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Socio-economic determinants of childhood mortality in Navrongo DSS

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UNIVERSITY OF THE WITWATERSRAND

FACULTY OF HEALTH SCIENCES

SCHOOL OF PUBLIC HEALTH

RESEARCH REPORT

PROJECT TITLE

SOCIO-ECONOMIC DETERMINANTS OF CHILDHOOD MORTALITY IN NAVRONGO DSS

Mahamadou. M. NDIATH

Research report submitted to the Faculty of Health Sciences, University of the Witwatersrand, Johannesburg in partial fulfillment of the requirements for the Degree of Master of Science in Medicine in the field of Population Based Field Epidemiology

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Financial support for this training was provided by the INDEPTH NETWORK under the Special
Programme for Scientific Development and Leadership

DECLARATION

I, Mahamadou M. Ndiath. declare that this research report work is my own work. It is being submitted for the degree of Master of Science in Medicine in the field of Population Based Field Epidemiology at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at this or any other University.

Signature 

Full Name: **Mahamadou M. Ndiath**

26 day of August, 2010

DEDICATION

DEDICATED TO

MY LOVING FAMILY

FOR THE UNLIMITED SUPPORT

AND

ENCOURAGEMENT I RECEIVED FROM ALL OF YOU

ESPECIALLY MY WIFE AND MY SON FOR THE DAYS THAT

THEY HAD TO BE WITHOUT ME

MY LATE MOTHER COUDY WANE

WHO PASSED AWAY ON MONDAY 23rd October 2000

MAY YOUR SOUL REST IN PERFECT PEACE WITH THE LORD

AMEN

ABSTRACT

Background

Improving the health of the poor and reducing health inequalities between the poor and non-poor has become central goals of international organizations like the World Bank and WHO as well as, national governments in the contexts of their domestic policies and development assistance programmes.

There are also unquantified and poorly understood inequalities in access to health services within and between various population groups. Little is known about the factors that determine these inequalities and the mechanisms through which they operate in various sub-groups.

Objectives

The aim of the study was first to describe under-five mortality trend according to wealth index; second to describe risk factors for under five mortality; and finally to investigate the relationship between socio-economic and demographic factors and under five mortality during the period 2001 to 2006.

Methods

The study involved all children born in 2001-2006. A total of 22,422 children younger than 5 years were found in 21,494 households yielding 36603.13 Person-Years Observed (PYOs) up to 31st December 2006. Household wealth index was constructed by use of Principal Component Analysis (PCA), as a proxy measure of each household SES. From this index households were categorized into five quintiles (i.e., poorest, poorer, poor, less poor and least poor). Life table estimates were used to estimate mortality rates per 1000 PYO for infants (0-1), childhood (1-5) and under-fives children. Health inequality was measured by poorest to least poor mortality rate ratio and by computing mortality concentration indices. Trend test chi-square was used to determine significance in gradient of mortality rates across wealth index quintiles. Risk factors of child mortality were assessed by the use of Cox proportional hazard regression taking into account potential confounders.

Results

The result indicates unexpected low mortality rate for infant (33.4 per 1,000 PYO, 95% CI (30.4 – 35.6)) and childhood (15.0 per 1,000 PYO, 95% CI (13.9 – 16.3)). Under-five mortality rate was 18.2 per 1,000 PYO (95% CI (75.6 – 108.0)). The poorest to least poor ratios were 1.1, 1.5 and 1.5 for infants, childhood, and under-five year olds respectively, indicating that children in the poorest quintile were more likely to die as compared to those in the least poor household. Computed values for concentration indices were negative (infant C= -0.02, children C= -0.09 and under-five C= -0.04) indicating a disproportionate concentration of under-five mortality among the poor. The mortality rates trend test chi-square across wealth index quintiles were significant for both childhood (P=0.004) and under-five year old children (P<0.005) but not for infants (P=0.134).

In univariate Cox proportional hazard regression, children in the least poor households were shown to have a 35% reduced risks of dying as compared to children in the poorest category [crude H.R =0.65, P=0.001, 95% C.I (0.50 – 0.84)]. The results showed that for under five children, a boy is 1.15 times more likely to die as compared to a girl [crude H.R =1.14, P=0.038, 95% C.I (1.00 - 1.31)]. Second born had a 18% reduced risk of dying as compared to first born [crude H.R =0.82, P=0.048, 95% C.I (0.67 – 0.99)]. After controlling for potential confounders, the adjusted hazard ratio for wealth index decreased slightly. The estimated hazard for wealth index in the univariate was 0.65 while in the multivariate modeling the estimated hazard ratio is 0.60 in the first model.

Conclusion

The study shows that household socio-economic inequality is associated with under-five mortality in the Navrongo DSS area. The findings suggest that reductions in infant, childhood, and under five mortalities are mainly conditional in health and education interventions as well as socioeconomic position of households. The findings further call for more pragmatic strategies or approaches for reducing health inequalities. These could include reforms in the health sector to provide more equitable resource allocation. Improvement in the quality of the health services offered to the poor and redesigning interventions and their delivery to ensure they are more inclined to the poor.

ACKNOWLEGMENT

First, I want to thank the Almighty God for wisdom, guidance and strength which has seen me through.

I am indebted to my sponsor INDEPTH Network for the award of the Special Programme Development and Leadership scholarship without which it would have been difficult for me to undertake my MSc. study.

Further, I would like to forward my deepest thanks to Dr. Cornelius Debpuur and Dr. Philippe Bocquier for their supervision, guidance and support given throughout this research.

I would like also to extend my sincere thanks to the Director and entire staff of Navrongo Health Research Centre for welcoming me into their midst and creating a very conducive learning environment for me to write this report, and more importantly for providing me with the data which serves as the basis for this report.

I would like also to thank the School of Public Health staff, especially Dr. Ronel Kellerman for providing suggestions and recommendations.

Special thanks to Pr Kerstin Klipstein-Grobusch and Dr. Peter Nyasuru the MSc. academic coordinators for the Population Based Field Epidemiology for the support rendered during the academic year.

I thank the whole team at School of Public Health : Sharon Fonn, Shan Naidoo, Steve Tollman, Prof. Clifford Odimegwu, Mr. Edmon Marinda, Dr Mary Kawonga, Georges Renier, and all other lecturers and mentors for providing their unlimited knowledge and creating appropriate learning environment. Thanks to Ms Lindy Mataboge (MSc Course Administrator).

Exceptional recognition from my heart, goes to Dr Aldiouma Diallo (Niakhar Site Leader) and his wife Maimouna Diallo for the unlimited support. Thanks also to all the staff of Niakhar DSS, especially to Adama Mara, Emilie, Paul, Ousmane, Pape, Prosper, and Antoine

I wish to thank Dr Aminata Niang Diene my great teacher in Geography at the University Cheikh Anta Diop Dakar/Senegal in a special way.

I pay tribute to my early spiritual guides: Mouhamadou Mansour Barro (RIP) - Thierno Ahmadou Tidiane BA- Thierno Cheikh Barro.

Special Thanks go to my father Daha Ndiath, to my parents Thierno Omar Ndiath-Khardiatou Ba and Family. My late parent Alghassoum Ndiath (RIP) and family- Late

Baba Belly Ndiath- my parent in laws Baba Racine Ndiath- Awa Faye. Thierno Souleymane Ndiath and Family.

I would like to say thanks to my brothers especially Dr Mamadou Ousmane Ndiath and his wife Marie Faye Ndiath for taking care of my family during my staying abroad.

Thanks to Fatima my sister and my siblings Raby-Mairame- Khardiatou- Khadia-Couro-Aicha- Coudy-Baba Dahirou-Ibrahima-Maimouna.

I would like to thank: Gogo Bolo-Gogo Ouleye- Go Khady- Gogo Farmata- Gogo Dieynaba- Gogo Selly- tantaw-Gogo Athia- Tata Sally

Thanks to: Nene Dia-Khadia Ball- Thieno Mansour Ndiath-Elhadj Ahmadou Tidiane Ndiath- tonton Adama Faye- khadia Mamoudou- Maimouna-

My thanks also are extended to my classmates at the school of public health; especially Sammy, Dani, and Seri who took time to proof read and helped edit the language of this research report.

Thanks to Kennedy and Joachim for their support and guidance.

To all of you mentioned above, I once more humbly say: ***MERCI INFINIMENT***

Last, though by no means least, special tribute goes to my wife Selly Ndiath who, despite her own academic obligations, remained a wonderful wife and a mother and so deserves abundant thanks. She and my son Mamadou Ndiath (and his baby sitter Binta) remain the persons behind the success of this work.

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DEFINITION OF TERMS

1) *Socio-economic index or asset index* – An indicator created with socio-economic variables in an attempt to assess household wealth and hence estimate household welfare.
2) *Principal component Analysis* – A straightforward and pragmatic statistical procedure called principal component analysis will be used to determine the weight for an index of the assets variables. In our study, the relation between socio-economic status and child mortality will be estimated without income or expenditure data but instead by using household asset variables. Principal component analysis provides plausible weight for an index of assets to serve as proxy for SES or wealth. An SES index will be created by categorizing the households in 5 social status or poverty groups.
3) *Concentration Index* – Means of quantifying the degree of income-related inequality in a specific health variable. This measures the extent to which a variable is distributed unequally across all five socio-economic quintiles, i.e. the concentration of inequality. The closer the index is to zero, the less concentrated the distribution of inequality
4) *Under five mortality rate* ($_5q_0$) – the probability of children dying between birth and their fifth birthday, expressed per 1000 children born alive.
5) *Childhood mortality rate* ($_4q_1$) – the probability of children dying between first birthday and fourth birthday, expressed per 1000 children born alive.
6) *Infant mortality rate* ($_1q_0$) – the number of deaths under one year of age, in a given period time, per 1000 live births in the same period.
7) *Neonatal mortality rate* – the number of deaths of infant during the first four weeks of life, expressed as a proportion.

8) *Household* – the unit of observations or analysis, defined as persons sharing the same cooking pot.

9) *Compound* – a dwelling unit that houses a group of people who may or may not be related. Also these individuals in a compound may not have and/or share common resources, including feeding arrangements.

10) *The Demographic Surveillance System* – This is a set of field and computing operations to handle the longitudinal follow up of well defined entities or primary subjects (individuals, households, and residential units) and all related demographic and health outcomes within a clearly circumscribed geographic area.

LIST OF ACRONYMS AND ABBREVIATIONS

AHR : Adjusted Hazard Ratio

ARI : Acute Respiratory Infection

C : Concentration Index

CI : Confidence Interval

CRBs : Compound Registration Books

DHS : Demographic and Health Survey

DSS : Demographic Surveillance System

FWs : Field Workers

GDHS : Ghana Demographic and Health Survey

HIRD : High Impact Rapid Delivery

HR : Hazard Ratio

HRS : Household Registration System

INDEPTH : International Network for continuous Demographic Evaluation of Population and their Impact on Health in Developing Countries

KND : Kassena-Nankana District

L (p) : Concentration Curve

MDG : Millennium Development Goal

MOH : Ministry Of Health

NDSS : Navrongo Demographic Surveillance System

NHRC : Navrongo Health Research Centre

ODBC : Open Database Connectivity

SES : Socio-economic Status

TBA : Traditional Birth Attendant

UNDP : United Nations Development Program

UNICEF : United Nations Children's Emergency Fund

VA : Verbal Autopsy

PYOS : Person Years of Observation

W.B : World Bank

WHO : World Health Organization

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CHAPTER ONE: INTRODUCTION, LITERATURE REVIEW AND OBJECTIVES

1.1. General Overview

Childhood mortality constitutes a major public health problem and one of the major challenges confronting the less developed countries. According to the UN report 2001 more than 10 million children die every year, almost all in low-income countries. 90% of these deaths occurred in just 42 countries. Diarrhea, pneumonia, measles, malaria, and HIV/AIDS, are the underlying causes of death among children younger than 5 years and neonates. The Millennium Development Goal on child mortality aims for a two-thirds reduction from 1990 to 2015.

Despite this initiative the situation for under five is not improving; according to WHO statistics an estimated 10.5 million children age under five die every year from largely preventable conditions and some 40% of these deaths occur within the first month of live.

There is a wide variation between countries and regions regarding the level of under five mortality. For the year 2006, the world wide average for under five mortality has been estimated at about 185 per 1000 live births. The level varied from 10 per 1000 live births in developed countries to 58 per 1000 live births in the developing countries to about 150 per 1000 live births in the least developed world[1]. The wide variation has been attributed to multiple factors. In spite of the general agreement on the leading causes of childhood mortality, the differential contribution of each cause is still controversial. The ongoing debate on diarrhea and acute respiratory infection (ARI) is one example of this controversy.

Aware of the intolerable situation, the Rockefeller Foundation sponsored a workshop in Bellagio, Italy, in February 2003. The meeting brought together three groups of

technical experts working on separate issues related to child health – the causes of child deaths, the evaluation of current strategies for reducing child mortality, and poverty and child health – who were determined to build an evidence base to stimulate and guide action for child survival. These scientists, speaking as individuals concerned with child health, produced a series of five articles[2,3,4,5,6]. The main conclusions from "The Bellagio Study Group on Child Survival" show that diarrhoea, pneumonia and neonatal causes of death are important throughout the world, with malaria and HIV infections also causing deaths in some countries, and the authorities must have capacity to take disease profile into account when planning child survival interventions. The group focused on the socioeconomic inequalities affecting child health through many pathways, including increased exposure to disease, reduced resistance, and lack of appropriate health care. Jones et al, 2003 pointed out that we have the knowledge and instruments to reduce child mortality, but children continue to die because the interventions are not reaching them. Poor children are far less likely to receive these interventions than children living in families, communities, and countries with more resources. About two thirds of child deaths could be prevented by interventions that are available today and are feasible for implementation in low income countries at high levels of population coverage. However, the health systems in many countries are too weak and fragmented to enable the scaling-up of essential interventions for maternal, newborn, and child health[7].

Over the last three decades, substantial progress has been made towards the reduction of infant and childhood mortality rates in third world countries[8].

Despite the progress made in addressing child mortality, under five mortality still remains high in less developed countries.

Over the last five years, national infant mortality and under five mortality rates in Ghana have not improved – evidence that children continue to die needlessly[9].

Every year in Ghana, about 80000 children do not live to celebrate their fifth birthday. Most of these children die from preventable causes. Among these causes malaria, Acute Respiratory Infection, diarrhea and malnutrition are responsible for 65% of under five deaths.

The government of Ghana recently adopted the High Impact Rapid Delivery (HIRD) approach as a national strategy to reduce child mortality. The approach bundles core health and nutrition interventions and delivers many of them in the heart of communities where families tend to lack access to health care facilities and lack even the most basic knowledge on how to manage common childhood disease.

At the local area, scientists at the Navrongo Health Research Centre in rural northern Ghana teamed with researchers at the Population Council to design and test an innovative program--employing nurses on motorbikes as well as community volunteers to deliver health care to people in their own homes. The program has succeeded in cutting deaths among children younger than five years by more than half and is on track to achieve a two-thirds reduction in the next few years. A two-thirds reduction of mortality among children under age five by 2015 is one of the eight Millennium Development Goals set by the United Nations in 2000. The program has thus demonstrated how professionals in a resource-poor setting can reach such a goal relatively quickly[10]**.**

In spite of this initiative, the under five mortality correlated with the low level of socio-economic status constitute a challenge for the populations.

