MODELLING THE RISK FACTORS OF NEONATAL MORTALITY IN GHANA USING LOGISTIC REGRESSION

BY

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DECLARATION

I hereby declare that this submission is my own original work towards the award of the M. Phil degree and that, to the best of my knowledge, it contains no material previously published by another person nor material which has been accepted for the award of any degree of the university, except where due acknowledgement had been made in the text.

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ABSTRACT

The purpose of this study was to use logistic regression to assess and analyse the risk factors of neonatal deaths in Ghana and to suggest some interventions that can be used in order to improve survival of newborns in the country.

Binary logistic regression was use for the presentation and analysis of data from the 2008 GDHS by the Ghana Statistical Service. Three models were developed each for mother level factors, child level factors and environmental level factors.

The results show that, for the mother level factors it was found that the age of the mother and the wealth index were risk factors as causing neonatal mortality in Ghana. For the child level factors which included size of child, sex of child and whether the child was a twin or not, none of these factors seen significant as causing neonatal mortality. For the environmental level factors it was found that only the region (site of delivery) of the respondent was significant.

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LIST OF ABBREVIATION

NM	Neonatal Mortality
SSA	Sub-Saharan Africa
UN	United Nation
GDHS	Ghana Demographic and Health Survey
GSS	Ghana Statistical Service
GHS	Ghana Health Service
WHO	World Health Organisation
NICU	Neonatal Intensive Care U nit
AOR	Adjusted Odds Ratios
NMR	Neonatal Mortality Rate
SNAP	Score for Neonatal Acute Physiology
NICHD	National Institute of Child Health and Human Development
CRIB	Clinical Risk Index for Babies
LBW	Low Birth Weight
TBA	Traditional Birth Attendant
NGO	Non-Governmental Organisation
UNICEF	United Nations Children Fund
SCBU	Special Care Baby Unit

EOS	Early Onset Sepsis
LOS	Late Onset Sepsis
UTI	Urinary Tract Infection
VIF	Variance Inflation Factor

DEDICATION

I dedicate this piece of work to the Almighty God for seeing me through this thesis writing.

I also dedicate to my lovely daughter Awedana Aurelia Kwara, my lovely son Awese Manuel Kwara and to my lovely mother Dampari Veronica Ayeko.

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND TO THE STUDY

Neonatal Mortality (NM) is the probability of a baby dying between birth and the first 28 days of life (Lawn, 2005). More than one million babies in Africa are dying in the first week of their life, half of them at the first day of life. Most deaths occur at home unseen and uncounted (Lawn, 2005).

This situation is serious worldwide especially in sub-Saharan Africa with Ghana being no exception. Even though 'newborn' is not a disease, large numbers of children die soon after birth: many of them in the first four weeks of life (neonatal deaths), and most of those during the first week (early neonatal deaths). For every baby who dies in the first week after birth, another is born dead (foetal death or stillbirths) (WHO, 2006). Causes and risk factors of neonatal deaths and stillbirths differ from country to country.

Some of the causes of neonatal deaths and stillbirths stem from poor maternal health, inadequate care during pregnancy, inappropriate management of complications during pregnancy and delivery, poor hygiene during delivery and the first critical hours after birth, and lack of newborn care. Several factors such as women's status in society, their nutritional status at the time of conception, early childbearing, too many closely spaced pregnancies and harmful practices, such as inadequate cord care, letting the baby stay wet and cold, discarding colostrum and feeding other foods, are deeply rooted in the cultural fabric of societies and interact in ways that are not always clearly understood (WHO, 2006).

In many societies, neonatal deaths and stillbirths are not perceived as a problem, largely because they are very common. Many communities have adapted to this situation by

not recognizing the birth as complete, and by not naming the child, until the newborn infant has survived the period.

Health workers at primary and secondary level of care often lack the skills to meet the needs of newborn infants, since the recognition of opportunity is only just emerging in countries, and their experience in this area of health is therefore limited. Babies die soon after birth because they are severely malformed, are born very prematurely, suffer from obstetric complications before or during birth, have difficulty adapting to extra uterine life, or because of harmful practices after birth that lead to some infections (WHO, 2006).

About 1% of infants have a major congenital anomaly. These anomalies are more common in developing countries than in developed countries, especially those caused by diseases such as syphilis and malaria or by nutrients deficiency, which leads to neural tube defects and cretinism.

Low birth weight has long been argued as one of the causes of neonatal deaths. It is associated with the death of many newborn infants, but has not been considered as a direct cause. Around 15% of new born infants weigh less than 2500 g, the proportion ranging from 6% in developed countries to more than 30% in the developing world. There is no doubt that maternal health and nutrition at conception are important factors of weight at birth.

Complications during birth, such as obstructed labour and foetal misrepresentation, are common causes of perinatal death in the absence of obstetric care. Birth asphyxia and trauma often occur together and it therefore becomes difficult to obtain separate estimates. In most cases, the baby dies during birth or soon after, due to damage to the brain and other organs. Less severe asphyxia and trauma will cause disability. Modern obstetric practices have almost eliminated birth trauma (WHO, 2006).

Conversely, where modern obstetric care is not available, intrapartum or early postnatal deaths are very frequent. It is estimated that in developing countries asphyxia causes around seven deaths per1000 births, whereas in developed countries this proportion is less than one death per 1000 births. Prolonged labour or prolonged rupture of membranes causes infections in mothers and babies.

However, babies are more susceptible than mothers and infections in infants are more difficult to detect. It is estimated that 26% of newborn infants who die is as a result of infections that occur during birth.

Although during pregnancy the uterus protects the baby from environmental infections, Some infections break through the safety barrier and affect the foetus. The most common diseases are syphilis and HIV. In countries where maternal syphilis is prevalent, many babies are stillborn, die soon after birth or are infected themselves (WHO, 2006).

Neonatal tetanus has been, and still remains, a common cause of neonatal death in areas where Lack of hygiene at birth and inadequate cord care are common, as in many cases women are not immunized against tetanus and cannot protect their unborn babies at birth. The majority of deaths from neonatal tetanus occur between the seventh and tenth day of life. Through massive tetanus toxoid immunization efforts, neonatal tetanus can be eliminated from many countries. There are over 50 countries where, in some districts, the proportion of cases of neonatal tetanus is 1 per 1000births (WHO, 2006).

After the first week of life, infections are the main cause of neonatal death in many countries. These are mostly acquired either in hospital as a complication of treatment for other perinatal conditions, or at home. Preterm infants are at greatest risk of becoming ill and dying. Harmful cord care practices cause neonatal tetanus if the mother is not

protected by immunization; poor feeding practices cause diarrhoea and poor growth; an unhygienic environment causes sepsis.

The relative contribution of each of these factors varies according to the health of the Pregnant woman and the prevalence of endemic diseases such as syphilis or malaria, but mostly due to the unavailability of adequate care during pregnancy, childbirth and the neonatal period. Early neonatal deaths are mostly due to complications during pregnancy or childbirth, preterm birth and malformations; late neonatal deaths are due to neonatal tetanus and infections acquired either at home or in hospital, when complications in special neonatal care occur.

The three delays model (Thaddeus and Maine, 1994), delay in recognition of illness, delay in seeking and accessing care and the delay in the provision of care once at a health facility has helped in understanding maternal deaths. Similar delays have been documented for newborns with severe illness and with the rapid progression of many neonatal illnesses it certainly can play an important role in neonatal deaths.

1.2 STATEMENT OF THE PROBLEM

The study area is Ghana, made up of the ten regions namely Greater Accra, Northern, Upper East, Upper west, Eastern, Westhern, Central, Volta, Brong Ahafo and Ashanti. Each region is demarcated in to districts currently made up of a total of 178 districts.

Ghana is a West African country bordering on the Gulf of Guinea and bounded by Burkina Faso to the north, Côte d'Ivoire to the west, Togo to the east, and the Atlantic Ocean to the south.

Currently, Ghana has a Land area of 238,538 sq. km. (92,100 sq. mi.) and total population of 24,339,838 (2010 caucus estimate). Additionally, it has growth rate 1.8%; birth rate of

28.0/1000; infant mortality rate of 49.9/1000;Life expectancy--62.3 yrs. for women, 59.8 yrs. for men; and density per sq. km: 101 (infoplease, 2011).

Ethnic groups include; Akan 45.3%, Mole Dagbon 15.2%, Ewe 11.7%, Ga-Dangme 7.3%, other groups 20.4%.In the area of religion, it is made up of 68.8% Christian , Muslim 15.9%, traditional 8.5%, other 0.7% , none 6.1%.It has a work force 11.1 million: Agriculture and fishing--47.9%;industry and transport—16.2%; sales and clerical--19.3%;services--5.9%; *professional*--8.9%; *other*--1.8%.

The proportion of child deaths that occurs in the neonatal period is increasing and The Millennium Development goal for child survival cannot be met without substantial reduction in neonatal mortality. Of the estimated 130 million infants born each year worldwide, 4 million die in the first 28 days of life. Almost two-thirds of infant deaths occur in the first month of life, of these, more than two-thirds die in their first week and among those, two thirds die in their first 24 hours after birth (Lawn *et al*, 2001).

Neonatal deaths account for 40% of deaths under the age of 5 years worldwide. Therefore, efforts to achieve the UN Millennium Development Goal four (4) of reducing childhood mortality by two-thirds by 2015 is focused on reducing neonatal deaths in high-mortality countries.

In Africa the story is not different but more serious as more than one million babies are dying in the first week of their life, half of them at the first day of life. Most deaths occur at home unseen and uncounted (Lawn, 2005).

Newborn survival is an issue of great concern to the world and especially to developing countries. Care for the neonate often receives little attention in maternal and child health programmes. Though various efforts have been made by governments to reduce infant

mortality, neonatal mortality keeps increasing. Of the approximately four million global neonatal deaths that occur annually, it is estimated that 98 percent occur in developing countries especially in sub-Saharan Africa, where most newborns die at home while they are cared for by mothers, relatives, and traditional birth attendants (WHO, 1996).

The world 2009 children's report indicate that Ghana had varying estimates ranging from 214-560 per 100,000 live births and observed that estimating maternal mortality was technically difficult because communities or facilities often did not identify new born or neonatal deaths.

There has been little progress in reduction of neonatal deaths in the first four (4) Weeks of life in Ghana, this study is therefore sought to assess the risk factors that lead to neonatal deaths and to suggest some interventions to help reduce the problem.

1.3 OBJECTIVES

General Objective

To assess and analyse the risk factors of neonatal deaths in Ghana and to suggest some interventions that can be used in order to improve survival of newborns in the country.

Specific Objective

1. To model mother level risk factors in Ghana using logistic regression.
2. To model child level risk factors in Ghana using logistic regression.
3. To model environmental level risk factors using logistic regression.

1.4 METHODOLOGY

Rates of neonatal deaths are calculated and bivariate analysis has been carried out to understand the relation between these mortalities with three aspects: mother level factors, child level factors and environmental level factors. The three models developed in the study are:

Model 1: Mother level factors which included age of mother, religion and the, wealth index.

Model 2: Child level factors which includes size of child, sex of child and child is a twin.

Model 3: Environmental level factors included place of delivery, source of drinking water and the region of respondent.

The data has been extracted from the nationwide large-scale sample survey "Ghana demographic and health survey (GDHS)'' conducted by Ghana Statistical Service (GSS), Ghana Health Service (GHS) and ICF Macro in 2008.

Computer software SPSS will be used for the data analysis to established the model for the data.

1.5 JUSTIFICATION

1. The study would serve as a guide to stakeholders in making informed and intelligent policy decisions with regard to neonatal mortality and the management of the risk factors to avoid the death of neonates in the country.

2. The results obtained from this study will add information to this problem and eventually help in the achievement of the millennium development goals of reducing under-five mortality by two-thirds between 1990 and 2015.

1.6 THESIS ORGANIZATION

Chapter 1 talks about the introduction, statements of the problem, objectives of the study, methodology and justification of the study. Chapter 2 deals with the literature materials and the sources consulted for complete and concrete information. Chapter 3 described the details of the methodology used in analysing the data whiles chapter 4 talks about the mode of data collection and analysis. Chapter 5 gives the summary and conclusion of the research and findings. Recommendations were also made in the chapter five to Governments and other stakeholders for further study.

CHAPTER 2

LITERATURE REVIEW

2.0 INTRODUCTION

This chapter present a review of the situation of neonatal mortality in general and the factors that neonatal mortality in particular.

All over the world, major changes are taking place in the area of maternal and child health to achieve the goals set out in international declarations and country commitments. The need for evaluation and information has, therefore, become increasingly apparent. Governments and professional organizations have to monitor the overall impact of the changes that are set in motion and compare them internationally. As under-five mortality is decreasing in almost all countries, except in those affected by the HIV/AIDS epidemic, neonatal mortality emerges as an increasingly prominent component of overall under-five mortality and is thus receiving additional attention. Consequently, information on perinatal and neonatal mortality at international level is in great demand (WHO, 2000).

