17) |
| ***Sex of Household head*** | | | | |
| Male | | 1.00 | 1.00 | 1.00 |
| Female | | 1.03 (0.99-1.07) | 1.07 (1.04-1.09)** | 1.05 (1.02-1.09)* |
| ***Place of delivery*** | | | | |
| Health facility | | | | 1.00 |
| Home | | | | 1.02 (0.99-1.06) |

| | |
|---|---|
| ***BP measurement*** | |
| No | 1.00 |
| Yes | 0.95 (0.89-1.02) |
| ***Urine test*** | |
| No | 1.00 |
| Yes | 0.86 (0.81-0.91)** |
| ***Blood test*** | |
| No | 1.00 |
| Yes | 0.98 (0.93-1.04) |
| ***Told of complications*** | |
| No | 1.00 |
| Yes | 1.20 (1.16-1.25)** |
| ***Took iron tablets(>180ds)*** | |
| No | 1.00 |
| Yes | 1.24 (1.15-1.34)** |
| ***Took Fansidar tablets*** | |
| No | 1.00 |
| Yes | 1.00 (0.96-1.04) |
| ***TT injections (2+ doses)*** | |
| No | 1.00 |
| Yes | 1.02 (0.99-1.06) |
| **ANC Adequate** | |
| No | 1.00 |
| Yes | 0.18 (0.13-0.25)** |

*Significant at 0.05; ** significant at 0.001

# Chapter 5

## 5.1. Discussion

The recent estimates of global child mortality indicates that there has been substantial progress in reduction of child mortality from 12.6 million in 1990 to around 6.6 million in 2012. Of these deaths 44% are happening within the first 28 days of life and further 75% of these deaths taking place within the first six days of life (early neonatal death) (You et al.,2013). This translates to around 33% of all the child mortality occurring within the first six days of life while the remaining 67% spread in the remaining 1774 days. This statistics is staggering and it shows that any effort directed at reducing child mortality must address early neonatal mortality because of its huge contribution to child mortality; addressing early neonatal mortality is critical success factor in the overall reduction of child mortality.

The aim of this study is to assess the role of ANC in relation to perinatal mortality and at the end be able to offer some policy considerations and future research directions. Overall, this study has found that utilization of focused ANC has the potential to significantly reduce the risk of perinatal mortality by factors of between 24% and 31%; 24% reduction for early neonatal death and 28% for stillbirths. This study also found that utilizing all the six elements of focused ANC reduces the hazard of perinatal mortality by around 82%. Similar rate reduction in neonatal mortality of about 30% among women who had skilled ANC has been reported by McCurdy (McCurdy et al., 2011). Similarly, Emmanuel (2011) in a case-control study involving eleven district hospitals in Mashonaland East Province of Zimbabwe reported that women who had ANC had around 62% risk reduction of perinatal mortality compared to those never had ANC services.

The overall perinatal mortality rate for Nigeria in the period 2008-2013 is 41 per 1000 births (early neonatal death rate of 29 per 1000 births and stillbirth rate of 12 per 1000 births), indicating a reduction of around 46% from the 2003 figure of 76 per 1000 births (Ahman and Zupan, 2007). When compared to earlier estimates of 86 per 1000 births, it shows a reduction of over 52% (WHO 2006). With early neonatal mortality rate of 27 per 1000, Nigeria still remains among the 25 countries with early neonatal mortality rate of more than 20 per 1000 births and hence a significant contributor of child mortality worldwide (Wang, 2014).This study, further, showed that there are several factors associated with perinatal mortality after adjusting for background factors; these are discussed below.

This study did not find any association between maternal age and perinatal mortality; this is an unexpected finding as one expects to see perinatal mortality being more at the very young and very old (Mostafa et al., 2011). For women at very young age it could be due to physical immaturity, lack of experience of pregnancy, poor nutritional status and proneness to pregnancy and child birth complications such as malaria in pregnancy, infection of the urinary track and pre-eclampsia and eclampsia leading to stillbirths and early neonatal deaths (Agarwal et al. 1998; Di Mario et al., 2007).Yakasai in Aminu Kano Teaching Hospital, Kano, in Northern Nigeria has reported that perinatal survival is poorest among women with severe eclampsia (Yakasai and Gaya 2011); eclampsia is more prevalent and severest among young women having pregnancy for the first time. As for the very old women, the plausible explanation could be that because of their experience in child and pregnancy, they do not use ANC and prefer to deliver unattended at home (Astolfi et al., 2005; Canterino et al., 2004). But also more importantly, it could be because of their high parity which is inherently a risk factor for perinatal mortality that make them high risk for perinatal mortality (Abu-Heija and Chalabi., 1997).

However, this study show that residing in Southern part of the country confers some significant advantage on perinatal survival compared to living in the North and expectedly perinatal mortality rate is slightly higher in the North than in the South (Table 3). This could be expected as the North has characteristically poor health infrastructure resulting in poor health indices such as maternal mortality ratio, skilled ANC coverage, skilled delivery assistance and institutional delivery rate (NPC 2014).

Another significant finding in line with the existing literature is the urban-rural differential in perinatal mortality rate. Living in rural areas increased the hazard rate of perinatal death by about 32%. Rural location is associated with various disadvantages of life such poor educational attainment, poor wealth status, poor access to health facilities either because of their distance (physical accessibility) or because they require financial capacity to utilize the best available services or because the health facilities are inadequately maintained in terms skilled staff and necessary equipment. All these constraints culminate to produce poor health outcomes among the people in rural areas. Therefore, use of maternal and health services in rural areas are similarly constrained by these factors manifesting in poor maternal and child health outcomes. The negative association between place of residence (rural or urban) and risk perinatal mortality is also same when the outcome is early neonatal death (HR=1.24, 95%CI: 1.19-1.30) or stillbirth (HR=1.25, 95%CI: 1.19-1.32). Feresu (2005) reported that risk of stillbirth is increased by a hazard of 33%, but the study by Feresu is hospital-based study with tendency for selection bias (more sicker pregnant women are disproportionately attended to as a result of referral from other lower-level facilities compared with when it is population-based). This type of study certainly inflates the rates derived.

