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The Nigerian Newborn Beyond 2015: Investigating the Impact of Community Context on Neonatal Mortality

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Abstract

The Nigerian Newborn Beyond 2015: Investigating the Impact of Community Context on Neonatal Mortality.
By Elizabeth I. Olorundare

Background: With approximately a quarter million newborn deaths per year, Nigeria's neonatal mortality represents the highest in sub-Saharan Africa and the second highest in the world, significantly contributing to the country's inability to achieve the United Nations 2015 target for reduction in under-five mortality. To improve chances of survival for Nigerian newborns beyond 2015, focused efforts and large-scale implementation of evidence-based interventions is required. Furthermore, identification of individual and broader contextual level factors that drive neonatal mortality in Nigeria is essential.

Objective: To investigate the influence of different domains of contextual factors on neonatal mortality in Nigeria using a recent nationally representative survey and examine the impact of individual-level determinants.

Methods: A modified conceptual framework for child survival highlighted possible factors associated with neonatal mortality. Data were drawn from the 2013 Nigeria Demographic and Health Survey (NDHS), representing 31,482 live-born infants born to women aged 15 – 49 years within the five years prior to the survey. Multivariable logistic regression models were fitted to analyze factors associated with neonatal deaths during this period using community, socio-economic status, and proximate determinants.

Results: The neonatal mortality rate (NMR) was 37 per 1000 live births, with over 80% of these deaths occurring within the first week of life. Bivariate analysis showed high community utilization of facility-based delivery, increased levels of female decision-making autonomy, older maternal age at marriage and at first childbirth, higher levels of parental educational attainment, higher household wealth status, and infant's receipt of postnatal care were associated with reduced odds of neonatal death. After adjusting for all levels of variables, the odds of death were higher for infants born into communities demonstrating higher justification of violence against women (OR 1.23; 95% CI 1.09 – 1.39) and having higher mean parity (OR 1.21; 95% CI 1.05 – 1.40). Neonatal mortality was also significantly associated with maternal illiteracy (OR 1.39; 95% CI 1.05 – 1.83), first-born infants (OR 1.76; 95% CI 1.35 – 2.31), higher rank infants with a short birth interval (OR 1.64; 95% CI 1.27 – 2.12), smaller than average-sized infants (OR 1.68; 95% CI 1.36 – 2.07), multiple gestations (OR 5.07; 95% CI 3.77 – 6.81), and male babies (OR 1.33; 95% CI 1.14 – 1.55).

Discussion: This study has provided evidence that individual, household and community factors significantly influence neonatal mortality in Nigeria. Further, it shows that norms surrounding women's fertility, autonomy, and worth have a marked impact on neonatal survival. These findings show that public health interventions targeting neonatal mortality may not achieve desired level of effectiveness unless they are coupled with community-based interventions aimed at addressing perceptions of women's worth and need for self-determination.

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Acronyms and Abbreviations

ANC	Antenatal Care
CHERG	Child Health Epidemiology Reference Group
DHS	Demographic Health Survey
EA	(Census) Enumeration Area
HIV	Human Immunodeficiency Virus
LBW	Low Birth Weight
LMIC	Low and Middle Income Countries
MDG(s)	Millennium Development Goal(s)
NDHS	Nigeria Demographic and Health Survey
NMR	Neonatal Mortality Rate
PCA	Principal Component Analysis
PNC	Postnatal Care
PSU	Primary Sampling Unit
UNICEF	United Nations Children's Fund
VIF	Variance Inflation Factor
WHO	World Health Organization

CHAPTER 1: INTRODUCTION

1.1 Background and Rationale

1.1.1 Neonatal Mortality: A Global Public Health Challenge

According to the United Nations Convention on the Rights of the Child, every child born into the world has a basic right to enjoy the highest attainable standard of health (1). To this end, the concerted efforts of global partners such as the World Health Organization (WHO) and United Nations Children's Fund (UNICEF) have been targeted at achieving this goal for all children over the past few decades. A prominent example of such is the global commitment made to reduce under-five mortality by two-thirds between 1990 and 2015, as enshrined in the 4th of the United Nations' Millennium Development Goals (MDGs) (2). Initiatives arising from this have resulted in substantial improvements being recorded in child health, including a significant reduction in mortality among children below the age of 5 years (3). However, the world still loses over 6 million children annually before their 5th birthday, and of these, over 3 million children do not survive past their first 28 days of life (4). Child deaths within this critical first month are referred to as neonatal mortality, and now pose an increasingly significant global public health problem.

Currently the global under-five mortality rate is reducing faster than at any other time during the past two decades (3, 5); however, this is mainly due to a reduction in post-neonatal mortality, while neonatal mortality has largely gone unaddressed. Thus, the proportion of under-five deaths represented by neonatal deaths increased from 37 per cent in 1990 to 44 per cent in 2013 (3, 6). To move beyond the 2015 target of the MDGs and

achieve an end to preventable child deaths by 2035, stronger and more specific efforts must be made to reduce newborn mortality (7).

1.1.2 Neonatal Mortality: A Regional and National Public Health Challenge

Of particular relevance is the fact that while neonatal deaths represent a significant proportion of under-five deaths worldwide, wide variations exist between and within regions and countries (8). A major concern is the widening gap between high and low income countries. Currently, more than two-thirds of the world's neonatal deaths occur in low- and middle-income countries (LMICs) in sub-Saharan Africa and South Asia, and the 10 countries with the highest neonatal mortality rates (NMRs) are in these regions (4, 9). While several African countries are showing progress toward reducing neonatal mortality – with countries such as Botswana, Eritrea, and Malawi now recording NMRs approximately 25 percent less than the regional average – others are making less comparable gains.

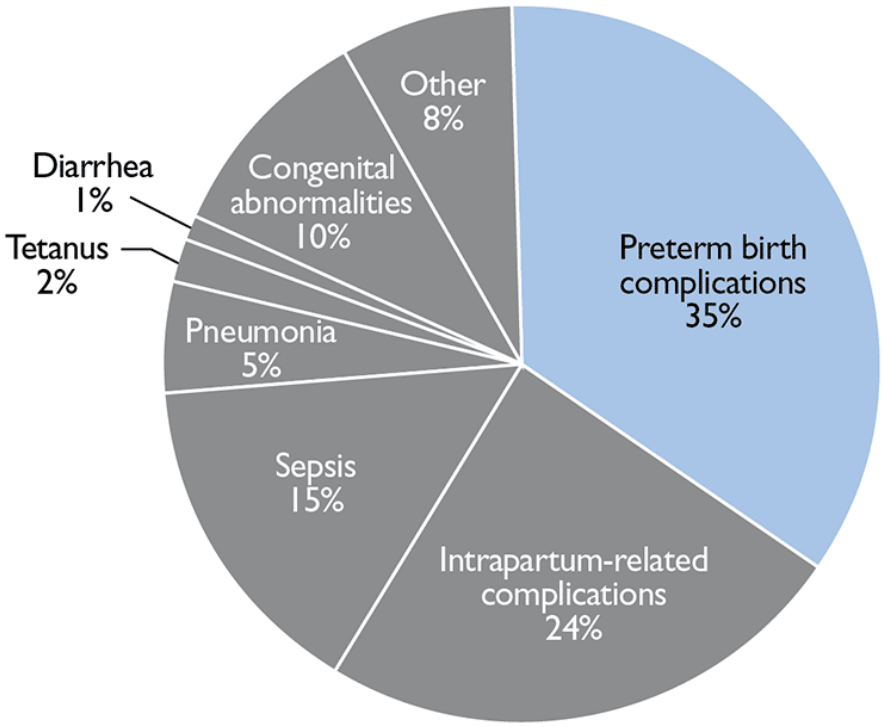
Nigeria in particular is a major driving force for the neonatal mortality trends in sub-Saharan Africa, with an NMR that is the highest in the region and 2nd highest in the world (10-12). As the most recent evidence from the country indicates only a marginal decline in NMR from 40 per 1000 live births in 2008 to 37 deaths per 1,000 live births is in 2013, it is evident that rate of neonatal deaths in Nigeria poses a significant challenge toward achievement of the child health goals of the sub-region (10, 11).

1.1.3 Neonatal Mortality: Addressing Causes and Determinants

Three direct causes of death are responsible for more than 85% of the global burden of 3.1 million neonatal deaths, namely complications of preterm birth, intrapartum–related events

(or "birth asphyxia"), and infections or sepsis (4, 13) [Figure 1]. In the high-mortality settings of sub-Saharan Africa, these three causes together account for nearly

Figure 1: Global distribution of neonatal deaths, 2013.



Note: Estimates are rounded, and therefore may not sum to 100%.

Source: WHO-CHERG provisional estimates 2014 (14).

90% of newborn deaths (15). Preterm births (births before 37 completed weeks of gestation) and low birth weight (LBW, birth weight below 2,500 g) are now the leading cause of under-five deaths globally, not just of deaths in the neonatal period (16, 17). High-

mortality countries have also have a high proportion of deaths from intrapartum-related causes and neonatal infections, such as sepsis and tetanus (4, 18).

Various studies have shown that the burden of the main causes of neonatal mortality can be significantly reduced through greater investment in the quality of maternal and newborn care during the pre-, peri-, and postnatal periods (19, 20). However a number of factors also act as underlying influences to shape the risk of newborn death from the above causes. These determinants of neonatal mortality act at the level of the individual, household, and community, and can be characterized by conceptual frameworks that describe newborn survival (12, 21).

Of prime importance is the link between maternal and neonatal health which manifests through a variety of proximate factors, such as maternal age (21-24), parity (25), nutrition (26), and birth spacing (24, 27-30), among others. Other significant proximate factors are intrinsic to the newborn, such as gender (23, 31, 32), birth rank (31-33) and type of gestation (34). Socio-economic factors which impact upon neonatal survival include parental education, occupation and wealth status (35-37); and maternal status and household structure (37-40) which influence the availability and distribution of resources available for the care of the newborn. Health system factors related to access, competence, and awareness have also been found to influence the risk of neonatal mortality (31, 41). Closely tied in with the above are cultural, structural and positional factors which relate to the demographics of the community into which the child is born (42). Such contextual factors have become the subject of attention as the world grapples with the burden of neonatal mortality.

1.1.4 Neonatal Mortality: Putting the Challenge into Context in 2015 and Beyond

There is increasing evidence that the effect of context on health outcomes is stronger than previously considered (43, 44). More attention is being directed at addressing the "social determinants of health," defined by the WHO as "the conditions in which people are born, grow, live, work and age; these circumstances are shaped by the distribution of money, power and resources at global, national, and local levels" (45). Multiple dimensions of community context, such as socio-economic status, attitudes and norms, have been shown to affect patterns of reproductive behavior (46), healthcare utilization (47), and morbidity and mortality among individuals (48).

The impact of social determinants of health are reflected in the fact that even within the high mortality LMICs, most of the burden of child morbidity and mortality is concentrated among the poorest and most disadvantaged communities (49). Inequalities in environmental health, water and sanitation facilities, and health care distribution and access, worsen the odds of survival for children and their families (50).The impact of community context has been seen in relation to risk for child stunting and malnutrition (51, 52); LBW (53); and under-five mortality (54). It has also been postulated that contextual factors may be far more influential for reduction in neonatal mortality than previously suspected (12, 50). Therefore, inadequate attention to the interplay of these multiple determinants – which are particularly evident in low-resource, high-mortality settings such as Nigeria – may be contributing significantly to the public health challenge of curtailing neonatal deaths in these areas.

1.2 Problem Statement

Global progress in reducing under-five mortality has suffered from a sub-optimal reduction in the burden of newborn deaths, which currently represent 44% of under-five mortality (16). Sub-Saharan Africa shoulders the world's highest burden of child deaths, as 1 out of every 11 children born in sub-Saharan Africa dies before the age of five years (55). This mortality rate is nearly 15 times the average rate in high-income countries (55), and reflects the wide disparities that exist globally and regionally. As the most populous country in Africa, Nigeria is critical to the region's progress towards the MDGs. However, since the year 2000, Nigeria has consistently experienced the highest neonatal mortality in sub-Saharan Africa (6). Currently, Nigeria is not on track to achieve MDG 4, and the country's death toll of about a quarter million newborn deaths per year also represents the second highest in the world (3, 6, 56, 57). To ensure greater neonatal survival in Nigeria in the post-MDG era will require more focused efforts.