The 2000 report by the WHO provides neonatal and perinatal mortality estimates by country, regional groupings and globally. The results show that every year over 4 million babies die in the first four weeks of life; 3 million of these deaths occur in the early neonatal period. Moreover, it is estimated that more than 3.3 million babies are stillborn every year; one in three of these deaths occurs during delivery and could largely be prevented. Ninety-eight per cent of the deaths take place in the developing world. In developing countries, the risk of death in the neonatal period is six times greater than in developed countries; in the least developed countries it is over eight times higher. With 41 neonatal deaths per 1000 live births, the risk of neonatal death is highest in Africa; the sub-Saharan regions of Eastern, Western and Central Africa have between 42 and 49 neonatal

deaths per 1000 live births. South-central Asia, with 43 neonatal deaths per 1000 live births, shows rates close to those registered in sub-Saharan Africa, while the neonatal mortality rate for Latin America and the Caribbean is 15 per 1000 live births. Most neonatal deaths occur in Asia, which is where most children are born. Given the high mortality rate in the South-central Asia sub region, over 40% of global neonatal deaths take place here, which presents a formidable challenge. to those leading to stillbirths. Worldwide, there are over 6.3 million perinatal deaths a year, almost all of which occur in developing countries, and 27% of them in the least developed countries alone. Stillbirths account for over half of all perinatal deaths. One third of stillbirths take place during delivery, and are largely avoidable. Intrapartum deaths (i.e. those occurring during delivery) are closely linked to place of, and care at, delivery. In developing countries, just over 40% of deliveries occur in health facilities and little more than one in two takes place with the assistance of a doctor, midwife or qualified nurse .Compared with earlier estimates, global and regional neonatal and perinatal mortality rates have slowly declined. Improvements appear to have been more noticeable in South America than in other regions of the world (WHO 2000 cited in 2006).

Thanks to public health interventions, under-five and infant mortality rates are decreasing at a faster pace than neonatal mortality; consequently, neonatal deaths will represent an increasing proportion of child deaths. The 2000 report by the WHO suggests that countries should be allowed to review their achievements in the area of maternal and neonatal health and compare their results with those obtained by other countries. They were also of the view that the Problems related to early mortality data and its availability is hoped to stimulate further research and collection of population-based data, which will help to improve mortality monitoring and provide health managers with comparative information about the nature and extent of the problem in their country. This chapter presents a review

on neonatal mortality, its relationship with stillbirth and perinatal mortality and the risk factors or causes of neonatal mortality

2.1 ANALYSES AND PREDICTION OF MODELS OF NEONATAL MORTALITY

Considering the effects of the death of a neonate or the mother on the immediate family, the community and the society as a whole. A lot of research has been conducted both locally and globally on neonatal mortality and its risk factors.

Lawn et al. (2005) did a study on why, when and where 4 million babies dies each year. They observed that every year an estimated 4 million babies die in the first 4 weeks of life (the neonatal period). A similar number are stillborn and 0.5 million mothers die from pregnancy-related causes. The results of the study indicate that the main direct causes of neonatal death are estimated to be preterm birth (28%), severe infections (26%), asphyxia (23%) and neonatal tetanus (7%). Low birth weight is an important indirect cause of death. Maternal complications in labour carry a high risk of neonatal death. They concluded that poverty is strongly associated with an increased risk.

Karen et al. (2008) conducted a study which objective was to describe the timing and distribution of causes of stillbirths and neonatal deaths according to site of death (health facility or home). A community-level verbal autopsy tool was used to obtain data on the aetiology of stillbirths and neonatal deaths in rural Ghana. Data was collected from 1 January 2003 to 30 June 2004; 20 317 deliveries, 696 stillbirths and 623 neonatal deaths occurred over that time. They find out that most of the deaths occurred in the antepartum period (28 weeks gestation to the onset of labour (33.0%)) and noticed that the highest risk periods were during labour and delivery (intrapartum period) and the first day of life. Infections were a major cause of death in the antepartum (10.1%) and neonatal (40.3%)

periods. They concluded that the most important cause of intrapartum death was obstetric complications (59.3%).

Abdullah et al. (2008) implemented a community-based intervention package through government and non-government organisation infrastructures to reduce neonatal mortality in Bangladesh. In Sylhet district, 24 clusters (with a population of about 20 000 each) were randomly assigned in equal numbers to one of two intervention arms or to the comparison arm. All married women of reproductive age (15—49 years) were eligible to participate. In the home-care arm, female community health workers identified pregnant women, made two antenatal home visits to promote birth and newborn-care preparedness and postnatal home visits to assess newborns on the first, third, and seventh days of birth, and referred or treated sick neonates. In the community-care arm, birth and newborn-care preparedness and care seeking from qualified providers were promoted solely through group sessions held by female and male community mobilisers. The number of participants was 36059, 40159, and 37598 in the home-care, community-care, and comparison arms, respectively, with 14 769, 16 325, and 15 350 livebirths, respectively. The results show that in the last 6 months of the 30-month intervention, neonatal mortality rates were 29·2 per 1000, 45·2 per 1000, and 43·5 per 1000 in the home-care, community-care, and comparison arms, respectively. Neonatal mortality was reduced in the home-care arm by 34%.

Karen et al. (2007) conducted a study on the effect of early infant feeding practices on infection specific neonatal mortality. The objective of the study was to assess the effect of early infant feeding practices on infection-specific neonatal mortality in breastfed neonates aged 2–28 days. It was a prospective observational cohort study based on 10 942 breastfed singleton neonates born between 1 July 2003 and 30 June 2004, who survived to day 2, and whose mothers were visited in the neonatal period. Verbal autopsies were used to ascertain the cause of death. The results show that 140 neonates died from day 2 to day 28;

93 died of infection and 47 of non-infectious causes. The risk of death as a result of infection increased with increasing delay in initiation of breastfeeding from 1 h to day 7; overall late initiation (after day 1) was associated with a 2.6-fold risk. Partial breastfeeding was associated with a 5.7-fold adjusted risk of death as a result of infectious disease.

Claydon et al. (2007) conducted a study of which the purpose was to identify the risk factors for neonatal intensive care unit (NICU) mortality among Canadian-born minority infants and, furthermore, to determine whether ethnicity was in itself an independent predictor of mortality or major morbidity in the NICU. Data were prospectively gathered on 6528 infants admitted to nine regionally located NICUs across Canada. Multiple logistic regressions were used to develop risk-adjusted models for NICU mortality and major morbidity. The results show that despite adjusting for differences in small for gestational age (SGA), outborn status and gestational age less than or equal to 28 weeks, South Asian infants still had significantly greater odds of mortality in the NICU. Neonatal sepsis was the strongest predictor of mortality among African infants, even greater than birth at 28 weeks or less. At significantly greater odds of survival with major morbidity were Aboriginal males and East Asian females. They concluded that there were ethnic disparities in the risks of neonatal mortality and morbidity in the NICU.

Mavankar et al. (1991) to estimate levels and determinants of perinatal mortality conducted a hospital-based surveillance and case-control study, linked with a population survey, in Ahmedabad, India. The found out that perinatal mortality rate was 79.0 per 1000, and was highest for preterm low-birth-weight babies. The case-control study of 451 stillbirths, 160 early neonatal deaths and 1465 controls showed that poor maternal nutritional status, absence of antenatal care, and complications during labour were independently associated with substantially increased risks of perinatal death. Multivariate

analyses indicate that socioeconomic factors largely operate through these proximate factors and do not have an independent effect.

Lee et al. (2008) conducted a study, of which the goal was to identify antepartum, intrapartum, and infant risk factors for birth asphyxia mortality in a rural, low-resource, population-based cohort in southern Nepal. Data were collected prospectively during a cluster-randomized, community-based trial evaluating the impact of newborn skin and umbilical cord cleansing on neonatal mortality and morbidity in Sarlahi, Nepal. A total of 23662 newborn infants were enrolled between September 2002 and January 2006. Multivariable regression modelling was performed to determine adjusted relative risk estimates of birth asphyxia mortality for antepartum, intrapartum, and infant risk factors. The results show that birth asphyxia deaths (9.7/1000.0 live births) accounted for 30% of neonatal mortality. Antepartum risk factors for birth asphyxia mortality included low paternal education, Madeshi ethnicity, and prim parity. Facility delivery; maternal fever; maternal swelling of the face, hands, or feet; and multiple births were significant intrapartum risk factors for birth asphyxia mortality. The concluded that maternal infections, prematurity, Low socioeconomic status and multiple births are important risk factors for birth asphyxia mortality in the low-resource, community-based setting.

Mercer et al. (2006) conducted a study aimed at identifying the main factors associated with neonatal mortality in Bangladesh and with a view to developing appropriate strategies for prevention. A case-control design was adopted for collection of data from mothers whose children, born alive in 2003, died within 28 days postpartum (142 cases), or did not (617 controls). Crude and adjusted odds ratios (AOR) were calculated as estimates of relative risk for neonatal death, using 'neighbourhood' controls (241) and 'non-neighbourhood' controls (376).The main risk factors for neonatal death among 122 singleton babies, based on the two sets of controls, were: complications during delivery,

prematurity and care for a sick neonate from an unlicensed 'traditional healer'. They concluded that there is the need for identification of babies at high risk and early postpartum interventions because accorded to them40.2% of the deaths occurred within 24 hours of delivery.

Huffiman *et al. (2001)* review literature on the relationship between breast-feeding practices in the first month of life and neonatal mortality. Medline and Cochrane databases were searched using the keywords breastfeeding, and neonatal mortality, supplemented with additional searches using the keywords developing countries, colostrum, infant feeding and infant mortality, hypoglaecemia, hypothermia, breastfeeding practices, and suckling. The findings show that breast feeding helps prevent hypothermia and hypoglycaemia in newborn babies, which are contributory causes of early neonatal deaths especially among low birth weight and premature babies. Feeding colostrum and breast feeding, especially exclusive breast feeding, protects the newborn against deaths. *The* concluded that in most developing countries, nearly all women breast feed in the first month of life, but often breast feeding is delayed beyond the first hour after birth, and exclusive breast feeding is not usually practised.

Abhay et al. (1999) developed a package of home based neonatal care, including management of sepsis and tested it in the field, with the hypothesis that it would reduce the neonatal mortality rate by at least 25% in 3 years. They chose 39 interventions and 47 control villages in the Gadchiroli district in India, collected baseline data for 2 years (1993-95), and then introduced neonatal care in the intervention villages (1995-98). Village health workers trained in neonatal care made home visits and managed birth asphyxia, premature birth or low birth weight, hypothermia, and breast-feeding problems. They diagnosed and treated neonatal sepsis. Assistance by trained traditional birth attendants, health education, and fortnightly supervisory visits were also provided. Other

workers recorded all births and deaths in the intervention and the control area (1993-98) to estimate mortality rates. In the third year of intervention 93% of neonates received home-based care and the indicated Neonatal, infant, and perinatal mortality rates in the intervention area compared with the control area, were 25·5 (62·2%), 38·8 (45·7%), and 47·8 (71·0%), respectively. Case fatality in neonatal sepsis declined from 16·6% (163 cases) before treatment, to 2·8% (71 cases) after treatment by village health workers.

Adnan et al. (2003) to assess the burden of disease on neonatal mortality in two developing regions. The study area was South Asia and Sub-Saharan Africa. Data on neonatal mortality were gathered from peer-reviewed literature, reports of the Demographic and Health Surveys and websites of country-based organisations. The base year for this study is 1995. For each country, a weighted mean neonatal mortality rate was calculated and the total number of neonatal deaths estimated. The results show that neonatal mortality rate for South Asia ranged from 41.9 to 56.9 per 1000 live births for 1995. Sri Lanka was an exception with a neonatal mortality rate of16.3 to 18.6 per 1000 live births. The estimated regional neonatal mortality rate for South Asia was 46.27 per 1000 live births for 1995. There was a significant lack of data from Sub-Saharan Africa, resulting in highly variable neonatal mortality rates, ranging from 13 per 1000 live births in Kenya to 108 per 1000 live births in Senegal. The mean regional neonatal mortality for Sub-Saharan Africa for 1995 was estimated at 38.8 per 1000 live births. They concluded that the burden of neonatal mortality in only these two regions of the developing world represents more than 2 million annual deaths

Baiden et al. (2006) in describing the trend and causes of neonatal deaths in a rural district in northern Ghana. Descriptive analysis of data collected from the Navrongo Demographic Surveillance System and verbal autopsies conducted on all neonatal deaths from 1995–2002.The Results show that of 1118 recorded neonatal deaths 1068 (95.5%)

could be analysed. Only 13.2% of deaths occurred at the health facility; 62.7% occurred in the early neonatal period, with prematurity (38%) and birth injuries (19%) as leading causes. Infectious causes (66%) were the major contributors to late neonatal deaths. Infanticide accounted for 4.9% of all neonatal deaths. The cause-specific mortality rate for neonatal tetanus remained under 2.5% throughout the 8-year period. Overall, the neonatal mortality rate declined at an average of 2.5 per 1000 live births per year: Down by nearly 50% from 40.9 in 1995 to 20.5 in 2002.Theyconcluded by saying various health interventions undertaken in this district have had the collateral effect of causing decline in neonatal mortality.

Hill and Choi (2006) presented a paper that examines age patterns and trends of early and late neonatal mortality in developing countries, using birth history data from the Demographic and Health Surveys (DHS). They found out that the median neonatal mortality rate (NMR) across 108 nationally-representative surveys was 33 per 1000 live births. NMR averaged an annual decline of 1.9 % in the 1980s and 1990s. Declines have been faster for late than for early neonatal mortality and slower in Sub-Saharan Africa than in other regions. Age patterns of neonatal mortality were comparable with those of historical data, indicating no significant underreporting of early neonatal deaths in DHS birth histories.