This study also show that educational attainment of the women does not have any role in determining birth outcome as well as survival within the first six days of life. A similar result was reported by Titaley (2011) where educational attainment is not factor in influencing early neonatal death. The role of maternal education on positive maternal and child health outcomes has long being studied by researchers; education increases mother's knowledge about child health and child health care practices, ability to make decision on her own, more likely to negotiate with her partner in seeking health care and more likely spend resources (money) on child care since she may be on salary employment. All these gives her the leverage to have better maternal and child health outcomes (Caldwell 1979; Ware 1984; Mellington and Cameron 1999 and Basu and Stephenson 2005). However, maternal education could also serve to be a double-edged knife; her employment keeps her away from ANC and from her children that can adversely affect the survival of the children (Simkhada 2008). This is perhaps may be the operational pathway in this study as shown in Tables 6 and 7 where we see increasing maternal educational attainment being associated with increasing risk of stillbirths and early neonatal deaths, though not statistically significant.

The study found that newborns of birth order 2-4 are less likely to die within the perinatal period. This could likely be due to experience in pregnancy, delivery and child care by women and that this number of children is manageable enough not to put strain on the woman when it comes to child care practices. The larger the number of children in the households the more the likely that household resources are depleted which can lead to child care neglect and poor use of ANC and other child health care services. Related to women parity is the number of cowives in the household; being in household with between one and three other wives significantly increases the risk of perinatal mortality by about 21%. This relationship might be as a result of household resources that has to be shared among the other wives; and therefore this effect becomes more pronounced in low wealth quintile households.

Wealth index of the household is an important protector against perinatal mortality. Perinatal mortality is significantly reduced by being in the middle or rich wealth quintile by factors of about 6% and 13% respectively. This result is not surprising in the Nigerian context where access to health care services is inequitably distributed in terms of financial ability of individuals and geographical accessibility of health facilities (Kabir et al., 2005). Wealth has been documented as a strong determinant for the use maternal health care services including antenatal care services (Ononokpono et al., 2013; Hazarika et al., 2011and Abor et al., 2011) and those in the rich quintile tend to use health services more than those in poor quintile. Additionally, those in the rich quintile are more likely to reside in urban areas where health services and other infrastructure are more available and are also affordable to them; they are more likely to be more educated and have a good salary employment. All these advantages that make the rich better off in terms health indices which is also applicable in this study.

The result of this analysis further indicates that the risk of perinatal mortality increases when the head of the household is female in contrast to when the head is male. This increased risk might be due to some reasons: firstly, being female and the head of the household means either never married, separated, widowed or divorced which deprives her of transferring/sharing responsibility to or with her partner/husband and little or no support from her spouse/partner. She might not have adequate resources to purchase adequate health care services and she might not be working with no steady stream of income. About 35% of females who are heads of households are not employed at the time of the survey (NPC 2014). These factors put strain on household resources and the consequent inability to access medical services.

During antenatal visits, pregnant women were given health advices as well as some tests to screen them from diseases or conditions that jeopardizes their health and that of the unborn fetus. Some of these tests are blood test for malaria, HIV/AIDS and anaemia; and urine test for protein whose presence indicates elevated risk for eclampsia and it also reveals urinary tract infection and diabetes of pregnancy. Apart from undertaking some laboratory tests during ANC, pregnant women receive some preventive medical interventions to improve their survival chances. Such interventions among others include blood pressure screening to detect high blood pressure, tetanus injections (at least two doses during the current pregnancy), iron and folic acid tablets supplementation to prevent and correct anaemia of pregnancy and anti-malaria drug (Fansidar tablets) at least two doses during the pregnancy as well as sleeping under insecticide treated bed net (bed nets are distributed free to those women attending ANC). This study show that those women who had urine test are less likely to experience perinatal mortality by around 24%. The utility of urine test in this situation means that those women with positive test are treated adequately and promptly so as not to experience adversely pregnancy outcomes such as stillbirth, maternal mortality and early neonatal death. And this is a confirmation that ANC is effective in reducing perinatal mortality, in some way. Expectedly from this result is the fact that those women who were informed of having a pregnancy complication had an increased risk of perinatal mortality (HR=1.20, 95%CI: 1.16-1.25).

Consumption of iron tablets supplements for more than six months increases the risk of not only perinatal mortality by 24% (HR=1.24, 95%CI: 1.15-1.34) but also the risk of stillbirth by 23% (HR=1.23, 95%CI: 1.14-1.33). However, for early neonatal death taking iron supplements for at least than six months has a protective role by reducing the chance of early neonatal death by 14%. Iron or a combination of iron and folic acid (IFA) supplements during pregnancy has been demonstrated to protect against newborn death (Titaley et al., 2009). It is known that anaemia in pregnancy leads to restricted fetal growth that can result in preterm delivery or low birth weight. Therefore, failure of iron supplementation to protect against perinatal mortality as indicated by this study possibly means that those women that took iron supplements for at least six months are already diagnosed to suffer from anaemia from the outset, hence the ineffectiveness of the iron supplementation in protecting newborn death since the damage to the fetus has already being done; conversely those who did not take iron supplements may indicate good level of blood and therefore no need to take the supplements. This bi-directional nature of explanation of the finding may likely be due to the nature of the data used here, cross-sectional and the limitations associated with it are expounded below. The European review of the effectiveness of antenatal care documents that iron/folic acid supplementation before pregnancy and up to 12weeks in pregnancy is effective in preventing neural tube defects in fetuses (Di Mario et al., 2005); it is not certain at this stage if iron supplements has a protective role in perinatal mortality (either early neonatal mortality or stillbirth). Furthermore, in a review of evidence of the impact of packaged interventions on neonatal mortality by Haws (Haws et al., 2007) indicates that iron supplementation during pregnancy does not seem to have any impact on newborn survival. The result of the current analysis with respect to effectiveness of iron supplementation in perinatal mortality is at variance to that documented by McCurdy et al (2011) where they reported a risk reduction of about 17% (aOR=0.83,95%CI: 0.749-0.919) in neonatal mortality in those mothers who had iron/folic acid supplementation. However, these researchers used multivariate logistic regression rather than Cox proportional hazard model to test their hypothesis as is the case in this investigation. To support my finding from previous research, Singh (2013) concluded that IFA supplementation “did not influence neonatal mortality” in rural North India. It is clear from the 2013 Nigeria DHS that information on folic acid supplementation during pregnancy was not captured and therefore the role of iron and folic acid (IFA) combination could not be established.