There is growing evidence for available interventions that can effectively reduce the occurrence of the major causes of neonatal deaths, thereby curbing the mortality rates, even in low-resource settings (58, 59). However, for the most part, investigation into the important determinants of neonatal survival that can be targeted through these interventions has been adversely affected by the lack of focus and funding for neonatal health interventions globally, regionally, and nationally. Importantly, there have been too few studies that have explored the influence of context on neonatal mortality in sub-Saharan Africa and in Nigeria in particular (25, 31, 60). Many of the prior studies have focused on the associations between individual-level factors and neonatal mortality, with little investigation into the impact of community-level or contextual factors (30). Others have

looked at neonatal deaths in the larger context of under-five mortality, with recommendations that are not as specific to the problem of neonatal mortality (54, 61). There is therefore a pressing need for relevant research that will provide a platform to address the challenge of neonatal death in Nigeria at many inter-related levels.

1.3 Purpose of the Study

This study arose out of a recognition of the need to provide a clearer understanding of the interplay of various individual and group-level factors that influence neonatal mortality trends in Nigeria. Using population-based data, this study seeks to explore the influence of factors that operate at the level of the individual and their association with newborn deaths. This study will also focus on contextual determinants such as community socio-economic disadvantage, healthcare utilization practices, as well as gender norms and attitudes toward female autonomy and fertility as they impact upon neonatal survival.

1.4 Research Questions:

The primary research question that this study aims to answer is what are the factors associated with the high neonatal mortality in Nigeria?

In order to properly answer this question, the following were also identified:

1. Using a child survival conceptual framework, what factors should be considered as key determinants of neonatal mortality in Nigeria?
2. What are the factors that operate at the level of the individual mother-newborn dyad and their household to influence the likelihood of neonatal death?
3. Taking into account the individual- and household-level determinants, what are the important factors that exist at the level of the community that may be associated with

neonatal mortality in Nigeria? Specifically, what is the influence of the following four domains of contextual or community-level factors on neonatal mortality in Nigeria:

   a. Community socioeconomic disadvantage,
   b. Community fertility norms;
   c. Community gender norms and attitudes towards female autonomy; and
   d. Community maternal health care access and utilization?

4. What are the pathways that may be targeted in on-going and future prevention and intervention strategies for neonatal health in Nigeria, and for future research on determinants of neonatal mortality in Sub-Saharan Africa?

1.5 Significance of the Study

Acceleration of the rate of reduction in neonatal mortality in Nigeria is crucial to achieving progress for sub-Saharan Africa. With the emergence of a growing body of evidence that several factors operate at the contextual or community-level to influence the health of newborns and their mothers, there has been a call for further studies to assess the interaction between the community context and neonatal mortality with a view to spurring targeted and relevant interventions to curb the unacceptable rates seen in sub-Saharan Africa (34, 49, 62). Understanding the causes and determinants of neonatal deaths will allow for better planning and targeting of maternal, neonatal and child health (MNCH) interventions to ensure improved survival for the Nigerian newborn beyond 2015.

CHAPTER TWO: LITERATURE REVIEW

2.1 The Challenge of Neonatal Mortality

Twenty-five years on from the Convention on the Rights of the child and on the eve of the deadline set for attaining the Millennium Development Goals (MDGs), the global community has recorded several gains in child health (1). However, despite seeing a dramatic decline in preventable child deaths during this period (55), the global rate of progress is still insufficient to achieve the target of Millennium Development Goal 4 (MDG 4), which calls for reducing the under-five mortality rate by two-thirds between 1990 and 2015. This is largely because mortality in the neonatal period – that is, the first 28 days of life – is not declining as fast as deaths among children after the first month of life (55). Therefore, the world is currently faced with the reality of 3.1 million neonatal deaths annually, and greater investment in newborn survival is necessary to achieve an accelerated reduction in neonatal mortality beyond 2015 (63).

2.2 Trends in Neonatal Mortality

While neonatal deaths represent a significant proportion of under-5 deaths in all regions of the world, there are wide regional variations (55). Progress is being made in reducing the rates and numbers of neonatal deaths in every region of the world—yet this varies dramatically between regions and even within regions, and there are marked differences in progress even for neighboring countries. A major concern is that there is a widening gap between high and low income countries. Currently, more than two-thirds of the world's neonatal deaths occur in sub-Saharan Africa and South Asia, and the 10 countries with the highest NMRs are in these regions (4). While several African countries are showing

progress toward reducing neonatal mortality – with countries such as Botswana, Eritrea, and Malawi now recording NMRs approximately 25 percent less than the regional average – others are making less comparable gains (12).

2.3 Causes of Neonatal Mortality

Three direct causes of death are responsible for more than 85% of the global burden of 3.1 million neonatal deaths: complications of preterm birth, intrapartum –related events (or "birth asphyxia"), and infections or sepsis (4). As with the neonatal mortality rates themselves, the relative proportions of the causes of mortality vary both between countries and within countries. For instance, in the high-mortality settings of sub-Saharan Africa, these three causes together account for nearly 90% of newborn deaths (15).

A recent analysis shows that preterm birth complications are now the leading cause of under-5 deaths globally, not just of deaths in the neonatal period (16). Preterm birth is said to occur when babies are born before the normal 37 weeks of gestation. Low birth weight (LBW) is when the weight at birth is less than 2,500 grams (17). Individually, each of these conditions is associated with higher risks of death. However, babies who are both preterm and growth restricted have an even higher risk of death (4, 64).

Preterm babies have a 13-fold higher risk of death than full term babies (64). Specific complications of preterm birth include breathing difficulties, jaundice, feeding problems, and intracranial bleeds. LBW is associated with an increased risk of infections, low blood sugar (hypoglycemia), and low body temperature (hypothermia). LBW may occur because a baby is preterm or because s/he has suffered restricted growth during pregnancy. Such growth restriction may arise for several reasons, such as the effect of infections in pregnancy (particularly malaria and HIV); multiple pregnancy; small maternal size; poor

maternal nutrition or overwork. Babies born with LBW have approximately twice the risk of death compared to normal sized babies.

Globally, LBW contributes directly or indirectly to between 60% – 90% of neonatal deaths (30). However, rates for prematurity and for LBW vary among regions. In sub-Saharan Africa, 14% of babies are born with LBW. Babies in Africa are also at a high risk of being born preterm (regional estimate is about 12%) (4). South Asia on the other hand has a LBW rate that is almost twice that of Africa's, but the majority of these babies are term, but small for gestational age.

In high-mortality countries, such as Nigeria, about half of neonatal deaths are due to infections such as neonatal sepsis (6). Such countries also have higher proportions of deaths from intrapartum-related causes than countries with the lowest overall mortality (40).

2.4 Determinants of Neonatal Mortality

While there are specific medical causes and mechanisms that ultimately result in neonatal death, an understanding of mortality is incomplete without an identification of the underlying determinants that directly influence these risks. Conceptual frameworks have been widely utilized for characterization of determinants of health outcomes, and are also useful for implementation or evaluation of intervention strategies (41).

2.4.1 Proximate Determinants

Maternal factors: the link between maternal and neonatal health

It has been said that "prevention of the death of a mother is the single most important intervention for the health of a child"(42). Several studies have shown that mother and child outcomes are closely linked, and consequently improved maternal survival will also

enhance the survival of young children. In most societies, children are largely dependent on their mothers, and therefore maternal death usually has a catastrophic impact on the family, with those infants who survive the death of their mothers having a greater likelihood of succumbing early on to lack of appropriate childcare and nutrition (43) (44). For example, a study in Nepal found that the risk of death among infants of mothers who died during childbirth increased by as much as 52-fold between age 4 and 24 weeks (45). An earlier study in the Gambia found that for 9 mothers who died in childbirth, all of the babies died within the first year of life (46).

More directly, the link between maternal and neonatal health manifests through a variety of factors, including maternal age, education and parity, and existing maternal illness, among others. The interaction between the mother and the newborn is a complex one which pre-dates conception, as many individual factors related to the mother's biology and environment interact to influence the intrauterine experience of the neonate, as well as what will transpire in the intra- and postpartum period.

Maternal age

Extremes of maternal age are associated with increased risk of obstetric complications for both mother and newborn. Older maternal age at childbirth (above 35 years) has been found to be a risk factor for preterm delivery and/ or LBW. Older mothers are also at a higher risk of hypertensive diseases in pregnancy and gestational diabetes, which have significant impact on neonatal survival (47). Globally, about 18 million girls aged less than 20 years give birth every year (8) (48). In the developing world, West and Central Africa account for the highest burden of these adolescent pregnancies, with the Democratic Republic of

the Congo, Niger, Ethiopia, and Nigeria as the countries with the highest percentages of reported births (48).

Younger maternal age at childbirth is associated with higher risk of adverse birth outcomes for both the mother and her newborn (49)(50). These "child mothers" are not physically mature and are prone complications of labor and delivery, such as obstructed labor, which result in maternal morbidity and death, as well as neonatal mortality from birth asphyxia. Adolescents have a 2- to 5-fold higher risk of dying from pregnancy-related causes than women aged 20 – 29 years (51). As such girls often enter pregnancy with nutritional deficiencies, they are also at risk of anemia and infections, and their babies are at increased risk of preterm birth and LBW, with their attendant implications for neonatal death (51) (48). Mondal *et al.* reported neonatal mortality of the babies whose mothers aged below 20 years at the time of the child's birth nearly 10% higher than those babies whose mothers were in the age range 20-29 years (49).

To a large degree, the biologic impact of extremes of maternal age on birth outcomes is mediated through attitudes to and accessibility of health care in pregnancy. Some studies suggest that women at the extremes of age are less likely to use antenatal and delivery care, thus complicating the risks to which these groups are already prone (52) (23). However, this may be because of the confounding effect of parity – women of higher parity (who tend to be of older age) may see themselves as experienced mothers and less in need of skilled care, while many adolescents often lack the resources to obtain adequate health care on their own.

The health consequences of pregnancy for adolescent mothers and their newborns in particular are greatly influenced by the interplay of a large number of socioeconomic factors operating at the family, community and societal levels (53). Poverty, family attitudes and expectations, cultural norms and values, and government policy conspire to place girls in a position to have early pregnancy, and also interact as determinants of the health-care-seeking behavior of pregnant adolescents.

Maternal nutrition

Pre-pregnancy weight and weight gain during pregnancy are two of the strongest determinants of birth weight , and maternal under-nutrition is estimated to contribute to 800,000 neonatal deaths annually through low birth weight (38)(54).

A large body of evidence shows that deficiencies in several micronutrients have significant implications on fetal growth and subsequent perinatal and neonatal outcomes (54). For example, anemia in pregnancy (most commonly caused by Iron deficiency) is associated with fetal growth restriction and increased risk of LBW with its attendant complications (8) (42). Anemia is also a risk factor for stillbirths and perinatal death (55). Rahman *et al*. found that neonatal death was as great as 1.8 times higher among babies born to mothers who did not receive iron supplementation in pregnancy compared with those whose mothers did (56). Folate deficiency is a known risk factor for congenital abnormalities such as neural tube defects, and periconceptual folate supplementation has been shown to be associated with reduction in this risk. Calcium deficiency is increasingly being investigated as a risk factor for hypertensive diseases in pregnancy and its attendant impact on preterm birth, birth weight and intrapartum-related events (8).

Birth Interval

The inter-birth interval is also of importance in determining birth outcomes, and both closely spaced births as well long intervals between births are risk factors for neonatal morbidity and death (44) (59) (50). Research suggests that birth interval of at least 36 months is ideal and associated with the lowest neonatal and maternal mortality risks (60). Short inter-pregnancy intervals (less than 12 months) are associated with increased risks for maternal anemia, uterine rupture, and stillbirths (8). Babies of mothers with inter-pregnancy intervals shorter than 6 months are twice as likely to be born preterm, LBW or small for gestational age (SGA), compared with babies born to mothers with intervals of between 18 to 23 months (61). NMRs of as high as 49 deaths per 1,000 live births have been seen for babies born in a time frame less than 24 months after the birth of their preceding sibling; this rate drops to 30 deaths per 1,000 live births for infants born 35 months after (56). For each month that the inter-pregnancy interval is shortened from 18 months, there is 1.9% risk increase for preterm birth and a 3.3% risk increase for LBW (61).

Although the reasons for the association between a shorter birth interval and poor perinatal outcomes is unclear, it has been suggested that maternal nutritional depletion plays a role, and that a close succession of pregnancies and periods of lactation leave insufficient time for the mother to recover from the physiologic stresses of her preceding pregnancy and rebuild her nutrient stores (61) (62). Other theories link the effect of shorter birth intervals to several factors, such as socioeconomic status and inadequate use of health care services (58) (61).