Murray et al. (2000) conducted a study to test and compare published neonatal mortality prediction models, including Clinical Risk Index for Babies (CRIB), Score for Neonatal Acute Physiology (SNAP), SNAP-Perinatal Extension (SNAP-PE), Neonatal Therapeutic Interventions Scoring System, the National Institute of Child Health and Human Development (NICHD) network model, and other individual admission factors such as birth weight, low Apgar score and small for gestational age status in a cohort of VLBW infants from the Washington, DC area. Data were collected on 476 VLBW infants

admitted to 8 neonatal intensive care units between October 1994 and February 1997. The calibration of models with published coefficients was assessed using the standardized mortality ratio. Calibrated models were derived for the current database using logistic regression techniques. Goodness-of-fit of predicted to observed probabilities of death was assessed with the Hosmer-Lemeshow goodness-of-fit test. The results show that the standardized mortality ratios for the NICHD, CRIB, and SNAP-PE models were .65, .56, and .82, respectively. The variables in the best model were birth weight, birth weight squared, low 5-minute Apgar score, and SNAP (AUC = .930). They concluded that Published models for severity of illness over predicted hospital mortality in this set of VLBW infants, indicating a need for frequent recalibration.

KarunaseKera and Pathirana (1999) conducted a study to estimate the incidence of neonatal septicaemia, to identify risk factors, clinical presentations and causal organism. A cross-sectional study of neonates admitted from January to December 1996 with clinical evidence of septicaemia. Gestational age, birth weight and mode of delivery were evaluated as risk factors for septicaemia. Data was analysed by using Epi Info version 6.The results show that 98 babies had septicaemia. Incidence of septicaemia was 24.4 per 1000 live births and case fatality rate was 11.2%. Incidence was significantly higher in preterm babies, babies with low birth weight (LBW) and those born following instrumental delivery. 21.4% developed septicaemia on the first day of life, 74.5% between 2 and 7 days and 4.1% after the first week. Common presenting features were fever 61.2%, jaundice 52%, lethargy 37.8% refusal of feeds 25.5%, coffee grounds vomiting 22.4%, and fits 12.2%. Common bacteria identified were Klebsiella 26.5%, Staphylococcus aureus 15.3%, coliform bacilli 9.2% and spore forming bacilli 9.2%. Common sensitive antibiotics were amikacin 88.9%, amoxycillin + clavulanic acid 83%, ceftriaxone 78.1%

and netilmicin 63.9%.They concluded that Septicaemia is an important cause of morbidity, particularly in preterm babies, in babies with LBW and those with instrumentation at birth.

Mukhtar et al.(2007) conducted a study to identify the common causes of neonatal morbidity and mortality among babies admitted to the special care baby units (SCBU) in Aminu Kano Teaching Hospital (AKTH) the case-notes of all admitted neonates from January 1998 to December 2004 were retrospectively reviewed. A total of 2963 (98.3%) babies had complete records. There were 1455 (49.1%) in-born and 1508 (50.9%) out-born babies. The sex ratio was1.25:1in favour of males. A total of1868 (63.0%) were of normal birth weight, while 951 (32.1%) and 134 (4.5%) were low birth weight and macrocosmic, respectively. There results show that the leading diagnoses were birth asphyxia (27%), neonatal sepsis (25.3%) and prematurity (16.0%). Out of the 2963 babies, 501 (16.9%) died. The risk of dying was significantly higher (20.5%) among out-born babies compared with those delivered in AKTH (6.4%). They concluded that neonatal mortality could be prevented through effective antenatal care, supervised delivery and appropriate care and early referral of sick neonates.

Njokanma and Olanrewaju (1995) did a two-year prospective study of neonatal deaths at a Nigerian University Teaching Hospital. There were 55 deaths among 1081 inborn live deliveries (50.88/1000). Low birthweight babies accounted for 60% of deaths. There were 49 (45.33/1000) perinatal deaths, 61% of which occurred within 24 hours. The mortality rate of term small-for-gestational age neonates was higher than that of their appropriate-for-gestational age counterparts. The mortality rate for 315 referred admissions was 400/1000. Severe infections, severe birth asphyxia, respiratory distress syndrome and recurrent apnoea were among the leading causes of death in this study. They concluded that there is a need for improved intensive care facilities for the high-risk newborn.

Isaacs and Royle (1999) conducted a study on late onset systemic infections with coagulase negative staphylococci. Prospective longitudinal study of coagulase negative staphylococcal infection in 18 Australasian neonatal nurseries. The results show that from 1991 to 2000 inclusive, there were 1281 cases of coagulase negative staphylococcal (CoNS) sepsis, comprising 57.1% of all late onset infections. The male/female ratio was 1.27:1. The incidence of CoNS sepsis was 3.46 episodes per 1000 live births. Most infected babies (71%) were 24-29 weeks gestation at birth. The first positive culture was day 7-14 in 49% of babies. Five cases of meningitis were reported, an incidence of 0.4% of all CoNS infections. Twenty nine babies (2.3%) had concurrent necrotising enterocolitis and CoNS septicaemia. Four babies (0.3%) died from CoNS infection, but CoNS infection possibly contributed to the death of an additional 20 babies (1.6%). The mortality directly attributable to CoNS infection was significantly lower than that from late onset infections with Staphylococcus aureus (13.1%; relative risk (RR) = 36.1 (95% confidence interval (CI) 13.0 to 100.2) or with Gram negative bacilli (14.2%; RR = 45.5 (95% CI 16.8 to 123.3)).They concluded that CoNS are currently responsible for most late onset neonatal infections.

Lim (1995) conducted a survey to determine the rate, outcome, and culture and sensitivity patterns of bacteraemic infections in a large Neonatal Intensive Care Unit (NICU). Over a nine-month period, 136 episodes of infection occurred in 132 (6.9%) out of 1926 admissions. Early onset infection accounted for 35 episodes (25.7%) and was associated with a higher mortality rate compared to late onset infection (45.7% vs. 23.8%, $p < 0.02$). Very low birth weight (VLBW) infants had significantly higher rates of infection (19.4% vs. 5.3%, $p < 0.001$) and mortality (45.2% vs. 23.3%, $p < 0.02$) compared to bigger babies. Gram negative bacilli accounted for 25 early and 90 late isolates while gram positive organisms accounted for 10 early and 16 late isolates. The two main organisms

(Acinetobacter and Klebsiella) showed a 69.0 to 85.3% resistance to aminoglycosides and 3rd generation cephalosporins. Ten of 13 isolates of Staphylococcus epidermidis and 3 of 4 Staphylococcus aureus were methicillin resistant. He concluded that multiply resistant infections were a major problem in this NICU and efforts to eradicate them needed to be intensified.

Kuruvilla et al (1998) study the pattern of sepsis in a neonatal unit in south India and assess the influence of maternal factors on early onset sepsis (EOS).It was a prospective survey from 1995-1996 at the Medical College Hospital. All inborn babies who had clinical signs of sepsis or were born to mothers with potential risk factors for infection were screened for sepsis. Among 13,367 live births in the study period, there were 131 episodes of neonatal septicemia among 125 newborn infants, 18 (14.4%) of whom died. Thirty (24%) had EOS and 95 (76%) had late onset sepsis (LOS). Sepsis occurred in 9.8 per 1000 livebirths and 4.4% of all nursery admissions. E. coli and E. fecalis were the predominant organisms causing EOS, while Klebsiella and E. fecalis were the predominant organisms in LOS. The mean gestational age (GA) and birth weight (BW) of babies with EOS was significantly higher than those with LOS.They concluded that the incidence of neonatal bacterial sepsis is 9.8 per 1000 livebirths. E. coli and Klebsiella were the most common organisms causing EOS and LOS, respectively.

Mesko et al. (2003) reported on a combined quantitative and qualitative study of care seeking obstacles and practices relating to perinatal illness in rural Makwanpur district, Nepal with particular emphasis on consultation strategies. The analysis included a survey of 8798 women who reported a birth in the previous two years [of whom 3557 reported illness in their pregnancy], on 30 case studies of perinatal morbidity and mortality, and on 43 focus group discussions with mothers, other family members and health workers. The results show that the most common recalled maternal complications were prolonged

labour, postpartum haemorrhage and retained placenta. Neonatal death, though less definable, was often associated with cessation of suckling and shortness of breath. Self-medication was common. They concluded by saying the major obstacles to seeking care were: a limited capacity to recognise danger signs; the need to watch and wait; and an overwhelming preference to treat illness within the community.

Runwese-Abiodun (2001) conducted a study with the aims at documenting the prevalence of malaria in neonates admitted into neonatal ward. Hospital records of 230 patients admitted into the Neonatal ward of Olabisi Onabanjo University Teaching Hospital, Sagamu between 1st January 1998 and 31st December 1999 were reviewed. 57 neonates who had a positive blood smear for the malaria parasite were included in the study. Socio-demographic data as well as clinical correlates of each of the patients were reviewed. The Epi-Info 6 statistical software was used for data entry, validation and analysis. The results show that the Prevalence of neonatal malaria in this study was 24.8% and 17.4% for congenital malaria. While the mean duration of illness was 3.60 days, it varied from 5.14 days in those that died and 3.55 in those that survived respectively. It was concluded that taking a blood smear to check for the presence of the malaria parasite should be included as part of routine workup for all neonates with fever or those whose mothers have history of fever two weeks prior to delivery.

Bang et al. (2001) conducted a study to estimate: the incidence of various neonatal morbidities and associated case fatality in home-cared rural neonates, proportion of neonates with indications for health care and the proportion who actually receive it. Neonates in 39 study villages in the Gadchiroli district (Maharashtra, India) were observed during one year (1995-96) by 39 trained female village health workers at birth and during neonatal period (0-28 days) by making eight home visits. A physician checked the data and the morbidities were diagnosed by a computer program. Vital statistics in these villages

was independently collected. The results showed that out of 1016 live births, 95% occurred at home and 763 (75%) neonates were observed. The agreement between observations by health workers and physician was 92%. The neonatal mortality rate was 52.4/1000 live births. They concluded that nearly half of the neonates in rural homes developed high risk morbidities ten times the neonatal morbidity rate and needed health care.

Ross et al (1982). Observed that little has been published about the underlying disorders responsible for the high perinatal mortality rates found in African cities. They searched for answers by identifying the causes of fetal and neonatal death in Blacks living in and around Durban. A 91% autopsy rate was achieved when 506 postmortem examinations were performed in 557 consecutive cases of fetal and early neonatal death. The perinatal mortality rates were 55/1000 for single births and 170/1000 for twins; 29% of the deaths were due to amniotic fluid infections, 9% to abruptio placentae, 5% to birth trauma, 4% to congenital syphilis, 4% to obstructed labour, 4% to major congenital malformations, 2% to umbilical cord compression and the rest to more than 20 other specific disorders.

Tallur et al. (2000) observed that septicemia is a leading cause of neonatal morbidity and mortality in India. In a study of 242 infants with septicemia conducted between March 1996 & June 1997 at Hubli, Karnataka, Its showed that 43.39% infants had 'very early onset' sepsis (VOS), 40.08%, had 'early onset' sepsis (EOS), and 16.53% 'late onset' sepsis (LOS). 54.55% neonates had birth weight below 2000 g and 39.67% were born before 37 weeks of gestation. The cardiorespiratory signs and jaundice were the most frequent clinical features. The overall mortality rate was 47.52% and the case fatality rate in LOS was higher than in VOS and EOS. The mortality was significantly higher in neonates with lower birth weight and lower gestational age. They concluded that the study underlines the importance of monitoring the various features of neonatal septicemia, as well as the drug resistance of the pathogens from the nurseries.

Onayade et al. (2006) did a study with the objective to assess sociodemographic and other determinants of neonatal mortality in Wesley Guild Hospital (WGH), Ilesa, Nigeria. A record review of 235 neonatal deaths reported at WGH from January 01 2001 to December 31 2003. Similarly, records of equal number of neonates (235) admitted to the same hospital during the same period but who were discharged alive was also reviewed for comparison. 470 records were reviewed. The two groups were matched for age, sex and within a 7-day period of admission. Information collected included the bio-data of the mothers, birth weight of neonates, estimated gestational age at delivery, age at death or discharge, date of admission, duration of the illness and date of discharge. Others included mode and place of delivery, maternal booking status and complications of pregnancy and birth. Data were analyzed using descriptive and inferential statistics by computer software, Epi-Info 2002.The results show that teenage pregnancy, low birth weights (LBW), prematurity and neonatal tetanus were positively associated with neonatal death. Unbooked mothers, deliveries at missions and homes and low socioeconomic status were also positively associated with neonatal death. There was no statistically significant association between the sex of neonate, parity of mother and complications in pregnancy with neonatal death. They concluded that the major determinants of neonatal deaths were teenage pregnancy, prematurity, LBW, poverty and lack of skilled attendance at delivery.