This study further documents that other preventive interventions in pregnancy are not associated with positive perinatal outcome. For instance, both blood pressure measurement, blood test, use of Fansidar against malaria in pregnancy and having two doses of tetanus injections in the current pregnancy do not lead to better perinatal survival. However, use of Fansidar to prevent malaria is associated with 7% reduction in hazard rate of stillbirth (HR=0.93, 95%CI: 0.89-0.97) and 6% for early neonatal death (HR=0.96, 95%CI: 0.90-0.98). Malaria is an important cause of stillbirth and child death especially in endemic countries. Malaria causes stillbirths directly through the parasitization of the placenta thereby blocking the supply of blood and oxygen to fetus or indirectly by causing some complications that adversely affects the survival of the fetus such as maternal anaemia and low birth weight; these leads to growth restriction. Because of the adverse effects of malaria in pregnancy, prevention of malaria using at least two doses of Fansidar has become part of the standard of care in antennal care services. The result derived here of the effect of Fansidar on stillbirth is therefore an expected finding further confirming the positive impact of ANC on perinatal survival.

Tetanus is still a cause of child death in developing countries despite its elimination in Europe in the 1950s before the discovery of tetanus toxoid vaccine. Tetanus is currently responsible for about 70,000 neonatal deaths in Africa indicating a failure of the health system to deliver the vaccine to pregnant mother as well as lack of hygienic delivery care practices such as cutting of cord and its care (Lawn 2006; WHO 2001).To address neonatal death due to neonatal tetanus, every pregnant woman is required to receive at least two does of tetanus toxoid (TT) injection during pregnancy. This study reveal that women who had at least two doses of TT injection have increased risk of perinatal mortality rate by 2%, however this is not statistically significant; similar non-statistically significant increase is associated with early neonatal mortality and stillbirth. The lack of positive impact of TT injection on perinatal mortality could be due to short reporting period of the study (that is six days). Tetanus has at least seven days of incubation period before it manifest itself; and therefore newborn death from tetanus most likely occur outside the critical period of six days after delivery. Because of this time-reference bias, most newborn deaths due to tetanus are captured as post-neonatal deaths (deaths between 7 and 28days of days of life) rather than early neonatal deaths. This proposal is confirmed by the study of Singh (2012) and Singh (2013) whom reported that at least two doses of tetanus toxoid injection in the current pregnancy is associated with significant risk reduction of neonatal mortality by 45% and 27% respectively. Singh (2012) further reported that lack of at least two doses of tetanus toxoid injection could be responsible for at least 6% of neonatal deaths in India.

## 5.2. Policy implication

The results of this analysis corroborates WHO's recommendation and other research output making a case for the implementation of focused antenatal care as a means to overall improvement of maternal and child health in developing countries (WHO 2001). This implies that governments and non-governmental organizations working in the field of maternal and child health have empirical evidence to promote the implementation of this strategy in the overall framework of MDG 4 and 5 and beyond as the world pushes towards sustainable development after 2015. It also provides evidence for the role of ANC in preventing child mortality (and maternal mortality) within the broad population policy of Nigeria as it throttles towards achieving MDG 4 and 5 and beyond.

In the context of Nigeria's heath systems, this finding suggests that government at all levels (Federal, State and Local) should invest more in the provision of antenatal care services based on this new model to make it more accessible and of the desired quality mindful of the fact that perinatal mortality is measure of the quality of obstetrics services offered at around labour and delivery (Das Gupta 2003). This model (focused ANC) is demonstrated here to have the potential to reduce the risk of perinatal deaths by approximately 31% translating to around 82,770 perinatal deaths annually by simple extrapolation (Nigeria recorded 267,000 perinatal deaths in 2012 [UNICEF 2013]).

While the analysis show the positive impact of focused ANC in reducing perinatal mortality (and by extension child mortality since around 33% of under-five deaths occurs within the early neonatal period), it also indirectly indicates the potential roles of background factors related to the use of focused ANC. The perinatal mortality differentials with regards to rural-urban residence, North-South dichotomy, household wealth index and sex of household head are sources of concern to policy-makers and they all indicate major areas where governments and NGOs should direct their resources in addressing the use of ANC. It is clear that rural areas in Nigeria suffer from lack of adequately equipped and staffed health facilities and it is also true that the Northern part of the country has a relative disadvantage in this regard also. Therefore, addressing ANC service utilization will be more effective when resources are allocated to those areas with relative disadvantage: the North and rural areas. So also women empowerment, empowering them to make best decision on health care utilization as well as poverty reduction programs to reduce the gap in ANC use between the rich and the poor. Addressing these major challenges can be best done within the overall socio-economic development programme aimed at addressing basic developmental needs of basic schooling (particularly female education) and economic empowerment and poverty reduction.

## 5.3 Further Research Implications

While this study has established the empirical role of focused ANC in reducing risk of perinatal and therefore corroborating the results of the WHO's trial of the new model, it also provides potential areas for future research. Translating research into practice requires series of operations research in order to fine-tune the smooth transition from what is obtained currently to the desired new level of service provision and performance. However, before embarking on operations research it is important to enrich the evidence by further evaluating the role of focused ANC using higher and more rigorous study design such as application of multilevel analysis. It has earlier been pointed out that one of the limitations of this investigation is ignoring the role of contextual factors such as neighborhood and community characteristics as they determine use of ANC and its impact on perinatal mortality. It will also be a worthwhile future research direction to address the issue of endogeneity (unobserved individual characteristics) in the use of focused ANC in relation to perinatal mortality by applying instrumental variable estimation (Lambon-Quayefio and Owoo, 2014). Using a cross-sectional data as utilized here, propensity score matching will be able quantify the reduction of perinatal deaths attributable to focused ANC. This may obviate the need to conduct a randomized control trial to assess impact of this new model of ANC (Babalola and Kinkaid, 2009).