Long (greater than 60 months) intervals are associated with as great as a 20% to 43% increase in risks of preterm birth and low birthweight (8) (61). Longer birth intervals may be associated with a decline in physiologic reproductive capacity ("physiological regression"), which results in the succeeding birth outcomes being similar to those of primigravid women.

Parity

High parity increases the risk of neonatal death, as has been shown by several studies. For example, a study conducted in Ghana showed that neonates delivered by women who have had 5 children or more were had a 3-fold increased likelihood of dying compared with those delivered by first time mothers (21). Aside from the biologic complications of high parity, some socio-economic associations could include poor resources to maintain adequate nutrition for a larger number of children (23). However, neonatal mortality is also much higher for nulliparous women than for subsequent births.

Antenatal care

Antenatal care coverage is an indicator of access and utilization of health care during pregnancy. It is defined by the WHO as the percentage of women who utilized antenatal care provided by skilled health personnel for reasons related to pregnancy at least once during pregnancy as a percentage of live births in a given time period. However a single antenatal visit does not give information about the components or quality of the care provided. Additional indicators such as the number of visits (at least four per pregnancy are recommended) and the timing of the first visit may be more useful. However a single antenatal visit does not give information about the components or quality of the care provided. Additional indicators such as the type of care provider, the number of visits (at

least four per pregnancy are recommended) and the timing of the first visit (recommended timing is within the first trimester of pregnancy) may be more useful.

Delivery and post-delivery factors

Maternal health care during pregnancy and professional delivery assistance are key factors in reducing maternal and neonatal mortality, because they help to identify high-risk cases and make deliveries safer. There is a strong association between utilization of antenatal, delivery and postnatal health care services and neonatal survival, as studies have shown that risk of neonatal death is reduced among infants whose mothers access care (21) (13). Studies show that women who had no antenatal care visits had a higher probability of neonatal mortality, however, as the rate of antenatal care visits increase, the risk of neonatal mortality decreases (23) (56). Regular antenatal care aids early identification of pregnancy complications, exposes the mother to essential health information important; it also increases the chances of her delivering in a health facility with the assistance of a skilled attendant (13) (23). In Burkina Faso, neonates whose mothers had an unskilled attendant at birth were twice as likely to die as those delivered by a skilled attendant (63), while neonatal death was reduced by 60% for babies born with the assistance of skilled birth attendants in Indonesia (13). Likewise, babies born at home have a higher risk of dying than those born in health facilities (22)

Although access to skilled care is important to reduce perinatal mortality, other studies have shown that babies born via cesarean section have a relatively higher risk of mortality compared with normal deliveries (64). Complications that necessitate emergency cesarean sections, as well as delays in presentation at health facilities could explain this observation.

According to the WHO definitions of postnatal care (PNC), a mother is considered to have made adequate utilization of PNC services if she and her baby were checked by qualified healthcare personnel within 42 days of child birth (65). In settings where there are shortages of skilled health workers, the WHO recommends that countries equip community health workers to carry out many of the essential tasks for basic newborn care (65, 66). This has been successfully implemented in countries such as India, Nepal, and Ethiopia. Often overlooked and under-utilized, postnatal care services also serve as an important preventive measure against poor maternal and child health outcomes.

Neonatal factors

Sex

Several studies have shown that neonatal mortality tends to be higher among males compared with female neonates (13) (49) (56) (64). This has been attributed to a physiological advantage of female infants compared with male infants, and increased risk of death in the neonatal period among males has been attributed to a higher susceptibility to infectious diseases due to relative immunodeficiency (65), as well as a higher incidence of respiratory diseases in males compared with female neonates (66).

Birth rank/order

Strong associations have been reported in the literature between birth rank and neonatal mortality (13) (62) (67). Neonatal mortality is much higher among first births (56), with some studies reporting NMRs above 55 deaths per 1,000 live births among first-borns, decreasing to 30 deaths per 1,000 live births at birth order 2–3 (56). However the risk of mortality increases again as the birth order increases beyond 4, and babies of higher order births record very high mortality (56).

There may be an interaction between birth interval and birth rank, with shorter birth interval apparently negating some of the benefit of lower birth rank. For example, studies have shown that despite 2nd and 3rd birth rank being somewhat protective from neonatal death, when such infants also have a birth interval shorter than 2 years, their risk of death approximated the risk seen in 4th born infants with a shorter birth interval (13) (64).

Multiple Gestation

Multiple gestation has been associated with an increased risk for neonatal mortality in many settings. In Burkina Faso, twin births had almost 10-fold increased likelihood of neonatal death (63). Similarly, in Ghana infants of multiple gestation were found to have a 5 times higher likelihood of dying in the first month of life (21).

2.4.2 Socioeconomic Determinants

Maternal education

Education of a child's parents, and particularly that of the mother, has been found to play an important role in both maternal and neonatal health outcomes. Babies born to mothers of lower educational level tend to suffer higher risk of mortality compared to educated mothers, as seen in Bangladesh, where 47.2% of neonatal deaths occurred to illiterate mothers, compared with 21.5% of deaths for mothers with secondary and higher education (49). A multi-country analysis of newborn survival also found that high mortality settings had female literacy rates below 50% when compared with low mortality countries (NMR 5 – 15 per 1000 live births) where female literacy rates were > 90% (41). Beginning from the level of the adolescent, educational attainment has been found to be strongly correlated with lower rates of pregnancy among teenage girls, and education has been described as a major protective factor for early pregnancy (48) (51). The longer a girl stays in school, the

less likely she is to marry young, and the more likely she is to use contraception and prevent early pregnancy, with its attendant maternal and neonatal morbidity and mortality.

There is also a strong association between a mother's education and her health-seeking behavior. Education makes a mother socially advanced and changes her pattern of behaving and attitude. Educated women are more likely to realize the benefits of using healthcare services and have increased decision-making power within the household to actually do so (57). Many studies support the finding that educated mothers are more likely to utilize health care services, particularly antenatal care and facility/ skilled delivery care (13) (49) (58). In a review of the literature related to maternal uptake of antenatal care in low-resource countries, Simkhada *et al*. found that women's education is a dominant factor in the utilization of ANC (52). Education of women may also change power relationships in the household such that women have more say in decisions which influence child survival.

Work status

While higher status occupations for children's fathers have been associated with lower child mortality, work status may present a complex situation for mothers (37). Employment may enable a mother to have a measure of economic independence and increased socioeconomic status, which in turn provides the resources to have improved opportunities for survival for herself and her children. On the other hand, a mother's outside work may result in decreased time spent caring for her children and may influence mortality (67).

Marital status and household structure

Marital status is an important influence on infant mortality. Unmarried women tend to have lower socioeconomic status than married women, and thus have a higher risk for infant

mortality. Women who are in polygamous marriages are likely to be less educated and follow traditional child-bearing practices, such as home births. Being in a polygamous union may also lend to less empowerment in the household through subordination to the other wives, in addition to the husband. Finally, being in a polygamous setting has been found to be associated with higher risk for infant and child mortality (39).

2.4.3 Contextual determinants

While a large proportion of current research focuses on the distribution of disease in populations as explained solely in terms of individual characteristics, it is becoming increasingly clear that group level factors may affect individuals directly and also influence the choices that they may. According to the WHO, these socio-contextual determinants of health are "… the conditions in which people are born, grow, live, work and age … are shaped by the distribution of money, power and resources at global, national and local levels, which are themselves influenced by policy choices. … (and) are mostly responsible for health inequities - the unfair and avoidable differences in health status seen within and between countries" (45). There are associations between community-level factors and various health outcomes, such as under-five stunting and mortality (16) (18). Likewise, There is a range of social, economic, cultural and structural factors that are known to operate through the proximate determinants to influence neonatal survival (12).

Poverty

Mothers and newborns in poor families are at increased risk of illness and face more challenges in accessing timely, high-quality care compared with wealthier families. Many studies have identified cost as a barrier to accessing healthcare for poor people in developing countries (52). For maternal and neonatal health, this is particularly true with

respect to emergency or technological procedures for delivery care, such as cesarean sections, which are often life-saving but also so costly that poorer families are left with limited options. In many cases, the time spent looking for cash can delay access to emergency life-saving care in health facilities; in other situations, the fear of anticipated cost may deter use of available services. On the other hand, women in wealthier families are able to seek out higher levels of healthcare. Higher living standards may also permit women to have better access to information available through mass media about the benefits of maternal and neonatal healthcare services (68).

Place of Residence

Place of residence impacts neonatal mortality primarily through availability of and access to health care. Additionally, regional variations in child mortality have been found across both developed and developing countries. This may be attributable to regional variation in environment; female socioeconomic status; disparities in health-seeking behavior; availability and utilization of social amenities and health care services (54). For example, studies have shown that the Northern regions of Nigeria have higher proportions of younger age at first marriage, younger age at first childbirth, home delivery; and lower knowledge and use of contraception compared to the Southern regions of the country (68). In many developing countries, there is also a disproportionate distribution of health facilities and services to the urban areas. Additionally individuals living in rural areas may not have reliable or available transportation to the existing facilities (39). Infants born to families living in rural areas have poorer access to essential services and have a higher risk of neonatal death than babies born in urban areas. However, even for individuals living in urban areas, health outcomes may vary depending on where the family lives in the area and

the environmental conditions to which they are exposed. In particular, economic status and education appear to be more powerful determinants of which urban mothers use available facilities (58).

Female autonomy

In any society, the women should demonstrate the dual roles of maintaining the community through birthing, and caring for the next generation, as well as enhancing society through their leadership and contributions to the economic and social development of villages, communities, and nations (69). However, each community is characterized by norms, attitudes and beliefs that determine how much autonomy and rights women have, and the dominant view of women in any society is a combination of value biases, cultural traditions, and gender role stereotyping (69).

In many low-resource countries, from birth, the female individual is seen as an object, property or a reproductive machine. Thus, women are persistently denied the basic human rights available to most men, resulting in them having little or no say in the course of their destinies. The results include female infanticide, unrestrained procreation, and needless morbidity and mortality at different stages in a woman's life. For example, gender norms can significantly impact girls' and women's age at marriage and childbirth, as well as her access to contraception and control of fertility. In countries with a high prevalence of child marriage and a strong preference for sons, neonatal survival is jeopardized by the attendant complications associated with young maternal age, high parity and shorter birth intervals (48).

These community-level forces are especially important in determining whether a woman can access reproductive and maternal health services to ensure that she is in optimal health

and that her newborn has the best chance at survival. This is reflected by the fact that women in settings characterized by high female autonomy are much more likely to be able to space their pregnancies or terminate childbearing through modern contraceptive methods. They are also five times more likely than women in low-resource settings to give birth with a skilled attendant. The combination of these factors lead to positive health outcomes for both mother and newborn (69). Conversely, fewer than half the pregnant adolescents in Chad, Ethiopia, Mali, Niger and Nigeria have received any antenatal care from a skilled provider, and even fewer delivered with skilled assistance, yet these countries account for some of the highest burden of neonatal mortality in sub-Saharan Africa (48).

Many studies show that higher levels of female autonomy correlate with increased chances of survival for children; this is partly mediated through higher utilization of maternal health care services (69, 70). Conversely, in many settings where husbands and in-laws make all major decisions about a woman's reproductive health – including which hospitals she goes to and where she must deliver her baby – there are high rates of neonatal mortality (48). For instance, the Nepalese woman traditionally occupies a low social status, and decisions about nutrition, healthcare utilization and newborn care practices are usually not under her control (58).

Women's autonomy and decision-making power has been shown to influence a woman's ability to seek health care for herself and her children. This is of particular consequence in sub-Saharan Africa where the traditional norms require that women have less power in their respective unions. For example, previous literature shows that a woman's bargaining

power in the household through decision-making (either solely or jointly) may influence child mortality through access to and control over resources (40).

Exploring the relationship between empowerment of women and infant and child mortality is therefore important to better understand areas with high neonatal mortality and recommend policies and practices to decrease mortality.

Female fertility

Previous studies have shown that living in communities with low mean age at marriage and low mean age at first childbirth may reduce a woman's use of contraception (71) and uptake of maternal health services (72). These may be indicative of fewer alternative opportunities (such as education or employment) available to women of child-bearing age in such communities; they may point to community expectations of early marriage and childbearing and community attitudes in favor of large numbers of children. These in turn operate through factors such as sub-optimal birth spacing, poor utilization of hospital delivery services or skilled birth attendants, which have a negative influence on newborn survival.