Malik and Pennie (1994) conducted a prospective study of 486 high risk neonates admitted to a level II nursery in a relatively poor and rural area of Malaysia. It was carried out to determine the incidence, the spectrum of micro-organisms and predisposing factors in relation to early onset septicaemia. The results show that the incidence of proven or probable septicaemia was 57.61 per 1000 high risk newborns over 1.5 kg. The case fatality was 10.71 per cent. Coagulase negative staphylococci, Streptococcus Group B and Klebsiella species were the most commonly isolated organisms. Meconium staining of

liquor was the most common risk factor for admission to the nursery, and prematurity was the most significant risk factor for early neonatal infection followed by small for gestational age.

Bhutta and Yusuf (1997) prospectively evaluated risk factors for early-onset neonatal (EON) sepsis in a case-control study among inborn patients at the Aga Khan University medical Centre in Karachi between 1990 and 1993. A total of 38 cases with blood culture proven bacterial sepsis were identified within 72 hours of birth (prevalence 5.6 of 1000 live births) and matched with two consecutive gender matched births with no complications. The most common isolates were Staphylococcus aureus (18%), group B Streptococci (13%), and Klebsiella pneumoniae (13%). Univariate analysis of maternal risk factors revealed a significant association between maternal urinary tract infection (UTI), maternal pyrexia, vaginal discharge, and vaginal examinations during labour, and EON sepsis. They concluded that the data suggest the possibility that both vertical transmission from the mother as well as postnatal acquisition of infection from the environment may be of importance in the pathogenesis of EON sepsis in Karachi

Taha et al. (1997) conducted a study to determine if cleansing the birth canal with an antiseptic at delivery reduces infections in mothers and babies postnatally. It involved Clinical trial; two months of no intervention were followed by three months of intervention and a final month of no intervention. Manual wipe of the maternal birth canal with a 0.25% chlorhexidine solution at every vaginal examination before delivery. Babies born during the intervention were also wiped with chlorhexidine.3635 women giving birth to 3743 babies were enrolled in the intervention phase and 3330 women giving birth to 3417 babies were enrolled in the non-intervention phase. There were no adverse reactions related to the intervention among the mothers or their children. Among infants born in the intervention phase, overall neonatal admissions were reduced (634/3743 (16.9%) v

661/3417 (19.3%), P < 0.01), as were admissions for neonatal sepsis (7.8 v 17.9 per 1000 live births, P < 0.0002), overall neonatal mortality (28.6 v 36.9 per 1000 live births, P < 0.06), and mortality due to infectious causes (2.4 v 7.3 per 1000 live births, P < 0.005).They concluded that cleansing the birth canal with chlorhexidine reduced early neonatal and maternal postpartum infectious problems.

Bang et al (1999) developed a package of home-based neonatal care, including management of sepsis, and tested it in the field, with the hypothesis that it would reduce the neonatal mortality rate by at least 25% in 3 years. They chose 39 intervention and 47 control villages in the Gadchiroli district in India, collected baseline data for 2 years (1993-95), and then introduced neonatal care in the intervention villages (1995-98). Village health workers trained in neonatal care made home visits and managed birth asphyxia, premature birth or low birth weight, hypothermia, and breast-feeding problems. They diagnosed and treated neonatal sepsis. Assistance by trained traditional birth attendants, health education, and fortnightly supervisory visits were also provided. Other workers recorded all births and deaths in the intervention and the control area (1993-98) to estimate mortality rates. The findings show that Baseline (1993-95) neonatal mortality rate in the intervention and the control areas was 62 and 58 per 1000 live births, respectively. In the third year of intervention 93% of neonates received home-based care. Neonatal, infant, and perinatal mortality rates in the intervention area compared with the control area, were 25.5 (62.2%), 38.8 (45.7%), and 47.8 (71.0%), respectively. Case fatality in neonatal sepsis declined from 16.6% (163 cases) before treatment, to 2.8% (71 cases) after treatment by village health workers. They concluded by saying that our approach could reduce neonatal mortality substantially in developing countries.

Musoke and Revathia (2000) observed that over the years there has been an increasing resistance of organisms isolated in the neonatal unit. There was a need therefore to

scrutinize the problem so as to be able to plan for the future. Over a 5-month period, 716 infants were admitted of which 192 were screened for sepsis. Overall, 121 (16.7%) had positive blood cultures. The predominant organisms were Gram negative (73.6% of isolates) with Klebsiella species topping the list at 31 per cent. Case fatality for infants infected with Gram negative organisms was 41 per cent. Resistance to gentamicin was 20% chloramphenicol 23.6%, and amoxicillin/ampicillin 66.3%.They concluded that if these drugs cannot be used in 20-27% of cases then the situation is serious.

Bhutta Z. (1996) noticed that enterobacter sepsis is commonly recognized as a hospital-acquired infection in childhood. In a five year prospective surveillance of neonatal sepsis at the Aga Khan University Hospital in Karachi, they identified Enterobacter sepsis in 28/292 (10%) cases, with an incidence of 0.7 per1000births among inborn infants. There was no significant difference in predisposing factors and clinical features between Enterobacter and other infections. Approximately half (47%) of Enterobacter infections presented within 72 h of birth and the associated mortality was 21%. They concluded that Enterobacter infections are emerging as significant pathogens among cases of neonatal sepsis in Karachi.

Tan et al. (1998) conducted a study which aims was to establish the incidence and clinical characteristics of early and late onset Group B Streptococcal (GBS) septicaemia in neonates in the hospital over a period of 1 year. By a system of clinical case review and follow-up, mail, telephone and home visits, the outcome of all 15,062 livebirths in the hospital over a 1-year period were verified and reported. Our results show a low incidence of GBS infection in neonates in the hospital: early onset disease was 0.265 per 1,000 livebirths and late onset a quarter of that. The majority of cases of early onset GBS disease were in premature infants. Because of our low incidence, prophylaxis schedules would have to ensure an acceptably smaller number of mothers exposed to antibiotics over and

above the current level and the cooperation of our obstetricians. We have devised a schedule incorporating a current prelabour premature rupture of membranes(PROM) protocol which would result in only an additional 2.2% of mothers requiring prophylactic antibiotics.

Isaacs and Royle (1999) conducted a study aimed to determine the incidence of early onset infections caused by group B Streptococcus (GBS) and other organisms in Australia and to assess intrapartum antibiotic use. It involved a longitudinal, prospective surveillance of neonatal infections in Australian neonatal units from 1991 to 1997. Early onset infection defined as clinical sepsis in first 48 h after birth, with positive cultures of blood or cerebrospinal fluid or positive urine GBS antigen detection. The results show that the incidence of EOGBS sepsis fell from 2.0 per 1000 live births in 1991 to 1993, to 1.3 in 1993 to 1995, to 0.5 in 1995 to 1997. The incidence in Aboriginal babies was 5.2 in 1991 to 1993, 5.1in 1993 to 1995 and 1.8 in 1995 to 1997. The incidence of early onset infections caused by organisms other than GBS also fell, from 1.2 per 1000 live births in 1991 to 1993, to 0.8 in 1993 to 1995 and 0.5 in 1995 to 1997. They concluded that steady fall in EOGBS infections in Australia from 1991 to 1997 has been associated with increasing use of intrapartum antibiotics.

Diallo et al. (2011) conducted a study to measure the neonatal mortality rate (NMR) and investigate its predictors in a rural area of Burkina Faso. A cohort of infants born in 24 villages in Banfora region was followed until the children were 6 months old. We estimated the risk of neonatal death and used logistic regression to identify its predictors. Among 864 live births followed to day 28, there were 40 neonatal deaths, a NMR of 46.3 per 1000 live births. Multivariable regression identified twin birth, having a nulliparous mother, and birth into a polygynous household as the main predictors of neonatal death. They concluded that the burden of neonatal mortality in rural Burkina Faso is very high.

Robillard et al (1993) did a four-year study (1987-1990) at the Neonatal Department, University Hospital Pointe-à-Pitre (French West Indies), blood culture was systematically performed on all admitted newborns. The results show that the incidence of septicemia was 48 of 1000 admissions and 8.9 of 1000 inborn live births. Among the 107 neonatal positive blood cultures, group B streptococcus accounted for 37% of blood culture isolates and was the most frequent cause of septicemia. The overall mortality rate was 8.4%. The incidence of neonatal bacterial septicemia was among the high rates reported.

Kuruvilla et al. (1999) observed that Group B Streptococcus (GBS) is an infrequent cause of neonatal septicaemia in many developing countries. In a perinatal centre in India with 60,119 live births between 1988 and 1997, GBS was isolated from blood cultures of 10 babies. Thus the incidence of GBS bacteraemia was 0.17 per 1000 live births. Lethargy, respiratory distress and poor perfusion were the presenting features in eight symptomatic babies. Two babies had meningitis, three required ventilatory support and one died. There were no cases of late onset disease. The low incidence could be due to the low rate of colonisation and high prevalence of protective antibody in the mothers.

Al-Harthi et al. (2000) conducted a study to determine the prevalent bacterial agents of neonatal meningitis and their antibiotic susceptibility in a referral intensive care unit in Assir Central Hospital, Saudi Arabia, during the years 1993-1998.Records of newborn infants with positive cerebrospinal fluid culture during the period were retrospectively studied. The results show that there was 1473 nursery admissions, of which 32 episodes of meningitis occurred amongst 31 neonates. Klebsiella pneumoniae (31%) and Serratia marcescens (21%) were the main pathogens. The incidence of concurrent septicemia among these infants was 58%. Klebsiella pneumoniae appears to dominate in both early and late onset infections. The sex incidence was equal and the mortality rate was 48%.The

concluded by saying the survey identifies Klebsiella pneumoniae and Serratia sp. as the leading bacterial agents of neonatal meningitis in our environment.

Dawodu and Effiong (1995) conducted a study to help improve the survival of neonates. Selective measures were taken to improve care of low-birth-weight infants and prevent or treat intrapartum and postnatal hypoxia, metabolic acidosis, hypoglycemia, and hypothermia. In the 5-year period (1976 to 1980), the neonatal mortality in babies weighing 2,500 g and more at birth dropped significantly from 1.2% to 0.7%. The case fatality rates from birth asphyxia and neonatal sepsis dropped by 48% and 32%, respectively. These results suggest that early identification of infants at risk of developing birth asphyxia or neonatal septicemia and institution of prompt and appropriate management could produce a significant reduction in mortality in infants of normal birth weight. The concluded that efforts might be made on decreasing the incidence of low birth weight.

Airede (1992) conducted a study of ninety-nine cases of neonatal septicaemia prospectively seen over a 3-year period in a large cosmopolitan African city of high altitude is presented. An incidence of 6.5 per 1000 live births was noted. Though the most important pathogens were Klebsiella spp. and Staphylococcus aureus, Citrobacter difficile and Alkalegenes faecalis were the pathogens associated with a high mortality rate. Low birth weight infants were significantly more affected. The results show that the overall mortality rate was 27.3 per cent. The commonest predisposing perinatal factors were birth asphyxia and prolonged rupture of fetal membranes. On the basis of the trend of organisms isolated and their sensitivity pattern, it is suggested that the initial use of gentamicin alone is satisfactory.

Adejuyigbe et al. (2001) conducted a study to determine the incidence, predisposing factors, clinical features, bacteriological pattern and antibiotic sensitivity in septicaemia in high-risk newborns. It wasa prospective study at the neonatal unit, Ife, Nigeria. It involve all newborns admitted with clinical features and or risk factors suggestive of neonatal septicaemia from February 1994 to March 1995.The results indicate that the incidence of neonatal septicaemia among new born was 22.9 per 1000 livebirths. The predisposing perinatal factors were low socio-economic status, lack of antenatal care, maternal peripartum pyrexia and congenital malformations. Gram-positive bacteria were found to be the most prevalent causative organisms (59.4%). Staphylococcus aureus (36.2%), Pseudomonas aeruginosa (18.8%) and Coagulase negative Staphylococcus (15.9%) were the commonest causes of septicaemia. The overall mortality rate was 33.3%.The concluded that improvement in the socio-economic status of the populace and the availability of affordable antenatal care would help reduce the incidence of neonatal septicaemia in Nigeria.

Engmann et al.(2011) conducted a study to calculate perinatal mortality (stillbirth and early neonatal death) rates in the Upper East region of Ghana and characterize community-based perinatal in terms of timing, cause of death, and maternal and infant risk factors. Birth outcomes were obtained from the Navrongo Health and Demographic Surveillance System over a 7-year period. The results show that out of Twenty thousand four hundred and ninety seven pregnant women who were registered in the study. The perinatal mortality rate was 39 deaths/1000 deliveries, stillbirth rate 23/1000 deliveries and early neonatal death rates 16/1000 live births. Most stillbirths were 31 weeks gestation or less. Prematurity, first-time delivery and multiple gestations all significantly increased the odds of perinatal death..Approximately 70% of early neonatal death occurred during the first 3 postnatal days, and the most common causes of death were birth asphyxia and injury,

infections and prematurity. The concluded that stillbirths and early neonatal death remains a problem in Navrongo.

Daoud et al. (1995) conducted a prospective study undertaken over a 1-year period in northern Jordan to determine the incidence, causes and characteristics of neonatal septicaemia which is a major cause of mortality and morbidity in newborns. The study identified 47 septicaemic neonates, representing an incidence of 2.3/1000 live births. The results show that the overall mortality rate was 40%. The concluded that Prematurity, low birthweight, early onset septicaemia and concomitant meningitis were associated with high mortality.