There is consistent evidence that the socioeconomically better-off individuals do better-on most measures of heath status including mortality, morbidity, malnutrition and health care utilization.

This inverse association has been detected between health outcomes and a matrix of SES indicators based on data collected at the individual, household and community levels, including education, occupation and income measures, information on household possessions and level of community development[11,12].

1.2. Level and Trends in child mortality in Africa and Ghana

The United Nations Children's Fund (UNICEF) today called for accelerated efforts to save young peoples' lives as new figures indicate that the rate of deaths of children aged under five continues its long-term decline around the world. The mortality rate has fallen by some 27 per cent since 1990, according to statistics released by UNICEF. In 2008, there were 68 deaths for every 1,000 live births, compared with 93 deaths nearly two decades earlier. Recent results also indicate encouraging improvements in many African countries due to basic health interventions, such as early and exclusive breastfeeding, measles immunization, Vitamin A supplementation, the use of insecticide-treated nets to prevent malaria, and prevention and treatment of HIV/AIDS[13].

Under five mortality varies between continents and countries; for instance in industrialized countries, there is now an average of just six deaths for every 1,000 births compared to developing countries where the under five mortality rate is still high despite considerable efforts made during the last decade.

There is considerable reduction of under-five mortality during the last decade. It is estimated under-five mortality dropped by 25 per cent from the nearly 13 million child deaths in 1990[14]. Of the estimated 9.7 million children who died in 2006, 4.8 million were from Sub-Saharan Africa and 3.1 million from South Asia. By far the highest rates of under-five mortality are found in sub-Saharan Africa (186 deaths per 1,000 live births in West and Central Africa and 131 per 1,000 in Eastern and Southern Africa), where

conflict and the spread of HIV/AIDS have undermined hard-won gains in child survival[15].

In a number of regions, the rate of reduction in child mortality since 1990 has been striking. Child mortality rates have been roughly halved in East Asia and the Pacific, Central and Eastern Europe and the Commonwealth of Independent States (CEE/CIS), Latin America and the Caribbean bringing the under five mortality for each of these regions below 30 per 1,000 live births in 2006. Considerable progress had been made in the Middle East and North Africa in the reduction of under five mortality but still had a childhood mortality rate of 46 per 1,000 equivalent to 1 in every 22 children dying before age five[13,15].

South Asia is also making a headway, although among the regions it has the second highest number of deaths among children under five, accounting for 32 per cent of the global total.

Sub-Sahara Africa remains the region where under five mortality is still high. The region as a whole has shown the least progress since 1990 which is the baseline for MDG targets. The reduction of under five burden in that region was only 14 per cent between 1990 and 2006. In 2006, 49 per cent of all deaths of children under five occurred in sub-Saharan Africa, despite the fact that only 22 per cent of the world's children are born there.

In some West African countries like Ghana, the situation is not improving yet. According to the Ghana Child Health Situation Report 2007, under five mortality estimates show no change for the seven year period between 1999 and 2006[9,16] . The most recent estimate of under five mortality for 2001-2006 is 111 per 1,000 live births. The underlying causes of death among children remain malaria, pneumonia, diarrhoea and malnutrition.

The rate of under five mortality is more pronounced among the poorest than the least poor because a child in the least poor quintile is 63 percent more likely to have been vaccinated against measles compared to a child in the poorest quintile[17].

1.3. Socio-Economic Status and Child mortality

Research on the effects of socio-economic well-being on child health is important for making population projections and in addition, by examining its determinants and its trends, it is used to evaluate level of development in a community.

The impact of socio-economic factors on child survivorship has been made evident by several literature on health in developing countries[18,19]. Generally child mortality varies by socio-economic background factors[20].

A study carried out in six sites in rural Upper Egypt to determine indices, leading causes, and socio-demographic determinants of childhood mortality[21] found child age and mother's age at childbirth to be the strongest determinants of childhood mortality and that a child born in poor setting is more likely to experience death than the one born in a rich family. Using logistic regression to investigate the association between socio-economic factors and under five mortality the study concluded that house ownership (OR = 2.6, 95% CI 1.6 - 4.5) maternal illiteracy (OR =2.4, 95% CI 2.2 – 5.9) household meat consumption (OR =2.3, 95% CI 2.3 – 4.1) father illiteracy (OR =1.8, 95% CI 2.0 – 3.9) and parental age difference(OR =1.8, 95% CI 1.5 – 3.0) were significantly and independently associated with childhood mortality.

In Europe, a study focusing on the mortality differentials for instance, found out the lowest under five mortality rates are among girls and the highest rates among boys.

A significant difference in mortality indices according to the sex of the child was described in many research reports from developed as well as developing countries.

Females survive better than males in virtually all industrialized countries[22]. A different pattern is described in developing countries, where female mortality exceeds male mortality in the childhood period[8,23].

Using the Ghana Demographic and Health Survey (GDHS) and the Word Bank data Buor.D[24] found a positive relationship between women's education and child health. For Hobcraft.J.N[25] in sub-Saharan Africa, the trend is that the more years spent in school by mothers, the higher the survival rate of their children.

The relationship between socio-economic factors and child mortality is intricate[26]. Factors such as income, occupation, education, social class, urbanization, sanitation and availability of health care service are well known correlates of mortality in general and among infant and children in particular. The education levels of the mother and socio-economic status of the family have been identified as the most important factors in determining the level of child mortality. Children born to a mother who is very young or very old are known to be at high risk of both morbidity and mortality.

In a study conducted in Malawi Manda.S.O.M[27] pointed out a strong association between child mortality and some socio-demographic factors (maternal age, birth order, preceding birth and succeeding conception intervals). Contrary to some studies, the author concluded that there is a negative association between rural residence and child mortality in the presence of socio-economic status, medical care and maternal education levels. Living in rural areas decreases the risks of child death by about 0.37 relative to living in urban areas.

1.4. Health inequality measurement

Equity in health has been operationally defined as "minimizing avoidable disparities in health and its determinants, between groups of people who have different levels of underlying social advantage[28]. Measuring health inequalities remains useful for the formulation of health policies because they point specifically to conditions among the poor and to poor-rich differences[29]. For example, infant mortality rates among the poor or the differences in infant mortality between rich and poor sectors would be more useful indicators than the average infant mortality rates for the whole population.

While the conventional approach to the measurement of socioeconomic status is money –metric and uses income and /or expenditure data, multidimensional approaches employ several socio-economic indicators to compile these indices. Economists often use income to measure wealth, welfare, and others indicators of wellbeing. While income data has limitations in both accuracy and measurement, particularly in the context of developing countries[30,31,32].

Principal Component Analysis (PCA) is a multivariate statistical technique used to reduce the number of variables in a data set into a smaller number of 'dimensions'. In mathematical terms, from an initial set of *n* correlated variables, PCA creates uncorrelated indices or components, where each component is a linear weighted combination of the initial variables[33]. SES index in the absence of income or consumption data can be derived by performing PCA on durable asset ownership, access to utilities and infrastructure, and housing characteristic variables. The main advantage of this method over the more traditional methods based on income and consumption expenditure is that it avoids many of the measurement problems associated with income- and consumption-based methods, such as seasonality and data collection time. Compared with other statistical alternatives, PCA is computationally easier, can use the

type of data that can be more easily collected in household surveys, and uses all of the variables in reducing the dimensionality of the data[34]. Socio-economic categorization is obtained by ranking then classifying households within the distribution into various groupings. The indices derived are relative measures of SES, so while this type of measure is useful for considering inequality between households, it cannot provide information on absolute levels of poverty within a community[35]. It can be used for comparison across countries or settings (such as urban/rural), or over time, provided the separate indices are calculated with the same variables.

The poorest/least poor mortality rate ratio and rate difference are also used in some studies to measure health inequalities between levels of socioeconomic status. The poorest/least poor mortality rate ratio compares rates prevailing in the poorest quintiles with those in the least poor quintiles and is used as a measure of SES inequality[17] while the poorest/least poor rate difference measures absolute inequality. The limitation of these methods is that they ignore the information contained in the middle three quintiles; but still a very useful measure of inequality.

Concentration index (C) and Concentration curves are more and more used in epidemiological studies to measure health inequalities between the poor and rich. Concentration curves can be used to identify whether socioeconomic inequality in some health sector variable exist and whether it is more pronounced at one point in time than another or in one country than another. But a concentration curve does not give a measure of the magnitude of inequality that can be compared conveniently across many time periods, countries, regions, or whatever may be chosen for comparison[36]. The concentration index, which is directly related to the concentration curve, does quantify the degree of socioeconomic related inequality in a health variable[18,37].

It has been used, for example, to measure and to compare the degree of socioeconomic related inequality in child mortality[38], child immunization[39], child malnutrition[38], adult health[40], health subsidies[41] and health care utilization[42].

1.5 Research Question

Can the socio-economic status considered as proxy determinants explain the variability in mortality among under-fives in Navrongo DSS from 2001 to 2006?

1.6 Null Hypothesis

There is no difference in child mortality between levels of socio-economic status in Navrongo DSS from 2001 to 2006.

1.7 Justification

Mortality among children under five constitutes an important measure for further changes in population growth. Hence a study of the socio-economic determinants of under five mortality is very useful to highlight the factors that contribute to lessen it as well as those contributing to exacerbate it.

Although the association between childhood mortality and socioeconomic factors is well documented, there is no rank or ordering in the impact of the socioeconomic factors on childhood mortality; most of the previous studies – all over the world concentrated on the significance of these associations, even though they had shown conflicting results on the significance of some factors.

The present study tries to address the conflicting nature of results obtained by previous research investigating association between under five mortality and socio-economic status.

The study will also help to influence policy formulation and decision making toward reducing under five mortality in Navrongo.

1.8. General Objective

The aim of the study is to **determine** the relative impact of socio-economic and demographic factors on under five mortality in Navrongo DSS from 2001 to 2006

1.9. Specific Objectives

1- To **describe** under five mortality trends in Navrongo DSS

2- To **describe** the socio-economic risk factors for under five mortality.

3- To **investigate** the association between socio-economic and demographic risk factors and childhood mortality

CHAPTER TWO: METHODOLOGY

2.1 The Navrongo Demographic Surveillance Site

The Navrongo DSS employs the Household Registration System (HRS), which involves collecting, and documenting data on pregnancies and births, deaths, causes of death, in and out-migrations and socioeconomic status. The Navrongo DSS is operated by the Navrongo Health Research Centre (NHRC), which started in 1989 as a field station to investigate the impact of repeated large doses of Vitamin A Supplementation on child survival in the Kassena-Nankana District. In 1992 the Ministry of Health (MOH) designated it a research centre with the mandate to investigate health problems of the sahelian ecological belt of Northern Ghana and advice policymakers.

The Navrongo DSS started with a baseline census of the rural district in 1993, followed by compound visits at 90-day cycles to monitor demographic events (births, deaths and marriages, in- and out-migration and obvious pregnancies). The baseline survey included a socio-economic module, which lists compound possessions as well as the materials used in constructing the dwelling. In the last quarter of 1995, DSS activities were extended to include Navrongo town, the only urban area in the district. To qualify as a compound member, a person should have been either a resident in the compound for at least three months, or a newborn baby whose mother is already a compound member.

The main data-collection instruments used for the routine recording and updating of vital events are compound-registration books (CRBs) and event forms. CRBs are field registers containing basic demographic information on all compounds in a cluster.

During the compound visits, new events are registered. Pregnancies recorded earlier are also monitored during these quarterly visits, until the pregnancies are terminated. This is to help improve on birth and death reporting, in particular by capturing neonatal deaths.

For every vital event that is recorded, detailed information is collected using the appropriate event-registration form. Verbal Autopsy (VAs) on deaths of any of those registered with the Navrongo DSS are also conducted to obtain information on the circumstances leading to the death.

In the last quarter of 2004 (October), the data collection system was changed from the compound to the household level. The process of collecting data at the household level was initiated following a proposal submitted to the INDEPTH Network for funding to deploy the INDEPTH equity tool at the household level in Kassana Nankana District. This gave the Navrongo Health Research Centre the opportunity to reconfigure the data collection system while at the same time deploying the INDEPTH equity tool.

2.2 Socio-demographic characteristics of the study area

This study was carried out in a sahelian rural area, the Navrongo Demographic surveillance site in the Kassena-Nankana District in Northern Ghana. The district stretches over an area of about 1674 km^2 along the Ghana-Burkina Faso border and is home to a population of about 150,000 inhabitants as of June 2008. The populations consist of two distinct ethno-linguistic groups: the *Kassena* form 54% of the district's population, while the *Nankani* constitute about 42%. The *builsa* and others constitute 4% of the population. In terms of health services the district has a hospital, five health centers and one private clinic. The main religious faith is animism, but Christianity is gradually becoming more prominent, especially among women[43]**.** Currently, about 33% of the people are Christian, 5% are Muslim, and the rest profess the indigenous religion. However, the dominant animist faith guides daily life, economic decisions, health beliefs, and practices. This reliance on indigenous medicine hampers the use of health services according to Debpuur et al[43].

The district has 134 primary schools, 50 junior secondary schools, 8 senior secondary schools, 1 training college, and 2 vocational institutions. It is also home to the Faculty of Applied Sciences of the University for Development Studies, which focuses on integrated science. Also, the Catholic mission manages an orphanage.

About 89% of the houses in the district are mud huts with thatched roofs. The rest, which are built with cement blocks, are mostly found in the urban area. Almost two-thirds (65%) of the roofs are constructed with straw. Zinc sheets are used for the remaining 35%. The main sources of water in Kassena-Nankana are streams, wells, and boreholes[43]. In a few urban houses, however, pipelines have been installed to provide treated water. Similarly, only 7% of the compounds have access to properly constructed toilet facilities, suggesting that as many as 93% of households use the bushes in their immediate surroundings. For those compounds with toilet facilities, two-thirds use either Kumasi ventilated improved pit, pan, or pit latrines, and the rest use water closets[44].

The study area is characterized by a low access to education and most of the income is provided by subsistence agriculture. Lack of a communication system, a road network, and electricity in the district also impacts adversely on the health of the population.