2.5 Conceptual Framework

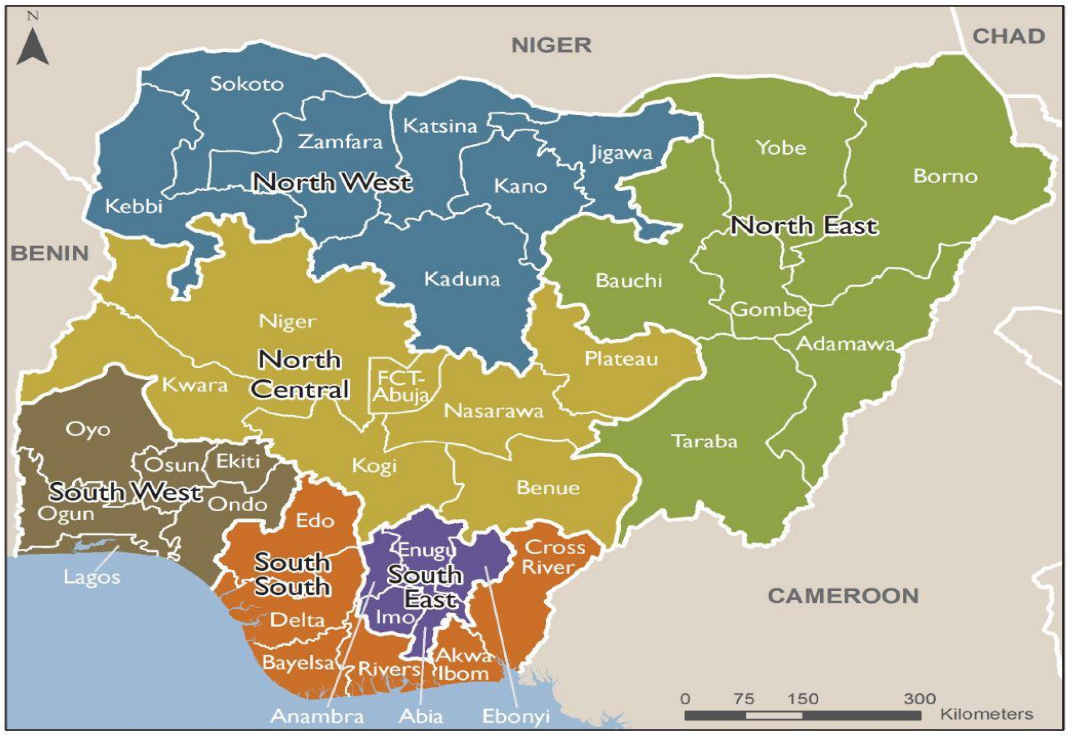
The conceptual framework of child survival developed by Mosley and Chen is the model most commonly referenced in studies on child mortality (21). According to this approach, there is a set of *proximate or intermediate determinants* which directly influence the risk of child morbidity and mortality. Furthermore, various *social and economic determinants* exist at the level of the individual, household and community, and operate through the proximate variables to influence child survival (12). Various adaptations of this framework have been used for analysis of factors influencing neonatal mortality; these include

adaptations by Titaley *et al.* and Kayode *et al.* (6)(7) (8)(9). The conceptual frameworks described by these researchers have been further modified in this study in order to fully explore the determinants of interest as described above; this is presented in the Appendix.

2.6 Research Setting

Nigeria lies on the west coast of Africa, bounded by the republics of Niger and Chad in the North, the Republic of Cameroon on the East, the Republic of Benin on the West, and the Atlantic Ocean to the South. Nigeria is the most populous country in Africa (10). Administratively, the country is organized into 36 states and the Federal Capital Territory. There are 6 geopolitical zones: North Central, North East, North West, South East, South South and South West.

Figure 2: Map of Nigeria (10)



While under-five mortality has declined from 201 deaths per 1,000 live births in 2003 survey to 128 deaths in 2013 (10), the drop in the rates of neonatal death have not been as impressive. Nigeria has the highest NMR in the region and 2nd highest in the world, and despite declining rates between 2008 and now, there is still much room for improvement (10).

2.7 Summary

The current trend of neonatal mortality in Nigeria does not suggest that the country will be able to meet up with the 2015 United Nations targets for child health. As part of the strategies moving forward beyond 2015, far more needs to be done regarding targeting neonatal mortality, including looking deeper into the determinants and driving force for the trends of neonatal death in the country

CHAPTER 3: METHODOLOGY

3.1 Study Objectives

This is a population-based analysis that utilized data from the 2013 Nigeria Demographic and Health Survey (NDHS) to identify individual and community determinants of neonatal mortality in Nigeria.

3.1.1 General Objective:

To identify the factors associated with neonatal mortality in Nigeria.

3.1.2 Specific Objectives:

1. To investigate the various individual, household, and community-level factors associated with neonatal mortality in Nigeria in an attempt to understand how the interplay of these factors influence neonatal deaths.
2. To explore the impact of four domains of contextual or community-level factors on neonatal mortality in Nigeria, namely: community socioeconomic disadvantage, community fertility norms, community gender norms and attitudes towards female autonomy, and community maternal health care access and utilization.

3.2. Study Population and Sample Size

The survey sample consisted of a total of 38,522 households from which 38,948 women between the ages of 15 and 49 years, and 17,539 men between 15 and 54 years of age were interviewed. The study sample used for the present analysis was 31,482 live births born to Nigerian women between the ages of 15 and 49 years in the five years preceding the 2013 NDHS.

3.3 Data Source

The data used in this study were sourced from the 2013 NDHS. The survey was implemented by the National Population Commission in association with ICF International through the MEASURE DHS program, and is the fifth of its kind in Nigeria (10).

The DHS program was established by the United States Agency for International Development (USAID) in 1984 (73). DHS surveys are nationally representative cross-sectional surveys that have been conducted in many developing countries to obtain data on socioeconomic, demographic and health indicators (73). These surveys have become the primary sources of data on child mortality for most low- and middle-income countries (74), as the routine data obtained from vital registration systems in these countries is often non-existent or may suffer from a number of data quality issues.

3.4 Study design, Sampling Method and Data Collection (10)

In the 2013 NDHS, a multi-stage, stratified cluster sampling strategy was employed for which an identified sampling frame was used to randomly select households within the Primary Sampling Units (PSUs), which will henceforth be referred to as clusters. A detailed description of the sampling strategy and interviewing strategy is available in the official report of the 2013 NDHS (10).

Briefly, the sampling frame used for the 2013 NDHS was the list of enumeration areas (EAs) identified for the 2006 Population Census of the Federal Republic of Nigeria; these EAs were used as the PSUs. Each of the 36 states and the Federal Capital Territory was then stratified into two groups of urban and rural areas. Next, systematic sampling methods were used to select a total of 904 PSUs (clusters), of which 372 were in urban areas and 532 were in rural areas. The survey sample was therefore designed to provide population

and health indicator estimates at the national, zonal, and state levels. In each of the selected PSUs, a complete listing of all households was carried out. This listing then served as the sampling frame or the selection of households to be interviewed in the final stage.

All women aged 15-49 years and all men aged 15 to 59 who were usual members of the selected households, or who spent the night before the survey in the selected households, were eligible to be interviewed. A total of 38,522 households, 38,948 eligible women, and 17,539 eligible men were interviewed, yielding response rates of 99.0%, 97.6%, and 95.2%, respectively.

3.5 Instruments

The data collection instrument used for the 2013 NDHS was a set of structured questionnaires made available in the major Nigerian languages and used to survey the households and individual women and men. The Household Questionnaire contains socioeconomic information about the household and was used to identify eligible women and men to be interviewed. The Individual (women's) Questionnaire includes indicators of demographic and socioeconomic characteristics; reproductive and birth history; childhood mortality; use of family planning methods; antenatal care; delivery; postnatal care, etc. It also includes questions related to household decision-making, husband's control over the wife, and attitudes about domestic violence. The Men's Questionnaire was the same as the women's questionnaire, but excluded a detailed reproductive history, maternal and child health, nutrition, and domestic violence modules.

3.6 Ethical Considerations

Protocols, procedures and questionnaires used for the 2013 NDHS survey were approved by the ICF International Institutional Review Board (IRB) in compliance with the U.S.

Department of Health and Human Services regulations for the protection of human subjects (45 CFR 46). Informed consent was obtained from all the participants before face-to-face interviews were conducted. Approval to make use of the datasets analyzed in this study was obtained through a process of electronic registration with MEASURE DHS via the website www.measuredhs.com. Since the study made use of secondary data, which was already de-identified at the collation stage, there was no risk of breaching confidentiality.

3.7 Procedures

3.7.1 Data Management

The data obtained from the questionnaires is stored in separate data files; hence, there are Household Recode, Individual Recode, and Male Recode datasets. Additionally, there is a Births Recode dataset which contains the same information from the Individual women's questionnaire; however the dataset has one record for every child born to the women interviewed in the 2013 NDHS. After the merging these datasets, variables that were not relevant to the analysis (for example, variables relating to contraception, malaria, child nutrition, etc.) were dropped to reduce computing and memory requirements. To adequately reflect key concepts explored in this study, some of the variables had to be constructed from a blend of different existing variables; this is described in the detail below.

3.7.2 Measurement of Study Variables

3.7.2.1 Outcome Variable

The primary outcome was neonatal death, the death of a live born infant between birth and the first 28 completed days of life. Neonatal mortality is the probability of dying within this period and the Neonatal Mortality Rate (NMR) is the number of neonatal deaths per

1000 live births. In the 2013 NDHS, women aged 15 – 49 years were asked about the survival status of the children born to them in the 5 years preceding the survey, with the age at death obtained for any child who was not alive at the time of the survey. By restricting the analysis sample to births that occurred within the preceding 5 years, recall error for birth and death reports was restricted.

NMR was calculated according to the method described by Rutstien and Rojas (10, 73), where neonatal mortality represents deaths at age 0 – 30 days, including those deaths reported at age zero month; deaths occurring up to a month are included in order to allow for age-heaping at 7-day intervals (73). Therefore, in this analysis, neonatal death was recoded as a binary variable, with neonatal death taken as "1" if death occurred within the first month of life, or "0" if the child survived past the first month.

3.7.2.2 Explanatory/Determinant variables

Determinants of neonatal mortality were considered from the existing literature and the available information in the 2013 NDHS. The modified conceptual framework (see Appendix) described in the preceding chapter was used as the basis for identifying the possible predictors of neonatal mortality at the following levels: (i) community; (ii) socio-economic (includes household); and (iii) proximate/ individual (21). The following are the variables used in this analysis to incorporate these levels of determinants and the operational definitions and categorization of the variables are summarized in Table 1.

Community-level (Contextual) Variables

The primary sampling unit (PSU) or cluster of the 2013 NDHS was used as a proxy to represent the "community," as had been utilized in other similar analyses of DHS survey data (31, 54, 60). PSUs are small, fairly homogenous units defined in relation to

population-level socio-demographic characteristics, economic status, and living condition, permitting their usage as proxies for the "neighborhood" or "community"(44, 48). As the DHS does not collect community level data, the variables used in this analysis were derived by averaging (aggregating) individual-level data to the PSU-level, a technique has been used previously to understand a range of health outcomes including neonatal mortality (31, 47, 51, 54, 60).

Community context was explored under the following five domains:

1. **Community Socioeconomic Disadvantage**.
    a. **Geographic region**. Region of residence was considered because previous literature has shown that regional variations in under-five mortality can be seen across the different regions of the country (54). For example, studies have shown that the Northern regions of Nigeria have higher proportions of younger age at first marriage, younger age at first childbirth, home delivery; and lower knowledge and use of contraception compared to the Southern regions of the country (68).

       Region as used in the NDHS has six categories that remain unchanged for the purpose of this study.

    b. **Community Socioeconomic Deprivation Index**. This analysis focused on factors that represent the socioeconomic disadvantage or deprivation of the community, as this may negatively impact newborn survival by its influence on the economic resources available to allocate for health care (43, 52, 60). Four variables were used to explore the characteristics of the community under this contextual domain, namely: place of residence; proportion of

people with no formal education; proportion of unemployed people; proportion of households in the two lowest wealth categories (poor and poorest quintiles). These four factors were combined using Principal Component Analysis (PCA) to create an index, which was subsequently classified into low, moderate and high deprivation tertiles.