Lawn et al (2006) outlined that Information on cause-of-death is lacking for 98% of the world's 4 million neonatal deaths that occur in countries with inadequate vital registration (VR). The aim of the study was to estimate, by country for the year 2000, the distribution of neonatal deaths across programme-relevant causes including: asphyxia, preterm birth, congenital abnormalities, sepsis/pneumonia, neonatal tetanus, diarrhoea, and 'other'. Two sources of neonatal cause-of-death data were examined: VR datasets for countries with high coverage (>90%), and published and unpublished studies identified through systematic searches. Multinomial regression was used to model the distribution of neonatal deaths. A VR-based model was used to estimate the distribution of causes of death for 37 low-mortality countries without national data. A study-based model was applied to obtain estimates for 111 high-mortality countries. Uncertainty estimates were derived using the jack knife approach. The results shows that based on 193 countries, the major causes of neonatal death globally are estimated to be infections (sepsis/pneumonia, tetanus, and diarrhoea, 35%), preterm birth (28%), and asphyxia (23%). Regional variation is important. The concluded that this exercise highlights the lack of reliable cause-of-death data in the settings in which most neonatal deaths occur. Complex statistical models are

not a panacea. Representative data with comparable case definitions and consistent hierarchical cause-of-death attribution are required.

Owa and Osinaike conducted a retrospective analysis of neonatal morbidity and mortality over a ten-year period (1981–1990) at a tertiary hospital in llesa, Nigeria, to determine the trends in neonatal morbidity and mortality in relation to places of delivery. 7,225 babies were admitted into the neonatal unit during the period wherein 3,232 (44.7%) were inborns and 3,993 (55.3%) outborns. Places of delivery of outborn babies were government hospitals/maternity centres (44.1%), home (28.5%), private hospitals/clinics (18.8%), and mission houses (8.7%). Major indications for admission among inborns were neonatal jaundice (45.6%), low birthweight (18.6%), birth asphyxia (14.2%), and neonatal infections (9.3%), while those for outborns were neonatal jaundice (39.5%), low birthweight (23.2%), neonatal infections (18.0%), neonatal tetanus (5.7%), birth asphyxia (4.8%). Overall mortality rate was 13.0%. It was higher in outborns than inborns ($p<0.001$). Mortality was lowest in 1983 and peaked in 1987 and 1988. It was higher in outborns than inborns during the period ($p<0.001$).The results show that the major causes of death were low birth weight (42.8%), neonatal jaundice (14.1%), neonatal tetanus (12.8%), infections (12.4%), and birth asphyxia (11.6%). In almost all cases, case fatality rates were higher among the outborns ($p<0.001$). Similarly, mortality was higher in outborns than inborns in almost all the weight range. Among the outborns, mortality was highest in babies delivered at home and private hospitals. The concluded that improved access to neonatal medical and antenatal care will significantly reduce neonatal morbidity and mortality in Nigeria.

Mavalanvar et al. (1992) to identify and quantify risk factors for preterm and term low birthweight (LBW) they conducted a hospital-based case-control study, linked with a population survey in Ahmedabad, India. The case-control study of 673 term LBW, 644

preterm LBW cases and 1465 controls showed that low maternal weight, poor obstetric history, lack of antenatal care, clinical anaemia and hypertension were significant independent risk factors for both term and preterm LBW. Short interpregnancy interval was associated with an increased risk of preterm LBW birth while primiparous women had increased risk of term LBW. Muslim women were at a reduced risk of term LBW, but other socioeconomic factors did not remain significant after adjusting for these more proximate factors. Estimates of the prevalence of risk factors from the population survey were used to calculate attributable risk. The concluded by saying this analysis suggested that a substantial proportion of term and preterm LBW births may be averted by improving maternal nutritional status, anaemia and antenatal care.

Juan et al. (2012) conducted a study to examine trends in the major causes and rates of neonatal infection-associated mortality (NIMRs) in different geographical regions in China from 2003 to 2008. Neonatal mortality data was collected from the Chinese National Women and Children's Health Surveillance Network which were analyzed. The results show that NIMRs declined. Pneumonia, sepsis, and diarrhoea were the top three infections that caused neonatal deaths. Compared to the coastal region, the relative risk (RR) of NIMRs in the remote and inland regions declined from 5.52 (95% CI: 4.05-7.52) and 2.37 (95% CI: 1.72-3.25) during 2003-2005 to 3.45 (95% CI: 2.58-4.61) and 1.72 (95% CI: 1.28-2.31) during 2006-2008, respectively. Once again, compared to the coastal region, the risk of pneumonia-specific mortality had significant regional disparities during 2006-2008 with a RR of 3.82 (95% CI: 2.74-5.32) in the remote region and 2.01 (95% CI: 1.44-2.80) in the inland region. The NIMRs in the remote region was characterized by more home deliveries and non-healthcare seeking behaviour prior to death than the coastal region. They concluded that Infection is still one of the main causes of neonatal mortality in

China. Although the NIMRs have been declining, disparities concerning neonatal infection-associated and pneumonia-specific neonatal morality still exist.

CHAPTER 3

METHODOLOGY

3.0 INTRODUCTION

Due to the advancement of technology and engineering especially in the field of computer science, one can easily make analysis of data with little knowledge about the statistical and mathematical concepts that underline it. It is vital that one acquires the best of knowledge and understanding about the theoretical and conceptual framework of the statistical method that is used to analyze the data efficiently and effectively. Therefore this chapter focused on the theoretical and conceptual framework on rate of neonatal death, bivariate analysis, and logistic regression.

3.1 NEONATAL MORTALITY RATE

Rates of neonatal mortality are calculated per 1000 live birth where live is defined as the complete expulsion or extraction from its mother of a product of conception, irrespective of the duration of the pregnancy, which, after such separation, breathes or shows any other evidence of life, such as beating of the heart, pulsation of the umbilical cord, or definite movement of voluntary muscles, whether or not the umbilical cord has been cut or the placenta is attached; each product of such a birth is considered liveborn (WHO,2000)

Early neonatal rate = (early neonatal deaths/Live birth)*1000.

Neonatal mortality rate= (Neonatal deaths/Live birth)*1000

The number of neonatal and early neonatal deaths by country is calculated by applying the estimated neonatal and early neonatal mortality rates to the number of births for that period.

The formula is given by:

Number of deaths = (rate * live births)/1000.

3.2 BIVARIATE ANALYSIS

With bivariate analysis, we are testing hypotheses of "association" and causality. In its simplest form, association simply refers to the extent to which it becomes easier to know or predict a value for the Dependent variable (DV) if we know a case's value on the independent variable (IV). A measure of association helps us to understand this relationship. These measures of association relate to how much better this prediction becomes with knowledge of the IV or how well an independent variable relates to the dependent variable. A measure of association often ranges between –1 and 1. Where the sign of the integer represents the "direction" of correlation (negative or positive relationships) and the distance away from 0 represents the degree or extent of correlation – the farther the number away from 0, the higher or "more perfect" the relationship is between the IV and DV. Statistical significance relates to the generalizability of the relationship and, more importantly, the likelihood the observed relationship occurred by chance. In political science, we typically consider a relationship significant (the association seen in this sample is not occurring randomly or by chance) if it has a significance level of .05 – In only 5/100 times will the pattern of observations for these two variables that we have measured occur by chance. Often significance levels, when n (total number of cases in a sample) is large, can approach .001 (only 1/1000 times will the observed association occur).Measures of association and statistical significance that are used vary by the level of measurement of the variables analysed.

Steps in Conducting Bivariate Analysis

Step 1: Define the nature of the relationship whether the values of the independent variables relate to the values of the dependent variable or not.

Step 2: Identify the type and direction, if applicable, of the relationship

Step 3: Determine if the relationship is statistically significant and generalizable to the population.

Step 4: Identify the strength of the relationship, i.e. the degree to which the values of the independent variable explain the variation in the dependent variable.

3.3 MODEL BUILDING

Model building entails the development of prediction equations (statistical models) by statistical or mathematical method from experimental data (Milton and Arnold, 1995).

3.3.1 LOGISTIC REGRESSION

In statistics, logistic regression (sometimes called the logistic model or logit model) is used for prediction of the probability of occurrence of an event by fitting data to a logistic function. It is a generalized linear model used for binomial regression. Like other forms of regression analysis, it makes use of one or more predictor variables that may be either numerical or categorical. For example, the probability that a person has a stroke within a specified time period might be predicted from knowledge of the person's age, sex and body mass index. Logistic regression is used extensively in the medical and social sciences fields, as well as marketing applications such as prediction of a customer's propensity to purchase a product or cease a subscription.

An explanation of logistic regression begins with an explanation of the logistic function, which, like probabilities, always takes on values between zero and one:

$$f(z) = \frac{e^z}{e^z + 1} = \frac{1}{1 + e^{-z}}$$

A graph of the function is shown in figure 1.

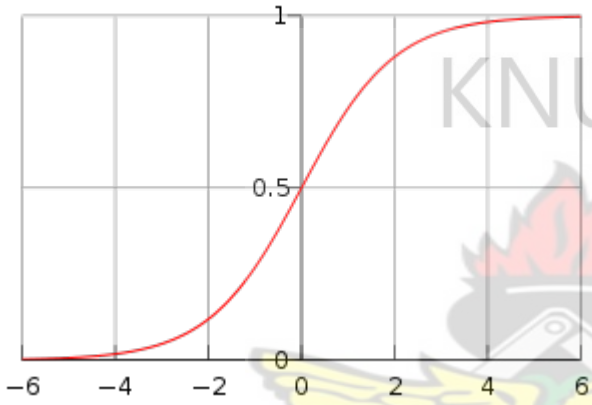

Figure1. The logistic function, with *z* on the horizontal axis and *f* (*z*) on the vertical axis

The input is *z* and the output is *f* (*z*). The logistic function is useful because it can take as an input any value from negative infinity to positive infinity, whereas the output is confined to values between 0 and 1. The variable *z* represents the exposure to some set of independent variables, while *f* (*z*) represents the probability of a particular outcome, given that set of explanatory variables. The variable *z* is a measure of the total contribution of all the independent variables used in the model and is known as the logit.

The variable *z* is usually defined as

$$z = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \cdots + \beta_k x_k,$$

where β_0 is called the "intercept" and β_1, β_2, β_3, and so on, are called the "regression coefficients" of x_1, x_2, x_3 respectively. The intercept is the value of z when the values of all independent variables are zeros (e.g. the value of z in someone with no risk factors). Each of the regression coefficients describes the size of the contribution of that risk factor. A positive regression coefficient means that the explanatory variable increases the probability of the outcome, while a negative regression coefficient means that the variable decreases the probability of that outcome; a large regression coefficient means that the risk factor strongly influences the probability of that outcome, while a near-zero regression coefficient means that that risk factor has little influence on the probability of that outcome. Logistic regression is a useful way of describing the relationship between one or more independent variables (e.g., age, sex, etc.) and a binary response variable, expressed as a probability, that has only two values, such as having cancer ("has cancer" or "doesn't have cancer")(Wikipedia,2011) .

3.3.2 SAMPLE SIZE-DEPENDENT EFFICIENCY

Logistic regression tends to systematically overestimate odds ratios or beta coefficients when the sample size is less than about 500. With increasing sample size, the magnitude of overestimation diminishes and the estimated odds ratio asymptotically approaches the true population value. In a single study, overestimation due to small sample size might not have any relevance for the interpretation of the results, since it is much lower than the standard error of the estimate. However, if a number of small studies with systematically overestimated effects are pooled together without consideration of this effect, an effect may be perceived when in reality it does not exist (Wikipedia, 2011).

A minimum of 10 events per independent variable has been recommended. For example, in a study where death is the outcome of interest, and 50 of 100 patients die, the maximum

number of independent variables the model can support is 50/10 = 5(Wikipedia,2011).

The application of a logistic regression may be illustrated using a fictitious example of death from heart disease. This simplified model uses only three risk factors (age, sex, and blood cholesterol level) to predict the 10-year risk of death from heart disease. These are the parameters that the data fit (Wikipedia, 2011):

$\beta_0 = -5.0$ (the intercept)

$\beta_1 = +2.0$

$\beta_2 = -1.0$

$\beta_3 = +1.2$

x_1 = age in years, above 50

x_2 = sex, where 0 is male and 1 is female

x_3 = cholesterol level, in mmol/L above 5.0

The model can hence be expressed as

$$\text{risk of death} = \frac{1}{1+e^{-z}}, \text{ where } z = -5.0 + 2.0x_1 - 1.0x_2 + 1.2x_3.$$

In this model, increasing age is associated with an increasing risk of death from heart disease (z goes up by 2.0 for every year over the age of 50), female sex is associated with a decreased risk of death from heart disease (z goes down by 1.0 if the patient is female), and increasing cholesterol is associated with an increasing risk of death (z goes up by 1.2 for each 1 mmol/L increase in cholesterol above 5 mmol/L).For example to predict a particular subject's risk of death from heart disease of a man of 50 years old and his cholesterol level is 7.0 mmol/L. The subject's risk of death is therefore

$$\frac{1}{1+e^{-z}}, \text{ where } z = -5.0 + (+2.0)(50-50) + (-1.0)0 + (+1.2)(7.0-5.0).$$

This means that by this model, the subject's risk of dying from heart disease in the next 10 years is 0.07 (or 7%)(Wikipedia,2011).