2.3 Study design

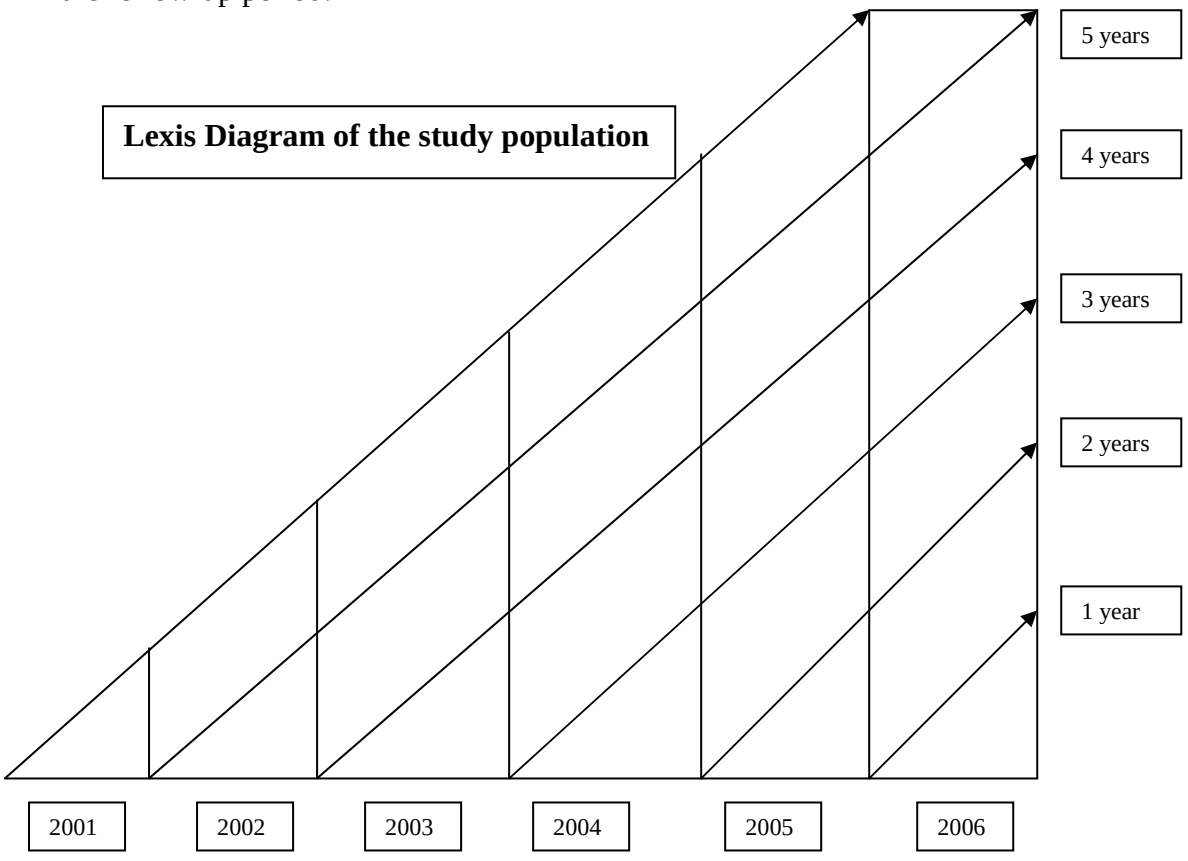
This study is a longitudinal study using data collected by the Navrongo Demographic Surveillance System during the 2001- 2006 rounds of data collection.

2.4 Study population

The study considers all children under the age of five, who were born and registered in Navrongo DSS and also were residing in the Navrongo DSS during the study period 1st January 2001 – 31st December 2006. Between January 2001 and December 2006, there were twenty three (23) rounds of data collections and all children less than 5 years registered during those rounds will be consider as part of our study population.

2.5 Inclusion and exclusion criteria

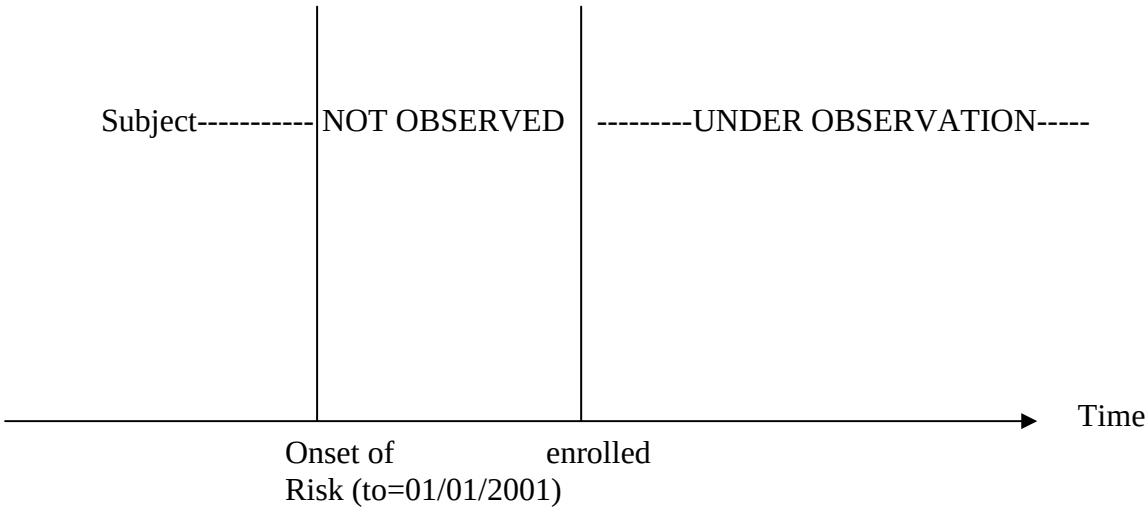
Only households with children younger than five years of age as at 31st December 2006 residing in the Navrongo Demographic Surveillance site where included in the study. The following Lexis diagram allows a better understanding of the study population and the follow-up period.



All children born in 01/01/2001 were followed up to 31/12/2005, while for children born after 2001 they were followed up to 31/12/2006.

2.5.1 Left truncation or delayed entry

The robustness of survival analysis is that it should account for all person time contributed by each participant in the analysis. The following figure illustrated the left truncation and how it had been addressed in the analysis.



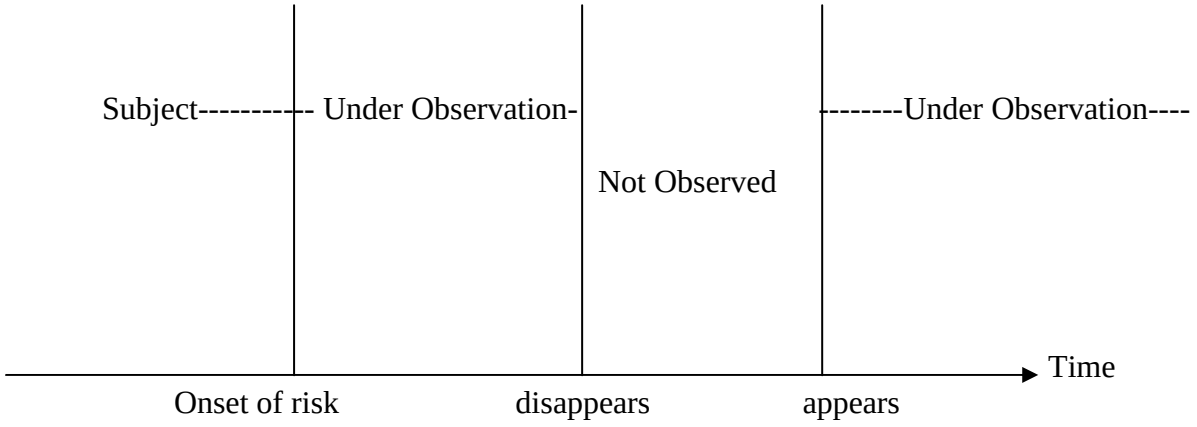
Looking at our dataset we realized that only children who in-migrated are involved in the procedure of left truncation (all date of births for children born in the DSS occurred either on 01/01/2001 or after that date meaning they are already part of the population at risk).

While for children who in-migrated and at the time of birth they were not resident and are involved in left truncation. For example a child born 01/01/2001 (not in DSS) but in-migrated during the study period let us say 02/02/2003.

This child will be involved in the analysis for the time he spent in the DSS site meaning from 02/02/2003 up to 31/12/2005. In NDSS the 3 months threshold used for data collection is also used in the analytical definition of residence variable.

2.5.2 Interval truncation or gaps

In and out-migration can affect survival analysis. Most of these movements lead to gaps or interval truncation. These intervals had to been taken in consideration during the analysis otherwise it can affect the reliability of the analysis. The following figure illustrated how the gaps can occur and how we addressed them in the analysis.



For example a child can be observed up to certain period and he/she disappears. So that in an out-migration created interval gap between periods of follow-up. In the analysis only the periods when he/she was under observation will be taken into account in the analysis.

2.6 Data source

The data for this study was collected as part of the longitudinal data and was extracted from NDSS database. The data contains information on all individuals, household, and deaths which occurred from 1st January 2001 to 31st December 2006.

2.7 Extraction and description of variables

2.7.1 Socioeconomic status was measured using an index based on ownership of assets, water and sanitation facilities, power source and housing quality and constituted the main independent variable. The asset approach was used as recommended by Filmer and Pritchett[45]. In a study conducted in several states of India, Filmer and Pritchett found that the asset index produces comparable results with other measures. The author noted that the asset index is significantly correlated with the state head count index as well as the domestic product per capita distributions.

The assets will be combined into a wealth index using weights derived through principal components analysis (PCA) using Stata 10. PCA involves breaking down assets (eg radio, bicycle) or household service access (eg water, electricity) into categorical or interval variables. The variables are then processed in order to obtain weights and principal components. The results obtained from the first principal component (explaining the most variability) are usually used to develop an index based on the formula: $A_{j=}f_1 \text{ x } (a_{ji}\text{-}a_{i)}/(S_1)_{+.....+}\ f_N\ \text{x}(aj_N - a_{N)}/(S_N)$[46]. Where f_1 is the scoring factor or weights for the first asset (or service), and a_1 and s_1 are the mean and the standard deviation of the first assets (or service) variable over all households respectively.

Based on this equation SES of households will be assigned to the residents of those households, and the resulting households will be divided into quintiles (i.e. poorest, poorer, poor, less poor, and least poor) that represent the proxies for SES.

The following household characteristics and assets were included in the PCA model: floor type of the household, wall type of the room (whether they were locally made with mud or with modern material such as cement), source of light power (firewood, kerosene/biogas or electricity, bicycle), car, motorbike, animal possessions.

The model was based on the presence or absence of each asset or the nature of the housing materials .i.e. each asset was dummied with the response, 1 and 0. We reparameterized all variables with more than two categories to generate binary variables to signify presence or absence of a characteristic. We ran the "pca" command in Stata to generate indices for all listed assets. The generated indices were used to categorize participants into five socio-economic groups or quintiles; poorest, poorer, poor, less poor, and least poor.

Table 2.1 reports the scoring factors from the principal components analysis or weight of the 14 selected variables out of the 43 variables included in the Principal component analysis. Generally, a variable with a positive factor score is associated with high socioeconomic status, and a variable with a negative score is associated with low socioeconomic status.

The scoring factor ranges from -0.6 to 1.232. From the principal component analysis we can say all the 42 variables are associated with high level of socioeconomic status except the following variables: household had enough food from the last farming, household had enough food from the land, household using cooking fuel, household having tractor and grinding mill.

The table shows that a household owning a car has an asset index higher by 0.78 than one that does not; possessing cattle raises a household's asset index by 0.03 units.

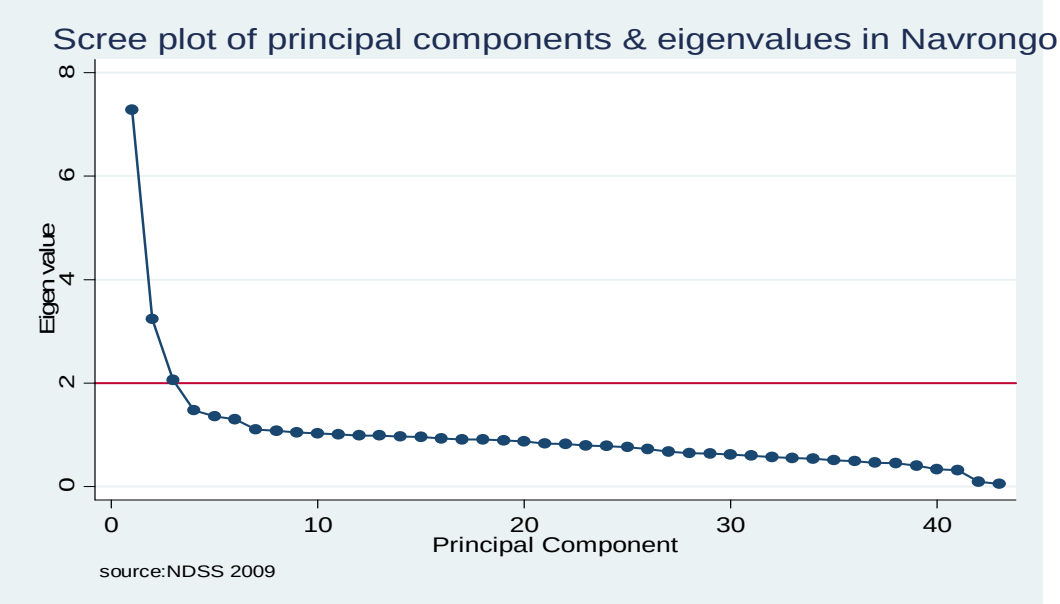
Using tractor lowers the asset index by 0.62. Household using toilet facilities reduced the asset index by 20%.

Table 2.1 Factor scores of selected variables after the Principal Component Analysis

Variable description	Summary Statistics			
	Total	**Mean**	**Std Dev**	**Factor Score**
Household durables and facilities				
Car	20897	0.015	0.124	0.787
Motor	20897	0.056	0.231	0.747
Bike	20897	0.789	0.407	0.987
Electric	20897	0.070	0.256	0.987
Solar	20897	0.011	0.106	0.275
Refrigerator	20897	0.046	0.210	**1.232**
Toilet	20897	0.008	0.091	-0.207
Tractor	20897	0.006	0.083	-0.623
Cooking Fuel	20897	0.010	0.103	**-0.000**
Household food security and animal possessions				
Cattle	20897	0.399	0.489	0.035
Sheep	20897	0.461	0.498	0.139
Goat	20897	0.673	0.468	0.184
Horse	20897	0.002	0.052	0.421
Enough Food	20897	0.558	0.496	-0.104

A plot of the obtained eigenvalues for each factor is presented in figure 2.1.

Figure 2.1:



There were 43 principal components included in the analysis. The first 6 eigenvalues, as extracted from correlation matrix of the selected components are plotted in figure 2.1. They explain 76.6% of the total variability in all 43 components selected. The PCA shows that the variance in the first component is explained by household using electricity (30.7%), and household possessing refrigerator (29.3%). Meaning that all things being equal, a household using electricity and possessing refrigerator will be ranked higher in terms of SES than a household that does not use electricity.

In the second component, the household raising cattle (28.2%) and sheep (29.3%) explained most of the variance. For the third component the variables on food security explained most of the variability. So for the forth component, household owning land explained 35% of the variability.

The output of the principal component shows that the variance in the first component is explained by household using electricity (17.7%), and household possessing refrigerator (9.5%). Meaning that all things being equal, household using electricity and possessing refrigerator will be ranked higher in terms of SES than a household that does not use electricity.

The plot shows also a cutoff point of eigenvalue >=2 in constructing wealth index of household in Navrongo.

This implies that each individual variable accounts for a variance of 2 or plus. If a component accounts for a variance more than 2, then it account for more variance than any one of the original observed variables could.

2.7.2 Other explanatory variables:

Mother's age at birth: The collection of longitudinal data doesn't give a direct measurement of the age. We generated the age of mother from a subtraction of the date of birth of the child and the date of birth of the mother. The age of the mother at birth ranges from 15 to 49 years old. A categorical variable of the mother's age had been generated with 4 categories less than 20 years, 20 to 29 years, 30 to 39 years, and 40 years or more.

Education of the mother: The current system of school in Ghana is such that you have lower primary for three years, upper primary for three years, and junior secondary school for three years and then a further three years of senior secondary school. Thereafter, one can proceed to college or university. To create the education of mother variable, we grouped all those in primary together and those in secondary (senior) together. Initially we had created 5 groups of education level. But as the tertiary was small to stand alone, we grouped it with secondary. We had finally 4 groups; None, Primary, Secondary or Tertiary, and Don't know

Place of birth: For the variable place of birth of child we followed the structure of the DSS birth forms. Three main categories or place of birth was created. Hospital regrouping births at (hospital, health center or clinic), Home regrouping births at (home, traditional birth attendant's home), and Others.