As regard operations research, certain research questions would need to be answered empirically. These research questions will include assessing the capacity of the health system to implement the new model of ANC. That is, does the health infrastructure capable of the new additional load? Secondly, policy-makers and health managers would want to know if there is the need for any reorganization within the health system. Reorganization in terms of staffing (and staff mix) and equipping the existing health facilities or perhaps do new health facilities need to be established. Staffing will involve the need or otherwise to train or re-train the current pool of staff in order to provide full range of services. Thirdly, there is the need to assess the perception of clients on the new model; are they satisfied with the quality of the services they received or do they prefer the previous old model where they make at least 12 ANC visits and receive very specific services based on their needs as judged by the health professional? Fourthly, Ekele (2003) has raised the issue of cultural acceptability with the new model and it is pertinent that implementing this model as a matter of national policy undergoes rigorous quality assessment exercise involving both the providers and the clients.

Finally, a carefully planned and well-conducted pilot-testing the model will have to be undertaken to answer questions of different cultural and health systems settings that will arise in the Nigerian cultural settings. The new model underwent randomized control trial in Argentina, Thailand, Saudi Arabia and Cuba (Villar et al., 2011). These countries are culturally and health system wise different from Nigeria and other in sub-Saharan Africa. Therefore, a multi-country analysis involving countries from sub-Saharan Africa will suffice to address these issues of varying culture and health systems.

## 5.4. Conclusion

The results of this study has demonstrated the continued public health challenge posed by perinatal mortality in Nigeria; with a perinatal mortality rate of 41 deaths per 1000 births, Nigeria remains a major source of both perinatal and early neonatal deaths (Wang et al., 2014). The results also show that focused ANC has the potential to reduce the risk of perinatal mortality. Focused ANC reduces the risk of early neonatal death by about 26% and stillbirth by about 28%. These risk reductions are more amplified when a pregnant woman receive all the six components of focused ANC tested here. A pregnant women who received two doses of tetanus toxoid vaccination, had blood pressure measured and monitored, had urine and blood tests done, took iron tablets supplements as well as two doses of Fansidar against malaria had 82% reduction in chance of having perinatal mortality. The study further highlights the significance of sociodemographic factors in association with perinatal mortality. For instance, residing in Southern part of Nigeria, being of parity between two and four, being in the middle and/or rich wealth quintile are all associated with reduced risk of perinatal mortality. However, other factors have been found to negatively affect perinatal mortality such as living in rural areas of Nigeria, living with between one and three cowives, having a complication during the pregnancy, living in a female-headed household and taking iron tablets supplements for at least six months increased the likelihood of perinatal mortality.

Finally, the result obtained have the utility of being used as basis for evidence-based programming and policy-making for the promotion of focused ANC in Nigeria as a strategy for reducing maternal and child mortality as well as investing in areas shown to negatively affect perinatal mortality like making maternal health services more accessible in rural areas. The study also highlights areas for future research such as conducting multi-country analysis to determine validity of mortality-reducing effect of focused ANC across different cultures and health systems in Nigeria in particular and in sub-Saharan Africa in general.

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## Appendices. Perinatal survival plots by selected factors

Figure A1. Baseline survivorship function for perinatal mortality, 2013 Nigeria DHS