2. **Community maternal health care utilization.** This domain explores the use of health services by mothers for their most recent birth in the 5 years preceding the survey. The following variables were used in this analysis as a measure of both the presence of health services and the community attitudes toward the use of these services: the proportion of mothers who had any contact with antenatal care and the proportion of mothers who had delivered in a health facility.
3. **Community fertility norms:** The norms and expectations surrounding fertility in a community may impact on newborn survival through multiple channels, such as sub-optimal birth spacing and poor utilization of maternal health care services. The community mean age at marriage for women and the mean parity were used to measure this context.
4. **Community gender norms & attitudes towards female autonomy.** Gender roles in a community are influenced by a multifaceted interplay of several social, cultural, and economic factors that determine the division and balance of power. Previous literature shows that a woman's autonomy may influence child mortality through access to and control over resources (40). This context was analyzed using:
    a. **The proportions of women and of men having at least a primary education in the community**: the original variable was categorized as

"None", "Primary", "Secondary", and "Higher" education levels, but was re-categorized as shown in Table 1.

b. **Women's decision-making autonomy index score:** a 5-point summative index scale created using variables in the DHS that recorded women's responses when asked 4 questions regarding their ability to have a final say on decisions in the household (see footnote, Table 1) The higher the score, the greater a woman's control over her decision-making.

c. **Violence justification index score**: a 6-point scale constructed from responses to questions on whether men and women felt a husband was justified in beating his wife in five situations. A higher score indicated a higher justification for domestic violence.

d. **The Husband Control Index score**: also a summative index, this was constructed using variables to identify the degree of control a husband has over his wife's activities. The higher the score on a scale of 0-5, the higher the level of the husband's control over the respondent.

For each of these, the score for each individual respondent was calculated and then averaged to give the mean community score for each PSU.

Socio-economic determinants

Maternal and Paternal factors: Maternal socio-economic characteristics considered in this analysis were: religion, marital status and rank in household, education and employment status. Paternal education and employment status were also investigated for their influence on neonatal mortality.

Household wealth: The DHS utilizes an index which defines wealth based on asset ownership consistent with expenditure and income measures (75). This index was constructed by using principal components analysis to provide weighted scores to each household based on an inventory of selected assets (durable goods and household amenities), and indicators of the housing condition; these are taken as (76). The factor scores were then categorized into quintiles and coded as a five-point ordinal scale ranging from 1 (poorest) to 5 (richest).

Proximate determinants

Neonatal factors: Six variables characterizing infant-specific factors shown from previous literature to influence neonatal mortality (25, 31, 32, 60) were included in this analysis: baby's sex, birth weight, birth size, type of birth, birth interval, and birth order (rank).

Maternal factors: Maternal age at index birth and age at first childbirth were analyzed.

Pre-delivery/Antenatal factors: Based on the WHO definition of antenatal care coverage (77), the variables used to explore antenatal care in this study were: number of antenatal visits and type of antenatal care provider for most recent birth.

Delivery factors: Mode of delivery and place of birth

Post-delivery/Postnatal factors: According to the WHO definitions of postnatal care (PNC), a mother is considered to have made adequate utilization of PNC services if she and her baby were checked by qualified healthcare personnel within 42 days of child birth (65, 66). In the 2013 NDHS, the following groups are classified as qualified healthcare personnel: doctors, nurses, midwives, auxiliary midwives and community extension health workers. Based on the above, PNC utilization was categorized in this study as "1," if

neonate received PNC by a qualified healthcare provider within 42 days after birth, and "2", if otherwise.

Table 1: Operational definitions and categorization of the variables used in the analysis.

Variables	Definitions and Categorization
COMMUNITY LEVEL FACTORS	
Community Socioeconomic Disadvantage	
Geographic region	Geographic Zone (*1 = North Central*; 2 = North East; 3 = North West; 4 = South East; 5 = South South; 6 = South West).
Residence [a]	Location of residence of the PSU. Coded as *1 = urban*; 2 = rural.
Community illiteracy rate [a]	Proportion of people in the PSU with no formal education. Coded as: 0 = Some education; *1 = No education*.
Community unemployment rate [a]	Proportion of unemployed people in the PSU. Coded as: 0 = Working ; *1 = Not working*
Community poverty rate [a, b]	Proportion of households in the PSU living Poor & Poorest wealth quintiles Coded as: 0 = Not poor (Middle/Rich/Richest); *1 = Poor (Poor/Poorest)*
Community maternal health care utilization	
Community antenatal care utilization	Proportion of mothers in the PSU who had antenatal care from a skilled provider for the most recent birth before the survey. Coded as: 0 = Had no skilled antenatal care; *1 = Had skilled antenatal care*.
Community hospital delivery	Proportion of mothers having hospital delivery for the most recent birth before the survey. Coded as: 0 = Non-facility delivery; *1 = Health facility delivery*.
Community fertility norms	
Community mean age at marriage for women	Mean age at first marriage for women in the PSU.
Community mean parity	Mean number of children ever born per woman in the PSU.

Table 1: Operational definitions and categorization of the variables used in the analysis (*contd.*)

Variables	Definitions and Categorization
Community gender norms & attitudes toward female autonomy	
Community female education	The proportion of women with at least a primary school education in the PSU. Coded as: 0 = Less than primary education; *1 = Primary education or higher*.
Community male education	The proportion of men in the PSU with at least a primary school education. Coded as: 0 = Less than primary education; *1 = Primary education or higher*.
Community mean women's decision-making autonomy index score [c]	4-point scale of women's decision-making power in multiple domains, where higher score indicated higher decision-making control. Coded: 0 = any situation where woman is not involved in decision-making; *1 = any situation where woman is independently or jointly involved in decision-making.*
Community mean violence justification index score [d]	5-point scale of attitudes towards domestic violence, where lower score indicates that violence is not justified. Coded: 0 = respondent did not consider wife-beating justified in a situation; *1 = respondent considered wife-beating to be justified in a situation.*
Community mean husband control index score [e]	6-point scale that indicates the extent to which the respondent's husband controls her mobility, contacts, money, and health-care seeking behavior, where higher score indicated higher degree of husband's control over wife. Coded: 0 = any situation where woman answers "no"; *1 = any situation where woman answers "yes*.
SOCIO-ECONOMIC FACTORS	*Includes individual- and household-level socio-economic determinants.*
Household Level Factors	
Household wealth index [b]	Composite index of household amenities used in the DHS to indicate inequalities in wealth distribution. Coded as: *1 = Poor*; 2 = Middle; 3 = Rich
Maternal Factors	
Maternal literacy	Mother's literacy level. Coded as: *1 = Able to read*; 2 = Cannot read at all.

Table 1: Operational definitions and categorization of the variables used in the analysis (*contd.*)

Variables	Definitions and Categorization
SOCIO-ECONOMIC FACTORS	
Maternal Factors	
Maternal education	Highest educational level attained by mother. Coded as: *1= No education*; 2 = Primary; 3 = Secondary; 4 = Higher.
Maternal employment	Mother's employment status. Coded as: *1 = Not working*; 2 = Working.
Maternal religion	Mother's religion. Coded as: *1 = Christian*; 2 = Muslim; 3 = Traditionalist or other.
Maternal marital status	Marital status of the mother. Coded as: *0 = Only wife (monogamous union)*; 1 = 1st wife; 2 = 2nd or higher wife; 3 = Currently unmarried (includes Never married, Separated, Divorced or Widowed).
Paternal factors	
Paternal employment	Paternal employment status. Coded as: *1 = Not working*; 2 = Working.
Paternal education	Highest educational level attained by father. Coded as: *1= No education*; 2 = Primary; 3 = Secondary; 4 = Higher.
PROXIMATE FACTORS	
Maternal Factors	
Age at index birth	Mother's age at birth of neonate. Coded as: *1 = 20 – 29 years*; 2 = <20 years; 3 = 30 - 39 years; 4 = 40 – 49 years.
Age at first birth	Mother's age at first childbirth. Coded as: *1 = < 20 years*; 2 = 20 – 29 years; 3 = 30 – 49 years.
Parity	Number of live births the mother had before the index infant. Coded as: *1 = 1;* 2 = 2 - 4; 3 = ≥5
Neonatal factors	
Sex	Sex of the neonate. Coded as: *1 = female*; 2 = male.
Type of birth	Type of birth. Coded as: *1 = singleton*; 2 = multiple birth.
Birth weight	Birth weight of neonate. Coded as: *1 = 2500 – 3500 g* 2 = <2500 g; 3 = > 3500 g; 4 = not weighed.

Table 1: Operational definitions and categorization of the variables used in the analysis (*contd.*)

Variables	Definitions and Categorization
Birth size	Mother's subjective assessment of the neonate's size at birth. Coded as: *1 = average*; 2 = smaller than average or very small; 3 = larger than average or very large.
Birth order/ rank and birth interval	Birth order/rank and birth interval of neonate. Coded as: *1 = 2nd or 3rd child, interval > 2 years*; 2 = 1st child; 3 = 2nd or 3rd child, interval ≤ 2 years; 4 = 4th or higher child, interval > 2 years; 5 = 4th or higher child, interval ≤ 2 years.
Antenatal Factors	
Antenatal care	(i) Number of antenatal visits for mother's most recent birth. Coded as: *1 = 4 or more visits*; 2 = Less than 4 visits; (ii) Mother received antenatal care received from skilled provider. Coded as: *1 = Yes*; 2 = No.
Delivery Factors	
Delivery assistance	Type of birth attendant during delivery. Coded as: *1 = Had skilled birth assistance*; 2 = Had non-skilled or no assistance.
Birth place	Place of delivery of the neonate. Coded as: *1 = home/ non-health facility*; 2 = health facility.
Mode of delivery	Mode of delivery. Coded as: *1 = Non-cesarean*; 2 = Cesarean.
Postnatal factors	
Postnatal care	Adequate postnatal care (timing and provider) received by neonate. Coded as: *1 = Yes*; 2 = No.

Note: Categories in italics have been used as reference category in the regression models

[a] Operationalized with principal component analysis

[b] The original variable in the DHS dataset is the household wealth index, consisting of 5 categories: poor, poorer, middle, rich, and richest.

[c] Whether or not the respondent usually had the final say on: (i) how to spend personal earnings; (ii) own health care; (iii) making large household purchases; (iv) visits to family or relatives.

[d] Whether or not violence was justified if a woman: (i) goes out without telling her husband; (ii) neglects the children; (iii) argues with her husband; (iv) refuses her husband sex; (v) burns husband's food.

[e] Women's experience of husband/partner's control over her (i) mobility; (ii) contacts with friends and family; (iii) money; and (iv) access to health care.

3.6 Statistical Analysis Plan

StataSE 13 software package was used for the analyses, with appropriate weighting factors applied to adjust for the differences in population area between clusters.

Frequency tabulations were first used to describe the percentage distribution of each of the categories within the predictor variables. Descriptive analysis was also used to examine the differentials in neonatal deaths across the selected covariates.

Bivariate analyses were then utilized to examine patterns and associations between the various independent variables and the outcome of neonatal death. Cross-tabulations were used to examine the distribution of neonatal deaths on the independent categorical variables. Pearson Chi-square tests were used to determine if there was a statistical association between the independent variables and the outcome variable. Binomial logistic regression was also employed to examine the crude effect of each independent variable on the outcome variable. Unadjusted odds of neonatal mortality were then calculated, and statistically significant variables were retained for the subsequent analysis.

At the multivariate level, binary logistic regression models were used to test the odds that a neonatal death would occur given a set of independent variables. All variables that were significantly associated with neonatal mortality at the 10% level of significance from the univariate logistic regression models were included in the multivariate logistic regression model. In order to fully examine the effect of the contextual variables, all the community level variables with the exception of geographic region were included in the multivariable regression, regardless of statistical significance. Before applying the regression models, possible associated factors were examined for evidence of collinearity using variance inflation factor (VIF) and Tolerance test. This revealed that the community-level variables

for proportions of women and men educated to primary level had very high VIFs. Therefore these variables were removed from the regression analysis. The small value of mean VIF (2.6) from the final regression model indicated the absence of significant collinearity among the variables. Furthermore, maternal literacy was used in the multivariate regression instead of maternal educational level to avoid high collinearity. Birth size was substituted for birth weight in the regression analysis due to the large proportion of missing data for the latter variable.