3.3.3 FORMAL MATHEMATICAL SPECIFICATION

Logistic regression analyzes binomially distributed data of the form

$$Y_i \sim B(n_i, p_i), \text{ for } i = 1, \ldots, m,$$

where the numbers of Bernoulli trials n_i are known and the probabilities of success p_i are unknown. An example of this distribution is the fraction of seeds (p_i) that germinate after n_i are planted. The model proposes for each trial i there is a set of explanatory variables that might inform the final probability. These explanatory variables can be thought of as being in a k-dimensional vector X_i and the model then takes the form

$$p_i = \mathrm{E}\left(\frac{Y_i}{n_i}\middle| X_i\right).$$

The logits, natural logs of the odds, of the unknown binomial probabilities are modelled as a linear function of the X_i.

$$\operatorname{logit}(p_i) = \ln\left(\frac{p_i}{1-p_i}\right) = \beta_0 + \beta_1 x_{1,i} + \cdots + \beta_k x_{k,i}.$$

Where odds ratio=$\frac{P_i}{1-P_i}$

Note that a particular element of X_i can be set to 1 for all i to yield an intercept in the model.

The unknown parameters β_j are usually estimated by maximum likelihood using a method common to all generalized. The maximum likelihood estimates can be computed numerically by using iteratively reweighted least squares.

The interpretation of the β_j parameter estimates is as the additive effect on the log of the odds for a unit change in the *j*th explanatory variable. In the case of a dichotomous explanatory variable, for instance gender, e^{β} is the estimate of the odds of having the outcome for, say, males compared with females. The model has an equivalent formulation

$$p_i = \frac{1}{1 + e^{-(\beta_0 + \beta_1 x_{1,i} + \cdots + \beta_k x_{k,i})}}.$$

This functional form is commonly called a single-layer perceptron or single-layer artificial neural network. A single-layer neural network computes a continuous output instead of a step function. The derivative of p_i with respect to $X = x_1 ... x_k$ is computed from the general form:

$$y = \frac{1}{1 + e^{-f(X)}}$$

where $f(X)$ is an analytic function in X. With this choice, the single-layer neural network is identical to the logistic regression model. This function has a continuous derivative, which allows it to be used in back propagation. This function is also preferred because its derivative is easily calculated:

$$\frac{\mathrm{d}y}{\mathrm{d}X} = y(1 - y)\frac{\mathrm{d}f}{\mathrm{d}X}.$$

3.3.4 ASSUMPTIONS

1. Assumes a linear relationship between the logit of the IVs and DVs

   However, does not assume a liner relationship between the actual dependent and independent variables

1. The sample is 'large'- reliability of estimation declines when there are only a few cases

2. IVs are not linear functions of each other

3. Normal distribution is not necessary or assumed for the dependent variable.

4. Homoscedasticity is not necessary for each level of the independent variables.

5. Normally distributed description of errors is not assumed.

6. The independent variables need not be interval level

3.4 THE HOSMER-LEMESHOW TEST

The Hosmer–Lemeshow test is a statistical test for goodness of fit for logistic regression models. It is used frequently in risk prediction models. The test assesses whether or not the observed event rates match expected event rates in subgroups of the model population. The Hosmer–Lemeshow test specifically identifies subgroups as the deciles of fitted risk values. Models for which expected and observed event rates in subgroups are similar are called well calibrated. The Hosmer–Lemeshow test statistic is given by:

$$H = \sum_{g=1}^{n} \frac{(O_g - E_g)^2}{N_g \pi_g (1 - \pi_g)}.$$

where O_g, E_g, N_g, and π_g denote the observed events, expected events, observations, predicted risk for the g^{th} risk decile group, and n is the number of groups. The test statistic asymptotically follows a χ^2 distribution with $n-2$ degrees of freedom. The number of risk groups may be adjusted depending on how many fitted risks are determined by the model. This helps to avoid singular decile groups.

3.5 LIKELIHOOD RATIO TEST

Likelihood ratio testis a statistical test used to compare the fit of two models, one of which (the null model) is a special case of the other (the alternative model). The test is based on the likelihood ratio, which expresses how many times more likely the data are under one model than the other. This likelihood ratio, or equivalently its logarithm, can then be used to compute a p-value, or compared to a critical value to decide whether to reject the null model in favour of the alternative model. When the logarithm of the likelihood ratio is used, the statistic is known as a log-likelihood ratio statistic, and the probability distribution of this test statistic, assuming that the null model is true, can be approximated using Wilks' theorem. In the case of distinguishing between two models, each of which has no unknown parameters, use of the likelihood ratio test can be justified by the Neyman–Pearson lemma, which demonstrates that such a test has the highest power among all competitors. Each of the two competing models, the null model and the alternative model, is separately fitted to the data and the log-likelihood recorded. The test statistic (often denoted by D) is twice the difference in these log-likelihoods:

$$\begin{aligned} D &= -2\ln\left(\frac{\text{likelihood for null model}}{\text{likelihood for alternative model}}\right) \\ &= -2\ln(\text{likelihood for null model}) + 2\ln(\text{likelihood for alternative model}) \end{aligned}$$

In many cases, the probability distribution of the test statistic is approximately a chi-squared distribution with degrees of freedom equal to $df2 - df1$, if the nested model with fewer parameters is correct. Symbols $df1$ and $df2$ represent the number of free parameters of models 1 and 2, the null model and the alternative model, respectively. The test requires nested models, that is: models in which the more complex one can be transformed into the simpler model by imposing a set of constraints on the parameters(Wikipedia,2011).

For example: if model 1 has 1 free parameter and a log-likelihood of −8024 and the alternative model has 3 degrees of freedom and a LL of −8012, then the probability of this difference is that of chi-squared value of $+2\cdot(8024 - 8012) = 24$ with $3 - 1 = 2$ degrees of freedom. Certain assumptions must be met for the statistic to follow a chi-squared distribution and often empirical p-values are computed (Wikipedia, 2011).

3.6 MAXIMUM LIKELIHOOD ESTIMATION OF THE LOGIT MODEL

3.6.1 THE LOGIT MODEL WITH ONE EXPLANATORY VARIABLE

Let $(Y_1, X1), ..., (Yn, Xn)$ be a random sample from the conditional logit distribution:

$$\Pr[Y_j = 1|X_j] = \frac{1}{1+exp(-\alpha_0-\beta_0 X_j)}, \qquad (1)$$

$$\Pr[Y_j = 0|X_j] = 1 - P_r[Y_j = 1|X_j]$$

$$= \frac{exp(-\alpha_0-\beta_0 X_j)}{1+exp(-\alpha_0-\beta_0 X_j)}$$

where the X_j 's are the explanatory variables and α_0 and β_0 are unknown parameters to be estimated. This model is called a Logit model, because

$Pr[Y_j = 1|X_j] = F(\alpha_0 + \beta_0 Xj)$ (2)

where

$$F(x) = \frac{1}{1+exp(-X)} \quad (3)$$

is the distribution function of the logistic (Logit) distribution. The conditional probability function involved is

$f(y|X_j, \alpha_0, \beta_0) = Pr[Yj = y|X_j]$

$= F(\alpha_0 + \beta_0 Xj)^y (1 - F(\alpha_0 + \beta_0 Xj))^{1-y}$

$$= \begin{cases} F(\alpha_0 + \beta_0 X_j) \; if \; y = 1, \\ 1 - F(\alpha_0 + \beta_0 X_j) \; if \; y = 0 \end{cases}$$

Now the conditional log-likelihood function is

$$\ln(Ln(\alpha, \beta)) = \sum_{j=1}^{n} In\left(f(Y_j|X_j, \alpha, \beta)\right)$$

$$= \sum_{j=1}^{n} Y_j In\left(F(\alpha + \beta X_j)\right) + \sum_{j=1}^{n}(1 - Y_j) In\left(1 - F(\alpha + \beta X_j)\right)$$

$$= -\sum_{j=1}^{n}(1 - Y_j)(\alpha + \beta X_j) - \sum_{j=1}^{n} In\left(1 + exp(-\alpha - \beta X_j)\right). \quad (4)$$

$E[\ln(Ln(\alpha, \beta))|X1, ...,Xn] \leq E[\ln(Ln(\alpha 0, \beta 0))|X1, ...,Xn]$.

Again, this result motivates to estimate α_0 and β_0 by maximizing $\ln(Ln(\alpha, \beta))$

to α and β: $In\left(L_n(\hat{\alpha}, \hat{\beta})\right) = max_{\alpha,\beta} In(L_n(\alpha, \beta))$

However, there is no longer an explicit solution for bα and bβ. These ML estimators have to be solved numerically.

3.6.2 PSEUDO t- VALUES

It can be shown that if the sample size n is large then

$$\sqrt{n}(\hat{\alpha}-\alpha_0)\sim N(0,\sigma_\alpha^2),\sqrt{n}(\hat{\beta}-\beta_0)\sim N(0,\sigma_\beta^2)$$

Given consistent estimators $\hat{\sigma}_\alpha^2$ and $\hat{\sigma}_\beta^2$ of the unknown variances σ_α^2 and σ_β^2 respectively

(which can be computed by software), we then have

$$\frac{\sqrt{n}(\hat{\alpha}-\alpha_0)}{\hat{\sigma}_\alpha}\sim N(0,1),\quad \frac{\sqrt{n}(\hat{\beta}-\beta_0)}{\hat{\sigma}_\beta}\sim N(0,1)$$

These results can be used to test whether the coefficients α_0 and β_0 are zero or not. In particular the null hypothesis $\beta_0 = 0$ is of interest, because this hypothesis implies that the conditional probability $Pr[Y_j = 1|X_j]$ does not depend on X_j. Under the null hypothesis $\beta_0 = 0$ we have

$$\hat{t}_\beta=\frac{\sqrt{n}\hat{\beta}}{\hat{\sigma}_\beta}\sim N(0,1)$$

For example the 5% critical value of the two-sided standard normal test is 1.96, the null hypothesis $\beta_0 = 0$ will be rejected at the 5% significance level in favour of the alternative hypothesis $\beta_0 \neq 0$ if $|\hat{t}_\beta| > 1.96$ and accepted if $|\hat{t}_\beta| \leq 1.96$. The statistic $\hat{t}_\beta$ is called the

pseudo t-value of $\hat{\beta}$ because it is used in the same way as the t-value in linear regression, and $\hat{\sigma}_{\beta}$ is called the standard error of $\hat{\beta}$.

3.6.3 THE GENERAL LOGIT MODEL

The general Logit model takes the form

$$\Pr[Yj = 1|X1j, \ldots Xk,j] = \frac{1}{1+exp\left(-\beta_1^0 X_{1j} - \ldots - \beta_k^0 X_{kj}\right)} \quad (5)$$

$$= \frac{1}{1+exp\left(-\sum_{i=1}^{k} \beta_i^0 X_{ij}\right)}$$

where one of the X_{ij} equals 1 for the constant term, for example, let $X_{kj} = 1$,and the β^0_i 's are the true parameter values. This model can be estimated by ML in the same way as before. Thus, the log-likelihood function is

$$\ln (Ln(\beta 1, \ldots, \beta k)) = -\sum_{j=1}^{n}(1 - Y_i)\sum_{i=1}^{k} \beta_i X_{ij} - \sum_{j=1}^{n} In\left(1 + exp\left(-\sum_{i=1}^{k} \beta_i X_{ij}\right)\right) \quad (6)$$

and the ML estimators $\hat{\beta}_1, \ldots, \hat{\beta}_k$ are obtained by maximizing In(Ln(β_1, ..., β_k)):

$$In\left(Ln\left(\hat{\beta}_{1,\ldots,}\hat{\beta}_k\right)\right) = \max_{\beta_1,\ldots,\beta_k} In\left(Ln(\beta_1, \ldots, \beta_k)\right)$$

Again, it can be shown that if n is large then for i = 1, ..., k,

$$\sqrt{n}(\beta_i - \beta_i^0) \sim N(0, \sigma_i^2)$$

Given consistent estimators $\hat{\sigma}_i^2$ of the variances σ_i^2, it follows then that

$$\frac{\sqrt{n}(\hat{\beta}_i - \beta_i^0)}{\hat{\sigma}_i} \sim N[O,1]$$

3.6.4 TESTING JOINT SIGNIFICANCE

Now suppose you want to test the joint null hypothesis

$$H_0: \beta_1^0 = 0, \beta_2^0 = 0, \ldots, \beta_m^0 = 0, \qquad (7)$$

where m <k.There are two ways to do that. One way is akin to the F test in linear regression: Re-estimate the Logit model under the null hypothesis:

$$In\left(L_n(0,\ldots,0,\tilde{\beta}_k)\right) = \max_{\beta_{m+1},\ldots,\beta_k} In(0,\ldots,0,\beta_{m+1},\ldots,\beta_k)$$

and compare the log-likelihoods[2]. It can be shown that under the null hypothesis (7) and for large samples,

$$LR_m = -2In\left(\frac{L_n(0,\ldots,0,\tilde{\beta}_{m+1},\ldots,\tilde{\beta}_k)}{L_n(\hat{\beta}_1,\ldots,\hat{\beta}_k)}\right) \sim X_m^2,$$

where the degrees of freedom m corresponds to the number of restrictions imposed under the null hypothesis. This is the so-called likelihood ratio test, which is conducted right-sided. For example, choose the 5% significance level, look up in the table of the χ^2 distribution then critical value c suchthat for a χ^2_m distributed random variable Z_m, $Pr[Z_m > c] = 0.05$. Then the null hypothesis (7) is rejected at the 5% significance level if $LR_m > c$ and accepted if $LR_m \leq c$. An alternative test of the null hypothesis (7) is the Wald test,

which is conducted in the same way as for linear regression models. Under the null hypothesis (7) the Wald test statistic has also a χ^2_mdistribution.