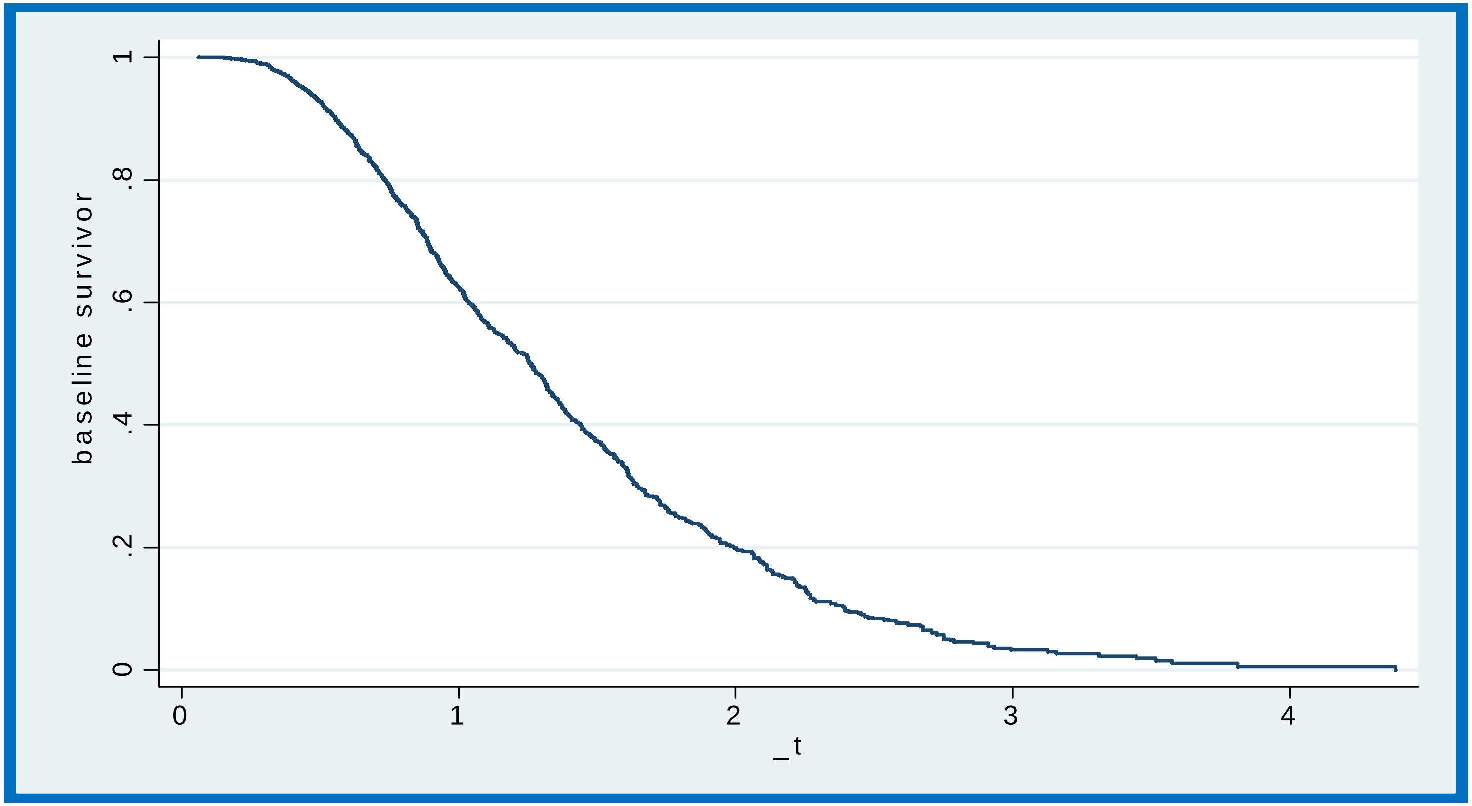


Figure A2. Kaplan-Meier survival estimates by focused ANC, 2013 Nigeria DHS

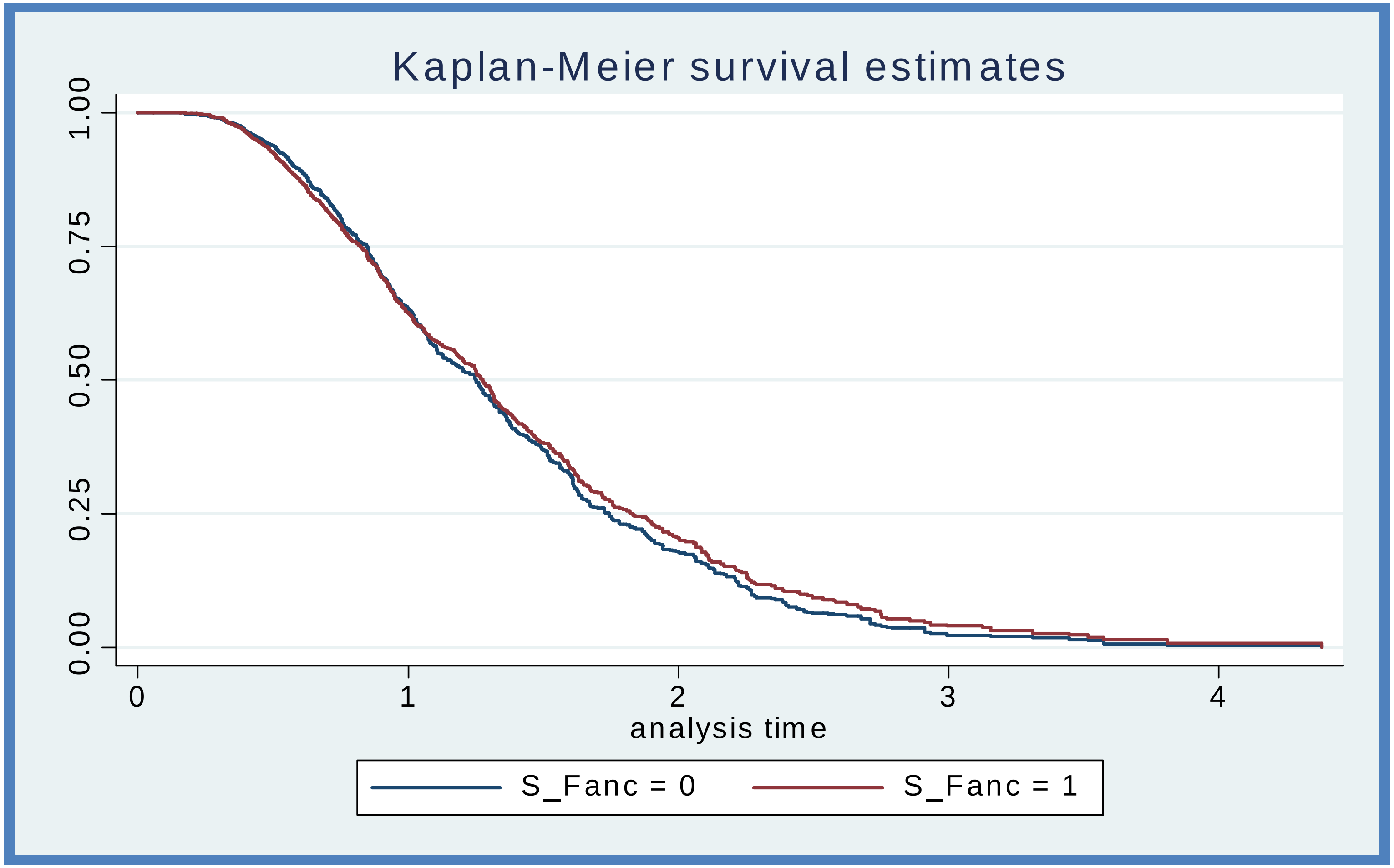


Figure A3. Kaplan-Meier perinatal survival estimates by place of residence, Nigeria DHS 2013.