Four models were fitted in the multivariate analysis containing community, socioeconomic (household and individual), and proximate determinants. Model 1 simultaneously adjusted for Community socio-economic and maternal health services utilization. In Model 2, the Community gender and fertility norms were included to simultaneously adjust for all the community-level variables. Model 3 included the Individual- and Household-level socioeconomic factors that were found to be significant from the bivariate analysis. Finally, the significant proximate determinants were included to give Model 4, which simultaneously adjusted for all variables at all levels. The simultaneous inclusion of community, socio-economic, and proximate factors into the model permitted the examination of community-level effects after the household- and individual-level confounders have been controlled for. It also permitted the examination of the household- and individual-level characteristics as modifiers of the community effect.

Adjusted odds ratios and 95% confidence intervals were determined. Goodness-of-fit tests were used to assess the fitness of the final model. All tests were done at 5% significance level and at a confidence level of 95%.

CHAPTER 4: RESULTS

4.1 Descriptive Statistics of Neonatal Mortality in Nigeria

A total of 31,482 live-born infants within the five-year period preceding the 2013 NDHS were included as the study population (weighted n = 31,828). A weighted total of 1,180 neonatal deaths occurred over this period, of which 967 occurred within the first week of infant life, giving a neonatal mortality rate (NMR) of 37.1 per 1000 live births and early NMR of 30.4 per 1000 live births.

4.2 Characteristics of the Study Sample

Table 2a and 2b show the distribution of the study variables by neonatal deaths and NMR, as well as the unadjusted odds of neonatal death for bivariate associations. As seen in Table 2a, infants born in rural areas constituted the majority (67%) of the study sample. The NMR ranged from 30.0 in the South South region of the country to 40.5 in the North West region. On average, communities had higher proportions of men than women educated at least to primary school level. The mean maternal age at first birth in this sample was 19 years and mean parity was 3.3; more than half of the infants were born to mothers aged 20 – 29 years. Over two-thirds of births occurred to mothers who had either no formal education or only primary level of education. The sample of births was fairly evenly split by gender, with 50.7% of the infants being male. Approximately 97% of the infants were singleton births. Neonates whose mothers perceived them as smaller than average or very small at birth represented about 15% of the sample.

While approximately 61% of mothers received skilled antenatal care for their most recent pregnancy in the 5 years preceding the survey, only 37% of mothers delivered in a health

facility and only about 39% of mothers had their deliveries assisted by a trained health professional. Moreover, only 25% of newborn infants received a postnatal check from a qualified professional within the first 42 days of life, in line with the current WHO recommendations.

Table 2b shows the mean community scores on the decision-making autonomy, violence justification, and husband control indexes.

4.3 Bivariate Associations between Community, Household and Individual Level Determinants and Neonatal Mortality

Table 2 also presents the crude odds ratios and 95% confidence intervals for associations between variables of interest and neonatal mortality. At the community level, Table 2a shows that geographical region of residence was not associated with neonatal death. However, infants born in communities with overall higher socio-economic deprivation had a significantly increased odds of neonatal death when compared with communities having a low level of deprivation (OR 1.31, 95% CI: 1.09 – 1.57; p-value = 0.004). As the proportion of poor households increased (Table 2b), the likelihood of neonatal death in those communities also increased (OR = 1.34, 95% CI: 1.11 – 1.62; p-value = 0.002). Being born in a rural area was also a risk factor for neonatal mortality, as such infants had a 32% higher odds of neonatal death compared with their peers born into urban areas.

Communities which demonstrated a higher justification of violence against women showed a 27% higher odds of neonatal death (OR = 1.27, 95% CI: 1.14 – 1.41; p-value = 0.000). Similarly, for every one unit increase in the mean parity for women in communities, the odds of neonatal death increased significantly by 17%. Conversely, lowering of the mean

age at first marriage in communities independently significantly reduced the odds of neonatal mortality.

The socio-economic status of the household was also a significant predictor of neonatal mortality; babies born to middle-class and rich households had 19% and 22% lower odds of dying, respectively, when compared with their counterparts born into poor households Maternal education higher than primary level was significantly associated with a reduction in the odds of neonatal deaths, with the odds of neonatal mortality reduced significantly by 21% and 32% among infants born to mothers with secondary and post-secondary education respectively, compared with infants of mothers with no education. Similarly, infants whose fathers had higher than secondary level of education had 29% reduced odds of neonatal death, compared to children of uneducated fathers.

Among the proximate determinants analyzed, it was seen that births to mothers at the extremes of age (less than 20 years and between 40 and 49 years) were significantly associated with higher odds of neonatal death (Table 2a). Male sex was also a significant risk factor for neonatal mortality, and the odds of dying in the neonatal period were 30% higher for male babies compared with females. Although a large proportion of the newborns were not weighed, those recorded as having low birth weight (LBW) had an almost 4-fold higher likelihood of dying before attaining the age of one month compared to their normal birth weight counterparts (NMR = 45.8; OR 3.63, 95% CI: 1.75 – 7.51; p-value = 0.001). This correlated with mothers' subjective assessment of birth size, and infants as being "small or very small" had higher odds of neonatal death (OR 1.99, 95% CI: 1.64 – 2.41; p-value = 0.000). Being born as a multiple gestation was associated with a 5 times higher likelihood of neonatal death. Although maternal parity was found not to

significantly influence the odds of neonatal death, both 1st birth rank and higher birth rank coupled with a shorter preceding birth interval were significantly associated with higher odds of mortality.

Infants of mothers who had fewer antenatal visits during pregnancy had a significantly higher likelihood of dying during the neonatal period, compared to those whose mothers had at least four antenatal visits (OR 1.23, 95% CI: 1.02 – 1.47; p-value = 0.031). Infants who did not receive postnatal care were about 3 times more likely to die compared to those who had (OR 2.80, 95% CI: 1.98 – 3.94; p-value = 0.000). Counterintuitively, type of antenatal care and delivery assistance, and place of delivery did not show a significant effect on neonatal death outcomes.

All the factors related to utilization of maternal and child health services were recorded only for the most recent birth in the five years preceding the survey. Due to this, these variables were not considered for further analysis at the individual level in the multivariate regression. Other variables which did not show statistical significance on bivariate analysis included maternal religion and marital status, as well as maternal and paternal employment status; these variables were not used further in the analysis.

4.4 Multivariate associations between study variables and Neonatal Mortality

Table 3 shows the results of fitting logistic regression models to explore the effects of multiple variables on the odds of neonatal death. Model 1 shows that after adjusting for community level maternal health service utilization, the significant association between high community socio-economic deprivation and increased odds of neonatal death is still maintained (aOR 1.67, 95% CI: 1.18 – 2.35; p-value = 0.004). However, counterintuitively, having a higher proportion of mothers in the community accessing antenatal care from a

skilled provider significantly increased the odds of neonatal death (aOR 1.95, 95% CI: 1.31 – 2.92; p-value = 0.001). When community socio-economic status and antenatal care utilization were controlled for in this model, it was seen that a higher utilization of health facility delivery reduced the odds of neonatal mortality; however this was not a statistically significant association (aOR 0.76, 95% CI: 0.50 – 1.15; p = 0.192).

Using Model 2, the effects of inclusion of community gender and fertility norms can be seen. Infants born in communities where violence against women was justified in more circumstances on average had 20% higher odds of dying in the neonatal period. There was no significant effect of community level decision-making autonomy on neonatal mortality, nor did higher husband control over the wives' mobility, contacts or resources appear to have a significant association with neonatal death. However a significant association was seen between parity at the community level and neonatal mortality, with infants born into communities with higher mean parity experiencing about 18% higher odds of dying. Although both mean community age at first marriage and at first birth were significant in the bivariate analysis, only mean community age at first marriage was entered into the model due to collinearity issues. However, this variable did not have a significant effect on the odds of neonatal death in the presence of other community level covariates. Community socio-economic deprivation, while still associated with increased odds of neonatal mortality, was no longer significant in this and subsequent models which adjusted for other factors.

Model 3 simultaneously adjusted for all community-level variables plus household- and maternal-level socioeconomic factors. Household wealth status and maternal literacy were not significantly associated with neonatal death in adjusted models.

Finally, Model 4 shows the effects of inclusion of all proximate determinants to control for all individual- and contextual covariates simultaneously. At this level, maternal age at infant's birth is seen to retain the significant association shown in the bivariate analysis, with 26% and 82% increased odds of neonatal death for infants born to mothers younger than 20 years and older than 40 years, respectively, when compared with those born to mothers aged 20 -29 years. It can be seen that the maternal age at birth, sex of the baby, birth size, type of birth, birth order and interval, and mode of delivery maintain a significant association with increased odds of neonatal mortality. Maternal literacy was also significant as a predictor of neonatal death, with 38% higher odds of mortality among infants of illiterate mothers (p-value = 0.026), after holding all other independent factors constant. In this final model, the only community-level factors that retained statistically significantly associations with neonatal mortality were mean parity, mean violence justification score, proportion of women accessing skilled antenatal care.

Table 2a: Characteristics of the study population: Neonatal deaths, Neonatal Mortality Rate, and Bivariate Odds Ratio with 95% Confidence Intervals, NDHS, 2013.

VARIABLES	Live births (%) N = 31,482	Neonatal death (N = 1,180 [a])	NMR [a]	OR (95% CI) [a, b]
COMMUNITY LEVEL DETERMINANTS				
Place of Residence				
Urban	10,351 (32.9)	344	30.9	1.00
Rural	21,131 (67.1)	836	40.4	**1.32 (1.12 – 1.56)**
Geographic Region				
North Central	4,614 (14.7)	146	33.6	1.00
North East	6,517 (20.7)	202	36.2	1.08 (0.82 – 1.42)
North West	9,906 (31.5)	477	40.5	1.21 (0.95 – 1.54)
South East	2,816 (8.9)	106	37.3	1.12 (0.81 – 1.53)
South South	3,747 (11.9)	88	30.0	0.89 (0.64 – 1.22)
South West	3,882 (12.3)	160	36.7	1.09 (0.78 – 1.52)
SOCIO-ECONOMIC DETERMINANTS				
Household wealth index				
Poor	14,462 (45.9)	617	41.5	1.00
Middle	6,272 (20.0)	205	34.2	**0.81 (0.67 – 0.99)**
Rich	10,748 (34.1)	358	32.6	**0.78 (0.65 – 0.93)**
Maternal religion				
Christian	12,654 (40.4)	417	35.8	1.00
Muslim	18,354 (58.6)	745	37.8	1.06 (0.90 – 1.25)
Traditionalist or other	314 (1.0)	11	36.7	1.00 (0.55 – 1.80)
Maternal marital status)				
Only wife (monogamous union)	20,037 (64.1)	737	36.1	1.00
1st wife	7,866 (25.2)	297	36.9	1.02 (0.86 – 1.22)
2nd or higher wife	1,875 (6.0)	77	42.5	1.19 (0.83 – 1.71)
Currently unmarried	1,492 (4.8)	63	47.1	1.31 (0.97 – 1.78)
Maternal employment				
Not working	9,649 (30.8)	389	39.6	1.00
Working	21,697 (69.2)	789	36.1	0.91 (0.78 – 1.06)
Maternal literacy				
Able to read	13,044 (41.8)	393	31.0	1.00
Cannot read at all	18,153 (58.2)	769	40.8	**1.33 (1.13 – 1.56)**

[a] Weighted for the sampling probability; [b] statistically significant figures are marked in bold; NMR, Neonatal Mortality Rate; OR, Odds Ratio; CI, Confidence Interval

Table 2a: Characteristics of the study population: Neonatal deaths, Neonatal Mortality Rate, and Bivariate Odds Ratio with 95% Confidence Intervals, NDHS, 2013 (*contd*.)