The number of live births: This variables can be defined as birth types (meaning single birth, twins or triplets). The variable has been categorized in 2 categories with single and multiple births.

Residence of the child: A binary variable has been generated using the location variable which has details about those who resided in a rural area and those living in town. Based on that, a residence variable had been created.

Sex of the child: The dataset has a string variable that represented gender. A dummy variable "sex" was created to replace gender, with the sex of the child being male (0) or female (1).

2.7.3 The outcome Variable

The outcome being measured is mortality among children less than five years old. A binary variable was also generated and took the value 1 if a child died, and 0 if not. Under five mortality rate was measured by using Kaplan Meier survival estimates. It was expressed per 1,000 person years observed. Mortality rate for infants (0-1 years), childhood (1-5 years) and children less than 5 years who died in the period 2001-2006 were computed similarly.

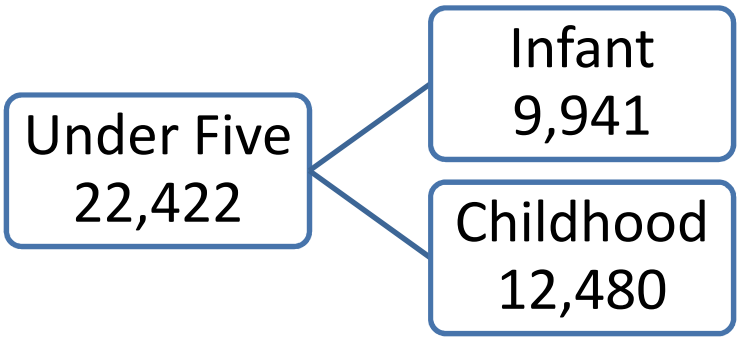
2.8. Data management

The data extraction, cleaning, joining of tables and statistical analysis were done using Stata version 10. Before exporting the data from Visual FoxPro to Stata version 10, data transfer was done using ODBC (Open Database Connectivity). The variables for this research were selected from seven different tables namely Individuals, Births, Education, Relationship, Socio-economic baseline, Residency, and Pregnancy outcome.

The date of deaths was obtained from the table of all resident individuals in the demographic surveillance area. The date of birth was obtained from the birth table which contains the personal information about the individual. The type and number of assets were also stored in separate tables. From date of birth, ages where computed and only children who were less than five were kept for the final analysis. All these tables were linked together by social identifiers and the required variables for analysis were then selected and stored in a separate table. This ensures that every child is linked to a particular household and also accommodates households with more than one child. Data cleaning involved the checking of quality of the data in terms of missing values, internal consistencies and validity of responses.

2.9 Sample size

The study involved all children less than 5 years old during the period 01/01/2001 to 31/12/2006 and residing in Navrongo Demographic Surveillance Site (NDSS). A total of 22,422 children less than 5 years were found in 21,494 households yielding to 36603.13 Person-Years. Among those we had 914 deaths among children less than 5 years old available for analysis.



A flow diagram on different total number

2.10 Analysis

***Data format*:** The data was reshaped in long format where observations had single record or multiple records considering the migration status of the child during the study period from 1st January 2001 to 31st December 2006.

Measurement of living standards: A straightforward and pragmatic statistical procedure called principal components analysis (PCA) has been used to determine the weights for an index of the assets variable[37]. The principal component analysis was created without income and expenditure due to the problems raised in other studies[30,31,45], but instead by using household asset variables. It provides plausible weights for an index of asset variables to serve as proxy for socioeconomic status or wealth index. An index of living standards was created and households were categorized into five social status or poverty groups and then the relationship between these groups and under five mortality was assessed using Cox proportional hazard.

Mortality rate: Person-years of observation from 1st January, 2001 to 31st December, 2006 were computed for all children younger than five years of age born or present during the study period. Also mortality rate was computed for infant (less than one year), and childhood (one to five years old), and under five mortality. The computations also took into account in and out migrations. Mortality rates were estimated separately for infants, children and under five year old children by Kaplan-Meier (K-M) survival estimates of incidence (mortality) rates and were expressed per 1,000 person years of observation.

Life table: Life table analysis was used to estimate the survival rate at different times of follow-up. An estimate of the survival rate, standard error and the 95% confidence interval were calculated at different time periods to analyze the under five mortality level controlling for left-and-right-censoring.

Health inequality measurement: Two measures of health equity were used in this study. First, we used the concentration index (C) by Kakwani et al[47]. This measures the extent to which a variable (i.e. mortality rate) is distributed equally or unequally across all five socio economic quintiles. The concentration index lies between -1 and 1. A value of 0 indicates that there is no difference in terms of mortality between rich and poor. A negative value indicates a concentration of the health variable (i.e. mortality) among the poor and a positive value indicates the poor are getting less than would be expected[42]. The concentration curve is a graphical representation of the distribution. Secondly, we calculated the poorest/least poor ratio which compares rates prevailing in the poorest quintiles with those in the least poor quintiles. This ignores the information contained in the middle three quintiles. Trend test (Chi- squared) was used to determine the significance of any gradient in the inequality across wealth quintiles.

Univariate and multivariate analysis: Both univariate and multivariate Cox proportional regression analysis were used to determine the association between SES (as measured by the components resulting from PCA) and under five mortality. Potential confounders such as mother's education, mother's age and place of birth of the child were controlled for in the multivariate model.

2.11. Ethical Approval

Ethical approval was obtained from the Human Research Ethics Committee of University of the Witwatersrand with Protocol Number M080976 (appendix). Ethical approval was given for the use of the NDSS dataset by the Navrongo Health Research Centre and the Institutional Review Board with number NHRC/IRB/078 (appendix). A copy of the findings of this report will be presented to Navrongo Health Research Centre for dissemination, in accordance with the Institutional Review Board guidelines for conducting health research.

CHAPTER THREE: RESULTS

This chapter presents the results. The analysis was performed for infant ($_1q_0$), childhood ($_4q_1$), and under five ($_5q_0$) mortality. The analyses are in three parts. The first part describes the study population and also estimates the mortality rate for wealth quintiles using life table methods. The second part of the analysis looks at socioeconomic status and under five mortality using econometric measurement such as concentration index (C), Concentration curve (L(p)) and poorest/ least poor ratio to measure health inequality between the poorest and least poor. The third part of the analysis investigates the association between under five mortality and socioeconomic status using Cox proportional hazard's regression.

3.1. Socio demographic background of study participants

Table 3.1 shows the distribution of the study population and number of deaths by covariates. In this study, a total of 22,422 study participants were included. There is a slight difference in the proportion of males (50.7%) compared to the proportion of females (49.3%). Out of the total, 914 (4.0%) died during the observation period. Among the males 495 (4.3%) died and among the females, 419 (3.7%) died .

For education of the mother, those with no education were the majority in the study sample. The proportions of women with no education, primary, secondary/tertiary education were 60.4%, 19.8%, and 14.2% respectively. Out of the total study participants, 448 (4.0%) children died to mother who did not have formal education, 140 (3.8%) children died to mother who had attended primary level of education, 84 (3.2%) were children whose mothers had completed either secondary or tertiary level education while for those with unknown education status 53 (5.3%) children died.

For the marital status of the parents, 914 (4.0%) deaths among under-five children were recorded. Out of the total study sample, 132 (4.2%) deaths occurred to children born to not married couple and 782 (4.0%) to married couple.

The proportion of Kassim (50%) included in the study was larger than the other ethnic groups; Nankani (46.1%), Builsa (2.0%) and other (1.8%). Out of the total number of under-five children, 460 (4.5%) deaths had occurred in Nankani groups, while the Builsa minorities in this area registered 11 deaths during the study approximately 2.3%.

Among the total number of live births recorded during the study period, single births were 18,908 (97.4%), and multiple births 497 (2.6%). The data shown that more deaths were recorded among single births 793 (4.1%). For multiples, approximately 46 deaths (9.2%) were recorded.

The distribution of deaths according to place of birth indicates more deaths among the children who were delivered at home 529 (4.9%). A total of 5,537 (28.5%) births were recorded at different health facilities (hospital, clinics, and health centers) out of which 268 (4.8%) died before age five.

Table 3.1: Distribution of children by covariates used in analysis of child mortality

Covariates	Alive		Deaths		Total		P_value
	Number	%	Number	%	Number	%	
Sex of the child							
Male	10,868	95.64	495	4.36	11,363	50.68	0.030
Female	10,640	96.21	419	3.79	11,059	49.32	
Mother's education*							
None	10,631	95.96	448	4.04	11,079	60.45	
Primary	3,491	96.14	140	3.86	3,631	19.81	0.037
Second/tertiary	2,533	96.79	84	3.21	2,617	14.28	
Unknown	949	94.71	53	5.29	1,002	5.47	
Marital status							
Married	18,542	95.95	782	4.05	19,324	86.18	0.665
Not Married	2,966	95.74	132	4.26	3,098	13.82	
Ethnicity*							
Builsa	453	97.63	11	2.37	464	2.09	
Kassim	10,635	96.15	426	3.85	11,061	49.91	0.005
Nankam	9,772	95.50	460	4.50	10,232	46.17	
Other	395	97.53	10	2.48	405	1.83	
Birth order*							
One	5,854	95.54	273	4.45	6,129	27.34	
Two	4,154	96.29	160	3.71	4,316	19.25	
Three	3,539	96.56	126	3.43	3,671	16.38	0.040
Four	3,055	96.10	124	3.90	3,183	14.20	
Five and +	4,891	95.51	231	4.51	5,118	22.83	
Live births*							
Single	18,115	95.81	793	4.19	18,908	97.44	0.000
Multiple	452	90.74	46	9.36	497	2.56	
Place of birth*							
Health facility	5,269	95.16	268	4.84	5,537	28.53	0.000
Home	10,072	95.01	529	4.99	10,601	54.63	
Other	3,225	98.71	42	1.29	3,267	16.84	
Migration status							
Non migrant	15,967	95.22	801	4.78	16,768	74.78	0.000
Migrant	5,541	98.00	113	2.00	5,654	25.22	
Residence							
Urban	1,620	96.89	52	3.11	1,672	7.46	0.031
Rural	19,888	95.85	862	4.15	20,750	92.54	
Maternal Age							
Less 20 years	2,541	95.45	121	4.55	2,663	11.88	
20 – 29 years	10,081	96.18	400	3.82	10,487	46.77	0.025
30 – 39 years	6,733	96.02	279	3.98	7,015	31.29	
More 40 years	2,143	94.99	113	5.01	2,257	10.07	
Wealth Index*							
Poorest	3,911	96.21	154	3.79	4,065	20.05	
Poorer	3,921	96.60	138	3.40	4,059	20.02	0.000
Poor	3,911	96.05	161	3.95	4,072	20.08	
Less Poor	3,917	96.88	126	3.12	4,043	19.94	
Least Poor	3,943	97.65	95	2.35	4,038	19.91	

*** missing values omitted**

A total of 5,654 (25.2) children became residents of DSS by in-migration during the study period. Out of this 113 (2.0%) children died, while for the non migrants 801 (4.7%) died out of the total.

In terms of the place of residence of the child, a total of 22,422 participants were distributed between rural and urban area covered by the Navrongo Demographic Surveillance Site. The majority of the study participants were living in rural areas 20,750 (92.5%) compared to those living in urban area 1,672 (7.4%).

Maternal age was classified in four categories. A total of 22,422 children were distributed in those 4 groups. Child mortality varied across the 4 different categories. More deaths were recorded among children born to women aged between 20 – 29 years (400 or 3.8%)) than in the other categories. For maternal age less than 20 years 121 (4.5%) deaths, 30 – 39 years old 279 (3.9%) deaths and those more than 40 years old 114 deaths were recorded, meaning (5.0%) approximately.

Using principal component analysis (PCA), children less than five years old were distributed according to wealth index quintile. About 20% are classified as Poorest with 149 (3.8%) deaths recorded, while only 93 (2.3%) deaths were registered in households classified as least poor. The Poor households recorded 156 (3.9%) deaths out of the total study participants. While the poorer had recorded 136 (3.4%) deaths, and the less poor had 119 (3.1%) deaths

3.1.1 Mortality rates and survival probabilities

The table 3.2 presents the probability density function F (t), meaning the probability of the failure time occurring at exactly time t and the survival probability S(t) with the 95% confidence interval.

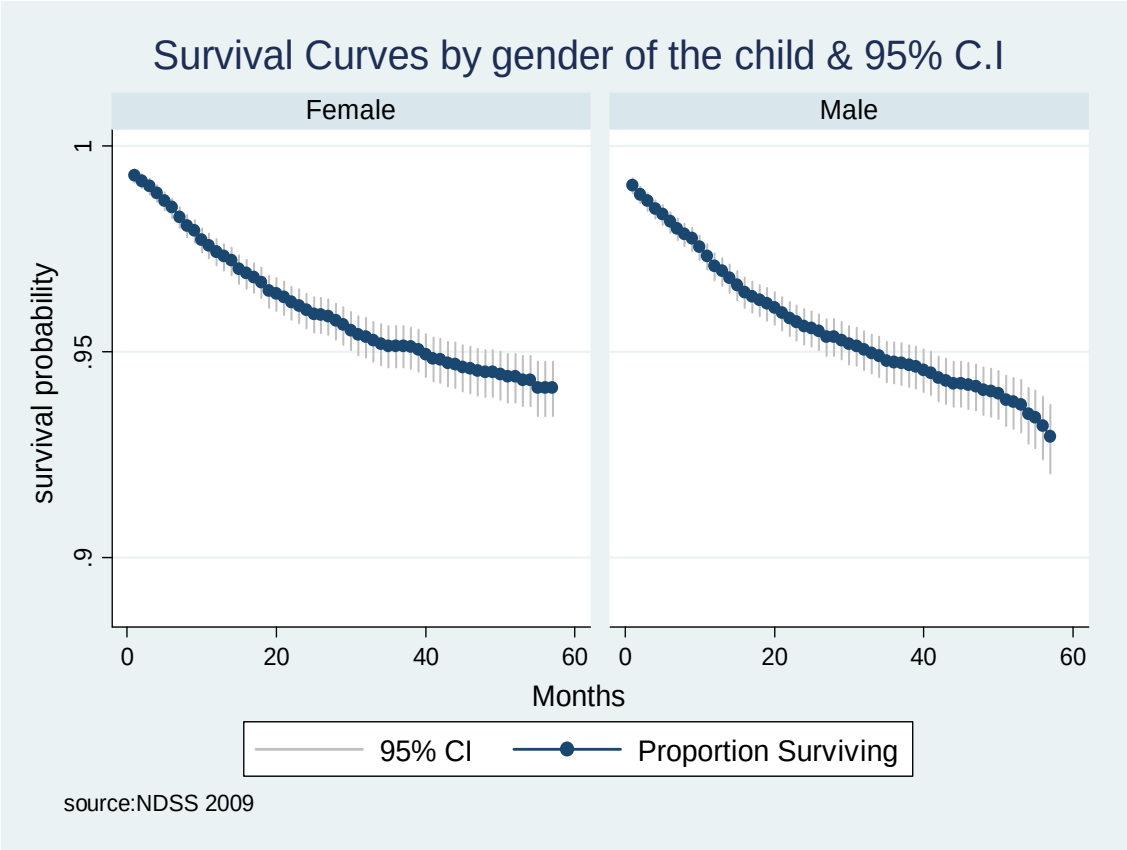
At one year of follow up a total of 13,830 person years were under observation among which 462 deaths were recorded. The infant mortality rate was 33.4 per 1,000 (95% C.I 30.4 – 35.6). For under five children, the mortality rate was estimated to be 18.2 per 1,000 with it 95% confidence interval (95% C.I 17.0 – 19.4)

Table 3.2: Survival probabilities S (t) and the probabilities density function F (t)

Time at Risk	Persons time at risk	Failures	F(t)	S(t)	Std-Error	95% C.I
12 months	13830	462	0.0334	0.9673	0.0013	0.0246 – 0.0318
24 months	11313	201	0.0412	0.9588	0.0017	0.0409 – 0.0478
36 months	9051	99	0.0500	0.9500	0.0019	0.0324 – 0.0573
48 months	6380	63	0.0576	0.9424	0.0021	0.0312 – 0.0653
54 months	3239	23	0.0624	0.9376	0.0023	0.0543 – 0.0704
60 months	68	21	0.0827	0.9172	0.0084	0.0756 – 0.1086

Survival plot curves shown in figure 3.1, compared survival probabilities between males and females. The graphs showed that females survive more than male.