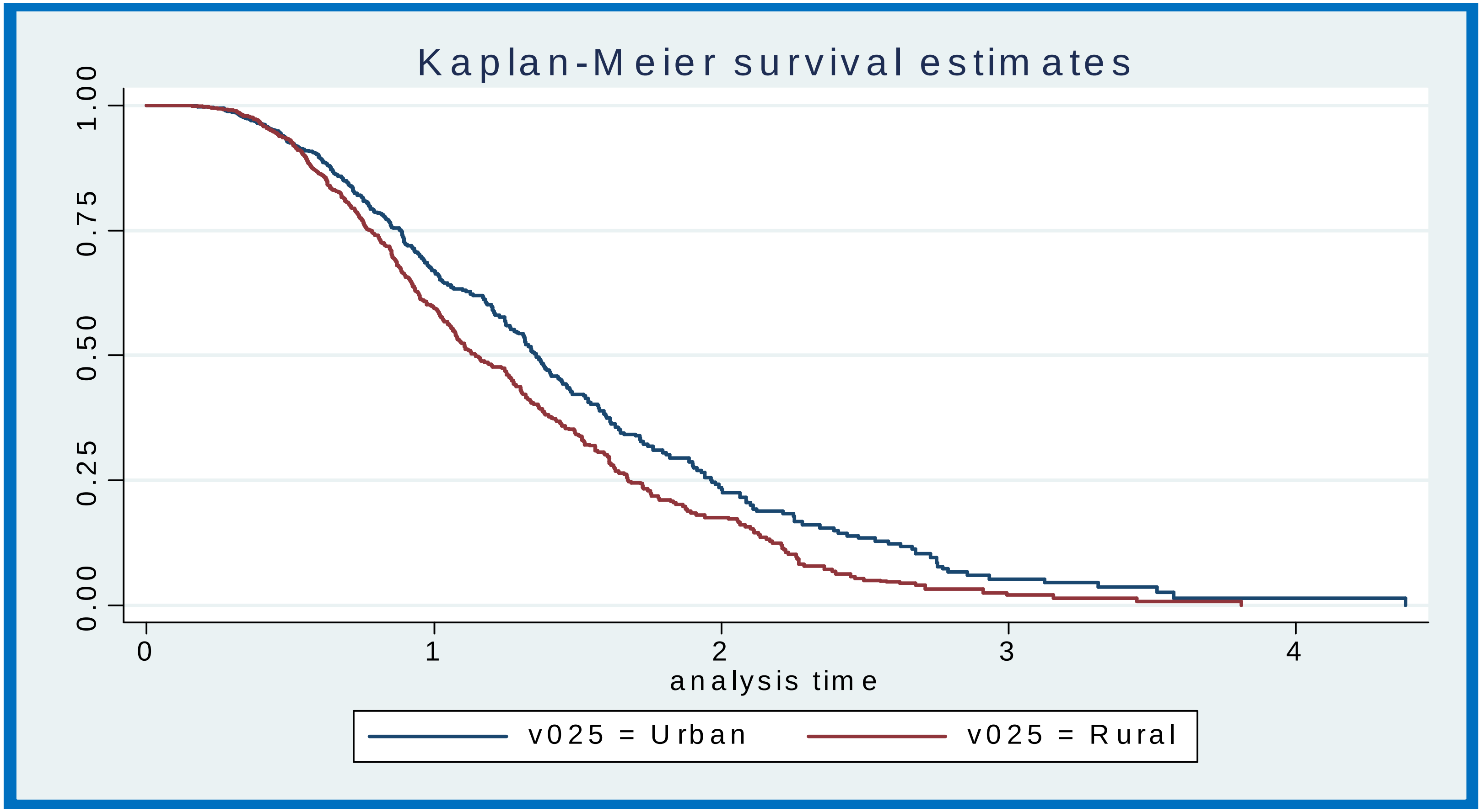


Figure A4. Kaplan-Meier perinatal survival estimates by geopolitical zone, Nigeria DHS 2013.

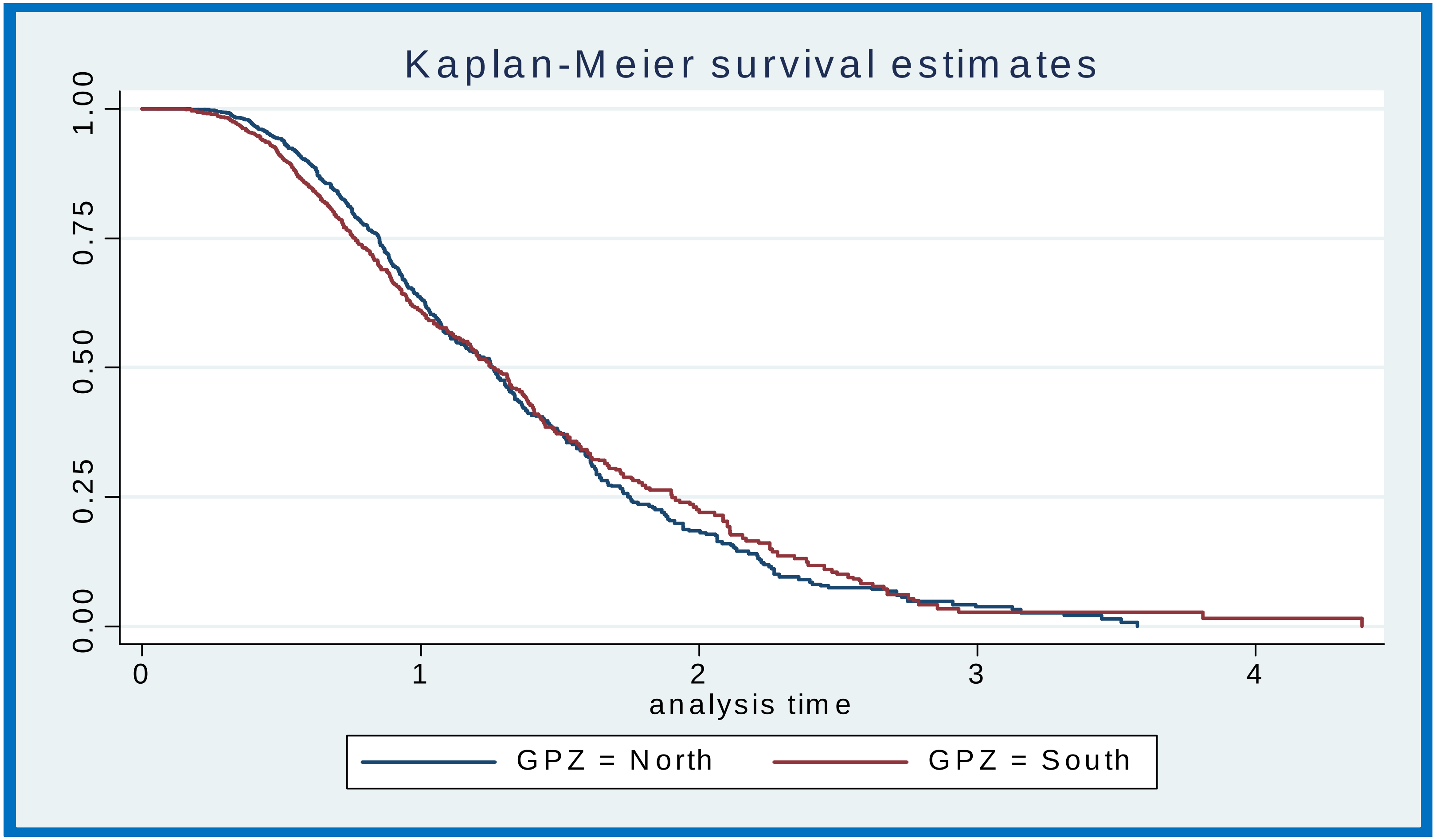


Figure A5. Kaplan-Meier perinatal survival estimates by maternal level of education, Nigeria DHS 2013.