VARIABLES	Live births (%) N = 31,482	Neonatal death (N = 1,180 [a])	NMR [a]	OR (95% CI) [a, b]
SOCIO-ECONOMIC DETERMINANTS				
Maternal education				
No education	14,762 (46.9)	613	39.1	1.00
Primary	6,432 (20.4)	262	42.7	1.09 (0.89 – 1.35)
Secondary	8,365 (26.6)	256	31.1	**0.79 (0.65 – 0.96)**
Higher	1,923 (6.1)	49	26.7	**0.68 (0.48 – 0.97)**
Paternal employment				
Not working	276 (0.9)	5	21.1	1.00
Working	30,414 (99.1)	1,150	37.2	1.89 (0.86 – 4.17)
Paternal education				
No education	11,610 (38.0)	499	40.5	1.00
Primary	5,985 (19.6)	223	37.9	0.94 (0.76 – 1.15)
Secondary	9,009 (29.5)	310	34.3	0.84 (0.69 – 1.02)
Higher	3,981 (13.0)	110	29.2	**0.71 (0.54 – 0.94)**
PROXIMATE DETERMINANTS				
Maternal Factors				
Age at index birth				
< 20 years	4,524 (14.4)	226	47.8	**1.45 (1.20 – 1.75)**
20 – 29 years	16,270 (51.7)	551	33.4	1.00
30 – 39 years	9,138 (29.0)	328	36.0	1.08 (0.91 – 1.29)
40 – 49 years	1,550 (4.9)	75	49.3	**1.5 (1.13 – 2.01)**
Age at first birth				
< 20 years	18,665 (59.3)	702	37.0	1.00
20 – 29 years	12,009 (38.2)	444	36.9	1.00 (0.85 – 1.17)
30 – 49 years	808 (2.6)	34	41.9	1.13 (0.76 – 1.69)
Parity				
1	3,624 (11.5)	140	38.1	1.00
2 – 4	14,966 (47.5)	520	34.0	0.89 (0.70 – 1.13)
≥ 5	12,892 (41.0)	520	40.4	1.07 (0.85 – 1.34)
Neonatal Factors				
Sex of child				
Female	15,517 (49.3)	512	32.5	1.00
Male	15,965 (50.7)	668	41.6	**1.30 (1.13 – 1.49)**
Type of birth				
Single	30,384 (96.5)	1,011	32.9	1.00
Multiple birth	1,098 (3.5)	169	153.4	**5.33 (4.12 – 6.89)**

[a] Weighted for the sampling probability; [b] statistically significant figures are marked in bold; NMR, Neonatal Mortality Rate; OR, Odds Ratio; CI, Confidence Interval

Table 2a: Characteristics of the study population: Neonatal deaths, Neonatal Mortality Rate, and Bivariate Odds Ratio with 95% Confidence Intervals, NDHS, 2013 (*contd*.)

VARIABLES	Live births (%) N = 31,482	Neonatal death (N = 1,180 [a])	NMR [a]	OR (95% CI) [a, b]
PROXIMATE DETERMINANTS				
Neonatal Factors				
Birth size				
Small or very small	4,595 (14.9)	299	63.0	**1.99 (1.64 – 2.41)**
Average	12,689 (41.1)	420	32.7	1.00
Large or very large	13,589 (44.0)	373	27.4	0.83 (0.70 – 0. 99)
Birth weight				
< 2500 grams	377 (1.2)	19	45.8	**3.63 (1.75 – 7.51)**
2500 – 3500 grams	3,315 (12.0)	43	13.1	1.00
> 3500 grams	1,497 (5.42)	12	8.0	0.61 (0.28 – 1.33)
Not weighed	22,436 (81.2)	1037	40.9	**3.22 (2.16 – 4.79)**
Birth rank and interval				
1st child	6,109 (19.5)	288	46.4	**1.84 (1.45 – 2.32)**
2nd or 3rd child, interval > 2years	7,227 (23.0)	191	25.9	1.00
2nd or 3rd child, interval ≤ 2 years	2,775 (8.8)	117	41.2	**1.62 (1.21 – 2.17)**
4th or more child, interval > 2yrs	11,406 (36.3)	328	28.9	1.12 (0.89 – 1.41)
Antenatal Factors				
Number of antenatal visits				
Less than 4 visits	9,145 (46.5)	285	30.1	**1.23 (1.02 – 1.47)**
4 or more visits	10,507 (53.5)	259	24.8	1.00
Skilled antenatal care				
Yes	12,266 (61.3)	309	24.9	1.00
No	7,760 (38.7)	227	28.8	1.16 (0.96 – 1.41)
Delivery factors				
Mode of delivery				
Non-Cesarean section	30,512 (97.9)	1,115	36.1	1.00
Cesarean section	659 (2.1)	48	74.2	**2.12 (1.53 – 2.94)**

[a] Weighted for the sampling probability; [b] statistically significant figures are marked in bold; NMR, Neonatal Mortality Rate; OR, Odds Ratio; CI, Confidence Interval

Table 2a: Characteristics of the study population: Neonatal deaths, Neonatal Mortality Rate, and Bivariate Odds Ratio with 95% Confidence Intervals, NDHS, 2013 (*contd*.)

VARIABLES	Live births (%) N = 31,482	Neonatal death (N = 1,180 [a])	NMR [a]	OR (95% CI)[a, b]
PROXIMATE DETERMINANTS				
Delivery factors				
Delivery assistance				
Had skilled birth assistance	12,030 (38.7)	449	37.0	1.00
Non-skilled/ No assistance	19,027 (61.3)	672	34.9	0.94 (0.80 – 1.11)
Place of delivery				
Non-health facility	19,660 (63.1)	714	35.5	1.00
Health facility	11,512 (36.9)	410	36.0	1.01 (0.87 – 1.19)
Postnatal factors				
Infant received Postnatal Care				
Yes	5,076 (25.3)	58	11.4	1.00
No	14,966 (74.7)	475	31.2	**2.80 (1.98 – 3.94)**

[a] Weighted for the sampling probability; [b] statistically significant figures are marked in bold; NMR, Neonatal Mortality Rate; OR, Odds Ratio; CI, Confidence Interval

Table 2b: Characteristics of study population: Means and Bivariate Odds Ratio with 95% Confidence Intervals, NDHS, 2013.

VARIABLE	Mean ± SE [a]	OR (95% CI) [a, b]
COMMUNITY LEVEL DETERMINANTS		
Community socio-economic disadvantage index [c]	-	1.00
Low	-	1.18 (0.96 – 1.44)
Moderate	-	**1.31 (1.09 – 1.57)**
High		
Proportion of people living in rural clusters	0.65 ± 0.01	**1.32 (1.12 – 1.56)**
Proportion of uneducated people in the cluster	0.42 ± 0.01	1.19 (0.96 – 1.46)
Proportion of unemployed people in the cluster	0.31 ± 0.00	0.69 (0.40 – 1.18)
Proportion of households in poverty	0.47 ± 0.01	**1.34 (1.11 – 1.62)**
Community Maternal Health Services Utilization		
Proportion of mothers who had antenatal care from a skilled provider	0.60 ± 0.01	0.98 (0.79 – 1.21)
Proportion of mothers who delivered in a health facility	0.37 ± 0.01	**0.79 (0.62 – 0.99)**
Community gender norms & inequalities		
Proportion of women in cluster with at least a primary education	0.53 ± 0.01	0.84 (0.68 – 1.02)
Proportion of men in cluster with at least a primary education	0.71 ± 0.01	0.93 (0.75 – 1.15)
Mean community decision-making autonomy score	1.78 ± 0.03	**0.92 (0.85 – 0.99)**
Mean community violence justification score	1.03 ± 0.02	**1.27 (1.14 – 1.41)**
Mean community husband control score	0.46 ± 0.00	**1.49 (1.06 – 2.1)**
Community fertility norms		
Mean age at first birth among women in the cluster	19.3 ± 0.51	**0.95 (0.91 – 0.99)**
Age at first marriage among women in the cluster	17.5 ± 0.07	**0.96 (0.93 – 0.99)**
Mean parity	3.3 ± 0.03	**1.17 (1.09 – 1.27)**

[a] Weighted for the sampling probability; [b] statistically significant figures are marked in bold; NMR, Neonatal Mortality Rate; OR, Odds Ratio; CI, Confidence Interval

Table 3: Adjusted Odds Ratios and 95% Confidence Interval estimates for Community, Household and Individual-level Determinants of Neonatal Mortality, NDHS, 2013.

VARIABLES	**Model 1[a]**	**Model 2 [b]**	**Model 3 [c]**	**Model 4 [d]**
	OR (95% CI)*	OR (95% CI)*	OR (95% CI)*	OR (95% CI)*
Community socio-economic disadvantage index				
Low deprivation	1.00	1.00	1.00	1.00
Moderate deprivation	1.26 (0.98– 1.62)	1.08 (0.84 – 1.39)	1.08 (0.81 – 1.45)	1.05 (0.76 – 1.45)
High deprivation	**1.67 (1.18 – 2.35)**	1.32 (0.93 – 1.86)	1.25 (0.84 – 1.87)	1.22 (0.79 – 1.87)
Community Maternal Health Services Utilization				
Proportion of mothers who had skilled antenatal care	**1.95 (1.31 – 2.92)**	**1.77 (1.18 – 2.64)**	**1.83 (1.21 – 2.77)**	**1.98 (1.28 – 3.07)**
Proportion of mothers who delivered in a health facility	0.76 (0.50 – 1.15)	0.92 (0.55 – 1.53)	0.99 (0.59 – 1.66)	0.97 (0.55 – 1.73)

Table 3: Adjusted Odds Ratios and 95% Confidence Interval estimates for Community, Household and Individual-level Determinants of Neonatal Mortality, NDHS, 2013 (contd.)

VARIABLES	**Model 1[a]**	**Model 2 [b]**	**Model 3 [c]**	**Model 4 [d]**
	OR (95% CI)*	OR (95% CI)*	OR (95% CI)*	OR (95% CI)*
Community gender norms				
Mean community decision-making autonomy score		1.02 (0.90 – 1.16)	1.04 (0.91 – 1.18)	1.04 (0.91 – 1.20)
Mean community violence justification score		**1.20 (1.07 – 1.35)**	**1.20 (1.07 – 1.35)**	**1.23 (1.09 – 1.39)**
Mean community husband control score		1.05 (0.73 – 1.50)	1.05 (0.73 – 1.51)	0.93 (0.61 – 1.42)
Community fertility norms				
Mean age at first marriage		1.02 (0.95 – 1.08)	1.02 (0.96 – 1.09)	0.98 (0.92 – 1.05)
Mean parity		**1.18 (1.04 – 1.34)**	**1.19 (1.04 – 1.35)**	**1.21 (1.05 – 1.40)**
Household wealth index				
Poor			1.00	1.00
Middle			0.91 (0.72 – 1.15)	0.98 (0.77 – 1.25)
Rich			1.04 (0.75 – 1.44)	1.15 (0.81 – 1.64)
Maternal literacy				
Able to read			1.00	1.00
Cannot read at all			1.29 (0.99 – 1.67)	**1.39 (1.05 – 1.83)**

Table 3: Adjusted Odds Ratios and 95% Confidence Interval estimates for Community, Household and Individual-level Determinants of Neonatal Mortality, NDHS, 2013 (contd.)

VARIABLES	**Model 1**[a]	**Model 2**[b]	**Model 3**[c]	**Model 4**[d]
	OR (95% CI)*	OR (95% CI)*	OR (95% CI)*	OR (95% CI)*
Maternal age at birth				
< 20 years				1.12 (0.87 – 1.43)
20 – 29 years				1.00
30 – 39 years				**1.26 (1.01 – 1.56)**
40 – 49 years				**1.82 (1.31 – 2.52)**
Sex of child				
Female				1.00
Male				**1.33 (1.14 – 1.55)**
Type of birth				
Single				1.00
Multiple birth				**5.07 (3.77 – 6.81)**
Birth size				
Small or very small				**1.68 (1.36 – 2.07)**
Average				1.00
Large or very large				**0.81 (0.68 – 0.97)**
Birth rank and interval				
1st child				**1.76 (1.35 – 2.31)**
2nd or 3rd child, interval > 2 years				1.00
2nd or 3rd child, interval ≤ 2 years				**1.46 (1.06 – 2.01)**
4th or more child, interval > 2yrs				0.78 (0.60 – 1.01)
4th or more child, interval ≤ 2yrs				**1.64 (1.27 – 2.12)**

Table 3: Adjusted odds ratios and 95% CI estimates for Community, Household and Individual-level determinants of neonatal mortality, NDHS, 2013 (contd.)				
VARIABLES	**Model 1[a]**	**Model 2 [b]**	**Model 3 [c]**	**Model 4 [d]**
	OR (95% CI)*	OR (95% CI)*	OR (95% CI)*	OR (95% CI)*
Mode of delivery				
Non-Cesarean section				1.00
Cesarean section				**2.22 (1.49 – 3.29)**

**Weighted for the sampling probability*

[a] Model 1 simultaneously adjusts for Community socio-economic and maternal health services utilization

[b] Model 2 simultaneously adjusts for the variables in Model 1 plus Community gender and fertility norms

[c] Model 3 simultaneously adjusts for the all variables in Model 2 plus Individual- and Household-level Socioeconomic factors

[d] Model 4 simultaneously adjusts for all the variables in Model 3 plus Proximate determinants

CHAPTER 5: DISCUSSION

5.1 Summary

The objective of this study was to conduct an analysis of the 2013 Nigeria DHS in order to examine factors that are significantly associated with neonatal mortality in Nigeria at various levels of influence. Several contextual and individual-level factors were found to be significantly associated with neonatal mortality, as discussed below.