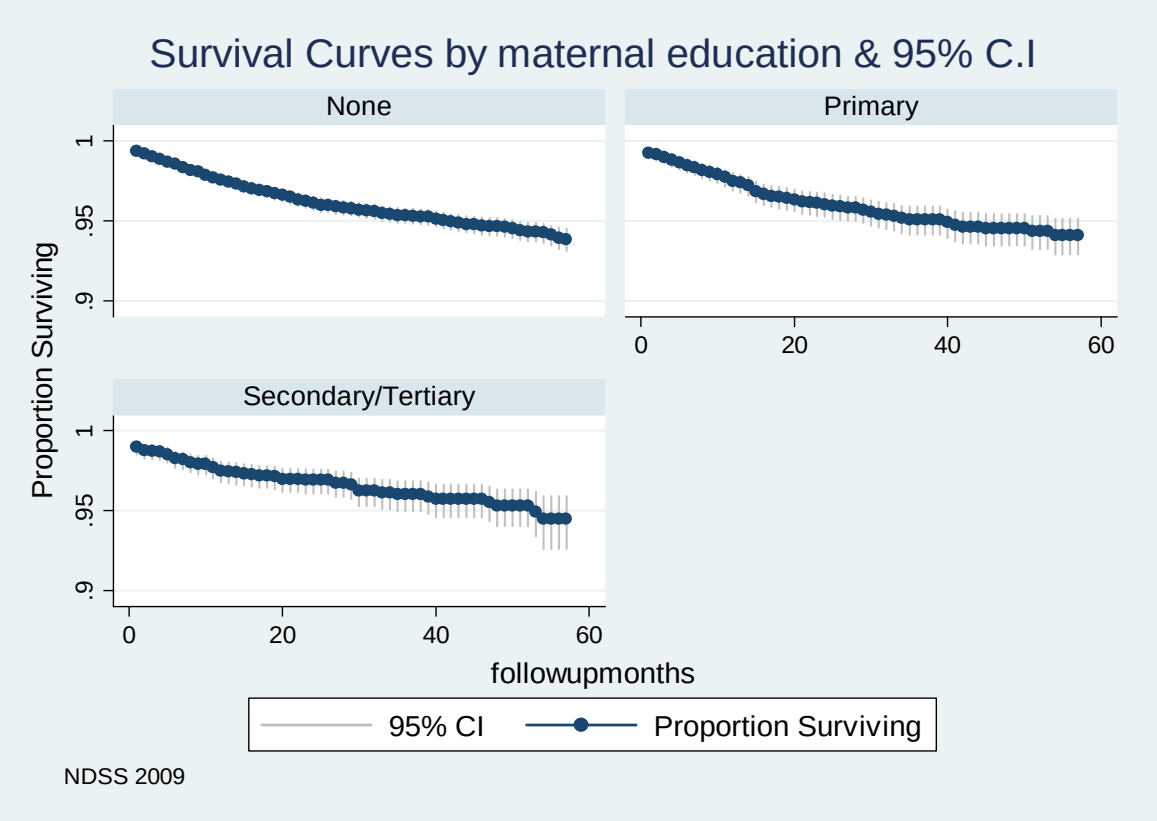
Figure 3.1:



The mortality rates computed also showed that under five mortality rate is higher for males 101.2 per 1,000 (95% C.I 82.8 – 123.5) as compared to females 81.7 per 1,000 (95% C.I 56.5 – 117.4)

The graph 3.2 compared survival probabilities of children according to maternal education. The results showed that children born to a mother with higher level of education had a higher probability of surviving as compared to children born to a mother with low level of education.

Figure 3.2:



Mortality rates computed showed also that under five mortality rate was higher among no educated women 95.3 per 1,000 (95% C.I 71.6 – 126.4) as compared to women with primary level of education 67.2 per 1,000 (95% C.I 53 – 84.9), and secondary or tertiary level of education 56.2 per 1,000 (95% C.I 43.9 – 71.9)

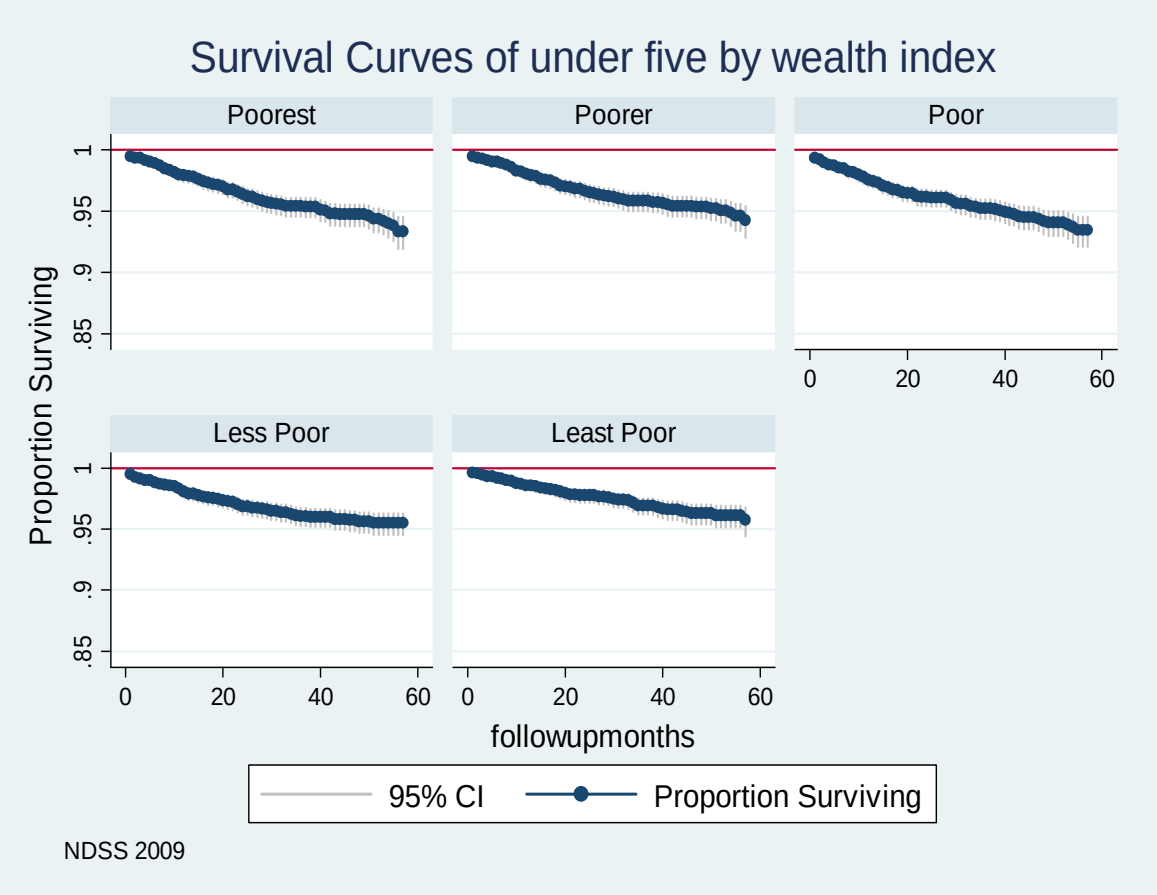
3.2 Socioeconomic status and mortality outcome

The relationship between socioeconomic status and child mortality is assessed using a comparison of survival probabilities between poorest and least poor, the poorest/least poor ratio and the concentration index with chi-square trend.

There is 13.27% of missing data for the wealth index variables because of that all our mortality rates are expressed using the Kaplan Meier survival estimates F(t)

The comparison of survival probabilities is presented in figure 3.3.

Figure 3.3:



A comparison of survival curve for poorest and the least poor showed that there is a difference in the probability of dying between poor and rich.

3.2.1 Socioeconomic status and infant mortality

The relationship between socio-economic status and infant mortality (deaths to children between age zero and one) is presented in table 3.3. The mortality rates are expressed in 1,000 PYOs using the probability density function S (t).

Table 3.3 Infant mortality by socio-economic status

Quintile	Infant Person Years Observed (PYOs)	Deaths (0-1 Yr)	Infant Mortality Rate (95% C.I)
1st (Poorest)	2,845	91	31.9 (25.9 - 39.0)
2nd (Poorer)	2,735	94	34.3 (27.9 - 41.8)
3rd (Poor)	2,806	109	38.8 (32 - 46.6)
4th (Less Poor)	2,744	88	32.0 (25.8 - 39.3)
5th (Least Poor)	2,700	80	29.6 (23.6 - 36.6)
Total	**13,830**	**462**	**33.4 (30.4 - 35.6)**
		Poorest-Least Poor Ratio	**1.1**
		Concentration Index	**-0.02**
		Chi-Square Trend	**P = 0.134**

For the analysis of infant mortality, a total of 9,941 children were included in the analysis yielding 13,830 person years observed (PYOs). The trend in infant mortality rate was not significant. We observed an inverted U shape due to the inconsistency between wealth index and infant mortality. Children in the poorest households are about 10% more likely to die in infancy than those in the least poor or better off.

If the socioeconomic status of the poorest households were improved to the level of the better off, then about 23 per 1,000 infants could be saved annually (rate difference).

3.2.2 Socioeconomic status and child mortality

The relationship between socio-economic status and child mortality (deaths to children between age one and five) is presented in table 3.4. The mortality was calculated from the Kaplan Meier survival rates and expressed in 1,000 person years observed.

Table 3.4 Child mortality by socio-economic status

Quintile	Child Person Years Observed (PYOs)	Deaths (1-5Yr)	Child Mortality Rate (95% C.I)
1st (Poorest)	5,970	106	17.7 (15.1 – 20.7)
2nd (Poorer)	6,068	96	15.8 (13.3 – 18.6)
3rd (Poor)	5,932	94	15.8 (13.2 – 19.7)
4th (Less Poor)	6,012	85	14.1 (11.8 – 16.8)
5th (Least Poor)	4,852	54	11.1 (8.8 – 13.8)
Total	**28,836**	**435**	**15.0 (14.9 – 25.3)**
	Poorest-Least Poor Ratio		**1.5**
	Concentration Index		**-0.09**
	Chi-Square Trend		**P = 0.004**

A total of 12,480 children in the age group one to five years were included in the analysis yielding 28,836 person years of observation (PYOs). The poorest household had higher probabilities of child deaths. There is a significant trend (C = -0.09; P_value < 0.05). Children in the poorest households are about 50% more likely to die than those in the least poor or better off.

If the socioeconomic status of the poorest households were improved to the level of the better off, then about 66 per 1,000 children could be saved annually (rate difference). Adding the first 3 quintiles, it showed a linear trend of childhood mortality between wealth index.

3.2.2 Socioeconomic status and Under five mortality

The concentration index and the poorest and least poor ratio is calculated and presented in table 3.5. The mortality rates were estimated from the Kaplan Meier life table an expressed in 1,000 person years observed

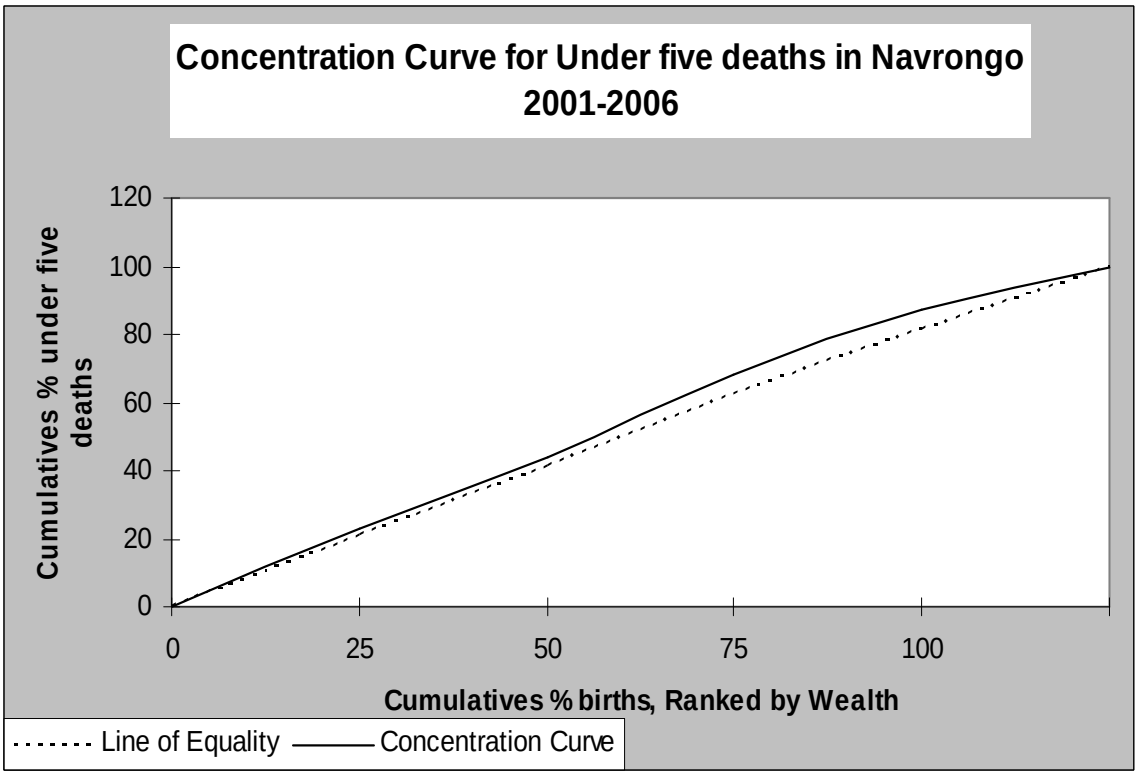
Table 3.5 Under five mortality by socio-economic status

Quintile	Under-5 Person Years Observed (PYOs)	Deaths (0-5Yr)	Under-5 Mortality Rate (95% C.I)
1st (Poorest)	8,815	197	22.3 (19.8 - 25.0)
2nd (Poorer)	8,803	190	21.5 (19.1 - 24.2)
3rd (Poor)	8,738	203	23.2 (20.6 - 26.0)
4th (Less Poor)	8,156	173	21.2 (18.7 - 23.9)
5th (Least Poor)	7,552	134	17.7 (15.3 - 20.3)
Total	**42,664**	**897**	**21 (19.7 - 22.4)**
Poorest-Least Poor Ratio			**1.2**
Concentration Index			**-0.04**
Chi-Square Trend			**P < 0.005**

The table 3.5 showed how under five mortality is distributed across the different socio-economic groups. The data presented indicates that under five mortality is higher in the poor quintiles and lower in the Poorer, Less Poor, and Least poor. When we grouped the first 3 quintiles we observed a linear trend. The data reveals that children in the poorest category are 20% more likely to die before reaching their fifth birthday than those of the better off households. If the socio-economic status of the poorest households were improved to the level of the better off, then about 46 lives per 1,000 children under five years could be saved annually(Poorest/ Least Poor Rate Difference).