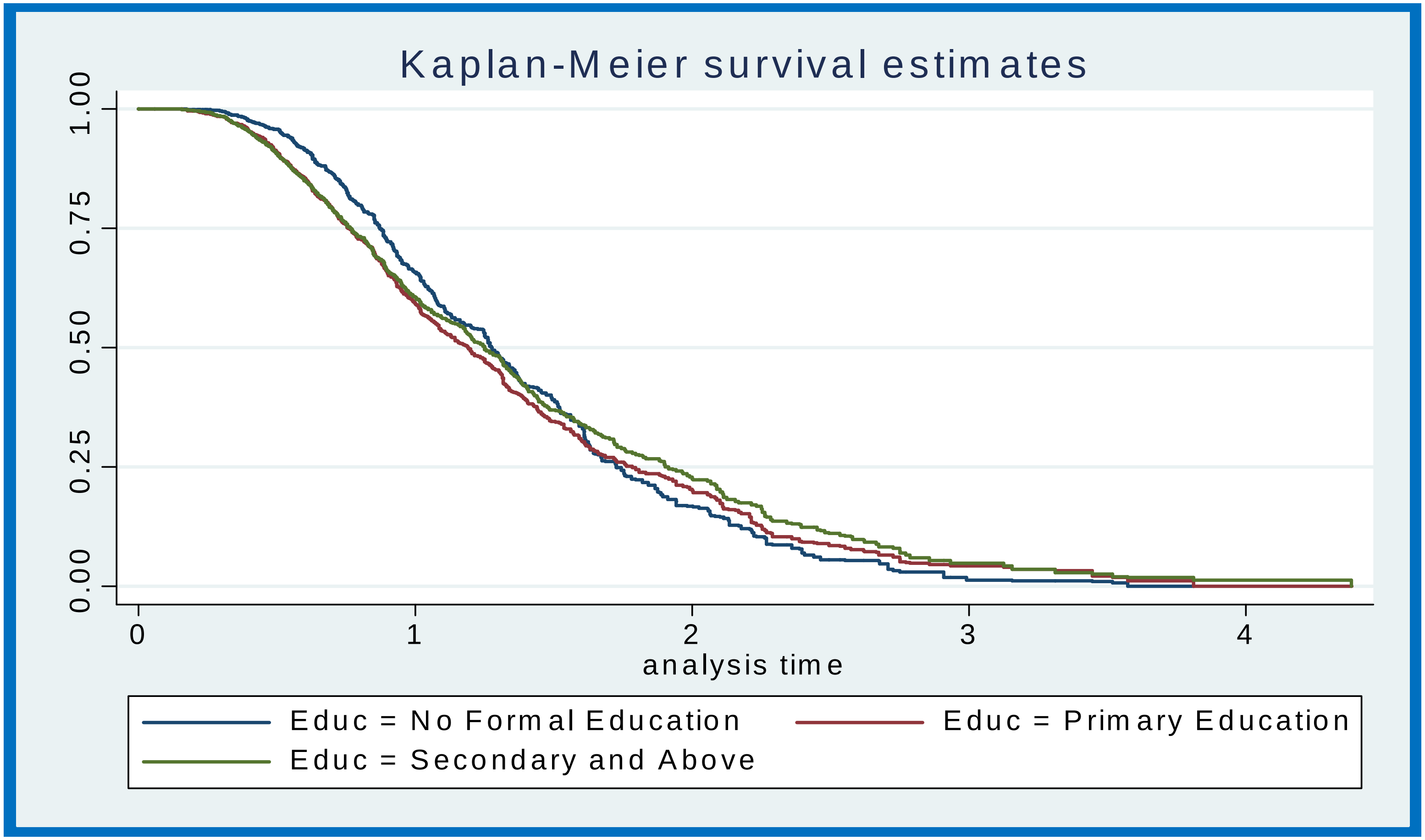


Figure A6. Kaplan-Meier perinatal survival estimates by maternal level of education (Formal/None), Nigeria DHS 2013