3.7 INTERPRETATION OF THE COEFFICIENTS OF THE LOGIT MODEL

3.7.1 MARGINAL EFFECTS

Consider the Logit model (2). If $\beta_0 > 0$ then $Pr[Y_j = 1|X_j] = F(\alpha_0 + \beta_0 X_j)$ is an increasing function of X_j :

$$\frac{dP[Y_j = 1|X_j]}{dX_j} = \beta_0 . F'(\alpha_0 + \beta_0 X_j)$$

where $F'$is the derivative of (3):

$$F'(x) = \frac{exp(-x)}{(1+exp(-x))^2} = \frac{1+exp(-x)}{(1+exp(-x))^2} - \frac{1}{(1+exp(-x))^2}$$

$$= \frac{1}{1+exp(-x)} - \frac{1}{(1+exp(-x))^2} = F(x) - F(x)^2$$

$$= F(x)(1 - F(x))$$

Therefore, the marginal effect of X_j on $Pr[Y_j = 1|X_j]$ depends on X_j :

$$\frac{dP[Y_j = 1|X_j]}{dX_j} = \beta_0 . F(\alpha_0 + \beta_0 X_j)(1 - F(\alpha_0 + \beta_0 X_j)),$$

which renders the interpretation of β_0 difficult. However, the coefficient β_0 can be interpreted in terms of relative changes in odds.

3.7.2 ODDS AND ODDS RATIOS

The odds is the ratio of the probability that something is true divided by the probability that it is not true. Thus, in the Logit case (2),

$$\text{Odds (X)} = \frac{Pr[Y_j=1|X_j]}{Pr[Y_j=0|X_j]} = \frac{F(\alpha_0+\beta_0 X_j)}{1-F(\alpha_0+\beta_0 X_j)} = exp(\alpha_0 + \beta_0 X_j), \quad (8)$$

The odds ratio is the ratio of two odds for different values of X_j, say $X_j = x$ and $X_j = x + \Delta x$:

$$\frac{Odds(x+\Delta x)}{Odds(x)} = \frac{exp(\alpha+\beta x+\beta\Delta x)}{exp(\alpha+\beta x)} = exp(\beta\Delta x)$$

where Δx is a small change in x. Then

$$\lim_{\Delta x\to 0}\frac{1}{\Delta x}\left(\frac{Odds(x+\Delta x)-Odds(x)}{Odds(x)}\right) = \lim_{\Delta x\to 0}\frac{exp(\beta_0\Delta x)-1}{\Delta x}$$

$$= \beta_0 \lim_{\beta_0\Delta x\to 0}\frac{exp(\beta_0\Delta x)-1}{\beta_0\Delta x} = \beta_0 \times \frac{dexp(u)}{du}\Big| u=0$$

$$= \beta_0 exp(0) = \beta_0$$

Thus, β_0 may be interpreted as the relative change in the odds due to a small change Δx in X_j :

$$\frac{Odds(x+\Delta x)-Odds(x)}{Odds(x)} = \frac{Odds(x+\Delta x)}{Odds(x)} - 1 \approx \beta_0\Delta x, \quad (9)$$

For example, if X_j is a binary variable itself, $X_j = 0$or $X_j = 1$, then the only reasonable choices for $x + \Delta x$ and x are 1 and 0, respectively, so that then

$$\frac{Odds(1)}{Odds(0)} - 1 = \frac{Odds(1) - Odds(0)}{Odds(0)} = exp(\beta_0) - 1$$

Only if β0 is small we may then use the approximation $\exp(\beta_0) - 1 \approx \beta_0$. If not, one has to interpret β_0 in terms of the log of the odds ratio involved:

$$In\left(\frac{Odds(1)}{Odds(0)}\right) = \beta_0$$

The interpretation of the coefficients β_i^0 , i = 1, ..., k − 1 in the general Logit model (5) is similar as in the case (9):

$$\frac{Odds\left(X_{1j}, \ldots, X_{i-1,j}, X_{i,j} + \Delta X_{i,j}, X_{i+1,j}, \ldots, X_{k,j}\right)}{Odds\left(X_{1j}, \ldots, X_{i-1,j}, X_{i,j}, X_{i+1,j}, \ldots, X_{k,j}\right)} \approx \beta_i^0 \Delta X_{ij}$$

if $\Delta X_{i,j}$ is small. For example, β_i^0 may be interpreted as the percentage change in Odds $(X_{1j}, .., X_{k,j})$ due to a small percentage change $100 \times \Delta X_{i,j} = 1$ in $X_{i,j}$.

CHAPTER 4

DATA COLLECTION AND ANALYSIS

4.0 INTRODUCTION

This chapter looks at the analyses of neonatal mortality as in the Ghana demographic health survey data. The predictor variables included in the analysis are age of mother, religion and wealth index for mother level factors. For the child level factors, the variables include sex of child, size of child and child is twin. The last level of factors was the environmental factors which included place of delivery, source of drinking water and the region of the respondent.

4.1 DISPLAY OF DATA

The data extracted from the Ghana demographic health survey 2008 is represented in Table 4.1 below. From the table 19.6% of the women were in the ages of 35 to 39 while 10.3%were in the age range of 15 to 19 years. Also 38.6% of the women were Pentecostal while 3.6% were not identifying with any religion. Considering the wealth index majority of the women were in the poorest level representing 22.6% of the population. For the child level factors; 43.5% of the babies were female and 40.9% male. Also 80.4% of the babies were a single birth while, only 4% were multiple birth. Majority of the women deliver at home (36.7%), while only 6.1% deliver at a private health facility. Almost half of the woman had access to pipe drinking water.

Table 4.1: Percentage Distribution of Background Characteristics.

Attributes	frequency	percent(%)
Current Age		
15-19	54	10.3
20-24	74	14.1
25-29	73	13.9
30-34	77	14.6
35-39	103	19.6
40-44	73	13.9
45-49	72	13.7
Religion		
Catholic	69	13.1
Anglican	8	1.5
Methodist	45	8.6
Presbyterian	26	4.9
Pentecostal	203	38.6
Other Christian	45	8.6
Moslem	76	14.4
Traditional	35	6.7
No religion	19	3.6
Wealth Index		
Poorest	119	22.6
Poorer	108	20.5
Middle	104	19.8
Richer	94	17.9
Richest	101	19.2
Sex of Child		
Male	215	40.9
Female	229	43.5
Child is Twin		
Single Birth	423	80.4
2nd of Multiple	21	4
Size of Child		
Small	39	7.4
Average	101	19.2
Large	168	31.9
Region		
Western	224	42.6
Central	21	4
Greater Accra	23	4.4
Volta	65	12.4
Eastern	29	5.5
Ashanti	37	7
Brong Ahafo	14	2.7

Northern	48	9.1
Upper East	23	4.4
Upper West	42	8
Place of Delivery		
Home	193	36.7
Government Facility	168	31.9
Private Facility	32	6.1
Others	2	0.4
Source of Drinking Water		
Pipe Water	235	44.7
Well Water	168	31.9
Surface Water	100	19
Others	23	4.4

Note: Some of the frequencies do not add up to 526 because of missing value.

4.2 COLLINEARITY DIAGNOSTIC TEST

Before building the model for factors of neonatal mortality, the set of independent variables must be tested for collinearity. Table 4.2 below displays the Tolerance and the Variance Inflation Factor (VIF) of the independent variables to be used for predicting factors that affect neonatal mortality. The two statistics used for collinearity test are the Tolerance and the VIF. From Table 4.2, the Variance Inflation Factor (VIF) for each independent variable is less than 10 meaning that, there is no interaction (linear relationship) between the independent variables that might affect the results in the analysis. This implies that all the independent variables in table 4.2 are fit to be used in developing the model for neonatal mortality in Ghana.

Table 4.2 Collinearity test of independent variables

Independent Variables	Collinearity Statistics	
	Tolerance	VIF
Age 5-year groups	0.972	1.029
Religion	0.907	1.103
Wealth Index	0.46	2.172
Size of Child	0.913	1.096
Sex of Child	0.967	1.034
Child is Twin	0.926	1.08
Region	0.606	1.65
Place of Delivery	0.754	1.326
Source of Drinking Water	0.742	1.347

4.3 MODEL 1: MOTHER LEVEL FACTORS

Table 4.3(a) Summary Results for Mother Level Neonatal Factors (Categorical)

Overall Model Evaluation			
Test	X^2	df	p
Likelihood ratio test	39.280	18	0.03
Goodness-of-fit test			
Test	X^2	df	p
Hosmer-Lemeshow	11.518	8	0.174
R^2-type indices			
Cox and Snell R Squared=.072			
Nagelkerke R Squared=.110			

Table 4.3(b) Summary Results for Mother Level Neonatal Factors (Categorical)

Predictor	B	SE β	Wald's	P	Odd Ratio	95% C.I For Exp(B)	
						Lower	Upper
Constant	-1.747	0.614	8.079	0.004	0.174		
Age-5 Year Group							
15-19(ref))			9.379	0.153			
20-24	1.337	0.596	5.029	0.025	3.808	1.184	12.254
25-29	0.641	0.63	1.034	0.309	1.898	.552	6.526
30-34	1.442	0.596	5.849	0.016	4.228	1.314	13.600
35-39	1.24	0.58	4.56	0.033	3.454	1.107	10.776
40-44	1.279	0.598	4.58	0.032	3.594	1.114	11.599
45-49	1.345	0.599	5.04	0.025	3.836	1.186	12.408
Religion							
Catholic(ref)			11.558	0.172			
Anglican	-0.144	0.908	0.025	0.874	0.866	.146	5.127
Methodist	-0.059	0.453	0.017	0.896	0.942	.388	2.289
Presbyterian	1.677	0.796	4.439	0.035	0.187	.039	.890
Pentecostal	-0.662	0.341	3.775	0.052	0.516	.264	1.006
Other Christian	-0.463	0.471	0.964	0.326	0.63	.250	1.585
Moslem	0.072	0.379	0.036	0.85	1.074	.511	2.259
Traditional	-0.388	0.486	0.637	0.425	0.679	.262	1.758
No Religion	-0.791	0.639	1.533	0.216	0.453	.130	1.586
Wealth Index							
Poorest(ref)			10.375	0.035			
Poorer	-0.267	0.344	0.603	0.438	0.765	.390	1.503
Middle	-0.180	0.335	0.289	0.591	1.197	.621	2.310
Richer	-0.906	0.410	4.887	0.027	0.404	.181	.902
Richest	-0.580	0.379	2.341	0.126	0.560	.266	1.177

Considering the results of the mother level factors categorically, as shown in Tables 4.3(a) and 4.3(b) above. The two descriptive measures of goodness of fit presented in Table 4.3(a) are R^2 Indices defined by Cox and Snell (1989) and Nagelkerke(1991).The Nagelkerke R square show that about 11% of the variation in the outcome variable(Neonatal Mortality) is explained by the logistic model. Also Hosmer-Lemeshow test show that P value >.05 which indicate that model fit well. The SE also show that the model is statistically stable since they are not large, this show that multicolinearity does

not exist. Also the age range 15-19 compared to 20-24 is 3.808 (95% C I 1.184 to 12.254) and 15-19 compared to 45-49 is 3.836(95% C I 1,186 to 12.408).For religion, a catholic compared to a moslem is 1.074(95% C I .511 to 2.259).The categories that were found to be statistically significant includes the age range of 20-24,30-34,35-39,40-44 and 45-49.That of wealth index includes poorest and richer.

Table 4.3(c) Summary Results for Mother Level Neonatal Factors (Overall)

Overall Model Evaluation			
Test	X^2	df	P
likelihood Ratio Test	11.683	3	0.090
Goodness -of-fit test			
Hosmer-Lesmeshow	16.038	8	0.038
R^2-type indices			
Cox and Snell R Squared=.022			
Nagelkerke R Squared=.033			

Table 4.3(d) Summary Results for Mother Level Neonatal Factors (Overall)

Predictor	β	SE β	Wald	P	Odd Ratio	95% C.I For Exp(β)	
						Lower	Upper
Age	0.117	0.057	4.220	0.040	1.124	1.005	1.257
Religion	-0.039	0.049	0.632	0.427	0.961	0.873	1.059
Wealth Index	-0.192	0.077	6.229	0.013	0.826	0.710	0.960
Constant	-1.002	0.449	4.985	0.026	0.367		

Consider the three predictors age, religion and wealth index without the categories as shown in Tables 4.3(c) and 4.3(d) above to come out with the appropriate model for the mother level factors. It was found that the Nagelkerke R square now explained 33% of the variation in the outcome variable by the logistic model. The factors that were found to be statistically significant are age with a P value (.04) < .05 and wealth index with a P value of .013 which is less than .05.The model for the mother level will then be: Predicted Logit(Neonatal Mortality)=-1.002+.117*Age-.192*wealth index. Inspecting the values of the SEs in table 4.3(d) ranging from 0.049-0.449 is within the acceptable criterion , that is, must be between 0.001-5.000(Chan,2004) and shows that multicolinearity does not exist among the independent variables. This implies that the model is statically stable.