A graphical representation of the inequality in under five mortality between poor and rich is presented in figure 3.4.

Figure 3.4:



The value (-0.04) of the concentration index showed that the concentration curve L(p) lies above the line of equality, further indicating disproportionate concentration of under five mortality among poor. Similar disproportionate results were revealed in the case of infant mortality (concentration index = -0.02), and childhood mortality (concentration index = - 0.09).

3.3. Predictors of under five mortality:

To investigate the association between under five mortality and socioeconomic status, Cox proportional hazard regression was run separately for infants (0-1 year), childhood (1- 5 years) and under five (0- 5 years). In the multivariate analysis two different models were run. The first one included only covariates found to be significant at 5% in the univariate analysis and the second model included all the covariates used in the univariate analysis. Table 3.6 presents the Hazard Ratio (H.R) or Relative Rate Ratio (RR) with its 95% Confidence Interval (C.I) and the significance level (P-value) at 0.05 that were obtained from univariate and multivariate Cox proportional hazard regression for infants (less than one year old). Sex of the child, education level of the mother, marital status of the mother, ethnic group, number of live births, place of birth, migration status, place of residence, age of the mother, and wealth index of the child were used as explanatory variables in the univariate Cox proportional hazard regression.

At 5% level of significance, the results of the univariate Cox proportional hazard regression showed that ethnic group of the child, maternal age, number of live births, birth order, maternal education, place of birth, and marital status of mother were associated with infant mortality.

The variables place of residence, and migration status were not statistically significant in their association with infant mortality.

For the wealth index of the child there was no association between socioeconomic status and infant mortality.

The number of live births is associated with infant mortality. Those who are twins or triplets are 2.83 times more likely to die compared to those who are single births [crude H.R =2.83, P=0.000, 95% C.I (1.96 – 4.07)].

Maternal age was associated with infant mortality in Navrongo. Children born to a mother in age group 30 – 39 years old had a 37% reduced risk of dying as compared to children born to a mother aged less than 20 years [crude H.R =0.63, P=0.0004, 95% C.I (0.47 – 0.86)].

Also birth order is a significant predictor for infant mortality. Second and third born are protective against infant mortality. Second born had a 25% reduced risk of dying as compared to first born [crude H.R =0.75, P=0.041, 95% C.I (0.57 – 0.98)]. Third born also had a 39% reduced risk of dying as compared to first born [crude H.R =0.61, P=0.002, 95% C.I (0.45 – 0.83)].

In the multivariate Cox proportional hazard regression, live birth, place of birth, and birth order remained significant at 95% confidence interval in both Model I and Model II while maternal age was not significant.

In the first model where only factors found to be significant in the univariate were included, the results showed that the hazard ratio for live birth remains almost constant. It was 2.83 in the univariate and in the multivariate; it changed slightly to 2.57 in the Model I and 2.78 in the Model II.

For place of birth, there are changes in the hazard ratio from the univariate to the multivariate. There are changes of the hazard ratio in the Model as well as in the Model II. In our study place of birth was considered as a factor confounding the association between socio-economic status and infant mortality.

Table 3.6 Univariate and multivariate analysis for infant mortality (Full Table in Appendix D pages 69-70)

Covariates	Univariate (Unadjusted)			Multivariate (Adjusted)					
				(Model I)			(Model II)		
	H.R	P_Value	95% C.I	H.R	P_Value	95% C.I	H.R	P_Value	95% C.I
Live birth									
Single	1			1			1		
Multiple	2.83	**0.000**	1.96 – 4.07	2.57	**0.000**	1.70 – 3.90	2.78	**0.000**	1.68 – 4.60
Birth order									
First	1			1			1		
Second	0.75	**0.041**	0.57 – 0.98	0.81	0.252	0.56 – 1.15	0.81	0.331	0.54 – 1.22
Third	0.61	**0.002**	0.45 – 0.83	0.59	**0.016**	0.38 – 0.90	0.38	**0.000**	0.22 – 0.65
Fourth	0.76	0.067	0.56 – 1.01	0.93	0.756	0.60 – 1.43	0.66	0.134	0.39 – 1.13
Fifth and +	0.80	0.081	0.62 – 1.02	0.84	0.465	0.52 – 1.33	0.62	0.100	0.35 – 1.09
Place of birth									
Health Facility	1			1			1		
Home	0.88	0.185	0.72 – 1.06	0.86	0.260	0.68 – 1.10	0.98	0.904	0.71 – 1.33
Other	0.07	**0.000**	0.03 – 0.15	0.04	**0.000**	0.01 – 0.14	0.07	**0.000**	0.02 – 0.22
Wealth Index									
Poorest	1						1		
Poorer	1.05	0.756	0.73 – 1.51				1.10	0.612	0.74 – 1.65
Poor	1.35	0.079	0.96 – 1.90				1.29	0.185	0.88 – 1.89
Less Poor	0.91	0.655	0.63 – 1.33				0.90	0.649	0.59 – 1.38
Least Poor	0.83	0.370	0.57 – 1.23				0.85	0.527	0.52 – 1.38

The table 3.7 presents the estimated hazard ratio of the association between socioeconomic status and childhood mortality (1 to 5 years). The main predictor for childhood mortality during the study period was migration status [crude H.R =1.28, P=0.023, 95% C.I (1.03 – 1.60)]. Also associations were found between childhood mortality and education of the mother [crude H.R =0.63, P=0.022, 95% C.I (0.43 – 0.93)], birth order of the child [crude H.R =0.66, P=0.015, 95% C.I (0.48 – 0.92)], and wealth index [crude H.R =0.54, P=0.001, 95% C.I (0.38 – 0.77)].

In contrast to the effect on infant mortality, the wealth index was associated with childhood mortality. Children in the least poor households had a 46% reduced risk of dying as compared to children in poorest household [crude H.R =0.54, P=0.001, 95% C.I (0.38 - 0.77)]. Children in a less poor household had a 30% reduced risk of dying as compared to children in poorest household [crude H.R =0.70, P=0.031, 95% C.I (0.51 - 0.96)].

Children who in-migrated are 1.2 times more likely to die compared to children who are born in the Demographic Surveillance Site [crude H.R =1.28, P=0.023, 95% C.I (1.03 – 1.60)].

A fourth born had a 34% reduced risk of dying as compared to first born [crude H.R =0.66, P=0.015, 95% C.I (0.48 - 0.92)]

Adjusting for potential confounders such as maternal age, education of the mother, and birth order, only socioeconomic status of the child remained statistically significant in both Model I and Model II. The hazard ratio remained constant in the univariate and in the multivariate analysis

Children in the least poor households have 52% reduced risk of dying as compared to children in the poorest household [Adjusted H.R =0.48, P=0.003, 95% C.I (0.29 – 0.78)] based on the second model.

Table 3.7 Univariate and multivariate analysis for child mortality (Full Table in Appendix D pages 71-72)

Covariates	Univariate (Unadjusted)			Multivariate (Adjusted)					
				(Model I)			(Model II)		
	H.R	P_Value	95% C.I	H.R	P_Value	95% C.I	H.R	P_Value	95% C.I
Migration									
Non migrant	1			1			1		
Migrant	1.28	**0.023**	1.03 – 1.60	0.92	0.699	0.62 – 1.36	0.93	0.748	0.63 – 1.38
Birth order									
First	1			1			1		
Second	0.90	0.466	0.68 – 1.19	0.03	0.877	0.70 – 1.51	1.10	0.646	0.72 – 1.66
Third	0.78	0.108	0.57 – 1.05	0.90	0.619	0.60 – 1.34	0.91	0.697	0.57 – 1.44
Fourth	0.66	**0.015**	0.48 – 0.92	0.75	0.194	0.49 – 1.15	0.70	0.187	0.41 – 1.18
Fifth and +	0.80	0.116	0.62 – 1.05	0.80	0.251	0.56 – 1.16	0.72	0.227	0.42 – 1.22
Maternal Education									
None	1			1			1		
Primary	0.97	0.882	0.74 – 1.28	0.94	0.706	0.68 – 1.29	0.96	0.813	0.69 – 1.32
Secondary and +	0.63	**0.022**	0.43 – 0.93	0.77	0.280	0.49 – 1.22	0.77	0.273	0.48 – 1.22
Wealth Index									
Poorest	1			1			1		
Poorer	0.87	0.401	0.65 – 1.18	0.79	0.196	0.55 – 1.12	0.79	0.192	0.55 – 1.12
Poor	0.93	0.655	0.69 – 1.25	0.87	0.460	0.62 – 1.23	0.86	0.425	0.61 – 1.22
Less Poor	0.70	**0.031**	0.51 – 0.96	0.73	0.101	0.51 – 1.06	0.74	0.113	0.51 – 1.07
Least Poor	0.54	**0.001**	0.38 – 0.77	0.49	**0.002**	0.31 – 0.77	0.48	**0.003**	0.29 – 0.78

Cox proportional hazard regression analysis was run to investigate association between socio-demographic and economic factors and under five children in

Navrongo demographic Surveillance Site during the period 2001 to 2006.

The results are presented in table 3.8. Socioeconomic status [crude H.R =0.66, P=0.001, 95% C.I (0.50 – 0.84)], marital status [crude H.R =1.47, P=0.000, 95% C.I (1.22 – 1.78)], birth order [crude H.R =0.69, P=0.001, 95% C.I (0.56 – 0.85)], and sex of the child [crude H.R =1.15, P=0.037, 95% C.I (1.00 – 1.31)] were highly significant.

The univariate analysis shows that most of the predictors of infant and childhood mortality are also predictors for under five mortality in Navrongo.

Children in a household classified as least poor had a lower risk compared to children in a household classified as poorest. Children in a least poor category had a 35% reduced risk of dying as compared to children in the poorest category [crude H.R =0.65, P=0.001, 95% C.I (0.50 – 0.84)].

For maternal age, children born to a mother in age group 20 to 29 years old had a 23% reduced risk of dying as compared to children whose mothers were less than 20 years old [crude H.R =0.77, P=0.014, 95% C.I (0.63 – 0.94)]. Also children born to a mother in age group 30 to 39 years had a 30% reduced risk of dying as compared to children whose mothers were less than 20 years old [crude H.R =0.70, P=0.001, 95% C.I (0.56 – 0.87)]

The results showed that for under five mortality, a boy is 1.15 times more likely to die compared to a girl [crude H.R =1.15, P=0.037, 95% C.I (1.00 - 1.31)].

A second born had a 18% reduced risk of dying as compared to first born [crude H.R =0.82, P=0.048, 95% C.I (0.67 – 0.99)]. Also a third born had a 31% reduced risk of dying as compared to first born [crude H.R =0.69, P=0.001, 95% C.I (0.56 – 0.85)].

Adjusting for potential confounders (mother's education, maternal age, and sex of the child, and number of live births), only birth order [adjusted H.R =0.66, P=0.036, 95% C.I (0.45 – 0.97)], place of birth [adjusted H.R =0.20, P=0.000, 95% C.I (0.13 – 0.30)], live birth [adjusted H.R =1.85, P=0.004, 95% C.I (1.21 – 2.83)], and wealth index [adjusted H.R =0.60, P=0.002, 95% C.I (0.43 – 0.83)] were statistically significant in the Model I.

The adjusted hazard ratio for wealth index decreased slightly. The estimated hazard for wealth index in the univariate was 0.65 while in the multivariate modeling the estimated hazard ratio is 0.60 in the Model I, meaning that we estimate children in the least poor household to face 0.60 of the hazard of children in the poorest household.

All conditions remaining constant, a third born was estimated to face 0.63 of the hazard of a first born [adjusted H.R =0.63, P=0.008, 95% C.I (0.44 – 0.88)]. Also a fourth born was estimated to face 0.67 of the hazard of first born [adjusted H.R =0.67, P=0.036, 95% C.I (0.46 – 0.97)] based on the Model II.

Table 3.8 Univariate and multivariate analysis for under five mortality (Full Table in Appendices page 73-74)

Covariates	Univariate (Unadjusted)			Multivariate (Adjusted)					
				(Model I)			(Model II)		
	H.R	P_Value	95% C.I	H.R	P_Value	95% C.I	H.R	P_Value	95% C.I
Sex									
Female	1			1			1		
Male	1.15	**0.037**	1.00 – 1.31	1.15	0.104	0.97 – 1.37	1.15	0.104	0.97 – 1.37
Birth order									
First	1			1			1		
Second	0.82	**0.048**	0.67 – 0.99	0.94	0.717	0.71 – 1.26	0.94	0.712	0.70 – 1.26
Third	0.69	**0.001**	0.56 – 0.85	0.63	**0.008**	0.44 – 0.88	0.63	**0.008**	0.44 – 0.88
Fourth	0.71	**0.003**	0.57 – 0.89	0.67	**0.037**	0.46 – 0.97	0.67	**0.036**	0.46 – 0.97
Fifth and +	0.80	**0.019**	0.67 – 0.96	0.66	**0.037**	0.45 – 0.97	0.65	**0.033**	0.45 – 0.96
Maternal age									
Less 20 years	1			1			1		
20 – 29 years	0.77	**0.014**	0.63 – 0.94	0.91	0.569	0.65 – 1.25	0.91	0.599	0.66 – 1.26
30 – 39	0.70	**0.001**	0.56 – 0.87	1.07	0.714	0.71 – 1.61	1.09	0.665	0.72 – 1.64
More 40 years	0.86	0.278	0.66 – 1.12	1.14	0.578	0.70 – 1.85	1.16	0.642	0.71 – 1.88
Wealth Index									
Poorest	1			1			1		
Poorer	0.94	0.646	0.75 – 1.19	0.90	0.474	0.69 – 1.18	0.90	0.470	0.69 – 1.18
Poor	1.06	0.577	0.85 – 1.33	1.00	0.967	0.78 – 1.29	1.00	0.984	0.77 – 1.29
Less Poor	0.81	0.094	0.64 – 1.03	0.83	0.205	0.64 – 1.10	0.83	0.197	0.63 – 1.09
Least Poor	0.65	**0.001**	0.50 – 0.84	0.60	**0.002**	0.43 – 0.83	0.63	**0.008**	0.45 – 0.88

CHAPTER FOUR: DISCUSSION

The main objective of this study was to investigate the relative impact of socio-economic and demographic factors on childhood mortality in Navrongo. Specifically, this study purposed to describe under five mortality trends, and the socio-economic risk factors for childhood mortality. It also aimed to investigate the relationship between socio-economic and demographic factors and childhood mortality in Navrongo. The analysis was performed for infant mortality, childhood mortality, and under five mortality. The study illustrates that socio-economic inequality in under-five mortality is present at Navrongo DSS. The findings show unexpectedly low infant mortality rate 33.4 per 1,000 person years). Concentration indices computed indicated a concentration of mortality in the poorest households.