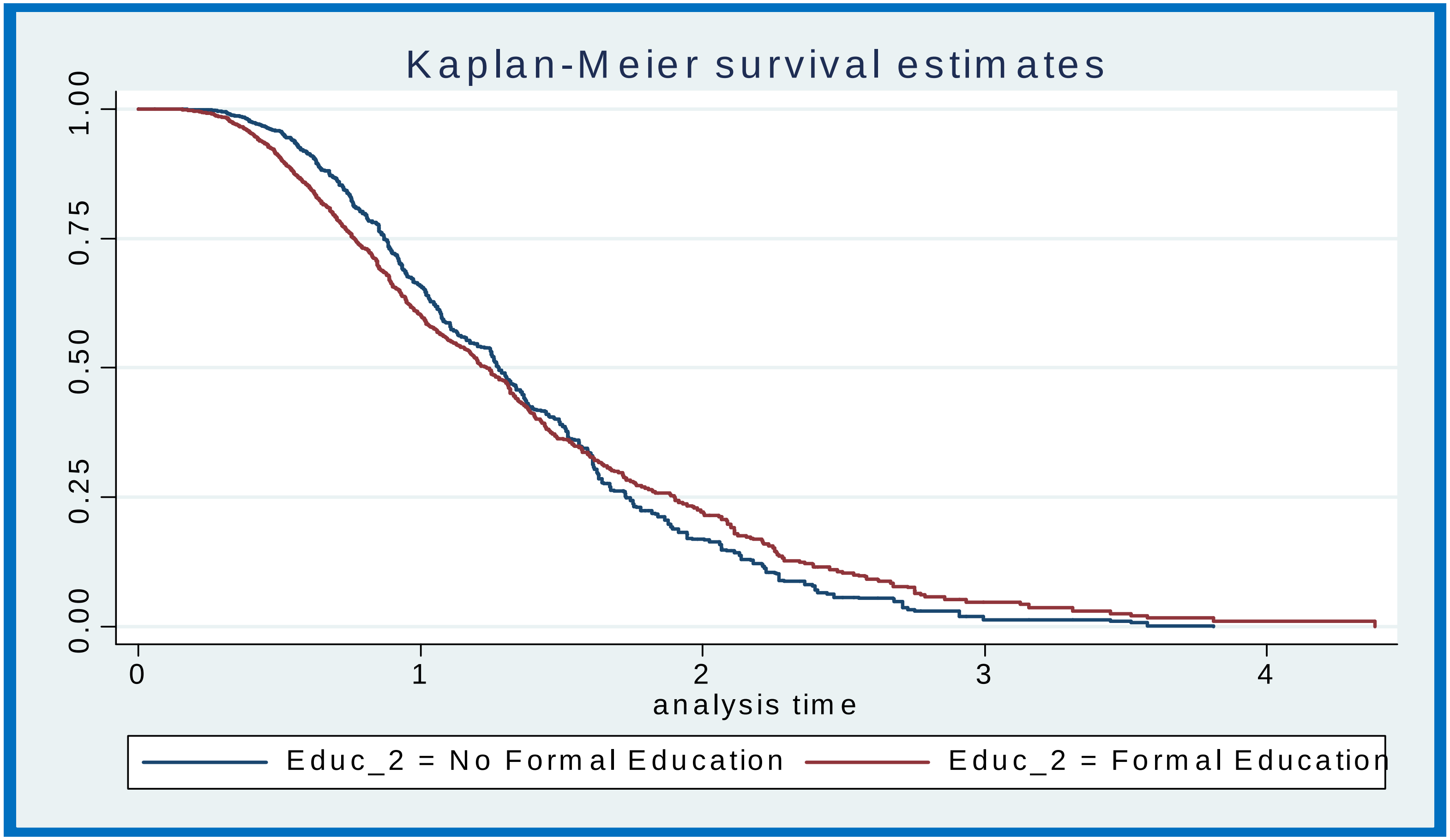
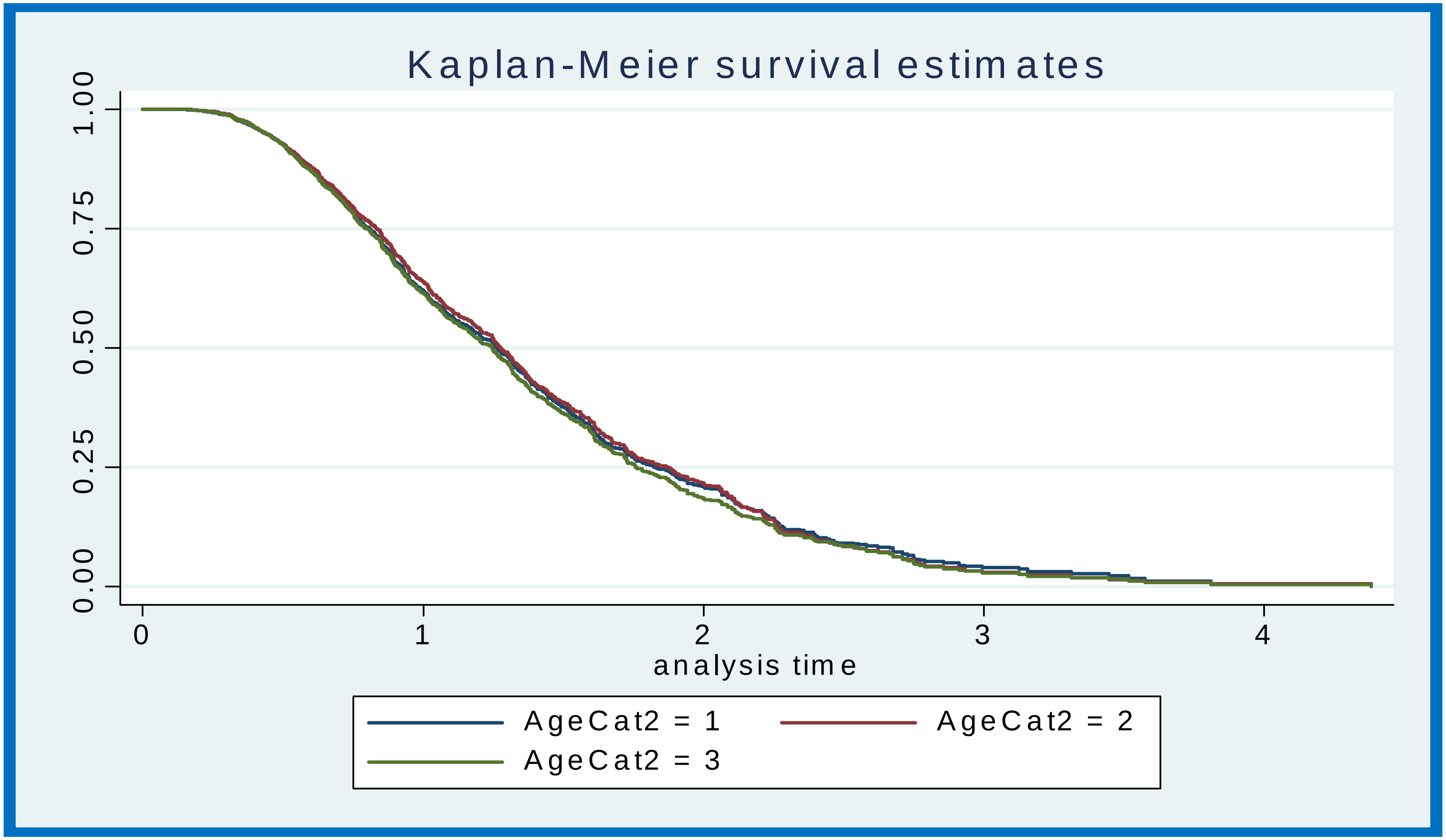



Figure A7. Kaplan-Meier perinatal survival estimates by maternal age, Nigeria DHS 2013¶.




¶(15-24=1; 25-34=2 and 35and above=3