5.2 Neonatal Mortality Rate

This study revealed that burden of neonatal deaths remains high in Nigeria. This study found that the NMR for live-born infants between 2008 and 2013 was of 37.1. This is similar to the findings of the preliminary report from the 2013 NDHS (10). Importantly, over 80% of these deaths occurred within the first week of life. This correlates with current knowledge regarding the first week of life being the riskiest time for the newborn, and associated with about three-quarters of all neonatal deaths (78).

5.3 Socio-economic and Proximate Determinants of Neonatal Mortality

Consistent with other studies in high-mortality settings (24, 25, 30), this study found that socio-economic determinants including household wealth and maternal education/ literacy were associated with neonatal mortality. Women with a higher household wealth status and higher educational attainment had improved chances of survival for their newborns. In fact, women's literacy remained the single most important socioeconomic factor associated with neonatal mortality in the multivariate analysis. Illiterate mothers had higher odds of neonatal mortality, and this finding is consistent with the strong association noted in previous studies (24, 30).

Proximate determinants that increased the odds of neonatal mortality were: extremes of maternal age, male sex, multiple gestation, smaller than average sized infants, high birth rank and shorter birth interval, and Cesarean delivery. These effects were maintained even after controlling for several community- and household-level confounders and were similarly seen in previous studies on neonatal mortality (25, 30-32, 60, 79) . Infants born as twins or other higher order gestation showed an increased odds of dying in the neonatal period as was seen in other studies from sub-Saharan Africa and elsewhere (32, 34). This association was unaffected by subsequent adjustment for other determinants such as sex of the baby, LBW, and maternal age. LBW showed an independent association with neonatal mortality and smaller infant size emerged as one of the strongest proximate predictors of neonatal mortality, as seen in previous studies (31, 64). The higher odds of death seen among male babies was also supported by previous research and is consistent with observed biological trends that predispose male babies to death in the neonatal period, such as higher prevalence of respiratory and infectious diseases (80).

5.4 Relationships between Community Context and Neonatal Mortality

The different domains of community context that were found to increase the odds of neonatal mortality independent of household socioeconomic status or proximate determinants were high level of community socio-economic disadvantage, higher utilization of skilled antenatal care, higher justification of violence against women, and higher mean parity for women in the community.

5.4.1 Community socio-economic disadvantage

Socio-economic deprivation in this study was characterized by rural residence and high prevalence of illiteracy, unemployment and poverty. Being born into a community where

these factors co-exist can influence neonatal survival through several channels, and it is likely that both the community and individual pathways link socioeconomic conditions to neonatal survival. For example, community disadvantage may mediate its impact through poor access to financial resources, leading to inability to afford good nutrition. Maternal under-nutrition is estimated to contribute to up to 800,000 neonatal deaths annually through preterm birth and LBW (17, 26), and previous studies have identified that higher levels of neighborhood socio-economic disadvantage are associated with lower birthweights (81). Additionally, in a setting like Nigeria where health care costs are still largely settled out-of-pocket (82, 83), families that lack the resources to afford these costs are unable to access life-saving interventions and services that would reduce improve the chances of survival for their newborns.

With respect to wealth status, richer households were found to have lower odds of neonatal death than poor ones. However it would appear that this protective effect is not significant in the presence of the contextual factors. As poorer communities are also often overlooked when it comes to distribution of health infrastructure, it is highly likely that even households of moderate means may have a higher odds of poorer health outcomes when situated within communities which are deprived of the necessary health services. Higher odds of mortality among rural dwellers have also been described in previous studies in association with limited access to maternal health care facilities (30, 84).

5.4.2 Community Maternal Health Care Utilization

At the community level, it was found that higher utilization of skilled antenatal care by mothers in the community was associated with increased odds of neonatal mortality in the presence of other variables. This appears counterintuitive and indeed other studies have

found that wider utilization of prenatal care at the community level is associated with improved survival among newborns (25, 60) The findings of the current study may however be related to individual mothers seeking out delivery services specifically due to high-risk pregnancies, which are already at risk for poorer outcomes. Mothers at the extremes of age or those who have multiple gestation or risk for preterm delivery may selectively access skilled maternal health care.

Also contrary to the usual expectation, it was seen that higher levels of community utilization of institutional delivery were not significantly associated with reduced odds of neonatal mortality. This is similar to the findings of Mekonnen et al. in Ethiopia (24). It is possible that other factors such as community socioeconomic deprivation influence the availability of and access to health facility delivery. Even in the presence of adequate facilities, the significant proximate determinants may play a more important role in women's childbirth experiences than the community infrastructure.

Although not explored at the community level, skilled and timely postnatal care for newborns was strongly associated with reduced odds of death. However only about one quarter of the neonates in this benefited from postnatal care. The impact of postnatal care on neonatal mortality has been highlighted in previous studies (31, 85), and has been described as being instrumental in identifying at-risk newborns (9, 65).

5.4.3 Community Fertility Norms

The impact of community fertility norms and attitudes on neonatal survival was also seen to be significant. As more women in the community delayed child-bearing till older ages, neonatal mortality reduced significantly. Conversely, a higher mean parity of communities was found to be highly associated with increased odds of neonatal death. It is worthy of

note that these findings were sustained even when other community and individual level factors were taken into account. It has been demonstrated that community attitudes and norms surrounding fertility and childbearing play a role in influencing women's use of contraception (51) and uptake of maternal health services (86). Communities where women have lower age at marriage and initiation of childbearing may point to widely held expectations of high fertility, and a prolonged reproductive career. These in turn operate through factors such as sub-optimal birth spacing, poor maternal nutrition and inadequate utilization of maternal health services which have a negative influence on newborn survival. As seen in this study and also supported by previous research, younger maternal age at childbirth is associated with higher risks of death for the mother and neonate (31, 54).

Interestingly, the impact of young maternal age was not significant when the analysis controlled for all community-, socioeconomic-and individual-level confounders. Rather, advanced maternal age was seen to be significantly associated with increased odds of neonatal death. This may reflect the biologic risks associated with older maternal age, including medical complications such as diabetes and hypertension which predispose to delivery of preterm and / or LBW infants (22). As seen in this study and elsewhere (17), LBW is a significant predictor of neonatal death. Also, it has been observed that older women are less likely to access healthcare for their pregnancies (25).

In the presence of contextual factors, inadequately spaced births still had a significant influence on neonatal mortality. The length of the birth interval was inversely related to neonatal mortality and this association was maintained even in the presence of other factors. This finding was consistent with previous studies (31, 33, 60). In communities

where high fertility is encouraged and even celebrated, women may be under pressure to have several offspring and eschew contraceptive methods that would prevent them from achieving this reproductive goal. The effects of high fertility; shorter birth interval; and early childbearing are thus seen to operate at the community and individual levels.

5.4.4 Community gender norms and attitudes towards female autonomy

Research suggests that higher levels of female empowerment correlate with increased chances of survival for children (70, 87). There are multiple domains of women's empowerment that may be important for child survival including decision making and mobility. In many settings where husbands and in-laws exert a high degree of control over women's mobility, financial capacity, and contacts, there are high rates of neonatal mortality (35, 86). Women in such communities experience higher mortality for their newborns because their nutrition, healthcare utilization and newborn care practices are out of their own control (79). As well, some studies have seen that women's involvement in healthcare decision-making is a powerful influence in reducing infant mortality in low-resource settings (88). Such women are also usually able to have better access to and control over resources necessary to maintain health status and provide an optimal environment for their infants, both during and after the pregnancy (40).

Consistent with these findings, our bivariate analysis found that in communities where women had less engagement in decision making, less control over resources or greater justification for violence against women, the odds of neonatal mortality increased. However, of these three indicators, only community level justification of violence against women remained a significant determinant of neonatal death after adjusting for decision making, mobility and other community, household and individual level factors. People

living in the same community are subject to common contextual influences (89). A common community attitude towards violence may suggest that there are deeper issues related to the communities' perceptions about the worth of women and of the degree of autonomy that should be given to them. This may in turn impact their well-being and the survival of their neonates.

5.5 Strengths and Limitations of the study

The strengths of this study include the fact that the 2013 NDHS was a nationally representative survey, using standardized methods that achieved high response rates. Secondly, use of birth history data from a five-year period preceding the survey reduced the risk of recall errors or bias about the births and deaths by the mothers (90, 91). Thirdly, since the DHS variables are defined similarly across countries, these results are comparable across various countries (54). Also, this study investigated contextual domains in a country and region which have been researched by only a few other studies (60, 86)

Some limitations need to be considered when interpreting the findings of this study. First, since only surviving women were interviewed there is the possibility of underestimation of the neonatal mortality rate. This would arise from the association of neonatal deaths with maternal deaths, such that mothers who died in the perinatal or postnatal period would not be represented in the study population; hence, the burden of mortality may be higher than reported. Secondly, there was missing data for some variables such as birth weight, so birth size was used instead; as this was subjective there might be some misclassification of exposure. Likewise, individual level maternal health care utilization data were only available for the most recent birth. Thirdly, some unobserved confounders might be a problem. For example, a high odds of mortality was seen among babies who did not receive

postnatal care. However, some babies may have died so early that not receiving postnatal care would not have contributed to their death, and so the observed association may have been overestimated.

Despite these limitations, the findings of this study are still pertinent to the understanding of the determinants of neonatal mortality in Nigeria.

CHAPTER 6: PUBLIC HEALTH IMPLICATIONS AND RECOMMENDATIONS

Public Health Implications and Recommendations

Neonatal mortality is a significant global, regional, and local public health burden. It remains a challenge that needs to be addressed by concerted efforts of all stakeholders, particularly in the countries that are hardest hit. Several studies have concentrated on the impact of various factors on neonatal survival. However, more research needs to be done to investigate the influence of contextual determinants on neonatal mortality. Therefore this study examined individual- and community-level factors associated with neonatal death in Nigeria.

This study has highlighted the existing burden of neonatal deaths in Nigeria, with as many as 37 out of every 1000 Nigerian babies dying annually within the first month of life. This represents a slight reduction from the NMR of 40 per 1000 reported during the preceding survey exercise conducted in 2008.The results reveal a high burden of early neonatal deaths among infants in Nigeria, and thus underscore the need for targeted interventions to improve neonatal survival within the first week of life.

The results show the influence of community socio-economic disadvantage, maternal health care utilization, gender norms and attitudes towards female autonomy, and fertility norms on neonatal mortality. The results further show the high level of association between certain individual-level determinants on neonatal death. These include: maternal age, maternal education and literacy, birth order and interval, and infant gender.

The findings have provided other insights into areas to be targeted. Public health policies and interventions aimed at reducing neonatal mortality in Nigeria should be designed with socio-economic context in mind. Strong financial and political commitment of government

is crucial to ensure more equitable distribution of resources, such that infants born in rural areas do not continue to experience deprivation that would put them at higher odds of neonatal mortality compared with their counterparts in urban areas. A comprehensive approach to poverty alleviation and bridging the inequality gaps are essential in order to tackle the challenge that socio-economic disadvantage poses.

This study also revealed that norms and attitudes toward female autonomy impact significantly on neonatal survival. These factors should therefore be taken into account while designing interventions; in particular, community-oriented strategies to empower women. There also needs to be a focus on female education so as to provide women with wider opportunities and incentive to acquire skills that will provide them with options other than that of early marriage and long reproductive careers. However, due to the pervasive influence of community perceptions and attitudes, these interventions must be tailored in such a way harness the support of all members of the community so as to encourage a gradual but sustained change. This is particularly crucial in male-dominated communities.

Community norms surrounding fertility were also found to be associated with neonatal mortality. Also, infants born to mothers with shorter birth spacing intervals were found to be more likely to die in the neonatal period. These findings underlie the importance of effective implementation of reproductive health education and family planning programs. Utilization of maternal and neonatal health care services must also be supported across the continuum of the antenatal, delivery, and postnatal periods. This study shows that there is poor uptake of delivery and postnatal services among women in Nigeria and that this may impact negatively on the survival of their newborns. Scaling up of utilization of postnatal care services must therefore be a focus of future health interventions and programs. The

findings from this study can also serve as a framework to further investigate strategies to reduce neonatal mortality in Nigeria and sub-Saharan Africa.

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APPENDIX: Modified Conceptual Framework for factors influencing neonatal mortality: *adapted from Titaley et al.; Kayode et al. (31, 60)*