The findings could have been expected as evidence from previous studies suggested a relationship between socio-economic inequality and under-five mortality. The findings showed there is difference in terms of under five mortality between the first quintile and firth quintile while there is no significant difference between the first three quintiles. Our study provides further evidence for the important role of household socio-economic status in under-five mortality. Children in households classified as least poor have a lower risk compared to children in the poorest household.

The discussion will be around three points. In the first part we will discuss about under five mortality rate. The second point of discussion will be on measurement of health equity. Thirdly, we discuss about the factors associated with childhood mortality.

4.1. Mortality rate

Table 3.3 presents the differential in infant mortality by wealth index. The estimated mortality rates for each category of wealth index are for the 6 years period (2001-2006). The findings show a higher infant mortality in the third quintile (poor; 38.8 per 1,000 persons years observed) compared to the first and the last quintiles.

Children in the poorest households are about 10% more likely to die in infancy than those in the least poor or better off. If the socioeconomic status of the poorest households were improved to the level of the better off, then about 23 per 1,000 infants could be saved annually (rate difference).

The table 3.4 summarizes childhood mortality rates across wealth index. The poorest households have higher probabilities of dying. As with infant mortality, the pattern is not consistent between the second (Poorer) and third (Poor) quintiles. The reasons for this inconsistency are not known, however it may be due to differences in the heterogeneity of scores within quintiles. Children in the poorest households are about 90% more likely to die than those in the least poor or better off. If the socioeconomic status of the poorest households were improved to the level of the better off, then about 66 lives per 1,000 children could be saved annually (rate difference).

The table 3.5 shows how under five mortality is distributed across the different socio-economic groups. The data presented indicates that under five mortality is higher in the poorest, poorer, and Poor quintiles and lower for the Less Poor, and Least poor. The data reveals that children of the poorest households are 50% more likely to die before reaching their fifth birthday than those of the better off households. The gradient for under five mortality is not very consistent between the first (poorest), second (poorer) and third (Poor) quintiles. If the socio-economic status of the poorest households were

improved to the level of the better off, then about 70 lives per 1,000 children under five could be saved annually(Poorest/ Least Poor Rate Difference).

As expected the findings show inequality in under five mortality with level of socioeconomic status, except for the poorer appearing to have higher chances of dying compared to the poorest. The chances of child mortality are lower at higher levels of socioeconomic status than at lower levels of socioeconomic status.

The results show that under five mortality rate is lower compared to infant mortality rate. The improvement in health culminating in mortality decline was credited to either improvement in public health and medical knowledge brought about by the importation of medical technology from the west or improvement in social and economic conditions, or both[48].

In Ghana, the decline in child mortality can be attributed to strong campaigns for immunization, (which is free of charges) offered at the community level. In Navrongo, the staff of the campaign makes home visits to ensure all children have been immunized. Also a strong face-to-face communication program may have contributed to the improvement in child survival.

We observed a statistically significant trend across wealth index quintiles for childhood ($P = 0.004$) and under five mortality ($P < 0.001$). For infant mortality we did not observe a statistical association with household socioeconomic status. Also the magnitude of the problem of infant mortality is underestimated when mortality rates are based only on number of deaths reported in death certificate[11,26].

4.2. Measurement of health equity

The study aims to measure socioeconomic inequalities in under five mortality. The concentration indices computed for infant (C = -0.02), childhood (C = -0.09), and under five (C = -0.04) mortality show inequalities between levels of socioeconomic status.

The concentration index showed the degree of inequality across the socioeconomic quintiles. The concentration index is defined as twice the area between the concentration curve (Figure 3.4) and the line of equality (the 45^0 running from the bottom left corner to the top right). So, in the case where there is no health related inequality, the concentration index is zero. The convention is that the index takes a negative value when the curve lies above the line of equality, indicating disproportionate concentration of the health variable (in this case mortality) among the poor. If the health variable is a 'bad'one, (such as mortality), a negative value of the concentration index means that under five mortality is higher among the poor. Using the concentration index, a similar result for under five children in a study demonstrated that a gap exists in health status between the poorest and the richest[49]. Previous studies had found this inequality in under five mortality between wealth index quintiles. Inequalities in under five mortality was found across nine developing countries, with inequalities highest in Brazil, high in Nicaragua and the Philippines, intermediate in Cote d'Ivoire, Nepal, and South Africa, and lowest in Ghana, Pakistan and Vietnam[38].

Woelk and Chikuse[50] showed that in Zimbabwe stunting, underweight, and occurrence of diarrhoea varied according to socioeconomic status, noting that being in the lowest socioeconomic group increased the risk of being underweight for children by about three times compared to those in the highest socioeconomic group.

The inequalities are confirmed by the poorest / least poor ratio (PPR). The key advantages of the poorest / least poor ratio (PPR) used here is that it is readily comprehensible by policy-makers. Maybe the inequalities between rich and poor are due to financial issues that can be a limitation for accessibility to health care for poor groups of population.

4.3 Predictors of under five mortality

The study aims to investigate the relationship between socio-demographic and economic factors and under five mortality in Navrongo during the period 2001 – 2006.

The discussion on the predictors for under five mortality will focus on seven variables that are strongly associated with under five mortality.

4.3.1 Socioeconomic status

The output of the principal component shows that variance in the first component is explained by household using electricity (17.7%), and household possessing refrigerator (9.5%) which contributed to the wealth heterogeneity. Also 2nd and 3rd components were tested but there was no significant difference.

The findings of the study show that children in the least poor category had a 35% reduced risk of dying as compared to children in the poorest category. After controlling for potential confounders such as mother's education, mother's age, and sex of the child in the multivariate model, the effect of household socioeconomic status remains constant. The finding confirms the hypothesis that there is difference in under five mortality between levels of socio-economic status. Several studies in sub-Saharan Africa had shown strong relationship between socioeconomic status and under five mortality[11,51] .

Similar findings had been pointed out in India, children born to the poorest mothers die at a rate that is 56 percent higher than babies born to the richest mothers; and in Bolivia, the newborn mortality rate is 70 percent higher among the poor[26].

The household socioeconomic factors mainly influence its members' health through the income and wealth effects. Child mortality is especially sensitive to fluctuations in the standard of living. Several studies have pointed out a highly significant statistical association between the likelihood of dying before age five and certain economic indicators.

4.3.2 Maternal education

The results show that education of the mother is associated with under five mortality in Navrongo during 2001 to 2006. Children with mothers attaining secondary or tertiary level of education had 8% reduced risk of dying as compared to children whose mothers had no formal education. Numerous socio-economic determinants have been studied in the context of child mortality in sub-Saharan Africa. In many of the studies, the education of the mother is found to be the most significant determinant of child survival, even when other variables associated with education are controlled. Even though it is generally accepted that education is an important factor, the pathway by which education operates on mortality is much less certain. Caldwell 1993 suggests that increased maternal education works by increasing a woman's autonomy. An educated woman is more likely to take her children or herself to a health clinic when ill, may feel more comfortable dealing with health professionals, and is more likely to identify and use modern medical knowledge.

4.3.3 Maternal age

Mother's age at the time of the child's birth can affect child survival. Infants born to mothers under 20 and over 30 are at higher risk of death, because women under 20 years are less likely to have fully developed reproductive systems, while the reproductive systems of women over 30 may be deteriorated[52]. The findings of the study are in line with current literature. Children born to a mother in age group 20 to 29 years old had a 23% reduced risk of dying as compared to children whose mothers were less than 20 years old. The relationship between mother's age and child mortality may also be due to other factors. For example, children to older women are more likely to be competing with other siblings for resources while children of very young mothers may suffer through the lack of maturity of the mother. However, childhood mortality seems to be higher among the children of the mothers under 20, than among the children of mothers over 30.

4.3.4 Place of residence

As expected the survival chances of children living in rural areas is less than their counterparts in urban areas. Children living in the rural area are 1.34 times more likely to die compared to children living in the urban area. Hill et al (2001) in a study conducted in Kenya had reported an inverse relationship between place of residence of the child and mortality. Urban areas showed higher mortality risks than rural, but when adjusted for HIV prevalence, child mortality was lower in urban.

4.3.5 Live birth and birth order

The number of live births and the birth order were major predictors of under five mortality in Navrongo study area during our study period. The findings show that twins or triplets are 2.29 times more likely to die compared to single births. Also the second up to third born children are more protected compared to first births. Similar findings have been observed in Burkina[53] and Bangladesh[52].

4.3.6 Sex of the child

The results for under five show that a male is 1.14 times more likely to die compared to female children. Contrary to our findings, many studies have shown that females have higher mortality rates than males, even though males have a higher natural risk of death. The reason for higher female mortality might be that the male children are highly valued because of their potential to help ameliorating the family's economic situation and because of cultural and traditional causes. As parents are forced to selectively distribute resources such as food, clothing and medical care to their offspring, they might prioritize their male children[52].

4.4 Implication of the study

This study has important policy implications. The findings of the investigation call for more attention to strategies or approaches for reducing health inequalities particularly for the poor. In doing so, health ministry's might work more closely with other ministries, but should also take a wider view, e.g. exploring alternative delivery methods to reach the poor and finding improved ways of increasing the knowledge of the poor about healthy behaviors[38].

These could include reforms in the health sector to provide more equitable allocation of resources, improvement in the quality of health services offered to poor and redesigning interventions and their delivery to ensure that they are more pro-poor. Such a proactive measure will be important if health-equity goals at the community level are to be achieved[54].

Since progress towards the MDG may be achieved at the expense of health equality across society, we believe that monitoring under five mortality among different socioeconomic groups is of the utmost importance[55]. Specifically, the MDG relating to child mortality should be reformulated to incorporate an equity dimension, and this would provide an impetus to adopt policies that addressed health inequalities.

4.5 Limitations of study

The first potential limitation of the study is the difficulty in establishing temporality of events. The study could not establish whether the deaths occurred before or after the household assets were acquired. There is also a possibility of an endogenous relationship between under-five mortality and socio-economic inequality. There could be factors such as education that influence both risk of child mortality and the risk of asset ownership. Some households are advantaged by education, drive and existing human capital. This creates a positive selection (i.e. talent, drive and nutrition) that is good for asset accumulation and also good for offsetting child mortality.

A second limitation is while asset-based measures are increasingly being used, there continues to be some debate about their use. Importantly, a key argument revolves around their interpretation. These measures are more reflective of longer-run household wealth or living standards, failing to take account of short-run or temporary interruptions, or shocks to the household.

Therefore, if the outcome of interest is associated with current resources available to the household, then an index based on assets may not be the appropriate measure.

Also the study does not adjust for the weight of child at birth due to NDSS having no data on birth weight. In previous research it has been suggested that children with low birth weight had increased risk of dying and low birth weight is also associated with children in the poorest quintile[27].There are other variables (e.g. family size, mothers haemoglobin, survival of the mother, birth interval, and nutritional status) which were not also available for this analysis.

Finally there is a possible omission of deaths in infant leading to an underestimated infant mortality during the period 2001-2006.

CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS

This study has examined the risk factors for under five mortality with the main aim of determining the relationship between socioeconomic status and childhood mortality. The study also leads to the conclusion that household socio-economic wealth inequality is strongly associated with under-five mortality. Low socioeconomic status is associated with an increased risk of dying. Maternal age was also found to be significantly associated with under-five mortality. The findings show socioeconomic inequalities in infant, childhood and under five mortality.

Reducing poverty and making essential health services more available to the poor are critical to improving overall childhood mortality in Kassena Nankana District in rural Ghana. Measures to address or reduce health inequalities are needed in order to improve child survival in settings like Navrongo.

The findings further call for more pragmatic strategies or approaches for reducing health inequalities. These could include reforms in the health sector to provide more equitable resource allocation, Improvement in the quality of the health services offered to the poor and redesigning interventions and their delivery to ensure they are more inclined to the poor. Such measures are crucial if health equity goals at the community level are to be achieved.

Macroeconomic and microeconomic policies that succeed in raising average income without having adverse effects on its distribution are thus likely to have payoffs in terms of improved child survival. The same is true of policies aimed at improving the living standards of the poor. Social protection programs can act as antipoverty programs as shown by most of developed countries.

Making health services and other health determinants less expensive in a way improves health utilization and outcomes among the poor. The cost of health care can be lowered through variety of means including health insurance, health card fee waivers, and vouchers.

Health services accessibility to the poor should be adequately improved. One way is to reduce the travel time to existing health facility. Geographic resource allocation formulas have the potential to increase the resource endowments of facilities serving the poor. These have provided means of reducing inequalities in resources between poor and better off in regions in industrialized countries.

The survival advantage of under-five year old children associated with maternal education calls for expansion in female education within the KND. This however is a long term strategy which will benefit future mothers. Health education and health outreach activities should be stepped up within the KND in the immediate run. Although women should be the main targets of such programmes, it should be extended to include fathers as well and the KND at large. Although mothers are responsible for childcare, their relationship with the significant others define the limits of possibilities of healthy behaviour. Thus health activities that do not involve these significant others may not achieve the desired results. Health programs that strengthen the capacity of mothers by providing them and their families with information, skills, resources and technologies to promote child health will need to be implemented.

The findings suggest that reductions in infant, childhood, and under five mortalities are mainly conditional in health and education interventions as well as socioeconomic position of households.

To reduce infant, childhood, and under five mortalities, effort should be exerted to increase the spread of immunization coverage and concomitant control of the spread of infectious disease such as diarrhea, pneumonia, measles, malaria, and HIV/AIDS.

Educational opportunities for women should also be expanded to help reduce infant and child deaths. Furthermore, mother's access to trained birth attendants should be improved in order to save the lives of children and mothers.