4.4 MODEL 2: CHILD LEVEL FACTORS

Table 4.4(a) Summary Results of Child Level Neonatal Factors (Categorical)

Overall Model Evaluation			
Test	X^2	df	p
Likelihood ratio test	12.350	4	0.015
Goodness-of-fit test			
Test	X^2	df	p
Hosmer-Lemeshow	1.508	4	0.825
R^2-type indices			
Cox and Snell R Squared=.044			
Nagelkerke R Squared=.063			

Table 4.4(b) Summary Results for Child Level Neonatal Factors (Categorical)

Predictor	B	SE β	Wald's	P	Odd Ratio	95% C.I For Exp(B)	
						Lower	Upper
Constant	-0.561	0.401	1.960	0.162	0.511		
Size of Child							
Small(ref)			8.404	0.015			
Average	-1.049	0.442	5.638	0.018	0.350	.147	.833
Large	-0.199	0.394	0.254	0.614	0.820	.379	1.774
Sex of Child							
Male(ref)	R				1.000		
Female	0.065	0.276	0.056	0.812	1.068	.662	1.832
Child is Twin							
Single Birth(ref)	R				1.000		
2nd of Multiple	-0.561	0.401	1.960	0.162	0.571	.657	6.523

For the child level factors in categories as shown in Table 4.4(a) and 4.4(b), using the Cox and Snell R square and Nagelkerke R square values the model was able to explain 44 per cent (Cox and Snell) and 63 per cent (Nagelkerke) of the variability in the dependent variable(Neonatal Mortality).The likelihood ratio test has a chi square of 12.350 and significant at P(.015)<.05.Also the Hosmer-Lemeshow test has a chi square of 1.508 and significant at P(.825)>.05,this shows that the data fit the model well. For the individual predictors, a small child compared to an average child is 0.350(95% C I .147 to .833).That

of a small child compared to large child is 0.820(95% C I .379 to 1.774).For the sex of the child, male compared to the female was 1.068(95% C I .662 to1.832) and that of whether the child was a twin or not, single birth compared to 2nd of multiple is 0.571(95% C I .657 to 6.523).The only significant predictor variable was size of child(average category) with a P value(.018) <.05.

Table 4.4(c) Summary Results for Child Level Neonatal Factors (Overall)

Overall Model Evaluation			
Test	X^2	df	P
likelihood Ratio Test	3.761	3	0.288
Goodness -of-fit test			
Hosmer-Lesmeshow	8.943	5	0.111
R^2-type indices			
Cox and Snell R Squared=.014			
Nagelkerke R Squared=.019			

Table 4.4(d) Summary Results for Child Level Neonatal Factors (Overall)

Predictor	β	SE β	Wald	P	Odd Ratio	95% C.I For Exp(β)	
						Lower	Upper
Size of Child	0.135	0.194	0.487	0.485	1.145	0.783	1.674
Sex of Child	0.157	0.270	0.337	0.561	1.170	0.689	1.984
Child is Twin	0.534	0.285	3.505	0.061	1.705	0.975	2.981
Constant	1.534	0.665	5.320	0.021	0.216		

Considering the child level variables without the categories as shown in Tables 4.4(c) and 4.4(d), the Nagelkerke R square shows that about 14 percent of the variation in the outcome variable is explained by the logistic model. Looking at the P value of the predictors in Table 4.3(d),all the value exceed 0.05 indicating that none of the variable is significant and the model will include only the intercept. Inspecting the values of the SEs in Table 4.4(d) ranging from 0.194-0.665 is within the acceptable criterion, that is, must be between 0.001-5.000(Chan,2004) and shows that multicolinearity does not exist among the independent variables. This implies that the model is statically stable.

4.5 MODEL 3: ENVIRONMENTAL LEVEL FACTORS

Table 4.5(a) Summary Results for Environmental Level Neonatal Factors (Categorical)

Overall Model Evaluation			
Test	X^2	df	p
Likelihood ratio test	69.521	15	0.000
Goodness-of-fit test			
Test	X^2	df	p
Hosmer-Lemeshow	6.177	8	0.627
R^2-type indices			
Cox and Snell R Squared=.161			
Nagelkerke R Squared=.244			

Table 4.5(b) Summary Results for Environmental Level Neonatal Factors (Categorical)

Predictor	B	SE β	Wald's	P	Odd Ratio	95% C.I For Exp(B)	
						Lower	Upper
Constant	-2.128	0.324	43.16	0.000	0.119		
Region							
Western(ref)			44.169	0.000			
Central	2.334	0.525	19.777	0.000	10.320	3.689	28.868
Greater Accra	2.137	0.762	7.859	0.005	8.477	1.902	37.774
Volta	0.294	0.674	0.191	0.662	1.342	.359	5.025
Eastern	2.102	0.632	11.060	0.001	8.182	2.371	28.242
Ashanti	1.846	0.523	12.465	0.000	6.336	2.273	17.656
Brong Ahafo	1.409	0.907	2.4120	0.120	4.092	.691	24.215
Northern	1.599	0.451	12.576	0.000	4.951	2.045	11.983
Upper East	-0.710	1.15	0.381	0.537	0.492	.052	4.687
Upper West	1.797	0.513	12.277	0.000	6.032	2.207	16.482
Place of Delivery							
Home(ref)			1.106	0.776			
Government Facility	0.149	0.307	0.235	0.628	1.161	.635	2.119
Private Facility	0.409	0.553	0.548	0.459	1.506	.509	4.451
Others	1.340	1.808	0.549	0.459	3.820	.110	132.206
Source of Water							
Pipe Water(ref)			3.611	0.307			
Well Water	0.244	0.374	0.425	0.514	1.276	.613	2.656
Surface Water	-0.427	0.475	0.811	0.368	0.652	.257	1.653
Others	-1.017	0.853	1.423	0.233	0.362	.068	1.923

The next level of factors included in the study were the environmental factors, the results of the categories as shown in Table 4.5(a) and 4.5(b).The Nagelkerke R square show that about 24.4 % of the variation in the outcome variable(Neonatal Mortality) is explained by the logistic model. The likelihood test has a chi square value of 69.521with a P value of 0.000 which is less than .05.Also the Hosmer-Lemeshow test has a chi square of 6.177 and a P value of .627 which is greater than .05, this shows that the data fit the model well. The SEs are all small within the range of.001-5.000 which show that the model is statistically stable. The Wald estimates give the importance of each variable in the model. The Wald values ranges from 44.169(western region) which is higher significant to.191 which is insignificant. Western region compared to Central region, Greater Accra, Volta, Eastern, Ashanti and Upper West is 10.320(95% C I 3.689 to 28.868), 8.477(95% C I 1.902 to 37.774), 1.342(95% C I .359 to 5.025), 8.182(95% C I 2.371 to 28.242), 6.336(95% C I 2.273 to 17.656) and 6.032(95% C I 2.207 to 16.482) respectively.

Table 4.5(c) Summary Results for Environmental Level Neonatal Factors (Overall)

Overall Model Evaluation			
Test	X^2	df	P
likelihood Ratio Test	29.232	3	0.000
Goodness -of-fit test			
Hosmer-Lesmeshow	18.360	8	0.019
R2-type indices			
Cox and Snell R Squared=.071			
Nagelkerke R Squared=.108			

Table 4.5(d) Summary Results for Environmental Level Neonatal Factors (Overall)

Predictor	β	SE β	Wald	P	Odd Ratio	95% C.I For Exp(β)	
						Lower	Upper
Region	0.200	0.038	27.854	0.000	1.221	1.134	1.315
Place of Delivery	0.108	0.199	0.295	0.587	1.114	0.755	1.644
Source of Drinking Water	-0.259	0.170	2.317	0.128	0.772	0.553	1.077
Constant	-1.671	0.525	10.113	0.001	0.188		

Taking the three environmental factors without the categories, the results as shown in Tables 4.5(c) and 4.5(d).The Nagelkerke R square shows that about only 10.8% of the variation in the outcome variable is explained by the logistic model. The Wald estimate for the variable religion(27.854) as compared to that of place of delivery(.295) and source of drinking water(2.317).This show that region is more important in the model as the higher the Wald value, the more important it is. This can be supported by the p values of the region (P value (0.000) <0.05 at 95% C I), place of delivery (P value (.587)>.05 at 95% C I) and that of source of drinking water (P value (.128)>.05 at 95% C I).Therefore the only independent variable that was significant for the environmental level factors is region (site of delivery) in which the child was born. The model for the environmental level factors is therefore given as Predicted Logit(Neonatal Mortality)= -1.671+.200*Region. . Inspecting the values of the SEs in Table 4.5(d) ranging from 0.038-0.525 is within the acceptable criterion, that is, must be between 0.001-5.000(Chan,2004) and shows that multicolinearity does not exist among the independent variables. This implies that the model is statically stable.

4.6 DISCUSSION

From the presentation and analysis so far of the three level of factors namely mother level factors, child level factors and environmental level factors. At each level of factors, three categories were considered making a total of nine factors in all. For the mother level factors it was found that two factors out of the three factors namely age of mother and wealth index were significant factors as contributing to neonatal mortality in Ghana. The age of the mother is a very important factor in the surviving of a newborn since the mother has to be mature both physically and mentally. Women who are physically and mentally mature are likely to be well informed and may be in a position to take good care of their pregnancy when it's come. Also when the give birth the newborn is given the appropriate care. In Ghana women give birth very early or very late in life especially in the rural area. Young age of the mother (14-16years) due to early marriage or unwanted pregnancy certainly plays a role in her health care seeking behaviour. She has no experience in pregnancy, childbirth and postnatal care and is dependent on her husband and other family members what decisions to take. The decision to deliver at home is mostly taken by the husband and the other family members. The complications that can arise during delivery are not properly explained to her so she will deliver without a skilled birth attendant and seeking care will be delayed for her and also for the child when getting ill during the first week of life (Partnership MNCH 2006). In some communities in Ghana it is common to hear or see that a newborn has been abundant in a toilet or in the burst for the reason that they can't take care of them. This led me to the second factor that was significant which was the wealth index. The wealth index is considered a very important factor in child bearing and taking care of the newborn. Poverty level among families is high especially in Sub-Saharan Africa of which Ghana is no exception. In most families especially in the rural areas there is little or no money available for transport and to pay for the health

facility so the delivery is mostly done at home without a skilled birth attendant. There is a user fee to be pay in most of the countries and the health facility also ask the mother and family sometimes to bring baby clothes, maternity pads, clothes etc. which they cannot afford (Stekelenburg 2004). Poverty plays an important role in the low use of Maternal Health services so we can conclude that poverty and the ill health and deaths of newborns are intimately linked. The newborn health gap between rich and poor is unacceptable high (MNCH2006).

The next set of factors was the child level factors which included the size of the child, sex of the child and whether the child was a twin or not. These factors are mostly not directly related to the family after the woman becomes pregnant. They are mostly related to nature except for the size of the child that is related to nutritional statues of the mother. In this study all the three factors were not significant as causing neonatal death. Considering the categories, the size of the child was significant at a certain level but was not influential enough to affect the totality of the size of the child variable as a whole.

The last set of factors the study looked at was the environmental level factors which included the place of delivery, source of drinking water and the region of the respondent (site of delivery). The place of delivery and source of drinking water were found to be insignificant both at the categories level and as a whole. The only factor that was highly significant was the region or site of delivery. Every region in Ghana depicts a different setup, that is, different ways of life, different environment, different foods, different health facilities and different taboos. This shows that neonatal mortality is no respected of any region.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

The following conclusions were draw from the results of the study: From the mother level factors it was found out that the age of the mother was an important factor to consider talking about neonatal mortality. It was also found out that wealth index affect neonatal mortality. The model that was developed for the mother level factor was given as: Logit(Neonatal Mortality)=-1.002+.117*Age-.192*wealth index. Secondly it was found out that the child level factors were all not significant, it was however found out that the size of the child was significant at a certain level looking at the various categories. The model developed for the child level factors will only involve the intercept.

It was also found out for the environmental level factors, the only factor that was significant was the region (site of delivery). The model developed was given as: Logit(Neonatal Mortality)=-1.671+0.200*Region.

5.2 RECOMMENDATIONS

Based on the findings and the conclusions drawn from this study, the following recommendations are worth looking at: It recommended the social support system in the communities should be strengthen and improved to help prevent young girl from becoming pregnant and eventually leading to neonatal death. Also women above 18 years should be encourage to give birth early and not to wait until they are 35 years and above .Women who want to give birth above 35 years should be encourage to attend antenatal from the beginning to the end.

It is also recommended that the income level of Ghanaian should be improved especially those in the rural area since the wealth index was a significant variable as far as neonatal mortality is concern. This will help families in accessing quality health care and also improve their nutritional statues.

Again it is recommended that the nutritional statues of pregnant women should be improved and the nutritional section of every health facility, if any, should strengthen to advice pregnant women on the importance of feeding well during the pregnancy and after delivery.

Also it is recommended that health facilities in every district should be improved to help in safe delivery at all times. Also every region should have a well-equipped regional hospital to take care of complicated and referral cases.

Finally it is recommended that further research should be conducted using other risk factors of neonatal mortality.

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