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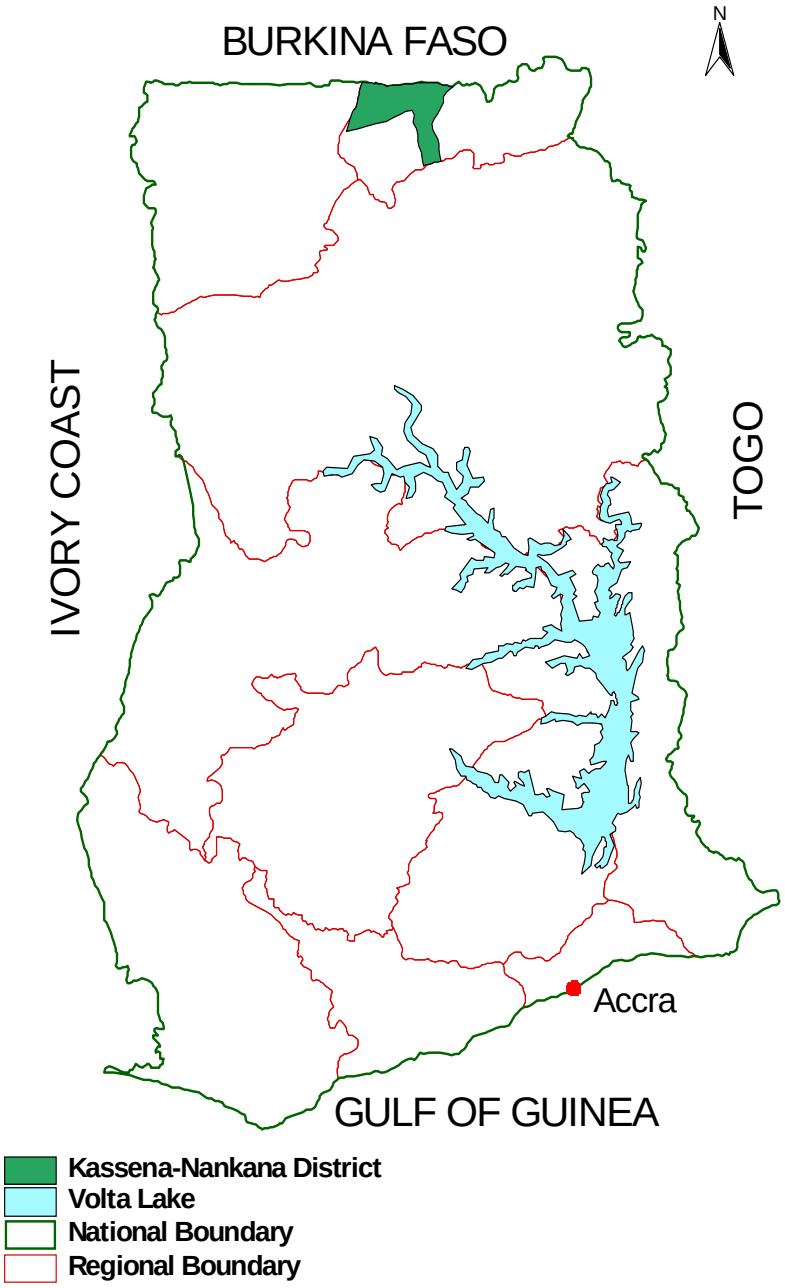
Appendix A: Map of the Kassena Nankana District



Appendix B: Ethical approval from University of Witwatersrand

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Division of the Deputy Registrar (Research)

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
R14/49 Ndiath

CLEARANCE CERTIFICATE	**PROTOCOL NUMBER M080976**
PROJECT	Socio Economic Determinants of Childhood Mortality in Navrongo DSS Ghana
INVESTIGATORS	Mr MM Ndiath
DEPARTMENT	School of Public Health
DATE CONSIDERED	08.09.26
DECISION OF THE COMMITTEE*	

Unless otherwise specified this ethical clearance is valid for 5 years and may be renewed upon application.

DATE **CHAIRPERSON** .....
(Professor P E Cleaton Jones)

*Guidelines for written 'informed consent' attached where applicable

cc: Supervisor : Dr R Kellerman

DECLARATION OF INVESTIGATOR(S)

To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10004, 10th Floor, Senate House, University.
I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee. **I agree to a completion of a yearly progress report.**

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

Appendix C: Ethical approval from Institute Review Board of Navrongo Health Research Centre IRB/NHRC

In case of reply the number and date of this letter should be quoted.

My Ref. : app078
Your Ref:



Navrongo Health Research Centre
Institutional Review Board
Ghana Health Service
P. O. Box 114
Navrongo, Ghana
Tel: +233-742-22310/80
Fax + 233-742-22320
Email: irb@navrongo.mimcom.net

10th February 2009

Mr. Mansour Ndiath
University of Witwatersrand
School of Public Health
7 York Road
Parktown 2193
South Africa

ETHICS APPROVAL ID: NHRCIRB078

Dear Mr. Ndiath,

Approval of a protocol titled "Socio-economic determinants of childhood mortality in Navrongo DSS"

I write to inform you that the NHRCIRB reviewed and approved the above-mentioned protocol.

Please note that any amendment to this approved protocol must receive ethical clearance from the NHRCIRB before its implementation.

You are also by this approval required to submit a final report of your study to the Board for review.

The Board wishes you all the best in this study.

Sincerely,

Dr. John Awoonor-Williams
Chair, NHRCIRB

Cc: Director, NHRC

Appendix D: Tables of Univariate and Multivariate Cox proportional hazard regression

Table 3.6 Univariate and multivariate analysis for infant mortality - ($_1q_0$)

Covariates	Univariate			Multivariate					
				(Model I)			(Model II)		
	H.R	P_Value	95% C.I	H.R	P_Value	95% C.I	H.R	P_Value	95% C.I
Live birth									
Single	1			1			1		
Multiple	2.83	**0.000**	1.96 – 4.07	2.57	**0.000**	1.70 – 3.90	2.78	**0.000**	1.68 – 4.60
Birthorder									
First	1			1			1		
Second	0.75	**0.041**	0.57 – 0.98	0.81	0.252	0.56 – 1.15	0.81	0.331	0.54 – 1.22
Third	0.61	**0.002**	0.45 – 0.83	0.59	**0.016**	0.38 – 0.90	0.38	**0.000**	0.22 – 0.65
Fourth	0.76	0.067	0.56 – 1.01	0.93	0.756	0.60 – 1.43	0.66	0.134	0.39 – 1.13
Fifth and +	0.80	0.081	0.62 – 1.02	0.84	0.465	0.52 – 1.33	0.62	0.100	0.35 – 1.09
Place of birth									
Health Facility	1			1			1		
Home	0.88	0.185	0.72 – 1.06	0.86	0.260	0.68 – 1.10	0.98	0.904	0.71 – 1.33
Other	0.70	**0.000**	0.31 – 0.15	0.04	**0.000**	0.01 – 0.14	0.07	**0.000**	0.02 – 0.22
Wealth Index									
Poorest	1						1		
Poorer	1.05	0.756	0.73 – 1.51				1.10	0.612	0.74 – 1.65
Poor	1.35	0.079	0.96 – 1.90				1.29	0.185	0.88 – 1.89
Less Poor	0.91	0.655	0.63 – 1.33				0.90	0.649	0.59 – 1.38
Least Poor	0.83	0.370	0.57 – 1.23				0.85	0.527	0.52 – 1.38

Sex									
Female	1						1		
Male	1.18	0.073	0.98 – 1.42				1.10	0.424	0.85 – 1.43
Marital Status									
Married	1						1		
Not married	1.69	**0.000**	1.32 – 2.17	1.34	0.094	0.95 – 1.89	1.22	0.364	0.78 – 1.90
Maternal Educ									
None	1						1		
Primary	1.06	0.634	0.81 – 1.40				1.23	0.216	0.88 – 1.70
Secondary +	1.19	0.238	0.88 – 1.61				1.27	0.243	0.84 – 1.91
Ethnicity									
Builsa	1			1			1		
Kassim	2.25	0.108	0.83 – 6.05	2.29	0.155	0.73 – 7.18	1.52	0.476	0.48 – 4.81
Nankam	2.69	**0.049**	1.00 – 7.25	2.65	0.094	0.84 – 8.32	1.85	0.292	0.58 – 5.83
Other	2.45	0.152	0.71 – 8.38	2.04	0.331	0.48 – 8.62	2.85	0.187	0.60 – 13.53
Migration									
Non migrant	1						1		
Migrant	0.77	0.357	0.45 – 1.32				1.73	0.227	0.70 – 4.26
Residence									
Urban	1						1		
Rural	1.31	0.181	0.87 – 1.96				1.68	0.166	0.80 – 3.54
Maternal Age									
Less 20 years	1			1			1		
20 – 29 years	0.79	0.109	0.59 – 1.05	0.90	0.622	0.61 – 1.33	0.99	0.998	0.63 – 1.57
30 – 39 years	0.63	**0.004**	0.47 – 0.86	0.83	0.461	0.51 – 1.35	1.03	0.919	0.57 – 1.86
More 40 years	1.00	0.982	0.71 – 1.41	1.35	0.289	0.77 – 2.37	1.38	0.353	0.69 – 2.77

Table 3.7 Univariate and multivariate analysis for child mortality - ($_4q_1$)

Covariates	Univariate			Multivariate					
				(Model I)			(Model II)		
	H.R	P_Value	95% C.I	H.R	P_Value	95% C.I	H.R	P_Value	95% C.I
Migration									
Non migrant	1			1			1		
Migrant	1.28	**0.023**	1.03 – 1.60	0.92	0.699	0.62 – 1.36	0.93	0.748	0.63 – 1.38
Birth order									
First	1			1			1		
Second	0.90	0.466	0.68 – 1.19	0.03	0.877	0.70 – 1.51	1.10	0.646	0.72 – 1.66
Third	0.78	0.108	0.57 – 1.05	0.90	0.619	0.60 – 1.34	0.91	0.697	0.57 – 1.44
Fourth	0.66	**0.015**	0.48 – 0.92	0.75	0.194	0.49 – 1.15	0.70	0.187	0.41 – 1.18
Fifth and +	0.80	0.116	0.62 – 1.05	0.80	0.251	0.56 – 1.16	0.72	0.227	0.42 – 1.22
Maternal Educ									
None	1			1			1		
Primary	0.97	0.882	0.74 – 1.28	0.94	0.706	0.68 – 1.29	0.96	0.813	0.69 – 1.32
Secondary +	0.63	**0.022**	0.43 – 0.93	0.77	0.280	0.49 – 1.22	0.77	0.273	0.48 – 1.22
Wealth Index									
Poorest	1			1			1		
Poorer	0.87	0.401	0.65 – 1.18	0.79	0.196	0.55 – 1.12	0.79	0.192	0.55 – 1.12
Poor	0.93	0.655	0.69 – 1.25	0.87	0.460	0.62 – 1.23	0.86	0.425	0.61 – 1.22
Less Poor	0.70	**0.031**	0.51 – 0.96	0.73	0.101	0.51 – 1.06	0.74	0.113	0.51 – 1.07
Least Poor	0.54	**0.001**	0.38 – 0.77	0.49	**0.002**	0.31 – 0.77	0.48	**0.003**	0.29 – 0.78

Sex									
Female	1						1		
Male	1.11	0.249	0.92 – 1.35				1.19	0.138	0.94 – 1.52
Marital Status									
Married	1						1		
Not married	1.25	0.124	0.94 – 1.67				1.45	0.111	0.91 – 2.29
Place of birth									
Health facility	1			1			1		
Home	1.14	0.276	0.89 – 1.44	1.09	0.558	0.80 – 1.50	1.07	0.672	0.77 – 1.48
Other	0.22	**0.000**	0.15 – 0.34	0.26	**0.000**	0.16 – 0.42	0.26	**0.000**	0.16 – 0.41
Ethnicity									
Builsa	1						1		
Kassim	1.33	0.480	0.59 – 3.01				1.79	0.319	0.56 – 5.66
Nankam	1.62	0.238	0.72 – 3.66				2.27	0.160	0.72 – 7.13
Other	0.44	0.316	0.08 – 2.18				1.82	0.524	0.28 – 11.54
Live birth									
Single	1						1		
Multiple	1.47	0.229	0.78 – 2.75				0.97	0.944	0.42 – 2.19
Residence									
Urban	1						1		
Rural	1.34	0.168	0.88 – 2.04				0.85	0.658	0.42 – 1.71
Maternal Age									
Less 20 years	1						1		
20 – 29 years	0.75	0.059	0.56 – 1.01				0.83	0.435	0.52 – 1.32
30 – 39 years	0.77	0.092	0.56 – 1.04				1.10	0.721	0.63 – 1.94
More 40 years	0.71	0.097	0.48 – 1.06				0.96	0.914	0.49 – 1.89

Table 3.8 Univariate and multivariate analysis for under five mortality - ($_5q_0$)

Covariates	Univariate			Multivariate					
				(Model I)			(Model II)		
	H.R	P_Value	95% C.I	H.R	P_Value	95% C.I	H.R	P_Value	95% C.I
Sex									
Female	1			1			1		
Male	1.15	**0.037**	1.00 – 1.31	1.15	0.104	0.97 – 1.37	1.15	0.104	0.97 – 1.47
Birth order									
First	1			1			1		
Second	0.82	**0.048**	0.67 – 0.99	0.94	0.717	0.71 – 1.26	0.94	0.712	0.70 – 1.26
Third	0.69	**0.001**	0.56 – 0.85	0.63	**0.008**	0.44 – 0.88	0.63	**0.008**	0.44 – 0.88
Fourth	0.71	**0.003**	0.57 – 0.89	0.67	**0.037**	0.46 – 0.97	0.67	**0.036**	0.46 – 0.97
Fifth and +	0.80	**0.019**	0.67 – 0.96	0.66	**0.037**	0.45 – 0.97	0.65	**0.033**	0.45 – 0.96
Maternal age									
Less 20 years	1			1			1		
20 – 29 years	0.77	**0.014**	0.63 – 0.94	0.91	0.569	0.65 – 1.25	0.91	0.599	0.66 – 1.26
30 – 39 years	0.70	**0.001**	0.56 – 0.87	1.07	0.714	0.71 – 1.61	1.09	0.665	0.72 – 1.64
More 40 years	0.86	0.278	0.66 – 1.12	1.14	0.578	0.70 – 1.85	1.16	0.642	0.71 – 1.88
Wealth Index									
Poorest	1			1			1		
Poorer	0.94	0.646	0.75 – 1.19	0.90	0.474	0.69 – 1.18	0.90	0.470	0.69 – 1.18
Poor	1.06	0.577	0.85 – 1.33	1.00	0.967	0.78 – 1.29	1.00	0.984	0.77 – 1.29
Less Poor	0.81	0.094	0.64 – 1.03	0.83	0.205	0.64 – 1.10	0.83	0.197	0.63 – 1.09
Least Poor	0.65	**0.001**	0.50 – 0.84	0.60	**0.002**	0.43 – 0.83	0.63	**0.008**	0.45 – 0.88

Live birth									
Single	1			1			1		
Multiple	2.30	**0.000**	1.68 – 3.15	1.85	**0.004**	1.21 – 2.83	1.86	**0.004**	1.21 – 2.84
Marital Status									
Married	1						1		
Not married	1.47	**0.000**	1.22 – 1.78	1.34	0.064	0.98 – 1.85	1.35	0.059	0.98 – 1.86
Maternal Educ									
None	1						1		
Primary	1.02	0.834	0.84 – 1.23				1.08	0.502	0.86 – 1.35
Secondary +	0.91	0.453	0.72 – 1.15				1.01	0.945	0.74 – 1.37
Ethnicity									
Builsa	1			1			1		
Kassim	1.70	0.095	0.91 – 3.19	1.07	0.520	0.85 – 1.35	1.64	0.233	0.72 – 3.70
Nankam	2.05	**0.024**	1.09 – 3.85	0.99	0.976	0.73 – 1.34	2.05	0.081	0.91 – 4.62
Other	1.22	0.656	0.49 – 3.01	1.25	0.248	0.85 – 1.83	2.45	0.134	0.75 – 7.94
Migration									
Non migrant	1						1		
Migrant	1.18	0.099	0.96 – 1.44				0.99	0.975	0.69 – 1.42
Residence									
Urban	1						1		
Rural	1.33	0.054	0.99 – 1.78				1.21	0.451	0.73 – 2.02
Place of birth									
Health facility	1			1			1		
Home	0.97	0.773	0.84 – 1.13	1.03	0.789	0.82 – 1.28	1.02	0.861	0.81 – 1.27
Other	0.15	**0.000**	0.11 – 0.22	0.20	**0.000**	0.13 – 0.30	0.20	**0.000**	0.13 – 0.30